Geopolitics and Renewable Energy:
A Study on the Implications of the Energy Transition

Bachelor Thesis in Political Science

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Preface and Acknowledgements

This bachelor's thesis marks the end of our political science studies at the University of Stavanger. Our chosen theme was inspired by our growing interest in international politics and energy policy, fostered by the courses we took at UiS. We found ourselves interested by the intersection of geopolitics and energy transitions.
The recent outbreak of war in Ukraine has heightened the importance of this subject, as concerns about energy security in the European Union and beyond have become increasingly prominent. Our collaborative thesis-writing journey has been marked by numerous discussions, occasional frustrations, and long hours spent in the library. We have challenged each other, and we hope our thesis reflects that effort.

We would like to express our gratitude to our thesis advisor, Professor Oluf Langhelle, for his invaluable guidance and support throughout the semester. His expertise and insightful feedback have been instrumental in shaping this thesis. Additionally, we are grateful to Tom Yngve Hanssen who has generously proofread the thesis and assisted us in refining our work.

Our aim with this thesis is to make it accessible and engaging for all readers. We hope that it proves to be informative not only for us, but for a wider audience as well.

Maren Emilie Haakensen & Thomas Kleppa Hanssen, May 11th, 2023

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Abstract

This thesis investigates the potential geopolitical implications of the transition to renewable energy for the USA, EU, Russia, and China, addressing the question: "*To what extent can the transition to renewable energy be described as a 'game changer' in geopolitics*?".

Utilizing a document analysis approach, the study reviews relevant theoretical frameworks and literature on the geopolitics of renewable energy, examining themes of winners-losers, direct-indirect influences, and conflict-peace. In addition, the thesis offers an analysis of Scholten et al. (2020) work on the six clusters of implications related to the geopolitics of renewables.

The conclusion reveals that in the long-term, the transition to renewable energy may be considered a "game-changer" in geopolitics, particularly in energy geopolitics. The USA and the EU are likely to emerge as winners, while Russia may become a loser due to its heavy reliance on fossil fuel exports. China, with its commitment to renewables and clean technology manufacturing, may also emerge as a winner. The transition is poised to reshape global power structures, creating new sources of conflict and challenges. However, the continued dependence on fossil fuels in the short to medium term tempers the immediate impact of renewable energy on global geopolitical dynamics.

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1. Introduction

The politics of energy has long shaped the global geopolitics in determining great powers, alliances between countries and the outcome of wars. Coal was the backdrop of the British Empire in the 19th century, oil has been at the core of the "American Century" where the United States has been the leading superpower, and there are expectations that China may become the world's renewable energy superpower in the 21st century (Hafner & Tagliapietra, 2020, p. xv).

Energy politics has generally been associated with fossil fuels, especially oil and natural gas (Scholten, 2018, p. 1). But the transition to renewable energy has sparked a new era in the field of geopolitics and energy politics (Scholten, 2018, p. 6), with countries reassessing their positions and seeking opportunities to maintain or enhance their influence in the emerging energy order as the power balance in energy politics is expected to shift (Paltsev, 2016, p. 390). This shift in power balance has the potential to disrupt the geopolitical status quo, as countries with abundant renewable energy resources could emerge as new power players in the global energy landscape. While at the same time, traditional energy powers may face significant challenges in adapting to the changing dynamics (Vakulchuk et al, 2020, p. 5). In this context, understanding the interplay between renewable energy and geopolitics is crucial for comprehending the broader implications of the ongoing energy transition.

The primary aim of this thesis is to explore the geopolitical implications of the transition to renewable energy and to what extent it can be regarded as a "game-changer", focusing on four key geopolitical actors: The United States of America (USA), The European Union (EU), Russia, and China. By examining each region, this thesis seeks to provide a comprehensive understanding of the interplay between renewable energy and geopolitics, particularly in terms of emerging winners and losers, as well as the potential for conflict and peace. In doing so, it will draw on a range of academic literature and expert opinions to offer a nuanced and multilayered perspective on this critical issue. As the global energy landscape shifts, the renewable energy transition is anticipated to bring about a geopolitical and strategic reshuffle, with some countries experiencing economic and political gains while others face challenges to their geopolitical power. Additionally, this transition raises questions about its impact on global security and the potential for new conflicts or opportunities for peace within the international arena.

1.1. Theme and Relevance

The relevance of this theme is rooted in the growing urgency to address climate change and the global transition to a more sustainable energy system, as renewable energy sources is expected to be a cornerstone of this system (Scholten & Bosman, 2016, p. 273). Renewable energy is becoming increasingly important in the global energy system, as its increased use slowly but surely erodes the dominance of fossil fuels (Scholten, 2018, p. 3), and may be leading to shifts in power dynamics and geopolitical relations among states (Paltsev, 2016, p. 390). The rapid growth is giving a motivating force to a new phase in geopolitical thinking, and especially the claim of consequences of the energy shift is the increasing competition over critical materials (Overland, 2019, p. 36). The energy transition is also about technology and innovation, which makes the prediction of which renewable energy technologies will be developed impossible (Overland, 2019, p. 37).

Geopolitics refers to the way geographical factors shape politics, particularly in the context of international relations, with politicians often considering geographic considerations in their actions (Scholten, 2018, p. 8). The rise of renewable energy and the global shift towards renewables have the potential to challenge the conventional understanding of geopolitics as they transform the dynamics surrounding natural resources, especially fossil fuels. This transition could lead to a redefinition of power structures and dependencies based on new forms of energy and resources, ultimately reshaping the geopolitical landscape. This is due to how energy geopolitics is generally associated with fossil fuels as they have dominated the global energy mix. Coal, oil, and gas accounts for more than 80% of global energy consumption (Scholten, 2018, p. 1). Consequently, understanding the geopolitical implications of renewable energy is crucial.

Furthermore, this thesis' relevance is underlined by the fact that renewable energy sources are perceived to have the potential to enhance energy security and international peace (Vakulchuk et al., 2020, p. 9), and reduce greenhouse gas emissions as countries transition from fossil fuels to renewable sources (IRENA, 2019, p. 9). However, the shift also brings challenges and uncertainties, like the consequences on fossil energy markets and countries producing fossil resources, and the consequences on the global economy (Hache, 2018, p. 134). These uncertainties could potentially influence the geopolitical positions and strategies of major actors in the global energy landscape.

In this context, the theme and relevance of this thesis lie in examining the political implications and power dynamics associated with the transition to renewable energy in the four key geopolitical regions. By focusing on USA, the EU, Russia, and China, this thesis aims to provide a comprehensive understanding of how renewable energy may become a "game-changer" in the geopolitical landscape and the strategic implications for these major actors.

1.2. Thesis Question

In the context of this thesis, the term "game changer" refers to a development or event that significantly alters the existing power dynamics, relationships, or rules that govern the interactions among states (Scholten, 2018, p. 1). Game-changers can disrupt the status quo, create new opportunities or challenges for actors, and lead to shifts in power balances and strategic alliances (Sweijs et al., 2014, p. 55). In the case of renewable energy, a game-changer could involve developments that reshape energy markets, influence energy security, or transform the global distribution of resources and power (Overland, 2019, p. 38).

The central question that this thesis seeks to address is: "*To* what *extent can the transition to renewable energy be described as a 'game changer' in geopolitics*?". This thesis question is both timely and pertinent, given the growing importance of renewable energy in the global energy mix and its potential implications for the future of international politics (Scholten et al., 2020, p. 2).

The concept of a game-changer is particularly relevant to the study of renewable energy geopolitics, as the transition to cleaner energy sources has the potential to fundamentally alter the traditional energy geopolitics centered around fossil fuels (Stegen, 2018, p. 92). By examining whether and to what extent the transition to renewable energy may become a game-changer in the context of geopolitics, this thesis aims to contribute to a better understanding of the complex and multifaceted relationship between renewable energy and international politics.

1.3. Scope and Delimitation

This thesis will primarily focus on the geopolitical implications of the transition to renewable energy, with specific attention given to the main geopolitical actors. By narrowing the scope to these four actors, the study aims to provide a comprehensive analysis of their roles,

challenges, and the potential consequences of the energy transition in the global geopolitical landscape. While this topic has been thoroughly examined since 2010, the discussion on the geopolitics of renewable energy can be traced back to the 1970s (Pintilie, 2021, p. 112).

However, it is important to acknowledge the limitations of this approach. Initially, by focusing on the four geopolitical actors, the research might not cover the complete spectrum of nations and regions participating in the renewable energy transformation. Other significant actors, such as India, Brazil, or countries in the Middle East, may also play crucial roles in shaping the geopolitics of renewable energy (Vakulchuk et al., 2020, p. 4). Nevertheless, the selected actors represent the most influential players in the current global energy landscape, and their actions are likely to have far-reaching implications for the renewable energy transition and its geopolitical consequences.

Secondly, the complexity and rapidly evolving nature of the renewable energy landscape and associated geopolitical dynamics may pose challenges in providing a complete and up-to-date analysis (Overland, 2019, p. 38). As new technologies, policies, and international agreements emerge, the geopolitics of renewable energy may continue to evolve in ways that are difficult to predict. Consequently, this thesis aims to provide a snapshot of the current situation, while recognizing that the analysis may need to be updated and revised in the future.

Finally, given the interdisciplinary nature of the topic, the study will draw upon literature from various fields, including energy policy, international relations, and political economy. While this approach enables a comprehensive analysis of the geopolitics of renewable energy, it may also introduce challenges in synthesizing and integrating the diverse perspectives and methodologies found in the literature.

1.4. Structure

The thesis will be organized into several chapters, each addressing different aspects of the topic. Following this introduction, the subsequent chapter will present our chosen research method, which details the research methodology employed in the thesis, focusing on the document analysis approach, data collection, and the assessment of reliability and validity. Then, a chapter based on our theory and literature review, where we will present the literature framework of our thesis, as well as Scholten et al.'s (2020) "six clusters of implications".

Furthermore, our chosen geopolitical actors. This chapter offers an in-depth study of the main geopolitical actors in the renewable energy transition, specifically USA, the EU, Russia, and China, and their roles and positions in the evolving energy landscape. Each chapter will explore the specific challenges and opportunities these actors face in transitioning to renewable energy, and how these factors may affect their geopolitical positions.

With the literature and theoretical framework presented, as well as an overview over our four chosen actors, the discussion can begin, which explores the findings from the previous chapters and discusses the geopolitical consequences of the transition to renewable energy and provides a summary of the main insights and arguments. And lastly, the conclusion, which offers concluding remarks, highlights the main contributions of the thesis, and suggests potential avenues for future research on the geopolitics of renewable energy.

2. Research Method

Our chosen method is a document analysis. The term "document" can cover a wide range of different kinds of sources, e.g. personal (diaries, letters and autobiographies), official (stately documents, public inquiries, by organizations), virtual (blogs, chatrooms, forums, social media) or the media and news (Bryman, 2016, p. 545). In our research, we have decided to focus on peer-reviewed research articles as our main source of documents. This is because these types of sources will provide us what we need to further research our thesis and provide us with the knowledge that our collected data is credible. It will also help us get an overview of the different perspectives to the discussion so we can create a "pro-con comparison" to the question of renewables being a game-changer in geopolitics.

In addition, books available through the library were also examined to gather information related to the research topic. This chapter provides a detailed overview of the data collection process, including the search for methods used, the selection criteria for including sources, and the steps taken to ensure the quality and reliability of the data gathered.

2.1. Data Collection

The process of collecting data consisted of a thorough search of academic literature and books available through the library, Google Scholar and Oria. The websites were used to search for relevant articles, and each source was carefully evaluated to ensure that it met the criteria of being peer-reviewed. When using Google Scholar and Oria, we chose to include the terms "renewable energy" and "geopolitics" in most of our searches, as well as some of the four chosen actors, whenever we searched for articles as these were important and based on our main topic. On the assumption that research articles without any of these terms would be irrelevant, we were able to source the most relevant material for our paper.

In the Oria search engine, the search terms "renewable energy" and "geopolitics" were used separately, with the option to only retrieve peer-reviewed texts selected (as you can do on Oria). The search for "renewable energy" produced a total of 283 427 search hits, while the search for "geopolitics" generated 29 964 hits. To narrow down the search results, both search terms were combined and the option to only retrieve peer-reviewed was again selected. This resulted in a total of only 411 search hits. Compared to Google Scholar, which gave 515 000 results for "geopolitics", 2 580 000 results for "renewable energy", and the two terms

combined gave 59 100 results. Oria gives you the option to filter results as peer-reviewed, which is why we mostly used Oria.

With the result of 411, we had to choose which articles would be most relevant. While also using the terms previously mentioned, we became familiar with the names of researchers relevant to our topic. Through our research, Daniel Scholten, Roman Vakulchuk, Indra Overland, and Rick Bosman were re-occurring names which made the sources more trustworthy. Additionally, other research articles referencing these four experts frequently and using their definitions were viewed as relevant.

2.2. Reliability and Validity

Reliability and validity are crucial aspects of any research study to ensure the trustworthiness and generalizability of the findings. Reliability refers to the consistency and stability of the research findings, while validity is concerned with the accuracy and truthfulness of the findings (Bryman, 2016, p. 41).

In the context of document analysis, reliability can be established through the careful selection and evaluation of the sources used in the study. We made sure to use research articles that were reviewed by other experts in the field, which helped us trust the information we gathered. This way, we know that the data we used were reliable. Additionally, using multiple sources to gather information helped increase the reliability of the study by providing a more comprehensive understanding of the research topic (Bryman, 2016, p. 278). We also chose to rely on newer publications to provide the most up-to-date and relevant information for our study.

Validity, in the case of document analysis, can be achieved by ensuring that the selected sources are relevant and appropriate for the research question and that the interpretation of the data is accurate and unbiased. By using search terms closely related to our research question and carefully evaluating each source to ensure its relevance, we have taken steps to enhance the validity of our study. Moreover, we have attempted to minimize potential biases in the interpretation of the data by considering various perspectives and engaging in a critical analysis of the sources.

2.3. Discussion of our Research Method

The main limitation to our approach is our incapability to access and review all available literature related to the subject due to time and resource constraints. As a result, our study will not capture all perspectives and debates in the field. Moreover, the document analysis approach relies heavily on the quality and relevance of the sources selected, which means that any gaps or biases in the available literature might impact the findings of our study.

Another limitation is the potential for researcher bias in the selection and interpretation of the sources. While we have tried to minimize this by using systematic search strategies and by critically analyzing the sources, it is essential to acknowledge that our interpretations and understanding of the literature might be influenced by our own perspectives and preconceptions.

Lastly, the renewable energy sector and geopolitical landscape are evolving rapidly, which could affect how well our research findings apply to current circumstances. As new technologies and policies emerge, the geopolitical implications of renewable energy might change, and our study might not completely capture these ongoing changes.

3. Theory and Literature Review

3.1. Geopolitics and Renewable Energy

In this chapter, we define and explore the interplay between two key concepts: geopolitics and renewable energy. We aim to provide a clear understanding of these concepts and contextualize our investigation within the broader geopolitical landscape. This chapter serves as a literature review, drawing on relevant academic sources to support our arguments and insights, and setting the stage for the discussion that follows.

Geopolitics

Geopolitics has its roots in the early 20th century when scholars such as Sir Halford Mackinder and Alfred Thayer Mahan developed theories emphasizing the importance of geography in shaping the political landscape. Since then, geopolitics has evolved as a field, incorporating various perspectives and methodologies to better understand the complex relationship between geography, power, and politics (Campbell, 2007, p. 551-552).

The definition of geopolitics has changed over the years, but it was first referred to as a belief that geography was the primary factor driving international relations, with a focus on imperial powers competing for territory, expansion, and military dominance (Vakulchuk et al., 2020, p. 2). However, as time passed, the term evolved to encompass a broader understanding of how geography impacts state power and global affairs. This new perspective places less emphasis on determinism and emphasize instead on the strategic importance of natural resources, their localities, ways of transportation, and bottlenecks (Vakulchuk et al., 2020, p. 2). As Vakulchuk et al. defines, geopolitics is the competition among great powers for access to strategic locations and natural resources. Scholten (2018) on the other hand, refers to geopolitics as to how geographical factors influence politics, especially international relations, and how politicians act upon geographic considerations (Scholten, 2018, p. 8).

The history of geopolitics as a subject and theory can be traced back to the late 19th and early 20th centuries, although the broader idea of geographic factors influencing politics has been around for much longer (Anderson, 2000, p. 2). The roots of geopolitics can be found in the works of ancient Greek historians and philosophers like Herodotus and Thucydides, who recognized the importance of geography in shaping political and military strategy (Anderson, 2000, p. 6). The formal study of geopolitics is often attributed to the German geographer

Friedrich Ratzel, who published his work "Anthropogeographie" in 1882. Ratzel argued that the growth and survival of a state were determined by its Lebensraum, or living space, which was influenced by geography and natural resources (Kearns, 2009, p. 4-5).

Another key figure in the development of geopolitics was the British geographer Halford J. Mackinder, a close reader of Ratzel. In his 1904 paper "The Geographical Pivot of History," he proposed the "Heartland Theory," which argued that the control of the Eurasian landmass was the key to global dominance. He believed that the power that controlled this area would be able to exert significant influence over the world. (Mackinder, 2004). Around the same time, American naval strategist Alfred Thayer Mahan developed the concept of "sea power", emphasizing the importance of naval forces in maintaining and expanding a nation's influence. Mahan's ideas influenced the naval policies of several major powers, including USA, UK, Germany, and Japan. (Kearns, 2009, p. 4).

In the 1920s and 1930s, the German geographer Karl Haushofer developed the concept of "geopolitik", which sought to combine geographic factors with political and military strategies. Haushofer's ideas were later adopted by the Nazi regime and used to justify their expansionist policies (Murphy, 2014). After World War II, the focus of geopolitics shifted to the power structure of the Cold War, with USA and The Soviet Union as the dominant global actors. With the end of the Cold War, geopolitics has evolved to encompass a more complex and interconnected global landscape. Today, it is used to analyze a wide range of issues, including regional conflicts, economic competition, and the rise of emerging powers such as China and India (Vakulchuk et al., 2020).

As for the history of geopolitics as a subject and theory, during the mid-20th century, geopolitical thought was dominated by the Cold War rivalry between USA and the Soviet Union. During this time, scholars such as Nicholas Spykman developed theories that emphasized the importance of controlling the "rimland" or the coastal areas surrounding the Eurasian landmass (Cahnman, 1945, p. 319). Geopolitical thought also extended to the study of proxy wars and containment strategies, as both superpowers sought to exert influence in various regions around the globe (Kearns, 2009, p. 3). In recent decades, geopolitics has evolved to incorporate new perspectives, such as critical geopolitics, which critiques traditional state-centric approaches and examines the role of discourse, power relations, and social constructions in shaping geopolitical outcomes (Tuathail, 1999, p. 107-108).

Additionally, scholars have increasingly focused on understanding the geopolitical implications of globalization, technology, and environmental change (Dalby, 2009, p. 236).

Throughout its history, geopolitics has been both praised and criticized. While some see it as a valuable tool for understanding the role of geography in shaping international relations, others argue that it can be overly deterministic and used to justify aggressive or expansionist policies. Nevertheless, geopolitics remains an important framework for analyzing the complex interplay between geographic factors and political dynamics (Scholten, 2018, p. 5). Overall, the history of geopolitics reflects an ongoing evolution in the way that scholars understand and analyze the relationship between geography, power, and international politics.

Renewable energy

As for the term "renewable energy", there are several definitions that slightly differ. In our thesis, we refer to EIA's definition: "*energy from sources that are naturally replenishing but flow-limited; renewable resources are virtually inexhaustible in duration but limited in the amount of energy that is available per unit of time*." (EIA, 2022a). Unlike fossil fuels such as coal, oil, and natural gas, which are finite and contribute to environmental pollution and climate change, renewable energy sources offer a cleaner and more sustainable alternative for meeting global energy demand (Owusu & Asumadu-Sarkodie, 2016, p. 11).

The main types of renewable energy sources include:
Solar energy: Solar energy is harnessed from the sun's radiation using photovoltaic (PV) panels or solar thermal systems. Solar power can be used for a variety of purposes, including generating electricity, heating water, and powering transportation. (Owusu & Asumadu-Sarkodie, 2016, p. 7).
Wind energy: Wind energy is generated by harnessing the kinetic energy of wind through wind turbines. These turbines convert wind's kinetic energy into mechanical energy, which is then converted into electricity. (Owusu & Asumadu-Sarkodie, 2016, p. 7).
Hydropower: Hydropower involves generating electricity from the movement of water, typically by using dams or run-of-the-river systems. The kinetic energy of flowing water is converted into mechanical energy by a turbine, which in turn generates electricity. (Owusu & Asumadu-Sarkodie, 2016, p. 5).
Bioenergy: Biomass energy is derived from organic materials such as wood, agricultural crops, and other biological waste products. These materials can be burned directly for heat or

converted into biofuels like ethanol or biodiesel, which can be used for transportation or power generation (Owusu & Asumadu-Sarkodie, 2016, p. 6).
Geothermal energy: Geothermal energy is harnessed from the Earth's internal heat, usually by tapping into underground reservoirs of hot water or steam. This heat can be used directly for heating buildings or converted into electricity through geothermal power plants (Owusu & Asumadu-Sarkodie, 2016, p. 7).
Ocean energy: Ocean energy can be derived from the movement of tides, waves, or temperature differences in seawater. Tidal and wave energy systems convert the kinetic energy of water movement into electricity, while ocean thermal energy conversion (OTEC) systems generate power from the temperature differences between warm surface water and colder deep water (Owusu & Asumadu-Sarkodie, 2016, p. 7)

Renewable energy is seen as a crucial component in the global effort to combat climate change and reduce dependence on fossil fuels. As the technology for harnessing renewable energy continues to advance and becomes more cost-effective, its adoption is expected to increase significantly in the coming years (Owusu & Asumadu-Sarkodie, 2016, p. 11-12). The transition to renewable energy is crucial for addressing climate change and reducing dependence on fossil fuels. The increasing deployment of renewable energy technologies is contributing to a shift in the global energy landscape, with implications for geopolitics and energy security (Overland, 2019, p. 38).

3.2. Geopolitics of the Energy Transition

The transition to renewable energy is inherently connected to geopolitics, as strategic resources such as energy influence the distribution of power, the dynamics of international relations, and the security concerns of nations (Overland, 2019, p. 36).

The utilization of renewable energy is on the rise, surpassing the usage of fossil fuels in most cases, driven by factors such as apprehensions about climate change, the exhaustion of fossil fuels, and efforts to diversify away from oil and gas. The adoption of renewable energy is outpacing all other sources, with an average annual growth rate of 2.6%, followed by nuclear power at 2.3%, and fossil fuels lagging at less than 2% (Scholten, 2018, p. 3). Yet, because of an increase in global energy demand, it is still expected that the share of fossil fuels will be at 78% in 2040, while renewables and nuclear at 22% (Scholten, 2018, p. 3).

The energy transition is primarily based on expanding the use of renewables and decreasing the use of fossil fuels (Pintilie, 2021, p. 116). Therefore, geopolitics of renewable energy includes the political and economic implications, both domestically and internationally, of utilizing and advancing renewable energy sources (Henderson & Mitrova, 2020, p. 94). The transition is driven by various factors such as climate change, advancements in technology, and the emergence of innovative solutions that can improve the energy industry and disrupt traditional approaches. It has potential to address economic concerns of nations and promote growth by providing affordable energy. Additionally, it addresses the global concern of energy security, which is also a critical geopolitical issue. (Henderson & Mitrova, 2020, p. 94).

3.2.1. Direct and Indirect Influences

The transitions effect on different countries can be grouped into two categories: direct and indirect influences. Direct influence is seen when countries sign up for international climate agreements like the Paris Agreement, obligating them to comply with official targets and obligations. This necessitates a change in their energy mix, driving them to develop new low-carbon strategies that focus on renewables, energy efficiency, and other methods to reduce emissions (Henderson & Mitrova, 2020, p. 94). Additionally, global innovation and technological advancements often make new technologies more affordable and appealing. Consequently, countries, motivated by local stakeholders, may choose to voluntarily promote these technologies to decrease energy costs and maintain economic competitiveness (Henderson & Mitrova, 2020, p. 94).

Indirect influence mainly affects countries that are lagging in the energy transition. The evolving global fuel mix curbs the demand growth for fossil fuels, resulting in lower export volumes of them from resource-rich countries (Henderson & Mitrova, 2020, p. 94). New regulations are being discussed in parts of the world regarding carbon tracking for internationally traded goods and the creation of border carbon adjustments as part of the carbon taxation mechanism. A high carbon footprint for exported goods may become a long-term source of instability for economies that rely on fossil fuels (Henderson & Mitrova, 2020, p. 94). Furthermore, banks and financial institutions are increasingly assessing climate risks, becoming more reluctant to finance fossil fuel projects. This trend is most visible in the coal industry and will create more challenges for the continued development of conventional energy in resource-rich countries. (Henderson & Mitrova, 2020, p. 94).

3.2.2. Winners and Losers

A global transition to renewable energy is anticipated to result in a geopolitical reorganization, with new winners and losers emerging. Fossil fuel exporters risk their resources becoming stranded assets, potentially weakening their economies and diminishing their geopolitical power. Vakulchuk et al. (2020) discuss the potential impacts of stranded assets on petrostates, including their economic and geopolitical power, and their potential responses to the renewable energy transition.

In contrast, countries that achieve industrial leadership in clean technologies, along with related patents, may emerge as winners. Technologies and intellectual property are crucial components of renewable energy (Vakulchuk et al., 2020, p. 5). The potential gains from renewable energy leadership include employment, revenues, and international prestige. However, the overall picture of winners and losers in the global shift to renewable energy remains complex, as several factors may partially cancel each other out, making it challenging to identify clear-cut winners and losers (Vakulchuk et al., 2020, p. 5).

3.2.3. Conflict and Peace

The literature on renewable energy and geopolitics exhibits a divide when it comes to the security implications of renewable energy growth. Vakulchuk, et al. (2020) identifies two main perspectives on this issue: the "renewed conflict" camp and the "reduced conflict" camp. The former believes that the energy transition will not necessarily reduce energy-related conflict, while the latter sees greater self-sufficiency resulting from the transition leading to a decrease in conflict between states.

Proponents of the renewed conflict camp argue that a world powered mainly by renewables will still experience conflict like those caused by fossil fuels. This group highlights concerns such as new energy security vulnerabilities, geopolitical tensions related to renewable energy technologies, dependence on countries with access to critical materials, and the potential for cyber-attacks on renewable energy systems (Vakulchuk et al., 2020, p. 3-4).

On the other hand, the reduced conflict camp contends that geopolitical tensions are less likely in a world where renewables are the primary energy source conflicts (Vakulchuk et al., 2020, p. 4). This perspective emphasizes that renewable energy is more difficult to control, manipulate, or monopolize than fossil fuels, leading to greater energy self-sufficiency and

reduced conflict. Proponents of this view argue that renewable energy resources have fewer geopolitical motivations for conflicts, as they are more evenly distributed geographically and not exhaustible. Additionally, the focus on domestic production could reduce interdependence between countries and lower the likelihood of conflicts (Vakulchuk et al., 2020, p. 4).

However, they also point out that there is a group of scholars who argue that it is too early to draw conclusions about the implications of the energy transition on future geopolitical tensions. These agnostic scholars emphasize that the outcomes remain uncertain and that contrasting scenarios of the renewables-geopolitics nexus may emerge. (Vakulchuk et al., 2020, p. 4-5).

3.3. Renewable energy as a game-changer

3.3.1. Six Clusters of Implications

Some experts claim that renewable energy and the transition to renewables represents a game-changer in geopolitics. Scholten et al. (2020) provide a comprehensive overview over potential geopolitical implications of renewable energy. They point to six clusters which demonstrate how renewables can disrupt the traditional energy landscape, changing global markets, energy systems, resource competition, regionalization of energy relations, the nature of energy trade, and the dynamics of global energy markets. By analyzing these clusters, the authors highlight the transformative potential of renewable energy and its ability to reshape geopolitical dynamics in various ways that will reshape energy relations and transform patterns of cooperation and conflict between countries.

The first cluster presents how abundant and variable resources will create a shift towards less oligopolistic global markets, i.e. most countries do have some kind of renewable energy resource creating an opportunity to become less dependent of other countries. When more countries are able to produce and sell, the buyers can pick and choose, making it difficult for the sellers to set their own price (Scholten et al., 2020, p. 2).

The second cluster highlights how renewable energy sources can potentially facilitate a shift towards a "*two-tier and more resilient energy system, which includes centralized facilities run by large energy companies, and decentralized modes of generation by and for a more varied set of local actors*" (Scholten et al., 2020, p. 2). Unlike traditional fossil fuels, renewable energy technologies are more conducive to decentralized generation, which allows for greater

local control of energy resources. From a political standpoint, the localization of energy production can "democratize" energy systems, empowering regions by providing job opportunities and improved access to energy resources. However, this decentralization may also inadvertently strengthen the centrifugal forces within a country, leading to a heightened sense of regional autonomy. This increased autonomy, in turn, has the potential to create divisions and civil conflict, as regions may compete for greater control over their resources and decision-making power, challenging the central government's authority (Scholten et al., 2020, p. 2).

The third cluster, about critical minerals and metals, renewable energy technologies rely on critical minerals and metals (like cobalt, lithium, neodymium, and dysprosium), which introduces new dependencies and potential geopolitical challenges. This can result in competition and potential conflicts, though skepticism remains as alternative solutions and measures may mitigate these concerns. Yet, said metals can be recycled, as well as different technologies might be discovered, to solve these types of problems. Still, some sort of conflict is expected (Scholten et al., 2020, p. 2).

The fourth cluster is about electrification and regionalization of energy relations. Most renewables rely on electricity as the energy carrier, which may lead to a shift from global networks to regional or continental grids. This changes trade routes and partners, emphasizing infrastructure operations rather than commodity supply security. This can make rivaling countries and organizations more competitive and create a fear of dependency, making it difficult to cooperate (Scholten et al., 2020, p. 2-3).

The fifth cluster is about the changing nature of energy trade. The increasing use of renewables reduces the need for continuous import of fossil fuels and increases decentralized production, which may reduce international trade volumes. The focus shifts to trade in generation technologies and energy services, rather than energy sources and carriers. As both sun and wind power are free of access, the international trade will decrease (Scholten et al., 2020, p. 3).

The sixth cluster explains the creative destruction in global energy markets. As the industrial rivalry over market shares in clean energy generation technologies intensifies. Current net-importers are frontrunners and net-exporters are laggards, indicating technical and

institutional lock-in and path-dependence. Being an industrial frontrunner in renewables can result in a political leadership position within climate-oriented institutions (Scholten et al., 2020, p. 3).

The authors highlight that while there has been an increasing academic and political focus on the geopolitical implications of renewable energy, there is still a great deal of uncertainty about how the transition to renewables will reshape energy security policies and patterns of cooperation and conflict between countries. They aim to provide insights into the challenges and opportunities that renewable energy presents for interstate energy relations, ultimately inviting more research on this novel topic (Scholten et al., 2020, p. 2-3).

3.3.2. Renewables Limited Impact on Geopolitics

The transition to renewable energy has been hailed as a potential game-changer in geopolitics, with the ability to reshape international relations and power dynamics. However, a closer examination of the ongoing global energy transition, as outlined by Smil (2016), reveals that the shift to renewables may not be as transformative as initially anticipated. This subchapter explores the arguments behind this assertion, examining the slow pace of energy transitions, the continued reliance on fossil fuels, and the limited impact of renewable energy on global geopolitical dynamics.

According to Smil (2016), energy transitions throughout history have been slow and gradual processes. In Europe, USA, and China, the shift from traditional biofuels to coal took more than a century. While some countries experienced more rapid transitions after WWII, global energy transitions have remained prolonged affairs. The transition to renewable energy sources is not an exception, as evidenced by the still-dominant role of fossil fuels in the global energy supply.

Despite the growth in renewable energy, Smil (2016, p. 195) argues that more than 80% of the world's energy in 2015 was provided by fossil fuels. The carbon intensity of the global energy supply remains high, and renewables have only managed to double their market share in the last 25 years, a growth rate that is not extraordinary in comparison to previous energy transitions. Furthermore, the impact of renewable energy on the overall decarbonization of the global energy supply has been minimal, indicating that the shift to renewables is unlikely to disrupt the geopolitical dynamics surrounding fossil fuels. Smil also highlights that even the

most determined and deliberate shifts to renewable energy, such as Germany's *Energiewende*, have failed to significantly reduce the country's reliance on fossil fuels. Shifting from thermal electricity generation to renewable sources may be a comparatively easier task than substituting liquid fossil fuels in transportation. However, when it comes to essential industries such as iron, cement, ammonia, and plastics production, the complexities of replacing fossil carbon impose significant limitations on the potential geopolitical impact of renewable energy (Smil, 2016, p. 196).

The existing global energy infrastructure, heavily reliant on fossil fuels, is the largest and most expensive human-made infrastructure in existence (Smil, 2016, p. 196). The scale of investment and the energy embodied in this infrastructure make it difficult to write off or replace rapidly. Consequently, the transition to renewable energy is unlikely to radically reshape global geopolitics in the short to medium term.

While the transition to renewable energy sources is a necessary goal, it is important to recognize that its impact on global geopolitics may be limited, as argued by Smil. The slow and gradual nature of energy transitions, continued reliance on fossil fuels, and the challenges of replacing fossil carbon in various industries suggest that the transition to renewables is unlikely to be a game-changer in geopolitics. Instead, a more realistic approach should focus on understanding and managing the complexities and interdependencies between renewable energy and fossil fuels in the evolving geopolitical landscape.

4. Geopolitical Actors

This chapter will present the four chosen geopolitical actors most relevant to the renewable energy transition. These main actors are USA, The EU, Russia, and China. These are important actors as they account for most energy consumption and production in the world (Gielen et al., 2019, p. 44).

4.1. The United States

USA has been a dominant player in the global energy landscape due to its abundant fossil fuel resources and influential position in international politics. In the 1970s and 1980s, American scholars and experts were the first to bring attention to the topic of geopolitics of renewable energy (Vakulchuk et al, 2020, p. 2).

Since the late 19th century and up to the present time, the primary energy sources in USA have been fossil fuels. After the 1990s, USA saw a rise in energy consumption from biofuels, geothermal, solar, and wind energy (EIA, 2022a). In 2021, both production and consumption of renewable energy achieved unprecedented levels. In 2021, renewable energy represented 12% of the total energy consumption. The electric power sector was responsible for nearly 59% of the total US renewable energy usage in 2021, and around 20% of the country's overall electricity generation came from renewable energy sources (EIA, 2022a). The significance of renewables in USA's energy framework, particularly in power generation, has been steadily growing. In 2018, 17% of electricity generation came from renewables, following a remarkable expansion of wind and solar energy throughout the country, propelled by reduced costs and state policies. Additionally, renewable energy constituted roughly 8% of the overall primary energy supply and 9% of total final energy consumption, with ethanol in transportation making a substantial contribution (IEA, 2019, p. 87).

USA has made significant steps in the renewable energy sector in recent years, particularly in the development of wind and solar power. Despite facing some setbacks under the Trump administration, such as withdrawing from the Paris Agreement, the country has re-emphasized its commitment under the Biden administration by rejoining the agreement. USA holds a prominent position in the realm of energy-related research, development, and demonstration and highly prioritizes innovation within the energy sector. The Department of Energy (DOE), including its 17 national labs, leads federal government initiatives to fund and support energy

advancements, with these labs being recognized as top-tier energy research and development centers. Currently their research efforts concentrate on battery storage, small modular nuclear reactors, and carbon capture and storage (IEA, 2019, p. 13). As the prevalence of variable renewable electricity generation, electric vehicle adoption, and extreme weather events and cyberthreats increase, the emphasis on modernizing and fortifying the power grid in research is also gaining importance (IEA, 2019, p. 13).

USA seeks to maintain its global leadership and influence through the energy transition, driven by objectives such as energy security, economic development, and climate change mitigation (IEA, 2019, p. 43). The country has invested heavily in renewable energy research and development, aiming to become a leader in clean technology innovation and export these technologies worldwide (Hook & Sanderson, 2020). USA government's policy revolves around the idea of "energy dominance", emphasizing a plan to optimize energy output, increase exports, and lead in energy technologies. A key aspect of this approach is environmental deregulation, which could potentially impact the trajectory of emissions (IEA, 2019, p. 3).

The transition to renewable energy has the potential to enhance USA's geopolitical position by further reducing its dependence on foreign energy sources, although for the first time since 1952, became a net total energy exporter in 2019, continuing to hold that status in both 2020 and 2021 (EIA, 2022b). It may also promote economic growth through the development of a new industry and strengthening its leadership in clean technology. Renewable energy will play an important part in reducing US greenhouse gas emissions, reduce energy imports and fossil fuel use, which is the largest source of carbon dioxide emissions in USA (EIA, 2022a). Yet, USA might face several challenges in transitioning to renewables, such as political opposition, competing interests in their large fossil fuel industry, and the need for substantial investments in renewable energy infrastructure. For example, US offshore wind has yet to be developed as strongly as it has in other countries (IEA, 2019, p. 101).

Their interactions with other geopolitical actors in the energy transition will likely involve a mix of cooperation and competition. On one hand, they may collaborate with other countries to share knowledge, technology, and best practices to promote the global adoption of renewable energy. On the other hand, competition may arise as USA seeks to maintain its global leadership and secure its interests in a changing energy landscape.

4.2. The European Union

The EU represents a political and economic alliance between 27 nations in Europe. Established post WWII, its initial objective was to promote economic collaboration. By encouraging trade among members, the EU aimed to establish economic interdependence, thereby reducing the likelihood of conflict between nations (European Commission, n.d.b). Because it represents an effort to resolve geopolitical conflicts in Europe, it provides a rather unique political context for studying the geopolitics of renewable energy sources (Sattich, 2018, p. 178). It is challenging to approach European energy politics from a geopolitical perspective given the legal and political structure of the EU (Sattich, 2018, p. 164).

Each member, and the EU as a whole, are essential components of the global geopolitical landscape. But it may be challenging to distinguish between the different states and their European environment due to the advanced state of European integration and the multilevel system of the EU. Therefore, the distinction between national and inter-national is much less distinct than it is in other parts of the world (Sattich, 2018, p. 164). For example, the EU is not a single, collective purchaser of energy supplies. Energy is supplied to recipients in the individual EU member states. However, the fundamental rules of the energy game should be the same across the entire Union's territory and should be applicable to all EU Member States, at least theoretically (Godzimirski & Nowak, 2018, p. 222). The geopolitics of renewables in the EU are being shaped by market liberalization and integration as well as shared responsibilities between the Union and its member states for energy policy (Handke, 2018, p. 277).

There are two important turning points that transformed the debate on renewable energy directives in the EU. First, the legal landscape changed when the Kyoto Protocol came into effect, making it necessary to implement low-carbon strategies to slow down climate change (Handke, 2018, p. 293). Second, 2011 marked a turning point for EU renewable policies, because Germany continued plans to phase out its nuclear power generation in the wake of the Fukushima disaster in Japan. This choice required a massive increase in the production of renewable electricity to offset the amount of nuclear-based electricity (Handke, 2018, p. 293).

The EU has set ambitious targets, with the European Commission (EC) proposing to increase its target to 45% renewable energy sources in the EU's energy mix by 2030 and use renewables to reach the goal of reducing net greenhouse gas emission by at least 55% by 2023

(European Commission, n.d.a). It has implemented various policies and initiatives to support the deployment of renewables, such as the European Green Deal from 2019, which included a set of 50 actions for the following five years to prepare the EU economy for climate neutrality by 2050 (IEA, 2020, p. 13). The EU seeks to reduce its reliance on imported fossil fuels through renewables (European Commission, 2022), and to strengthen its position as a global leader in renewable energy and climate action. Renewables also present new opportunities for exporting technology and creating jobs (Handke, 2018, p. 299).

As a union between several European states, each of them faces different challenges (Handke, 2018, p. 281), such as an uneven distribution of renewable energy sources across member states. Poland for example is the largest coal producer in the EU and therefore has a low level of dependence on energy imports, while many members are more than 75% dependent on imports (Ćwiek-Karpowicz, 2012, p. 44). This may cause varying levels of political support for the renewable energy transition. Additionally, the EU must navigate the complexities of coordinating energy policies among its diverse member states.

The EU's transition to renewable energy could strengthen its geopolitical position by reducing its reliance on importing energy supplies and enhancing its reputation as a global leader in renewable energy. The EU enlargements in 2004 and 2007, along with the gas transit crisis between Russia and Ukraine in 2006 and 2009, have significantly impacted the energy security. As a result, new member states in East-Central Europe became more vulnerable to disruptions in gas supplies from Russia (Siddi, 2018, p. 262). Additionally, due to historical reasons, these countries tend to view Moscow's policies with greater suspicion. The mistrust of Russia reached a peak with the Ukraine crisis in 2014, although the flow of Russian gas through Ukraine never stopped during that crisis (Siddi, 2018, p. 262). But when Russia launched its attack and Ukraine again in 2021, it has become even more obvious that dependence on Russian exports is an energy security issue the EU must deal with.

The EU’s reliance on Russian gas has grown over the past decade, from 26% in 2010 to an average of over 40% through 2018-2021, and then it dropped from 23% in 2022 to under 10% in January 2023 (IEA, n.d.). The transition to renewable energy has potential to be a significant game-changer for the EU, given its ambitious targets for climate mitigation and increased use of renewables, as well as the potential benefits in terms of energy security.

However, tensions may arise with countries such as Russia, which may view the EU's push for renewable energy as a threat to their fossil fuel interests.

4.3. Russia

Russia is a major global power with a historically strong presence in the energy sector, particularly as one of the world's leading producers of oil and natural gas. Its energy resources have been central to its geopolitical influence, as they provide significant revenues and serve as strategic tools in its relationships with other countries (Paltsev, 2016, p. 392). Russia may become a leader alongside China in the worldwide nuclear export market, and their market power carries serious geopolitical implications for other geopolitical actors (Sivaram & Saha, 2018, p. 137).

While Russia has made some efforts to develop renewable energy, its progress has been relatively slow compared to other major geopolitical actors. The proportion of renewable energy sources, such as solar and wind power, in the overall energy mix is insignificant, and it is formally not anticipated to exceed 1% by the year 2035 (Henderson & Mitrova, 2020, p. 95). Russia's primary objective, like other actors, is to maintain its energy security and geopolitical influence which largely depends on the continued dominance of fossil fuels, and which will be reduced by the transition to renewables (Paltsev, 2016, p. 391). However, as global energy markets shift towards renewables, Russia may need to adapt its strategies to remain competitive and avoid potential economic risks associated with an overreliance on fossil fuels (Tynkkynen et al., 2017, p. 9). As Tynkkynen et al. states; Russia’s best interest should be the development of renewables because a consequence of not joining the market can lead to a large loss of power for their geopolitics.

Russia may face several challenges in transitioning to renewable energy, including its vast fossil fuel reserves, limited domestic incentives for renewables, and the potential loss of geopolitical influence associated with a decline in demand for its traditional energy exports (Henderson & Mitrova, 2020, p. 99, 109-110). Additionally, Russia's political and economic systems may hinder the development of a more diversified and competitive renewable energy sector (Henderson & Mitrova, 2020, p. 101).

The transition to renewable energy could have significant implications for Russia's geopolitical position, particularly if it leads to a decline in the importance of fossil fuels in the

global energy mix, as "*being an industrial frontrunner can result in the added benefit of a political leadership position within broader climate-oriented institutions*." (Scholten et al., 2020, p. 3). Also, it seems that there is a lack of motivation for change in Russia, unless they can successfully innovate energy efficiency technologies which are possible to export globally (Henderson & Mitrova, 2020, p. 101-102). It can also be a perception that it is politically risky to increase prices or mandate investment in energy efficiency during a period of economic stagnation (Henderson & Mitrova, 2020, p. 102). This may result in shifts in power dynamics, alliances, and competition with other geopolitical actors, as Russia's traditional energy resources may become less valuable and strategically significant (Henderson & Mitrova, 2020, p. 103).

As for it being a game changer for Russia, it depends on its ability to adapt its energy sector and geopolitical strategies to the evolving global energy landscape (Vakulchuk et al., 2020, p. 7). As Russia's current position is "*a major hydrocarbon exporter and consumer, any rapid change in energy transformation is problematic*." (Henderson & Mitrova, 2020, p. 110). Yet, Russia's interactions with other geopolitical actors in the context of the energy transition may involve both cooperation and competition. For example, Russia may collaborate with countries such as China to develop renewable energy technologies and infrastructure (Raszewski & Nowak, 2015, p. 224). However, Russia may also face conflicts with other geopolitical actors, particularly if the transition to renewable energy undermines its traditional energy relationships and geopolitical influence (Raszewski & Nowak, 2015, p. 228). As mentioned, if Russia can diversify its energy mix, invest in renewable energy technologies, and maintain its influence in the global energy markets, it may be able to minimize their potential negative impacts of the energy transition.

4.4. China

China has emerged as a leading player in the global renewable energy sector, driven by a combination of government policies, technological innovation, and domestic energy security concerns, and has emerged at the center of the world's energy stage (He et al., 2018, p. 1; Freeman, 2018, p. 187). While seen as the world's largest emitter of greenhouse gases and largest energy consumer, China's per capita energy consumption is still less than one-third of USA's per capita energy consumption (Zhao et al., 2020, p. 202). Historically, China has relied heavily on fossil fuels, and their energy resource ability is characterized by "*coal*

abundance, natural gas inadequacy, and oil shortage" (Zhao et al., 2020, p. 202), resulting in a coal-dominated structure of their energy resources (Zhao et al., 2020, p. 202).

China's power generation growth is now largely driven by renewable energy, with clean energy substitution playing an increasingly prominent role. By actively promoting the development of renewable energy resources, China aims to enhance energy security and reduce reliance on traditional energy sources. Achieving the emission-reduction goal set for 2030 will have a positive impact on China's sustainable development and overall environmental quality (Zhao et al., 2020, p. 203). Their role in the energy transition is characterized by its massive investment in renewable energy technologies and infrastructure, both domestically and internationally (Li & Wang, 2012, p. 519.

As Zhao et al. states: "*To reduce carbon emissions and the share of fossil energy in energy consumption, China needs to accelerate the development of hydropower, wind power, and solar power generation and actively promote renewable energy sources such as geothermal energy, biomass energy and ocean energy*." (2020, p. 203). The utilization of wind, solar, and hydropower in China encounters obstacles as their most plentiful sources are located in the inland regions, far away from the high-demand coastal areas. Yet, outside of China, geopolitics of renewables is not relevant in terms of territorial control of energy resources (Freeman, 2018, p. 188).

However, China may face several challenges in transitioning to a renewable energy-based economy. China's growing energy demand requires investment in renewable infrastructure, while integration of variable renewable sources remains a challenge. Policy implications include financing low-carbon transitions, shifting to cleaner energy sources, increasing private investment for green growth, implementing environmental taxes, and improving the green financial system (Zahan & Chuanmin, 2021, p. 43626). Additionally, the country's continued reliance on coal for electricity generation complicates its efforts to reduce carbon emissions and achieve its renewable energy targets (Freeman, 2018, p. 189)

But what renewable energy type would be most relevant to China? In Ren & Sovacool's research, they find that while solar power has the least potential as its production cost is to too high, hydroelectricity and wind power have the greatest potential to strengthen China's energy security (2015, p. 135). As for the financial and economics side of renewables, Zhao et al.,

through their quantitative analysis, conclude through their evidence and findings that the financial development has a more positive impact on renewable energy uses (2020, p. 207-208). Their evidence suggests this financial development "*ensures sustainable economic development in China by providing more funds for the renewable energy projects and also promoting demand for renewable energy*" (Zhao et al., 2020, p. 208). Because of this, one can expect that the financial sector's development may help China with the growth of sustainability. Further, the authors conclude with how policy makers in China should realize the importance of renewable energy as the share of it in total energy mix can significantly increase and meet the increasing demand for energy by all sectors of the country, as well as tax incentives for renewable energy firms (Zhao et al., 2020, p. 208).

As for the impact on their geopolitical position, the transition has the potential to significantly impact China. As a leader in renewable energy technologies, China can be able to enhance its global influence, force new alliances, and gain a competitive advantage in emerging industries (Freeman, 2018, p. 198-199). In addition, their investments in renewable energy infrastructure abroad can help to strengthen its economic and political ties with other countries (Li & Wang, 2012, p. 14-21). And for the game changer potential, this depends on its ability to address the challenges and obstacles it faces, such as competing interests in the fossil fuel industry and navigating geopolitical tensions.

In conclusion, China's rapid growth in the renewable energy sector has positioned it as a major geopolitical actor in the global energy transition. The extent to which China can overcome the challenges associated with renewable energy deployment and fully realize the potential benefits of a low-carbon economy will determine whether the transition is a geopolitical game-changer for the country.

In summary, USA, EU, Russia, and China are the key geopolitical actors that significantly influence the energy transition, and important when discussing the potential game-changer the transition is. While USA, EU, and China are recognized as major actors in the renewable energy market, Russia remains reluctant to rely on anything other than fossil fuels. Nevertheless, the actions, policies, and investments of all these actors collectively shape the global energy landscape, with far-reaching implications for the future of energy and geopolitics.

5. Discussion

5.1. The Transition as a Game-changer

In this section, we explore the idea that the energy transition towards renewables may indeed be a game-changer for the four geopolitical actors by discussing the direct and indirect influences affecting their authority in the renewable energy transition, whether there is a winner or loser in this transition, potential for conflict and peace, and whether he transition to renewables is a game-changer for them, considering the six clusters of implications introduced by Scholten et al. (2020).

As an effort to summarize and systemize our research on the four actors based on the 6 clusters, we created Table 1. This table reflects the implications of the six clusters for the four geopolitical actors based on the discussions in chapter 3, which we will discuss next.

Table 1. Summary of the clusters' applicability to the geopolitical actors.

	Cluster#1	**Cluster#2**	**Cluster#3**	**Cluster#4**	**Cluster#5**	**Cluster#6**
USA	Less oligopolistic	More decentralized	Some competition	Regional shift	Import independence	Industrial leader
EU	Less oligopolistic	More decentralized	Some competition	Regional shift	Reduced import	Industrial leader
Russia	Still oligopolistic	Centralized	Less relevant	Less relevant	Reduced export	Lagging behind
China	Growing presence	More decentralized	In control of minerals	Regional shift	Reduced import	Industrial leader

5.1.1. The United States

When discussing direct and indirect influences affecting USA in the renewable energy transition, we can refer to the first cluster, which highlights the shift towards less oligopolistic global markets, i.e. there will be more sellers and producers. They can benefit from the increased availability of renewable resources, making it less dependent on other countries. The fifth cluster, which deals with the changing nature of energy trade, also suggests that they can focus on trading renewable energy technologies and services.

USA's potential to be a winner in the renewable energy transition can be linked to the second cluster, which discusses the shift towards a two-tier and more resilient energy system. Their advanced technology and innovation capacity make it well-equipped to adapt to this shift. However, the third cluster, which focuses on critical minerals and metals, introduces new dependencies and potential geopolitical challenges that USA must address to maintain its winning position. China's dominating position in essential materials, control over critical minerals and emerging technologies could carry "serious implications" for the national security (Vakulchuk et al., 2020, p. 8). In 2010, China imposed a rare earths embargo on Japan over a territorial dispute, as they dominated global production creating a dependency for Japan on supplies by China (Overland, 2019, p. 37). USA's influence may therefore be challenged by other geopolitical actors, such as China, who are also investing heavily in renewable energy and seeking to become a leader in providing solar, wind, and nuclear technologies (Paltsev, 2016, p. 394).

Other than conflicts connected to critical minerals in the third cluster, the potential for conflict in USA's renewable energy transition can also be linked to the fourth cluster, which emphasizes the regionalization of energy relations as a result of electrification. Regional competition and potential civil conflict may arise over resource control and decision-making power. The sixth cluster, which discusses creative destruction in global energy markets, also points to the possibility of international rivalries in clean energy markets. However, the transition to renewable energy presents opportunities for peace, as it fosters international cooperation in addressing climate change and sustainable development.

The renewable energy transition has the potential to be a game-changer for USA when considering the six clusters of implications. Successfully navigating the challenges and

opportunities presented by these clusters could enhance USA's global influence, foster new alliances, and reshape its energy security policies.

5.1.2. The European Union

Direct influences for the EU in the renewable energy transition include strong political commitment to climate change mitigation, ambitious renewable energy targets, and a well-developed renewable energy market. Indirect influences, such as the need to diversify energy sources and ensure energy security, also play a role in shaping the EU's approach to renewables.

The EU has the potential to become a winner as its commitment to climate goals and the development of renewable energy align with the first cluster on abundant and variable resources. The shift towards less oligopolistic global markets provides the EU with opportunities to decrease their dependence on fossil fuel imports and rather improve energy security. The second cluster, focusing on a two-tier and more resilient energy system, further supports the EU's potential to be a winner as it fosters regional cooperation and creates a more sustainable and resilient energy system. However, the EU may face challenges in securing critical minerals and metals required for renewable energy technologies, as highlighted in the third cluster. Additionally, managing cross-border electricity grids and maintaining strong energy ties with neighboring countries can be challenging, as suggested by the fourth cluster on electrification and regionalization of energy relations.

Potential for conflict arises from competition for critical minerals and metals, as well as struggles to maintain cross-border energy cooperation. Still, the renewable energy transition also offers opportunities for peace, as it fosters regional cooperation and aligns with the EU's goals of addressing climate change and promoting sustainable development, as well as having the potential of energy security from other actors.

Considering the direct and indirect influences, winners and losers, and potential for conflict and peace, the transition to renewable energy has the potential to be a game-changer for the EU. Successfully navigating the challenges and opportunities presented by the shift to renewable energy, i.e. securing critical minerals and metal, could strengthen the EU's position as a leader in sustainable development and climate action. The transition can also reshape

their energy security policies, reduce dependence on fossil fuel imports, and foster new alliances among member states and neighbor.

5.1.3. Russia

Direct influences for Russia in the renewable energy transition include the country's vast fossil fuel reserves, limited domestic renewable energy development, and reliance on hydrocarbon exports. Russia has also committed itself to the Paris Agreement. Indirect influences, such as the global shift towards renewables, international pressure for climate action, and changing global energy markets, also play a role in shaping Russia's approach to renewables as they may eventually be pressured to transition.

Russia faces challenges in the renewable energy transition, which may position them as a potential loser. As the first cluster highlights a shift towards less oligopolistic global markets, Russia's dominance in fossil fuel exports may be challenged, resulting in reduced revenues and geopolitical influence. The second cluster, focusing on a two-tier and more resilient energy system, is less relevant to Russia due to its limited renewable energy development. The third cluster, about critical minerals and metals may offer Russia some opportunities, as the country possesses reserves of these resources. However, Russia's current focus on fossil fuel production might limit its ability to capitalize on this advantage. The fourth cluster, discussing electrification and regionalization of energy relations, could further challenge Russia's energy export market, as regional energy ties become more important and global fossil fuel demand decreases.

Conflict may arise from Russia's reliance on fossil fuel exports, competition for critical minerals and metals, and concerns about maintaining its geopolitical influence. However, the renewable energy transition also offers opportunities for Russia, if they choose to diversify their economy and invest in renewable energy technologies, fostering cooperation with other countries in addressing climate change and sustainable development.

Considering the direct and indirect influences, winners and losers, and potential for conflict and peace, the transition to renewable energy has the potential to be a game-changer for Russia. Overall, Russia seems to be the loser among the four geopolitical actors in the transition to renewables, as they are clearly lagging. The country's ability to adapt to the changing global energy landscape, diversify its economy, and invest in renewable energy

technologies will determine the overall impact of the energy transition. Successfully navigating the challenges and opportunities presented by the shift to renewable energy could lead to a more diversified economy, enhanced cooperation with other nations, and new opportunities for Russia in the global energy market, but the current policies in Russia makes this seem unlikely.

5.1.4. China

Direct influences for China in the renewable energy transition include its rapidly growing renewable energy sector and domestic environmental concerns. Indirect influences, such as global market shifts, international climate agreements, and the growing demand for clean energy, also play a role in shaping China's approach to renewables.

China has the potential to be a winner in the renewable energy transition due to its leadership in clean technology manufacturing, vast renewable energy resources, and commitment to transitioning towards a more sustainable energy system. As an industrial frontrunner in renewables, China may capitalize on the increasing global demand for clean energy technologies and assert its political leadership in climate-oriented institutions.

China also has the potential to become a winner related to the third cluster, concerning critical minerals and metals, which Chinas is gaining control over and can use as a geopolitical tool. However, the fourth cluster, discussing electrification and regionalization of energy relations, could lead to more complex regional energy dynamics, as China seeks to balance its energy import needs with regional cooperation and competition.

Potential for conflict arises from China's control and competition over critical minerals and metals, as well as regional power dynamics in energy relations. However, the renewable energy transition also offers opportunities for peace, as China's investment in renewables can foster cooperation with other countries in addressing climate change and sustainable development and reduce its dependence on energy imports.

Considering the direct and indirect influences, winners and losers, and potential for conflict and peace, the transition to renewable energy has the potential to be a game-changer for China. The country's ability to maintain its position as an industrial frontrunner and political leader in the renewable energy sector, while addressing challenges related to critical minerals

and metals and regional energy dynamics, will determine the overall impact of the energy transition on Chinese geopolitics. Successfully navigating the challenges and opportunities presented by the shift to renewable energy could enhance China's global influence, create new alliances, and reshape its energy security policies.

In summary, the transition to renewable energy has varying implications for USA, EU, Russia, and China. Each geopolitical actor experiences direct and indirect influences, faces challenges and opportunities, and has the potential to be a winner or loser in the renewable energy transition. As the discussion shows, the six clusters of implications introduced by Scholten et al. (2020) help illustrate the potential impact of the energy transition on each actor's geopolitics. The transition to renewables can serve as a game-changer, with the potential to alter global market structures, reshape energy security policies, create new alliances, and present new sources of conflict and peace. The table below presents the implications of the six clusters for each geopolitical actor, summarizing the outcomes of our discussion.

5.2. The Transition in a Temporal Perspective

Here we will look at the transition to renewable energy as a potential game-changer in geopolitics from a temporal perspective, focusing on the four actors. We will draw upon Scholten et al.'s article, which divides the transition into short-term, medium-term, and long-term stages, to examine the implications for each actor. Additionally, we will consider the counterarguments presented by Smil (2016) in chapter 3.3.2, which suggest that the transition to renewables may have a limited impact on geopolitics.

In the short term, renewables are expected to soften oil and gas-related geopolitical tensions. The EU and China, being importers of energy, will benefit from diversification and increased autonomy in global energy markets. Investments in renewable energy technologies provide opportunities for these actors to develop their domestic industries and reduce dependence on foreign energy sources. In contrast, Russia, as significant exporters of fossil fuels, may face challenges due to shifting investments from fossil fuels to renewables. USA being a net exporter of fossil fuels yet developing a renewable energy industry seems to be running a dual race. Overall, the short-term stage may not be a game-changer for these actors, but it sets the stage for future changes in the energy landscape. At the same time, Smil's arguments about the slow pace of energy transitions and the continued reliance on fossil fuels must be

considered. As the transition to renewable energy is not an exception, the short-term stage may be less transformative than anticipated, with fossil fuels still playing a dominant role in the global energy supply.

The medium-term stage will see a fundamental redrawing of the energy map, with the construction of microgrids and supergrids, and an increased regionalization of energy markets. USA and the EU will likely focus on building regional energy partnerships and developing new trade routes. Meanwhile, Russia and China will need to adapt their energy strategies to accommodate these changes, potentially seeking new markets and alliances. The scramble for critical minerals and metals may also intensify, creating competition and potential conflict between the actors. The medium-term stage could be considered a game-changer for these actors, as it significantly alters the structure of global energy markets and trade relations.

However, it is essential to acknowledge Smil's argument that substituting thermal electricity generation with renewable sources is a relatively simpler task than replacing liquid fossil fuels in transportation and vital sectors. This challenge could limit the extent to which the medium-term stage of the transition truly disrupts existing geopolitical dynamics. In the long term, renewables will supply most energy needs, leading to the emergence of grid communities and a shift to “grid politics”. USA, EU, and China, with their advanced renewable energy technologies, may have an advantage in shaping these grid communities and securing strategic positions within them. Russia, however, will need to adapt their energy strategies to remain competitive and influential in the new energy landscape. The long-term stage can be considered a game-changer for these actors, as it fundamentally changes the nature of energy geopolitics and the distribution of power among nations.

Yet, Smil's argument about the existing global energy infrastructure, which is heavily reliant on fossil fuels and difficult to replace rapidly, must be acknowledged. This factor could limit the transition's capacity to reshape global geopolitics in the long term.

In conclusion, the transition to renewable energy, considered from a temporal perspective, appears to be a potential game-changer in geopolitics. The short-term stage sets the stage for changes, while the medium-term stage significantly alters global energy markets and trade relations. Finally, the long-term stage brings about a fundamental shift.

5.3. Continued Fossil Fuel Dependence

Despite the ongoing transition to renewable energy sources, it is important to recognize that fossil fuels will still play a significant role in the global energy mix in the foreseeable future.

The IEA explores three different scenarios based on varying visions of how policymakers might respond to today's challenges (IEA, 2022, p. 32). In the Stated Policies Scenario (STEPS), the energy system evolves based on the retention of current policy settings, including the latest policy measures adopted by governments worldwide, such as the Inflation Reduction Act in USA (IEA, 2022, p. 32). The “Announced Pledges Scenario" (APS) operates under the assumption that governments meet their objectives punctually and comprehensively, whether pertaining to climate change, energy systems, or other national commitments like energy accessibility (IEA, 2022, p. 32). Lastly, the Net Zero Emissions by 2050 Scenario (NZE) works backward from specific goals, like capping global warming to 1.5°C, and demonstrates how they can be achieved (IEA, 2022, p. 32).

Referencing the STEPS scenario, the peak in coal demand is anticipated to occur within the upcoming years, natural gas demand will reach a plateau towards the end of this decade, and oil demand will hit its maximum in the mid-2030s, followed by a slight decline (IEA, 2022, p. 30). From the current 80%, which has been consistent for decades, the fossil fuel share in the global energy mix is projected to fall to less than 75% by 2030 and to just above 60% by 2050 (IEA, 2022, p. 30).

All of the scenarios suggest that fossil fuels will still be in use in the future to some extent (IEA, n.d., p. 84). This continued dependence on fossil fuels supports Smil's argument that the transition to renewables might not be a game-changer in geopolitics. The existing and future role of fossil fuels highlights the importance of understanding and managing the complexities and interdependencies between renewable energy and fossil fuels in the evolving geopolitical landscape.

5.4. Geopolitical Consequences of the Transition to Renewables

The transition to renewable energy has the potential to significantly reshape the geopolitical landscape among the major actors. As countries shift their focus from fossil fuels to renewable energy, the traditional balance of power based on fossil fuel resources may be disrupted. The direct and indirect influences of the renewable energy transition may lead to a

redefinition of winners and losers in the global energy landscape. Nations that effectively harness renewable energy technologies and resources could gain a competitive advantage and challenge the existing power dynamics.

The transition to renewable energy may lead to the formation of new alliances and partnerships between countries with shared interests in renewable energy development, enabling collaboration on technological innovation, infrastructure development, and policymaking. The potential for conflict and peace that arises from the renewable energy transition may further impact geopolitical relations, as countries cooperate to address common challenges or compete for scarce resources.

Countries that take a leading role in renewable energy technologies and climate policy can increase their soft power and global influence, improving their international standing and reputation as responsible actors addressing global challenges. The winners of the renewable energy transition may experience enhanced global influence, while losers may find their geopolitical position weakened.

As countries invest in renewable energy technologies and reduce their dependence on fossil fuel imports, the influence of major fossil fuel-exporting nations may decline, leading to a reconfiguration of geopolitical relationships. This reduction in dependence aligns with the shifting dynamics between winners and losers in the renewable energy transition and has the potential to reshape global power structures and foster new alliances.

In conclusion, the geopolitical consequences of the transition to renewables are closely tied to the direct and indirect influences of the energy shift, the redefinition of winners and losers, and the potential for conflict and peace among the major actors. The renewable energy transition may significantly alter the geopolitical landscape, leading to a redistribution of power, shifting alliances and partnerships, enhanced soft power and global influence, and reduced dependence on fossil fuel exporters.

5.5. Implications and Future Research

The potential geopolitical consequences of the transition to renewable energy have significant implications for policy-making and future research in the field. Geopolitical actors should integrate energy policies that prioritize renewable energy development, considering the

broader geopolitical implications of their energy choices. By doing so, they can enhance their energy security and geopolitical influence while addressing the global challenges of climate change.

The transition to renewable energy presents opportunities for increased international collaboration among geopolitical actors. Future research could explore the potential benefits of collaboration on renewable energy development, such as sharing technological innovations, best practices, and financing mechanisms. As the transition to renewable energy progresses, it is essential to monitor and analyze the evolving geopolitical dynamics among the major actors. Understanding these dynamics can inform policymaking and help identify potential areas of cooperation or conflict.

Future research should explore strategies for overcoming the challenges associated with renewable energy deployment, such as technological integration, financing, and ensuring a just transition for affected communities and industries. This research can help policymakers navigate the complex landscape of the energy transition and mitigate potential negative consequences.

In conclusion, the transition to renewable energy has the potential to significantly impact the geopolitical landscape among USA, the EU, Russia, and China. Understanding these potential consequences and their implications for policy-making and future research is crucial for navigating the complex dynamics of the global energy transition.

6. Conclusion

The central question of this thesis was to determine to what extent the transition to renewable energy can be described as a "game-changer" in geopolitics. This conclusion aims to synthesize the findings from the analysis of the four key geopolitical actors and the broader implications of the transition to renewables on the global geopolitical landscape.

In the long-term perspective, the transition to renewable energy may be considered a "game-changer" in geopolitics, particularly in energy geopolitics. Traditionally, fossil fuels have been the primary energy source that has influenced geopolitical relations and power dynamics among states. As countries eventually need to transition away from fossil fuels due to their finite nature, climate change mitigation, and increasing global demand for clean energy, the different geopolitical actors will have to adjust their positions in the geopolitical landscape accordingly.

The analysis of the four key geopolitical actors reveals that the transition to renewables presents both opportunities and challenges for each actor. USA and the EU may emerge as winners in the renewable energy transition, given their technological advancements, innovation capacity, and commitment to climate action. On the other hand, Russia's heavy reliance on fossil fuel exports and limited domestic renewable energy development may position it as a potential loser in the transition. However, China's leadership in clean technology manufacturing and commitment to renewables make it also a potential winner in the energy transition.

The transition to renewable energy will likely disrupt the traditional balance of power based on fossil fuel resources and lead to a redefinition of winners and losers. New alliances and partnerships may emerge, while renewable energy leaders may gain increased soft power. The transition has the potential to reshape global power structures and relationships, creating new sources of conflict and challenges, different from the traditional ones connected to fossil fuels (Scholten et al., 2020).

Despite the potential for the renewable energy transition to be a game-changer, it is important to acknowledge the continued dependence on fossil fuels in the short to medium term. As Smil (2016) argues, the slow pace of energy transitions and the ongoing reliance on fossil fuels limit the immediate impact of renewable energy on global geopolitical dynamics.

In conclusion, the transition to renewable energy can be considered a game-changer in geopolitics, particularly in the long-term perspective. As countries navigate the complex landscape of shifting power dynamics, new opportunities and challenges will arise, requiring geopolitical actors to adapt their strategies accordingly. Policymakers should prioritize renewable energy development in their energy policies, considering the broader implications for their security and influence. Opportunities for increased international collaboration among actors should be explored, as well as strategies for overcoming challenges associated with renewable energy deployment. Future research should continue to monitor and analyze evolving geopolitical dynamics to inform policymaking and identify areas of potential cooperation or conflict.

By examining the relationship between renewable energy and geopolitics, this thesis contributes to a better understanding of the complex interactions between renewable energy and international politics. However, as the energy transition continues to unfold, the true extent to which renewable energy serves as a game-changer in geopolitics remains uncertain and will be determined by the actions of the key geopolitical actors and the global community at large.

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