Understanding the geopolitical implications of a transition to green hydrogen as the dominant energy carrier

MASTER THESIS

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Preface

Dear Reader,

As the culmination of my two-year MSc at the Delft University of Technology, I would like to write these final words for my report of my thesis research project with ardour and contentment.

This thesis research project started as a discussion between me and my supervisors when I expressed my interest to perform thorough research in the field of the geopolitics of the energy transition. After several sessions, I thought it would present great interest to measure specifically the geopolitical impact of an introduction of a new, green energy carrier such as green hydrogen. This quickly made me dive into the literature, to increase my knowledge and expertise on two sectors. On one hand, to gain a better understanding of the technology and scientific aspects of green hydrogen, and on the other hand to understand institutionalism in international relations and geopolitics. As the patterns I began formulating started gaining shape, it really boosted my motivation to continue connecting the dots.

As I was searching for more details, I started looking into secondary and tertiary data and, even in newspapers, and this made me rethink and recalibrate many of the patterns and many of the views I had on certain topics and specific regions. It made me realize that the energy supply chain global system is much more complex than I thought and it becomes even more complex every year that the demand on the Global South is on the rise. This bring so many more issues in the security of supply, currently not discussed as they should be, and hence this thesis translates into acutely valuable insights for my future career as a geopolitical risk and energy policy analyst. But most importantly, this thesis research project should also translate into meaningful information for national governments and international institutions, such as the EU, on their way to achieve energy security of supply, without disrupting the geopolitical world order.

I would like to express my thanks to both my committee members, Aad Correlje and Nihit Goyal. Their previous research and their insightful input during our sessions served as inspiration to select and specify my topic, but also to continue my research and ameliorate certain elements of my thesis project during the course of it. Lastly, I would like to thank all of my friends that supported me throughout this journey and motivated me to choose a topic that I love but is not quite conventional for a technical university setting and were by my side until the moment I saw it through.

This thesis project marks the end of my student career. I hope that you, the reader, will enjoy reading this research project as much as I enjoyed finishing it.

Executive Summary

The effects of climate change on the global community are becoming more strongly felt every year, creating devastation on our everyday lives. To combat that, a transition to low-carbon energy carriers is being envisioned by state and private actors through pledges during climate conferences and several candidate carriers are proposed. Among these, green hydrogen, produced through electrolysis stemming from renewable electricity is poised to become the dominant renewable energy carrier. However, its production process entailes serious challenges, as for importing countries it will be very difficult to achieve security of supply. The field of security of supply is a highly complex one and correlated with the technological, scientific background of the energy carrier but also with the financial and market structure and the political stability of the importing and the exporting country. All of these components together formulate a very complex system that needs to be studied and further understood to better deal with the security of supply for importing regions, such as Europe.

There are several ways to study the foregoing system and its implications on the security of supply. These entail focusing on the technological aspects, the market structure or the geopolitical context. The first one would include research on the technology arms race by several state actor, whereas the second one would encompass a comparative case study between centralized and decentralized distribution and transmission systems, and whether unbundling would be beneficial for the energy transition. The third aspect, the geopolitical one, was chosen for two reasons. The first one is that a more holistic approach was needed and the problem of security of supply should be seen from a more spherical point of view. The second one is that there is already thorough research taking place in the previous two fields.

Hence, the following research question was answered: How might the geopolitical implications of a transition to green hydrogen affect the energy security of supply of the EU?

To answer the research question, initially, pattern modeling was introduced. To develop the patterns, the neoliberalism and neorealism schools of thought in international relations were used as foundation. A discursive approach was taken to formulate the patterns. Out of the many discourses that could have been used, the storyline approach was considered as most appropriate. Hence, two storylines were developed based on the two IR schools of thought. A deductive approach was taken and hence these schools of thought were used as a foundation to develop general themes that would be followed in each storyline. However, very little information and projections exist on the shape of the future green hydrogen system. Thus, a comparative case study was taken between the hydrogen and the natural gas system. The rationale is that there are many structural similarities with the existing gas system and the projections for the green hydrogen one. Initially, the gas system pattern is created based on historical data and expectations and the main insights gained are used as a foundation for the green hydrogen system pattern. Later, the green hydrogen system pattern is formulated based on a combination of its own projections and the gas system insights.

The results verify that there are indeed clear indications that the security of supply of the green hydrogen system will be challenging in a similar way such as the gas one. However, this research reveals that there will be much higher complexity in the green hydrogen system than in the gas one. The fact that green hydrogen is interconnected with the need for electricity and water and hence the security of these systems as well, there are many more ways that disruption can be brought to the supply chain. At the same time, this thesis showed that the geological advantage is much less of an

issue at the green hydrogen system rather than the fossile fuel industry, which increases the number of potential patterns on energy imports significantly.

Overall, this research acknowledges the importance of understanding the geopolitical implications of a shift to renewable energy carriers. It is a clear indication for policymakers to implement and incorporate plans within their energy strategies that include ensuring security and stability to the main green hydrogen supplying countries. Additionally, it provides a brand new approach to academia in the energy transition sector, so that more focus takes place on ensuring the security of supply in the energy-food-water nexus rather than on advocating in favor of conflict resolution as a result of the shift to renewable energy.

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List of accronyms

AU: African Union

BRI: Belt and Road Initiative

CAU: Central Asia Union

CBAM: Carbon Border Adjustment Mechanism

CSTO: Collective Security Treaty Organization

EAEU: Eurasian Economic Union

ECHA: European Clean Hydrogen Alliance

ECLAC: Economic Commission for Latin America and the Caribbean

ECCAS: Economic Community of Central African States

ECOWAS: Economic Community of West African States

ENTSO-E: European Network of Transmission System Operators for Electricity

ETS: Emissions Trading Scheme

EU: European Union

GATT: General Agreement on Tariffs and Trade

H2LAC: Hydrogen Congress for Latin America and the Caribbean

IEA: International Energy Agency

IRENA: International Renewable Energy Agency

MENA: Middle East & North Africa

MERCOSUR: Mercado Commun del Sur (English: Southern Common Market)

NAFTA: North American Free Trade Agreement

OLADE: Organizacion Latinoamericana de Energia

OPEC: Organization of the Petroleum Exporting Countries

PMC: Private Military Company

REM: Rare Earth Metals

SAARC: South Asian Association of Regional Cooperation

SADC: Southern African Development Community

SCO: Shanghai Cooperation Organization

SMR: Small Modular Reactors

TAP: Turkmenistan Afghanistan Pakistan (high-voltage interconnection)

TAPI: Turkmenistan Afghanistan Pakistan India (pipeline)

TPP: Trans-Pacific Partnership

TSI: Three Seas Initiative

TTIP: Transatlantic Trade and Investment Partnership

TUTAP: Turkmenistan Uzbekistan Tajikistan Afghanistan Pakistan (interconnection)

UK: United Kingdom

UN: United Nations

UNFCC: United Nations Framework Convention on Climate Change

US(or USA): United States(or United States of America)

USMCA: USA – Mexico – Canada Agreement

V4: Visegrad Four

WTO: World Trade Organization

Chapter 1. Introduction

1.1.Problem Context

The accelerating climate crisis, whose impact is evident and tangible for the majority of the global population, poses as a call for more action on decarbonization of energy. Progress has been made, but has been rather slow and inconsistent(Genus, 2016). One of the main reasons for that is related to the intermittency of wind and solar energy in particular, which calls for detection of storage and transportation methods. Hydrogen, among other solutions, has been recognized as the most promising choice(Kovac et al., 2021). Hydrogen, based on the manner of production, can be characterized as grey(created through SMR or gasification by methane or coal), blue(created through carbon capture also by coal or methane), turquoise(produced through pyrolysis from methane) and green hydrogen(produced through electrolysis by renewable energy sources)(Marchant, 2021). Green hydrogen is poised by many as the solution to drastically reduce CO2 emissions in several sectors, among which the transport sector(Valente et al.,2021), as an alternative to natural gas(provided costs decrease)(Gillen & Bazillian, 2021).

As with any transition, a new energy carrier entails different characteristics that separate it from its predecessor. Nonetheless, there is one trait that remains the same and that is its complexity. This formulates several societal issues, among which conflicts and disruptive events. These problems that might occur within the societal realm ought to be addressed properly so that there is an endeavour to make this transition as smooth as possible.

1.2.Societal Problem: Energy (in)security as a source for large-scale conflicts and societal disruptive events

For sound policy making in the deployment of sustainable energy technologies, various factors, such as environmental and public health concerns, technology advancement, energy crises and financial recessions have been taken into consideration so far(Genus, 2016). There is, nonetheless, very little discussion and correlation between the aforementioned factors and political ones, such as geopolitics, security of supply and political stability. To have a clear understanding of geopolitics, they have been defined by Dodds (2005) as the geographical factors that influence international politics and all sectors that are related to them, among which energy.

More specifically, military conflicts over energy resources have existed over a long period of time. The main reason is that reserves of resources are concentrated in specific areas and virtually all state actors want to assume control of them to increase their energy security. It is important at this point to elaborate on the definition of energy security and its challenges. While the broader concept of the term is easily correlated with the uninterrupted supply of energy, there is no major consensus on a widely accepted specific definition of energy security. However, recent literature research has led to a list of overall accepted indexes and indicators that are used to measure energy supply, such as energy availability, infrastructure, energy prices, societal effects, environment, governance and energy efficiency(Ang et al., 2015).

Samaras et al. (2019) have asserted that all armed forces missions' worldwide have energy as their main consideration. According to Stark et al. (2010) energy security is a major driving factor for political instability. In particular, for communities in towns and cities of the developing world that

need energy to perform their daily home and work activities, energy insecurity and power cuts can bring political instability, resulting in conflict. Military conflicts are often combined with energy conflicts formulating hybrid threats for society. A prevalent example is Ukraine, where Russia has been deploying cyber-attacks, supply disruptions, economic, political and military pressure, which result in huge stress in the society and political instability(Mara et al., 2022).

1.4Knowledge Gap

Most research so far on the geopolitics of energy transition has been focusing on soft power. Soft power is defined as a persuasive approach in the sphere of international relations, involving cultural and economic means. It should be noted that only the literature of the geopolitics of the energy transition related to the green hydrogen supply chain was chosen to be studied.

To become more specific about the foregoing argument , Van de Graaf (2020) has been pointing towards a potential technology arms race among key players such as China, the USA and the EU. Technology evolution plays a vital role on the energy transition and hence should be considered as a decisive factor on its geopolitical dimension. Also, the same author has been warning over trade risks, which are directly correlated with the market structure of each key state actor. Van de Graaf (2021) also provides a list of exporting and importing superpowers as well as potential losers. Finally, there is mentioning over stranded assets of fossil fuels. However, for these potential risks neither are the affects in security of supply mentioned nor the affects in the security and defense sector overall.

Scholten (2020) attempts to touch upon the subject by maintaining that rivalry over ownership of key infrastructure assets will be of significant importance during the energy transition, which points towards the direction of the importance of researching the affects of the transition on security. Albert (2021) on a similar note asserts that there is the possibility that “anarchy” might be brought to the global energy system bringing great conflict between opposing coalitions and this possibility ought to be examined. Despite these references, there is still not a systematic study of what the actual effects will be to security of energy supply, but also what potential hard power measures could be implemented, severely affecting the security and defense landscape. This systematic study lies at the epicenter of the above mentioned research of technology, finance and market structure and the geopolitical aspect of energy and is presented in a concise manner in Figure 1.

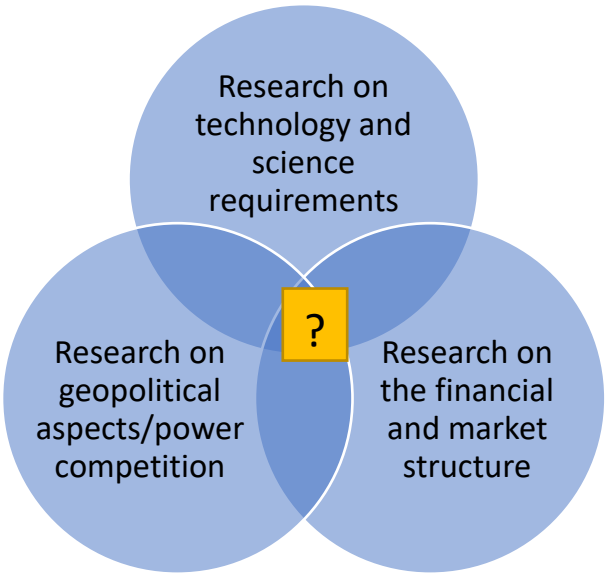

Figure 1. . Knowledge gap: There is no systematic research on how technology and science characteristics, geopolitical aspects and financial and market structure intersect to create the landscape of the future security of green hydrogen supply.

1.5Research Scope

1.5.1. Research Objectives and choice of cases

The end goal of this research is to better understand the manner in which a new energy carrier, in this case green hydrogen, will influence the energy security of supply for the EU. To do that, this thesis initially investigates how the gas system affects the geopolitics and the energy security of supply with the EU at the epicenter. The reason for the choice of the gas system as a point of reference is the similarities in the transmission and distribution grid and pathways, namely shipping and pipelines. The similarities refer to the shape of the projected green hydrogen system, so it is not about existing characteristics but rather speculations. Summarizing, the research objectives consist of the following:

- Identifying the effects of the gas system on the energy security of supply
- Using the most relevant insights to formulate the pattern that the green hydrogen system would follow
- Identifying the potential effects of the green hydrogen system of the energy security of supply
- Detecting commonalities and differences between the two systems

1.5.2.The choice of geographies

For this thesis, several countries were chosen as individual actors. The EU is contemplated to be the most important one and thus will be the one under study. The main reason is that the Union is poised to remain a major net importer of energy even in an era dominated by green hydrogen as an energy carrier. This is not the case in other regions, where there is no consensus on whether imports will be needed at all. Hence, it is of the greatest importance to study, primarily, the energy security of supply for the European continent. There are also other states, such as China, Russia and the USA that can be considered as one actor as well. The main rationale behind it is that, in the regions and empires storyline that will be described later in the process, these countries can form “empires” of their own and resort to unilateral or bilateral moves that can generate changes in the global energy landscape. More specifically, the EU, the USA and China are among the biggest oil and gas importers globally and the growth of China leads to projections of dominance on that field. Russia, on the other hand, is the biggest oil and gas exporter and hence its role is also paramount and can easily be considered as an “empire”. The USA are also gaining a prominent role in gas exports and their importance is, thus, double.

On the other hand, specific blocs were chosen, such as the Gulf States, Latin America and Central Asia. The reasoning for each one is different based on their strategic importance:

- Africa is gaining significant importance on the energy sector because of its abundant and untapped gas reserves, currently comprising 7% of the global reserves (Boakye-Adjei, 2021), but also because of its colossal renewable energy potential(Hafner et al., 2018). The aftermath of the Russian invasion of Ukraine made additional energy supplies ever more important for Europe. This has led all the energy-related actors in the continent to resort to Africa as a source of supply(Holleis & Schwikowski, 2022), which means that it is of great importance that the continent is added as a whole in the modeling process.
- The Gulf States have been exporters of fossil fuels ever since the 1940s, which has largely contributed to the spike in their economy’s growth and industrialization rates(El-Katiri, 2013). The same trend is being observed in both the oil and gas sectors. In addition, currently there is a massive shift seen in some Gulf states’ policies with regards to renewables, because of their increasing cost competitiveness and their contribution to facing climate

change, and their renewable energy potential are deemed to be enormous(and not just the solar one), making them the ideal exporter in the new energy world order(IRENA, 2019). These actors were selected as one due to the collective stance that they have been taking historically. An endemic example of this behavior is the establishment of OPEC during the Baghdad convention which was an initiative predominantly of states around the Persian Gulf.

- Latin America is home to 19.4% of global oil reserves and only 5% of gas reserves. However, a very small part of both has been exploited so far, which makes the region substantially important for the energy landscape of the future(Hollanda & Branco, 2016), especially if other much more exploited reserves get depleted over the coming years. In addition to its increasing contribution in the global fossil fuel supply chain, there have been estimates already about the outstanding renewable energy potential of the region and its direct connection to growth in foreign direct investment, trade(and hence exports) and even tourism(Ben Jebli et al., 2019). Thus, it presents great interest to further investigate the impact the current energy regime as well as the transition will have.
- Central Asia has recently become point of competition for China and Russia, both of which are trying to secure as many reserves as possible. Given that Moscow is the main energy partner of the EU, this translates to the fact that Central Asian states are main gas suppliers for the two biggest markets in terms of energy demand, namely Beijing and Brussels(Pirani, 2020). Their strategic position combined with the already existing relations and established energy network with these two markets make them a perfect candidate for supply of green hydrogen, in particular because of their renewable energy potential. More specifically, solar potential estimates go as high as 3.760.000 MW, whereas wind ones reach 354.000 MW(Laldjebaev et al., 2021). It becomes apparent, hence, that the region is remarkably relevant for the energy sector in both landscapes and ought to be modeled in this research.

1.5.3.The choice of the time period

The time period that will be under study will primarily be 2022-2050. The rationale behind this stems from the World Energy Outlook provided by the IEA, according to which natural gas presents the largest growth(or the smallest decline depending on the scenario) from all fossil fuels, starting from 2020 and until 2050. This is the case in all scenarios. At the same time, green hydrogen is almost non existing in the previous decades and currently it is already enjoying a rise in production. For 2050, hydrogen demand is expected to grow sixfold, from a modest 90Mt to a colossal 540Mt, with the net zero emissions target indicating the need for clean(green) hydrogen at most. This race to satisfy this demand will create an eminent need to promote it as a prevalent energy carrier for this time period. For the time following 2050 very few speculations are being made over the world order and hence 2022-2050 was the time period chosen to be under study.

Employing empirical patterns in research has been an efficient method in analyzing and better understanding complex systems and Grand Challenges. Hence, the geopolitical aspects of the transition to green hydrogen, being a Grand Challenge itself, are a perfect fit for applying pattern oriented modeling (POM). Patterns can be classified as strong, mostly described quantitatively and weak, described qualitatively. In this research, a weak pattern shall be applied in two cases. The reason is that, although strong patterns provide a stronger indication and may prove more useful than a single weak pattern, applying multiple weak patterns and comparing them can achieve a higher structural realism. Thus, this research aims at gaining valuable insights out of the comparison between the future green hydrogen and the gas system and pattern identification, that can be later used by policymakers of the EU(and other state and institutional actors) with the objective of better

understanding how the future green hydrogen system will potentially function and better anticipate and prepare for any uncertainties and geopolitical implications that it might bring. In this way, they will be able to ensure security of supply under a series of disruptive scenarios. Policymakers from other regions could also utilize this research to either counter or support the strategy of the EU. Finally, the methodology in this research can be used by other researchers that wish to study the effects of the transition to green hydrogen in specific regions and/or will want to develop strong(quantitative) patterns.

1.6.EPA Relevance

The main theme of EPA curriculum is working towards understanding and solving Grand Challenges. Among the four most important Grand Challenges are sustainability, health, security and joy of living. This thesis addresses at least two of these themes, as energy security of supply during the energy transition, and its geopolitical implications, touch upon both the notion of finding a sustainable means to live and maintaining security , both in the sense of security of supply and of sovereignty and security of living. In addition, this research is very relevant to the EPA theme, as it formulates institutional frameworks, which are deemed as models to better understand natural and social phenomena.

Thus, this research aims at providing a novel approach and fresh insights on how geopolitics will affect the energy security of supply after the energy transition, under a new energy carrier, which will be green hydrogen.

This summarizes the overall aim of the research. Nonetheless, to proceed, the specifics of the research approach ought to be articulated and the main research question and its subquestions need to be concocted.

1.7.Research Approach

As mentioned, explaining the research approach thoroughly is paramount for the outline of the thesis and the main research question, together with its subquestions, lie at the epicenter of the research.

1.7.1.Research Questions

Hence, the main research question asks:

How might the geopolitical implications of a transition to green hydrogen affect the energy security of supply of the EU?

The main research question is answered by consequently answering the following sub-questions:

Q1: How have transitions to other energy carriers in the past reshaped and affected energy security of supply, globally and within EU member states?

Q2: Which factors influence the energy security of supply of the EU?

Q3: What are the potential strategies that key state actors or regional blocs can deploy within an energy system?

Q4: What are similarities and differences between the geopolitical and energy security landscapes in conventional fuel systems(such as natural gas) and the future green hydrogen system?

Q5: What common patterns between these two landscapes can be identified?

Q6: What additional patterns can be formulated regarding the new green hydrogen system?

Q7: What are the geopolitical and security implications of a transition to green hydrogen for the EU, with regards to its strategy?

1.7.2.Research Design

This question is tackled by a holistic approach, which is achieved through pattern modeling. Literature review in Chapter 2 provides the scientific background, as the challenges related to science, technology and market structure that could affect the geopolitical landscape are identified. Chapters 3 and 4 lay down the analytical framework, which comprises of the conceptual framework which will be identified as the methodology and the theoretical framework. For the theoretical framework, new institutionalism will be used, with a discursive approach, that entails discourses or storylines. This will lead to researching both the neoliberal and neorealist schools that exist. For the analysis, initially pattern modeling will be used, where two patterns will be formulated, based on the storyline approach. Using and modifying an existing storyline approach on energy security, two storylines are being formulated. These storylines are then applied to the global natural gas system, as a point of reference and comparison. The results from this system will then be analyzed and generate results, stemming from the conclusions of this analysis. These results, in combination with the meaningful insights gained through the literature research on green hydrogen, will then be used to formulate the pattern for the green hydrogen future global system. Later, through the usage of comparative case studies and comparative case analysis the similarities, differences and common patterns of the two networks, analyzed under the framework, will be explained and translated into insightful recommendations for the EU. This will be done by translating the results in the context of the EU and how the disruptive events that might happen could influence the continent and the union.

The structure of the thesis will be the following:

In Chapter 2, the scientific background on the main energy-related, environmental, technological and potentially public health issues regarding transition to green hydrogen will be laid down. The aspects of these issues that are most relevant to security of supply and geopolitics will be highlighted. Moreover, the theoretical background will be articulated. This entails the international relations theory with its two schools of thought and the neo-institutionalism theory, but also on the use of storylines in the field of IR. The literature review will also be presented.

In Chapter 3, the methodology used will be introduced. Initially, the analytical framework will be explained. The holistic approach in research will be explained further, as well as its suitability for this research, but also the reason why pattern modeling is being chosen as adequate for this thesis. In addition, the comparative case study is being presented and its use is justified. Finally, the operationalization of the foregoing methods will be elaborated, to better understand how these methods will be used and incorporated in the research.

In Chapter 4, the storyline approach is operationalized, but in a broader geopolitical context. More specifically, based on the two schools of thought of IR, the two storylines are created and their meaning for the geopolitical landscape of the actors under study is further explained.

In Chapter 5, the research design is presented. The exact methodology based on which each sub-question will be answered will be elucidated and the expected insights gained from each one will be briefly described.

In Chapter 6, the first case of the comparative case study will be introduced. This case will be the current gas network. In this case, there will be thorough analysis of each relevant region and the framework will be put in the context of natural gas.

In Chapter 7, the main insights of the analysis of the gas network will be provided. This will include, initially, the overall expected stance of each actor in the network and to which extent it follows a certain storyline over another. This stance is going to be translated into insights and, essentially, input for the formulation of the green hydrogen network pattern. The reason for this, as mentioned, is the many structural similarities between the two systems, which make the insights gained from a gas system pattern an ideal starting point to create a green hydrogen one.

In Chapter 8, the second case of the comparative case study will be introduced. This case will be the future hydrogen network. Again, painstaking analysis of all relevant regions will take place and the framework will be applied to hydrogen.

In Chapter 9, two actions will take place. The first one will be reaching into conclusions that the analysis of the green hydrogen system pattern involves. Again, primarily, the overall stance of each actor will be better understood. The second part will include comparison with the natural gas system pattern. More precisely, the commonalities and differences between the two systems will be explained, as well as the rationale behind them.

In Chapter 10, a reflection on the methodology will take place

In Chapter 11, the main conclusions from the comparative analysis will be highlighted as answers to the research sub-questions.

In Chapter 12, the main research question will be answered. Also, the analysis and the conclusions will be translated into insightful recommendations for the EU.

A research flow diagram is exhibited in Figure 2.

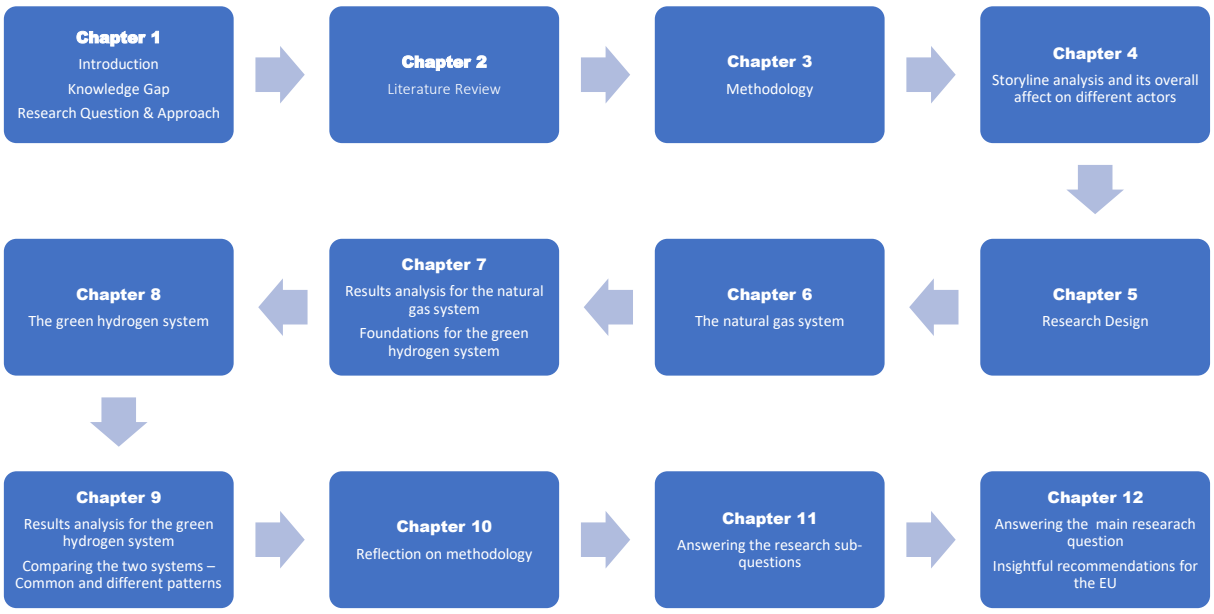

Figure 2. Research Flow Diagram

Chapter 2: Scientific Background and Literature Review

2.1.Literature Review

In this chapter, a state-of-the-art literature review is presented. The key objective of the literature review is to better understand and situate the work of this research within the broader field of energy security of supply and geopolitics. For that to happen, literature research on the theoretical background, more generally, of the schools of international relations and the overall international relations is taking place and is being presented In this way, the novelty and relevance of the work done will become more eloquent and will have a strong and sturdy foundation for the next steps. This review, additionally, aims at identifying all of the scientific, technological, strategy and market issues that a potential shift to a green hydrogen energy system might entail. To do that, the foregoing issues are being investigated both for green hydrogen and gas. The reason is that gas will be used as a point of reference, because its distribution and transmission grid, as well as its usage, has several similarities with the green hydrogen one and hence it was deemed as very useful to first create a pattern concerning the gas system. Of all these issues, it has as a secondary, but also paramount, objective to distinguish the ones that are more relevant to the field of geopolitics. Then, based on the frameworks and models developed, the most important geopolitical implications for the EU can be detected.

2.1.1.Method

For the performance of the literature review, the initial phase included the research of relevant articles. Many available search engines and libraries were used, among which Scopus, Web of Science, JSTOR and Google Scholar. The literature research had two main pathways. The first one concerned the green hydrogen system, whose understanding was the endgoal of this research. The second one revolved around the interest for the natural gas system, because it was the one used as a point of reference for this research. The following terms were used to detect the most relevant research papers:

Geopolitics AND green AND hydrogen

Geopolitics AND renewable AND energy

Renewable AND energy AND security

Green AND hydrogen AND security

Natural AND gas AND security

Natural AND gas AND geopolitics

The results were numerous and, in order to narrow down the scope, three main criteria were used. Firstly the papers had to be relatively recent, preferably after 2007, so that the progress on green hydrogen actually gets acknowledged. In the case of natural gas, similarly papers after 2005 were used, because that is when the revolution in the horizontal drilling and hydrauling fracturing techniques started taking place, providing a boost in the gas production. Secondly, the title and abstract was checked so that it contained words such as geopolitics or geoeconomics, so that we ensure relevance. Lastly, there was ensuring that the keywords used were in the correct order, so that there is no confusion with other meanings of security or other potential uses of hydrogen. The

engines used were JSTOR, Scopus and Google Scholar. The result was that 26 papers were identified to be most of relevance.

For the initial literature review, nonetheless, only academic papers published by university professors on prominent scientific journals were taken into account, which left us with the papers that are described below. It should be noted that there will be focus in research papers and articles published by think tanks and other institutions as well, as overall they are also deemed to be great sources of information.

For the scope of the research, out of renewable energy and green hydrogen technologies and their relevance to geopolitics, aspects related to strategy and policy were distinguished. In addition, barriers & drivers in technology, science and markets were identified and gathered.

2.2.History of energy transitions so far

The prospective transition to green hydrogen as an energy carrier is not the first one in history. Over the past centuries, energy systems have transformed from biomass(mostly wood) to coal, oil and most recently, gas. Research on these transition is far from new. Schurr and Netschert (1960) were among the first to present such a research, more precisely on the transition from biomass to coal and then to petroleum in the US. The fact that transitions in the US were in significantly faster than those on the UK (Humphrey & Stanislaw, 1979; Fouquet & Pearson, 1998; Fouquet, 2008) sketch the divergence in factors that influence the energy transitions, which means that they are not uniform on a global scale. This can also be verified by several other scholars that have conducted similar research in numerous European countries and can verify that the nature and pace of the transition is largely dependent on characteristics of the historical context, such as accessibility of resources, industrial and household demand but also public policies related to the energy sector (Gales et al., 2007; Bartoletto & Rubio, 2008; Madureira, 2008; Kunnas & Myllyntaus, 2009).

Extensive research on 14 past transitions has pointed out towards specific drivers that cause a transition or accelerate an existing one. The price at which the energy services of a specific carrier were provided was considered to be the most important precondition for an energy carrier to become dominant (Fouquet, 2010). Other pushing factors that were detected were flexibility, cleanness, exclusivity, novelty and status, which were not deemed to be as strong as the cost, but could function as accelerating factors.

While the average cost of an energy service has proven to be a dominant factor, it is not the sole financial one. Price shocks have repeatedly provided the momentum needed to energy carriers to penetrate the markets at a quicker pace. They have proven to be able to create this shift at a societal level, rather than a macroeconomic one. Consumers are easily frightened by the strong fluctuation of prices and to be diverted to other resources(Allen, 2009).

Another paramount characteristic of historic energy transitions has been the increase on the overall energy demand. After the industrial revolution, this demand has been increasing exponentially and hence energy carriers with higher energy density had been needed to compensate. This led the previous energy sources' demand to increase as well, but at a lower pace(Grubler, 2004).

A workshop conducted at Cardiff University in 2011 that involved numerous experts from many disciplines attempted to answer questions related to the decisive factors that have influenced past energy transitions and are poised to influence this one as well.Combining their expertise to generate multidisciplinary knowledge was seen as a useful input in the research on the field. They found both supply and demand-side issues to be influencing an energy transition. More specifically, they asserted that from the supply side, financial markets and access to capital have been a decisive

factor. They also added the kind of financing as an important issue, as the percentage of public participation in the funding process has proven to influence the energy transition. Finally, the tendency of the incumbents of a transition to "fight-back" is also a way to reduce the impetus that a novel energy technology might have. As far as the demand side is concerned, the energy prices severely affect the trajectory of a new energy source and the transition to it. This means that an initial significantly high price, if not subsidized, can work as a blocking mechanism for the entry of a new energy source in the market. In addition, they found social acceptance and the domestication process of an energy carrier to be even as important as the prices themselves in some cases. Lastly, the timing has always been of the essence. According to them, certain intellectual currents such as laissez-faire or the support towards Keynesian macroeconomic models have influenced the penetration of specific energy technologies, whose deployment was directly correlated with them (Fouquet & Pearson, 2012).

2.3.Overview of challenges

2.3.1.Strategy challenges in green hydrogen deployment

Several challenges have been identified in existing literature as the ones the most important ones to tackle in order to be able to deploy green hydrogen. Lambert(2020) points out at the EU hydrogen strategy, that focuses on the infrastructure sector and is aligned with Zhang et al. (2021), who detects the special attention that is paid in numerous countries to the infrastructure elements of the hydrogen network. More specifically, the EU strategy has special points dedicated to the need for the electrolyzers and the importance of maintaining a sustainable supply chain in their market. Special focus also exists on transportation or storage innovations, such as green ammonia(Zhao et al., 2021). Both Lambert's(2020) mapping of the EU strategy and Dickel's(2020) research on the German one limn that there is a European trend towards investments in other, less expensive, forms of hydrogen, such as the blue one, as a "transition fuel". Another transitional path involves implementing a green hydrogen roadmap with focus on the green hydrogen blend. In this path, a gradually increasing percentage of green hydrogen will be incorporated in the natural gas network, until that percentage reaches 100%(Pellegrini et al., 2020). Strategies also involve investment on research, development and innovation(Lambert, 2020).

An overview of the EU Hydrogen strategy can be found in Figure 3.

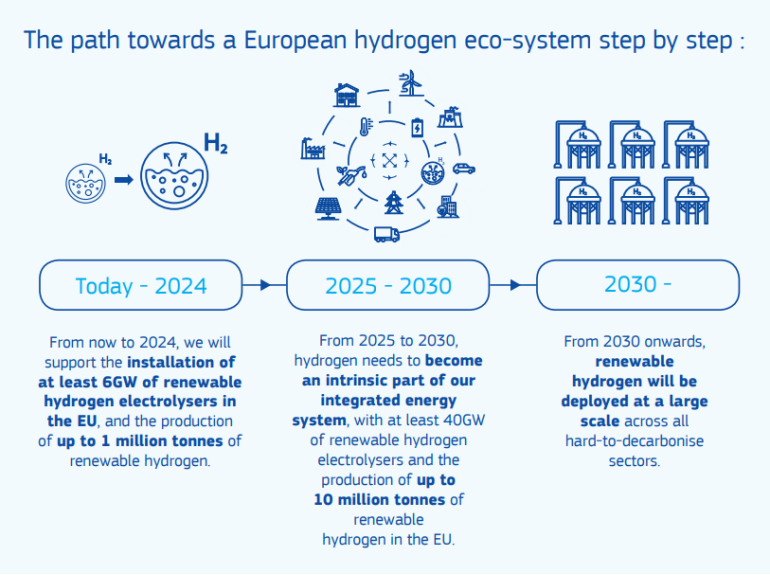

Figure 3.The path towards a European hydrogen system, as demarcated by the European Commission (2020).

Another challenge connected to the scientific and technology aspect of green hydrogen is regarding the standards of quality and origin of the hydrogen used and the strategies that are related to it. Li et al. (2021) pointed out that China, a major energy consumer, has published a strategy on hydrogen, but this strategy is focused, in its biggest part, in hydrogen produced from conventional fuels, whose usage is already taking place in some industries. In addition, Abad & Dobbs (2020) see a lack of commonly accepted standards on the quality and origins of hydrogen, which, if not dealt with, has good potential of derailing any effort to move to green hydrogen as the main energy carrier and it might result in conflicts.

2.4.Hydrogen as an energy carrier

2.4.1.Scientific background

In order to lay the groundwork for the geopolitical analysis of a green hydrogen-based energy system, it is paramount to understand the scientific and technology aspects of it.

As mentioned, green hydrogen is the one that can be produced by electrolysis powered by renewable energy sources. According to the Italian National Hydrogen Strategy (2020), the green hydrogen supply chain can be developed via three manners:

- Complete on-site production, which entails a green hydrogen production facility next to the solar/wind park
- On-site production with renewable electricity transportation on site
- Transportation and storage of hydrogen in a centralized location

These potential structures have two main consequences for green hydrogen as an energy carrier. Primarily, it is closely connected to renewable energy sources and their own geopolitical issues. Secondarily, electrolysis requires electricity, which might result in an interconnected grid and a significantly more important role of electricity on the energy landscape. To add to that, electrolysis needs electrolyzers as well, which consist of metals that are not easy to possess. This can encompass geopolitical implications as well. Based on this understanding, several risks and threats are identified on a geopolitical level.

Concerning renewable energy sources, the issue of greatest geopolitical importance is the acquisition of rare earth metals(REM). REMs are paramount for the security of supply of high efficiency power electronics and other modern energy technologies, wind and solar being one of them. It is paramount to point out that REMs are not necessarily rare, but the geological conditions whose consequence is the concentration of these metals to levels warranting economic extraction is particularly what makes them rare(McLellan et al., 2014). Geographical concentration makes the acquisition of these metals very highly geopolitically sensitive. The lower expected income compared to the oil industry reduces the risk of a resource curse to emerge, but that is not the case for all countries, as several countries in Africa and South America are still very vulnerable to that (Manberger & Johansson, 2019). In addition, global powers with a high concentration of REMs, such as China, are projected, according to analyses, to utilize their REM dominance as a geopolitical weapon in the future(Turner, 2020). On the other hand, global powers that do not possess REMs will follow a security strategy with the ultimate goal of securing these metals, hinting at security strategies in resource-rich regions such as Central Asia and Africa (Criekemans, 2021). These raise serious geopolitical concern over renewable energy and, consequently, its utilization for the purpose of fabricating green hydrogen.

Another crucial geopolitical factor is grid interconnection. With green hydrogen, “clean” electricity is expected to become an active component of an energy carrier, or even an energy carrier of itself(Blondeel et al., 2021). This can increase the incentives and motivation for grid interconnection, so that more state actors can produce their own green hydrogen. However, research has shown that grid interconnection might have a detrimental effect on security (Zheng, 2020) and there are four specific reasons to advocate in favor of far-reaching geopolitical ramifications of such a move. The first one revolves around the idea of the zero-sum game. Many countries might perceive the neighboring country’s gains in cross-border grid interconnection as its own losses and this might result in friction between the two countries. The second reason concerns the fact that grid dependence is virtually always asymmetrical and formulates power dynamics in the region. The less dependent state, then, might capitalize on its relative gains and extract political concessions from its neighbors, a situation that took place in the Mekong river basin between China and Vietnam. The third reason is the lack of political trust in numerous neighboring relations. Armed conflicts, tribal or religious rivalries and bitter political rivalries can destabilize a region and have terrible consequences for the grid interconnection, resulting in major disruptive events. This can also drive-off investors. The final reason is about the energy security – economy dilemma. Many countries, like Japan, having had to face the oil price shock crisis in 1973, opt for energy self-sufficiency so it would be highly unlikely that they would actively participate in an interconnected grid, without hesitance(Fischhendler et al., 2016). The aforementioned points can pose as great geopolitical implications on an interconnected grid with the objective of creating green hydrogen in multiple sites and hence ought to be taken into consideration.

The increasing demand for green hydrogen is poised to also increase the demand for electrolyzers. This surge in demand for electrolyzers necessitates an analysis on the existence and abundance of materials and technologies that can also fulfill the three pillars of sustainability(technological, environmental and social). One of the most promising electrolyzer technologies, the Proton Electron Membrane(PEM) one, increases the need for Platinum Group Metals(PGM), such as platinum, iridium, scandium and yttrium with a very high projected supply risk (Kiemel et al., 2021).

Another issue that is important to point out for green hydrogen is the need for water, in order to perform the electrolysis. Normally, 10-15L of pure water are needed for the production of one kg of hydrogen output and input water needs to be deionized. Combined with the fact that countries, such as the MENA and the Sahel region, that have enormous renewable technical potential, already face water stress, putting additional pressure to the water infrastructure creates security concerns(Noussan et al., 2021), such as potential social unrest that could fuel rebel and extremist groups to bring political instability. Ziada (2021) distinguishes water-related conflicts to hydro-political and hydro-energy conflicts. The former involves conflicts where countries with natural control over the water resource use their geographic advantage to stress targeted countries into producing a certain political or diplomatic reaction that enhances the geopolitical or military objectives of the offender country(Turhan, 2020). The latter describes conflicts generated around water basins for the exploitation of the energy resources that are embedded within them. In the case of green hydrogen, special attention will be paid to the former, as there will be a huge demand for water to produce the much needed energy carrier. This has high potential of increasing the necessity for water desalination in regions such as MENA. And while countries such as Saudi Arabia and the UAE are able to invest in water desalination projects, several other countries face financial issues or lack the maritime sources to produce desalinated water, which makes it all more of a complex issue.

2.4.2.Technology Background

With grid modernization due to renewables and grid interconnection to produce green hydrogen, the technological complexity of the energy system increases exponentially. In much of the developing world, with Africa being the prevalent example, growth is driven by “green energy innovation ecosystems”, which combine telecoms, digital platforms, solar power, and the internet of things. This requires, among other things, an excellent system of data regulation. As Chinese expertise and funding is involved in the development of such systems, such as data centers, there is fear from African governments and businesses over abuse of the digital platforms and data, as well as fear for cyberattacks. It will be critical whether the EU, through its EU Cybersecurity Strategy, China, or other global powers will assume responsibility over the African cybersecurity(Tanchum, 2022) . The situation is similar in most of the developing world, which is poised to be increasingly active in the green hydrogen market and possesses and obsolete energy and electricity grid that needs modernization. Black and Veatch, a consultancy firm, has ranked cybersecurity as the third most pressing issue for electricity and energy utilities. The cyber attack on the Ukraine electricity grid in 2016 that left 225.000 people without power proves this point, whereas Stuxnet, in 2010, was the proof that there can be cyberattacks in power plants as well(Hatipoglu et al., 2020).

2.4.3.Market Drivers

An electricity system with a significant presence of renewable energy sources requires numerous changes, the most important of which is reforms in the market structure. Research has illustrated that, for OECD countries, market liberalization has the second largest effect on renewable energy deployment only after the per-capita income, and is driven chiefly by reduction to entry barriers(Nicolli & Vona, 2019). Academic debate has highlighted corruption among the detrimental factors for the resistance to adoption of environmental-friendly policies(Nicolli & Vona, 2019).

However, in regions with high potential for green hydrogen production, several difficulties exist on liberalization of the market and unbundling of the respective utilities. In Africa, for example, reforms involve mostly amending the electricity law, corporatizing service provision and solely the creation of new institutions that are assigned with doing the reforms instead of the government. Little commitment is being shown to actually liberalize the market and unbundle the services and state-owned vertically integrated companies continue to integrate the scenery(Nworie, 2017). Central Asia is facing a similar situation, as strategies and national plans have been adopted by all states to comply with the framework set by the UNFCC, however very little political commitment has been proven so far. Furthermore, in all countries system operators are controlled either via one state-owned company(e.g Kyrgyzstan, Tajikistan) or via two state-owned companies(e.g Kazakhstan). No efforts to liberalize the market have taken place and this poses as a major obstacles should renewable energy sources deploy with the objective of creating green hydrogen (Shandrina, 2020). Even in Latin America, where there has been liberalization in most sectors, among which electricity, utilities have gone under control of large family-owned business groups with ties to the government, which makes the market hardly liberalized and the need for even more reforms eminent (Schneider, 2008). Considering the connection of the aforementioned factors to political corruption, a major characteristic of authoritarian regimes, makes the matter highly geopolitical and is also a structural aspect of green hydrogen that has to be taken into account when weighing the geopolitical implications of a shift to such an energy carrier.

2.4.4.Carrier options explained financially

Considering that the move to a world order dominated by renewable energy sources that are not transportable creates a mandate for hydrogen transportation, the transportation across vast distances, which at times include the sea, becomes a necessity. It is, hence, paramount to examine which way of transportation is the least expensive and has the higher potential of becoming the preferred solution.

Assessment conducted by the European Commission (2021) proved that pipeline transportation is significantly less expensive than all shipping options, with prices ranging from 0.55-0.6 EUR/kg H2. Repurposing old natural gas pipelines is bound to draw costs even further down, making this choice by far the most cost-effective. D'Amore-Domenech et al. (2021) confirm the foregoing notion, going one step further and asserting that pipeline transportation makes sense even in sub-sea transactions of distance up to 1000km and equivalent to up to 2GW.

Liquified H2 is considered as the second cheapest option at 0.75-0.9 EUR/kg H2 and will thus be deemed as the most suitable carrier for shipping transportation, whereas the cost for LOHC surpasses 4 EUR/kg H2 in most scenarios(European Commission, 2021). Hurskainen & Ihonen (2020), however, argue that LOHC has the potential to become even cheaper than LH2 and make transportation costs even lower. Nonetheless, their solution relies heavily on the heat supply method that releases the hydrogen and thus is largely dependent on the usage of waste heat, which is not easily attainable. The selection of LH2 remains the most viable solution.

2.5.Natural Gas as an energy carrier

A gas-fueled energy system is much less complex than a hydrogen one. Game-changing technological breakthroughs can be considered only those that facilitate the actions of pumping, piping or transportation.

The spread of the natural gas usage in Europe in 1960 was seen by the Soviet Union as a great opportunity to find a buyer for its natural gas, leading it to invest in piping technologies and develop pipelines, which eventually led to supplying Europe at a low cost. The cost was especially significantly much lower than that of Norwegian or British gas. This happened because undersea-gas pumping technologies required a higher investment to become mature and low cost and hence the two countries' gas was not competitive, comparing to the Soviet one(Gustafson, 2020).

Moscow capitalized on that competitive advantage and, since pipelines are rigid infrastructures that take decades to built and governed by long-term contracts, its prevalence in the European markets was hard to change(Gustafson, 2020).

Two main breakthroughs seem to be strong enough to question the Russian dominance in Europe. The first one is the shale gas revolution, which started from the Marcellus natural gas field in 1990 and continues with investments in research & development in the field on behalf of the USA, has given the opportunity to numerous states to become self-sufficient or even net exporters of gas and energy in general, with the USA being the first one. This technology is serving as a major geopolitical "weapon" for Washington, as, through it, it can exert influence in countries that want to follow a similar path, such as Uzbekistan(Lillis, 2022). The second one concerns the technologies related to lowering costs for LNG transportation. The capital-intensive nature of liquefication, tanker transportation and regasification resulted in a very high cost for gas, which made this option preferable on the Asian markets, where pipeline connection is extremely challenging due to geographic, geological and geopolitical factors(Jensen, 2003). However, through efforts such as lowering charter rates and liquefaction costs before shipping, many countries including the USA,

have managed to lower the costs, with the exception of periods of high demand in large markets like the Chinese(Rogers, 2018). At the same time, a laggard behavior is observed by Russia on these technologies, which may result in losing potential buyers and having to reduce its output and revenue. Despite the fact that the country increased its LNG output to almost 40bcm in 2021, the USA's exports are more than double and are a reflection of the investments in technology and infrastructure that the two global powers have made.

2.6.Theoretical background to institutionalism and international relations

The next sections aim to further explain the usage of the new institutionalism framework and its suitability for the cases of the global natural gas and future hydrogen systems. This chapter later elaborates on all potential approaches to new institutionalism and advocates in favor of the ones chosen to be a better fit for the research. Furthermore, it provides details into the two schools of institutionalism, namely the neoliberal and the neorealist one, with their main features and their significance for our research. Finally, it gives insights into the storyline approach in institutionalism, as well as why is it important for the research.

2.6.1.Theory of Institutionalism

2.6.1.1.Old vs New Institutionalism

The field of institutionalism in political science emerged in the late nineteenth century, when scientists made the attempt to describe and map all formal institutions of the government, but also the modern state, both within the countries themselves and on a comparative basis. Initially, there was a major debate on what constitutes an institution. A solid definition is given by Douglass North:

> "Institutions are the humanly devised constraints that structure political, economic and social interaction. They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights). Throughout history, institutions have been devised by human beings to create order and reduce uncertainty in exchange. Together with the standard constraints of economics they define the choice set and therefore determine transaction and production costs and hence the profitability and feasibility of engaging in economic activity. They evolve incrementally, connecting the past with the present and the future; history in consequence is largely a story of institutional evolution in which the historical performance of economies can only be understood as a part of a sequential story. Institutions provide the incentive structure of an economy; as that structure evolves, it shapes the direction of economic change towards growth, stagnation or decline." (North, 1991, p.97)

There is a distinction between "old" and "new" institutionalism. The main aim of old institutionalism was on charting the legal and administrative formal arrangements that existed within the government, but also within the public sector and its organizations in general. This was also deemed to be the biggest disadvantage of old institutionalism, as the emphasis was on descriptive processes about institutions rather than explanatory and theory building ones. Moreover, another shortcoming could be considered to be the fact that old institutionalism was presuming that constitutions would be followed in a strict manner and were the most important, if not the only, starting point for political action within a country. Lastly, the approach in this kind of institutionalism was considered to be rather holistic, working under the assumption that all institutions ran smoothly and were created to produce effective governance in all governance models(Peters & Pierre, 2020).

2.6.1.2.Different approaches of New Institutionalism

Despite discussing about new institutionalism as a collective and integrated approach, it is rather a variety of theories and approaches that compete with, but also complement each other. Peters and

Pierre (2020) distinguished five prominent approaches that have been widely used by numerous scholars and researchers. The first one is the normative approach, according to which, individuals within an institution calculate carefully the consequences of their future actions and their decisions are determined by these calculations. This approach also assumes that these individuals act and behave independently of their institutional structure, but still endogenously, based on the philosophy of the institution. The second approach is the rational choice institutionalism, the political science version of neoclassical economics, where the individual is assumed to be a utility maximizing entity, making decisions based on its personal views and fully exogenously, not taking into account the views and the structure of the institution it is a part of. The third approach is historical institutionalism, where it is assumed that all institutions continue their initially-set paths until a shocking or disruptive event brings them apart. Researchers on the field have elaborated on how crucial it is to find the why of the change and the nature of the disruptive event. The fourth approach is the empirical institutionalism, which focuses on the consequentiality of the formal institutions. It is similar to old individualism, but in this case much more attention is paid in the role of structure in shaping the behavior of individuals and the institution as a whole. Lastly, the fifth approach is the discursive institutionalism, where institutions are identified by their shared ideas and patterns of communication rather than by their specific hierarchy, which means that culture, traditions and other similar notions are also taken into consideration for the analysis of the institutions.

Out of the five prominent approaches, the one that was considered most suitable for this research was the discursive institutionalism one. This is due to the fact that the other institutionalist approaches do not take into consideration the probability of disruptive events, which is a regular ocurrance in geopolitics as history has portrayed.

2.6.1.3.The Neo-Institutionalism approach to a geopolitical analysis

The two divergent approaches of new institutionalism to geopolitics and international relations are neoliberalism and neorealism. When these approaches are presented in the form of a discourse, e.g a storyline, they can fit perfectly with the concept of discursive institutionalism. This will be further explained in the methods section in chapter 3. Hodgetts et al. (2018) attempt to make the connection with the two schools of geopolitics, maintaining that neorealism theory in IR is consistent with the theory of classical geopolitics, whereas elements of neoliberalism are found in the critical geopolitics theory.

2.6.1.4.Neoliberalism

Springer (2013) asserts that neoliberalism emerged as the main response to the atrocities of World War II and expressed the belief of many, that government intervention can only put personal freedoms in jeopardy. The neoliberalism approach to social sciences encompassed three main points. The first one was the focus on the individual, who was deemed as the most suitable to effectively express his or her desires and governance models should be oriented towards tackling factors that impede this goal. The second element was the notion that unregulated markets are the most efficient means for an individual to achieve self-sufficiency, with the “invisible hand” of the free market formulating the price in a fair manner. The third point revolves around the non-interventionist nature of the state and emphasizes on the need to guarantee free markets and the respect of individual and collective rights. The last point is highly relevant to the geopolitical landscape, as it depicts that the main assumption of neoliberalism in IR is that a free market and a respect for all institutions is taking place. The non-interventionist claim also implies that there is a

lack of military interventions, potentially hinting towards the lack of conflict or disruptive events that would cause it.

Professor Frank H. Knight developed the sportsmanship assumption in order to put the neoliberal theory in a more realistic context. He admits that people are utility maximizing entities, but he realizes that there might be exceptions to this rule. Based on that, he developed the idea that most people want to be competitive but according to healthy kind of competition, deeply rooted in the "rules of the game". These rules of the game are the ones set by international institutions and regional blocs and respected by the majority of the member states(Dow & Duncan, 1974).

2.6.1.5.Neorealism

The theory of realism is almost as old as history itself. The notion is first mentioned by Thoucydides, who was skeptical about whether there can be norms of justice in relations among states for which power in crucial. The theory was revisited during the 20th century, where classical realism was created and set the ground for neorealism. Hans Morgenthau (1948) was the first one to map systematically the principals of realism. According to him, these are:

- Politics is governed by objective laws which have roots in human nature
- National interest is defined in terms of national power
- Interest is always dynamic
- Abstract moral principles cannot be applied to politics
- Difference between moral aspirations of a nation and the universal moral principles
- Autonomy of international politics

These principles were paramount to better understand IR and international politics and showed that there was a lack of explanatory framework for accidental or unexpected events or unable to explain behaviors within the political sphere. Using these principals and studying realism in a systematic manner, Kenneth Waltz (1979) developed the neorealism theory, which uses the aforementioned principles to explain specific foreign policies rather than containing himself in abstract theories. It should be pointed out that neorealism is applicable solely to the international politics field and generally would fail to explain domestic politics. Waltz also reflects on Raymond Aron's work (1962) who argues that the political, economic and social landscape of a country cannot be separated and their goals in all of these sectors are largely affected by the other ones, showing that full collaboration in an international scale might be a utopia.

The main argument of neorealists in international system is the existence of an anarchic order. This makes it impossible to achieve international security and thus motivates state actors to act based solely on their own capabilities. This can be translated into unilateral or bilateral actions, not taking into consideration what the coalition or neighborhood has set as a collective target. In addition, Greco(1988) stresses that the "fundamental goal of states in any relationship is to prevent others from achieving advances in their relative capabilities". Overall, neorealism perceives international politics as a contest among states for relative position, which provides the grounds for actions such as military force and the formulation of balancing coalitions.

For this research and for the formulation of the framework and the storylines, both theories are going to be taken into consideration. The main reason is that using both neorealism and neoliberalism as complementary ideas to research different concepts and issues in social sciences has been considered as an efficient method. Krupnick (1996) first asserted that neorealism and neoliberalism could be complementary for solving real security issues. According to him,

neoliberalism explains in a better way how Europe evolved after the Cold War in its security strategy, however it needs a realistic perspective as a conscience to prevent latent idealism from getting out of hand. Solingen (2008) even stressed out that a combination of neorealism, neoliberalism, constructivism and domestic politics approaches can lead to answering questions about the reason that institutions emerge and their effects on the global landscape.

2.6.2.The use of storylines

From all different styles of discursive institutionalism approaches, this research will aim at answering the research questions through the storyline concept. Storylines are considered elements of discourse and have been instrumental in answering questions related to institutional theory, analytical governance and policy networks. Reflecting on the fact that the research questions are all correlated to these fields, the storyline approach is a great fit for this thesis. The storyline concept shall be used to identify similarities, differences and common patterns between the natural gas global system and the future green hydrogen one. Hajer (1995) stated that discursive storylines have been explained as recurring figures of speech that dominate public understanding, but also manage to find logic and naturalize the existing world order of our society. Agents usually conceptualize storylines by building upon discourses, with the objective of giving meaning to physical and social phenomena, such as climate change or the geopolitical world order. According to Hajer (2006), with the concept of the storyline we touch on a condensed statement that includes a series of complex narratives, which people use in their everyday shorthand discussions, but also interactions of any kind. Using and researching these discussions and interactions among actors, which in this case are state actors, institutions and their main decision-makers, storylines can be formulated that can shed light on a discursive structure and its dynamics over time. In our case, the discursive structure is mostly about the evolution of the natural gas and the future green hydrogen systems. The dynamics that change over time will be presented with the two option. The first one will involve respecting institutions and solving potential conflicts through communication within the institutions or between them. The second one will involve more unilateral, bilateral or regional movements and military interventions in case there are conflicts of interest or disagreements.

The two storylines that are going to be used as frameworks stem from the different perspectives of institutionalism and its application on social sciences. In the context of the global energy system, they were first used by Correlje & Van der Linde (2006) and their version for the systems under study in this thesis are presented in the chapters 7 and 9.

2.7.The importance of geopolitics

Geopolitics is a field that affects supply chains across a variety of sectors. It ought to be pointed out that there has been a systematic failure to identify the exact definition of geopolitics, a lack of theorization of the analytical framework and this fully complex topic remains underdeveloped (Vakulchuk et al., 2020). Out of the numerous definitions that exist in the field, Dodds'(2005) is deemed to cover all aspects of the geopolitics sector, according to which:

> "Geopolitics provides a way of seeing the world in which a great deal of emphasis is placed on exploring and explaining the role of geographical factors (such as territorial location and/or access to resources) in shaping national and international politics."

Throughout history, the geographical meaning for strategy has been a perpetual theme and has always been in the mind of most political and military leaders in their operations(Gray & Sloan,

2000). This is due to the fact that, historically, all leaders were concerned with coming up with strategies to control and have access to specific geographic locations of great importance(because of natural resources, being an important passage etc.).

There are several branches and schools of geopolitics and are mainly related to the disciplines that geopolitics have been associated with. Research on the field has taken place in two main lines. The first one is related to international relations and follows the notion of realism on the field. This notion is mostly correlated with the conservative sphere of politics. It is grounded in realpolitik, which focuses on the states and their need, above all ideologies, to defend their national, military and strategic interests(Gayan, 2007). The second one is called critical geopolitics is mostly similar to political geography, taking a more critical approach to foreign policy practices. The French school of geopolitics has adjusted the critical theory of geopolitics to take foreign policy even less into consideration and focus at large on local dynamics and local actors, not necessarily state-related ones(Lacoste, 2012;Subra, 2016;Lacoste, 1993). An overview of the different branches and schools of geopolitics can be found in Figure.

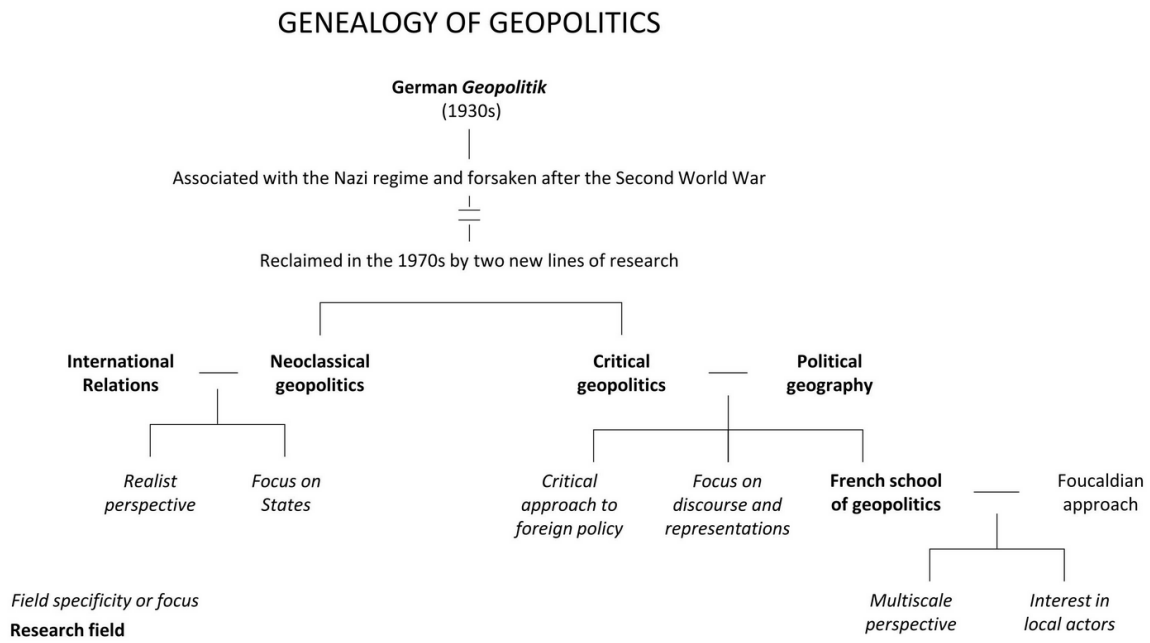

Figure 4.Genealogy of Geopolitics. Source: Angelique Palle(2021). Bringing geopolitics to energy transition research.

Geographical factors have been instrumental in shaping the energy landscape as well. Kaplan(2014) asserts that every international order in early modern and modern day history has been centered around an energy resource. The Age of Coal and Steam was paramount for the rise of the British Empire in the 18th and 19th century. Once the power of coal was discovered, the global powers strived to control the large international (colonial) markets. Their main method was via modernizing their military with coal and steam powered vessels that were far superior than the existing wind powered ocean vessels, giving them an advantage. That is another direct connection between security and geopolitics and the energy sector. The Age of petroleum, on the other hand, from the 19th to the 21st century was the backdrop of the American Empire, but it also continued supporting the growth of the British one. More specifically, Winston Churchill himself, in the thick of the rising power of the German navy, established a commission with the responsibility of exploring the possibilities of creating a British oil based navy(Bilgin, 2012). This is another sign of the uttermost importance of energy on the security and geopolitics field. The division of energy producers and

suppliers, as well as the ones who have access to energy or not, in a spatial manner, have always formulated major challenges to nations(Karanikolas & Vagiona, 2016). Bradshaw(2009) commented on the importance of geopolitics in energy in particular over the next decades, because of the changing patterns in energy demand and supply. He asserts that the shift in demand from EU and the USA to India and China, due to their enormous growth, affects and will continue to affect geopolitics and make the study of the geopolitics of energy paramount.

Bridge et al. (2013) first stressed the criticality of geographical factors for the energy transition, such as location(absolute and relative), landscape, territoriality, spatial differentiation, scaling and spatial embeddedness. There is a political dimension in any transition by nature and this has been explored for many years through governance approaches that focused on building consensus and mediating among different actors, with the objective to accept that transition(Palle, 2021).

2.7.Security of Supply

2.7.1.Security of supply and the gas sector

Considering the very high dependency of the EU on energy imports, security of supply is a concept that is pivotal to the bloc's energy policy. As there is no universally accepted definition of security of supply on the energy sector, the one that is understood as most acceptable is that it is "the uninterrupted availability of energy sources at an affordable price". In this way, the environmental, societal and military aspects of the notion are encompassed(Patrahau & Van Geuns, 2021).

In the European energy landscape, gas is considered instrumental. It accounts for 21.5% of the continent's primary energy consumption and it provides more than half of the heating needed for households. At the same time 80% of the fuel comes from imports, which increases the vulnerability and reduces the security of supply(ACER, 2022).

A positive development in this sector has been the growth of the LNG trade flows. These flows had presented a double digit growth every year from 2016-2019 and they continue to grow, reaching 420bcm/y by 2019(IEA, 2019). For Europe, solely in 2021, the total flows reached 391.2bcm(Heringa et al., 2021). This is overall good news, as buyers on the LNG market demand more flexibility through an equity-lifting model resulting to a rise in security.

There are two negative developments as well, nonetheless. The first one is that indigenous production within the EU is facing a sharp decline due to the decommissioning of the gas field in Groningen, increasing the need for imports on the region. This also increases the needs for conversion facilities in the Netherlands, as the industry in North-West Europe worked with the Dutch low-calorific gas (L-gas), whereas the vast majority of the imported one is expected to be high-calorific (H-gas)(IEA, 2019). In addition, gas fired power generation will play an increasingly important role due to the decommission of coal-fired and nuclear-fired power plants(Patrahu & Van Geurs, 2021), which will make the EU even more vulnerable to potential disruption events in the gas supply chain.

The second negative development involves the Russian invasion of Ukraine. With the severe crisis that the whole continent has been going through because of Moscow, the damage done is twofold, both in energy prices but also in exposing energy vulnerabilities. Russia has already proved it is willing to use energy supply to serve political purposes. Economic sanctions could potentially be used as a counter-measure, nevertheless Russia has enhanced its resilience to such measures through filling up its foreign currency reserves. Josep Borrell (2022) has indicated that expanding the renewable energy fleet is paramount in reducing dependence on Moscow, but he also pointed out towards diversifying the gas supplies even more. Such claims were made also in the joint EU-US

statement to create a task force that will reduce European dependence on the Russian fossil fuels. During the discussion it was announced that the USA will try to provide the EU with additional 50bcm/y of gas(The White House, 2022).

Such statements both do not show certainty and they also mention amounts of gas that are nowhere near enough to substitute for the fuel supply from Russia. Another point that deserves consideration is the fact that import dependency within the EU is characterized by severe fragmentation, where Central and Eastern Europe is largely dependent on Russian pipelines, Western Europe relies on LNG imports and North-West Europe previously almost self-sufficient, now will rely on US LNG gas(Patrahau & Van Geuns, 2021). This creates a fully divergent set of dynamics and dependencies translates to the fact that maintaining gas security of supply is a highly sensitive issue and research ought to take place to understand how it can be achieved under a variety of scenarios.

All the aforementioned issues have led to a complete shift on the policies related to the security of supply for the EU from a neo-liberal perspective to a more neo-realist one, showing an indication to prevail over the Russian threats and achieve resilience rather than collaborate with all available partners.

2.7.2.Security of supply and the green hydrogen sector

Green hydrogen is poised by many to be the fuel that will end geopolitical disputes and will annihilate security of supply concerns in the future. According to Mazengarb(2022), Fransesco La Camera, director-general of IRENA, in particular asserted that “It is green hydrogen that will bring new and diverse participants to the market, diversify routes and supplies and shift power from the few to the many”, adding that “with international co-operation, the hydrogen market could be more democratic and inclusive, offering opportunities for developed and developing countries alike”.

However, this does not necessarily seem to be the case. While the oil & gas world order was mandated by geological characteristics of each country, the green hydrogen one shall depend primarily on the renewable energy potential of each country. Reflecting on the national hydrogen strategies and the report from IRENA (2021) on the security of supply of green hydrogen, the situation does not seem to differ much from the existing one. The new trade routes, pointing at the exporters and importers of green hydrogen, are almost the same as the old ones, becoming the messenger bearing the news that the security of supply still needs to be addressed in the same way as it used to for the oil & gas industry.

To add to that issue, the overall notion that a shift to green hydrogen is the free pass to get detached from all potential dependencies is not supported by all. Westphal (2021) maintains that the EU specifically has more to lose by cutting off supplies from neighboring regions, such as Russia and Algeria. This is bound to lead to societal impoverishment and potentially to turmoil, which will affect the EU on the long-term, creating a reinforcing loop.

Another issue that is directly related to the security of supply is the uncertainty in demand. The green hydrogen sector is still in its infancy and there is little recognition over it. This has as a consequence that there is no current demand on products that derive from its usage like green steel or green ammonia. Moreover, several hydrogen strategies do not distinguish green hydrogen from other means, such as blue, which is much cheaper, making it even more difficult for the clean form of hydrogen to penetrate the market. Not having a clear understanding on the final demand make the infrastructure development have very little momentum(IEA, 2021). This entails a huge risk for two reasons. The first one is that when impetus is developed because the countries will want to reach the net zero target, there will be very little supply to satisfy a big demand. The second one is that many

disagreements and, potentially disputes, might arise from this debate. For example, the Netherlands are implementing the SDE+ strategy that provides all the incentives necessary for investors and end-users to prefer green hydrogen. On the other hand, countries like Japan have signed numerous Memoranda of Understanding with countries like Australia, Brunei and Saudi Arabia and have been focusing on promoting different forms of hydrogen, stemming from either carbon capture and storage or from fossil oil and gas. This might make security of supply more easily attainable for certain countries and bring them at odds with other countries that are focusing on the origination of hydrogen as well, making it more challenging to secure supplies.

2.8.Conclusion: Why are geopolitics important for the future energy security of supply?

The literature review has depicted that there is a markedly sizeable possibility that the emerging green hydrogen global system will have numerous geopolitical implications. The components that are needed for the system, based on the scientific background analysis, are either geographically concentrated in areas where there are already various disputes taking place. In addition, there is little consensus over the certification process of hydrogen quality and origin, which can also be the cause of conflict and the ending of alliances. Finally, these very future systems, being technologically much more progressive than the current ones, are prone to cyberattacks and other technological disruptions which are deemed as geopolitical “weapons” . All of these factors are strongly correlated with supply disruptions such as power cuts and have far-reaching ramifications for local communities. Hence, geopolitics are significantly important to better understand the energy security of supply with green hydrogen and anticipate the potential disruptive events.

Chapter 3:Methodology

This chapter introduces the research methods used in this thesis. Initially, the analytical framework will be laid down. For this, a qualitative deductive approach was used, in which pattern modeling and case study methods were combined to ultimately be used in the pattern matching process that was used to compare multiple cases. All the aforementioned information will be used to support the use of the institutional theory-related storylines of Regions and Empires, as well as Markets and Institutions. Overall, this chapter focuses on motivating the fitness of a combination of these methods for answering the research question and all its subquestions.

3.1.Analytical framework

As mentioned in chapter 1, this research began with an interest to examine the geopolitical implications of the evolution of the green hydrogen system and see similarities, differences and common patterns with the natural gas system. In addition, some knowledge on institutionalism in the political science and the international relations field existed. The results of the literature review contained the emergence of an analytical framework grounded on qualitative analysis and its application in the sphere of political science and geopolitics, in which a better understanding was developed in the course of this research. This qualitative approach is mainly done through the pattern modeling method, which is explained in this chapter. Moreover, the need for comparative analysis between the two systems is being addressed through, primarily, comparative case study analysis, and secondarily through scenario creation. Hence, this chapter presents the analytical framework that was used for this research. This is going to compose the framework based on which this research is being executed, in combination with the theoretical background provided by the literature review.

3.1.1.Need for further research

The research conducted during the literature review depicted that there was a divergence of opinions on the energy transition and a green hydrogen-dominated future energy market. While researchers such as Overland(2019) claim that the geopolitical risk in green hydrogen-related technologies is limited and that the emergence of a resource curse is highly unlikely, Van de Graaf(2020) maintains the notion that a geo-economic rivalry over green hydrogen and relevant raw materials, such as rare earths, has a high possibility of becoming a geopolitical implication of the energy transition, once large-scale hydrogen trade takes place. In addition, whereas both the aforementioned researchers focus on trade routes, electricity and rare earths, Blondeel et al. (2021) stress the great importance of the digitalization and cybersecurity factor. It is, ergo, unclear neither what the exact factors that will determine the geopolitical landscape for green hydrogen nor what their level of importance is.

3.1.2.Qualitative research

The (geo)political dimension of the energy sector consists predominantly of non-economic factors that have a major positive or negative impact on any kind of process within the global energy system. Taking this into account, formal quantitative methods could be used at the cost of empirical truth and qualitative research was the method that was deemed as most suitable. Denzin and Lincoln (2005, p.3) have given an adequate definition for qualitative research, according to which:

> Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.

3.1.3. Qualitative Deductive Approach

A choice was made to move forward with an analytical and deductive approach. The rationale for this choice will be further clarified in this section. Bueno de Mesquita (1985) argues that logically rigorous deductive reasoning is more likely to produce novel hypotheses. Krasner (1985, p.142) explains Bueno de Mesquita's rationale in an adequate way:

> "The behavioral revolution was strongly informed by a neo-positive, empiricist, and justificationalist epistemology. There was a pronounced tendency to work from the bottom up, to make observations and then see how they added up to support or reject more general propositions. The literature in international relations, both quantitative and nonquantitative, is filled with studies examining various bivariate or multivariate relationships that are never related to any larger research programs. These studies examine specific problems as if they are presented by nature. It is precisely such exercises that are most subject to arbitrary decisions concerning operationalization and statistical assessment. Inductive studies that are informed by more general theoretical concerns, that are part of a larger research program, have made much more important contributions. However, even here Bueno de Mesquita is right in arguing that logically rigorous (and ideally mathematical) deductive reasoning is more likely to produce novel hypotheses."

In this research, a deductive approach was considered the most suitable method. Alfred Tarski (1941) provided an adequate and highly detailed description of such an approach on research, but on the domain of mathematics. According to this, the first step involves the concept of sentential calculus, where a proposition or a set of propositions is made, all of which fully unanalyzed at the beginning. The theorem that explains the proposition/equivalence would be introduced after the actual proposition. Tarski did not deny the fact that this method can be used in other, non-numerical kinds of research, such as theoretical and qualitative ones.

More specifically, Hyde (2000) argues that qualitative research covers untested theory investigation, which makes the deductive approach an exemplary candidate to explore such theories. He uses the example of a neo-realist case to prove his point, which makes the choice of this approach even stronger as this thesis will deal with a neo-realism case. Finally, he proposes the approach of theory testing through 'pattern matching', which is fully consistent with this research.

Among the fields where qualitative research is cardinal is the field of political science and political economy. Bohm-Bawerk & Leonard (1890, p.256) noted, regarding the usefulness of deductive approaches in the political economy, that:

> "The problems of political economy, from a technical point of view, fall into two classes. Upon those of one class the mark of the historical school is indelibly stamped. Nor would I proceed otherwise than by the historical-statistical method if I had to study, for example, the influence of retail trade

upon price or the economic influence of the division of property in land. Even here we cannot do wholly without deductive reasoning, as is shown by the masterly combination of sharp-sighted deduction with solid empiricism in the works of many of the strongest advocates of the historical method-Nasse, Conrad, Miaskowski, Schanz, Schonberg, and others."

Jahn (2010) focused on the benefits of deductive methods in comparative politics. He stressed out that an inductive approach can yield good results in a series of datasets with scores on each indicators, but the meaning of each of these indicators is not as clear and it is very challenging to connect them to political concepts such as Left and Right, or Conservatism and Liberalism, because they are rather dynamic concepts. A deductive approach would make interpretation much easier and conceptualize such concepts differently based on the context.

The qualitative deductive method is by many considered as the most suitable method to conduct analysis on a theory and then review and reflect on the theory's results (Creswell, 2007; Hyde, 2000; Løkke & Sørensen, 2014; Miller & Crabtree, 2005; Bitektine, 2008). During the execution of this method, the researcher uses an existing theory, gathers empirical data with the objective of proving it and then reflects on its verification or comments on the elements that reject it(Creswell, 2014).

3.1.4.Case analysis

Despite the fact that case study is comprehensively used and is uppermost to social scientific research, its use has not been as widespread on the field of geopolitics(Flint, 2021). Yin (1989) maintains that a case study is a research method and in the case of a multiple case design(like in this thesis), it results in constructing a framework in which either literal replication yields similar results for all the cases under study or in a theoretical replication where there are different results and are explained by a variety of theoretical reasons. On the contrary, Stake(2005) claims that a case study is a selection of what will be studied and not a methodological choice. In this thesis, a case study will be used to reflect upon multiple(two) cases and see if similar results, differences or similar/different patterns emerge.

According to Stake, a case should be a system with specific boundaries, but it is also understandable that it can be often very challenging for the researcher to set exact boundaries on the cases under study(2005). On the other hand, Yin(1989) stated that a case study ought to be used only under four conditions. The first one is when the research questions are of an exploratory or an explanatory kind. The second is when the researcher cannot manipulate the behavior of those involved in the study. The third is when the researcher wants to include the context of the phenomenon under study, as it is believed to be relevant, whereas the fourth is when the boundaries between phenomenon and context are unclear.

During the thesis, two energy system cases, the natural gas and the hydrogen one, will be studied. As the main research question as well as the subquestions are clearly of an exploratory nature, a case study is highly relevant. Nevertheless, as the geopolitics of the global energy system and their implications on the EU are studied, it is acutely demanding to set boundaries and hence it might be unclear what the exact boundaries are. According to Baxter and Jack (2008) this is among the most common issues that researchers who use case studies have to face. This can easily derail a research as it can lead to having to answer a question that is too vague or to deal with a study that has uncommonly many objectives.

When applying case study during research, it is of great importance to answer the question of "What is a case?". According to Ragin (1992), numerous starting points exist from which the question can be answered. Based on these starting points, two dichotomies can be identified. The first one is about whether they can be seen as involving empirical units or theoretical constructs. The second one is regarding whether these are understood as general or specific. The first dichotomy basically describes the difference between realism and nominalism, respectively. According to a realist, cases are either given or empirically discoverable, whereas for a nominalist cases are consequences of theories and conventions. The second dichotomy concerns the generality of cases and questions whether these designations are specific and developed in the course of research or general and relatively external to the conduct of research.

Reflecting on the research and the two cases of the natural gas and the future green hydrogen global systems, they both can be deemed as empirically real and general. Assessment of the empirical boundaries of the different cases is paramount for the research process. In this way, cases are defined and their boundaries are detected in an inductive way (Ragin, 1992).

3.1.5.Holism

Wilber and Harrison (1978) thoroughly described the qualitative abductive research method of holism. According to them, holism can be considered the method for institutionalism and an alternative to the logical-positive approach that has been used in neoclassical economics. Wilber and Harrison's description is basically a summary of Diesing's analysis of the holistic approach, which is painstakingly explained in his work "Patterns of Discovery in the Social Sciences" (1971). Diesing explained holism in a very elaborative way as follows:

> The holist standpoint includes the belief that human systems tend to develop a characteristic wholeness or integrity ... a unity that manifests itself in nearly every part. ... The characteristics of a part are largely determined by the whole to which it belongs and by its particular location in the whole system. ... The holist ... believes not only that the wholes exist, but that his account of them should somehow capture and express this holistic quality. ... By "holistic quality" is meant, not only the manifold interrelations among parts that appear in the original, but also some of the unique characteristics, the distinctive qualities and patterns that differentiates this system from others. (Diesing, 1971, p.137-139).

Ramstad (1986, p.1071) has asserted that there is lack of a clear distinction between the empirical and logical nature of things.

> Meaning, therefore, is linked to the context; entities or activities are assumed to be truly comprehensible only in their interrelations with other entities or activities. Additionally, the whole is seen in the main to determine the part. Obviously if one is committed to this interpretation, one should study a whole living system rather than just one part taken out of the context (Ramstad, 1986, p.1071).

The explanation of the holistic approach is applicable to our specific two cases. The nature of research is not predictive, as the complexity and openness of the systems of the two cases make it substantially burdensome, even impossible. Deductive logic and empirical generalizations are deployed during the course of the research, but they mainly serve as tools to search for or formulate patterns and verify or reject existing ones (Wilber and Harrison, 1978).

3.1.6.Pattern Modeling

According to Diesing (1971), the former method is deemed to be the among the most suitable ones for the fabrication of holistic approaches in social sciences. He also introduces a thorough

explanation of the holistic process formulation. Ramstad (1986) presented a synopsis of Diesing's analysis through which the steps to systematically create holistic knowledge are explained in his work. This procedure is also known as "pattern modeling" and encompasses a series of actions that ought to be done in a chronological manner.

The approach begins with the assumption that there is a whole system that comprises of several interrelated parts. The primary focus for the researcher lies on one segment of the whole system. The objective is to let the context of this specific part of the system to suggest meanings, rather than verifying or rejecting previous assumptions. By closely monitoring this specific part of the system, analytical themes transpire and the focus will be transferred to other parts of the entire system with the aim of determining whether the same themes can be detected in other parts of the whole. This procedure, hitherto, relies in comparing different segments of the same system. Once a theme is identified and, for example, the same theme has been observed in more than one parts of the system, there will be an attempt to find connections with other themes that exist in the same part. In addition, a comparison with other parts ought to (dis)qualify this link from having real existence.

After a certain number of reiterations of the previous steps, the themes convert into assumptions about the nature of these links within the whole. These assumptions are then tested using data from a broad spectrum of sources, such as scientific literature, think tank reports, newspapers, blogs and interviews. This evidence is assessed through comparison with other types of evidence that exist around the same theme. In this way, a broader and more complex landscape of the system will come out (Ramstad, 1986). If there is no further evidence to support these assumptions regarding the connections, the assumption under test is then rejected. All assumptions that are deemed as consistent with all the different kinds of data that are gathered are connected in a network. The result of this process is a pattern model. The process of increasing the coherence between the pattern model and the real world is a continuous one and, with the discovery of new data, the system is subject to constant alterations.

According to Diesing, there are two more steps in the holistic knowledge formulation process: the creation of typology and the detection of universals that stem from this typology. For Diesing, these universals are considered as "holistic general theory". Unfolding a general theory, unfortunately, is objected to broadening the scope of the study and Diesing admits that the creation of a general theory is the most challenging and complex part in projects that are part of a case study. General theory is deemed to be a very different notion than an individual case, which explains how big of a challenge it is (Diesing, 1971).

3.1.7.Pattern Matching

After the patterns have been modelled, a pattern matching procedure shall take place. Pattern matching has been introduced as a concept by Campbell (1975), who asserted that a single-case study could yield convincing results over a certain theory only if the set of expectations that stem from that theory prove to be true, which in many cases is very challenging. Hence, pattern matching emerges, where the researcher connects the data of his study to the themes that articulate the theory he is trying to prove (Campbell, 1975; Hyde, 2000; Sinkovics, 2017; Trochim, 1985). He does so by comparing a pattern that comprises of results from already done actions in an existing system to another pattern regarding a future system. For this future system pattern, the expected results are derived from the theory under test(Bitektine, 2008).

According to Almutairi, Gardener & McCarth (2014), very little literature exists explaining painstakingly the process of pattern matching. However, there have been researches where the pattern matching process was applied, by Lee & Mitchell (1996), Sinkovics, Sinkovics & Yamin (2014), or Hyde (2000) and each work provides an explanation of that process. Reflecting on each one of these works, they describe a very similar process which comprises of the following three steps;

1. Theorizing, where the researcher formulates the theoretical pattern that will be tested (Sinkovics, 2017).
2. Translation of this theory or model into a specific theoretical pattern, which means that the more general and theoretical pattern is put into a specific context. Since the context is different, the explanations and/or generated results might be divergent ((Hyde, 2000; Sinkovics, 2017; Trochim, 1985).
3. Empirical procedure. Here the researcher collects data from various resources depending on the case. The researcher uses this data to measure the extent to which the phenomenon under study is consistent with the theory. Usually the process of coding is the most suitable to analyze the collected data and understand whether the tested theory and the specific phenomenon are a match (Fereday & Muir-Cochrane, 2006; Pearse, 2019; Stuckey, 2015; Yukhymenko et al., 2014).

3.1.8.Scenario analysis

Exploring scenarios has long been considered an effective way of looking into future possible scenarios under a range of different conditions. It is especially within the field of climate change and all sectors that are affected by it, such as the energy sector, that assessment of scenarios has the greatest value and impact (Lloyd & Schweizer, 2013). Ramirez et al. (2015) in particular have elaborated in the usefulness of scenarios to produce “interesting research” and they show that by testing the scenario method across different sectors, such as the retail industry, the evolution of migration patterns, as well as climate change. A survey conducted by Taheri (2018) across students of different disciplines has also depicted that scenario-based case studies, specifically, significantly facilitate the learning process and help the students implement their learning outcomes also in non-school and non-university environments. Scenario-based case studies are deemed as the most suitable methods in this research as well, as the energy transition(as well as all energy transitions) are strongly correlated with the environment and climate change, both of which fields have been painstakingly studied through scenario methods. In our research multiple scenarios will be tested for each case.

Scenario analysis is viewed as suitable for a pattern modeling analysis where the patterns are finite and the research revolves around the topic of security. In this case, two patterns(storylines) are going to be explored in the field of international relations and security of supply, so scenario analysis is a perfect fit to detect potential breaches in the security of supply and revise strategies to ensure supply(Liu et al., 2008). At the same time, the scenarios themselves can be revised if there is another shift in the world order.

Several questions are being raised regarding the choice of scenario analysis instead of sensitivity analysis, especially contemplating over their many similarities. The main reason is that scenario analysis is far more suitable for qualitative research. In sensitivity analysis, only one variable(or in some cases multiple variables) is tweaked into discrete and specific variables, which means that a quantitative approach ought to be taken, which is not the case in our research. Scenario analysis, on the other hand, involves formulating a small number of scenarios, in which the great majority of the variables are shifted, or a total qualitative shift of the system is observed. Scenario analysis is an excellent manner to understand what would happen if human, financial or equipment support is

increased or decreased in the system, or if constrained resources were not available as scheduled(Schuyler, 1994; Pollack-Johnson & Liberatore, 2005). Such an analysis fits perfect to this research, as it is paramount for the EU to be prepared in changes in resource supplies if it is to anticipate the geopolitical implications that will affect its security of supply.

Now that the research methods are proposed, ther operationalization is of utmost importance for the research, so that the exact storylines are formulated and then adapted to the global gas and green hydrogen systems.

3.2.Operationalization of Analytical Framework

3.2.1.Use of methodology for the cases under research

As mentioned, this thesis will follow such a deductive approach. For each of the storylines, a set of claims that describe a theme shall be made for each of the actors. These claims and themes will be mainly related to the level of integration that each region has made and to the expansion magnitude in their neighborhood. If research depicts that a need to measure the expansion in other regions beyond the neighborhood exists, then other regions will be explored as well.

There are two energy systems that are used as cases as part of the research. The first one is the global natural gas system, which comprises of all participating states, producers and consumers, affiliated international institutions, as well as related infrastructure, such as pumping, piping and shipping technologies. The second case concerns the future green hydrogen system. As there is currently no tangible green hydrogen market, projections are made based on the (inter)national hydrogen strategies published by countries, organizations and institutions. Due to the existing projections and expectations as well as the technologies related to energy carriers, green hydrogen is also deemed to utilize pipelines and ships, in its vast majority, for transportation. The fact that only two systems are chosen for comparison and that other ones, such as the oil one or other forms of hydrogen are omitted is due to the fact that it is paramount that a significant amount of time is given to go in depth in both systems. Due to that fact, there was a preference of selecting two cases and going in depth instead of a shallow analysis of multiple cases and themes.

These themes will initially be applied in a broader geopolitical context without mentioning their effect on the natural gas or green hydrogen markets. While the framework of the geopolitics of gas differs from that of the geopolitics of green hydrogen, they both stem from a broader geopolitical framework, which needs to be drawn up before becoming more specific. Once mentioned in that frame of reference, empirical data will be used to either confirm or deny the foregoing claims.

In the next stage, a similar process will be applied to the specific cases of natural gas and green hydrogen. The framework of the broader geopolitical world order that will have been created through the deductive approach and the pattern modeling processes is applied to these two cases and the same process takes place. The empirical data points towards either affirming or rejecting the themes through the claims that formulate them. In addition, this is where pattern matching is applied. By comparing the two cases, the extent to which the two patterns are similar is understood. Moreover, reflecting over the differences will take place.

A brief overview of the themes can be found on Table 1 and Table 2. The themes on the Regions and Empires storyline are grounded on the neo-realism institutional theory, which is extensively elucidated in Chapter 2.6.1.5. The implications for each region and the rationale behind it is extensively explained in Chapter 4.1. More specifically, based on the prior-mentioned theory, states in this storyline pursue bilateral agreements instead of international collaborations, avoid free trade agreements and are in support of, or indifferent to, military interventions. On the other hand, the themes related to the Markets and Institutions storyline stem from the neo-liberalism institutional theory expounded in Chapter 2.6.1.4. Respectively, the ramifications for each region and the reasoning for it are elaborated in Chapter 4.2. In this context, countries or regions pursue creating large international trade blocs with the objective of promoting free trade and facilitating cooperation and generally solve disputes solely via the diplomatic path. In addition, a list of the metrics and indicators to measure to what extent each theme corresponds or is projected to correspond in reality is presented.The choice of these specific indicators was made because, after rigorously researching literature related to neoliberalism and neorealism in IR, these metrics were deemed as the most suitable, as they portray the behavior of these schools of thought in an

Table 1. Themes and metrics for each key actor in the Regions and Empires storyline

Region	**Theme**	**Metric**
Europe	- Moderate expansion to Eastern Europe and Neighborhood - Protectionism - Fragmentation	- Number of different blocs with different views - Bilateral agreements with external actors
Russia	- Unilateralism, dominance in regionalism - Military interventions	- Free trade breach or lack of free trade - Number of interventions
USA	- Military Interventions - Dominance in regionalism	- Number of interventions - Free trade breach or lack of free trade
China	- Military presence - Dominance in blocs - Dominance in production	- Military agreements - Level of Chinese participation in projects abroad
Gulf States	- Fragmentation	- Misalignment on foreign affairs(or other) views
Africa	- Fragmentation - Regionalism	- Number of regional blocs - Misalignment on foreign affairs(or other) views
Latin America	- Fragmentation - Lack of interconnection	- Number of regional blocs - Number of interconnections
Central Asia	- Numerous regional blocs	- Number of regional blocs - Number of social unrest events

	- Social Unrests - Military Interventions by foreign powers	- Number of military interventions

Table 2. Themes and metrics for each key actor in the Markets and Institutions storyline

Region	Theme	Metric
EU	- Full integration - Collaboration with neighborhood	- Elimination of regional blocs - Number of collective agreements
USA	- Collaboration globally - Alignment with global community on all issues	- Number of free trade agreements - Political and financial support in projects endorsed by the global community
Russia	- Cooperation in regionalism - Shift to environmental policy aligned with global community	- Number of free trade agreements - Political and financial support in projects endorsed by the global community
China	- Inclusive governance on regional blocs - Investments centered on development and not deb-trap diplomacy	- Number of free trade agreements - Development of the local communities/respect towards the environment
Gulf States	- Policy alignment	- Similar views to foreign affairs(and other) issues
Africa	- Collaboration mainly through the African Union, harmonization of policies	- Aligned views on foreign affairs(and other issues)
Latin America	- One regional bloc, one interconnection	- Number of regional blocs and interconnections
Central Asia	- One regional bloc, solely diplomatic manner of solving issues, no intervention from outsiders	- Number of regional blocs and military/diplomatic interventions

Availability of data was also a very important feature for the choice of the two cases. Diesing (1971) states that the formal method needs initially a minimum set of postulates and definitions. While for

the former, empirical evidence and observations will be used, for the latter, gathering of data is critical. This needs scrupulous literature research of any kind, starting from scientific journals and finishing in regular newspapers and blogs. If lack of data after the aforementioned procedure is observed, then the continuation of the research will take place through the form of interviews. In the case that there is total absence of data to back claims about the geopolitical trajectory of a specific region in a specific storyline, a different approach will be followed. Assumptions will be made based on the institutional framework of each storyline and it will be explained that it is contradictory to the current region's trajectory and hence, will carry far lower weight compared to the claims backed by literature.

The whole in our case is considered to be the energy system, whereas its two parts or cases under study are the natural gas system and the future green hydrogen system. The global energy system, which is our whole in this case, contains all past, present and future global energy systems, such as oil, coal and others.

In order to deal with general theory and construct typologies, a study of all possible cases, or at least multiple ones, is required. Nonetheless, due to the limited time and resources that an MSc thesis contains, this will not be enacted in this research. Since only two cases are under study, only the first step of the fabrication of the general theory will take place. There are no typologies or general theories generated in this research. Instead, this analysis can serve as a starting point for their formulation in future research, which will include other energy systems as well.

3.2.2.Data collection

Data was collected predominantly gathered through literature research. During this research an enormous amount of all kinds of documents were collected, that can be classified into three categories.

The first category included scientific journals in the field of energy policy, geopolitics, political geography, energy research in social sciences, energy, political science. The keywords mentioned in the literature review in chapter 2 were used in Google Scholar, Web of Science, Scopus and JSTOR. It ought to be noted that, while different geographies were under study, the keywords mentioned in chapter 2 were combined with the geographies given e.g "geopolitics AND green AND hydrogen AND Europe" to provide more concrete insights. After researching the results, it was understood that papers from academic journals on green hydrogen saw a significant increase from 2008 onwards and hence that was the base year chosen for papers related to the energy transition and green hydrogen. For gas the base year was chosen to be 2005, because of technological advancements mentioned in chapter 2. At the same time, the main scope of this research was security of supply and geopolitics with regards to the energy transition to green hydrogen. Hence, the abstract and title of each paper was examined. Papers that focused solely on local communities/societal-humanitarian aspects of the energy transition were disregarded. The same was done with regards to scientific journals that discussed socio-technical and political factors for very specific innovations on the hydrogen sector and/or on other innovative fields.

A special category was deemed to be reports from international institutions. The most important ones included the world outlook of the IEA and of IRENA. For the world energy outlook of IEA, the 2021 report was chosen, because it was the latest version that was able to be found and the most updated one. As far as the IRENA reports are concerned, attention was paid to the hydrogen reports issued, but also on the geopolitics of the energy transformation one. Versions of 2022 of both reports were chosen, because they were the most updated ones that could be found. Moreover, the IPCC

report on climate change and mitigation pathways to avoid the 1.5 degree Celsius scenario were taken into account to better understand the role of hydrogen in that process and to compare and contrast the scenarios posed by the IPCC to those presented by IEA. Finally, to strengthen the knowledge background and to have a more spherical understanding of the aforementioned role of hydrogen, the UN report on climate change was painstakingly studied.

In addition, think tank reports related to the intersection of geopolitics and energy were researched. The same keywords were taken into consideration. As far as the time period was concerned, 2017 was chosen as the cut off date for green hydrogen-related articles. The main rationale was that 2017 was the year that state actors began issuing hydrogen strategies and hence it became relevant for think tanks to research the subject. For natural gas, 2005 was again selected as the base year. As mentioned, special focus was given to the ones related to natural gas and green hydrogen, but more general researches or even the ones related to the oil industry were also taken into account, as they might contain information relevant to the natural gas system. Preference was given to think tanks that operate within the realm of the EU, such as Bruegel, ECFR, but also within Europe in general, such as Chatham House. Special attention was paid to the ones in Washington as well, due to the fact that knowledge institutions such as the CFR, CSIS and FPRI are deemed to be the best at a global scale within the fields of geopolitics and security of supply. Finally, when specific geographies were studied and the existing knowledge from the foregoing sources were insufficient, local knowledge institutions were used very specific information on e.g special geographic, political,financial or market characteristics that well-known global researchers might have missed.

To add to this data, newspaper articles, blogs and other forms of news and opinion pieces were studied, which provided much help on the verification or rejection of certain aspects of the patterns studied. While such data is not preferrable across all sectors, in political science and related subjects they are among the prevalent data. Wolley (2000) argues that media-based literature counts extensively, especially in public policy. He also points out that shifting beliefs, expectations or information of key actors and players might be directly correlated to policy outcomes. Receiving support for certain policies often is dependent on favorable media attention which depicts the importance of media related data. Mutz (2002) also reflected on the importance of the messages sent by media to shape the perceptions of citizens and eventually shape the political landscape. Newspaper articles and blogs were not relevant for the literature research part. They were, nonetheless, very useful in providing geography-specific context. More specifically, in order to better formulate the pattern for each region and empire and to make projections on the trajectory of the two systems, specific developments in each region were needed. These developments can be bilateral agreements, protests or anything else that can be mentioned, for instance, in the local news. This is the primary reason why it was deemed paramount to include them as well in the research.

Finally, where no data could be collected to create a framework, assumptions and hypotheses based on the scientific literature were made. For example, on making assumptions about an outcome on the Regions and Empires storyline, in absence of literature to back it up, a landscape based on the neo-realism theory was formulated. According to Binoy (2019), a hypothesis is an educated guess which describes a possible relationship between two variables. One of the main purposes of hypotheses is that they provide a direction to the investigation, in this case to check whether a certain region follows a specific storyline. In addition, if furnishes the proof that the researcher has enough knowledge to make suggestions to extend the existing knowledge. In our case, it will provide the grounds for this research to extend existing knowledge on the two storylines to all key regions, to check painstakingly which ones are closer to which storyline.

3.2.3.Data analysis

Analyzing qualitative data has always been deemed to be a hectic and arduous process. The main reason for that is that it is not considered a purely technical or mechanical exercise, but rather a dynamic one that is based more on intuition and theorizing, reasoning and thinking (Basit, 2003). One of the prevalent methods used in qualitative data analysis is coding. Seidel & Kelle (1995) describe the coding procedure as observing relevant phenomena, gathering examples of them and analyzing those phenomena with the aim of finding similarities and differences. This aids the researcher in comparing across data and formulating a hierarchical order of them. The coding procedure has been seminal in qualitative research historically as well. Glasser & Strauss (1967) pointed out that ”joint collection, coding and analysis of data is the underlying operation [toward] the generation of theory”.

Based on the literature, coding is deemed as the most suitable method for data analysis for this thesis. More specifically, the process propounded by Williams & Moser (2019) will be applied. In this process, distinct concepts and themes will be found based on empirical observations of the data, leading to a generic set of themes. The second step will involve axial coding, where the generic themes will be refined and aligned to the context of this research. The third and final step is the selective coding, where the researcher, out of the refined themes mentioned in the axial coding, will choose certain ones and integrate them further into the context of this research. This will result in having 2-3 codes for each storyline and using these codes/themes as metrics to measure probability of each of the different futures from happening. The different codes are presented in Table. During the research, there will be a quest to find these different themes/codes within the data and if found they will verify the claims made. If they are not found, assumptions will be made and listed as such and there will be reflection over them.

Chapter 4: The storylines and their overall affect on different actors

In this chapter, the wider geopolitical framework of the two storylines is going to be settled and put in the context of the actors under study. Firstly, the utilization of the theoretical framework and categorically the IR schools of thought in our storyline approach is put forward. The first storyline, Regions and Empires, is congruous with the neorealist philosophy, whereas the second one, Markets and Institutions is reconcilable with the neoliberal postulation on IR. Secondly, in chapters 4.3 and 4.4 the way the two storylines affect the IR and geopolitical approach of each actor under study is painstakingly explained. This will serve as foundation for the analysis performed in the next chapters.

4.1.Regions and Empires

The Regions and Empires storyline is the offspring of realism and institutionalism. Realism has been a prevalent notion among international relations(IR) and geopolitics and their scholars and its main theme is the security competition and war among the great powers. As John J. Mearsheimer had predicted, “States will continue to be competing among themselves for power even in the 21st century. Joseph Grieco highlighted that realism provides insights on “the impact of the anarchical structure of the international system on the preferences, strategies, interactions, and domestic institutions of states, of inequalities on international affairs, and in particular, inequalities in power, but also in particular, into the importance of continuity in international affairs, but realism also alerts us to the pervasiveness of change”.

Based on the aforementioned, the Regions and Empires storyline assumes that there is a tendency towards social, economic but also cultural separation. This happens on the basis of ideology, religion and political arguments. It is important to focus on religion as a recurring topic. The reason is that, despite the fact that the ISIS “caliphate” has been broken up, the general demographic trends in Muslim-majority countries act as a warning that religious extremism might persist as a threat for the next decades(Cordesman, 2019). In addition, new trends in religious extremism, such as far-right activists and Christian nationalists arise(Boston, 2021), depicting that the threat is rising from both sides.

State actors are expected to act unilaterally or bilaterally or form regional blocks to pursue their policies. The different regions are expected to be somewhat fragmented between them, with very little communication and cooperation taking place. If any parts of the world market are excluded from the world system of trade, then regionalism is considered to take place and the Regions and Empires storyline is valid. Global markets are not fully “global”, as they do not embrace the countries or regions that refuse to play the game.

Empires can be sole global powers like the USA or Russia, but they can also be regional blocks. During the Regions and Empires storyline, countries shall trade virtually only within their block.

However, not only strong countries will comprise these regional blocks. Weak states which, either will not have gas reserves or they will not have the necessary means to develop green hydrogen, shall resort in acquisition of WMD's and in more hostile policies. Even if they have the resources to develop their own means of energy, if the local population is not benefitted from it, this might act as a reason of disruptive events like rebellions, street protests or even overthrowing of the government. This is the case for Africa, in particular, as European hydrogen projects throughout the continent are increasingly being seen as an effort for Europe to "preserve its exploitative, neo-colonialist relations with Afirca" (Hamouchene, 2021).

International institutions of global scope are weakened in a Regions and Empires storyline. The main arguments towards that is that many state actors will refuse to participate an opt instead for bilateral or regional agreements. In addition, dominant behaviour of unilateral nature is not expected, as in a world where there are several resource dependencies, unilateralism is barely an option. Instead, dominant states will resort to regionalism and attempt to fully influence their regions through that.

In addition, lack of collective interests further weakens the international institutions' strength and this may lead to unilateral(or multilateral by only a small part of the state actors) moves, such as military interventions, sanctions of any kind or cease of diplomatic relations.

4.2.Markets and Institutions

On the contrary, Markets and Institutions is a storyline that was derived from the liberal institutionalism theory. This was the theory that inspired how the world was ordered ever since the 1940s. According to liberal institutionalism, it is assumed that domestic and international institutions further cooperation and peace among countries until there is full integration(Johnson & Heiss, 2018).

Politics, religion and any kind of ideology that drives people to radicalism insists on creating conflicts, however these are effectively managed solely through negotiations and interventions of international institutions.

Liberalization of markets and unbundling of certain services allows the flow of goods to grow. In addition, it enhances competition, which drives down prices and reduces the complexity and difficulty for even smaller players to enter the market.

Regional blocks and their economic unions continue to exist, but in the Markets and Institutions storyline these blocks cooperate, both on an international and on an interregional level. These institutions support international development in a way that is considered just and takes into consideration the smaller nations as well.

Peace-keeping and development work as drivers that reduce local social tensions. Local communities see the benefits of working together with their neighbouring communities, but also with their respective governments, and do not produce conflicts or resort in acts of terrorism in order to maintain the development momentum.

Climate change is accelerating and its effects are felt by most populations around the world, resulting in huge environmental stress. Nonetheless, NGOs and civil society, as well as environmental groups, work together with local governments to form policies and that is very well received and respected by people and nations, who continue to cooperate amidst environmental degradation and disasters. There is an overall agreement on the energy transition strategy, especially with regards to sensitive issues like the usage of nuclear power. The majority of the countries adopt similar measures towards

them and even the ones that do not do it, still are respectful of others' decisions and continue to play the game.

To get a better understanding of how the previously mentioned storylines will be incorporated in our research, their impact on each relevant region's and/or country's geopolitical state of affairs is illustrated in chapters 4.3 and 4.4 respectively.

The development of the two storylines, as mentioned, is a product mostly of literature research. The main foundation and the basic elements of each storyline is formulated by the theoretical background related to the international relations theory, with neorealism being the basis for the development of the regions and empires storyline, whereas neoliberalism is the main element of the groundwork of the markets and institutions storyline.

The evidence used to support the storylines for each region have also been derived from literature research. More specifically, scientific journals, think tank reports and newspapers were selected in a way that is thoroughly described in the data collection section.

4.3.Development of Regions and Empires storyline

Europe

In a Regions and Empires storyline, the EU expansion towards Eastern Europe is relatively moderate. Economic nationalism that was initially witnessed in Poland and Hungary is now spread among all EU member states of the region, where the sentiment that liberalism has failed is prevalent and there is a need for a radical break (Varga, 2021). The main theme stemming from this behavior is regionalism within the EU, expressed through bilateral or subregional agreements that have no intention of serving the union as a whole. More specifically, blocs like the Three Seas Initiative (TSI) and the Visegrad 4 (V4) arise. Both of these blocs are forms of post-Cold War subregionalism, which had the intention of bringing previously communist states closer to the EU, but has been much messier than expected (Bailes, 1997; Dangerfield, 2016). The TSI has been a perfect example of that. Despite its success in bringing North-South interconnection in Eastern Europe, it constantly gives the impression that it serves solely Polish and U.S interests and might be used as a lever for anti-EU agenda-setting (Grgic, 2021). Scott (2021) reflects to the role of the V4 to promote illiberal regionalism and to becoming an organ that promotes the Hungarian and Polish agenda and especially the views of Hungary against the EU and its soft stance towards Russia.

The EU strategy towards the Western Balkans does not prove to be successful, as the countries do not adopt the reforms necessary, do not manage to catch up with the living standards of the EU or restore credibility in their political leadership, which are the most important challenges of that region(Besimi, 2016).

In addition, in a Region and Empires storyline, new, both sectoral and regional tensions might emerge. Ethnic issues, such as Bulgaria's demands for North Macedonia to amend its constitution in order to involve the Bulgarian minority(Bechev, 2022), may impede new European nations from entering the EU and the European integrated markets. These issues may also lie in a sectoral level and worsen relations between already existing member states. Nuclear can be a great example for that as, after the Fukushima accident, Austria, who is leading the anti-nuclear alliance within the EU, resumed the debate over nuclear power and this brought small tensions with the Czech side, which has plans to build several nuclear power plants(Bell, 2012). Nuclear energy, in fact, has been the primary reason that these two nations, as well as their respective supporters, have been at an all-time low in their relations for several years(Fawn, 2006). Such small tensions are not expected to

escalate, but might rather expand to the gas or hydrogen sector, for questions such as the origination of hydrogen or electricity from clean resources.

Protectionism is also a prevalent theme for Europe in this context. European sovereignty and making Europe stronger on the global stage are the main points of Brussel's agenda and this policy is expected to continue, both in a trade, security and defense, and energy and environment level(Von der Burchard et al., 2019), which are mainly addressed to protect the bloc's rights on the world.

Different external policies within Europe are a commonality in the aforementioned storyline. This is witnessed in particular with regards to the relations of the EU member states with global powers and important players in the neighbourhood. A great example are the relations with Turkey, with Greece insisting on a stricter policy that involves sanctions and moving away from an integrated market with Ankara(Koumoutsakos, 2022), whereas Germany makes several attempts for further market integration and of focusing on common interests. This has the potential of creating additional friction and minor conflicts within the union. On a sectoral level, this situation plays out by disagreement on energy security policies. Countries such as France are resorting to nuclear energy, other such as Poland utilize coal as a fuel that guarantees energy security. Finally, a bloc of countries, with Germany, Hungary and Greece being prevalent examples, supports gas as a transitional fuel and make moves towards securing even larger volumes.

A last feature of the EU in the context of Regions and Empires is that it remains a price-taker. This translates to a continuation in energy dependency, but depending on the type of fuel, it can shift from one group of producers to another(gas to hydrogen or oil to gas). In this storyline, the EU status as price-taker can have severe consequences, as the countries that will act as energy suppliers can use this as leverage to negotiate for a higher price or to avoid potential sanctions.

Russia

Russia proceeds with its current strategy in a Regions and Empires storyline. Initially, it reinstates its dominance in the CIS members, either by leading them to a full dependence from Moscow, or through military means. To fully assert that dominance, Moscow will use a military approach in this storyline. More specifically, the main target is to get all post-Soviet states with abundant natural resources and energy reserves into the CSTO to ensure that it has full control over the exchange of military equipment and training of personnel in all of the neighboring countries. The Russian strategy revolves mostly around either military interventions or fear-mongering, to portray the increasing need for all Eurasian states to join the CSTO. Regarding Turkmenistan, CSTO officials regularly cite threats from Afghan extremist groups on the Turkmen-Afghan border. This was the case in November 2018, followed by Moscow's similar claims about existing threats coming from Afghanistan (Annayev, 2020). Uzbekistan, which entered the organization but left in 2006, faces the same intimidating behavior. The social unrest and protests in Kazakhstan became a lever of pressure for President Vladimir Putin, but also director of Central Asia and Kazakhstan department of the CIS, Andrei Grozin, to point out how important it is for Uzbekistan to join the CSTO so as to not have the same fate as Kazakhstan (Temirov, 2022). Russia can also act as the main guarantor of security in the region, handling disruptive events throughout regions such as the South Caucasus and Central Asia.

Another way to exert influence and pressure to the aforementioned states, as well as Georgia who has not expressed any desire to re-join the CSTO, is through the partially recognized states. More specifically, political leaders in the Community for Democracy and Rights of Nations, namely Abkhazia, South Ossetia, Transnistria and Artsakh, have asserted that they are willing to further integrate with Russia and even join Russian-led blocs(London School of Economics Blog, 2016), such

as the CSTO. Similar statements have been made by the leaders of the de facto states of Donetsk and Luhansk(Savelyeva, 2022).

In terms of the existing regional blocs, Russia will attempt to strengthen economic ties with Central Asia and the South Caucasus. This will happen primarily with further integrating the EAEU's financial body, the Eurasian Economic Union. However, in the aforementioned storyline, the primary aim of Russia will be to control both of these regions' economies through becoming the leader of the bloc. In addition, Moscow will make the endeavour to further integrate the region's military system and increase the importance of the CSTO, again with itself taking full control of this uneven alliance.

As far as the Russian market structure is concerned, the main markets targeted will again be the European ones. Nonetheless, trying to increase its empire status, the Kremlin will reach out to more Asian markets. More specifically, it will primarily move forward with new agreements with Beijing, and secondarily will approach Japan, Korea, and potentially India.

USA

In a Regions and Empires storyline, the USA will follow a more inward-looking and regionally-oriented policy. The most important trait of that policy is unilateralism. Washington moves forward with sanctions or military operations towards other state actors without the consent of international or even regional institutions, like the attack on Iraq, for which there was no consent not even from the United Nations(Evans, 2003).

In the neighborhood policy, the dissolution of NAFTA and the shift to USMCA as a free trade scheme is instrumental in defining the foreign relations in North American states. The 2018 elections in Mexico followed by the 2020 US ones generated instability in the region, since in Mexico a transition from a liberal leadership to a protectionist one brought a change in policy, whereas in Washington the reverse trend was observed(Cunningham, 2018). If such events continue to be frequent, free trade and cooperation agreements are expected to have a short life span.

Another paramount point in the American strategy in the aforementioned storyline is the shift to regionalism. Regional blocs such as the Central America Integration System(CIAS) have faced numerous challenges such as the withdrawal of Costa Rica amidst the Cuban migrant crisis (Stein, 2021). The USA are expected to deal with them and facilitate further integration, however under a Washington leadership. A similar approach is expected in the Economic Commission for Latin America and the Caribbean(ECLAC), where the neo-structuralism efforts of framing the Latin American issues in a world capitalist system are rattling the commission's unity and solidarity(Leiva, 2018). Likewise, in MERCOSUR, there is also a lot of dealing with issues such as corruption in Brazil and increasing trade with China, an opposing "empire" to the USA(CFR Editors, 2021). Washington is expected to either rule these blocs separately or unify them under one large regional institution led by itself. In both cases, these entities will follow their own strategy, independently from international institutions of global scope such as the UN or the IEA.

Regions that are relevant for the American energy policy will be stabilized with unilateral operations in a Regions and Empires storyline. These operations involve military interventions, but also support to political/military leaders that will promote the American agenda in the aforementioned regions/countries. This is put within a framework of a broader American strategy, which aims at reducing energy insecurity because of the virtually fully depleted energy resources in the North. This comes in combination with the aspirations that the USA has as a self-proclaimed leader of a coalition representing the interests of the north. These two factors have prompted the USA, on behalf of the

coalition of the North, to seek to military dominate a significantly large part of the oil and gas reserves around the world(Singh, 2007).

This puts additional weight on the importance of foreign affairs and defense policies of Washington and makes them paramount for its overall energy policy. The three policies are interconnected and are geared towards protectionism, in order to support the American interests for energy security under any cost.

With regards to the EU, the USA will do anything within their power to discourage Brussels from growing closer to Russia and China. Moscow enjoys privileged status as the main energy supplier of the EU and the USA want to avoid this relationship turning into Russia entering a Europe-related trade bloc. Washington would prefer that Europe will instead opt for American shale gas through the LNG network or alternative fuels controlled by the US(such as green hydrogen). The EU is also on a good path concerning relations with Beijing and in this storyline it is in the American best interest that these relations deteriorate.

China

Because of its accelerating pace of development, China can be considered a separate "empire" in the Regions and Empires storyline. In this situation, Beijing increases competition with important players in the region, and in particular with Japan, India and Australia(Reeves et al., 2017; Hassan, 2019). This competition takes place in a technological context, such as the development of ICT, telecommunication technologies, but also energy technologies. It also takes place on a military and foreign affairs context and China is expected to attempt to challenge Japan on contested areas, such as the Senkaku Islands. Struggle is expected to happen with India on the controlling of critical sea routes like the Straits of Malacca. Beijing has long been discussing over the "Malacca Dilemma" and the need to "break" it by finding alternative maritime routes. However, it is largely challenging to diversify and it becomes more appealing to Beijing to modernize its naval forces with the sole purpose of increasing security in the Malacca region(Lanteigne, 2008). Military presence is also expected to escalate both by China and by Australia and the USA in the South China Sea(Yahuda, 2013).

China shall also try to maintain the structure of the current regional blocs and will lead all of them. The Belt and Road initiative has acted as a "reaching arm" to regions like Central Asia and Southeast Asia. Currently, members of the Association of Southeast Asian Nations(ASEAN) created an institutional framework with the objective of balancing the USA and China's geopolitical influence in the region(Koga, 2018). This is evident in the foreign affairs strategy of some of the member states', such as Vietnam, Indonesia and Philippines. Under this narrative, China, through economic and military influence, manages to bring some of the ASEAN states solely to its sphere of influence, and creates a divide among the coalition members. To handle this divide and conflict in the region, Beijing becomes the security guarantor and coalition leader. As far as Central Asian states are concerned, regionalism is practiced mostly through the Eurasian Economic Community(EEC) and the Shanghai Cooperation Organization(SCO). EEC, being Russia-led, and SCO, being China-led, show a great balance of powers in the region. Nevertheless, under a Regions and Empires storyline, China shall bring Central Asian states fully under its influence, which will translate in them potentially leaving the EEC and even the CSTO, the Russia-led military organization. This will most probably lead to friction with Russia as well. In that front, Beijing is expected to initially remain neutral and pursue cooperation with the Kremlin in order to get scientific and technology support on military equipment. Once the Chinese army has comparable technology to the Russian one, China will become more aggressive on the region and try to bring all state actors under its regional blocs.

China is the leading nation in rare earth metals, being responsible for 55-70% of the mining and over 90% of the processing(Zhou & Brooke, 2022). Under this storyline, China shall not only try to maintain control of the current percentage of such metals, but also increase its influence in other sectors, such as energy carriers, semiconductors and microchips and shall attempt to dominate every tech and energy related market. It will also try to become the main supplier in other critical industries such as the military one.

Finally, the EU-China cooperation is expected to continue. Nonetheless, Beijing will opt to use its economic strength to support regional blocs within the EU. Some of them include the Three Seas Initiative(TSI). China will also eagerly try to bring the Western Balkans under its control, as well as the Eastern Partnership countries, making their member states refrain from joining the European Union.

Persian Gulf – Gulf States

Relations among Gulf States as well as Iran and Iraq are severely affected by any kind of international dispute in the Regions and Empires storyline. For example, the EU-Turkey or the USA-Turkey frictions lead to some of the countries in the region aiding the American or European side(UAE, Oman, Saudi Arabia)(Aydintasbas & Blanco, 2021) and others resorting in helping Turkey(Iran, Qatar)(Youssef, 2021). This shall be a lesson for them to realize that there is a divergence of views in a series of topics and might spark minor conflicts.

The most important relations, however, that need to be monitored, are the Israel-Palestine and the Israel-Arab World relations. These relations have become the reason for disputes among the Arab World and the Persian Gulf is no exception to that. The Abraham Accords have been signed only by a number of Arab countries and this has caused a divide based on the views of each country.

This divide is the exact reason that there is no dominance in the Persian Gulf, which is the only region in the world that even in a Regions and Empires scenario no global power manages to dominate.

Africa

Many potential winners may arise, but none of this wins will have occurred through collaboration. International institutions such as the African Union will lose strength and become irrelevant in problem solving. Most state actors will resort in their own regional blocs, such as ECOWAS or ECCAS to deal with potential conflicts. The overlapping of multiple memberships to the African Union and the numerous regional blocs has proven to severely affect the integration efforts in the continent. In addition, the lack of (Hailu, 2014). Such coalitions shall prove ineffective both in regional and interregional conflicts. For the former, in most regions there is not a clear member state that bears the title of the regional leader and hence, any country that will try to take initiatives will be contested. For the latter, it will be very challenging to coordinate two regional authorities with all their member states to find a solution.

In any case of the potential energy carrier, be it gas or hydrogen, construction of the energy infrastructure will bring development for African countries. However, the development is expected to be disproportionate and it will cause discontent for the people that are left behind. It has been observed, in fact, that the strong growth rates achieved in Africa over the past decade have not had an impact neither on employment nor on poverty and great challenges pertain(World Bank, 2012). This, in turn, shall create a sentiment of neo-colonialism(Hamouchene, 2021) and will bring

disruptive events that may even lead to the mobilization of the military in some countries. This will give the chance to countries whose foreign policy is approached mainly through military means to intervene and exert influence in these regions.

Latin America

In Latin America, the Regions and Empires storyline will see MERCOSUR facing even bigger problems concerning integration. Statements like Brazil's Bolsonaro's claim that he wants a larger and more inclusive bloc(CFR, 2021) will find opposition from leaders like Argentinian president Alberto Fernandez, but also from members of the Pacific Alliance, such as Mexico, which want to promote their own agenda and drag all Latin American states eventually into their sphere of influence. Both regional blocs are facing great social discontent with neoliberal policies and it is expected to be increasingly challenging to move to further integration or further liberalize their markets(Nelson, 2022; Botto, 2022).

In Central America, events that rattle regional stability, such as the Cuban migrant crisis, cause state actors like Costa Rica to withdraw from regional blocs and act in a unilateral manner. This raises several questions over the historical differences between member states in Central America, the benefits of potential membership and immigration issues(Stein, 2021). These doubts turn to vulnerabilities for all the regional integration initiatives and can only lead to further fragmentation.

In addition, there is no coordination with regards to which "empires" will the region follow. Countries like Uruguay became part of the Belt and Road Initiative, whereas others like Colombia moved forward with agreements with the USA, from trade to technology and military(CFR, 2021). This will also create disagreements within MERCOSUR.

Escalation of these tensions will lead to failing governance systems. This is bound to formulate discontent and several state actors will follow the example of Venezuela, as it is considered that no Latin American democracy has so far established full civilian control of its military forces. Countries like Bolivia and Peru, relatively sensitive to disruptive events, might see military interventions(Diamint, 2015) or rebel groups taking over control. Such shift of power will, like in Africa, favor global powers with a military-oriented foreign affairs approach.

Central Asia

Central Asian states in general face the struggle, due to their energy wealth, to be approached by all global powers. This, combined with the great diversity in the political landscape of each country in the post-Soviet era has formulated simultaneity issues in their economic transition. Their increasing need to find a new kind of statehood, combined with the different levels of liberalization of their own political agenda and markets, has made the integration of the Central Asian region a very difficult puzzle to solve(Ahrens & Hoen, 2013).

Hence, the current situation sees Kazakhstan as the self-proclaimed leader(Kikuts, 2021), formerly as part of the main regional block, the Central Asia Union(CAU), but also as a representative within the EEC the SCO and the Turkic council. In a Regions and Empires storyline, this leadership is contested. Disruptive events such as the massive protests that resulted in many fatalities throughout Kazakhstan will make either Uzbekistan or Turkmenistan challenge the current order within Central Asia.

The biggest issue at a regional level, though, is the inexistence of an actual regional block without the interference of a global power, and the fact that foreign policies of the state actors diverge significantly. The ramifications of such a state of affairs are that the CAU or any of its potential equivalent blocs are never formulated (Zhambekov, 2015).

This might have further fragmentation as a result, closing borders between the countries and even in larger conflicts. This situation has a high chance of escalating given the proximity to Afghanistan.

Another major issue with Central Asia are the governance failures themselves. In 2020, Kyrgyzstan faced rebel groups that overthrew the government of Sooronbai Jeenbekov to put Sadyr Japarov in his position(Pikulicka-Wilczewska, 2021) and, only a year later, protests that started in Western Kazakhstan quickly spread across the country and led to the removal of Nursultan Nazarbayev from most governmental bodies he was a part of, including the State Security Council. In addition, the central government of Tajikistan is constantly under severe tensions with the Gorno-Bandakhstan Autonomous Oblast(GBAO)(Madbekov, 2022), which formulates a feeling of instability. In the Regions and Empires narrative all these tensions persist and even escalate on occasions, forcing the CSTO, or, at times, the Russian military to perform interventions.

4.4.Outcomes of Markets and Institutions storyline

Europe

There is a much more optimistic view for the future of the EU in the Markets and Institutions storyline. Regarding Eastern Europe, full integration has taken place, all Eastern and Southern European states have taken the necessary reforms to bridge the gap with the rest of the EU. In addition, the EU itself successfully pulls out its strategic plan to align all states to one climate policy. There are allegations that strategies such as the ETS are “trojan horses”, aiming dividing the EU over climate action, but such a strategy by outsiders not only fails, but also increases support on the low-carbon transition by an even broader range of stakeholders(Markard & Rosenbloom, 2020) . Moreover, it successfully completed its full integration on security and defense, formulating a union that can have a joint and coordinated foreign policy(Ruy et al., 2022). Also, the neighbourhood policy in the Western Balkans was successful. Amidst the Russian invasion of Ukraine, the EU leaders seized the opportunity and grew closer with them(Borrell, 2022). This is only a small part of a broader plan by Brussels to reformulate its agenda so as to bind the Balkan states to its own policies and objectives. This makes it increasingly challenging to act independently and unilaterally(Pavlicevic, 2019). The result of these developments is that all of them eventually manage to establish political credibility and stability and few years after their reforms they join the EU integrated markets. A similar situation exists in the Eastern Partnership member states. Initially, the Associated Trio, namely Moldova, Ukraine and Georgia, push towards a resolutely path to join the EU and Brussels embrace that effort (Lokker, 2021). This helps showcase the ideological appeal of the European project and hence gradually the other EaP countries move forward with joining.

EU-Turkey relations took a turn for the better in the Markets and Institutions storyline. There is no accession to the EU, but there is modernization of the Ankara agreement(Toygur, 2022) and Turkey ends up creating a legislative package that would ensure religious freedom, transparency and free trade within the country. A similar situation with Russia also has as a consequence Moscow’s accession in EFTA, which increases exponentially the trade volumes. This comes in contrast to the existing environment in the EU-Russia relations amidst the invasion of Ukraine.

Significantly ameliorated EU-Russia relations in this narrative have a positive impact on the political landscape of Belarus and Ukraine. Political stability is prevalent in both nations and policymakers and decision-makers, having less distractions, manage to establish a fair and transparent political system, leading eventually in both countries engaging in a more active way in trade and other sectors with the rest of Europe.

In the Markets and Institutions storyline, there is an overall agreement within the EU over environmental and energy policy. Targets set by the EU Green Deal, as well as the Paris Agreement and the yearly COP summits are fully adopted by the majority of the member states. There is consensus over the usage(or no usage) of transitional fuels(e.g gas) as well as in controversial topics such as nuclear energy. There is complete integration of the energy markets and all member states adopt a similar energy system structure with a liberalization of their national markets and unbundling of most services.

Conflicts are not absent from the Markets and Institutions narrative, they are taking place relatively often in other regions of the world, but also internally within Europe. Nonetheless, a strong EU coordinates with other international institutions such as the UN and the IEA and, combined with its successful security and defense policies, deals with these conflicts in an effective and quick way.

USA

Washington depicts a much more extrovert behavior in a Markets and Institutions storyline, pursuing more trade ties with Europe, the Asian markets and Africa. The result of a Biden administration is that the USA engages more actively in international institutions like WTO and works on modifying GATT in a way that fair trade is ensured on a global scale. Its engagement in WTO does not happen in a dominant way, though. The American delegation is respectful of other countries' views and decisions on global trade are made through majority consensus(Willems, 2021). This leads other countries, such as Turkmenistan, in joining the WTO and global trade volumes portray a surge.

The overall uncertainty over the USMCA is replaced by political stability in the USA and Mexico, contrary to the current projections, and the free trade agreement acts as a driver for further integration with Central and South America.

Interventions in disputes are also present in the Markets and Institutions storyline for the USA. Nonetheless, in this case, they occur more in the form of diplomatic missions to negotiate with local governments and international institutions over the way to solve local and regional crises. Lobbying is also a very popular method to facilitate solving conflicts in these regions. In these ways, countries end up with good governance models, which has a positive impact on their engagement in international institutions, regional blocs and on global trade in general. This benefits the US in the long-term, as they have more and more reliable partners in technology, energy, trade and military.

Energy and environmental policy are fully aligned for Washington in a Markets and Institutions storyline. The $2 trillion climate plan proposed by President Joe Biden(Glueck & Friedman, 2021) is fully applied in an energy context and many of these funds are targeted at renewing the obsolete American energy infrastructure, but also towards just transition, which results in capacity building of old energy workers in order to be able to contribute to construction of renewable energy sources units. In addition, there is full alignment with the US free trade policy. This means that there is participation in the regional electricity market, which has been fully liberalized, but also in the global free energy market, in oil, natural gas and hydrogen. Usage of nuclear for non-military purposes is

also a vital part of the US energy policy, as a significant part of the climate plan funding goes towards nuclear power plants that replace coal-fired or oil-fired ones.

As far as the relations with EU, China and Russia are concerned, in a Markets and Institutions storyline there is major progress being made. Washington manages to resume negotiations with Brussels on the Transatlantic Trade and Investment Partnership(TTIP) (Khorana, 2015) and result in full agreement that boosts trade and cooperation even more. A similar approach is geared towards the Transpacific Trade Partnership(TPP)(Freeman, 2021), which sees China joining as well and ending the trade dispute between Beijing and Washington.

Russia

There is virtually no evidence currently backing such a stance from Russia, like the one mentioned in this narrative. However, there will be a framework design for Moscow based on assumptions and on the trajectory of other "empires" on this storyline. The Russian approach in a Markets and Institutions narrative is relatively similar to the Regions and Empires one, there is however the difference that there is no intent to dominate, but rather to cooperate. Moscow focuses on alliances such as the CSTO and the EEC in Central Asia and the Caucasus, but the main goal is to enhance collaboration and promote free trade in the region, with the objective of strengthening the regional economies(Devonshire-Ellis, 2021). Hence, it is not in their interests to dominate. Assistance in riots such as those in Kazakhstan or Kyrgyzstan happens in a diplomatic way, where the Russian delegation provides a safe space for the opposing parties to negotiate and come up with a peaceful solution.

The biggest shift in the Russian policy concerns the market structure in this storyline. Many state-owned companies that also enjoy the monopoly privileges of their sectors face privatization. Prevalent examples include Gazprom and Lukoil. All markets, including energy, technology and electricity, are fully liberalized and their utilities and services, along with other ones such as water, are unbundled. Moreover, formulating a free market, it becomes more attractive for international oil companies to invest in Russian markets and trade Russian oil and gas globally.

Relations with OPEC and IEA, as well as other energy-related institutions are ameliorated and there is cooperation which facilitates the formulation of free international markets for all fuels.

Engagement with the EU happens also in a non-dominant way. Both parties sign a free trade agreement similar to EFTA. Energy supply to its member states is a very important aspect of Russian energy policy, there is no exerting of pressure, though, to Brussels to fulfill the bulk of its energy needs from Russia. Moscow accepts that the EU will opt for diversification of suppliers, increasing its supplies from Africa and America and taking into consideration other energy carriers as well, such as LNG, LH2, ammonia and green hydrogen through pipelines. Reflecting on the free market principles, Russia, in turn, diversifies its supplies and moves forward with agreements with Beijing to provide oil and gas, or even hydrogen, to fuel its economy. Moscow also provides the technology expertise and the funds necessary to complete the TAPI pipeline that will transfer over 30bcm from Turkmenistan to India, finding in this way a new group of customers for its energy. Agreements also take place with Japan and South Korea, resulting in a broader East Asia and South Asia collaboration.

China

The Markets and Institutions storyline sees China on a similar path as Russia. Again, very little information exists on projections that China is heading towards this narrative. Disputes with neighboring countries and regions are solved through diplomacy. The dispute over Taiwan finds its solution through negotiations and Beijing actively listens to the demands from Taipei City and a joint

decision is taken, which results in a full recognition of the Taiwanese status. A similar approach takes place in the Senkaku Islands. Initiatives such as the Tokyo-Beijing forum for the resolution of conflicts through discussions is proven effective and hence no use of armed forces is needed, as a peaceful way is found(Kudo, 2013). This type of progress facilitates discussions which lead eventually on a free trade agreement between theses strong economies. South Korea embarks on a similar path as well.

Cooperation with Russia is enhanced, especially on the energy sector. There is support on technology expertise on the military sector as well, but in this storyline this kind of support is much less than on the energy sector. This translates into agreements on gas trade, but also on trading of rare earth metals and other minerals trading, as well as uranium to develop nuclear power plants(Reuters, 2022).

Joint naval programs are initiated between China and India on strategic locations like the Malacca Straits. In addition, Beijing joins coalitions like AUKUS for joint naval exercises in the South China Sea and strengthens their strategic partnership. This does not mean that military budget increases. On the contrary, there is a reduction in military budget which instead is strategically spent to strengthen the Chinese presence in these partnerships.

Similarly to Russia, China's business landscape comprises predominantly of state-owned enterprises. There is a major shift in that policy as well, with the majority of these companies seeing privatization and the Chinese markets being liberalized. In this case as well, market operators in sectors such as energy and telecommunications are unbundled and this paves the way for international companies from various sectors to invest on the Chinese market.

The Belt and Road Initiative(BRI) is prevalent in the Chinese foreign policy in this narrative as well. Nevertheless, the notion of One Belt, One Road, depicting dominance, is absent. Beijing, instead, seeks cooperation from other global powers as well, such as Russia and the USA for the joint development of projects and the investment schemes in the developing world in particular(Enterprise Singapore & Infrastructure Asia, 2018). In Europe, China, as part of the BRI, communicates centrally with Brussels to coordinate its actions with the consensus of the majority of the EU member states and current agreements on free trade expand on other sectors, in particular energy and rare earth metals, as well as semiconductors, which are very much needed in Europe.

Persian Gulf – Gulf States

A Markets and Institutions storyline sees states around the Persian Gulf in a shift to less radical policies. New governments and political leaders choose to adopt a series of reforms in order to shift to a more liberal society, by liberalizing all markets, promoting free trade and being accepting of human rights. Countries such as Saudi Arabia and Iran, follow the modernization path that Bahrain and Oman set in the beginning of the century. In this way, the two former states adopt the reforms that the two latter ones had implemented first (Common, 2008). Free trade agreements, as part of that shift, are signed within the region but also with external global powers. This comes as a logical continuation of numerous existing discussions over the topic(Agence France Presse, 2000; Nandi, 2022; Matthews, 2022)

Cooperation on energy in particular is even more strengthened and the role of coalitions like OPEC becomes broader and involves all oil producer states. Similarly, there is the inauguration of new institutions similar to OPEC, but for gas and hydrogen, which can be called GASPEC or HYDROPEC. Gulf states assume a leading role in formulating these institutions, however they refrain from dominating and follow an inclusive approach.

Energy is not traded through bilateral contracts, but rather on the free market. International institutions, however, possess the necessary mechanisms to control excess increase(or decrease) in prices in order to protect consumers and producers.

Africa

Governance in this narrative is much more efficient and leaders elected through "clean" elections manage to bring political stability and avoid military interventions. Acts of incivility, insecurity and violence are still observable within certain nations. However, the steps towards democratization in the continent that started in 1990 remain bigger and more than the reversals. Eventually, these processes aim at socio-economic rights and the physical security of African citizens, which leads to an even more meaningful democratization process(Lynch & Crawford, 2011).

The long-term plan of the African integration is finally proving fruitful. Many efforts have been made in the past, such as the Monrovia Symposium, the Addis Abeba Declaration of 1973 and the Kinshasha Declaration of 1976, which led to the Lagos Plan of Action 1980-2000 and eventually to the formulation of the African Union. This portrays clear and consistent will of African leaders to fully integrate economically(Kouassi, 2007). This consistency and willingness in the end is rewarded and integration of their market structure is achieved.

On the energy sector, producer states are active on the international energy market and eagerly join institutions such as OPEC or the future GASPEC and HYDROPEC. North Africa and the Sahel remain the key energy producers in the Markets and Institutions storyline. The region is a major producer of oil and gas and has great potential for hydrogen and hence great importance for Europe. There is broad cooperation, therefore, between the two regions, based on existing roadmaps on how to move forward with such an approach(Lebovich, 2017). Cooperation takes place, for example, on existing pipelines, on construction of new ones and on transferring of LNG and LH2 and ammonia through the port of Mauritania.

There are, however, examples of bad governance models. In this storyline political instability that comes from these forms of leadership is being dealt with peaceful and effective intervention of international institutions such as the UN, the African Union and diplomatic missions from state actors that can function as brokers.

Latin America

Good governance is the main theme in the Markets and Institutions storyline for Latin America as well. This brings political stability in the region and "clean" elections take place even in Venezuela and Bolivia, which eventually join MERCOSUR again and participate actively. There is also merging of MERCOSUR, the Pacific Alliance and NAFTA and Latin American states become more extrovert and go out in the international free market(Albertoni, 2016). There is also further integration and policy alignment with the USA, but not so much on the military sector, rather on energy, technology and telecommunications. This also facilitates the modernization of the relevant infrastructure for all Latin American states. Another prevalent theme is the strengthening of ties with the EU but also with Asia. Nonetheless, none of these state actors becomes dominant in the region. MERCOSUR states manage to maintain a balance and coordinated collaboration with all global powers. Finally, the biggest country in the region, Brazil, does not depict a dominant behavior as well, but instead promotes active engagement of even the smallest states in Latin America.

Central Asia

Major shifts are expected in Central Asian states in a Markets and Institutions storyline. For most of them zero indications exist until now, but The most important one is the liberalization of the regional markets. Most of the region's countries' market sectors consist of state-owned companies that maintain control on over 90% of the market. Enormous reforms result in a liberalized market and unbundled operators. For this to happen, governance systems for each of the state actors significantly ameliorated, becoming transparent and involving local communities in the decision-making process. This increases regional political stability which, in turn, enhances credibility of the aforementioned countries, driving international investment in the countries. Funding moves away from military institutions such as the CSTO and is geared more towards trade-related ones, such as the SCO. This does not cause discontent in Russia, nonetheless, as it is also a member state in the SCO and the SCO's form is no longer based on Chinese dominance, but rather on interregional and international cooperation and free trade. In this storyline, therefore, there is also accession of China in the CSTO, which results in an interregional organization for free trade and in another one for broad collaboration on military expertise. The latter, in this narrative, is of less importance and receives less funding and attention.

The analytical framework developed in the last chapter, combined with the theoretical background on institutionalism, international relations and the scientific and technology aspects of the energy system, will formulate the complete framework on which the whole research will be based. This overall framework will be used in the next chapters. More specifically, in chapter 6, the scientific and technological background of the global natural gas system, as well as the geopolitical background will be used as context and the framework developed will be adapted to it, so that an explanation of how the two storylines will unfold under such a system can take place. Next, in chapter 7, the results of the analysis of the gas system pattern will be made. In this way, valuable insights will be gained, which will be later used as a point of reference to develop the pattern of the expected green hydrogen system. These insights will be used together with the scientific and technological background of green hydrogen, as well as with the overall geopolitical background, as a context-setter. This will take place in chapter 8. The same analytical framework as with the gas system will be applied and the analysis will be of explanatory nature.

Chapter 5: Research Design

A set of seven sub-questions that are relevant to answer the main research question were formulated. The sub-questions, mentioned also in chapter 1, are the following:

Q1: How have transitions to other energy carriers in the past reshaped and affected energy security of supply, globally and within EU member states?

Q2: Which factors influence the energy security of supply of the EU?

Q3: What are the potential strategies that key state actors or regional blocs can deploy within an energy system?

Q4: What are similarities and differences between the geopolitical and energy security landscapes in conventional fuel systems(such as natural gas) and the future green hydrogen system?

Q5: What common patterns between these two landscapes can be identified?

Q6: What additional patterns can be formulated regarding the new green hydrogen system?

Q7: What are the geopolitical and security implications of a transition to green hydrogen for the EU, with regards to its strategy?

These sub-questions make the transition to answer the main question less complex and function as steps towards the answer. The overall approach has been stipulated in chapter 3. Initially, the literature research will be the main method to collect data with regards to the scientific, technological background of the energy carriers and the theoretical background of IR, that will be paramount for formulating the patterns. This will lead to the creation of the global natural gas system pattern. The results from this pattern will be the foundation of the green hydrogen pattern, which will be fabricated based on these results and the literature research on the energy carrier. These research demands will be answered based on the previously defined sub-questions. This section will provide a brief explanation of each sub-question. After the explanation, its purpose and contribution to answer the main question will be discussed. Finally, the research methods and the process according to which these sub-questions will be answered will be laid down.

Table 3.Research methods used to answer each one of the sub-questions.

Research Question	Method
Q1	Literature & Desk Research
Q2	Literature Research
Q3	Pattern Modeling
Q4	Comparative Case Study
Q5	Pattern Matching
Q6	Pattern Matching
Q7	Documentations and Research Results Analysis

5.1.Sub-question 1

The main objective of the first sub-question is to have a point of reference in order to better understand how the green hydrogen system deployment might unfold. Historical data has been particularly useful for energy systems that share similar technologies. In this case, both oil and gas markets operate through either pipelines or shipping, which is very similar to the strategies that may be followed in hydrogen and, consequently, in green hydrogen.

For that reason historical data is paramount. This data is selected primarily through literature research on historical transitions, such as the one from coal to oil and the current move away from oil and closer to gas as a "cleaner" fossil fuel. The data selected is then utilized to create a scientific background for the natural gas global system. This data will be of high value to fabricate the pattern models that will be used for the storyline approach for the natural gas system.

5.2.Sub-question 2

The second sub-question has two objectives. The first one is to have a better understanding of what the exact form of a future green hydrogen system will be. Currently, there is no clear picture of the final shape of the system, but rather (inter)national strategies and roadmaps. Through this answer, knowledge from the aforementioned strategies and literature will be critically assessed, so that the most relevant insights are then used for the research.

The second one is to use this information to create the patterns that are relevant to the green hydrogen system. This is a crucial step towards answering the main research question as it encompasses having two patterns to compare and have conclusions, one of which will be the green hydrogen one.

For both questions, literature research on the strategies and literature already mentioned takes place, with interviews being complementary to that research.

5.3.Sub-question 3

This sub-question is among the most critical ones for this thesis. As mentioned, creating potential storylines is the main approach that will be taken in this research. These storylines basically depict the potential ways the geopolitical landscape, the alliances, regional blocs and rivalries might evolve within the context of the global energy system. These potential ways are directly and fully affected by the potential strategies that major state actors and regional blocks might follow. Hence, to adequately use the storyline approach in this research, this sub-question is of utmost importance.

The approach to answer this sub-question will be pattern modeling. By using data gathered from the previous sub-questions and using a holistic approach the patterns will be created, based on which we will do the comparative case analysis.

5.4.Sub-question 4

The fourth sub-question's purpose is to find a point of reference to understand the severity of the potential geopolitical implications of a green hydrogen system. For that, natural gas is being used as a point of reference, as, based on the literature research, green hydrogen infrastructure is expected to be very similar to the natural gas one. The main objective is to find similarities and differences between the two systems. In this way, actors such as the EU will know which security strategies to keep(based on the similarities) and which to change(based on the differences). This knowledge leads

straight to better understanding how will the green hydrogen system affect the EU, which is the main question

The research method used will be comparative case study. The two patterns that will be created will be utilized as case studies, showing that the research performed so far leads to answering a very important part of the main research question.

5.5.Sub-question 5

The fifth sub-question's objective is very similar to the fourth one's. Finding common patterns between the storylines makes it easier to identify in which ways is it more possible that the energy system will be affected with green hydrogen as the new carrier. It is again a very critical to answer question for the whole research.

The research method will again be comparative case study. There will be an effort to detect common patterns applied by different actors in the geopolitical decision making arena both in the natural gas and the green hydrogen system. However, also common patterns across storylines within the same system, be it natural gas or green hydrogen, will be identified, as they are also useful for answering the main research question.

5.6.Sub-question 6

This sub-question is expected to be the most insightful one. The main objective is what new patterns will emerge in the green hydrogen system. The differences in how the system will function are expected to bring also different interactions between actors and, thus, different patterns. As these patterns have a high probability of affecting the geopolitical landscape, it is paramount to answer that question.

As with the previous two questions, comparative case study will have to lead the way on this one as well. Pattern identification, however, shall take place mostly by comparing the two storylines in the same pattern(green hydrogen and natural gas, respectively). Then, all the patterns will be listed and there will be comparison to see which ones that belong to green hydrogen are different than natural gas.

5.7.Sub-question 7

This is the final sub-question that basically sums up the previous sub-questions, with the objective of answering the main research question. The aim of this thesis, as mentioned, was to provide meaningful insights that can be used by the EU and its member states when planning the (inter)national hydrogen strategies that will basically formulate the green hydrogen system and determine its security policy.

The main method will be picking the most relevant information for the EU out of all the information that was gathered in the previous sub-questions. The second stage of this method will be to put this information in the context of the EU, so that it can be useful for its policymakers.

Chapter 6: The natural gas global system

6.1.Overview

In the previous chapters, the analytical and theoretical framework was set, so that the two pattern models(the natural gas and the green hydrogen one) would be developed. In addition, the scientific, technology and market background was described for both systems. In this chapter, the aforementioned elements are being combined with the aim of formulating the pattern model specifically for the natural gas system. As mentioned, for the natural gas system, historical data about the system structure and the scientific and technological background were used. In addition, projections about the participation of natural gas on the energy mix were combined with the previous historical data to generate the pattern, related to the future of the natural gas system. It is presumed that this pattern will generate valuable insights that will be used as foundation to build the future green hydrogen system pattern because, as it is already mentioned, the two system share similar traits.

To apply the formulated storylines into natural gas, information from the latest IEA World Energy Outlook, but also from the latest IPCC and UN reports were used. This took place primarily because the storyline that was used as a point of reference, developed by Correlje & Van der Linde (2006) utilized these reports as foundation for their own pattern models. To add to those reports however, the EU Green Deal was used for its insights on future policies and initiatives on the energy sector.

Furthermore, to better understand the storylines and their relevance for the future of the global energy system, it is considered paramount to test them across a series of scenarios. The creation of the scenarios was based on the reports that were mentioned, like the IEA World Energy Outlook. Nonetheless, some additional information was gathered. The primary reason is that most reports and outlooks fail to address the projected massive failure of the current pipeline-centered gas system. More specifically, the Russian invasion of Ukraine has spurred total uncertainty over the gas landscape. The isolation of Moscow might entail the end of dependence on a pipeline system for the EU, a shift to LNG and other forms of energy. Despite the potential positive effects on transportation flexibility, on the long run it might create a decrease on investment and a financial strain for the CIS states leading to further political instability and societal disruption events. In addition, numerous scenarios related to gas supply and demand were selected, but also other ones, based on the speed of the energy transition and the technological progress on LPG transportation, were taken into consideration. Finally, the effect of the aforementioned disruptive social and political events is being put into the context of a scenario to observe how the global energy system will react to such shifts. These scenarios were also significantly helpful in determining what kind of disruptive events the energy system will face, in order to better understand their geopolitical implications for all nations.

As mentioned in the previous chapters, the natural gas trade landscape is predominantly a function of supply and demand. On the supply side, innovations on gas liquefaction have increased the volumes of LPG and the scenarios presented by IEA discuss a change in patterns in natural gas trade. They have also increased flexibility in gas trade. Nonetheless, according to the energy outlook, they have not solved all current energy security issues, chiefly due to the increasing demand and the

spikes that have been observed over the past years. The rise in need for gas both for residential and industrial use(heating and electricity) can have far-reaching implications on energy security. A prevalent example is the case of Texas, where in February 2021 a sudden fall in temperature in combination with an electricity demand spike resulted in a sudden disruption, namely a power outage. Another problem that might pose as a hazard for energy security is the supply gap. The current projections for total energy consumption in all scenarios range from 1.4-1.7%, whereas the total energy supply ones range from a 0.7% decrease to a 1.4% increase. There are expectations to cover this gap through energy efficiency technologies, but as innovations on that side come with a great amount of uncertainty, there are several concerns with regards to that. Moreover, the IEA outlook highlights the necessity of gas to balance variable renewable, which translates into an increasing need for gas. However, current projections for 2030 show a lower annual generation from gas, mainly due to the reduction in gas-related investment. The facts mentioned above mean that there is a large possibility for the creation of a supply gap. Lastly, the reduction in investment and in gas output in supplier countries is deemed by the IEA to result to social and political turmoil. More specifically, as production falls, financial strain will increase in these countries which, if not handled correctly, can create an enormous amount of stress on the society, which can generate political instability.

Initially, both storylines will be developed in the next sections. For each storyline, its impact on each region and/or nation will be described and in the end a description of overall impacts will be provided. After their thorough description, their reaction to the aforementioned scenarios will be tested. The endgoal of this analysis will be to formulate valuable insights so that it can be observed which storyline better represents the empirics and themes articulated.

6.2.Storyline 1: Regions and Empires

Europe

The main theme that characterizes the European natural gas landscape in the Regions and Empires storyline is the complete divergence of opinions over the gas supply. The main disagreement revolves initially around the investment volumes that are geared towards gas-related infrastructure. Towards that direction, the existence of multiple subregional blocs is instrumental in disaccords. With regards to TSI for example, in the 2021 list of its infrastructure projects, gas dominated the agenda, as, together with other fossil fuels, such projects outnumbered the renewable energy projects by a factor of more than 2 to 1. Being conceived during the Trump presidency, the TSI's initial ambitions were geared towards LNG supply from the U.S. While Western Europe does not necessarily object the origination of the LNG, eyebrows are raised over the sustainability and the environmental impact and the fact that it is not consistent with the efforts from Brussels to reduce fossil fuel consumption by 55% by 2030(Global Energy Monitor, 2021).

Another reason to cause divide is over the gas origination. This kind of divide happens even within the subregions themselves. In the case of the V4, Czech Republic and Slovakia managed to reduce dependency from Russian gas, a decision driven chiefly by commercial interests. On the other hand Poland and Hungary have not managed to diversify fully from Russian gas and this has been predominantly due to the fact that governments were the ones responsible for the decision-making process on the overall gas mixture of the country (Smirnov, 2021). Those opposing views exist just as much in the EU as a whole as well. On one hand, France has been reportedly preparing itself for a complete halt on Russian gas(Majeed, 2022). Supporting this view is also Spain, whose PM, Pedro Sanchez, urged the rest of the EU to adopt new measures and find alternative sources so as to not become Putin's "hostage"(Dombey & Pop, 2022) .On the other hand, Germany is constantly pushing calls from the U.S and Ukraine for a ban on imports of Russian gas and for a shift in the supply(Von

der Burchard & Sugue, 2022). A similar stance was taken by the Netherlands as well, where PM Mark Rutte (Reuters, 2022) stressed out that it is impossible for Europe to immediately halt its gas supply from Moscow.

The EU is constantly pursuing efforts to reduce the dependence of its neighborhood to Russia, with particular focus on the Western Balkans. However, despite the fact that the EU Balkans reduce gas dependence, this is not the case for countries like Serbia and Montenegro, which continue to have strings attached with Moscow and succumb to its demands(Kirillova, 2021), which makes it a chiefly complex process for the EU to expand there.

Such a landscape will lead to a fragmented European gas system, verifying several views that there exists an EU East-West divide. Albeit the debunking of many of the myths related to that, it shows that there is a relative truth to the divide claims(Lehne, 2019). This is bound to have numerous geopolitical implications. Firstly, a disagreement over the gas supply source could create a snowballing effect on disagreements. A potential point that could be raised is the gas storage spaces within the EU. Currently, the vast majority of the gas stored is in Austria, the Netherlands, France and Denmark, all of which are located in West and North Europe(European Commission, 2022). Amidst tense relations, this arrangement might seem as a threat to the East European states' energy security. This can provide good grounds so that regional blocs, such as the Three Seas Initiative, agree on the construction of a storage facility in one of the member countries' territory. Secondly, the East bloc's dependence on Russian and Eurasian gas translates to dependence from pipeline infrastructures, whose main characteristics include long-term contracts and a rigid market structure. On the West, with recent and projected developments in LNG technology, shipping gas will be the preferred method, chiefly characterized by flexibility. This can create a significant shift in the market structure and the system will be severely affected. Creating flows from the West to the East instead of the other way around can lead to pipeline bottlenecks and gas might not be delivered to many regions. Also, a gas mix with more LNG is bound to shift prices upwards(McWilliams et al., 2022). Overall, there is the potential for increasing social and political turmoil.

Both of these scenarios are expected to generate a major financial burden to European countries. This burden will either be held by state or private actors, leading to increasing debt and risk of default, or within the end users, namely the citizens, which can result in societal tension and unrest. There is another downside to this, however. Financial resources that would otherwise be allocated to aid the energy transition will be used to invest in more, unnecessary, gas infrastructure. This will derail any effort to mitigate or even adapt to climate change, increasing its detrimental effects and creating a reinforcing loop. In this reinforcing loop, for the unrest and poverty created from the aforementioned set of actions, the state will try to alleviate the burden by increasing welfare state funding, reducing investment from climate change mitigation and adaptation, which in turn would increase (energy) poverty and unrest. Overall, effects of a Regions and Empires storyline are expected to be catastrophic for the EU, especially in case that there is no provision from the Union to tackle potential tensions within the geopolitics of energy sector.

Russia

As mentioned, Russia will mainly attempt to solidify its dominance in regions that are characterized by their vast reserves, such as the South Caucasus, Ukraine and Central Asia. This will initially unfold through investments in the form of bilateral agreements(instead of free trade/multilateral

agreements) by state owned Russian companies, such as Lukoil and Gazprom. These agreements will involve locations such as the Azov Sea, the Shah Deniz field in the Caspian Sea and the Galkynysh gas field in Turkmenistan, all of which are deemed to have a great amount of gas.

The most typical example in this case is the Russia-Turkmenistan relations, which, in the context of gas, started shortly after the Turkmen independence. In 2003, the two sides signed a bilateral agreement valid for 25 years, allowing state-owned Gazprom to buy virtually all of the Turkmen gas for that period of time(Dubnov, 2016). In 2015 gas supply from Ashgabat was almost completely halted from Gazprom, amid ameliorated relations between Turkmenistan and China, but resumed in 2019 and resulted in an additional 5-year gas agreement between Russia and Turkmenistan (Eurasianet, 2019; Putz, 2019).

Uzbekistan is in a similar predicament, as Gazprom is also dominating its gas landscape via bilateral deals. In 2017, the state-owned energy giant signed an agreement with Tashkent for the purchase of 4bcm in the price of USD125 per 1000 cubic meter, a significantly low amount(Eurasianet, 2017). Efforts by Tashkent to diversify its collaborations on the gas sector by including U.S companies in shale gas explorations within the country (Lillis, 2022) are being seen as a threat by the Kremlin which moves forward with intimidations and flex of its military muscle towards Uzbekistan (Temirov, 2022).

Another commonality in the Russian gas sector, which is far from free trade agreements, is swap trade agreements. An example of these trilateral agreements is the swap deal with Kazakhstan and China, where Gazprom and Rosneft would operate within Kazakhstan for the exploitation of oil & gas with the objective of selling it to Beijing(Sokolov et al., 2022). The gas relations with Nur-Sultan go back to 2006, where a similar long-term contract was signed with Moscow(RFE/RL, 2006).

For cases like the Ukrainian one, soft power and sheer intimidation might not be enough to bring the country closer to Moscow's sphere of influence. In this case, Russia uses hard power and resorts to military interventions, with the invasion that took place in February being a prevalent example(Kirkby, 2022).

As mentioned on chapter 4.1. , another way to pressure state actors is through the partially recognized states in the post-Soviet space. The common feature of all these states is that they are home to gas pipelines, which are used to fuel Moldova, Ukraine and Georgia and indirectly the EU. By using non-state actors, Moscow can make all of these countries potentially succumb to its dominance and follow the path of interconnection in the post-Soviet space. This chiefly takes place through actions by the separatist groups in these regions, such as the explosion of the pipeline in Luhansk, leaving more than 100 homes without gas and causing damage to infrastructure that is paramount for the European gas security of supply(Reuters, 2022). Finally, Russia shall continue to use embargo-related strategies, such as the gas supply cuts to Belarus amidst a series of outstanding debts of Minsk in 2010(VOA News, 2010).

There are several expectations based on the Russian trajectory so far in the gas landscape. With regards to collaborations, Russia will not pursue any partnerships. Out of the existing ones, it is expected to become less active in the SCO and revisit existing agreements within that framework, as well as any other framework of cooperation with China. Their partnership will solely focus on trade and the Power of Siberia pipeline, together with the ones from Turkmenistan, all of them operated by Russian stated owned firms, will create a huge rise in prices in gas, which is very much valuable for the accelerated development pace observed in China. A similar landscape is observed in Europe. Russia will eventually decide not to join EFTA and will also increase its prices to supply gas to the continent. It can also deploy similar tactics to the ones used for Ukraine and Georgia. By disrupting

energy supply e.g in Luhansk or Donetsk, issues are created in Europe, as it is these pipelines that will supply the continent with gas. Finally, Moscow is projected to pursue bilateral agreements instead of collective agreements with the EU, in order to exploit vulnerabilities of single member states.

USA

The Regions and Empires storyline in the gas context revolves around the shale gas revolution, which converted the USA from an oil & gas net importer to a net exporter(IEA, 2019). This theme can be translated to the fact that Washington can utilize its energy independence and create an "empire" of its own. In the context of energy trade, it will follow a similar stance to Moscow, trying to exploit vulnerabilities of single state actors through bilateral agreements instead of participating in larger agreements through international institutions. In North America, NAFTA will not be used as a point of reference for the USA, Canada and Mexico to coordinate their energy trade efforts and cooperate. In the case of the Trump administration, many issues were raised with Canada which led to a hardball game between the two neighbors and President Trump showed his intentions to negotiate bilaterally on energy with Mexico multiple times. However, the road on working together with Mexico has been bumpy as well, with the political transition after the elections of 2018 resulting in a more protectionist Mexico (Cunningham, 2018). After several revisions and serious discontent over the free trade agreement, NAFTA was replaced in 2020 by USMCA. One of the new FTA's main themes was free trade on oil and gas. However, a change of leadership in Washington, combined with environmental concerns and Mexico's alleged discriminatory actions against U.S energy companies are painting a picture that the new agreement is not projected to outlast the former one and fragmentation in the region is closeby(Cunningham, 2018; Pskowski, 2020; Baker, 2021).

For collaboration with Latin America, Washington will not follow the communication channels that international institutions, such as ECLAC and MERCOSUR provide. This is proven by the fact that, outside of Central America, only Chile and Colombia have successfully penned free trade agreements with Washington. If states are not oil & gas producers, such as Uruguay, there is not enough gas demand that would justify LNG imports. Nonetheless, the U.S are very likely to find other means of persuading these countries (Reuters, 2018). This can happen either via soft power, namely sanctions and embargo, or via hard power, via military interventions. In cases like Venezuela or Colombia, where there is already extraction of their fossil fuels going on, the USA can exert influence again either through sanctions or military interventions to overthrow the government. In the case of Caracas, in particular, there was already an effort from opposition leader Juan Guaido to overthrow the government and speculation over potential military intervention by Washington has been on the rise(Kwong, 2019). Finally, given the so far behavior from the USA towards oil & gas producing states, in case there is a similar shale gas revolution or recent oil and gas discovery, US energy companies are likely to leverage these countries with their expertise and make them dependent on the scientific and technological capital that they provide and, through bilateral agreements, they can get oil or gas at very cheap rates, which will allow them to make great profit.

Washington's relations with Beijing are projected to worsen in this narrative. In an effort to secure new gas resources amidst increasing energy demand, all global powers will see Africa as a 'gold mine' to control more gas, after the explorations both in the East and West part of the continent(Compinschi, 2020). Given the continuing competition between Washington and Beijing in

Africa (Cheng, 2021), China and USA are expected to lock horns within the continent consequently bringing disputes, primarily diplomatic ones. Because of this, the USA shall continue their LNG exports to Asia, but will refrain from supplying to China, as a potential LNG price hike will result to China and the USA blaming one another, resulting to withdrawal of potential trade agreements. As a side-effect of this dispute, China will strongarm regions such as Southeast Asia, where it is easy for it to exert pressure, and this is expected to reduce potential buyers for the American LNG, resulting in a reduction of revenue from the Asian markets, which are paramount in LNG demand(Asia Watch, 2021; GlobalData Energy, 2021).

China

China's global significance in trade and finance means that it should be considered as an "empire" in the Regions and Empires storyline, as already mentioned. Nonetheless, it is not in a beneficial situation, as it is dependent largely on oil, gas and coal imports, which can have far-reaching ramifications for its position in the gas system in such a narrative. There will be competition with regional players such as Korea, Japan and India in securing energy resources and China will go at great lengths to achieve energy security. They will chiefly try to do this by flexing their financial muscle in countries that are important gas suppliers and preferably in neighboring regions, so that pipeline infrastructure can provide long-term security. More specifically, in Central Asia, Beijing shall continue implementing its Belt and Road Initiative. Similarly to Russia, China resorts in bilateral agreements with all interested parties. Despite the fact that the Central Asia – China gas pipeline brings the much desired fossil fuel both from Turkmenistan, Kazakhstan and Uzbekistan, there is no multilateral/regional agreement but rather a set of bilateral agreements separately with Ashgabat (Jafarova, 2014), Nur-Sultan (Suleimen, 2014) and Tashkent(Reuters, 2007). Agreements are similar to the ones with Moscow, with solely state-owned companies taking part. However, unlike Russia, China focuses on intimidation with financial means based on two axes. Firstly, it tries to lock state actors into a debt-trap diplomacy, which has as a consequence that these countries are on the verge of default on Chinese debt. As a form of payback, states, like Turkmenistan, cede control over the gas infrastructure(Gupta, 2020; Caravanserai, 2021). Secondly, by constructing roads and investing in processing plants that use petrochemicals etc, it creates enormous dependencies, making these countries heavily addicted on Chinese capital to resume and operate this infrastructure(Jaborov, 2018). The main advantage of the Chinese financial muscle, in contrast to the American one, for example, is the lack of string attachments to the agreements with other governments(Pinto, 2022). Whereas the Western world asks for reforms to move forward with investments, this is not the case for China, which makes its offers more appealing to authoritarian regimes. A similar case exists in Southeast Asia. Within the region, Myanmar maintains the vast majority of gas reserves, with over 23tcf at its disposal(Worldometer, 2017). And while ASEAN, the regional bloc, had agreed to follow a balanced stance between USA and China, after the coup in Naypyidaw, Myanmar has clearly leaned towards Beijing's special diplomacy towards authoritarian states(Tower & Clapp, 2021).

This rationale will be fully implemented in Africa as well. By funding and supporting authoritarian leaders, Beijing will try to gain support on exploitation of gas reserves in resource-rich areas like Angola and Mozambique. A similar pattern unfolded in the oil landscape where, Angola in particular, is a country in despair, facing high external debt, high poverty and inequality and lack of basic health and education facilities, pointing towards the need for reforms and potential shift in the regime. China, though, continues to deepen relations with a corrupt government and increase its support, also financially, by signing oil agreements via its state-owned Sinochem (George & Aizhu, 2015; Chakrabarty, 2021; Xinhua, 2021). It is bound, however, to face competition there, from countries like the USA and France, which might lead to diplomatic and even financial disputes.

Reflecting on the so far stance of Beijing, it is poised to follow the same path in its relations to Europe in this storyline. Instead of continuing its set of collective agreements with the EU and boosting ties with EFTA as well, China will seek to incentivize single member states in bilateral agreements on gas, which might not be in full alignment with the EU core values and propositions. This might lead to disagreement within the EU and might raise the issue of keeping active membership of all member states.

Finally, regarding the USA, in this narrative, there will be no agreement with Beijing on trade. This has geopolitical implications for gas as well, as the USA might attempt to exert pressure to collaborating countries, like Canada, to refrain from energy trading with China.

Persian Gulf – Gulf States

As mentioned, in the Regions and Empires storyline, the Israel-Arab World relations will play a major role in the outcome of the gas landscape in this narrative. In the context of gas, the discovery of the Leviathan field in Israel has sparked the interest in Tel-Aviv and there is willingness to export. Instead of being seen as a chance for collaboration, the Gulf States will mostly see this as a form of competition and it will create additional friction to the relations with Israel, resulting in their deterioration.

Another reason for conflict is probably the relations with Turkey. Iran, with the largest gas reserve in the world, will continue to collaborate with Turkey, as well as Qatar(Stempel & Hals, 2021; Youssef, 2021). These forms of collaboration extend on the field of gas bilateral agreements as well, but not trilateral ones (Al Arabiya, 2022; Reuters, 2022). This can not be received well, in particular by Saudi Arabia and the UAE, as well as Iraq, because of the disputed behavior that Ankara has depicted over the past years(Akkas, 2022). These countries, being in good terms with the USA and the EU(Gundogar, 2021; Mattingly & Atwood, 2022), will see this behavior suspiciously and if the gas is transferred chiefly via pipeline infrastructure, this friction and conflict might lead to disruptive events. In the case of LNG trading, the risk is somewhat lower.

Africa

For Africa, the renewed interest over the continent's gas reserves will be the prevalent theme in the Regions and Empires storyline. In particular, the new reserves found in Tanzania, Mozambique and Uganda(Kato, 2021; Kedem, 2022; Apofeed, 2022) are bound to generate a fight over power in these regions. And while French giant Total seems to be heavily invested in the Mozambique and Uganda fields(Kedem, 2022; Apofeed, 2022), ventures come jointly with Chinese giant CNOOC. That does not guarantee French dominance within the regions, but it also raises environmental concerns within the local population, especially because drilling close to nature reserves is involved(Deutsche Welle, 2022). This causes discontent within the population that is expressed through protests. This is combined with the action of non-state actors, namely ISIS causing unrest in Cabo Delgado(Schwikowski, 2021) and The Great Lakes(Otafiire, 2021) region, respectively. The combination of these two disruptive events is mayhem in the region of East and Central Africa. In this narrative, international institutions such as the African Union, will not try to trace the funding towards these organizations and solve the matter in a peaceful and collective manner. Instead, only regional blocs will attempt to take action. In the case of Uganda, since the Great Lakes region is located in the border of two regional blocs, namely ECCAS and EAC, there will be disagreement over the type of action that should be taken. This means that there is a higher chance that the conflict will escalate in both regions and it will be seen as an opportunity for global powers, such as Russia, to

intervene militarily to restore order. In the second case, Mozambique is part of the SADC, which has already proven ineffective to solve issues like the social unrest in Eswatini(Mathekga, 2022). A similar situation is expected in Mozambique, where the terrorism action in Cabo Delgado will not be solved via diplomatic and non-violent ways and a military intervention in the government will be needed.

The situation is expected to be somewhat different in North Africa and the Sahel. Despite the common feature of the ISIS action in these countries as well, the main theme of the disputes in this storyline will be the Israeli-Arab World relations. Gas reserves have been found in Morocco, Algeria, Egypt and Sudan. All of these countries' stances towards the Abraham Accords have been widely divergent and this has a strong effect on their relations towards other players(Mezran & Pavia, 2021), such as the EU, the USA and China. This results in the region not having a collective strategy on how the reserves will be exploited, by whom, how are the funds gathered going to support the local communities and which global powers will be the guarantors of security in the region. This formulates international conflicts like the one between Algeria and Morocco(Ghebouli, 2021) or national ones like the ones in Libya, Mali and Sudan. The African Union is once again proving to not be very competent in finding a diplomatic solution within the international institutions arena.

As far as the internal political situation is concerned, political leaders of these countries cannot manage to include local communities in the financial gains of these projects in this narrative. What happens instead is that authoritarian regimes share the benefits with the international companies that operate in the country and increase energy poverty and injustice within their respective countries. This is seen as a form of neo-colonialism by the local communities who instead resort to supporting the non-state actors, such as terrorist groups and local vigilantes. This reinforces the loop of violence and increases the need for military intervention.

Latin America

The main intergovernmental body of cooperation on energy in Latin America is the OLADE. In general, it has a very weak role, focusing mostly on scientific research rather than fruitful collaboration. However, in this narrative, it is expected to grow even weaker. Disruptive events such as the Russian invasion of Ukraine will divide the bloc, and countries such as Venezuela, Nicaragua and Bolivia, that have always been close with Moscow(Miller, 2022), will be removed from the organization. A similar behavior will be depicted by Brazil, where Bolsonaro, following the path that his close partner Donald Trump followed(Nicas, 2021), is also moving away from international institutions, like the OLADE, but also considering moving away from MERCOSUR as well. Another reasons that strengthens this position is the belief that Brazil's growth is slowed by the trade bloc as it has to contribute even 35% tariffs for certain goods(Paz, 2019). Moreover, there is no integration, but rather further alienation between the two trade blocs, the Pacific Alliance and MERCOSUR, as the former's ambitions do not include the latter, which brings confusion and frustration(Foster, 2020). In addition, there is disagreement over the type of interconnection. State actors without access to sea routes, such as Bolivia, or with socialist regimes, such as Peru, are projected to advocate in favor of pipeline infrastructures, with the objective of increasing energy security for the local communities. On the other hand, countries with vast resources and sea routes available that can invest in LNG infrastructure will push towards that direction. This is reflected by the fact that numerous efforts to connect the whole region through a gas pipeline have never yielded fruitful results (Lizarazu, 2008). This is expected to formulate a divide and a disagreement that might even result in minor conflicts. The most important implication, however, will be the social unrest and political instability. Many

countries in this region are already prone to such events and a potential crisis over gas reserves might enhance this sensitivity.

Central Asia

Central Asia is already fragmented in terms of gas infrastructure and a Regions and Empires storyline is only expected to worsen the current situation. There is currently a struggle for Russian state-owned companies, like Lukoil and Gazprom to maintain dominance in countries like Kazakhstan, Turkmenistan and Uzbekistan. However, the enormous Chinese funding is also reaching the gas infrastructure sector, which makes it increasingly challenging for Russia to follow up(Stegen & Kusznir, 2015). Moscow will instead attempt to keep its security guarantor status in the regions. In addition, it will use the power that labor migrants from Central Asia give to the Kremlin as leverage(Hashimova, 2021). Political leaders in Central Asia thus face a major dilemma: On one hand, showing a cold stance towards China will lead to a steep fall in Foreign Direct Investment, formulating a huge macroeconomic crisis that will be felt strongly by the local community and lead to unrest. On the other hand, turning their back on Russia, might mean losing military and security capacity which makes the state prone to potential invasions or regional conflicts, such as the ones in Afghanistan. It also means losing the remittances that labor migrants bring in the countries. Overall, this fragmentation of gas infrastructure, in the Regions and Empires narrative is expected to expand in more sectors and have larger geopolitical implications for the region.

Table 4. Summary of analysis of chapter 6 on the global gas system for the Regions and Empires storyline

Region	**Theme**	**Evidence**
EU	Different Blocs	Existence of different blocs
	Bilateral Agreements	Signed bilateral agreements on gas
	Opposing views	Statements/Declarations
Russia	Bilateral Agreements	Signed bilateral agreements on gas
	Military Interventions	Number of interventions made worldwide
USA	Free trade breach	Replacement of NAFTA with USMCA
	Lack of free trade	No FTA's with all neighboring states
	Military Interventions	Past behavior with oil, tendency for Venezuela now
China	Bilateral Agreements	Agreements with all states on energy (Central Asia mainly)
	Military Interventions	Increasing military agreements worldwide
Persian Gulf	Fragmentation	Opposing views on foreign policy issues
Africa	Bilateral Agreements with different external actors	Gas fields in Uganda, Mozambique and Tanzania with different developers
Latin America	Fragmentation	Two different blocs

	No interconnections	Failed attempts to interconnect

6.3.Storyline 2: Markets and Institutions

Europe

In the Markets and Institutions storyline, there is full alignment over the European gas strategy. The decision is being made in Brussels, at an EU level, and is implemented in full-scale by all member states. Disruptive events such as the Russian invasion of Ukraine or acts of terrorism in North Africa do not create fragmentation within the Union, but the responses are rather unified and the EU is brought together in ways that would otherwise be unimaginable(Langfitt, 2022). One of the implications of this stance is the joint statement of the EU member states within the European parliament that the Union would seek collective agreements with other gas suppliers to diversify its energy mix and reduce dependence on one state actor, in this case Russia (Abnett, 2022).

Disruptive events such as the Russian invasion of Ukraine have also a unifying effect on the European neighborhood. More specifically, amidst the conundrum of the war, Serbia and North Macedonia grow closer to the EU and see more positively the prospect of getting connected to the European gas market (EWB, 2022). This shows the chance the EU has for expansion in the region and for this narrative to fulfill itself as a scenario with high probability.

Another important point is the stance towards the gas suppliers. The first group of suppliers are the ones that, alone, cannot constitute “empires”. Many of them, especially in Africa, the Persian Gulf and Latin America, face inherent political instability(Campbell & Quinn, 2021). In this narrative, the EU attempts to solve the issues, in full coordination with the UN and regional institutions(such as the AU in Africa), with the aim of finding common grounds and a democratic way forward (Cardona, 2014; UNAMI, 2021).

The second group includes the “empires” that belong to the list of gas suppliers, such as Russia and the USA. Lack of a specific current coordination framework means that only speculations will be made. These speculations are about the trajectory of the negotiations with both parties to sign collective free trade agreements. For Russia, in this narrative, the EU reaches an agreement to include Moscow to EFTA and to sign a memorandum of understanding that agreements on gas trade are going to happen solely on a collective, European level, and not with bilateral agreements. This agreement comes as the aftermath of many meetings where both parties pursued free trade conditions(EFTA, 2013). Russia sees the opportunities of increasing trade volumes and expanding in other sectors in collaboration with the EU and moves forward with these agreements. This means that also the reforms necessary, including privatization and unbundling of the gas sector, take place.

Concerning the relations with the USA, there is an agreement over the TTIP(Khorana, 2015) and this trade pact includes gas trade, which reduces the LNG-related prices and increases the volumes traded, as part of the free trade scheme. Russia and USA both acknowledge that there is free trade with them and the EU, but do not see this relationship as competitive, but rather as complementary, and since there are gains from this collaboration, these partnerships do not cause friction within the respective relations.

Russia

Russia continues to be willing to further integrate with all its neighboring states, but not in a dominant way. In the Markets and Institutions storyline, more attention from Moscow will be paid to the EEC rather than the CSTO, promoting free trade across the CIS and the post-Soviet states in general(Devonshire-Ellis, 2021). Military alliances in this narrative are not considered fully entangled with the free trade and energy ones, and hence potential NATO entry talks from Ukraine or Moldova are not seen as a threat for the Kremlin. The forecast from Mikhail Myasnikovich, the chairman of the Eurasian Economic Commission, or EEC, the EAEU's permanent regulatory body prove to be true and free trade agreements that are part of the EEC include gas as well(Eurasianet, 2021). This creates a common gas market from which Eurasia benefits as a whole and it becomes an incentive for all Eurasian states to join. In this storyline, instead of "weaponizing" gas prices for partner countries that don't exhibit the right behavior, Russia develops an integrated pipeline system and a financing scheme that helps member states with financial issues to buy gas at an affordable price. Moreover, Moscow agrees to participate in funding projects that increase energy security in the broader Eurasia region, such as the TAPI pipeline and the TCP. For the former it had been indicated by Russian officials that it is their desire to do so(TASS, 2022), whereas for the latter this development goes contrary to the Russian stance so far(Pannier, 2019).Events of social unrest in Russia, Central Asia and the Caucasus are not being deterred through military force. On the contrary, they are seen as a ramification of energy or food insecurity which leads regional blocs like the EEC working closely with international institutions such as the ADB and the IEA to trace the exact nature of the problem and fund projects to alleviate the pain in these local communities.

Based on the market structure proposed by the institutional theory of this narrative, both pipeline and gas field operators, which are currently state-owned, are privatized and the different types of gas infrastructure projects are being handed to multiple companies. In addition, the gas transmission and distribution operators are unbundled and consumers can opt for one of the many potential operators that enter the market.

The Sino-Russian relations are also based on mutual understanding and sharing each one's strong points to generate the best outcome. This happens primarily when Russia provides its technical expertise in gas infrastructure to complete projects like the Power of Siberia. In return, Beijing provides the financing necessary to deploy the necessary gas projects that will bring gas security in the whole region, not just China.

Finally, based on the aforementioned landscape in this narrative, its relations with the EU are projected to move towards the same direction. After becoming a member of EFTA, Russia signs agreements on gas only in a collective manner. Potential disruptive events, powered by economic nationalism in Eastern Europe, aiming at growing closer to Russia, are not seen as a vulnerability, and all involved parties manage to resolve the issues in a diplomatic manner.

USA

In the Markets and Institutions storyline, USA is seeking to work together with its regional partners, but also in a global level. On a regional scale, USMCA that replaced NAFTA does not present any additional turbulences. Mexican President AMLO and President Biden manage to reset discussions and, together with Canada, they reinstate their trilateral relations which include two very important themes related to gas. Firstly, they facilitate free gas trading among Canada, the USA and Mexico(Zissis, 2021). Secondly, they have the potential to work as a coordination platform to deliver cheap gas to regions with energy insecurity such as Central America(via pipelines)(Buchanan, 2019)

and the Caribbean(via LNG). To facilitate that, LNG terminals are funded in key islands of the Caribbean, such as Jamaica(Gomes & Lambert, 2017).

Collaboration on a regional level is extended in South America. Gas coming from countries such as Colombia and Bolivia is not seen as a threat and form of competition, but rather as an opportunity to pursue collective efforts to modernize the energy infrastructure of the region, with the objective of reducing energy insecurity. FDI coming from the U.S is the largest financing source for Latin America and in particular oil and gas projects in countries like Brazil and Mexico are being heavily funded and operated by American companies. After the commodity boom investments in natural resources in the region have dropped, but Washington helps pick up the pace with gas pipeline projects(Viscidi & O'Connor, 2017), which help reduce the social unrest and the opposing views towards the USA foreign policy. However, there might still be disruptive events taking place. In this case, the USA attempts to solve them through coordination with regional blocs like MERCOSUR and solely through the diplomatic road. Such an example was depicted by former Secretary of State Mike Pompeo during his negotiations with the government of a gas producing country such as Mexico, concerning migration flows (Pompeo, 2019). This behavior is expected to be more frequent in this narrative.

Based on the framework set by this narrative, gas trade with the EU is expected to take place predominantly through the TTIP or a similar free trade pact, whereas the one with China happens through the agreed TPP or any other free trade agreement. The USA does not attempt to compete with Russia on the EU and with China in Africa and Southeast Asia, but instead there is joint understanding of which global power will develop gas infrastructure in which region. For Washington, West Africa is of greater importance and hence it develops the gas fields that exist there and supplies the needed gas based on agreements set solely by free trade agreements.

Social unrest is also reduced in Africa, as a large part of the revenue is targeting local communities and ameliorating their way of life, being successful in its peacemaking strategy in the continent(Gerhard, 1996). Nonetheless, in the potential protests or political instability that might arise, USA is again collaborating with other global players such as China in the context of the UN to prevent these events from escalating, working closely with the democratically and transparently elected leaders of the African countries.

China

China sees regional collaboration on the basis of free trade as the cornerstone of its energy policy in the Markets and Institutions storyline. In contrast to the reality of solely bilateral agreements(China Briefing, 2021), this narrative sees Beijing embracing free trade in Eurasia. As mentioned, there is a sharing of financial capital, technological and scientific expertise with Russia to build the Power of Siberia pipeline(Aizhu, 2022), as well as others to increase the gas supply. Similar partnerships are taking place with Central Asia, in particular with Turkmenistan, to construct Line D and other pipelines(Michel, 2017). Both agreements happen at the level of the SCO, with the aid of ADB and with the scientific and technological input of the IEA. In these agreements, Beijing strives to ask for reforms that will help bring prosperity to these countries and these reforms are being respected by Central Asian leaders, which is contrary to its current stance. The situation is similar in the China-Pakistan relations. The China Pakistan Economic Corridor is finally built and it includes gas imports in the form of LNG from the ports of Pakistan(Sacks, 2021). However, Beijing helps bring benefits from this infrastructure to the whole region, including India. This is achieved by integrating its BRI with the regional blocs, like the SAARC and the CAU and by including international institutions like the IEA in the process.

The TPP(Freeman, 2021) is functioning perfectly and China moves forward with LNG trading with USA and Australia as part of the free trade agreement, which reduces prices significantly. Regarding Southeast Asia, China continues to invest in Myanmar gas(Chan, 2021), but in a different way: It promotes a diplomatic solution to the junta that has been established in Naypyidaw to bring a democratically elected leader and facilitates the construction of an LNG terminal. This helps reshape the economy within the country and bring prosperity and energy security to the whole region. That is why this process is being conducted in full accordance and cooperation with the regional bloc, ASEAN. For all the foregoing claims there are scarce indications showing that this might be the case in the future.

With regards to Africa, China focuses on securing only the resources that are necessary for its development and does not resort in exerting influence by controlling all gas reserves possible. Seeing it from a strategic perspective, Beijing limits its investments in LNG terminals in Kenya and Tanzania and in gas fields on the Indian Ocean, where it works together with European companies to exploit the gas resources in an inclusive manner for the local communities as well. The local governments and the African Union are also involved in the process. There is no evidence pointing towards such a future and these claims are solely assumptions.

Persian Gulf – Gulf States

In this storyline, a different kind of revolution will take place in the Persian Gulf. Most states will move to an internal liberalized market and create a free trade zone that will include gas. This will be accompanied by a shared belief on what the regional foreign policy will be, as well as the stance towards global players.

This is validated by a joint initiative, this time proposed by Iran, being the regions(and among the world's) largest gas producers. Tehran proposes creating a similar cartel to OPEC called GASPEC and this is adopted by all gas producing nations of the Gulf. The cartel's main function is as a safety net, so that prices do not go below the actual cost of production. This benefits the Gulf States and their residents on the long term. Disruptive events for gas supply, such as an energy crisis or the energy transition itself, are being handled by GASPEC's coordination with the IEA, other gas producing countries and international gas companies, without resorting in military force and interventions. Finally, being fully aligned in terms of foreign policy, all Gulf States attempt to find a solution to the civil war in Yemen, which ends up in a positive outcome after negotiations.

Africa

The Markets and Institutions storyline finds Africa in a similar path as the Gulf States. Initially, the wave of coups that has taken over regions such as the Sahel or Central Africa will be replaced by a wave of democratization and liberalization of all state actors in Africa, as these violent political transitions do not end up spelling the end of democracy in Africa in the end (Mbulle-Nziege & Cheeseman, 2022). This will be followed by an initiative taken potentially by a large gas producer, presumably Algeria. This initiative will include the creation of a cartel similar to OPEC and to the one proposed by Iran in the Persian Gulf, a different kind of GASPEC. Nevertheless, the African GASPEC members will not see the West Asian ones as competitors, but rather as partners to facilitate the control over the gas prices, so that they don't end up bringing losses to the producing states.

In this narrative, African producing states are active participants in the gas production process. The political leaders demand from the international gas companies that they include benefits for the local communities in order to increase energy security in the region, but also to include Africans in their jobs. The regional markets become fully privatized and unbundled and this brings more entrepreneurial opportunities and increases profits for the local residents. For the moment, nevertheless, there are no projections showing such tendency within the continent, so apart from some vague indications such as expert views, the above mentioned propositions will be listed as assumptions.

Latin America

In the Markets and Institutions storyline, OLADE is gaining increasing importance. It takes the initiative to revive projects such as the South America Energy Ring that results to a big interconnection on the gas sector that involves gas producing and consuming countries (Lizarazu, 2008). It also moves forward with creating an energy free trade zone that includes Central and South America, but also the Caribbean. For connection with the Caribbean, either an enormous pipeline project or a series of LNG projects take place. There is a general agreement among participant countries over the origins of the Foreign Direct Investment and due to the liberalization of global markets, there is an influx of FDI from all global powers. In addition, the Latin American states agree to pool in their own profits from gas sales towards international gas infrastructure that will benefit the region as a whole. The member states that are the first ones to move forward with these initiatives are mostly the oil & gas producing countries and all of them are included in the decision making process, instead of leaving this process to the strongest player in the region, namely Brazil. In the case of Latin America, there have been several unsuccessful efforts to pursue the Markets & Institutions storyline, which is enough proof to depict that there is a general tendency towards that direction, more than mere baseless assumptions.

Central Asia

The most difficult change in the Markets and Institutions storyline for Central Asia is the privatization and the unbundling of the gas infrastructure. A complete shift through elections brings a liberal government revolution in the region that moves forward with liberalizing all markets, including the gas one. The transmission and distribution operators are also unbundled and opportunities for international companies arise, who invest heavily in a gas-rich region. Investments in energy infrastructure bring energy security in a blackout-torn region like Central Asia, and countries like Kyrgyzstan and Tajikistan do not need to suffer the power outages that they face every year. In addition, the cashflow influx facilitates the finalization of gas-related projects in the region, such as the TAPI pipeline and the Dostluk gas field in the Caspian Sea.

The CAU is established anew and gains increasing significance in this storyline. This happens contrary to the projections that want Central Asia to remain without an actual regional bloc. However, this does not happen with the objective of resorting to regionalism. The main function of the union, in this case, is to maintain the balance among global powers. All member states maintain a relative neutrality, becoming members of SCO, the Turkic Council(Tajikistan as an observer state) and the EEC. This does not create friction among China, Russia and Turkey as they all continue supporting financially the Central Asian states in the development of their gas infrastructure. The USA is also involved without causing conflict, as the scientific expertise on shale gas are very much needed, in

particular in countries like Uzbekistan and Turkmenistan. This increases the gas capacity of the region exponentially and, having constructed the necessary infrastructure, it increases its export capacity as well, bringing more profits and more prosperity in a liberalized market and society.

Disruptive events like the ones in Kazakhstan or Kyrgyzstan over the previous two years are being solved by the CAU, with the participation of international institutions such as the UN, where the source of the unrest is understood and reforms are taken to alleviate the pressure from the local communities and increase their energy security.

All of the claims on the Central Asian trajectory in this storyline are merely assumptions, as developments within the region depict that the current and the expected gas and energy landscape is the exact opposite than what is described in a Markets and Institutions storyline.

A summary of all the analysis performed in this chapter and its relevance to the themes correlated with the storylines are depicted in Table 4.

Table 5. Summary of the analysis of chapter 6 on the global gas system for the Markets and Institutions storyline.

Region	**Theme**	**Evidence**
EU	Collective action on gas	Stance towards Russia, Statements
	Diplomatic support instead of military in conflict struck regions	EU joint action with the UN on Iraq
	Free trade with USA and Russia	Vague statements
Russia	Free trade within the EAEU	Statements on gas free trade but no action
	Free trade with the EU	Vague statements
	Support over regional projects	Statement over support of TAPI pipeline
USA	Free trade with the EU	Vague statements
	Free trade in North America	Existence of USMCA
	Regional cooperation over gas	Financial support in gas infrastructure projects in South America
China	Collective agreements on gas, free trade	Assumption only
Persian Gulf	Collective joint actions as a bloc	Assumption only
Latin America	One bloc, one interconnection	Several efforts to unify
Central Asia	One bloc, one interconnection	Assumption only

6.4.Scenario Analysis

Scenario analysis has always been a key feature of strategic planning, as it helps anticipate uncertainties and deal with them in a quicker and more effective fashion. In the gas system case, three main scenarios were identified: The sudden disruption of supply in a region, such as the Persian Gulf or Central Asia, a potential supply gap due to a shift in the investment patterns and, finally, the

stranded assets. The impact of each of the scenarios is being assessed on both storylines and main winners and losers are identified.

Sudden Disruption

A sudden disruption event occurs during a disruptive event at the producing country or region. A prevalent example is the shutdown of the CPC pipeline that used to transfer oil from Kazakhstan onto the Black Sea. The shutdown took place amidst the Russian invasion of Ukraine and a landscape similar to Cold War, so there are also suspicions of this disruption taking place on purpose. A similar situation took place in February 2022, where damages caused the pipeline that passes through the self-proclaimed Republic of Luhansk to shut down. When tensions grow, the probability of this scenario grows exponentially and hence it is very important to further investigate this.

In the Regions and Empires storyline, separate EU member states and regional blocs are the ones that have the most potential to get severely affected. The East Europe states have chosen to receive gas mostly from Russia and Central Asia. This leads to potential unrest in these regions and unilateral moves to disrupt the supply of gas will have detrimental effects for the Eastern Europe bloc. As mentioned, in this narrative, assistance from the rest of the EU will be little and very expensive, which will eventually cripple these states' economy. Another potential ally could prove to be Turkey or the Gulf States, that could negotiate lower prices to compete with the EU, but that can result in further fragmentation of the Union. Also, the trade routes need to be found which, in the case of countries like the V4 member states it will be increasingly challenging. Another loser in this case is China. There is enormous demand and Beijing relies predominantly on long-term contracts, both in pipelines and LNG transportation. Hence, a sudden disruption of supply will make it virtually impossible to cover this demand.

The least affected players in this case are Russia and the USA. Russia, being self-sufficient and always ensuring adequate gas storage capacity, will face a severe drop in the export volumes and revenue, but the Foreign Currency Reserves will facilitate going over this crisis. As far as the USA is concerned, the country, after the shale gas revolution, has become a net exporter of energy and hence a disruptive event in another region can instead raise revenue. If this unrest happens within the USA, there will be easy ways of mitigating the effects of it through gas from Latin America that will be received via pipeline infrastructure.

The biggest winners, in case the disasters in gas infrastructure are not happening within their territory, are the Persian Gulf, Africa and/or Central Asia. All of them will be greatly positioned to increase their output. Central Asia, in particular, will have the biggest chances of increasing export volumes due to its pipeline infrastructure and the fact that most of it is not yet operating in full capacity. The Gulf States will also be in a great position, but will have to deploy a larger LNG fleet which might be challenging at first. Finally, Africa will have relatively low chances, as most gas infrastructure is not fully developed yet in the continent.

In the Markets and Institutions storyline the situation is different. The EU, being united and having an extremely diverse supply system (CIS, North Africa, Persian Gulf, Latin America, USA) is the least affected out of all the players. Synergies made in Brussels in a swift manner help mitigate the problem and provide emergency supply to the member states affected, with almost no strings attached. Thus, financial strain is shared by the whole Union and eventually it is dealt with.

China remains a loser in this storyline as well. Despite its participation in various institutions and regional blocs and the creation of other ones, as well as promoting its strategic BRI looking for collaborators instead of exerting dominance, it is still very challenging to find emergency energy supply. Pipeline infrastructure still comes only from one region, namely Central Asia(and Siberia) and LNG capacity is very limited. Hence it is still the key player that is mostly affected by this process.

The rest of the countries and regions are affected more or less the same way as in the Regions and Empires storyline. The Persian Gulf and Africa see a small shift, nonetheless. As mentioned in the respective chapter, in this narrative more investment is expected to be geared towards ameliorating the gas infrastructure and transmission network, synergies will be formulated and new trade routes will be uncovered. Hence, it is expected that these two regions will have the same chances to increase their output as Central Asia.

Supply gap

The supply gap scenario differs from the sudden disruption one in two main elements. Firstly, the supply gap is created gradually , instead of escalating within a matter of days. Secondly, the underlying reason might be different, with two reasons being the prevalent ones. The first one is the lack of investment because of the fear of financial partners that they might be left with stranded assets. The second reason is the strategic plan of each key player that might involve detaching from oil and gas, similar to the example of Germany moving away from nuclear power. There is high potential of this scenario happening and it is expected to have a large negative impact on the energy system of each one of the foregoing key players, so there is great interest in diving deeper into this scenario.

This scenario entails negative consequences again for the EU in the Regions and Empire storyline. A supply gap in a fragmented Europe will formulate a debate and potential conflicts about how the severely decreased amounts of gas will be distributed, if they are distributed at all. There will be a debate over which storage units will receive the little remaining gas and panic will spread regarding the future of the security of energy supply. From that perspective, a supply gap might cause even bigger conflict than a sudden disruption event.

China is expected to be much less affected in this scenario. Observing a fall in gas output, Beijing will initially be able to secure more gas, either via exploiting the full capacity of the existing pipelines or via spot LNG contracts. At the same time, it will have time to diversify its supplies, either through further investment on the gas sector in Central Asia, or by diversifying its energy mix, reviving oil or coal contracts or even shifting further towards a more renewable mix.

The biggest winners will be Russia and, consequently, Central Asia, as well as the USA, Latin America and the Persian Gulf. Depending on where the supply gap will stem from, it will be a great opportunity to increase their exports and hence their revenue and they will see it as a chance to take full advantage of their gas reserves.

In the Markets and Institutions storyline, the only country or region that stands to lose is the one responsible for the supply gap. In this case, the rest of the world, collaborating via international institutions and regional blocs will find other trade routes and means to cover this gap.

Stranded Assets

This scenario is similar to the supply gap, in the sense that it is also the effect of lack of investment in the sector. Here, however, the focus lies on the effects of these stranded assets on the local economies, but also on the global gas supply system as a whole. This is expected to create a chain reaction in the global economy, because international energy companies are heavily invested at these projects, but at the same time these gas fields support a local economy of technicians and an international community of engineers.

The mostly affected countries in the Regions and Empires storyline are the producing countries whose economy chiefly relies on oil and gas exports. These are Central Asia and the Gulf States. Stranded assets translate to macroeconomic stress for the national economies which, taking into consideration their current macroeconomic status, it will be impossible to overcome without a bailout package by the IMF or, in the case the international institutions do not move forward with support, by state actors which will add a very high interest rate.

Countries where international gas and energy companies are based at shall also face severe issues. However, most of them are located in the USA, the EU or China, all of which possess a great amount of reserves on their central banks and will be able through bailout packages to overcome this crisis.

The Markets and Institutions storyline of this risk is the only narrative across all risks that has a pernicious effect across multiple countries and/or regions. More specifically, there is a lot of financial damage being caused by the stranded assets effect. That is generally accepted by the international community and in the burden is shared via an institutional mechanism, namely the IMF, which provides the support needed to the countries that are most in need, but also coordinates with regional development banks, such as the EBRD and the ADB for the distribution of funds in a manner that does not lead to suffocation of the national economies.

Chapter 7: Results on the global natural gas system analysis

This chapter summarizes the findings of the application of the pattern modeling and scenario analysis methods for the global gas system. Initially, the overall expected stance, based on the literature and the assumptions made, will be designed for the gas system. Valuable insights will be gained about how the global gas system influences security of supply in the regions and empires under study. Some of these insights, as discussed, will be chosen as foundation to construct the pattern of green hydrogen, with the aid of the literature on this clean energy carrier. Lastly, there will be a reflection on the main insights gained by the scenario analysis for gas.

Overview

This research provided several insights into the current and future geopolitical world order, with respect to the global gas system and its supply chains. Contemplating on the overall results and looking at the bigger picture, it can be noted that for the neorealist themes, in general, it was eloquently easier to find backing evidence, in contrast to the neoliberal ones. This occurs for several reasons. One of them, in particular, is that the neorealist structure is based on the rather simple notion of security first that traditional realism encompassed. Based on that notion, nation-state behavior is characterized by unilateral or bilateral behavior regardless of how the world functions, which is much easier to detect. Neoliberalism, on the other hand, resorts to the perfect competition theory, which involves international institutions that abide by very specific rules with the endgoal of removing barriers to market entry and allowing perfect information(Sanders, 1996). Finding information that verifies this theory is far more challenging.

7.1.Overall expected stance of actors

EU

The future of the EU in the gas sector contains elements of both storylines. Overall, there is a clear willingness from all member states to create a fully liberalized market. However, since the continent is a gas net importer it relies on pipeline infrastructure and LNG imports that come mainly from bilateral/regional agreements. Such examples are the Nord Stream between Russia and Germany and the Trans Adriatic Pipeline among Turkey, Greece and Italy. Thus, there is a mix of elements from both storylines entailed in the way the EU is operating in the gas landscape. This makes the bloc vulnerable to disputed events by external actors such as Russia, which can divide the union. Examples include the annexation of Crimea in 2014, the war in Georgia in 2008 and the invasion of Ukraine in 2022. EU member states have shown that such events can easily divide them in terms of their views and geopolitical strategies. The shale gas revolution and the increase in gas producing countries brings up two potential scenarios for the future of the gas system in Europe, both of which are related to the fact that the number of potential suppliers will increase. The optimistic one is that diversification of suppliers will make the EU resilient to disruptive events, as it will be significantly easier to replace the (relatively smaller than now) amount of gas from the disputed country with another. The pessimistic one revolves around the fact that the EU will be more prone to frictions. New gas fields are uncovered and exploited by European companies in regions that are hit by acts of war and actions of non-state actors like terrorists, such as the Great Lakes region and the Cabo

Delgado. Being vulnerable to disorderly events from multiple external actors provides the foundation for multiple tension among European countries, which in the end can materialize to actual conflict. A fine line exists between these two futures and the European policymakers should be aware of both.

Russia

Russia has a very clear trajectory in the gas sector. The clear preference towards bilateral long-term agreements is among the clear signs of a Regions and Empires storyline tendency for Moscow. This can be observed not only in the agreements with Europe and China, but also within its own trade bloc, the EAEU. Russia provides different agreements to each of the EAEU member states, all of which include tariffs and hence are not characterized by free trade. In Europe, there are only talks over a free trade zone that never materialize and hence Moscow's direction towards a neo-realist approach is clear. The second indication is the numerous military interventions in regions of great importance for the gas sector. The annexation of Crimea, the invasion of Ukraine and the involvement in the Nagorno-Karabakh war, together with the military action of the Russia-led CSTO in Central Asia portray an effort from Russia to control gas reserves in a manner that is obviously not consistent with the theme of neo-liberalism.

China

China remains consistent on both cases following a clear Regions and Empires storyline approach. On the gas sector, Beijing, being hungry for energy resources such as gas, uses its virtually unlimited financial power and strikes bilateral long-term agreements, with no free-trade elements. These agreements, however, possess elements of debt-trap diplomacy, which is the Chinese way of ensuring continuous gas flows that will power the country's rapid development.

USA

For the USA, there is no clear tendency towards any storyline and two factors are decisive in its future trajectory. The first one is the energy dependence, whereas the second one is the developments over the USMCA, former NAFTA.

On the gas system, the shale gas revolution converts the US from a net importer into a net exporter of energy and becomes in big part self-sufficient on that front. Nonetheless, it still pursues free trade agreements, but most of them are bilateral. There is also a mixture of military and diplomatic interventions in regions that are relevant to the global gas supply chain. There are elements of both storylines and the prevailing one will largely depend on the leadership approaches that each president brings on the table. A Trump administration was the one that undermined NAFTA, which eventually led to the USMCA. As Mexico is crucial for the land connection with Central and South America and thus crucial for a potential gas interconnection into a liberalized market, the stance of the next presidents over the USMCA will be paramount.

Gulf States

The Persian Gulf is divided in both cases and probability of it following a Markets and Institutions storyline is miniscule.

In the case of gas, not all Gulf states possess the resources and, unlike in the case of OPEC, they are not looking for collaboration. Their divergence on views on Turkey and Israel make the deployment of gas infrastructure impossible, as both foregoing countries are considered major transit hubs for energy into high-demand regions like Europe.

Africa

For Africa a shift to green hydrogen as a major energy carrier carries a lot of potential for further integration.

In the gas sector, the current coalition structure that has been mandated by oil reserves and is dominated by OPEC remains in place, despite the gas reserve discoveries in numerous countries in the continent. This creates discontent among the new gas producing countries, whose local communities are already tense because of the governance models that are close to neo-colonialism. Despite the fact that gas infrastructure is proposed through bilateral agreements, these agreements remain at a bilateral level, without any free-trade elements and without prospects to power an integrated gas market.

Latin America

In Latin America there is a shift in the approach of the state actors on the market and infrastructure integration idea. There is, however, a small difference to Africa.

In contrast to the African countries, in South and Central America there are multiple efforts to integrate the gas market, they all however do not succeed in the end. This is the main difference with the landscape in Africa, where there have never been efforts to unify the continent under one gas market and only bilateral and small regional endeavors have taken place. Latin American countries, in a general institutional level, are divided in two alliances whose initiative was taken by Mexico and Brazil, respectively. However, competition is soft and there is readiness for cooperation, which never materialized predominantly for financing reasons. Combined with the instability in North America after the replacement of NAFTA with USMCA, the only attempt for integration and free trade has been made in the Pacific Alliance, which again excludes many state actors in Central and South America and does not reflect upon the lack of gas interconnections and free market.

Central Asia

Central Asia's energy grid is characterized by a very odd structure and, due to the lack of finances, projections for both systems point towards a neo-realist future.

The modus operandi in the gas grid is being mandated by bilateral agreements with "empires" under conditions that are not favorable for the local communities and only support autocrats. This ends up becoming a zero-sum game with the losers being the citizens and the useful for them infrastructure, such as the gas distribution grid.

7.2. Insights to be gained for the future hydrogen system

Reflecting on the analysis and the results of the global gas system, there are several characteristics that can be taken to build the foundation of the pattern of the future green hydrogen supply chain and global system.

Primarily, contemplating on the stance of the EU, the structure of the regional gas market comprises of several bilateral agreements on gas trade with partners such as Russia, Algeria and Norway, which are used to feed a liberalized an partly integrated market. Based on these results and on the information gained from the hydrogen strategy of the EU and of its member states, a similar structure is expected on the hydrogen market.

Another element, which is a result of the analysis of the Russian stance, that is expected to be found within the green hydrogen system is the hard power exercised by suppliers. Russia might become less relevant for the security of supply amidst the invasion of Ukraine, however other state actors that are poised to remain relevant, such as North Africa, are hit by acts of terrorism that are

expected to destabilize the green hydrogen system. Other potential suppliers, such as the Gulf States and Latin America, but also Central Asia, are witnessing political destabilization efforts that create havoc on a regional level and might also disrupt the green hydrogen supply chain. Hence, these elements are also going to be part of the green hydrogen pattern.

An important characteristic of the Gulf States is the fragmentation over views about external actors such as Turkey and Israel. These views lie on the overall international relations realm and, thus, are expected to be used as a building block in the green hydrogen system.

Finally, a stance that is expected to persist in Africa is revolving around the claims for neo-colonialism. These claims have been prevalent both while Europe is trying to diversify its gas mix and in the EU's struggle to satisfy the projected demand in green hydrogen. Hence, this is another aspect that will be included in the green hydrogen pattern.

In the next chapter, the insights gained from the analysis on the projections for the global gas system will be combined with the results that the literature research entailed. The endgoal is to create the pattern of the expected green hydrogen system and gain a better understanding over it. This will take place in chapter 9, where the conclusions of the green hydrogen analysis will be laid down.

Chapter 8: The green hydrogen system

8.1.Overview

So far in the previous chapters there was a thorough explanation of the scientific, technological and market characteristics that an energy system dominated by green hydrogen will have in the future. In addition, the framework was explained, based on which the patterns are going to be developed to better understand the natural gas and green hydrogen systems. Finally, in chapter 6 the natural gas system pattern was formulated and chapter 7 encompassed the results that the analysis of this pattern brought. This chapter shall include these elements to generate a pattern in particular for the potential future green hydrogen system. To put the scientific and technological knowledge into the context of geopolitical implications and risks, an energy outlook highlighting the risks was necessary. Hence, the IEA World Energy Outlook 2021 was used. The main risks are identified in the "Energy Security and the Risk of Disorderly Change" section of the outlook. This was deemed as the most comprehensive and complete directory of risks. As an aid to that, the IPCC report was used to ensure that no major risks are being omitted. The EU Green Deal was utilized as well, to have a better understanding of what the main aims and strategies in the green hydrogen decision-making arena the EU has. This storyline approach of Regions and Empires vs Markets and Institutions, as mentioned, has originally been used by Correlje & Van der Linde (2006) for the oil and gas industries. The main framework of these patterns is being used as a point of reference so that a new pattern is being formulated, this time with green hydrogen as an energy carrier.

Similar to the natural gas case, it is of great importance to list the biggest potential risks and create scenarios based on them, so that the green hydrogen system is tested in both storylines. The scenarios are taken from the foregoing reports, but only four of them are eventually tested, due to the time limit that a master thesis entails. The first threat involves overinvestment and stranded assets. Various projections and scenarios take place with regards to how the energy transition will unfold. There is great uncertainty for the trajectory of future demand and hence many miscalculations might be made by private and state actors. One of the potential outcomes is overinvestment which can lead to underutilized and stranded assets. This has consequences for both companies, which might face serious financial issues, even risk of default, but also for producing countries which might face a wave of lay-offs and unemployment. These traits can easily function as a driver for social unrest and political instability and thus it is paramount to study them.

Another potential risk includes the electricity sector, and this risk has two sides. A green hydrogen network will require electricity from wind and solar energy, which are intermittent and dependent on the weather. Hence, many different generation patterns will arise, which will require a major modernization of the electricity sector in regions where even the basic infrastructure is malfunctioning. This creates the need for big investments in these regions but also political and market reforms. Three major implications arise here. The first one is political instability. Countries like South Africa will face challenges detaching from fossil-fuel fired power, as its generation and operation is the backbone of the current socio-political regime, which creates racial(and other) inequalities(Baker & Phillips, 2018). However, electricity can also directly influence stability, as in

Uzbekistan, for example, protests in the Gusar district by angry citizens when a power outage started (Pannier, 2021). The second implication are cyber threats and cyber attacks. As mentioned, the cyber attack on the Ukraine electricity grid devastated the Ukrainian society, leaving 225.000 people without electricity(Hatipoglu et al., 2020). Recently, the Department of Homeland Security of the U.S issued a warning that Russian hackers can even disrupt the American electricity grid, showing the size of the damage that a cyberattack can do, also in terms of geopolitics(Whitaker, 2022). Finally, non-state actors such as terrorist groups, that can even cause damage to the grid to a point that it can bring mayhem. An intel grid, in particular, from the USA, asserted that the electric grid can prove to be an attractive target for extremists, even within the American borders(Sands, 2022). Recently, three men were found guilty under the charges of providing material that would help plan an attack on the American electricity grid, which is a sign that such a threat is very likely to happen(U.S. D.O.J. , 2022). The result of all of these probabilities is more power cuts which will affect the green hydrogen supply and should be taken into consideration seriously.

After the energy transition, critical minerals and rare earths will become the most important materials in energy trade. However, it is deemed by many that geographical diversity in mining and processing is even lower than that of oil and gas(Manberger & Johansson, 2019). In addition, it has been indicated that the whole supply chain of critical and rare metals is significantly vulnerable to political and economic disruptions, which, eventually could decrease the acceleration pace of the energy transition(Than, 2018). A report by the IISD on Green Mineral Conflicts depicts the most fragile countries and regions to conflicts generated by these metals and minerals. Sub-Saharan Africa is considered the conflict champion, but also the Gulf States and South Asia have a huge chance of seeing disruption unfold because of these extractives. It is a surprise that even Russia and China are prone to this issue(Church & Crawford, 2018). If there is no special attention paid by policy makes to ensure mineral security and technological innovation in these fields, there is a high chance that a supply gap will be faced. This formulates a necessity to investigate how this likely scenario will unfold in both storylines and how it can be addressed.

Finally, the NZE scenario in IEA clearly shows that there will be large volumes of inter-regional green hydrogen trade, where countries with abundant low-cost production potential of renewable energy will export to those that do not have this capacity. This is going in contrast to the claims about green hydrogen solving all geopolitical issues, as, according to the preceding notion, it can easily be used as geopolitical weapon, on purpose or accidentally. The current green hydrogen system exists only in theory and there is lack of historical data, which means that there are innumerable uncertainties, many of which exist on the operational side, as feedstock supply, hydrogen market price and other factors are unknown at the moment(Eljack & Kazi, 2021). Hancock & Wollenheim (2021) maintained the notion that green hydrogen encompasses great risk in terms of transportation capacities, which will be difficult to find. These capacities are directly correlated with the security of supply. Another potential side effect they mentioned was the potential international marginalization following the lack of coherent, long-term national climate and energy policy. There is, hence, high potential that a supply gap might emerge for numerous reasons. It could be either due to lack of sufficient investment on transportation capacities and increase of transportation volumes, or due to embargo stemming from international marginalization, or because producing states will first want to satisfy domestic demand. From the demand side such developments can be seen as grounds for (inter)national disputes and thus research should take place in this case.

As in chapter 6, both storylines will be fully developed. This means that the impact on the green hydrogen system will be examined for every region or “empire” that is relevant. After they are

painstakingly described, the most important insights from the regions'/empires' reaction to the previously explained scenarios will be researched.

8.2.Storyline 1: Regions and Empires

Europe

In this system, the Regions and Empires storyline leads to an even more large-scale fragmentation of the EU. First of all, the European Clean Hydrogen Alliance never manages to fully materialize and stays only in a theoretical level. There are vast opportunities to develop supply routes in the European neighborhood and there is no exact alignment over neither the energy or the electricity supply scheme. This results in each region moving forward with agreements with a certain supplier in isolation from Brussels. For example, on the South East, Greece and Egypt agreed on a mega-project that would include an electricity cable from Cairo to Athens(EURACTIV, 2021). This agreement is used to produce green hydrogen, as Egypt has enormous renewable energy potential and results in Greece trading regionally or even internationally, but not under a joint EU scheme and initiative. A similar landscape is observed in Italy, where an agreement of Eni and Sonatrach aims at bringing green hydrogen in Europe through Italy(Reuters, 2021). Spain, observing the general trend, moves forward with an agreement of similar nature with Morocco. These projects are not being seen as complementary to bring energy security at a European scale, but rather solely as means to bring profits on a national level. At the same time, countries such as Germany see profit from repurposing existing pipelines that come from Russia and Central Asia in order to bring green hydrogen generated from the Eastern neighborhood(Zabanova & Westphal, 2021). All these countries are going through great lengths, from lobbying to vetoing other countries' proposals over green hydrogen in Brussels and hence there is no common EU strategy, but rather regional strategies split in West, Central and East Europe. Based on this trajectory, it is expected that this will have implications for the electricity grid. The ENTSO-E network will now maintain a much weaker role and most nations will be limited to regional trading, on the fear that the electricity traded might be used by a "rival" bloc for the purpose of green hydrogen generation.

Another disagreement concerns the origination of the hydrogen. While Germany advocates in favor of clear green hydrogen produced solely from renewables, France puts pink hydrogen on the table, generated from nuclear energy(Moussu, 2022), which is solid ground for derailing of the hydrogen policies in light of new disputes.

Under green hydrogen, there is expansion towards the Western Balkans, but only by specific state actors through regional agreements. More specifically, Germany becomes the helping hand for the neighborhood to develop its green agenda (Todorovic, 2022), but does not include the EU into the process, nor any other European state actor. Hence this takes place with the ultimate goal of exploiting resources, both green hydrogen and critical minerals, solely for itself and not in the context for the EU.

Fuel dependence on Russia is reduced, but Russia possesses vast resources of critical minerals so a different type of dependence is being formulated. Moscow also takes advantage that many countries with great potential to become green hydrogen and/or clean electricity producers are in the post-Soviet space(Van Schaik et al., 2021) and, through military interventions, like the Russian invasion of Ukraine and the recognition of the de facto states, it continues being relevant for the energy landscape. These disputed moves create friction within the EU, as countries that benefit from hydrogen trading through pipelines from Central Asia stand to lose with a potential Russian isolation, whereas others stand to win. Since no common framework or alliance on hydrogen trading exists in

the EU, there is no agreement to cut off trading with post-Soviet states. Moreover, the response to Russian aggression is far from unified.

The relations with the USA are chiefly competitive in this narrative. The two global powers are trying to secure as many green hydrogen resources, especially in Africa and the Persian Gulf. Saudi Arabia is a perfect example of that. On one hand, a Memorandum of Understanding (MoU) has been signed with Germany on green hydrogen cooperation(Energy & Utilities, 2021). On the other hand, a joint venture involving a US-based company and a Saudi Arabia-based one started to build a hydrogen plant(Al-Atrush, 2022). There is no current framework explaining what will happen in the case of a supply shortfall from Riyadh, which will leaves room for conflict. There are cases of projects where the pipeline/LH2 infrastructure is operated by the EU whereas the solar and wind parks powering the hydrogen are constructed by American firms, or the other way around. This is particularly the case in countries like Egypt and Oman, where EU state actors, the USA, China and Kuwait are involved(Paddison, 2021; Meed, 2021; Renewables Now, 2022). The EU and the USA try to exert influence on one another with soft power and in some cases they take harder measures, such as stopping production of renewable electricity or green hydrogen, respectively. This also has detrimental effects for the local communities that cause protests leading to regional political instability.

The EU-China relations' main theme is the constant fear that Brussels have over the critical mineral security of supply. Beijing continues to dominate the critical minerals processing industry, but also due to its debt-trap diplomacy controls all of the regions that produce rare earths or other critical minerals. It uses them as a geopolitical weapon in most of the disputes that arise, including the Taiwan dispute and its military presence in the South China Sea. Being intimidated over the supply cuts, the European countries succumb to all parts of the Chinese strategy. These parts include promoting far-right leaders in Eastern Europe or not respecting human rights outside of Europe, both in countries like DR Congo but also internally, as it happens in Xinjiang and Tibet(Hilton, 2020). The UN and other international institutions prove to be weak and there is no resolution for any human rights violations.

Russia

Russia initially faces a shock from the fall of gas demand due to the energy transition. In the Regions and Empires storyline, the response includes expanding its dominance in the post-Soviet space. In Central Asia, Moscow competes with Beijing to invest heavily in regional infrastructure(Yau, 2020) such as the TUTAP interconnection, as well as the TAP high-voltage transmission system. This comes as complementary to the construction of solar and wind parks in the deserts and steppes of the region. The aim, in this narrative, however, is not to bring development and prosperity in Central and South Asia, but to exploit the renewable energy potential of two resource-rich regions. The electricity from these countries is used by Russia to develop green hydrogen and, together with its critical minerals, it is being used as a source of influence to both the EU and China.

Ukraine and the South Caucasus are also appreciated for their great potential. More specifically, in the beginning of 2022, political developments in Kyiv pointed out that the country would be able to become a major green hydrogen exporter by the end of the decade(Matalucci, 2022). Georgia, on the other hand, due to its mountainous terrain and abundant water resources, is a great candidate for green hydrogen exports, already understood and funded by international institutions like the EBRD(Bennett, 2020). However, relations with Ukraine and Georgia in particular, make it impossible to collaborate. Moscow, instead, resorts to military interventions(like the invasion of February 2022

in Ukraine and the 2008 in Georgia) to secure critical port infrastructure in the Black Sea(Daragahi, 2022), so it can increase its LH2 capacity and diversify from having terminals only in the Arctic and in the Ochotsk Sea.

The Sino-Russian relations are also not at their all-time high, however. Apart from Central Asia, Russia is looking to expand to Mongolia and take advantage of its enormous wind potential(Geropoulos, 2022). Nonetheless, a similar approach is being carried out by China, which is looking to build up on its own green hydrogen park in Inner Mongolia and make it an international one. There is no clear reaction from Ulanbataar due to its neutrality status and that leads to the two giants getting in a conflict over the resources of Mongolia. This can happen either via direct military confrontation, which will be the first time in the region, or with a missile crisis, as it happened in 1960(Smith, 1970).

The relations with the USA are not expected to become any better as well. As mentioned, there is already expected competition between Washington and Brussels over green hydrogen in Africa and the Gulf States. Russia has not become a pioneer in renewable energy technologies and thus it is finding it increasingly challenging to assume control in the regions through technological expertise(Pagliaro, 2020). However, the relative social unrest due to the perception of neo-colonialism is being seen as an opportunity for its PMC's, like the Wagner group, to get political control of many African regions, as it is already currently exerting influence(Saini Fasanotti, 2022). This can help take control of these assets via their nationalization , which will happen by a junta of military leaders supported by Russian PMC's.

China

China outpaces every other global power in the technology innovation on the green hydrogen sector, as with all other renewable technologies(Ladlslaw & Tsafos, 2020). This, combined with its possession of critical minerals as well as their processing facilities(Teufel Dreyer, 2020), is being utilized by Beijing as a force that helps put pressure on other regions or "empires" that do not act according to its wishes. The necessity for electricity to produce green hydrogen brings big developments in the neighborhood. In Central Asia, China provides its technological expertise to modernize the grid with new high-voltage transmission networks and smart grids, but does not ask for reforms from the energy and electricity sector of the Central Asian states. This means that their oligarchs and authoritarian leaders continue to maintain control over the infrastructure and choose to use the majority of the power generated in these states to satisfy the Chinese demand in green hydrogen. Following the Chinese way of conducting business, agreements are solely bilateral, such as the power line agreement with Kyrgyzstan(RFE/RL, 2015) as well as the electricity connection with Tajikistan (Kerimkhanov, 2019). Such agreements also contain the elements of debt-trap diplomacy that Beijing has allegedly been exercising in the developing world. In Lao, for example, the outstanding huge debt that the Southeast Asian state owed to China was paid back through ceding the majority of the electricity grid to Beijing(Zhai & Johnson, 2020). Furthermore, China tries to control the critical mineral and metal resources for the energy transition in this way, with the example of Tajikistan being a typical one. There has been speculation that in Dushanbe, China signed a bilateral agreement, according to which failure to pay back debt would mean the seizure of assets, in this case gold and copper mines(Shamiev, 2020). It should be noted that copper is increasingly important for the energy transition. The only actors that stand to lose from these deals are the local communities, which see a modernized grid but the same power outages as now.

There is a focus to export of technology and the financing of projects in Africa as well. Having invested in ICT and telecommunications in the continent through solely bilateral or regional agreements(Tanchum, 2022), Beijing finds an easier way than the rest of the global powers to enter the African markets and control the political and economic leadership. Agreements are made on a bilateral or regional level and the national leaders accept the Chinese funding as it comes with no reforms demand. In this case, as well, the local communities see no benefit and begin to rebel over neo-colonialism claims.

In its relations with the EU, Beijing is again trying to take advantage of the fragmented landscape that this narrative encompasses. It provides states critical materials or technological aid through bilateral agreements. While the former is appealing to all member states, the latter is mostly useful for Eastern European countries, whose scientific expertise in this sector is lower than that of the West European countries. China takes advantage of that, as it offers this expertise with no need for reforms in return. Combined with the era of economic nationalism, it gradually leads far-right leaders in the region to become fully alienated from the EU and grow closer to China.

Throughout this narrative, in most parts of the world there will be major competition with the USA taking place. Washington will be the main competitor in technology, both with regards to innovation and to financing infrastructure(Sarkissian & Kachinski, 2021). As mentioned, the competitive advantage of Beijing is the fact that financing is no reforms-related strings-attached. However, that might be used from the USA as a pretext that democratic concepts are not respected in countries and, instead of taking matters into the UN, there is a higher probability that it will intervene militarily, causing a fully-fledged war in these regions.

USA

In a green hydrogen-based economy, USA returns to becoming a net importer of energy. The reason is that in its hydrogen strategy, green hydrogen is barely mentioned and only produced in California. Most of the hydrogen produced is blue and after the energy transition demanding a clean origin of hydrogen it will no longer be able to produce(Crawford, 2021). It is also dependent on many critical minerals. In particular the US are finding it extremely challenging to detach from dependence from Chinese critical mineral processing. The reason is that the only company that was planning to operate on that front, MP Materials, had bankrupted and has a Chinese major shareholder, Shenghe Resources(Home, 2020). In order to diversify, they seek raw materials elsewhere in their own region. Most of them are situated in South America, namely in Bolivia and Chile. The American mining companies move forward with bilateral agreements with leaders from these countries and no international institutions or regional blocs are involved. These deals result in mining activities that have a negative effect on the environment and the benefits are not reaped by the vast majority of the population, but rather only the elitists, bringing very little societal value(Gersony, 2021; Wroblewski, 2022). The situation is similar in the deployment of renewables that will power the electrolysis for the green hydrogen as, in order to satisfy its demand, Washington will first resort in the neighboring Latin American countries. With regards to North America, in particular Canada and Mexico, the USA will function as a green hydrogen hub. The nature of the agreements will not be multilateral or international, however. Only bilateral agreements will take place, without free trade principles, in relatively high prices that will be accepted by all states if there is a lack of alternative. This, nonetheless, will make the three state actors alienated among each other, which will result in reducing trade volumes.

The relations of the USA with the EU, China and Russia will only deteriorate because of the previously-mentioned struggle over Africa and the Gulf States. The USA have the advantage of having

developed a strong military presence that can intervene in cases where there is fear of losing control over a certain territory. At the same time, based on the current American technological trajectory, its innovations on renewable energy technologies are streamlined and move into the socio-technical regime, making it easier for developing countries to implement them. The initial strategy will involve technology deployment in these countries, but in case Chinese or European technology is accepted by political leaders, hard power and military interventions are highly probable to take place.

Persian Gulf – Gulf States

The Gulf States have undoubtedly vast potential for the deployment of renewables and, considering their development in the water desalination sector(Hawa, 2020), they are poised to become a green hydrogen hub(Crawford, 2021). Nonetheless, in the Regions and Empires storyline there is a disagreement over that, with several financial and geopolitical implications taking place. Initially, not all state actors are in favor of moving forward with such a shift in the energy production mix. This creates three groups of countries in the region, based on their level of acceptance with regards to renewables Countries like Qatar, Kuwait and Iran, in particular, continue promoting investments in the oil and gas sector and do not make any developments in the deployment of green hydrogen(Alsaad, 2021; Nasiri et al., 2013). The second group composes of Saudi Arabia and the UAE, which understand the need to align with the energy transition, but adopt a model where they seek to fully exploit their oil & gas until the moment demand falls to zero(Blanco, 2021). At the same time they develop projects like the green hydrogen park in Neom, showing willingness to accept the pledges made at the Paris Agreement and the yearly COP's(Thomas & Vennema, 2022). The third group consists solely of Oman, a country that has been adopting climate change policies and participating in solar, wind and green hydrogen projects while at the same time it has significantly decreased investment and involvement in oil & gas projects(Muscat Daily, 2022).

An important aspect in this storyline are water conflicts. As mentioned, water is paramount for the production of green hydrogen and the Persian Gulf, together with North Africa, is among the most water-scarce regions in the world. The already existing current "wars" on water resources in the MENA region are, thus, expected to continue and directly affect the green hydrogen landscape. More specifically, there will be a shift from hydro-energy related disputes to hydro-political ones, such as the one between Turkey and Iraq over the Euphrates river(Ziada, 2021). In addition, with the war on Ukraine reducing wheat production, on which the region is highly dependent, will either force the region to make a trade-off between energy(green hydrogen) and food security and also increase stress among the local communities, which creates a high probability of political destabilization(Chibani, 2022).

After the energy transition has progressed at a latter stage, the first group of countries are being left with a great number of stranded assets, which leads a large part of the local communities to unemployment and puts great financial strain on the countries themselves. At the same time, the other two groups manage to adapt and become again exporting powers in the new energy system. This enhances the asymmetries that already existed in the region. The civil war landscape in Yemen continues to exist and it expands in Qatar, Iran and Kuwait, where unemployment and increasing poverty and inequalities bring protests and result in violent clashes. There is no effort to solve these issues in a multilateral and international level, including institutions such as the UN. Instead, the more developed countries see this as an opportunity to sell electricity or green hydrogen at an increasing price, as well as weaponry to support a specific side in these civil wars that unfold.

The lack of alignment also involves the choice of exporting routes. In order to deploy the green hydrogen fleet necessary, countries like Oman resort to agreements solely with EU partners, whereas

Saudi Arabia involves also American ones. The UAE, finally, opts for a partnership with China. This formulates a conflict of interests which makes a potential hydrogen or electricity interconnection virtually impossible. The proposal of developing a HYDROPEC in the region is not even taken into consideration given the increasing tensions.

Africa

The situation in Africa is rather similar to that of the Persian Gulf. The continent maintains one of the world's biggest solar and wind potential, which make it an ideal target for the deployment of green hydrogen infrastructure(De Feligonde & Huard, 2021). At the same time, locations like the Great Lakes region are abundant in critical minerals which makes them a very attractive region to control(Atta-Asamoah & Githaiga, 2012). Collective action could have created enormous benefits for the African population. This is not the case here, however. In the Regions and Empires storyline, countries that possess the means, are pressured by Europe, USA and China and do not want to leave stranded assets. Countries such as Nigeria, Congo and Equatorial Guinea are either laggards in the hydrogen revolution or do not participate at all (Adebayo, 2021). Only very few are the only ones that invest in green hydrogen. These include solely Morocco, Egypt, Namibia, South Africa and Kenya, all of them located in geostrategic positions. This also formulates a mismatch in the development of the whole continent. The mismatch is depicted in financial terms, where the countries not prepared for the new energy landscape fall to impoverishment and see their "rich" neighbors in a hostile manner. Hence, in each region there are conflicts generated. Morocco's conflict with Algeria ignites again(Ghebouli, 2021), as does Kenya's with Tanzania(Kirui, 2020). Finally Angola revives the South African border war memories(Ricks, 2015) as it initiates a conflict with Namibia. These are attempted to be resolved through bilateral diplomatic negotiations but soon these prove to be ineffective. Eventually, countries that have heavily invested in the green hydrogen infrastructure, namely USA, EU member states and China intervene militarily to restore the order.

Water conflicts are also a prevailing theme in this storyline for Africa. The already existing water stress that has resulted in conflict in the GERD between Egypt and Sudan(Ziada, 2021) now is even more persistent, because Cairo has deployed a rather ambitious hydrogen strategy that requires vast amounts of water (Habib & Ouki, 2021).

In countries that are rich in critical minerals and metals, such as DR Congo, the Dutch Disease comes alive, but it has many more implications. Mining companies from China continue to exploit Cobalt in an unsustainable way causing damage to the environment and harm to the local population(Overeem, 2018). This causes major destabilization of the region and other interested parties and global powers try to intervene in various ways. One way is to overthrow the existing government through military force. The other way involves utilizing non-state actors such as the ADF terrorist group to cause mayhem in the region, which will set the foundation so that a security guarantor is needed to restore order.

Latin America

In Latin America, the friction between different state actors has a different source in the Regions and Empires storyline. Not all countries within the region have the same technical solar and wind potential. Chile, for example, enjoys enormous wind potential due to its vast coastline and free land that can be exploited for that reason(Horwath & Feliba, 2021). Bolivia or Paraguay, on the other

hand, face challenges in deploying a sufficient amount of green hydrogen related infrastructure. For example, while Chile aims to already have 5GW of electrolyzers by 2025, Bolivia sets a tentative target of 2GW for 2030, whereas for Paraguay that number is even lower, at 250MW(Adler, 2022; British Embassy Asuncion, 2021; Power Engineering International, 2021) . This means that there are inherent challenges that lead to an asymmetry of investments and development of the energy infrastructure in the region. Bolivia in particular has abundant resources of rare earth materials. This translates to different types of investments in these countries. For example, in Chile, investment goes towards the deployment of renewable energy and green hydrogen infrastructure, which have a much smaller(even zero) negative impact on the environment, compared to the investments in mining that are conducted in Bolivia. Local communities see this as inequality and move forward with protests that destabilize the region. At the same time, Brazil is among the countries that has vast potential to exploit its land, but the Amazon rainforest inhibits this potential. This creates grounds for deforestation in the name of wind turbine installation(Badia i Dalmases, 2021). Interventions like the ones conducted by Jair Bolsonaro in the past result in cutting down millions of trees, which is condemned by the international institutions, like the UN, but there is no action to tackle this, nor there is action to aid Bolivia and other countries in dealing with the social unrest. All of this landscape results to MERCOSUR being largely ineffective and weakened and OLADE does not manage to assume a prominent role in the energy transition to green hydrogen, but rather remains an observer.

The USA maintain control over many of the countries in the Central and South part of the continent. However, in this narrative, China and Russia are much more active. The example of a pro-Russia and pro-China policy by Venezuela and Nicaragua is followed by Bolivia, Paraguay, Honduras and other countries which do not benefit as much from the energy transition. Beijing and Moscow assume roles of security and financial guarantors in these regions and, based on their own interest, develop fossil fuel production units, changing the overall energy mix of the region. This makes electricity interconnectivity highly challenging and creates tensions among neighboring countries, eventually leading to conflict. Instead of a solution via the ICJ and other UN bodies, issues are solved via military interventions by the security guarantors, causing potential escalation of these conflicts.

Central Asia

In Central Asia, the Regions and Empires storyline entails lack of willingness to collaborate among the state actors. For example, Kazakhstan follows a pro-green hydrogen strategy embracing investments from the EU and the USA towards that purpose(Matalucci, 2021). This is not the case with Turkmenistan, which is in full alignment with the Russian policy to use fossil fuels until they are fully depleted and becomes a laggard in the adoption of renewables and, consequently, green hydrogen. This creates disagreement among the region and, eventually, interconnection efforts such as the TUTAP and the TAP high voltage interconnections do not receive the funding necessary and Central Asia remains fully fragmented. In addition, there is a low percentage of modernization of the grid and that is translated in the current power outages persisting. This is combined with the impoverishment of the region, due to the lack of demand for their fossil fuels(for the countries that haven't moved to a green hydrogen system). Further impoverishment leads to escalating protests like the ones in Kazakhstan in January 2022(Putz, 2022). To deal with them, states that are part of the Russia-led CSTO will receive military aid from Russia for the protection of their authoritarian leaders. Nonetheless, this will happen in exchange for supply of free or very cheap resources to Russia(Kucera, 2022). Countries that are not members of the CSTO but are members of the Turkic Council will see Turkey as a security guarantor. This will be the reason for a confrontation between Russia and Turkey in the region, making Central Asian states that are in different sides even more alienated. In the case of water, there is an increase in scarcity in regions like the Ferghana Valley

where water is shared among Uzbekistan, Tajikistan and Kyrgyzstan. The already existing minor conflicts (Rheinbay et al. , 2021) end up escalating and result in fully-fledged wars, similar to the one on the not fully demarcated border between Kyrgyzstan and Tajikistan in 2021(Williamson & Sultanalieva, 2021). The stop of cease-fire that led to 3 people killed in 2022(Al Jazzeera, 2022) just depicts the severity of the conflicts and how challenging it will be to settle such disputes once the green hydrogen production is included in the water demand. It should be noted that this was just one out of the many conflicts that have taken place in this border, as the two nations share more than 40 water channels that are running dry(Kumanalieva, 2018).

Table 6. Summary of the analysis of chapter 8 on the projected global green hydrogen system for the Regions and Empires storyline.

Region	**Theme**	**Evidence**
EU	Bilateral agreements with no intention for collaboration	Existing agreements on electricity and on hydrogen, intentions only through assumptions and/or vague statements
	Competition with global powers	Competition with the USA on taking up projects in the MENA region
Russia	Regional agreements for personal interests only	Assumptions only
	Military interventions	Speculations based on current behavior
USA	Bilateralism	Bilateral agreements with some EU states, not free trade
	Fall of USMCA and regional free trade in general	Speculation based on the replacement of NAFTA
Persian Gulf	Fragmentation	Different views on electricity and hydrogen trade, transition from gas, also on foreign policy
Africa	Fragmentation	Different views on electricity and hydrogen trade, transition from gas, also on foreign policy
	Environmental, social and political disruption because of mining	The case of DR Congo
Latin America	Multiple regional blocs	Two existing
	No interconnections	Multiple failed efforts in electricity interconnection, pipelines as well
Central Asia	Multiple regional blocs	Multiple existing
	No interconnections	Several efforts made on electricity

8.3.Markets and Institutions

Europe

The EU Clean Hydrogen Alliance is the institution that brings the most value to Europe in a Markets and Institutions narrative. It provides a platform for collaboration among actors in the public and private sector, but also organizations that work closely with local communities. The Alliance assumes a prominent role in the security of energy supply of the continent and all the EU member states, but also the ones that haven't proceeded with full accession eventually become its members. The EUCHA becomes heavily involved in the operation of ENTSO-E(of which Ukraine and Moldova network operators have become members), but also in the newly founded association of green hydrogen network operators in Europe. In this way, this institution ensures the origins of the hydrogen that comes into the network. It also ensures, in full coordination with EFTA, that the free trade principles are applied in the green hydrogen network as well.

In this storyline it is much less challenging for Europe to achieve diversity of supply. The free trade an little, mostly diplomatic, intervention, principles are respected globally and this helps each many EU member states get converted into green hydrogen hubs. On the South East, Greece and Italy facilitate the repurposing of the EastMed pipeline to be used to bring green hydrogen from Egypt, Israel and the Gulf States. At the same time, the electrical cable from Egypt(EURACTIV, 2021), combined with the vast renewable energy potential of Greece(Zogopouos, 2021), aids the Greek efforts to become a major green hydrogen producer and eventually exporter. Similarly, in the West, Morocco and Algeria resolve all their previous conflicts and sign similar agreements on green hydrogen and electricity with Spain and Italy, respectively. Such progress in the hydrogen landscape results in the EU becoming a net exporter of energy to the developing world whose energy demand presents a spike after these states have developed a fully-functioning industrial economy.

In its neighborhood policy, the EU, in this narrative, moves forward with all the relevant projects as part of its EU Green Deal. More specifically, expansion towards the Western Balkans takes place, but only using the Green Agenda for the Western Balkans as a driving force, used by all EU member states in full collaboration (Petritsch & Freund, 2021).

On the East, relations with Russia return to normal and Moscow becomes part of EFTA. This facilitates the trading of rare earth metals and critical minerals in exchange for technological know-how and the continent eventually becomes self-sufficient also in the REM sourcing and processing front, which reduces dependence from China sharply. Russia is also benefitted from this progress and it develops its on renewable energy and green hydrogen fleet and, together with Central Asia, through the EEC, provides green hydrogen to North Europe through the repurposed Nord Stream 1 and 2, as well as through the Turk Stream. This is completely on the contrary to what is currently happening and thus will remain a wild assumption

Relations with the USA are ameliorated, the TTIP becomes the prevalent treaty based on which free trade is happening between the EU and USA, but trading volumes do not increase in energy. The American market is solely used to support peak demand and emergency occasions via shipping of LH2 and signing of spot contracts. The case is similar with the markets from Sub-Saharan Africa. This happens because initially the piping cost is significantly lower than the shipping one and neighboring regions manage to secure long-term contracts for pipeline transferring. In addition, the role of potential self-sufficiency of the EU is paramount in this development.

Russia

Russia maintains an active role on the global energy landscape, but through cooperation and less aggressive stance towards its neighborhood. The Post-Soviet space is fully integrated under the EEC regime, but Moscow depicts no opposition to Ukraine and Moldova entering the European electricity market. The EEC's main purpose is again to promote free trade among the Eurasian region and as part of it, it creates a Eurasian Clean Hydrogen Alliance(EACHA) and a common transmission and distribution operator network on electricity. Both the network and the alliance work in close collaboration with the ECHA and ENTSO-E to fully harmonize their grids. Another paramount function of the EACHA and the EEC is to support financially and technologically the states that are lagging the renewable and green hydrogen capacity to construct the network. This includes lower(subsidized) prices for wind or solar parks or green hydrogen conversion units for countries that faces struggles, such as Armenia, Kyrgyzstan or Tajikistan. It also includes capacity building skills. Support in financing and technical issues is provided in close collaboration with international financial institutions, like the EBRD, the ADB and the AIIB, as well as technical ones, such as the IEA.

For capacity building, the membership of most states in the Beijing-led SCO proves to be very useful, as China is considered among the champions of these technologies. . In return, the Eurasian bloc provides China with the green energy necessary, both in electricity and in green hydrogen. Pipelines such as the Power of Siberia and Line D, together with all the pipelines coming from Central Asia, are repurposed to transfer green hydrogen to China.

USA

In the Markets and Institutions storyline, NAFTA becomes the driving force of free trade for green hydrogen and electricity. North America utilizes the vast solar potential of Mexico, but also the enormous wind potential of Canada and USA. The former, in particular, has a huge amount of land that is not exploited and, in combination with the decommissioned oil fields, there is much space to facilitate enough wind energy to power a green hydrogen manufacturing plant. The NERC now involves the Mexican electricity grid and a similar corporation is created for the green hydrogen grid operator. Both corporations serve as facilitator for this free trade. Washington does not assume a dominant role in these alliances, but rather as a collaborator.

On a Panamerican level, there is integration of NERC with SIEPAC. This is brought to life after several studies showed that an interconnection of North and South America in a renewable energy-dominated world makes more sense than having two separate grids (Aghahosseini et al., 2019). This comes with full modernization of the Central American grid, bringing reliable electricity and energy to the local communities and promoting free trade. Fully democratized Central American states are now aligned with the American policy. On a similar note, there is collaboration with OLADE for the integration and modernization of the South American grid. This bring sufficiency to the USA and imports from other continents are being significantly reduced, saving costs and increasing reliability.

In South America, the USA are largely interested in the critical minerals that Bolivia and Chile possess. Competition with China is seen as opportunity for collaboration, with China providing the financing capital and the USA facilitating the sustainability component of the process through capacity building in sustainable mining, friendly to the environment. Through this cooperation, there is no need for military interventions and the political landscape is overall stable. However, destabilization efforts still exist by local vigilante groups and from opposition parties. These efforts are being dealt with at an international institution level, brought to the UN and the regional blocs such as MERCOSUR. Global powers support the process as security guarantors, but only on a diplomatic dimension.

China

China energy consumption profile is expected to outpace its installed renewable energy(and thus green hydrogen) capacity and it is projected to become a net importer. The main that, despite the uncertainties, projections lean towards a net importer status is that, regardless of the consumption profile, Beijing is expected to continue to rely on materials and components imports (Xinhua, 2021; Nakano, 2022). In the Markets and Institutions storyline, however, it is less challenging to find these sources to satisfy its demand. The region that is of greatest importance, as mentioned, is Eurasia. Beijing, as discussed before, provides Central Asian states, as well as Russia, with the technological and scientific expertise needed to create a modernized grid capable of manufacturing green hydrogen. In return, these states, having potential for a great amount of supply, provide the necessary energy to China through repurposed pipelines.

Nonetheless, there is still unmet energy demand which must be satisfied through shipping routes. Initially, this need is being addressed by regions closer to China, due to the very high initial costs of LH2 shipping. The Gulf States, with Oman being a prevalent example, together with East African countries, like Kenya, and Southeast Asian ones, like Indonesia, function as main suppliers. In this narrative, there is no struggle over acquisition of control over these areas. There is consensus that European countries provide the technological know-how, whereas China is the financial guarantor. In this way, the EU stands to gain a lot of this partnership as well.

A potential competition might arise with India on that regard. India is also projected to have a great need for green hydrogen in the future energy system and geographically will target the same groups of countries as China. In this narrative, however, an agreement between the two nations, ratified either by an international institution, like the UN, or by a series of regional blocs , sets specific boundaries. For example, it can either help distribute green hydrogen horizontally, where each country will be entitled to a specific amount of LH2 from a specific country, or vertically, where each one of the two countries will receive LH2 from a specific group of countries. This agreement is respected by both states in this narrative.

Persian Gulf – Gulf States

In the Markets and Institutions storyline, the Gulf States realize the macroeconomic prospects and benefits of collaboration on renewable energy. There is a shift in the investment environment and a general alignment by virtually all countries about a shift towards wind and solar energy and, consequently, green hydrogen. Saudi Arabia, being among the 15 countries with the best solar potential in the world and leading the Gulf(Seznec & Mosis, 2021), assumes again the role of formulating a cartel that also functions as an alliance on green hydrogen, similar to OPEC. However, the purpose of this alliance is not geared towards providing a safety net for fuel prices and controlling fuel flows. The fact that green hydrogen can be produced in most parts of the world deprives HYDROPEC of that “privilege”. Instead, HYDROPEC focuses on creating an integrated green hydrogen network in the region and ensure of its “clean” origins. It also facilitates the financing process and gathering the funds necessary for each state to develop its own National Hydrogen Strategy. There is already traction towards that end and both public and private actors in the region talk about a potential green hydrogen hub in the region(O’Farrell, 2022). All Persian Gulf states, including Iran and Qatar, have normalized ties with Israel. Similarly, even Saudi Arabia and the UAE

restore their good relations with Turkey. This helps bring more investment into the green hydrogen infrastructure that HYDROPEC wants to develop.

The region is again prone in potential water conflicts like in the Regions and Empires storyline. However, in this case, organizations like the Swiss Agency for Development and Cooperation (SDC) develop programs that promote peace and cooperation in the water sector and eventually manage to bring all stakeholders on board(Ghali, 2022).

Developing friendly relations with all global powers opens many potential trade routes. The Persian Gulf becomes among the key suppliers of the EU in the scenario that the EU is not self-sufficient, with the construction of pipelines that go through Jordan, Israel and utilize the EastMed pipeline infrastructure to reach Europe. Oman becomes a key port for the Asian markets. India, China, Korea and Japan in particular are the most important customers of the Gulf States in this case.

Turmoil continues to exist in Yemen with civil war causing havoc in the West Asian country(BBC, 20220. The rest of the Gulf States deal with this issue by mobilizing international institutions such as the UN, but also initiating dialogue within the region, involving East Africa as well(Al Mutawakel, 2019). No use of violence takes place.

Africa

Africa lies in a similar situation as the Persian Gulf. Enormous renewable energy potential make the green hydrogen opportunity a unique one for the continent. In the Markets and Institutions storyline the African Union assumes the most important role, which is the one of the further integration of the electricity and green hydrogen grids of all African regions. The main driver in this storyline is the Africa Hydrogen Partnership (AHP). The AHP, initially comprising of 14 member states(Koigi, 2021), eventually incorporates all countries within the continent and assumes a stronger role. In this way, the African Clean Hydrogen Alliance(ACHA) is formulated. The alliance is backed by the vast majority of the countries and not only ensures the free trade among countries and regions in the continent, but also globally with all interested parties, such as the EU, the USA and China. It also coordinates with the African Development Bank to provide the funds to the least developed countries to modernize their grid. Green hydrogen is not produced in every country, but there are arrangements per region, which are co-decided within the ACHA. Three regions are of particular interest.

Firstly, in North Africa, Algeria normalizes ties with Israel and hence gets on a better track in its relations with Morocco, after a diplomatic intervention by the USA (Magid, 2022). In addition, the wave of coups in the Sahel is followed by a wave of successful democratization efforts and thus the region is considered stable enough to be among the main suppliers of the EU. Destabilization efforts by religious extremists and local vigilantes continue taking place in the Sahel. However, missions from the UN as well as diplomatic interventions from global powers prove successful to mitigate these efforts.

Secondly, on the East of Africa, peace is established. On one hand, Ethiopia manages to solve the Tigray crisis. The Prime Minister reaches a diplomatic solution with Eritrea and its armed forces and tends to Tigrayans bringing peace(International Crisis Group, 2021). On the other hand in Somalia, the central government follows the example of the northern Somalian state of Puntland and makes peace with Somaliland, reaching an agreement(Koffic, 2021). Moreover, to the South, the terrorist attacks in Cabo Delgado by ISIS stop after successful operations from the Mozambique military. This region becomes China’s main LH2 supplier, which results in great revenue that is being used by the

democratically elected leaders for urban and rural development, access to electricity and mobility for all. Industrial development has a surge. However, Islam extremist movements bring instability in Mozambique. However, having become a part of the SADC again, the Southeast African country receives full support from South Africa and overcomes this obstacle in its path to political stability(Demuynck & Weijenberg, 2021).

Thirdly, West Africa is of great importance for the USA. In the Southwest, situation is already rather stable and investment from Washington facilitates the construction of modernized infrastructure which turns countries like Namibia into net exporters, but also benefits the local population. The Northwest, however, is much more unstable. However, Washington makes two strategic moves towards stabilization. The first one involves installing NATO representatives in countries of critical importance, like Mauritania(NATO, 2021), The second one is increasing its trade and investment presence in countries such as Senegal and Gambia through the West Africa Trade and Investment Hub. Thus, USA manages to become the region's security, political and financial guarantor, helping democratically elected leaders solve military crises by providing them with timely intelligence, while at the same time providing the investment that will assist the industrial development of these countries.

Latin America

As mentioned, Latin America is expected to grow much closer to the USA than to any other global player in the Markets and Institutions storyline. This is not expected to happen as a part of efforts of regionalism, but rather because of the much lower cost that piping entails. However, it is with the initiative of the EU that the first hydrogen alliance gets shaped in Latin America, namely the H2LAC, with the objective of promoting a common green hydrogen strategy within the region(Heynes, 2021). The ameliorated EU-US relations, though, bring cooperation on that front in Latin America. With the financial and political assistance of Brussels and Washington, there is finally full interconnection of the electricity grid. There is also construction of an integrated green hydrogen grid. A country that is central to the energy transition, such as Chile(due to its vast technical renewable potential and critical minerals), assumes the responsibility of creating a free trade zone in the region. At the same time, an interconnection with Central and South America is established. The only other global player that becomes active in the region in this narrative is China. With its rare earth processing capacity and virtually unlimited financing capabilities, it moves forward with mining activities in Bolivia and Chile. The EU and Russia, not being able to compete with champions on this market like China, abstain from this process.

Central Asia

Central Asian economies flourish in the Markets and Institutions storyline. Also, Russia becomes their main partner with much closer relations than that of other global players, but there is neither a monopoly nor an effort towards regionalism. On one hand, Russia provides them with the pipeline infrastructure so that their modernized grids can access European markets and export hydrogen. On the other hand, China's thirst for energy helps them find another exporting partner. In this narrative, the CAU is revived and neither Uzbekistan nor Kazakhstan agree to assume the role of the leader, but decisions are rather taken jointly by all member states, contrary to each state actor's behavior so far(Zhambekov, 2015). The CAU creates an intergovernmental body dedicated to green hydrogen and electricity, namely the Central Asian Clean Energy Pact(CACEP). This pact ensures free trade and

constructs one storage unit that is located in a country that every member state is in favor of. All electricity and hydrogen operators and markets have been privatized and unbundled and with huge exporting volumes taking place, Central Asia becomes increasingly attractive to all international energy and electricity companies, but also to utility operators. Access to electricity and energy becomes almost 100% secure. In addition, interest for multilateral agreements such as the Interstate Commission for Water Coordination of Central Asia (ICWCCA) and the Almaty Agreement is renewed. There is a more precise role to them , in contrast to the so far stance of the Central Asian states towards these institutions(Rheinbay et al., 2021). This leads to a state of affairs where water cooperation(including its usage for green hydrogen production) is achieved in the region. With the revenue gained from the macroeconomic growth, R&D projects on water desalination make the use of water from the Caspian Sea for electrolysis feasible and relatively cheap, which removes the water stress element from the green hydrogen projects.

Table 7. Summary of the analysis of the projected green hydrogen system for the Markets and Institutions storyline.

Region	**Theme**	**Evidence**
EU	Electricity and Hydrogen interconnection	ENTSO-E already exists, pipeline infrastructure exists and ECHA created (still weak institution because of the fact that it is in its infantry)
	Bilateral agreements supporting an integrated hydrogen market	Bilateral agreements mentioned in the previous storyline, but speculation that they will serve the interconnected grid
Russia	Joint free trade on electricity and hydrogen	Vague statements as part of the EAEU but no action
USA	USMCA inclusion of green hydrogen	No statements, solely speculations
	Regional free trade	Assumptions only
China	Collective agreements and free trade	Assumptions only
Persian Gulf	Joint action on the energy transition and green hydrogen	Assumptions only
Africa	Joint action on the energy transition and green hydrogen	Foundation of the AHP, still weak institution, but promising
Latin America	Joint action on the energy transition and green hydrogen	Creation of the H2LAC, a very promising institution
	Good mining practices	Solely assumptions
	One interconnection	Multiple efforts made so far, the H2LAC brings a lot of promise for speculation
Central Asia	Joint action on the energy transition and green hydrogen	Solely assumptions
	One interconnection	Efforts made on electricity, nothing on pipeline infrastructure

8.4.Scenario Analysis

As mentioned in chapter 6, scenario analysis maintains great importance for each actor's, be it state or private actor, strategy. It is deemed among the most efficient ways to map uncertainties and be better prepared for them. In the future green hydrogen system, four disruptive scenarios have been identified and the green hydrogen pattern that has been developed at this chapter is going to be tested on them: Stranded gas assets(which will be seen now from the point of view of a green hydrogen-dominated system), electricity power outages, critical minerals supply gap, as well as hydrogen supply gap. Potential scenarios were obtained after researching the IEA World Energy Outlook scenarios on electricity and alternative fuels. The impact of each of the scenarios is being assessed on both storylines and main winners and losers are identified.

Stranded Assets

The stranded assets issue is much more complex in the green hydrogen system, primarily because in order to shift to this system a substantial amount of funding is required. Combined with the financial burden that stranded assets encompass, the upsetting in this scenario has high potential of being several orders of magnitude higher than in the stranded assets scenario in a gas dominated system.

In a Regions and Empires storyline, the disturbance has a major negative impact on a global scale. Regions that would otherwise be considered paramount for the energy transition such as North Africa, the Persian Gulf, Latin America and Central Asia, many of which already face great debt, do not receive adequate support for their desired energy transition that would support the global energy transition. In addition, as mentioned, all of these regions are fragmented and many of the countries have been ill-prepared for a transition to a green hydrogen-dominated economy. Thus, stranded assets are the final hit in their national economies, leading to default and potentially causing a domino of defaults on international energy companies, which cannot carry the full burden of both modernizing the global electricity and pipeline grid and taking the hit for the default of the economies that they have been invested in. This is considered to be the worst outcome as virtually all regions globally are largely affected by it. This happens because all key players such as the EU, China and the USA are dependent on energy imports and will still be in most scenarios in a green hydrogen system. The only potential winner in such a scenario is projected to be Russia. Losses from stranded assets will be able to be mitigated via its enormous financial reserves and at the same time Russia possesses the means and the critical minerals, either by itself or by countries that depend on it, to design and build a green hydrogen system. This can help Russia thrive in this scenario where most of the world will be malfunctioning.

In the Markets and Institutions storyline, the burden does not change as the conditions for that burden remain the same. The way they are dealt with, however, is completely different. International financial institutions, namely the IMF, facilitate the transition process in the countries with stranded assets. More specifically, a financial institution is established by the IMF and the World Bank with the objective of financing projects that will help these countries overcome the burden of stranded assets and at the same time oversee the projects so that all of the process is transparent. In addition, international institutions come up with a rescue plan for largely indebted international energy companies due to these stranded assets. This is done in coordination with national governments, but also regional development banks, as saving these companies so that they contribute with their expertise to the transition to green hydrogen. This case is very similar to the previous narrative one, as there are huge financial losses and all countries are considered losers. Nonetheless, the burden is distributed with equality and justice in mind, hence it is tolerable and does not lead to defaults and social unrest.

Power Outages

Power outages in a green hydrogen system have a similar effect to that of sudden disruption in a gas supply system. Hence, the region that is mostly affected in the Regions and Empires storyline is Europe, in case on of the suppliers faces a blackout. The EU in this narrative is split into different regional blocs based on geography and each bloc receives green hydrogen from different countries or alliances of countries. If their suppliers face electricity outages, that has a double negative effect, as the role of electricity in this system is much more important: Both the electrification and the supply of green hydrogen are halted. The EU, based on its core values and principles eventually agrees to assist one of its blocs, but other member states are reluctant due to their relatively bad relations and after long-term discussions in Brussels they agree to support the regional bloc, but through providing electricity and/or green hydrogen at relatively high prices, considering the nature and mentioned values of the EU. China is in a much better position, as the lack of green hydrogen due to a power outage by one of the suppliers would cause little harm if it is one of the LH2 suppliers, as they are projected to account for a small percentage of Chinese supply due to their increasing costs. If blackouts happen in Central Asia then the issue might be bigger, but, having diversity in its supply, Beijing can take advantage of spot contracts on the LH2 market and cover the biggest part of the supply loss. Potential winners from this disorganization will be regions that have not faced the power outage but are large green hydrogen producers. For example, if an outage occurred in the Persian Gulf, Africa could see a great chance at increasing expensive LH2 exports to Beijing and thus increasing its revenue.

The landscape is considered somewhat similar in a Markets and Institutions storyline. However, in the bandwagon of the least affected countries and regions, EU manages to hop on. China is also part of that bandwagon. The main reason is that in this storyline the EU is fully integrated and interconnected and because of the expansion of its technological expertise globally has a significantly diverse set of suppliers, so it is very easy to get its supplies from other sources. A potential unexpected loser can be the USA, as it is receiving virtually all its supplies via piping infrastructure at relatively low prices. An upsetting in the electricity grid in the Americas can force Washington to turn to the much more costly solution of LH2, which even might not be available, causing severe stress on its energy sector and could result in making use of its whole storage capacity.

Critical Minerals/Metals Supply Gap

The importance of critical minerals has already been stated numerous times and thus a supply gap in them can be catastrophic for any region that faces it, because in that case the construction of renewable energy units becomes practically unfeasible.

In the Regions and Empires storyline, the EU as a whole has the biggest losses. More specifically, being among the pioneers in renewable technologies, European companies are manufacturing and deploying a large part of it to the countries that have the highest potential. This creates a disruption in the supply chain and makes the deployment part largely challenging. This leads to a reinforcing loop, as countries and regions that could power the EU with their vast green hydrogen potential are suddenly left without the means necessary. This means that these regions are also potential losers if they don't look out for other technology suppliers such as China. On the other hand, as mentioned, China stands to gain a lot from such a supply gap, if it does not happen within its land. Beijing is already almost self-sufficient in several rare earths and critical minerals, but it also has enormous processing capacity. A powerless Europe could help China increase its clientele and dependencies on

raw materials and technologies and become the sole dominant “empire” in the emerging green hydrogen-dominated economy.

In the Markets and Institutions storyline, however, the situation is expected to be completely different. Europe coordinates its action and works together with Russia on the supply of critical raw materials and together they develop their processing techniques to reduce dependence from China. A major turning point is the democratization of Afghanistan which is one of the richest countries in many of these materials. With the efficient democratization efforts, free trade agreements also come for the EU and it manages to increase its self-sufficiency even more. China’s role becomes much less significant in this world order and Beijing sees unexpected losses.

Hydrogen supply gap

A hydrogen supply gap, as green hydrogen is poised to become the dominant energy carrier, can have detrimental effects in the economies that will struggle with it. The difference with the power outages is that this supply gap can also occur from lack of supply from renewables due to weather conditions or in case of an increasing domestic demand.

In the Regions and Empires storyline, all global powers will face energy stress. EU, USA and China will have to struggle replacing these resources and it might lead to friction and conflict with the regions that were supposed to deliver this energy quantity. At the same time, as in the previous scenarios where this storyline was implemented, internal conflicts, especially within the EU, have a high chance of taking place. The region that will cause the supply gap will also face macroeconomic stress. A shortfall in exports will be translated in less revenue and that is expected to severely damage the national economies of these countries. An unexpected winner will be the region with a surplus of green hydrogen that will be able to deliver to the market on short notice, hence that country ought to be open to spot contracts

In the Markets and Institutions storyline of this case no country is expected to lose significantly. In a narrative where all regional markets are interconnected and coordinated through international institutions like the IEA it is much easier to cover this gap. At the same time the international financial institutions are able to support the countries that have lost revenue due to decreasing exports, in case this lost revenue can result in crippling their economy.

Chapter 9 will include the analysis of the pattern above in order to better understand how different regions and empires studied in this research might follow a certain set of strategies or if their trajectory will be a mix of both storylines.

Chapter 9: Results of the Green Hydrogen pattern analysis

9.1. Overview

In this chapter the most meaningful conclusions derived from the analysis of the future potential green hydrogen system pattern will be elaborated. All of these conclusions will facilitate better understanding on how the transition to a different and cleaner energy carrier might affect the security of energy supply for the regions and empires that are being researched.

The most important piece of information that can be gained from the analysis of the findings is that green hydrogen has two main geopolitical differences compared to fossil fuels, such as gas.

The first one is that green hydrogen as an energy resource and carrier is not bound by geological conditions, hence several countries that were lucky enough to possess fossil fuels within their jurisdiction will lose that competitive advantage. This does not mean that green hydrogen does not come with geographical characteristics that provide privilege to those that have them. For its production, primarily, vast pieces of land are needed, so that renewables can be deployed and generate the energy required. That provides a great advantage to regions such as Central Asia, the Gulf States and the Maghreb/Sahel. In addition, for the construction of all these renewable energy structures and the electrolyzers, critical minerals are needed, which cannot be found anywhere. These factors translate to reduction of dependencies on fossil fuel locations, but create new kinds of dependencies that ought to be studied.

The second one is the negative aspect of green hydrogen compared to fossil fuels. A global energy system with green hydrogen as a dominant carrier requires electrolysis from renewable energy sources, critical raw materials, a modernized grid with several cybersecurity issues and reliable sources of water. This means that many potential factors come into play and make the future energy system significantly more complex and hence more vulnerable to malicious behavior by state actors and other key players that might feel that the energy transition is not just towards them. The adequate management of this geopolitical system, thus, requires an approach that involves many more disciplines than in the gas sector.

EU

The green hydrogen projected future is very similar and diversification can be even bigger in that case. The formulation of ECHA depicts very clearly the eagerness of all state actors to create an integrated liberalized market in Europe. In combination with the already existing ENTSO-E network on electricity, it ensures that the principles of free trade and integrated markets will be respected across the union and possibly across the continent. To receive, however, the necessary amounts of green hydrogen, the situation is very complicated. An example is Egypt, where the USA has invested in the installation of solar parks that will generate green hydrogen by North European companies. However, the agreement on electricity and, eventually, on green hydrogen is being discussed with

Greece. In this case, again, we see a series of bilateral agreements that serve the purpose of developing two liberalized markets, the electricity and the green hydrogen one, which will be considered intertwined. An increase in the number of suppliers (because green hydrogen can be produced anywhere) creates the same number of scenarios as in the gas case. This creates a much more complex geopolitical predicament for the EU and a puzzle that the decision makers will need to solve if an integrated market is to be resilient.

Russia

The Russian behavior on green hydrogen is significantly different, but it is also not fit for a Markets and Institutions storyline. The Eurasian state so far has not taken any action either on expanding its action on the green hydrogen field or on the electricity side. Talks and speculations have been happening at an EAEU level and have casually mentioned potential integration and liberalization of the electricity market, but no action has been taken on that side. Similarly, in hydrogen, Moscow has signed bilateral agreements with the UAE and Japan on hydrogen, but neither its origination nor the starting date of infrastructure construction and trade have actually been mentioned. Moreover, the deployment of Russian PMC's such as the Wagner group in Africa, which is of critical importance for the global green hydrogen supply chain, is one of the classic Russian strategies to gain control of critical minerals and solar/wind potential. Judging from the Russian strategy on gas, there is a high chance that, if it is eventually involved in the green hydrogen supply, it will do so on a Regions and Empires storyline. Nonetheless, existing evidence show that Moscow, at least initially, is expected to fall into inertia.

China

Green hydrogen is not projected to bring any differences for Beijing. The electricity needed for potential green hydrogen production is being agreed on a bilateral level with countries that are highly indebted to China, such as Kyrgyzstan and Tajikistan. The case is similar for African countries, which in the end provide the green energy carrier to China via shipping for an extremely low cost in order to pay out their debt. Following the increasing presence of the Chinese military out of the country as security guarantor, after agreements with Tajikistan, the Solomon Islands and expected agreement with Turkmenistan, the neo-realist approach of China is projected to become even more aggressive in the future, resembling more to Russia's. There is an effort to create communication channels with the EU and the USA, but Beijing sees both more as competition rather than potential allies. Hence, the tendency in the new system is also not expected to shift at all.

USA

For green hydrogen the situation will be slightly different. The USA is poised to be dependent on imports and, initially, pipeline transportation is expected to be significantly cheaper. The same obstacles like the ones in gas remain, but here Washington is more incentivized in cooperation with Mexico and Canada to satisfy its demand, hence it is more likely to collaborate despite a potential shift in the institutional beliefs of the political leadership. However, a factor that might create a tendency towards protectionism and lack of support for integration could be the great costs needed for interconnection and construction of the relevant infrastructure for green hydrogen across the Americas. Under a more conservative government there might be skepticism over such an extrovert policy and these initiatives might be revoked.

Persian Gulf

Green hydrogen brings a similar landscape in the Gulf, but the number of points of conflict increases. The relations with Turkey and Israel remain a point of reference and the stance towards the origins of hydrogen and the overall environmental policy are added as fuel to the fire. The possibility of an integrated liberalized market on the region is hence even lower than in the case of gas and only escalation of the regional conflicts are to be expected. The continuation of the civil war in Yemen could prove to be crucial in that case.

Africa

On green hydrogen, a major breakthrough took place making things seem much more promising. The inauguration of AHP between 12 member states and the agreement to create an integrated network in South and East Africa gives hope that over time the whole continent will be united under the renewable energy carrier. A shift of patterns from a neo-realist to a neo-liberal perspective is observed. However, initially, there will be a mix of both storylines characterizing the situation in the continent. Reflecting on the post-2050 world, though, there are signs that depict that Africa might be on its way to fulfilling the requirements of a Markets and Institutions storyline-dominated continent.

Latin America

A green hydrogen network brings these regional state actors together. The fact that virtually any country can produce its own green hydrogen makes all countries eager in participating actively as energy prosumers and this is portrayed in the EU-proposed initiative of H2LAC, a clean hydrogen alliance in Latin America. Virtually all countries of the region jumped on this wagon, which sets the foundations for a clean hydrogen integrated market. There is no full commitment yet as there is no infrastructure to support these agreements, however the overall stance of all countries is much more positive than the one in the gas market integration.

Central Asia

Reflecting on a green hydrogen future, the current data shows that the tendency towards the Regions and Empires storyline shall remain. Bilateral agreements on electricity are an indication that external global powers like China want to harvest the renewable energy from Central Asia for personal uses, such as the production of green hydrogen. Memoranda of agreement signed with countries such as Germany on green hydrogen production provide virtually no evidence that reforms will be demanded in countries like Kazakhstan and cooperation will take place with autocrats with the sole objective of powering Europe with green hydrogen. None of the aforementioned initiatives have any chance of changing the state of affairs in Central Asia.

9.2.Common Patterns Among the Two Systems

The first pattern related to China that is followed in both systems is that of bilateral agreements. In a gas-dominated system, Beijing pursues solely bilateral ties, in particular with the Central Asian states via pipeline long-term contracts, but also the same kind of contracts are pursued in its LNG transactions. The same strategy is being put in the green hydrogen context. The critical ingredients are deemed to be electricity and all the relevant minerals and metals, as mentioned. It thus moves forward with bilateral agreements on electricity as well as mineral and metal supply. Examples include electricity agreements with Kyrgyzstan, Tajikistan and Uzbekistan and agreements on copper with Tajikistan. China participates actively in several regional blocs and formulates initiatives itself,

like the SCO. However, these are not being used as a lever to promote trade in the energy sector and instead bilateral, non-free trade tactics are being deployed.

Another Chinese pattern that stems from the previous one that is expected to continue under a green hydrogen-dominated system is the debt-trap diplomacy by China. As mentioned, in the gas landscape, China has provided gas producing countries with several multi-billion dollar loans under opaque contracts with unspecified conditions. In these bilateral agreements there is never mentioning of repayment of debt or the way it has been repaid, and numerous analysts speak of concession of the gas reserves(Caravanserai, 2021). The situation is very similar on the green hydrogen landscape. More specifically, on the infrastructure that is relevant to the transition to this fuel, Beijing is moving forward with bilateral agreements with conditions that resemble debt-trap diplomacy. Such examples, as mentioned, exist on the electricity sector, where Lao ceded the majority of its grid to China(Zhai & Johnson, 2020). In addition, in Tajikistan there have been speculations that the debt payback would include asset seizure, more specifically seizure of the gold and copper mines within the country, with copper being paramount for the transition to renewable energy and consequently to green hydrogen(Shamiev, 2020). The similarities in the approach from Beijing on the energy landscape in both cases translates to the fact that increasing attention should be paid in the developing world, especially in countries rich in relevant resources.

Central Asia and the Persian Gulf share a common pattern, but for different reasons. The pattern revolves around the lack of interconnection or willingness to interconnect and, consequently, the fragmentation of the region, pointing clearly towards a Regions and Empires storyline.

The Gulf States' inability to create a new, expanded version of OPEC that will promote collaboration in the region stems primarily from the complete divergence on views on external actors. The main ones that are considered the causes for the conflict are Turkey and Israel. The ambivalent stance that Ankara has been following in recent disruptive events, such as the wars in Syria, Libya and Yemen, have divided the Gulf in two and most of the state actors have embedded this stance in their national strategy, which involves the energy sector. Moreover, the conflict over the Abraham Accords holds strong. While in North Africa even Algeria has been considering signing the agreement with Israel, in the Middle East, both Qatar and Iran remain adamant in their view over collaborating with Tel-Aviv. This has far-reaching ramifications for both the gas and green hydrogen sector. The main reason is that Europe is a great source of energy demand and both Israel and Turkey are connection nodes to the continent for the Gulf states. Disagreeing over potential collaboration with them on energy only makes engaging with the EU more challenging. It also makes the creation of relevant interconnection infrastructure more complicated, hindering the development of a region that is extremely rich both on gas and on renewable energy that would produce the much wanted green hydrogen.

The state of affairs has some differences in Central Asia. The Great Game that started between the British and the Russian empires in the 19th century and resumed as soon as the discovery of the true hydrocarbon potential of the region was made is the main reason for fragmentation. Russia's failing foreign policy in the region is undoubtedly turning more states closer to Beijing. However, as Moscow is the main security guarantor of Central Asia, it still can exert influence over developments around the Caspian Sea. One specific example is the deterrence of social unrest in Kazakhstan in 2022 or the negotiations over the political transition in Kyrgyzstan in 2021. Also, the friendly stance from the new Turkmen President Serdar Berdymukhamedov towards the Kremlin proves the point. In this power struggle, Turkey is also trying to become a dominant power in Central Asia. This is done primarily through the Turkic Council and through cultural diplomacy. Finally, other external actors

such as the USA, Iran and the EU are casually pursuing bilateral collaboration within the region. This creates a fragmentation of views regarding foreign policy. This is enhanced by the fact that each state actor is pursuing market liberalization efforts at a different pace and with a different commitment.

The overall conclusion of these two patterns is that both regions suffer from lack of coordination and further (market) integration. The reasons, however, are completely different and the two cases should be dealt as such.

A very interesting common theme is the completely different outcomes in each storyline for the USA that largely depend on its leaderships' position over NAFTA/USMCA. President Trump's claims that it was the "worst deal ever" brought a revisit of the free trade agreement that eventually led to a new agreement. However, depending on the views of Canada and Mexico, a breach in this agreement might escalate and lead to an isolation of Washington in the continent. In the case of gas, the shale gas revolution has made the USA virtually self-sustained and secure on gas supply, so such an isolation might not have a big impact on the energy sector of the country. In a green hydrogen future, nonetheless, the impact is poised to be orders of magnitude higher. The reason is that for the moment pipeline transportation of green hydrogen is much cheaper and hence replacing continental green hydrogen with LH2 shipping will cause great damage to the American economy.

A final commonality that is being observed through both systems is the overall EU strategy. The general concept consists of multiple bilateral agreements that serve the purpose of powering a partly liberalized market. However, there are two issues raised here. Firstly, none of the bilateral agreements is binding and, in the Regions and Empires storyline, the energy resources are not shared with the whole union on a liberalized market basis. Secondly, bilateral agreements with certain actors like Russia are not endorsed by the whole bloc and hence lead to severe frictions, especially where there are disputed views over the supplier, such as in the case of Moscow after the Ukraine war. In the green hydrogen landscape, however, Russia plays a much smaller role so, unless there is a similar disruption taking place by a North African, Gulf or Central Asian country, the main risk comes from the USA agreements on green hydrogen with Netherlands and France. As Washington is prone to military interventions, moving forward with a new one might spur new conflicts in Brussels.

9.3.Different patterns

The main difference that is observed between the two systems is the completely different approach coming from Russia. In a gas dominated world, Russia assumes the role of an "empire" and its strategy is geared towards the corresponding storyline. Moscow signs solely bilateral agreements and resorts in military interventions to intimidate other state actors that might try to adopt a different energy policy line than the Kremlin. In the green hydrogen landscape one would expect one of the same. This would translate to bilateral/regional agreements on electricity and a stronger military presence in countries with critical minerals and metals for the energy transition. However, apart from vague statements on a common EAEU electricity network and interventions through PMC's in African states with important critical metals, the overall stance of Russia paints a different picture. Both Russia itself but also the post-Soviet space possess great potential to deploy green hydrogen infrastructure and abundance of relevant minerals and metals, which would put the Eurasian region in a great position, given the proximity to energy demand champions China and the

EU. However, Moscow has barely made any moves and in a green hydrogen future it is expected to cease to gain relevance. This stems mostly for its belief that gas will not just be the transitional fuel but will prevail even in a post net-zero world, so it's mostly speculation-related.

Another different theme that emerges is that of the integration efforts on the energy sector for the regions of Latin America and Africa. The processes in these two regions present dissimilarities and the challenges vary depending on the occasion.

In Latin America, OLADE is the sole entity that unified all state actors under the theme of energy cooperation. Its purpose allegedly is to promote energy policies that will lead to further integration of Central and South America. Nonetheless, as of now, very little has been done to move towards that direction, especially in the gas landscape, where the region is fully fragmented. This shows that OLADE's mission was not successful and the efforts of the Latin American state actors for integration of the gas infrastructure, although sincere, were not fruitful. In the green hydrogen landscape a different approach is attempted. The EU tries to bring together all the relevant state actors through the H2LAC alliance, which is used to coordinate action on the emerging hydrogen industry in Latin America and the Caribbean. The main difference in this approach is the emergence of an alliance solely with the objective of aligning hydrogen policies and possibly leading to hydrogen integration, whereas there was no similar initiative for gas. The reason is that while gas reserves exist in a specific number of countries, this is not the case for green hydrogen, which can be produced virtually in any place around the globe.

In Africa the circumstances are non-identical. The continent, in an energy context, was fragmented based on the fortunate countries that possessed the oil reserves and were OPEC members and the ones that did not possess them. And while the shift to gas has resulted in more countries participating in the energy production process, because more countries possess gas reserves, it has not led to any efforts of policy alignment other than the vague ones that are mandated by the African Union. In the new reality that renewable energy presents to us, led by public and private institutions, twelve African countries signed the AHP with the ultimate goal of creating hydrogen interconnection and integration routes in South and East Africa, predominantly. The point of divergence with Latin America is mainly that Africa is a much larger continent which makes interconnections more costly and difficult. In addition, governance models vary widely across the continent, which makes it even more challenging to find a point of convergence with all state actors. Nonetheless, comparing to gas, there is a major difference in perceptions regarding energy policy within Africa and. Combined with the creation of the AHP by several African states, for the first time there is an effort to unify the energy landscape of the continent under the principles of free trade.

9.4.Common Patterns and Differences in the Scenario Analysis

During the scenario analysis, several disruptive scenarios were examined further and insights were gained.

Stranded assets is a theme that is being discussed both with regards to gas and with regards to green hydrogen. As far as gas is concerned, using it preferably to oil has a high chance of translating to stranded oil assets in the short term. In the long-term, due to the net zero targets of 2050, gas assets are going to be the stranded ones. Hence, in the global gas system it is a more complex problem, but also a problem of a different nature. Process of extracting oil and gas presents similarities and hence international energy companies that work on the fields, as well as state actors, do not see technical

hurdles in diversifying their investments. In this case, the stranded assets issue is certainly upsetting and devastating as well, however it is easier to manage the losses, even in a Regions and Empires storyline. There is, nonetheless, a good chance that several states and/or companies might face default, especially in a Regions and Empires storyline. This risk is significantly lower in a more neoliberal future.

The case of hydrogen is a completely different story. Producing green hydrogen requires a completely different process than the oil and gas extraction and also completely different infrastructure. This means that an enormous amount of investment will be needed just for the state actors and the international energy companies to shift their production, which will create a level of debt that in the Regions and Empires will be unbearable. In the Markets and Institutions storyline the burden will also be high, but shared in a just manner with the assistance of international institutions, there is a higher chance that many countries and companies might avoid default. The outcomes in both systems are a great depiction about how important international institutions are for the global energy system and, consequently, the global financial system.

Another observation made is that the EU presents significantly fewer losses in virtually all scenarios under a Markets and Institutions storyline. In cases like the supply of disruption in critical minerals or in gas, a unified Europe can have a much stronger response and can emerge more robust and with less financial damage. This happens for a variety of reasons. In the case of critical minerals, a strong EU cooperating within the financial institutions eventually finds ways to diversify its supply but also to create a robust industry for rare earths processing. In the case of gas, after the shale gas revolution, the EU is diversifying its supplies as much as possible and there is sharing of the resources between the member states. So, an event of disruption in one supplier is merely seen as a small supply gap which is not very complicated to fulfill.

The increasing growth of China brings more issues and more vulnerability on the security of supply side. The enormous growth rates mandate exponentially increasing supply of energy, be it gas or green hydrogen, and the country itself does not possess great oil and gas resources nor does it have the technical potential to develop such huge solar and wind parks to fuel the green hydrogen future domestic demand. This poses as a major problem, because the overall stance of the country is geared towards the Regions and Empires storyline. In this narrative, as mentioned, the repercussions of supply disruptions and even simple supply gaps can cause much more damage and have tangible effects to the economy of the country. This portrays a weak point on the Chinese policy, that Beijing possibly tries to overcome through the Belt and Road Initiative.

In all supply gaps and disruptions of supply exporting regions that are not affected stand to gain a lot. This has the same effect on these regions in both storylines. However, it has been shown that in the Regions and Empires storyline there is a higher chance of disruptive events in virtually all regions, which brings a higher probability of a disruption in energy supply. Taking both facts into consideration, this might work as an incentive for these regions to cooperate and follow a storyline closer to the Markets and Institutions one. On the other hand, this might also function as a pushing factor for them to support extremist and/or other groups that cause disruption in other regions as well. This is something that ought to be monitored closely at an institutional level.

Chapter 10: Limitations & Future Work

10.1.Limitations

10.1.1.The connection between neoliberalism and nationalism

This model and this research was based on the assumption that neoliberalism and nationalism are two contradictory concepts. Historically, economic and cultural nationalism has been perceived as a reactive response to potential failures of the neoliberal globalization process (Barber, 1995; Radice, 2000; Worth, 2005). Scholars have also generally understood and commented on neoliberalism as the ideation of a borderless world, not taking into consideration nations and their disputes (Friedman, 2000; Ohmae, 1995). This has led to a widespread notion that neoliberalism and nationalism are two postulations that cannot be connected in anyway and hence ought to be deemed as antithetical (Varadarajan, 2006). However, over the past decades, researchers have been on a quest to question this binary view. They do that via two axes. The first one rejects the theory that economic nationalism is characterized by policy measures such as protectionism, but rather should be defined by its nationalist motivation (Helleiner, 2002; Helleiner and Pickel , 2005; Pickel, 2003). The second one adds the notion that neoliberal decision makers can in fact deploy nationalist policies, with the objective of universalizing them and promoting them globally(Helleiner and Pickel, 2005). Harmes (2012) went a step further with these ideas and made two main arguments. The first one was that neoliberalism and nationalism are not only compatible, but also some neoliberalist values could be depending on nationalist policies. The second one revolves around the idea that support on neoliberal nationalism might be increasing because of a shift among the leaders of social democratic movements from a broad strategy of economic nationalism to a more socio-democratic multilateral system.

Taking this literature and these notions into considerations, there are several propositions and theories from neoliberalism that could be applied to a neorealist IR landscape, which makes it increasingly difficult to distinguish several policies as consistent with the Regions and Empires or the Markets and Institutions storyline. This could be resolved via two manners. The first one would be to add a third storyline in the existing structure that would comprise with economic nationalism elements and essentially combine parts from both storylines. The second one would involve fabricating a different storyline scheme, where the socio-democratic and the nationalist values would be incorporated, respectively. Including these aspects on the model would increase the uncertainty detection of the green hydrogen supply chain(as well as the gas one), but that would also increase complexity proportionally and thus was chosen to be omitted.

10.1.2.The notions over China's neorealist stance

This model was constructed under the assumption that China follows a more neorealist stance in IR, based on the themes created and the literature found. This has been a highly debated subject, nonetheless, as scholars both sympathetic and skeptical of neoliberalism that advocate in favor of China's neoliberal stance. The comments of the former are mostly that the exponential growth of the Chinese economy is because of the free markets and private ownership, whereas the latter focus on social inequalities as a result of neoliberalism. At the same time, there are also advocates of Chinas non neoliberal behavior, from both sides. Again, the former blame Beijing for not conforming with the rules of the free market, whereas the latter maintain that China broke out of the slow growth and the great percentages of people below the poverty line, exactly because it disobeyed the policies codified by the Washington Consensus (Weber, 2018).

A model that would encompass all views would be more complete and reflect on all of the broad spectrum that neoliberalism entails and what that means for China. However, it would again remove the holistic nature of the model. In addition, it would shift the focus to a region that might be relevant for the study of security of supply of the EU, but it is not the main point of focus for this research. Hence, the view of a certain set of scholars was chosen. Based on the literature on neorealism and its application on the Regions and Empires storyline, not conforming with the rules of the free market was considered paramount and carried the largest weight so that a country/region could be considered as neorealist in this model.

10.1.3.The omission of constructivism

This model utilized the two most well-known "schools" of thought in IR, namely realism and liberalism, but did not take into consideration the third and new one, constructivism.

Constructivism comprises the third "school" of international relations, that emerged as a serious challenge to liberalism and realism in the post-1990s world. Wendt(1992) initially described the theory, after reflecting on the fact that the debate between the two prevalent theories was mostly one about structure(anarchy and distribution of power) versus process(interaction and learning). He noted that agency and social structure, both highly dynamic, were missing from each equation. Katzenstein (1996) was more vocal on that subject, as he describe the economic man to be a social moron. Constructivism, hence, is much more dynamic, bridges liberalism and realism in a sense, and takes into consideration the social structure, which is changing with an accelerating pace and can shift the behavior of a state. A solid example is Germany which, even though given its size and power it can function as an "empire", resorted to a more passive role after the atrocities of World War II.

The model does not take into account constructivism, in the sense that it does not include a third storyline based on that. Nonetheless, it is incorporated in a way. More precisely, it could be claimed that countries or regions that have a shift in their storyline from the gas system to the future green hydrogen system fulfill verify the assertions of both Wendt and Katzenstein over the constructivist theory. Nevertheless, including the third IR theory in the model would make it increasingly challenging to distinguish the different characteristics that each storyline and framework would entail. Thus, it was chosen not to be included.

10.1.4.The omission of emerging potential key players

The Russian invasion of Ukraine created an unprecedented chain of effects that led to a massive shift in the geopolitical world order. Food and energy insecurity caused severe financial strain to many countries, some of which were already on the verge of a financial fallout. Sri Lanka, a perfect example of such a situation, declared recently that it would stop paying for its external debt, essentially admitting a default(BBC, 2022). Many analysts point out that this will be only one piece of the looming domino defaults that will include countries in South, Southeast and Central Asia, but also Africa(The Economist, 2022). Their common trait is that Beijing is among their top financial guarantors. China is currently remaining silent in Sri Lanka and pulling back from several countries(Bloomberg, 2022). Adding the absence of Russia to the mix means that a vacuum of power is created, especially in Asia, which might be filled by emerging powers like India, Turkey or Iran and they might turn themselves into global powers and hence empires of great importance that ought to be added in models like this one.

This model, however, did not take the new developments into consideration. The main rationale behind this choice is that it is quite premature to judge whether China or Russia might reduce their activity in the geopolitical landscape. The majority of the choices within the model were made based on data and not on speculations.

10.1.5.The lack of focus on a specific country/region

This model attempted to take a global view of the gas and green hydrogen systems, however with the objective of putting the knowledge generated in the context of the EU and what it means for the union. This model could have focused instead only on the EU and the security of supply from one state actor or region, namely Russia or the Gulf States, diving more into detail. In that case, nonetheless, there would have been no holistic approach, which was the point of this thesis all along.

The lack of further details on the complexity of the water and electricity sector

The literature review briefly reflected on the importance of the water and electricity systems for the global green hydrogen supply chain, so that this data would be used to formulate the model. However, there is a much more complex relationship in the water-hydrogen and the electricity-hydrogen nexus which would need much more research to be understood. This has been shown by Eljack & Kazi (2021), but also Kazi et al. (2021) after researching in depth these fields for the country of Qatar. This would have been extremely challenging to model on a global scale and would remove the focus from the research question and the objectives of this research, so it was chosen not to have a more in depth study of these sectors.

10.1.6.The lack of reflection on CBAM and ETS

This model did not take into account the effects of carbon tax on the global gas and green hydrogen systems. The EU is pursuing an agenda that involves carbon taxation and recently presented its plan for the carbon border adjustment mechanism (CBAM), which would assist taxation even for international firms that outsource their energy-intense functions outside of the union. CBAM has been cited by experts as an instrument that will create geopolitical risks and is bound to reshape the broader global climate agenda having far-reaching geoeconomics ramifications for the EU as well (Bukowski, 2022). Hufbauer (2022) has also elaborated on the geopolitical implications of the EU green trade scheme that has brought objections from key players such as Australia, China and the USA. Both statements depict the relevance and utmost importance of the carbon tax schemes for the geopolitical landscape of the energy transition. In this model, however, the two energy carrier systems are being studied separately and there is no focus on the transition process itself. Thus, the CBAM and ETS are not included in the model.

10.2.Future Work – Recommendations towards researchers

Indeed, the limitations presented in this chapter audibly delineate the ample opportunities for future work based on this research. This thesis is still a new approach on the energy transition and thus it is anticipated to be under rigorous scrutiny in the climate science, the geopolitics and the energy sectors. The ensuing paragraphs propose future research paths for policymakers, researchers and professionals in the think tank field.

First, the probability of neoliberal nationalism emerging in several regions around the world could be embedded when modeling the behavior of state actors in the Markets and Institutions storyline. Such an approach would be particularly interesting because it could outline the fact that, in some cases, the two schools of thought in IR are much closer than they are perceived to be. It would be very insightful specifically for countries like the Eastern European ones, where neoliberal nationalism has been rife. It would also facilitate explaining what the true approach of China is on the geopolitics of the energy sector and the security of supply, as opposing views by scholars are perplexing the endeavors of putting Beijing's stance under a certain framework.

Second, the storyline approach could include the constructivism theory, having in total three storylines. Currently, in order to better understand the stance of each state actor in the gas and green hydrogen systems, the two storylines are used and the main conclusion is the actions of most of them are expected to be the result of a combination of these two storylines. Nonetheless, there are certain behaviors (such as Russia's in the green hydrogen system) which cannot be explained through this framework. Adding a third storyline could assist these attempts of acknowledging the stance of each state actor in both systems.

Third, this model could be used as foundation to better understand the geopolitical implications of other energy carriers. Numerous countries have not agreed on the origination of hydrogen and are looking into options such as pink hydrogen (e.g France) or blue hydrogen (generated from gas). These "colors" of hydrogen have very divergent supply chains and would prove to be separate case studies. A similar approach could be made to other potential carriers of the future, such as ammonia, bioethanol etc.

Fourth, the used model could be easily adapted to the carbon tax schemes. As mentioned, geopolitical implications of CBAM and ETS are anticipated to be fierce and it is paramount that they are further explored. The framework set in this research could facilitate a new research study, by replacing the technical, financial and scientific background of green hydrogen with that of e.g CBAM.

Fifth, this model can be used in a research with another region or specific country as a point of focus. The rapid growth of the Global South translates to enormous future energy demand. Thus, it is in their best interest to study what a transition to green hydrogen as a dominant energy carrier might encompass for them. For each region/country, different key players matter most. Hence, for the new countries/regions under study, the model should be adjusted and include the relevant actors and what the energy transition would mean for their geopolitical landscape and their security of energy supply.

Lastly, the sensitivity analysis can be enlarged so that it can include more robust uncertainty research. There are several scenarios that have not been studied. One of these is happening in the aftermath of the Russian invasion of Ukraine, where Moscow, isolated, is selling its crude oil significantly cheaper than the Brent price. A similar strategy is expected to happen with gas. Since the embargo is not unanimous and the environmental policies are not fully aligned globally, there are key players that might resort in buying cheap Russian oil and gas with the objective of refining it or consuming it, possibly having an effect on the transition to low-carbon hydrogen. Another set of scenarios that would be explored could be the scarcity of each rare earth separately, so that the geopolitical importance of each could be examined more in depth. These are just a few of the scenarios that were not studied due to the lack of time, but would be extremely useful to be done so in another research study.

Chapter 11: Conclusions & Insights Gained from the Research

SQ1: How have transitions to other energy carriers in the past reshaped and affected energy security of supply?

Based on the historical analysis of the factors that have influenced energy transitions in the past, several ways that new energy carriers reshaped energy security of supply can be detected. The first one revolves around the demand side and more specifically the energy price fluctuations. Spikes in the incumbent energy carrier price will divert society away from this option and into the new energy resource. However, this will require a shift of investment patterns from the private sector, which in the short-term is expected to reduce the energy security of supply, until the energy mix reaches its desired composition.

In addition, it is found that intellectual currents and institutional movements have by and large affected social acceptance over new and incumbent technologies. Their acceptance in a specific institutional framework, based on which trade is being conducted(including energy trade), can lead to a reshaping of the energy security of supply landscape.

Lastly, the transitions to new energy carriers have usually been influenced by an exponentially increasing demand, especially after the industrial revolution. Introduction of a new energy carrier amidst a spike in energy demand, so that it can compensate with its alleged higher energy density, can also create uncertainties over the supply of energy and thus cause damage to the energy security of supply on the short-term.

Nonetheless, research has delineated that in the long-term most energy transitions have affected security of supply in a positive manner.

SQ2: Which factors influence the energy security of supply of the EU?

During the literature research, interesting insights were unfolded regarding the factors that will shape the green-hydrogen system geopolitically. These include pure water, but also electricity security. For the former, either hydro-political dominance or technological advances in water desalination shall be needed. For the later, renewable energy to produce green hydrogen will add intermittency in the energy mix which will require modernizing of the existing grids to be able to cope with it. This will make states largely vulnerable to cybersecurity threats and to attacks from non-state actors and extremists to the physical electrical grid, which will be chiefly decentralized. Another determining factor will be the land available in combination with the technical solar and wind potential. The shift from conventional fuels means that countries that are geologically fortunate to possess fossil fuels will not have an advantage at a green hydrogen system and various analysts might think that this is bound to democratize the energy sector. However, in this new energy reality, vast quantities of renewable energy shall be needed, making the countries that have a great deal of unused land, in combination with great technical solar and wind potential, the fortunate ones, giving them a geopolitical edge. Lastly, the possession of critical metals and minerals, together with the processing power and technology needed for them will give the privilege to the key actors that will possess them to emerge stronger from this transition than others.

SQ3: What are the potential strategies that key state actors or regional blocs can deploy within an energy system?

Based on the trajectory of each actor in the two storylines that were developed during this research, a country/region can follow two different paths. The first one is more aggressive. It involves unilateral approaches from global powers. These can be expressed via two ways. The first one is about their external policy and it is essentially bilateral agreements with smaller players, not taking into consideration that they are a part of a bigger trade bloc. The second one concerns their internal strategy within their regional bloc. Instead of reaching to a collective agreement on energy with the whole region, they pursue their own strategy and that brings them at odds with other regional players. The result is fragmentation and subregionalism. Lastly, the most aggressive approach implies military interventions in countries of interest for the energy sector.

The second path is more consistent with the free market theory. It involves three main strategies. The first one is formulation of multilateral free trade agreements on energy, both within their own regional blocs, but also in a global scale. Such examples are the proposed free trade by the Pacific Alliance, USMCA, EFTA, but also the TTIP and the TPP that never materialized. The second strategy is about dispute resolution and entails diplomatic approaches to that using the global powers and international institutions soft foreign policy tools. The third strategy is active participation in international institutions such as the IEA and the UN.

SQ4: : What are similarities and differences between the geopolitical and energy security landscapes in conventional fuel systems(such as natural gas) and the future green hydrogen system?

The main similarities between the two systems orbit around the physical structure of the energy system. Green hydrogen will too be distributed through either pipelines or shipping routes. The small difference in this part is that, initially, green hydrogen will much more preferably be transported through pipelines, because of the significantly lower cost at the beginning. Nonetheless, that is bound to change. Another similarity is that both systems depend on geographic factors in general.

The differences, nevertheless, are more. The natural gas system is much less complex and depends only on the geological characteristics of the producing countries. The green hydrogen system depends on the water, electricity and critical minerals and metals sub-systems, as well as on the technologies that are related to these sectors. In addition, as mentioned, diverse geographic factors will determine this system. In brief, state actors with vast amounts of land untapped and great solar and wind potential shall be the winners and main exporters. The geopolitical landscape of green hydrogen, hence, will depend on a combination of these systems' dependencies, which will make it a significantly more complicated process than with gas.

SQ5: What common patterns between these two landscapes can be identified?

A common behavior in both systems is followed by China. Both in gas and in green hydrogen, Beijing pursues solely bilateral agreements to achieve energy security of supply. In addition, its financial strategy is somewhat aggressive as well as there are several critics of its debt-trap diplomacy. Overall, the Chinese neorealist pattern remains the same.

A similar approach is observed by Central Asia and the Persian Gulf. Virtually no substantial efforts had been made so far to integrate the regions on the gas system and there is no change expected to take place in the green hydrogen landscape as well. Both regions remain fully fragmented in terms of their gas grid, but the same situation applies to their green hydrogen projected grid and to all the separate grids that will be used to develop it.

The stance of the EU is expected to be approximately the same in both systems. The way the EU functions on the energy sector is that several bilateral or regional agreements are developed, with the objective of creating an integrated liberalized market. The green hydrogen system will be no exception to this rule. Already several bilateral agreements are being made in the hydrogen and the electricity sectors. Projections point towards an integrated liberalized hydrogen market. However, with the geopolitical world order shifting, such projections are far from becoming certainties.

In a similar path, in both systems the trajectory of the USA is highly uncertain. The common pattern here is that the overall behavior of Washington on the energy sector will largely depend on the leadership, as it has been proven that that its trade and energy policy is highly vulnerable to political transitions.

SQ6: What additional patterns can be formulated regarding the new green hydrogen system?

The first and most easily observable pattern is the game-changing stance from Russia. More specifically, Moscow has not taken any steps towards playing an important role in the green hydrogen system. Despite the fact that the country is rich in wind and solar potential, water resources and the know-how to develop pipeline networks, the Kremlin has remained silent in that regard, creating a new kind of storyline.

Another pattern that might emerge in several state actors is the neoliberal nationalism one. Countries such as China are investing heavily in the free market but are hardly playing by its rules. This describes the bulk of the developing world, including countries such as India, South Africa, Brazil and Turkey. Since these emerging key players are expected to be instrumental in the geoeconomics landscape of the future, this pattern can be considered as an addition to the overall framework created in this research.

SQ7: What are the geopolitical and security implications of a transition to green hydrogen for the EU, with regards to its strategy?

- It is paramount for the EU to set the ground and the rules for the formulation of a liberalized hydrogen market. Several bilateral agreements are being made in the electricity and hydrogen sectors already. The EU must ensure that at least a part of this hydrogen is traded at the free market. The ECHA should also coordinate with the producers and the importers so that the origination of hydrogen is ensured, but also so that a clause is included in bilateral and regional agreements that they will serve the creation of an integrated European green hydrogen market.
- Considering the significantly lower prices of pipeline-transported hydrogen that is expected until the mid-2030s, it would be the best practice for the EU to search for stable pipeline partners. As mentioned, the Persian Gulf is projected to carry instability in a green hydrogen dominated system as well. The Russian invasion of Ukraine makes it also extremely challenging to harness the enormous potential of Central Asia. That makes North Africa and

the Sahel the ideal markets for interconnection in order to secure the first green hydrogen imports.

- Given the chance to secure large volumes of green hydrogen at a relatively low price through pipeline repurposing, there is great value in trying to stabilize the geopolitical landscape in the post-Soviet space, as well as in the Persian Gulf. The union stands to gain a lot, both financially and in terms of needs for humanitarian aid in the long-term.
- Water ought to gain an increasingly important role in the EU foreign policy. Apart from supporting the Global South and the neighborhood at securing water volumes to achieve the wellbeing of local communities, Brussels should aim at a stable flow of good quality water for hydrogen production. It should do that while not disrupting water supplies for the local communities that might cause social unrest.
- Similarly, a new task force focused on cybersecurity on the electrical grid has to be established in Brussels. Interconnection with the post-Soviet space and with the MENA region comes together with a modernization of the grid. The modernization is a necessity given the shift to a grid that is in need of flexibility, due to the penetration of renewables. This translates to the usage of smart grids and other high-tech structures that can be easily victims of cyberattacks, without the right security strategy. The interconnection with the foregoing regions shall result in exposure to Russian cyberattacks, as mentioned, but also to terrorism acts by extremist groups acting in the MENA region and the Sahel. Brussels should formulate this task force and move cautiously always in coordination with it.
- From the shipping markets, Latin America seems indeed like the region that shows eagerness to work collectively and collaborate with external actors. The EU already made a very promising step towards cooperation in the field of clean hydrogen with the inauguration of H2LAC. Nonetheless, the USA plays a decisive role in the energy sector in the continent. Not including them in the decision making process and in the creation of an international institution could prove to cause damage in the coalition, in the event that there is a shift in the political leadership in Washington. The US should be included even as an observer.

Chapter 12: Recommendations for EU policymakers and academia

12.1.Answering the main research question

Based on the analysis so far and on answering the sub-questions, the main research question shall be answered.

How will the geopolitical implications of a transition to green hydrogen affect the energy security of supply of the EU?

The shift to an energy carrier that is not fully bound by geological formations is not expected to fully democratize the energy supply field and bring full security without dependencies. First of all, the literature review of this research unraveled that the main requirement for the development of green hydrogen is vast land or sea resources so that renewable energy sources can be deployed. Europe is a really dense continent in terms of population, which makes it extremely challenging to become self-sufficient. In addition, these requirements make particular regions ideal for the development of green hydrogen, which translates to potential future geographical constraints. Taking both into consideration, the forecast for the overall structure of the system is not different than the fossil fuels one. However, the increasing number of supply chains that affect the energy security of supply creates more interdependencies and complicates the state of affairs, as the pattern modeling approach of the green hydrogen system brought to light. The EU has to choose suppliers from a group of regions that so far have been largely fragmented, based on extrapolations about their potential (lack of) collaboration. This is a difficult puzzle to solve, as this choice has to take into consideration electricity interconnections, potential water disputes, but also the nature of pipeline infrastructure in these regions. This brings the EU within a tradeoff. On one hand, the proximity factor and the frugality of the pipeline infrastructure hint towards Central Asia, the Persian Gulf and North Africa as ideal suppliers of green hydrogen. These regions, though, are highly vulnerable to conflicts that can result in disruptions on supply. Central Asia used to be characterized by an overall stability. The Russian invasion of Ukraine has had a domino effect on the region as well and, since virtually all pipeline routes have to pass through Russia, it becomes virtually impossible to include them as partners. On the other hand, Latin America and a large part of Africa will necessitate shipping transportation routes, which will initially increase the cost significantly and there is no certainty over their decreased costs over time. In that case, however, an overall tendency for collaboration, integration of grids and support towards the energy transition is being observed in both regions. To add to that, an eagerness for cooperation with the EU is noted. These characteristics make these regions great partners on green hydrogen, once the financial barriers are reduced.

The EU can choose between two strategies. The first one involves substantial financial support to develop a large LH2 ship fleet that will connect the union with regions that are characterized with stability and low risk of disrupting the security of supply. The second one includes a painstaking security strategy combined with a lower investment on energy infrastructure to connect with conflict-prone regions, with an increasing risk of disruption in security of supply. Compared with the situation with fossil fuels as energy carriers, the EU is not affected in the sense that it still has to account for energy imports. However, there is a broader range of state actors and regions to choose as suppliers. This increases the leverage that the bloc has on the negotiations table, but only as long as agreements are made with the objective of formulating an integrated liberalized market. If subregions and separate member states attempt to create their own green hydrogen network

through bilateral agreements, both fragmentation is expected, but this will also be perceived as weakness when negotiating over prices for the energy carrier. This is also a commonality in the oil and gas sector, where Russia, for instance, has taken advantage of the bilateral nature of several agreements and has intimidated countries, negotiating a much higher price than the one expected.

A big change, as revealed during the literature research and pattern modeling processes, that is bound to affect Brussels as well, is the increasing complexity of the green hydrogen supply chain. For instance, when looking to import the energy source from North or East Africa, the EU has to take into consideration the great water disputes that have caused strain in Egypt, Sudan and Ethiopia over the GERD dam. In Central Asia, both the modernization of the electricity grid and the resolution of water disputes in the Ferghana Valley ought to be done before any agreements are made on green hydrogen trade. This means that both the public and the private sector of European countries should make the utmost effort to ensure that the water and electricity sectors of the supplying countries function well and guarantee the local communities' basic needs, before trade is initiated. Hence, water and electricity diplomacy is expected to be strongly correlated with the overall energy policy of Brussels in the future. In other words, European energy policy is projected to be highly sensitive to changes in the water and electricity security around the world.

Another shift that will affect the EU, is the shift of importance to rare earth metals. REM and critical mineral processing is paramount for the manufacturing of renewable energy units and many of them are concentrated in specific regions. China is among the countries that is fortunate enough to possess a high amount of them, but also to have the processing capacity. Other key players include India, Russia, Australia and South Africa. We see that most of these state actors follow a neorealist(or neoliberal nationalist) stance so it will be largely difficult for Brussels to approach them in a collaborative manner. In addition, the renewable energy units manufacturers that scale up production are mostly in the same countries(except for Russia) and, together with the USA, they are involved on the development on wind and solar parks around the world that have high potential of becoming green hydrogen hubs. This might have a direct effect on the price of green hydrogen, but also implications for the security of supply, leading to insecurity.

Lastly, the move away from oil and closer to gas brought lower dependence for the USA, as it was combined with the shale gas revolution. The transition to green hydrogen will affect this development in a negative manner, affecting Brussels in the long-term. Washington will now be much more dependent on green hydrogen imports and will initially look within the continent, via pipeline infrastructure, to achieve security of supply. As the EU is also heavily invested in partnership with Latin America via the H2LAC, this is bound to increase competition between the two otherwise allies. Considering that the competition with Beijing will remain at the same levels, a transition to green hydrogen as an energy carrier will only potentially worsen the relations with the USA, if no prior set of agreements, preferably free trade, are set. Still, if they are set, but only with a few member states, this is also something that can derail the trans Atlantic partnership.

12.2 Key academic contributions

This thesis also generated several academic contributions, out of which the key ones can be identified as:

- Contrary to what other academics on the energy transition have believed so far, renewable energy sources are very unlikely to bring democratization of the energy sector and resolution of all conflicts. The intermittency of wind and solar energy have a very low probability of

ceasing to exist and hence there is an eminent need for a means of storage. We used the example of the prevalent and most likely to dominate energy carrier, green hydrogen, and depicted that conflicts are projected to happen and there is a risk of escalation. The academic community ought to further investigate this risk and research the probability of this disruptive events becoming a reality.

- Multiple sectors become interconnected for the generation of green hydrogen. The water-energy security nexus becomes apparent and sheds light on a sector that has been very little studied. Combining it with the fact that renewable energy can be produced using agricultural land, a strong geopolitical aspect of the food-energy-water security nexus emerges from this thesis. It is important that these insights are used for further research.
- Many of the potential energy exporters in the green hydrogen era are facing serious energy security issues and are expected to be hit hard by climate change. This thesis exposed a general lack of research on the fields of climate change and the energy transition in regions like Central Asia and the Persian Gulf, but also Africa. Focusing on promoting energy efficient and clean energy practices in Europe has led to a lack of funding towards research, in addition to innovation, in these fields in regions that are going to face major issues and are likely to be further fragmented and face conflicts. This means that there will be enormous supply chain risks and calls for further studies in climate change and the energy transition in these regions.

12.3.Recommendations for policymakers

The results that this research project yielded can justify several recommendations for the policymakers, decision-makers within the EU and academics alike:

1. **Framework/Strategic roadmap to a hydrogen liberalized market** : This framework shall explain how the set of bilateral and regional agreements on electricity, water and hydrogen will serve the eventual formulation of an integrated liberalized market. As mentioned, a clear example is the mega-cable project in the East Mediterranean and the hydrogen agreement between Italy and Algeria. If there is no pellucid direction for the hydrogen market, Italy might result in trading other types of hydrogen that produce emissions and the Balkans might develop their own regional market if the wave of economic nationalism in Eastern Europe persists. Instructions should be set and only an roadmap supported by the vast majority of the member states can safeguard the energy gateways of the continent will function according to the European values of free and integrated markets. An adjacent proposal would be to include clauses in the bilateral agreements, that they will warrant that the energy imported will be used for the prior mentioned reasons. The skepticism, however, behind such a proposal would be the public reactions of such an interventionist strategy from Brussels on the national governments.
2. **Choosing the first set of suppliers - Stability and Proximity**: The best practice for the EU regarding the first imports will be to look at repurposing the existing pipelines from North Africa and Central Asia, focusing on stable partners. Such partners would include Morocco and Egypt at the moment. It should be noted, nonetheless, that even these states are very fragile and destabilization can come relatively easy. The delicate relations between Rabat and Algiers in combination with Morocco's strategy in West Sahara and the quarrelling with the Polisario Front paint a worrisome picture. In addition, Egypt's trajectory, from the Arab Spring onwards can present grounds for doubting its current stable image. Hence, when choosing investment on green hydrogen-related projects, the EU member states should have

a thorough scan of the political and social situation in these countries and should aid them in solving any potential conflicts. Overall, the first importing partners should be the most stable pipeline ones, but this selection must be done after a much more rigorous investigation.

3. **Tradeoffs for the second set of suppliers**: After reaching an agreement with the first suppliers, the most stable pipeline partners, the EU has to make a tradeoff as mentioned. On one hand, it can work closely with countries that are less stable or more tolerant to human rights and other relevant violations that provide a low-price(pipeline) solution or opt for a costly, even exorbitant, shipping solution from a supplier that has engaged in a free trade collaboration with Brussels in a collective manner. Both options will require considerable funding. The former will need diplomatic, or even military, capacity which will drive up costs, whereas the latter will lead to a notable rise in subsidies and public funding needed to develop the shipping fleet that will bring LH2 and the gasification facilities that will aid the transportation of the fuel. Policymakers should convey this information concisely to decision makers so that they can make a wise decision.
4. **Water Diplomacy**: European countries have already engaged in water diplomacy projects, such as the GERD dam in the Nile river. The rise of green hydrogen as a dominant energy carrier will exacerbate these water disputes. It is advised, hence, to create an advisory board for international water conflicts that will collaborate with the policymakers that developed the EU hydrogen strategy. They will assist them in refining the green hydrogen plan, identifying the ideal regions to develop the projects(the ones with the lowest water dispute probability) but also provide mediation services between states and regions that face water stress and its related disputes.
5. **Cybersecurity taskforce on electricity**: As mentioned, modernizing and interconnecting of grids will create unprecedented vulnerabilities which might be exploited, as the Russian Stuxnet cyberattack on Ukraine portrayed. The EU ought to create a task force specialized solely on monitoring the cybersecurity vulnerabilities of each grid segment that is connected to the European one or serves the green hydrogen production that satisfies the EU demand. It will monitor closely the changes in the digital infrastructure that are related to the grid and will provide consulting services so that all member states, but also all suppliers become as resilient as possible in terms of cybersecurity.
6. **Collaboration with the USA on Latin America**: In a green hydrogen-dominated era, Washington is bound to become a net importer of energy anew and is projected to seek more inexpensive manners of satisfying its demand, predominantly from Latin America via pipelines. At the same time the EU moved forward with the inauguration of H2LAC, audibly manifesting its eagerness to import the energy carrier from the continent. Disaccord with a strategic partner such as the USA is not desired. There should be an agreement for the creation of a free trade zone between the USA, H2LAC and EU member states, with the objective of not running into any form of miscommunication that can lead to escalation. Another objective will be responsible mining, which Brussels should promote. After the numerous testimonies in Chile and Bolivia over environmental regulations abuses that have an impact on society, it is paramount that the EU member states promote environmentally-friendly practices in the mining sector in these countries.
7. **International competition**: As demand for green hydrogen grows , so will the available land reduce and the great power competition will grow. It is paramount that the EU find much sooner rather than later a set of allies that share the same institutional values and creates a supply chain of all the needed components to build the green hydrogen network. In this way, it will decrease dependence on those key players not willing to cooperate and also reduce

the need for competition around the world, which can create conflicts, even of military nature.

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