



ΠΑΝΕΠΙΣΤΗΜΙΟ ΠΕΙΡΑΙΩΣ  

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**UNIVERSITY OF PIRAEUS**

**Master Thesis**

# **Hydrogen & Energy Security**

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## **ABSTRACT**

### Hydrogen & Energy Security

Marianthi Pelekanaki

With the climate change being more than present, the European Union has routed an energy transition process by the development of renewable energy sources. After the Russian invasion in Ukraine, the energy security issue become crucial within the European Union and now the goal was double: energy transition & energy security amid a volatile geopolitical and energy environment. This study focuses on hydrogen, as a renewable energy source and a tool towards energy transition, while it attempts to set hydrogen in the context of EU's energy security amid a number of challenges, a branch of research which has not yet been developed. Through a literature review and conducting primary research by interviewing three energy experts, this study investigates whether hydrogen could be a safe form of energy for the EU considering all current energy security and geopolitical challenges. Finally, it concludes that European conditions are not so mature as they should be in order for hydrogen to flourish and be able to contribute to EU's energy security, but the current geopolitical scene is more than variable, and conditions could be altered.

**Keywords:** Energy security, hydrogen, European Union, geopolitical challenges, energy transition

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# CHAPTER 1

## INTRODUCTION

### **1.1 Introduction**

Pushed by climate change, energy systems worldwide are undergoing a significant transformation, the so-called energy transition. Beginning with Paris Agreement (United Nations Climate Change, 2016), global states and specifically the European Union committed to take measures to “to limit the temperature increase to 1.5°C above pre-industrial levels.” Then, the European Green Deal (European Commission, 2020a) came up within the Union as the first legislative package to show the energy transition path to the European Union’s member states.

The European Green Deal has also recognized the role of hydrogen in reaching carbon neutrality by 2050. From that point forward, the renewable energy sources became the vehicle towards energy transition and the fulfillment of the EU’s commitments in Paris. So, a number of legislative initiatives promoting RES started being presented by the Commission in order to meet its climate goals as soon as possible and one such like that was hydrogen strategy (European commission, 2020b), which is the only referred here for this study’s purpose.

It is noteworthy that then, the EU was facing the most severe health and geopolitical challenge, the pandemic of Covid-19. Nevertheless, it was crystal clear that the EU had to secure its position in the new world order of the energy transition.

While the European ambitions about energy transition were arising, the Russian attack in Ukraine happened in February 2022 and world geopolitics of energy changed abruptly. (CNN, 2022). Because of the by-then EU’s energy dependence from Russia in fossil fuels and mainly natural gas, the EU placed a number of sanctions on Russia and a shock in energy prices all around Europe was prevailed (Bricout et al., 2022). Thus, the matter of energy security became more evident and urgent to the EU member states, while their main energy supplier (Reuters, 2022) was now their enemy.

Thus, the EU had to reform its energy context and transform its energy strategy in a different geopolitical landscape. Yet, its climate commitments had to be fulfilled or even not to be discarded. The solution came with the RePowerEU scheme (European

Commission, 2022) which had the scope to reduce EU's dependence on Russian fossil fuels, to save around 20% of the energy it consumes, to impose a price cap on gas and a global price cap on oil and the most important one, to double further deployment of renewable energy sources.

The concern over energy security, due to the Russian attack and the following energy crisis, along with the goal of carbon neutrality and energy transition, led EU countries to seek alternative energy sources, and in that way, hydrogen came again on the front scene.

Based on this context, this study aims at investigating the role of hydrogen as a renewable form of energy in relation with the energy security of the European Union. That is, how hydrogen can contribute to European energy security and in what extent this is feasible. Through a literature analysis and interviews with energy experts, this thesis presents the geopolitical challenges that the EU faces in terms of the EU's energy security per se, the preconditions for hydrogen to be developed within the Union, the geopolitical challenges around hydrogen and finally the geopolitical advantages for the EU in case it boosts hydrogen sector with a single hydrogen policy. These sub- themes will help to reach inclusive conclusions whether hydrogen can finally ensure EU's energy security.

The present analysis also constitutes a simple presentation of views and it has nothing to do with numerical, statistical and metrical analysis of real hydrogen development' size in the EU. Moreover, the study's findings should be interpreted as a snapshot of the circumstances at the time of the interviews because the geopolitical balances the moment conducting this thesis are somehow fragile while there are wars all around the world, which are expected to change more the global energy balances, and the EU's legislative framework for hydrogen, which will play the key role, has not yet completed.

The second chapter of this study is a literature review of renewable energy sources background, hydrogen background, the concept of energy security and finally of the hydrogen geopolitical challenges in relation with energy security in the EU. The third chapter describes the methodology that will be followed along with the constraints of this research and the interviews process. In the fourth section the views of the interviewees are displayed relating to the four aforementioned sub-themes. Finally, this study will quote conclusions whether hydrogen can finally ensure EU's energy security.



## CHAPTER 2

### LITERATURE REVIEW

#### **2.1 Introduction**

For a comprehensive understanding of this study, it is necessary to investigate the related literature review of the topic separately, as it embeds two dimensions. Since the polysemic concept of energy security must be linked with hydrogen as a source of energy transition for the purposes of this study, a conceptual framework for both must be constructed first.

It is important to note that the literature review covering all facets of the subject will focus on the recent three years (2020–2023), during which time the global geopolitical and energy landscape has swiftly changed due the pandemic of Covid-19 and the Russian invasion in Ukraine. It is also worth mentioning that the time this thesis conducting, energy balance of power is continuing to be hurt as there are active war fronts in different regions of the planet.

To begin with, a broad mention of renewable energy sources is also required to understand their vital significance in the current climate change times. More precisely, this section will quickly look at the role that have played in the energy policy of the European Union and how they were conceived in the policy and bibliography as an alternative to fossil fuels.

Afterwards, this chapter will evaluate the role of hydrogen as a source of European Union's energy transition and the risks around it, Additionally, given that the story of the hydrogen and energy transition is quickly developing as a result of recent global energy events, its geopolitical significance will be examined in accordance with the most recent three years of literature.

Furthermore, this chapter will cite the most important concepts of the energy security based on the last-three- year-research with focus on the European Union's energy security. In other words, it will discuss how the European Union has defined energy security and what roles it plays in the region's geopolitical landscape.

Finally, in the last part of this chapter, hydrogen will be combined with the concept of energy security in order to identify the related challenges or opportunities. This is to determine whether, based on the information currently available, hydrogen as a form of renewable energy has already significantly contributed to the achievement of EU's energy security or whether it has the potential to do so in the years to come.

Not to mention, the results of the literature review made a significant contribution to the ongoing investigation as well as the planning and execution of the ensuing energy-related expert interviews. At the conclusion of the investigation, the author was able to draw safe findings thanks in part to the literature review.

## **2.2 Renewable Energy Sources**

To begin with, renewable energy sources have been generally conceived as the main tool towards the European economy's decarbonization and recently, as a vehicle to energy transition and energy independence from Russia. Renewable energy sources came up in the European Union's legislation at an early stage with the Directive 2009/28/EC (European Commission, 2009) and then it was revised with Directive EU/2018/2001 (European Commission, 2018). Although there has not been a warm political environment around them in recent decades, the EU's interest in them has grown in the last five years. In other words, the European Union increased Renewables Target significantly through a variety of directives and schemes that demanded a faster pace of integration into the European energy mix, from 31% to 45% until 2030 (European Commission, 2023). The EU has firstly set this target via the RePowerEU scheme, just after the Russian invasion in Ukraine (European Commission, 2022) and then it legalized it under the said directive.

Owing to the European Union's accelerated objective, it is crucial to read the entire literature to understand how renewable energy sources fit into the European energy framework. The study will focus on findings from contemporary literature and investigate renewable energy sources collectively rather than individually (wind, solar, etc.). The goal is to provide the groundwork before looking more closely at hydrogen as one such energy source.

A broad review of the literature on renewable energy sources in the European Union during the last three years reveals that they have been conceived as a critical contributor to the concept of decarbonization. More specifically, a branch of bibliography is

concentrated on statistical report of the renewable energy sources' development. Based on percentages by the energy mix, a part of bibliography makes comparative numerical analysis among all or several member states as the ones of Stec & Grzebyk (2022) and Kacperska with his colleagues (2021) for the purpose to record the level of their use and analyze the prospects of its acceleration.

There is also a more detailed literature that taking into consideration the European Union's Renewable Energy Policy try to classify the countries and examine their perspectives and possible obstacles about their potential in the framework of energy transition. Indicatively, Bórawski and his counterparts (2022) Investigate the dynamic to sustainable growth of the renewable energy sources industry in European Union countries based on the shares of renewable energy sources in their energy mixes. Likewise, Miłek and her colleagues (2022) see through the development of renewable energy sources in the European Union under the prospects and targets of the European Green Deal. Based on a synthetic indicator they try to classify EU member states into clusters in order to indicate the future strongest group of countries in terms of RES development.

The aforementioned literature findings were indicative and more could not be referred due to the limited extent of this study. Generally, most of the literature regarding RES in the European Union record numerical and comparative analysis about their shares in energy mix, production rates, consumption percentages investigating how those numbers could change in response to European policy.

Since the European Parliament recently approved the Commission's goal of raising the share of Renewable Energy Sources (RES) in the European energy mix to 45% (2023), RES has grown in importance for the EU. Thus, it is intriguing to examine the role of hydrogen in this story and determine whether hydrogen—and, to some extent, renewables—could improve the energy security of EU member states.

### **2.2.1 Hydrogen**

Hydrogen is a modern form of energy and is widely considered as a critical piece in the clean energy puzzle in the European Union. Hydrogen is only seldom found in its pure form while primarily goes with other elements, like water molecules (H<sub>2</sub>O). It functions more as an energy carrier and not a pure energy source, while it needs other sources of

energy in order to be formed and is considered to be the lightest and most plentiful element (Van de Graaf et al, 2020).

Hydrogen has also different forms depending on its production manner and the energy form that is combined with. Therefore, a short separation of hydrogen forms is needed for better comprehension of this study. Van de Graaf and his colleagues, in accordance with the majority of literature recognize four types of hydrogen: a) the one produced from natural gas, which is called “grey”, b) the one produced from coal which is called “black”, c) hydrogen derived from fossil fuels with carbon capture technologies, which is called “blue”, and d) hydrogen produced by electrolysis via renewable energy sources, which is called “green”. Another type of hydrogen which recently came to the European debate is “pink” hydrogen that comes from nuclear energy, according to Incer-Valverde and her colleagues (2023).

As the main scope of this study, is to see how the energy security would be achieved facing the challenges of clean energy transition and energy decoupling from Russia, from now onwards where “hydrogen” is referred, it will primarily mean the renewable hydrogen or the so-called green hydrogen which is at the centre of energy transition policy of the EU today.

Aside from its types, hydrogen has formed a multidimensional landscape and has been the subject of a variety of studies up until now. In general, a large part of literature has investigated the technological and economic dimensions of clean hydrogen production (Kar et al., 2022) or its geopolitical and market implications (Van de Graaf et al, 2020 & Lebrouhi et al, 2022).

More detailed literature investigates the prevail role of hydrogen in global trade reshaping the global energy map with the potential of creating new energy exporters and importers and a new global energy class. Additionally, another part of bibliography reports the potential of some countries with limited renewable energy supplies importing hydrogen and how this could contribute as critical to decarbonizing their economies along with increasing their geopolitical importance.

For Van de Graaf and his counterparts (2020), importing green hydrogen from countries with relatively cheap, abundant renewables may help to lower both the expense of the energy transition and pressure on domestic resources used for the large-scale deployment of renewables. The EU is a typical example of that use of hydrogen.

According to Nuñez-Jimenez & De Blasio (2022), several member states rich in resources, like Spain, have been acknowledged as potential regional exporters with renewable hydrogen capacity exceeding their future domestic demand. However, authors report that none of EU the member states show signs of developing into a global export leader.

A different area of the research uses statistical models to highlight the possibilities of global hydrogen markets while examining the perspectives of hydrogen in energy systems (Blanco et al., 2022). Since it is considered beyond the present study, it will not be analyzed further.

Previously, it was referred that hydrogen is at the centre of the European Union's energy transition policy. Therefore, it is critical to cite here the European Hydrogen Policy in brief in order to complete the theoretical framework around hydrogen before this study continues.

The European Union set the development of renewable hydrogen as a priority with European Commission's proposal (2020) for accelerating the production of renewable hydrogen to ten million tonnes by 2030 and importing ten million tonnes by 2030. This strategy has a double scope, according to EU's official document: the first is hydrogen to "play a key role in decarbonizing sectors" and the second is to use renewable hydrogen "as an important energy carrier to move away from Russia's fossil fuel imports." This means, that even from its issued strategy, the European Union sets the main challenges around its energy security which has to address and recognizes the vital role of hydrogen to this project.

Considering all the aforementioned and living aside the numerous studies that have been conducted regarding production, exports and imports potential, this study will focus on hydrogen role in the European energy security, while it explains how hydrogen and energy security are interconnected within the context of the European Union using the body of available literature by examining potential challenges and opportunities. In Table 1, there are the most important literature review points about hydrogen.

**Table 1. Hydrogen**

Hydrogen		Hydrogen is an energy carrier and not an energy source & four types of hydrogen: a) grey, b)black, c)blue, d)green
	Van de Graaf et al. (2020)	Imports of hydrogen from countries with relatively abundant renewables may help to lower both the expense of the energy transition & pressure on domestic resources
	Kar et al. (2022)	technological and economic dimensions of clean hydrogen production
	Nuñez-Jimenez & De Blasio (2022)	none of EU potential regional exporters shows signs of developing into a global hydrogen export leader
	Blanco et al.(2022)	the perspectives of hydrogen in energy systems via statistical models highlighting the potential of international hydrogen markets

## 2.2 Energy Security

The idea of energy security has not been well defined and is currently undergoing evolution (Joița et al., 2023), since its definition has changed throughout time in response to various energy-related events. Many authors have tried to investigate it and provide holistic definitions, discerning its dimensions, components or quantifying it based on metrics, indicators, and indexes. However, as the goal of this research is to explore how European energy security might be improved in the future, it is not

required to give a thorough reference to the dimensions, indicators, or indexes listed in the current bibliography.

This literature review will be focused on the concept of energy security perceived in European Union's region after the pandemic of Covid-19 and the Russian invasion in Ukraine. That is, it will be quoted how energy security has been defined by the EU and what are the elements that are composed by based on the latest events in Europe's continent, according to European authors. Last but not least, the time restriction on bibliography review will facilitate an up-to-date approach to the concept and its later combination with the most modern form of energy, hydrogen.

First, a reference to the respective definitions of the energy security by the European Union and International Energy Agency has to be made for a better understanding of this study. The European Commission stated in a Communication issued in 2014 that *"the European Union's prosperity and security hinges on a stable and abundant supply of energy"* (European Commission, 2014), which could be considered more as a vague definition. On the other hand, the IEA went through in more detailed definition describing the energy security as *"the uninterrupted availability of energy sources at an affordable price"*. IEA also recognized the following aspects of energy security: the long-term *"which mainly deals with timely investments to supply energy in line with economic developments and environmental needs"* and the short-term *"which focuses on the ability of the energy system to react promptly to sudden changes in the supply-demand balance"* (IEA, 2023).

Despite the fact that it is a source outside of the time constraints for the literature of this study, the most common view of energy security, the "4As" from the Asia Pacific Energy Research Center (2007), could not be mentioned. These "As" stand for availability, affordability, accessibility and acceptability. According to that definition, energy security is viewed as *"the ability of an economy to guarantee the availability of the supply of energy resources in a sustainable and timely manner with the energy price being at a level that will not adversely affect the economic performance of an economy"* (2007).

Nonetheless, compared to a few years ago, the situation with regard to energy security has grown more complex. Energy security evolved as vital for the European Union. This has happened especially during the last decade, while the energy geopolitical

background has been constantly variable, and Russia has been proved a non-resilient supplier. Since the present overview of energy security as a concept in the European Union will be restricted to the last three years, the main geopolitical changes have to be highlighted. First was the pandemic of Covid-19, which brought about energy supply chain disruptions and then the Russian attack against Ukraine with the consequent crisis along which increased the rhythm of decarbonization in the EU setting a vehicle towards its energy security (Mišík, 2022).

According to the overall literature, the energy security in the European Union has been determined by two things: The first is the climate change and the road towards energy transition (Rabbi et al., 2022) and the second is its proximity with traditional energy giants like Russia and its geopolitical and energy interaction with them (Mišík & Nosko, 2023).

More specifically, the main European energy security's aspect is now the target of achieving decarbonization of its economy and carbon neutrality according to international standards. This has led to the energy transition mandate, an aspect that will be discussed in detail later on this study, explaining the role of hydrogen in the context of energy security and energy transition. In parallel, European Union decided to get away from Russian fossil fuels under the RePowerEU Scheme (2022). Some authors note that energy mix has to be diversified further, away from Russian energy imports (Rabbi et al., 2022), as it would help EU accelerating both clean transition and the creation of a more robust energy market in the future, which means the enhancement of European energy security.

Another critical issue that the Russian invasion to Ukraine made clearly apparent was the energy vulnerability of the EU. This duplicates the energy security challenge for the EU. According to Mišík (2022), the current events revealed EU's vulnerability to external supply problems and price shocks more than it was previously believed. It was the domestic production of hydrocarbons that has been decreasing during the last decade due to the depletion of resources along with further reductions connected to decarbonization. Entering to an energy transition period, with limited resources worsened the energy security of the EU and its member states.

In addition, according to Mišík & Nosko (2023) the concept of energy security in the European Union is primarily accompanied by a paradox: although member states know



that a single approach in the energy sector will help them to mitigate their energy dependency by third countries (Russia) and contribute to solving their energy security problems, they oppose to the creation of such a policy on the altar of national interests or they do not seek for further integration on this policy sector. Thus, it turns out that no member state has the same perception of energy security setting the same priorities with the rest, making the catholic and unique perception of energy security concept being impossible. This is translated to a lack of solidarity, which is recognized as a critical characteristic of the European energy security concept (Mišík & Nosko, 2023) and constitutes a notable challenge for the EU as well.

In Table 2, the main bibliography views about energy security are displayed.

**Table 2. Energy Security**

Energy Security	Rabbi et al. (2022)	energy security in the European Union have been determined by the climate change and the road towards energy transition
		enhancement of European energy security via the further diversification of the energy mix away from Russian energy imports → EU accelerating both clean transition and the creation of a more robust energy market
	Mišík & Nosko (2023)	Energy security in the European Union have been determined 1) by its proximity with traditional energy giants like Russia and its geopolitical interaction with them
		2) by a paradox: although member states know that a single approach in the energy sector will help

		them to mitigate their energy dependency by third countries, they oppose to further integration on energy security sector → lack of solidarity
	Mišík (2022)	current events revealed EU's vulnerability to external supply problems and price shocks

### 2.3 Energy Security & Hydrogen

Generally, renewable energy sources have been recently widely recognized as a strong alternative to fossil fuels, which can contribute to EU's energy security. This narrative has been intensified in bibliography and in European policies relatively lately, after the Russian's invasion in Ukraine, while renewable energy sources could facilitate EU's energy decoupling from Russia. This is also when the field of study about hydrogen's role in European energy security started emerging by the need of searching new reliable energy sources in a brand-new geopolitical landscape at the time when the EU has to fulfill its climate ambitions and face the challenge of the climate change.

In European Union's level, renewables have been established as the response before the Russian energy giant for ensuring its energy security via the REPowerEU scheme, which was launched by the European Commission in May 2022 and was the first reference to the goal of renewables' acceleration. Furthermore, as per the academic bibliography, renewable energy sources are considered a dependable means of guaranteeing energy security in the European Union, and they are vital in achieving the Union's environmental objective of decarbonization. This is clearly stated by Rabbi and his colleagues (2022) who argue that it is feasible for the EU to lower carbon emissions and achieve carbon neutrality by cutting emissions in other areas and the only way is the diversification of the energy sources, the investment on renewables and other clean technologies and the adoption of low-carbon practices. They also add that EU's

investments in renewable energy technologies can improve energy efficiency and ensure a reliable and cheaper energy supply.

Additionally, there's the argument that renewable energy sources promote an economy's sustainable growth, which implies they serve as a means of achieving environmental objectives (Bórawski et al., 2022) along with ensuring of energy security. Bórawski and his counterparts argue that if the emergence of the sustainable development happens proportionally to the increase of renewable energy, this could have a positive impact on EU's energy security. Another aspect of renewable energy sources related to energy security in general is that they help to mitigate and address climate change. This is an incredibly significant issue both for the time being, but also for future generations, according to Stec & Grzebyk (2022).

On the other hand, a different part of literature argues that renewables constitute a challengeable parameter of energy transition regarding energy security. According to Mišík, renewable energy sources have disadvantages due to their intermittent nature, an element that makes them difficult to incorporate into, for example, existing electricity grids (2022). In addition, Rabbi and his colleagues (2022) focusing on the energy industry via renewables, argue that EU could achieve decarbonization and energy security through three basic strategies: supply diversification, energy savings, and accelerate adoption of renewable energy instead of fossil fuels- the article saying RES means solar, nuclear, hydropower, wind, and hydrogen.

However, considering all the above aspects about the renewable energy sources such as the Russian energy rival, climate goals, climate crisis, decarbonization, benefits and advantages along with their dynamic contribution to the European Union's energy security, now it is time to see what role hydrogen as a renewable form of energy can play in the European Union's energy security.

An important share of literature argues that hydrogen is a challenging tool towards the EU's decarbonization and energy transition (Giuli & Oberthür, 2023; Rabbi et al., 2022), as the rest of renewables. According to Giuli & Oberthür (2023), renewables and specifically hydrogen could be geopolitically problematic as China, an authoritarian country, dominates RES supply and reserves at the moment. Precisely, hydrogen is logistically a challenging form of energy since a hydrogen economy necessitates continuous supplies, implying material sensitivities like those of natural gas. The latter

element, according to related bibliography, increases EU's vulnerability due to the absence of a coherent hydrogen policy among member states.

On the other hand, only a few studies discuss the geopolitical impact and threats of hydrogen in relation to the energy security. Primarily, Lazarczyk and her colleagues (2022), examining challenges regarding hydrogen, highlighted the following geopolitical threats: a) technology, patents, knowledge, b) increased role of electricity in the transition to a net-zero carbon economy, c) competition over resources. In addition, the same article, offering a more comprehensive perspective on hydrogen's challenges for energy security, examines the market and trade issues that alter the geopolitical environment of hydrogen.

On top of that, Van de Graaf and the rest (2020) recognizes the following geopolitical aspects which also have a multi-level effect on the European Union: a) the emergence of new dependencies between states regarding, importers, exporters and producers of hydrogen, b) the politics of the energy transition, c) the geoeconomics competition.

Another critical point of view which combines energy security with hydrogen is the one of Nuñez-Jimenez & De Blasio (2022). The two authors examine three specific scenarios regarding European priorities and potential about hydrogen. The major priorities of the European Union, that the said article has recognized, are related to energy independence, cost optimization, or energy security via an optimization model of international hydrogen commerce which is focused on production potentials and cost curves in the EU member states with potential trade partners. According to their findings, a) if the EU become hydrogen independent, imports from neighboring countries could reduce at minimum the overall energy costs despite higher transportation costs, b) imports from neighboring countries may alter previous energy dependence patterns and c) the vehicle to limitation of reliance on a single supplier without increasing overall costs, is for the EU to leverage long-distance imports.

Last but not least, another aspect regarding EU's energy security is the increasing dependency of the EU on imports of critical raw materials (Mišík, 2022). This aspect is interrelated with the energy transition mandate due to climate crisis along with the energy independence from Russia. Critical raw materials play an important role in the EU's energy transition process these days. Possible increasing dependency on other forms of energy like critical raw materials could undoubtedly influence both the

renewables and by extension, hydrogen development in the European Union and the energy security of the EU, while there is the risk of being dependent from countries like China, in the way it was from Russia (Mišík, 2022).

To conclude, the overall literature recognizes that current times are largely challenging. As a result, none can reach secure conclusions whether hydrogen is a safe choice for European Union’s energy security or even if the EU could rely on hydrogen for both achieving energy transition and decoupling from Russia. And this is because technology becomes increasingly wider and the international political scene is constantly volatile. Therefore, this study aims at examining whether hydrogen can be a vehicle for the EU to address its energy security challenges along with the fulfillment of its climate ambitions. On top of that, this study will attempt to investigate the potential of hydrogen being a reliable source for the EU’s energy security based on ongoing use and developments around it. So, the Table 3 lists the main bibliography points about energy security and hydrogen in combination for the better understanding of the rest of this study.

**Table 3. Energy Security & Hydrogen**

Energy Security & Hydrogen	Bórawski et al. (2022)	renewable energy sources vehicle towards the achievement of the environmental goals along with ensuring of energy security
	Rabbi et al. (2022)	EU 's decarbonization and energy security through 3 basic strategies: 1) supply diversification, 2) energy savings, and 3) acceleration of adoption of renewable energy
		hydrogen & rest of RES: geopolitically problematic-challenging tool towards the EU’s decarbonization and energy transition due to the absence of a coherent hydrogen policy
	Lazarczyk et. al (2022)	geopolitical threats of hydrogen relating to energy

Energy Security & Hydrogen		security: a) technology, patents, knowledge, b) increased role of electricity in the transition to a net-zero carbon economy, c) competition over resources d) market and trade challenges
	Van de Graaf et al. (2020)	a) the emergence of new dependencies between states regarding, importers, exporters and producers of hydrogen, b) the politics of the energy transition, c) the geoeconomics competition
	Nuñez-Jimenez & De Blasio (2022)	Three scenarios of European priorities & potential of hydrogen: a) if the EU become hydrogen independent, imports from neighboring countries could reduce at minimum the overall energy costs b) imports from neighboring countries may alter previous energy dependence patterns c) the vehicle to limitation of reliance on a single supplier without increasing overall costs, is for the EU to leverage long-distance imports
	Mišík (2022)	critical issue for the EU's energy security along with the development of renewables is the growing dependency of the EU on imports of critical raw materials

## CHAPTER 3

### METHODOLOGY

#### **3.1 Methodology**

The research for this article is based on three semi-structured interviews with energy experts with policy, industry and academic background. The expert interviews as the main used method in this research, will offer the opportunity to both the author and readers to derive knowledge in depth by experts and adopt narratives that may not be yet widely used due to the recent character of the matter.

The major goal of these interviews was to supplement the findings of the literature review and provide this research with a broader set of qualitative data so as to strengthen the reliability and integrity of the final study results. The choice of conducting semi-structured interviews was made because of the need for an up-to-date approach of this study and experts would give their most updated feedback on the matter of hydrogen and energy security considering that this sector is being in progress now, while things at a policy and geopolitical level constantly change the last few years.

The research in literature review and data collection was restricted in the period of 2020-2023. This is, first, because the EU is constantly in a process of reviewing its energy policy trying to cope with the arisen challenges and then because the global energy balance of power tends to alter.

Considering the interview, the questions are five and are presented here in Table 4. They were primarily open-end, and giving examples or options is considered here the only way several facilitate the interviewees to save time and give precise answers relating to the matter and the literature.

The concept behind them was dual: first, to report the major challenges that the EU is facing at this moment regarding its energy security and the use of hydrogen as a renewable form of energy and second, to find out the geopolitical opportunities for the EU if the hydrogen is used at a wide range. The final purpose of the interviews and of this study is to figure out whether hydrogen could be considered a safe form of energy and if it could contribute and what extent to EU's energy security within the current geopolitical and energy context.

**Table 4. Interview Questions**

<p>1) Which of the followings do you believe that is/are the most significant geopolitical challenge(s) for the EU's energy security at this moment, and why: a) decarbonization and energy transition; b) diversification of the energy mix away from Russian energy imports; c) competition on the energy market (with countries like China or Russia).</p>	<p>3) How feasible is it for the EU policymakers to develop a hydrogen policy that will guarantee the EU's energy security in the upcoming years? Please, mention two challenges or opportunities that could block or facilitate respectively the EU policymaking on hydrogen.</p>
<p>2) What are the three main measures that have to be taken at the European Union level (new policy framework, boost in investments, etc.) in order for hydrogen to become the preminent renewable energy source among the EU member states this decade?</p>	<p>4) Could be hydrogen a source of energy that can guarantee the energy security of the EU in the current geopolitical and energy landscape? Please, justify why yes or not.</p>
<p>5) What will be the potential geopolitical benefits for the EU if it structures a single hydrogen policy and reinforces its hydrogen industry?</p>	

The selected experts have a direct relation with the research matter and come from different fields (politics, academic field, industry/stakeholder). Undoubtedly, as the research is focused on the EU policy, experts directly related to the EU affairs would give this research a more insight comprehensive approach as regards with the ongoing policymaking and legislative process. Additionally, when it comes with the renewables' development potential, experts with long academic and professional experience on energy transition would be the added value of this research's validity. Finally, a spokesperson from industry could cover the aspect of a stakeholder in order to give a more holistic approach. So, the third interviewee is a person from Greek energy industry sector with multinational action. The anonymity will be also protected in this study and the expert's names will not be referred. However, some descriptive characteristics to reflect their specialty are provided in Table 5.



**Table 5. Interviewees' profiles**

Interviewee 1	Energy policy attaché in the EU
Interviewee 2	Energy policymaker in Greece with academic background
Interviewee 3	Energy Industry leader

Interviews were conducted in October 2023. The questions were sent to the interviewees via email and they had to answer via email as well within ten or fifteen days. The time restriction on behalf of the author was flexible in order for the experts to provide their best possible responses for this study at their time. While the interviewees are people with pressured agenda, the interview via emails was selected as method for interviewees' convenience and to avoid of any bias and misconceptions arising in oral dialogue. Finally, a live dialogue with supplementary questions was also impossible because experts live at a long distance.

The utilization of primary data obtained from interviews necessitates careful evaluation of potential biases, cultural differences, and the generalizability or transferability of results in order to ensure data quality. These possible limitations are recognized and mitigated by cross-checking views and analysis among experts consulted as well as secondary data from the literature. At the time of the interviews, the experts responded subjectively in proportion with their knowledge at that time about the matter of this study. It is important for the reader to keep in mind that the geopolitical environment the time this study is conducted is constantly volatile and unstable.

## CHAPTER 4

### RESULTS & DISCUSSION

This section will discuss the views expressed by the energy experts in the interviews regarding the following four themes combined with short commentary in case of a background to the reader to be set. The following text is a merge of experts' views, which are clearly apparent, but the four themes below is worth mention that they do not explicitly correspond to the series of the posed questions, for the purpose of this study's coherence.

The four key themes are the following:

- Current geopolitical challenges for EU's energy security
- Hydrogen as a preeminent renewable form of energy
- Hydrogen, a guarantee for the EU's energy security?
- Geopolitical benefits of a European single hydrogen policy

#### **4.1 Current geopolitical challenges for EU's energy security**

The European Union has undergone significant turbulences the last three years, which have pushed it to significantly alter its energy policy framework. First, the Covid-19 pandemic, then the Russian invasion in Ukraine in parallel with the global commitment of reducing carbon emissions. All of them have prompted a review of the context of European energy policy. The breakthrough in European Union's energy policy was the REPowerEU plan which the EU launched (European Commission, 2022) in direct response to the turmoil in the global energy market caused by Russia's invasion of Ukraine. The plan's role will analyzed later on the text.

However, the geopolitical challenges for EU's energy security are still there and require a constant eye on them. After a careful examination of the related bibliography, three main challenges were identified and given to the interviewees as options for better and concrete results. It is noteworthy that the following options include all the sub-challenges/ sub-themes and summarize all bibliography's aspects according to the author's point of view. These challenges the following: a) decarbonization and energy

transition; b) diversification of the energy mix away from Russian energy imports; c) competition on the energy market.

The interviewee energy experts highlighted the most important - on their point of view – by the given challenges, while they shed light on several specific aspects and further dimension of EU's energy security that were not found in bibliography until the moment interviews conducted.

The first critical issue that have been reported by all interviewees as the most severe for EU's energy security is the energy decoupling from Russia and the diversification of European energy mix away from Russian energy imports.

All of them essentially mentioned the current state of global politics and the instability of the (energy) power balance as the primary causes of the energy decoupling from Russia being the most significant problem. More precisely, the Russian invasion in Ukraine along with the ongoing events in other sides of the planet and the upcoming instability in the energy geopolitical map have posed the EU in a critical position for ensuring its energy security and lower its energy dependencies. Therefore, “*decoupling of the energy mix from Russia is a key prerequisite for the EU's energy security at the current time context*” (Interviewee 3).

The rest of the interviewees could not examine the challenge of the energy decoupling from Russia individually because they recognized an intercorrelation with the other two given options: decarbonization and energy transition & competition on the energy market.

More specifically, there is also the challenge of decarbonization and the energy transition, which have already linked by the EU with the energy decoupling from Russia in the framework of the RePowerEU Scheme (European Commission, 2022). The plan seeks to end dependence on Russian fossil fuels and look for further progress towards the EU's climate targets, while it includes energy savings, clean energy production and diversification of our energy supply. In this context, the “*energy decoupling from Russia is part of the energy transition*” (Interviewee 2) and it cannot be seen separately while the referred scheme indicates the dual nature of EU's challenge to face.

However, this does not imply that achieving climate targets will be an easy task. The decarbonization and energy transition “*are key issues for energy costs, the*

*competitiveness of the European economy and the EU's energy security, which are directly interrelated*” (Interviewee 2). This implies that if the energy transition is not processed in a right way, it could cause a multidimensional impact.

As part of the energy transition, the process of achieving energy independence from Russia might potentially introduce a significant risk to energy security. This can be the result of relying on different energy sources, which are necessary for energy transition, imported from other country. The aforementioned double goal increases the danger for the EU *“to become dependent on critical raw materials from other third countries which control most of their supply”*, like China which also recently restricted exports of gallium and germanium to the EU, *“two of the most important raw materials for the EU's energy transition”*(Interviewee 1). Thus, that point is where the difficulty lies, since *“the EU should learn the lesson from recent years in terms of what a certain dependency in the field of energy production and security of supply really means”* (Interviewee 1) and should avoid similar dependency relationships with countries like the one had with Russia and Russian natural gas a few years ago.

Therefore, the route towards energy independence from Russia along with the energy transition process form a *“new geopolitical game”* (Interviewee 1), in which competition with China becomes *“very crucial”* not only for the energy dependency of the EU but also, in terms of the *“competitiveness of the European economy”* (Interviewee 2).

The competition challenges in the energy market, and especially as regards with China, has been set as another challenge at the heart of the European interest. The stake is to form a bilateral energy trade relationship for the benefit of the EU's economy and security. Indeed, the President of the European Commission Ursula von der Layen, giving her speech about the State of the Union, recognized that *“it is so important for Europe to step up on economic security. By de-risking and not decoupling”* (Press Corner - European Commission, 2023), referring to the renewable forms of energy trade, in which China implemented unfair practices.

To sum up, current geopolitical challenges for the EU can be characterized as a complex of different dimensions which are *“directly interrelated”* among each other. While wishing to succeed the energy transition and the energy decoupling from Russia, the EU has to achieve many individual goals regarding its energy production, security of

supply and energy dependency, competition, new technologies and many other factors that make the game more complicated. One challenge cannot be examined individually while it affects and be part of the others at the same time. This is a sample of intercorrelation among energy security’s challenges. This interconnection was pointed out by the interviewees but can be also found in bibliography. According to Mišík (2022), decarbonization will may shorten the energy transition period, but during this the EU should safeguard its fossil energy security while being still dependent on these types of energy sources. Finally, this whole thing becomes more complicated for the EU to achieve while it is triggered by the said paradox: member states understand the energy vulnerability in front of current energy circumstances but there is lack of political willing on behalf of them to cooperate under a single energy security policy (Mišík & Nosko, 2023).

The Table 6 lists the key challenges for EU’s energy security.

**Table 6. Key Challenges for EU’s Energy Security**

<b>Interviewees number</b>	<b>Key Challenges for EU’s Energy Security</b>
Interviewee No1	The energy transition & energy decoupling from Russia increase the danger for the EU “to become dependent on critical raw materials from other third countries which control most of their supply”, like China
Interviewee No 2	The decarbonization and energy transition “are key issues for energy costs, the competitiveness of the European economy and the EU's energy security, (directly interrelated)/ energy decoupling from Russia is part of the energy transition
Interview No 3	Decoupling of the energy mix from Russia is a key prerequisite for the EU's energy security at the current time context”

## **4.2 Hydrogen as a preeminent renewable form of energy**

### **4.2.1 Prerequisites**

Hydrogen has recently been a hot topic in the context of energy transition. Yet, as evidenced by the bibliography and the interviewees, its evolution and dependability are still controversial, and it faces challenges in a variety of areas. For better understanding

hydrogen's potential and its place in the European energy mix, the interviewees were asked about the steps that should be taken as well as their opinions on the timeliness and viability of a single hydrogen strategy. It has to be mentioned that this work will not refer to challenges related to hydrogen in some extent as they have already been expressed in the section of literature review. The purpose of this work is to take a step forward and investigate how the process of energy transition and hydrogen adoption could be advanced from a political standpoint, as well as how the interviewees, as key economic variables, can estimate this process.

According to every expert, the EU's top priority should be to establish the right financial conditions in order to boost investments in hydrogen and guarantee a safe investment environment. This could be achieved only under the proper legal and policy framework, according to all interviewed energy experts. At this point, it is worth noting for the sake of avoiding any misconceptions that the interviewees speaking about policy framework throughout the interview used different adjectives (policy, legal, regulatory), but the way they described it showed they referred to the same policy framework as the author.

The first concern for the EU should be the establishment of a consistent and new legal/regulatory framework since it is considered as a prerequisite for a secure investment environment in the EU. More specifically, a *“new policy framework which will give strong investment incentives”* for hydrogen production will be the *“only way”* for the gradual domination of hydrogen as fuel, (Interviewee 3), while an *“up-to-date regulatory licensing framework”* is necessary to be established with *“concrete targets”* and *“time milestones”* (Interviewee 2), by reducing bureaucracy so as to encourage the development of the hydrogen industry. Additionally, an atmosphere of investment security might be developed by *“the establishment of national/European support mechanisms for these investments (State aid/IPCEI)”* (Interviewee 2). The EU Hydrogen Bank -a funding source designed to assist potential producers of hydrogen- is a step towards this direction, but this is not enough (Interviewee 1). Another important motivation for hydrogen investments is the *“decrease of the cost of production”*, which is catalytic in facilitation of this new technology to be applied at a larger scale (Interviewee 1) along with the *“reduction of investment and end-use energy costs”* (Interviewee 2) in order both to enhance production and consumption at a greater extent.

Nevertheless, no financial tool and no licensing to any industry or company can take place without the proper legal framework, which will embrace the industry development on hydrogen and *“the EU is on track to deal with it”*. The triologue with the European Parliament regarding the Regulation and the Directive for natural gas, hydrogen and renewable gases is ongoing and the new legal framework is expected to be in place *“until the end of this year”*, according to the source directly related to the EU policy. (Interviewee 1).

#### **4.2.2 Potentiality to happen**

Even though the interviewees come from different sectors, all agreed that hydrogen as a renewable form of energy will be possibly further developed at policy, production and usage level in the next decade for a variety of reasons. They did not give any possibility for hydrogen to flourish this decade, as it have passed almost the half of the decade and even the EU legislation is not completed. Given that the EU elections occur the following year, several legislations and priorities are at risk of being half-finished, which could have an impact on the environment around the hydrogen industry and policy.

More specifically, although the European Union has initiated a comprehensive plan for the adoption of hydrogen, *“for the time being, it has decided that the main tool in its decarbonization effort and its energy independence and security will be electrification of all sectors”*, a fact that blocks its wide use and its usage is restricted only *“for hard to abate sectors like industry and heavy transports or aviation.”* For the legal framework around hydrogen and renewables is being formed at the moment, its results could not be felt earlier than 2030s. So, *“this is a discussion for the next decade”* (Interviewee 1).

International geopolitical landscape could also play a significant role in hydrogen dominance as a form of energy in the EU. The Interviewee 3 made a reference to geopolitical context explaining that *“provided that the existing geopolitical conditions do not change radically, hydrogen could gradually dominate as the main renewable energy fuel from the beginning of the next decade (2030)”*. But, this is not the only pre-condition that he poses. Another serious aspect for hydrogen prevailing the renewables world, is *“the EU to intensify its climate campaign”* for addressing the impacts of

climate change and to create the right context for energy transition. However, this is “*extremely difficult*” to happen this decade, according to Interviewee 3.

Other important factors could also have an impact on the energy transition process and the dominance of hydrogen in the European energy mix, potentially delaying establishment even more. “*The "reaction" of fossil fuel producing countries, combined with the adequacy of existing reserves and/or the identification of new fossil fuel deposits*” (Interviewee 3), could affect the energy transition by delaying the consolidation of hydrogen and renewable energy sources in general. Because of this, the only way to accelerate the energy transition through hydrogen is for the EU “*to exploit the scientific community and scientific research, in order for the cost reduction to be achieved through investment and/or commercially exploitable research (learning by doing/ learning by research)*”. (Interviewee 2).

In general, the interviewees are not very optimistic about a quick establishment of hydrogen in the European energy mix, a fact that could affect its role of being considered as an energy form that can guarantee or contribute to the energy security of the EU. Therefore, the next sections will examine and express the interviewees’ views about the potential of hydrogen being a guarantee of the EU’s energy security and the potential strategic advantages should it be further established, respectively. But, before the study moves on, a summary of this sub-theme regarding hydrogen as a preeminent renewable energy source is listed in Table 7.

**Table 7. Key points/ Hydrogen as a preeminent renewable form of energy**

<b>Interviewees Number</b>	<b>Prerequisites</b>	<b>Potentiality to happen</b>
<b>Interviewee No 1</b>	1)“decrease of the cost of production”, which is catalytic in facilitation of this new technology to be applied at a greater scale 2)the new legal framework is expected to be in place “until the end of this year”	electrification of all sectors”/ a discussion for the next decade”



<b>Interviewees No 2</b>	1) up-to-date regulatory licensing framework is necessary to be established with “concrete targets” and “time milestones” 2) investment security via “the establishment of national/European support mechanisms for these investments (State aid/IPCEI)” 3) reduction of investment and end-use energy costs	the only way to accelerate the energy transition via hydrogen is the EU “to exploit the scientific community and scientific research, as cost reduction is achieved through investment and/or commercially exploitable research (learning by doing/ learning by research”.
<b>Interviewees No 3</b>	1)a new policy framework which will give strong investment incentives for hydrogen production 2)the EU to intensify its climate campaign	provided that the existing geopolitical conditions do not change radically, hydrogen could gradually dominate as the main renewable energy fuel from the beginning of the next decade / “extremely difficult” to happen this decade

### 4.3 Hydrogen, a guarantee for EU’s energy security?

A number of challenges and barriers have been already emerged both in literature review and the interviews, regarding the potential of hydrogen being a reliable energy source for the EU the current decade throughout energy transition. As noted by the interviewees, given the current geopolitical circumstances, the energy security is a top priority for the EU now, but hydrogen is not developed in such level as to be a guarantee of EU’s energy security. This apparently does not ignore the steps that have been done up until now in policy and entrepreneurship level around hydrogen, but more should be done.

Therefore, in this section, a comparison will be made among the main challenges highlighted by the literature and the ones indicated by the energy experts in the interviews in order to finally reach safe conclusions about the potential role of hydrogen today.

Although hydrogen could function as a dual tool both for energy transition and energy independence from Russian fossil fuels, it embeds several critical challenges regarding energy security, according to findings. First, in the bibliography, the absence of a coherent hydrogen policy in the EU has been pointed out (Rabbi et al., 2022) combined with the dominant status among member states regarding the lack of solidarity and cooperation in the wider energy sector (Mišík & Nosko, 2023). Indeed, as Interviewee 1 stated before, the final legal framework for renewables and especially for hydrogen (Directives, Regulations) is now under construction, which means that no direct quick and immediate results could exist this decade. *“It is too early for hydrogen to become an alternative fuel that can bring the EU energy security.”* Given the current high-risk and volatile geopolitical environment, it is conceived that the energy security is an imperative for the EU in this decade while it is a matter of its survival in the global map and hydrogen could not play this role. This will be analysed more below.

In addition, the economic dimensions of European hydrogen venture pose several risks on EU’s energy position in front of other energy giants like Russia and China, according to bibliography. More specifically, new dependencies among states, that is importers, exporters and producers of hydrogen, could also be created according to Van de Graaf et al. (2020), which will constitute a new world order, while the geoeconomics competition regarding hydrogen is another important issue as well.

Furthermore, Lazarczyk and his colleagues (2022) reported that geopolitical threats of hydrogen relating to energy security are the following: related technology, patents & knowledge, competition over resources and market and trade conditions, indicating a form of energy that lacks in its every aspect, a fact that is far from safety and security. *“We need more time for the technology to be mature enough, more investments and more funding”*, according to Interviewee 1. So, it becomes apparent that hydrogen (i.e. technology, investments, infrastructure etc.) has not reach the level at which could constitute a safe form of energy, whereas there has not been done such many as it should to reach it.

In accordance, some of the interviewees mentioned the similar challenges. Especially, the Interviewee 3 admitted that in today's energy landscape, *“hydrogen plays an extremely small role”* in the overall EU energy supply *“because there are still challenges in terms of cost competitiveness, production scale, infrastructure needs and*

*security conditions during production and transport*”. In terms of competition, both the interviewee 1 and 3 highlighted the risk which a potential transition to a different form of energy can result in, as the EU has to compete China with its dominance over critical raw materials, Russia with gas and fossil fuels, USA with LNG and the countries of Middle East with oil. That is, *“in the process of succeeding independence from fossil fuels coming from Russia,”* the EU enters the *“danger to become dependent on critical raw materials from other third countries”* (Interviewee 1) while it is possible to meet *“the “reaction” of fossil fuel producing countries”* (Interviewee 3) which may take unfair economic measures and practices in burden for the EU.

As regards with the infrastructure needs, it is a fact that there have not yet a developed hydrogen network and several projects have only commenced across Europe the last two years, whereas they are only focused on green hydrogen which is currently the most widespread (Euronews, 2023). In the meantime, among the key uncertainties around hydrogen remains the remuneration model to finance hydrogen infrastructure, which makes the investment on it harder (Euractiv, 2023a).

As a result, an alteration to a source of energy which seems doubtful without a secure investment environment around it, is certain for the energy experts that will have *“an impact on inflation and economic growth”* of the European Union (Interviewee 1) and will affect *“the competitiveness of the European economy and the EU's energy security”* (Interviewee 2).

Therefore, the only potential that experts see for hydrogen is for the “green hydrogen”, or otherwise “renewable hydrogen” which is produced by using energy from renewable sources and does not emit greenhouse gases during its production. Green hydrogen *“is particularly important as it can contribute to achieving climate neutrality in the future. In fact, it will be a crucial parameter for a climate-neutral Europe”* (Interviewee 2). This implies that green hydrogen could be the only form of energy being widely accepted and both industry and policymakers would place further emphasis on it in the upcoming years in order to achieve European climate targets and to respond to EU’s global commitments.

Another critical point is consumers conception and public opinion around hydrogen which also sets an important parameter in the context of energy security, as without public acceptance, hydrogen could never be considered as a safe form of energy. Both

Lazarczyk with his counterparts (2022) and the interviewee 1 recognized that especially in the EU the electrification has obtained an increased role in the transition process to a net-zero carbon economy, while hydrogen has not been accessible and affordable for usage yet to public in all member states. For instance, in Greece, there is a significant lack of motivations for consumers to turn to new sources of energy, whereas the appropriate financial incentives are missed. Thus, for example, a purchase of a vehicle with hydrogen becomes unaffordable for a Greek family due the *“lack of specific incentives like covering part of the increased costs, as there is for electric cars”* (Interviewee 1). So, it is necessary the member states to *“persuade”* local communities giving them *“specific incentives”* to accept hydrogen and renewables projects in their regions in order to first, establish a wider uninterrupted network of consumption and then the said form of energy can be considered as safe.

Moreover, according to industry sources, demand for renewable hydrogen in Europe is predicted to reach 8.5 million tonnes by 2030, significantly less than the EU's anticipated 20 million tonnes. This suggests that a change in hydrogen strategy is necessary to increase both supply and demand (Euractiv, 2023b). Yet, according to press reports, the European industry anticipated that new EU rules, which are going to be finalized until the end of the year, requiring the use of hydrogen in sectors like transport and industry will greatly increase demand for renewable hydrogen by 2030 (Euractiv, 2023b). This means that there has been an unstable situation around hydrogen yet, while it is left to see whether the demand - supply relationship can be balanced after the EU legislation passed. Finally, if the EU's do not reach its goal regarding hydrogen demand and supply, it could mean that the energy transition will collapse.

Arguably, all energy experts having in mind all the aforementioned challenges shared the view and concluded that hydrogen could not guarantee the energy security in the European Union especially this decade. So, it is noteworthy to quote their exact opinions here as a conclusion of this section:

**Interviewee 1:** *“It is too early for hydrogen to become an alternative fuel that can bring the EU energy security. We need more time for the technology to be mature enough, more investments and more funding.”*

**Interviewee 2:** *“Strengthening European and national policies for the production of hydrogen, (...) will be an essential and promising step towards its energy self-sufficiency*

*and security in an ever-changing geopolitical and energy landscape. The contribution of green hydrogen is useful, but we must be realistic about its contribution to guaranteeing the EU's energy security in the current geopolitical and energy context.”*

**Interviewee 3:** *“It is extremely difficult in the current decade for hydrogen to dominate as a renewable energy source in the EU, as hydrogen plays an extremely small role in the EU's overall energy supply. Much less in its energy security.”*

#### **4.4 Geopolitical benefits of a European single hydrogen policy**

Even though hydrogen meets numerous challenges in its route of being established in the EU as a renewable source of energy, this study attempts to also identify the benefits in case the EU structures a single hydrogen policy, reinforces its hydrogen industry overcoming the existent obstacles after all. It is worth noting that all interviewees recognized the existence of several opportunities and benefits for European Union's energy security and most of them were focused on the development of green hydrogen which is currently at the centre of European investment and political interest (Euractiv, 2023b).

In particular, according to Interviewee 2, the previous dependence on Russian gas has highlighted the urgent need to *“seek European energy autonomy, accelerate the energy transition and look for other forms of energy that will ensure energy security, strengthen the European economy and lead to the global goal of zero carbon emissions”*. Thus, a single European green hydrogen policy could play a decisive role in achieving these goals and European energy security, especially the aspect of energy autonomy. Furthermore, *“the benefits will be geopolitical as the EU can become a major player in the global hydrogen industry, but also social as the development of hydrogen research and technology is expected to create a real benefit for citizens by reducing energy costs and creating new jobs”*, the second interviewee also explains.

In a similar tone, the Interviewee 3 stressed out that forming a single hydrogen policy and *“boosting green hydrogen production will contribute to the EU's decoupling from fossil fuel producing countries, and in particular from Russian fossil fuels, while helping to deliver on its commitment to be climate neutral by minimizing pollutant production by 2050”*.

Additionally, the EU may reap broader geopolitical advantages from boosting its capacity to produce enough green hydrogen for its transportation and industrial sectors and enough renewable energy to meet its electricity demands, according to Interviewee 1. Particularly, if the EU really invest on renewables and more on hydrogen “*could become independent not only from Russian natural gas but also from oil imports from the Middle East*”. In this manner, its “*economy would not be sensitive to geopolitical developments in this turbulent area. Saudi Arabia and OPEC+ countries in general would not be able to exert influence by cutting oil production and increase oil prices*” (Interviewee 1). Thus, while it does not concern just the energy sector per se, the EU would be able to manage the inflation and economic growth “*forming its destiny on its own*”. Nevertheless, a transition to hydrogen has to be rapid in order for the benefits become evident and the EU has to “*proceed quickly and create the necessary environment to produce enough and cheap hydrogen*” in order to “*secure European future prosperity*” (Interviewee 1).

As a result, it is conceived that it is understood that if the necessary attention is paid by the Member States and a coherent position on hydrogen is developed, away from internal conflicts and controversies, the EU can use hydrogen to its advantage and in the future has the potential to achieve through it a stronger geopolitical and energy position as well as energy autonomy. For better understanding, the potential geopolitical advantages for the EU by a single hydrogen policy is listed below in Table 8.

**Table 8. Key Points/ Geopolitical benefits**

Interviewees Number	A single European hydrogen policy could...
Interviewee No 1	<ol style="list-style-type: none"> <li>1) make the EU independent not only from Russian natural gas but also from oil imports from the Middle East</li> <li>2) form a European economy which would not be sensitive to geopolitical developments in this turbulent area</li> <li>3) make the EU form its destiny on its own</li> </ol>
Interviewees No 2	<ol style="list-style-type: none"> <li>1) achieve European energy autonomy</li> <li>2) strengthen the European economy</li> <li>3) make the EU a major player in the global hydrogen industry</li> <li>4) create a real benefit for citizens via the development of hydrogen research and technology</li> </ol>

Interviewees No 3	<b>1)</b> contribute to the EU's decoupling from fossil fuel producing countries boosting green hydrogen production <b>2)</b> help to deliver on its commitment to be climate neutral by minimizing pollutant production by 2050
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## CHAPTER 5

### CONCLUSIONS

#### **5.1. Summary and conclusive points**

Setting its top targets via RePowerEU scheme, the EU prioritized the reduce from Russian fossil fuel dependence along with the achievement of its climate goals and commitments agreed in the European Green Deal. While reviewing and deciding to accelerate the development of Renewable Energy Sources, the European Union started to turn its focus on different energy sources. Thus, hydrogen due to its renewable nature, became a tool towards the energy transition. Yet, given the current variable and fragile global scene, energy security has become a hot potato topic for the EU at political level and it remains to be ensured as the EU face the current energy crisis.

This study aimed at examining whether hydrogen could constitute a safe form of energy for the EU which could contribute both to its energy security and energy transition given the current geopolitical context around and within the EU. Therefore, based on bibliography and primary research via interviews, this work tried to examine the potential of the aforementioned condition to happen, identifying in expert views regarding the matter hydrogen related challenges, energy security challenges and geopolitical opportunities if hydrogen prevails as a renewable source.

It is noteworthy that energy security challenges for the EU are severe enough to be overcome only with one form of energy, the hydrogen, which is still at primary level as this study shows from experts' views. On top of that, hydrogen embeds several additional challenges regarding its, production, infrastructure, transportation and economic resilience, a fact that does not allow its uninterrupted supply for the EU in order to be considered as a safe form of energy.

Moreover, this study has shown that conditions are not yet ripe within the Union for hydrogen can be expanded and established efficiently. Many steps at a variety of levels must be done, while the focus should be given on a stable and robust political and legal framework to be established and implemented, while that only could facilitate the activity around hydrogen and the following energy transition.



Nevertheless, if the hydrogen legislation is finalised, a secure environment for investment could be easily created and afterwards, the rest obstacles could be overpassed. Indeed, this study has showed that the window of opportunity for the EU is the green hydrogen which has now the biggest potential from other forms of hydrogen while there have already launched several long and medium- scale relevant projects across Europe. The EU could earn geopolitical gains investing properly on hydrogen and boosting in the right way its industry while according to the estimations could achieve or at least enhance its energy autonomy at the end of this decade or at the beginning of the next one.

However, this decade is too soon for hydrogen to be the preeminent renewable energy source within energy transition context and be developed at such a great level to reach to ensure or even contribute to the EU's energy security in the foreseeable future. The explanation behind this is that the legal framework has not yet been finished – three years after the entering in a new decade- and results never be apparent immediately.

To conclude, although things for hydrogen seem to be still premature and energy security is an imperative for the EU's survival considering the Russian war in Ukraine, current events in the Middle East and the emergence of China as a commercial competitor, developments are running now very quickly, and nobody can exclude the possibility of things about hydrogen to be changed at a rush in the following years. That is, the current circumstances in the European Union could be altered in an attempt to be adapted in the urgent need of the times, and so, the results from the under-construction hydrogen legislation that will being awaited at the beginning of the next decade, may come earlier if the imperative for energy security increases more in front of the ongoing numerous threats.

## **5.2. Limitations and recommendations for further work**

The present study has several limitations. It was based on a limited sample of interviews for the primary research to be conducted, due to the restricted time available of the rest questioned to give answers finally. So, a future study could include more interviews, that is more than one person from each sector/ branch in order to result in more precise conclusions and a complete approach.

Moreover, the estimations and anticipations displayed in this study have been made without taking into consideration the current discussions about hydrogen within the EU institutions, industry and member states, which the author would be impossible to have knowledge about, but certainly could have a high interest for further discussion. On top of that, this study concentrated on the bibliography reported up until a few months before the writing of this study and may there have been done steps in European energy sector that are not even reported in press, much less to be part of a research. So, future study could examine the later impact of hydrogen legislation on industry activity and the upcoming hydrogen development in the EU.

Last but not least, this study was more qualitative without many references to statistics and metrics regarding hydrogen demand, supply, imports/ exports. So, a quantitative study which will report this metrics may have an added value to the present one, while a combined version of both of them could constitute a robust study with concrete and reliable recommendations.

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