DOCTORAL THESIS

# Applying Reflexive-Adaptive Law for Safeguarding the European Union's Security of Gas Supply during the Transition Era

Javad Keypour

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TALLINN UNIVERSITY OF TECHNOLOGY
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**Declaration:**
Hereby I declare that this doctoral thesis, my original investigation and achievement, submitted for the doctoral degree at Tallinn University of Technology has not been submitted for doctoral or equivalent academic degree.

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JAVAD KEYPOUR

# Contents

## List of publications

The list of author's publications, based on which the thesis has been prepared:

I. Keypour, J. (2022). Replacing Russian gas with that of the United States: A critical analysis from the European Union energy security perspective. Russian Journal of Economics, 8(2), 189–206. https://doi.org/10.32609/j.ruje.8.78026 (1.1).

II. Keypour, J., Kerikmäe, T., & Chochia, A. (2023). Critical legal insight into the EU's Hydrogen Strategy. In J. Simões, F. J. Leandro, E. C. de Sousa, & R. Oberoi, Changing the Paradigm of Energy Geopolitics: Security, Resources, and Pathways in Light of Global Challenges (pp. 107–116). New York: Peter Lang Publishing. (3.1).

III. Keypour, J. (2022b). European Union Energy Security: Constructing a "Shelter" for Small States' Energy Security Preservation. Slovenská politologická revue, 22(1), 48–78. https://doi.org/10.34135/sjps.220103. (1.1)

## Author's contribution to the publications

Contribution to the papers in this thesis are:

I. The publication was single-authored by the author of this thesis.

II. The author of the dissertation was the lead author in formulating the research problem, structuring the research design, conducting data collection and analysis, writing a major portion of the chapter and coordinating correspondence.

III. The publication was single-authored by the author of this thesis.

## Abbreviations

| | |
|---|---|
| ACER | European Agency for the Cooperation of Different National Energy Regulators |
| CAC | Command and Control |
| CBA | Cost-Benefit Analysis |
| CCS | Carbon Capture and Storage |
| CEEAG | Guidelines On State Aid for Climate, Environmental Protection and Energy |
| ECSC | European Coal and Steel Community |
| EEAS | European External Action Service |
| ENTSO-E | European Networks for Transmission System Operators for Electricity |
| ENTSO-G | European Networks for Transmission System Operators for Gas |
| ETS | Emissions Trading Systems |
| EU | European Union |
| EV | Electric Vehicle |
| GATT | General Agreement on Tariffs and Trade |
| GBER | General Block Exemption Regulation |
| GHG | Greenhouse Gas |
| ISO | Independent System Operator |
| ITO | Independent Transmission Operator |
| LNG | Liquified Natural Gas |
| NC CAM | Network Code on Capacity Allocation Mechanisms |
| NDP | National Network Development Plan |
| NECP | National Energy and Climate Plans |
| NRA | National Regulatory Authorities |
| OU | Ownership Unbundling |
| PCI | Projects of Common Interest |
| RAB | Regulatory Asset Base |
| RGMCG | Baltic Regional Gas Market Coordination Group |
| TEN-E | Trans-European Energy Infrastructure |
| TEP | Third Energy Package |
| TEU | Treaty on European Union |
| TFEU | Treaty on the Functioning of the European Union |
| TSO | Transmission System Operator |
| TTF | Title Transfer Facility |
| UGS | Underground Gas Storage |
| WTO | World Trade Organization |

## Terms

| | |
|---|---|
| Alternative gases | Substitute gases for natural gas. |
| Biogas | A methane-rich gas generated through the anaerobic fermentation of organic matter within a sealed container. |
| Biomethane | The refined form of biogas, produced through the removal of undesirable acidic gases. Capable of being transported through the existing natural gas system safely. |
| Decarbonisation | Preventing, eliminating, or mitigating the greenhouse gas emissions linked to the entire life cycle of natural gas through the substitution of natural gas with biogas or non-methane alternatives, such as renewable hydrogen. |
| Decarbonised gas | Gas produced through decarbonisation processes. |
| Energy acquis | According to the definition quoted by DG NEAR (2023), “the energy acquis consists of rules and policies notably regarding competition and state aids (including in the coal sector), the internal energy market (opening up of the electricity and gas markets, promotion of renewable energy sources), energy efficiency, nuclear energy and nuclear safety and radiation protection”. Thus, the EU energy law is inextricably merged with the Union’s energy policy as reflected in the EU’s energy acquis definition. |
| Gas (plural: gases) | Any gaseous energy carrier, including natural gas, biogas, biomethane and hydrogen. |
| Law | In this dissertation, law is defined in its broadest sense, encompassing legal rules and the procedures, practices, and norms of legal institutions as a measure for meeting public policy goals. See: (Ostas, 2009, pp. 487, 490). |
| Natural gas | Gases found in underground deposits, whether in a liquefied or gaseous state, primarily consisting of methane. |
| Regulation | For the aim of this research, regulation is defined as “the sustained and focused attempt to alter the behaviour of others according to defined standards or purposes with the intention of producing a broadly identified outcome or outcomes, which may involve mechanism of standard-setting, information-gathering and behaviour-modification” (Black, 2002, p. 26). However, this should not be interpreted as if regulation is a subset of the law, as many scholars presume these to be the other way around, or they simply use them interchangeably (Barton, 2006). Unless otherwise mentioned, within this dissertation, law and regulation are used interchangeably. |
| Renewable hydrogen | Hydrogen produced through the electrolysis of water powered by electricity from renewable sources or through converting biogas or biomass, according to the EU hydrogen strategy document (European Commission, 2020b). |

# Introduction

## I. Navigating legal challenges of the energy acquis in the energy transition

In recent decades, climate change has necessitated changes in material and energy systems (Carley & Konisky, 2020). To comply with sustainability principles, various sectors, including agriculture (Hill & MacRae, 1996), transportation (Gössling & Lyle, 2021; Dominković, Franjo, Bačeković, Pedersen, & Krajačić, 2018), housing (Barnes, Krutilla, & Hyde, 2010), food (El Bilali, 2019), and energy (Chen, Xiong, Li, Sun, & Yang, 2019; Steg, Perlaviciute, & Werff, 2015), have made efforts to reduce carbon emissions. Notably, energy consumption has been identified as the primary human-induced source of global greenhouse gas (GHG) emissions, accounting for up to 75.6% (Ge, Friedrich, & Vigna, 2020). Considering energy transition as "a shift in the nature or pattern of how energy is utilised within a system" (Araújo, 2014), one can recognise that the world has already undergone transitions – from a biomass and wood-based energy system to a coal-dominated one during the Industrial Revolution, and the subsequent shift to oil post-World War (Song, et al., 2021). Now, the world is preparing itself to transition from a fossil fuel-based energy system to one that relies on renewable energies (Green, 2018).

Meeting the objectives of the ongoing energy transition necessitates an effective legal and regulatory framework that not only supports the attainment of climate goals but also ensures the continued functionality of our energy system, including the provision of energy security. Maintaining energy security throughout the transition is crucial, as any compromise in this area could undermine support for the transition. For instance, interruptions in energy supply or volatile energy prices may provide ammunition for climate change sceptics to question the necessity of the transition, potentially leading to a carbon lock-in scenario. Therefore, this study argues that ensuring the security of the gas supply[1] is necessary to ensure adherence to climate goals. However, securing the gas supply faces significant legal hurdles.

First, the external dimension of the security of gas supply, notably concerning gas trade with Russia, represents a major challenge. While the EU has used natural gas for roughly 20–22% of its overall energy needs since 2010, around 80% has been imported (Eurostat, 2023). Russia has been the EU's primary external natural gas supplier during this period. In 2021, the EU imported 155 billion cubic meters of natural gas from Russia, accounting for around 45% of total imports and almost 40% of its total consumption (IEA, 2022). While the EU-Russia gas relationship had previously experienced conflicts, e.g., the two gas crises in 2006 and 2009, the unjustified Russian invasion of Ukraine has prompted both sides to reduce trade in natural gas (European Council, 2022). The EU's commitment to cutting Russian natural gas imports concurrently with pursuing its climate goals was vividly reflected in the REPowerEU, among other plans.

Given the current circumstances, Member States have pursued various, sometimes conflicting, trajectories in their external energy policies. For instance, Estonia (ERR, 2022) and Germany (Mišík, 2022; RFE/RL, 2022) have increased the utilisation of renewable sources and reduced imports of Russian natural gas while expanding LNG capacity. However, some other Member States have increased their imports of Russian LNG (Klementi, 2023), and Hungary has extended its natural gas contract with Gazprom

[1] The term 'security of supply' is employed here interchangeably with 'energy security'. However, given the paucity of the term 'gas security' in the academic literature, the term 'security of gas supply' is used more in this study.

despite the Russian invasion of Ukraine (Preussen, 2022). Member States have justified their energy decisions by asserting their rights to independently choose their energy sources, as stipulated under Article 194(2)[2] of the Treaty on the Functioning of the European Union (TFEU). At the same time, it is important to note that Article 194(2) emphasises the importance of ensuring the Union's energy security "in a spirit of solidarity between the Member States." The significance of the energy solidarity principle and the potential for invoking it to challenge other Member States' energy decisions have become more pronounced due to the recent decision by the Court of Justice of the European Union (CJEU) in the OPAL case C-848/19 P[3] (Boute, 2020; Iakovenko, 2021). This could mean that Member States' conflicting perceptions of threats – which extend beyond Russian natural gas to encompass alternative external suppliers[4] – may lead to legal disputes and potentially disrupt collaboration among Member States, the EU Commission, and gas undertakings, all of whom share responsibility for the security of gas supply in the transition era according to Article 3 of Regulation (EU) 2017/1938. Given these legal intricacies, and without disregarding the political dimensions of such divergence perceptions, one can argue that legal provisions are necessary to mitigate conflicts among the stakeholders involved, particularly regarding the external aspects of gas supply security in the transition era.

The second concern arises due to the absence of essential legal provisions to facilitate the gradual shift from natural gas to alternative gases, potentially compromising gas supply security. More precisely, the energy transition requires natural gas consumption reduction by 2050, resulting in a gradual decommissioning of the existing network. However, the current regulations are silent about who should bear the dismantling costs. At the same time, continuous investment in the remaining natural gas network is expected to maintain its operation, especially for hard-to-abate industries like steel, cement, and petrochemicals (Poudineh, 2022). Yet, enforcement of rigorous climate policies and corresponding regulations, such as the Taxonomy Regulation[5], has made energy companies hesitant about such investment decisions due to the fear of these facilities becoming stranded assets in the future (Bricout, Slade, Staffell, & Halttunen, 2022). Concurrently with the natural gas phase-out, there is a need to facilitate the incorporation of decarbonised gases, e.g., biomethane and hydrogen, into the gas market. Unlike biomethane, hydrogen cannot be technically utilised in the existing natural gas transmission infrastructure, meaning that the current energy acquis does not cover it, especially considering Article 1(2) Gas Directive. This creates a legal vacuum in

[2] According to Article 194 TFEU, "the Union's energy policy, in a spirit of solidarity between Member States, shall aim to ensure the functioning of the energy market, ensure security of energy supply, promote energy efficiency and energy saving, and the development of new and renewable forms of energy, and promote the interconnection of energy networks". Achieving these aims should be coupled with environmental preservation and improvement, particularly as outlined in Article 192, and within the context of establishing and operating the internal energy market.

[3] The OPAL case C-848/19 P (Germany v Poland, 2021) ruled that 'energy solidarity' is not merely a political concept but rather a legal principle. Furthermore, it explicitly stated that Member States must 'consider' their energy policies' impact on other Member States' energy security while planning for their energy systems.

[4] For instance, there is criticism of decisions aiming for alternative natural gas sources reducing Russian gas dependence, e.g., Azerbaijan (Siddi, 2019), or Qatar LNG (von der Burchard, 2023) with some perceiving them as conflicting with the EU's geopolitical interests.

[5] The Taxonomy Regulation (Regulation (EU) 2020/852), aims to establish a unified framework for classifying environmentally sustainable economic activities. The regulation defines criteria for determining whether an economic activity contributes to six environmental objectives: climate change mitigation, climate change adaptation, sustainable use and protection of water and marine resources, transition to a circular economy, pollution prevention and control, and protection and restoration of biodiversity and ecosystems.

the establishment of hydrogen markets (II). Such a legal hiatus may adversely affect the phase-out of natural gas and the establishment and development of a market for alternative gases.

The third concern centres on the security of gas supply in smaller EU Member States. Smaller EU Member States feel more vulnerable regarding their energy security (Mišík, 2019, p. 6). This has been the case for the Baltic States, for which energy security has been a central policy concern (Wivel, Bailes, & Archer, 2014, p. 14). While establishing a system for alternative gases incurs significant costs, maintaining the existing natural gas system as its market volume shrinks can impose an additional burden on end consumers under current regulations (Belyi, 2020). This challenge is particularly pronounced for small Member States due to considerations of economies of scale. Similarly, administrative constraints in small states challenge their capacity for planning and management (Kattel, Kalvet, & Randma-Liiv, 2016), which can weaken their ability to ensure the security of gas supply during the transition as well. While market integration is proposed as a solution to enhance the security of supply in small states (III)**,** implementation has been delayed as the partners have not achieved consensus on shared interests (Belyi & Piebalgs, 2020). Imposing top-down regulatory obligations in this respect can be blocked by Member States who perceive an infringement of their rights under Article 194 TFEU. This necessitates finding other legal solutions or approaches that can drive regional market integration for better security of supply.

These challenges indicate legal vacuums and conflicts within the energy acquis that, if unaddressed, may jeopardise the security of the gas supply during the transition era. In addressing such legal challenges, one should note that the EU energy acquis is designed to direct the EU's complex energy systems towards 'specific objectives' (Bellos, 2018; Long, 2014). Therefore, it is imperative to critically review not only the current legal provisions but also the fundamental principles and overarching ethos and premises of the existing energy regulatory system to assess their compatibility and alignment with the goals of the energy transition. To elaborate, the existing regulations were developed in the early 2010s, especially with the advent of the Third Energy Package (TEP). The TEP primarily aimed to develop the European internal energy market, inter alia, to strengthen it against possible external (geopolitical) threats and enhance the security of supply. At the same time, it sought to maintain the ambitious trajectory initiated in the 1990s to promote competitiveness and liberalisation while reducing state control over the natural gas industry (Mete, 2019, pp. 16, 18). While environmental and climate objectives have been present in the outlines of the energy acquis, they have not been prioritised to the extent that energy transition objectives now demand, particularly within the EU natural gas market. Moreover, the energy transition essentially entails uncertainties like evolving ecosystems, technological progress, political and geopolitical shifts, and economic transformations (Gaines, 2002; Luhmann, 2018; Weaver & Camp, 2023). At the same time, the consequences of climate change are anticipated to intensify the inherent unpredictability and dynamism of ecosystems and resources (McDonald & Styles, 2014). This situation presents a deviation from a fundamental premise within the current regulatory paradigm, which posits that ecological shifts occur at a gradual and foreseeable pace, deemed stable enough for legislative planning (Craig, et al., 2017).

## II. The main and the sub-research questions

The disparities between the two regulatory paradigms necessitate adopting a systemic approach to address the identified legal challenges, rather than addressing each challenge in isolation. This implies an examination of legal texts, especially Regulations and Directives, in addition to the logical interaction between them and the overall legal system (Zweigert, Kötz, & Weir, 1998, pp. 35, 36; Fleming, 2019). This perspective contributes to the development of a regulatory system tailored to the intricacies of the energy transition in the gas sector, serving as foundational guidelines and general principles to overcome the threefold legal challenges. Consequently, the current research aims to provide systemic legal revisions – of both the EU energy acquis' ruling outlines and encompassing legal provisions – for safeguarding the EU's security of gas supply during the transition era, (i.e., by 2050). Thus, this study presents the following main research question: **"What principles and legal provisions can be formulated and put into practice to align the EU energy acquis with ensuring the security of gas supply during the energy transition?"**

The main research question points to the need for elucidating the principles expected to contribute to adapting the energy acquis to safeguard security of supply during the transition period. Simultaneously, crafting those 'legal provisions' necessitates the formulation of subordinate research questions. These questions must concurrently provide tailored solutions to the triple legal challenges discussed. Hence, the main research question mentioned above is intricately linked with the three sub-questions and the three publications upon which this dissertation is structured:

**A.** While articles 4(2)(i) and 194 TFEU recognise the shared responsibility of the Member States and the EU in safeguarding the security of energy supply in a spirit of solidarity, perceptual differences have caused conflicts between the actors in adopting the appropriate strategies. This limits the EU's capacity to negotiate with the Member States to lead them to specific energy policies, especially within the external aspect. Among other things, the energy acquis lacks a legally binding definition for energy security (Huhta, 2022), which could delineate a common understanding of threats and provide a tool for the EU to assess the compatibility of Member States' decisions with the Union's energy policy outlines. Consequently, the first pertinent sub-question emerges: **"How should the EU energy acquis perceive and evaluate the external security of gas supply during the transition era?"**

Section 3.1 develops and advocates for a legally binding definition of gas supply security, suitable for incorporation within the energy acquis and in alignment with principles derived from the reflexive-adaptive legal approach, as defined in Section 1. Correspondingly, the **first** publication addresses the need for a tool embodying this definition. More specifically, the paper adopts the N-1 formula outlined in Regulation 2017/1938 as a foundational basis and seeks to enhance it by incorporating additional parameters, particularly geopolitical risks, as crucial factors during the transition period. This enhanced formula can also serve to elaborate on the security of the supply scoreboard, as will be explained later. For instance, the article illustrates the application of such an index to offer comparative insights into two gas supply options, namely the United States' LNG and Russian pipeline gas, for the six major Russian gas-importing Member States (Germany, Italy, Czech Republic, Poland, and France).

**B.** Secondly, given the anticipated contraction in the Union's natural gas supply relative to demand (Keypour, 2023), the regulatory landscape needs to evolve to accommodate decarbonised gases to maintain gas supply security. Thus, the second research question is formulated as follows: **"What legal changes are necessary to facilitate the introduction of decarbonised gases, particularly hydrogen, into the EU's gas market to ensure and safeguard gas supply security during the transition era?"**

Section 3.2, along with the second publication, delves into the necessary adaptations in the energy acquis. The **second** publication critically examines existing laws and regulations, particularly the Gas Directive, concerning yet-to-be-established hydrogen or hydrogen-natural gas mixture systems. Additionally, it expands its inquiry beyond mere EU energy law to relevant World Trade Organization (WTO) rules, such as those regarding local content and preferential taxation, which the EU and the Member States must adhere to. This exploration lays the groundwork for Section 3.2, which argues that due to the inadequacy of existing legal tools and considering the principles of the reflexive-adaptive approach, updating the energy acquis is essential to facilitate the smooth establishment of the hydrogen market and safeguard gas supply security during the transition.

**C.** Thirdly, in the context of the challenges faced by small states and given the shrinking EU internal natural gas market during the transition period, it becomes evident that further market integration is required to safeguard gas supply security, which in turn necessitates additional changes to the regulatory framework. This prompts the third research question: **"What legal instruments are required to safeguard the gas supply security of small states during the transition period?"**

The primary objective of the **third** publication is to articulate a compelling rationale for embracing market integration to strengthen the energy security of smaller EU member states. By relying on this insight, Section 3.3 undertakes a detailed examination of the Baltic States' gas market integration, illuminating the legal impediments it encounters. Subsequently, it offers nuanced solutions grounded in the reflexive-adaptive approach, apt to surmount these challenges.

## III. Research novelty and contribution

In recent decades, there has been a consistent academic focus on the energy transition, with scholars exploring the relationship between energy security and the transition process (Cherp, Jewell, Vinichenko, Bauer, & Cian, 2016; Berdysheva & Ikonnikova, 2021; Guivarch, Monjon, Rozenberg, & Vogt-Schilb, 2015). Regarding the role of natural gas in the energy transition, scholars' opinions vary. Some predict it remains a significant energy carrier (Safari, Das, Langhelle, Roy, & Assadi, 2019; Bugaje, Dioha, Abraham-Dukuma, & Wakil, 2022), while others advocate for a quick phase-out (Kemfert, Präger, Braunger, Hoffart, & Brauers, 2022; Gürsan & de-Gooyert, 2021). Additionally, some adopt a middle ground, such as Tsafos (2020) or Stern (2020), presenting conditional predictions. Despite numerous publications offering policy recommendations for preserving the security of natural gas supply in the transition era (Sadik-Zada et al. (2021), Rodríguez-Fernández and colleagues (2022), and Westphal (2020), in addition to insights into the establishment of hydrogen markets (Gillessen, Heinrichs, Hake, & Allelein, 2019) and decarbonisation policy and regulatory implications (Azni & Khalid, 2021; Sulewski, Ignaciuk, Szymańska, & Wąs, 2023; Kochanek, 2022), the security of gas supply still displays clear knowledge gaps.

Firstly, most studies on this subject were conducted before the 2022 Russian invasion of Ukraine, which significantly impacted EU energy transition policies and the external aspects of security of supply. Consequently, there is a need to revisit these analyses considering the ongoing war and its repercussions. Secondly, while attention to the contribution of decarbonised gases to gas supply security during the transition period grows, further investigation is still needed from regulatory and legal perspectives, especially as the EU is reviewing the gas regulations. Thirdly, numerous studies on energy transition have adopted a snapshot approach in their analyses, comparing the current situation with energy systems in 2050. However, these studies primarily focus on the Union or Member States, rather than examining the changes during the transition era. Likewise, only a few have delved into the temporal dimension, with the distinction between conditions in the transitional phase and the post-energy transition world remaining vague (Vakulchuk, Overland, & Scholten, 2020).

The novelty of this research lies in elaborating on the legal and regulatory system requirements for preserving the security of gas supply. Moreover, this thesis takes into account the temporal aspect and transition pathways in its analysis. In other words, rather than solely comparing the present situation with the envisioned state in 2050, i.e., comparative statics, it adopts a dynamic approach that comprehensively examines the security of energy supply throughout the entire duration of the energy transition.

The findings of this study highlight the need to bolster the EU energy acquis' reflexivity and adaptability. Such an approach is crucial for addressing the flaws in the existing energy regulatory system to safeguard gas supply security while adhering to climate considerations throughout the transition period. The implications of this necessitate the inclusion of self-regulation which redistributes regulatory authority – held by the government in the conventional model – among various stakeholders. This fosters interaction between regulators and market participants. Moreover, the legal system is then enabled to promptly tackle unexpected situations caused by the uncertainties inherent in the transition era. Furthermore, the study conceptualises 'adaptability' as authorising the regulatory bodies to adapt 'resilient' legal provisions aligned with climate objectives while concurrently preserving supply security during the transition period. Specifically, this research delves into how foundational elements of the energy acquis, such as competition and associated mechanisms like unbundling and liberalisation, should be reinterpreted and regulated to ensure they do not hinder the development of the hydrogen market, which is deemed crucial for both preserving the security of supply and achieving decarbonisation goals.

The theoretical contribution of this dissertation deepens energy law foundations in two respects. Firstly, it develops guidelines for a legal framework designed to tackle environmental concerns while preserving supply security, with a particular focus on the shift towards carbon neutrality. Additionally, this study defines its scope within the nexus between EU energy law, energy transition theories, and security studies, as depicted in Figure 1. This lays the groundwork for advancing the theoretical connection between law, transition policymaking, and security studies, making a significant theoretical contribution to legal studies. Strengthening this connection solidifies the theoretical foundations of energy law, an inherently interdisciplinary field encompassing various sub-disciplines within and beyond legal studies. These sub-disciplines include environmental law, maritime law, technology law, human rights, energy policy, energy engineering, energy economics, and security studies (Huhta, 2020; Heffron & Talus, 2016). Given this interdisciplinary nature, energy law is less autonomous compared to other legal disciplines, necessitating a departure from purely legal approaches and requiring expertise from diverse fields of study (Huhta, 2020).

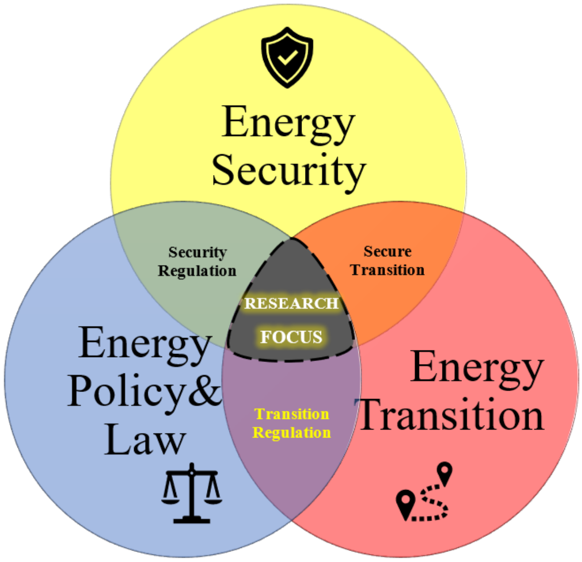


*Figure 1. The nexus of transition, law & policy, and security studies as the synthesis domain of this dissertation (Research Focus). Author's contribution*

Given the research's aim and the rationale behind the main and subsidiary questions, the interconnection among them, the research gap, and the dissertation's contribution are depicted in **Table 1**.

*Table 1. The interconnection between research's main features. Author's contribution.*

| Challenge | Identified research gap | Corresponding publication | The research's academic contribution | Research question |
|---|---|---|---|---|
| The EU energy acquis, designed to meet liberalisation demands, falls short in safeguarding the security of gas supply while addressing the imperatives of climate-oriented energy transition | The need for a systematic exploration of legal frameworks within the context of the energy transition era remains unmet | This publication | Adapting a **legal** framework, along with its guiding principles and outlines, to effectively address the identified legal challenges in ensuring gas supply **security** during the energy **transition** era | <u>Main RQ.</u> What principles and legal provisions can be formulated and put into practice to consolidate the EU energy acquis ensuring the security of gas supply during the energy transition? |
| EU's Legal Dilemma in Preserving the External Dimension of Its Security of Gas Supply in the Transition Era | The external dimension of the EU's security of gas supply has not been addressed systemically in the aftermath of the Russian invasion of Ukraine, especially within a legal context | I[st] | Developing a definition of **security** of supply applicable to the **transition** era and suitable to be made legally binding | <u>Sub RQ1.</u> How should the EU energy acquis perceive and evaluate the external security of gas supply during the transition era? |
| Energy Acquis' Legal Voids in establishing a market for alternative gases | The legal prerequisites of hydrogen market creation and development have not been addressed | II[nd] | Consolidating EU energy **law** needed to protect the **security** of gas supply in the **transition** era | <u>Sub RQ2.</u> What legal changes are necessary to facilitate the introduction of decarbonised gases, particularly hydrogen, into the EU's gas market to ensure and safeguard gas supply security during the transition era? |
| Regulatory Hurdles to Regional Gas Market Integration threatening supply security (focusing on the Baltic States) | Complementary legal provisions consolidating Small States's security of gas supply have not been addressed well | III[rd] | Offering provisional solutions to strengthen the main outlines of the EU **energy laws**, applicable to the establishment of regional integrated gas in the **transitional** phase to enhance the **security** of supply | <u>Sub RQ3.</u> What legal instruments are essential for safeguarding the gas supply security of small states during the transition period? |

This thesis is organised as follows: Section (1) delves into the analytical framework, proposing the 'reflexive-adaptive' legal approach and elaborating on how it can provide a foundation capable of addressing the pivotal trait of the transition period – namely, uncertainty. Section (2) covers the methodology, explaining how document analysis incorporated into doctrinal legal research was applied in this research. Section (3) systemically addresses each research question, building upon the framework of reflexive-adaptive law. This section proposes a definition coupled with an index for monitoring and measuring gas supply security during the transition period. It also discusses the legal requirement for establishing hydrogen markets while natural gas is phased out. Lastly, the section examines the unique characteristics of preserving the security of gas supply in small states, with a specific focus on the Baltic States. The final section discusses the potential limitations of the contributions and offers suggestions for future research.

## 1. Analytical framework: reflexive-adaptive law

In navigating the uncharted waters of the current energy landscape, the pursuit of a systemic legal approach tailored to the prevailing conditions precludes a simple adoption and wholesale application of conventional legal methodologies. This is accentuated by the need for the legal framework to articulate principles capable of addressing the two fundamental traits of the transitional phase – uncertainty and climate objectives. This does not entail a complete dismissal of past experiences; instead, certain regulatory tools, especially those rooted in the era of monopolies, remain pertinent but need (Vasconcelos, 2019). Thus, an exploration of the reigning legal approaches becomes imperative to tailor them effectively to respond to the legal needs of the transitional period.

In general, three approaches to energy sector regulation can be discerned: CAC, market-oriented, and decentred regulation (Hammer, 2006). Traditionally, energy sector regulation was linked to direct state control and the CAC regulatory model in Europe. In this approach, an institution is granted the authority of regulation, standard or rulemaking, in pursuit of specific objectives as outlined in its statute. The regulator holds the power to grant authorisations, permits, or licences to applicants; without these approvals, relevant activities are considered illegal (Barton, 2006). However, the Single European Act in 1986 signalled a gradual shift towards the adoption of a market-based approach to energy regulation in the 1990s, especially influenced by the liberalisation of energy markets in the UK and the US, which began a decade earlier. This shift was predicated on the conviction that competitive forces wield a more significant impact on influencing corporate conduct compared to regulatory interventions (Barton, Barrera-HernÁndez, Lucas, & Rønne, 2006; Talus, 2017).

Nevertheless, the liberalisation wave did not eradicate the CAC system; instead, it gave rise to a 'hybrid' system over time. For instance, in the early 2000s before the introduction of the TEP, ensuring the security of supply involved specifying a minimum level of storage obligations and, consequently, a minimum degree of command and control (Egenhofer & Gialoglou, 2004, p. 35). However, concerns about an investment gap in the EU energy sector and the security of supply following the 2006 and 2009 natural gas crises with Russia prompted a shift in the EU's energy policy approach. The EU's motivation to exert stronger public control over energy infrastructure investments, as reflected in the TEP, was more driven by geopolitical concerns rather than by market forces (Talus, 2017). Such an approach intensified following Russia's full-scale invasion of Ukraine in 2022, exemplified by Germany and Poland's decision to exert control over Gazprom subsidiaries, perceiving it as a threat to the security of the gas supply (Afanasiev, 2022).

However, the current hybrid system is not adequately equipped to navigate the transition due to several factors. Firstly, a CAC regulatory framework assumes environmental changes are typically gradual and predictable, and the ecosystem remains stable (Orts, 2002). This reinforces a bias towards maintaining the status quo, prioritising the preservation of existing institutions. It often leads to the enactment of regulations designed for predictable scenarios, neglecting the necessity to address unforeseen circumstances that require discretionary decision-making and an understanding of situational contexts (McDonald & Styles, 2014; Craig, et al., 2017; Sprankling, 1996). In contrast, the energy transition may necessitate institutional changes. For instance, as energy storage becomes more crucial in a decarbonised energy system, including tackling the intermittency of renewables, corresponding actors and regulatory institutions need to be created (Kalair, Abas, Saleem, Kalair, & Khan, 2021). Moreover, the inherent unpredictability and complexity of the transition pose significant challenges to the rigidity of the CAC elements within the current hybrid regulatory system, impeding its ability to provide timely legal solutions during this period of transition.

Additionally, the market-oriented element of the hybrid regulatory framework was initially designed to dismantle monopolies and foster competition within energy markets, primarily through liberalisation and unbundling mandates (Keypour, 2019). However, such a regulatory structure aimed at fostering competitive energy markets may not effectively address the needs of a market transitioning towards decarbonisation. It is important to highlight that the EU has gradually introduced these regulations into the natural gas market – while the infrastructures were already well developed – to ensure seamless functionality and prevent disruptions to normal operations (Talus & Aalto, 2017). Consequently, expecting this regulatory framework to be immediately applied to an emerging and underdeveloped market, which as yet lacks an adequate infrastructure such as hydrogen, is unrealistic and may even jeopardise its development (Baumgart & Lavrijssen, 2023). This indicates that the market-oriented component of the existing hybrid regulatory system may not fully align with the objectives of the transition.

Contrasting with CAC and market-based approaches, reflexive regulation was conceptualised by Teubner (1993; 1983) as a form of decentred regulation[6]. Teubner's idea was a response to the regulate-deregulate debate of the 1980s[7]. The reflexive law approach departs from the perspective that the role of law is not primarily to dictate and enforce behaviours in a certain direction. Instead, he sees law as providing guidance to actors through various processes and procedures (de Bruin, 2023). Therefore, reflexive law focuses on procedural changes in regulatory attitudes and processes without necessarily expecting substantive outcomes (Gaines, 2002). In fact, in contrast to the CAC and market approaches, Teubner advocated for the 'autopoiesis' of regulatory systems. His idea starts from the proposition that instead of the centred authority of regulation-making in the CAC model, the circle of regulatory establishment should become open to include other relevant actors and entities alongside the state. These actors should possess the essential legal guidance, knowledge, and adaptability required to tackle regulated issues (Garmestani & Benson, 2013; Orts, 2002). The type of regulatory tasks delegated to these actors can vary significantly in different cases (Barton, 2006). Specialised entities are tasked with tailoring appropriate regulations within such self-regulatory structures while adhering to the defined objectives. In this way, the burden of regulation is alleviated by the state by delegating some responsibilities to alternative agencies and actors (Teubner & Bremen, 1988).

Gaines (2002) exemplifies opening the regulatory circle through self-regulation by pointing to ISO 14001. This ISO provides a procedural framework for companies'

[6] Teubner's approach obviously has connections with socio-legal studies, like self-regulation and autopoiesis (self-organisation) which originates in systems theory, cybernetics and even biology (Barton, 2006). Due to this multidisciplinary, the theory serves as both a legal theory and a governance approach. In a broad spectrum of literature, the terms 'reflexive law' and 'reflexive regulation' are often used interchangeably with 'reflexive governance' owing to their procedural nature (Rolim, 2019; Gunningham, 2009). Additionally, the term 'reflexive law' has been employed to denote not only the regulations and legal acts themselves but also the 'legislative procedures' through which these regulations are drafted (Orts, 1995).

[7] During the 1980s, regulatory improvement efforts were pursued through two opposing approaches. One advocated for 're-formalisation' or legal neoliberalism and deregulation. The other, 'implementation', sought to tighten control over every aspect of the relevant social or economic system. In Teubner's perspective, none of these opposite approaches provided an adequate response to the regulatory crisis, prompting him to develop his own approach (Barton, 2006).

environmental management systems to adopt while requiring them to develop a written environmental management policy and appoint a senior officer with expertise to the organisation's board to oversee that policy and all environmental considerations. It also mandates third-party audits to ensure compliance with the requirements. Therefore, instead of imposing mandatory environmental thresholds and standards on companies, such as allowable pollution limits, ISO 14001 leaves it to companies' discretion to determine their own best practices for compliance with applicable regulations. It is believed that by strictly defining the details of the procedural management system "organizations can ensure they are taking proactive measures to minimize their environmental footprint, comply with relevant legal requirements, and achieve their environmental objectives" (ISO, 2021), which also reduces the need for continual oversight from higher levels (Gaines, 2002).

Although locating entirely reflexive regulations within the EU energy acquis[8] is not straightforward, remnants of self-regulatory mechanisms are discernible in EU gas market regulations, for instance, in the mechanisms aimed at ensuring the security of natural gas supply outlined in Regulation 2017/1938. Article 4 establishes a Gas Coordination Group (GCG) composed of representatives from Member States, the Agency for the Cooperation of Energy Regulators (ACER), the European Network of Transmission System Operators for Gas (ENTSOG) – which is a non-governmental registered entity run by gas companies whose businesses rely on building and operating gas infrastructure (Global Witness, 2021; FOEE, 2017) – in addition to industry representatives and relevant customers. The GCG is responsible for drafting gas security-related guidelines and risk assessment methodologies, allowing the abovementioned regulated entities and non-state actors to participate. Similarly, Article 7 mandates ENTSOG to conduct a Union-wide evaluation of gas supply and infrastructure disruption scenarios and identify emergency gas supply corridors every four years. However, the chosen methodology is left to be defined by ENTSOG in cooperation with the GCG. Independent competent authorities, including the national regulatory authorities (NRAs) and, in some cases, the EU Commission, remain responsible for supervisory tasks to ensure adherence to the principles and preservation of security of supply, as articulated particularly in Articles 3–13 of the Regulation. Like ISO 14001, this specific practice outlines procedures for risk assessment and mitigation against disruptions to the natural gas supply. Thus, these cases can be seen as procedural provisions and self-regulatory practices, as outlined within the reflexive law, where some guidelines are determined with the contribution of regulated entities, rather than exclusively by central authorities (CAC method).

Another example of self-regulation within the energy acquis is the EU Natural Gas Network Code on Capacity Allocation Mechanisms (NC CAM)[9], which particularly addresses interconnection points and effectively demonstrates the essence of different

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[8] In reality, laws are not informed solely by one single approach, i.e., CAC, market-based, and reflexive, but instead, the legislator may opt for different approaches within an act. Hence, even if reflexive procedures are prioritised, it does not necessarily entail the complete abandonment of the other two approaches.

[9] The CAM NC is Commission Regulation (EU) 2017/459 of 16 March 2017 establishing a network code on capacity allocation mechanisms. The capacity mechanism defines how adjacent transmission system operators cooperate to facilitate the sale and usage of bundled capacity in transborder gas flow within gas transmission systems. Therefore, CAM NC aims to achieve the harmonisation of capacity allocation mechanisms at all interconnection points across the European Union through the establishment of rules regarding the offer and allocation of firm and interruptible transmission capacity. Also see: https://www.entsog.eu/sites/default/files/2019-11/CAP%20leaflet.pdf

stakeholder involvement from multiple Member States, each having its own set of interests. The NC CAM does not impose rigid allocation criteria top-down by a central authority. Instead, it establishes a broad framework and procedural guidelines within which transmission system operators (TSOs) and market participants 'collaboratively' design capacity allocation mechanisms best suited to their regional contexts in response to local needs, evolving market dynamics, and technological advancements, as Regulation (EU) 2017/459 explains. This underscores the self-regulatory element advocated by Teubner, wherein regulatory frameworks actively facilitate the development of flexible or context-sensitive solutions defined by regulated entities. Consequently, the NC CAM's approach contrasts with traditional command-and-control models that prescribe uniform methods, often overlooking the intricate variations of individual gas transmission networks. In fact, the NC CAM seeks to strike a balance between regulatory oversight and the dynamism required for effective and adaptable capacity allocation in the natural gas sector.

Such examples demonstrate how applying a reflexive approach and establishing a self-regulation system can alter the regulatory procedures within the energy acquis. In a CAC system, energy regulation authority is highly centred in the hands of the EU (e.g., the Commission and its agencies like ACER) and, to some extent, national regulators (especially NRAs). In contrast, reflexivity implies a redistribution of regulatory tasks by empowering regulatory bodies at various levels, especially NRAs, while concurrently involving regulated entities and other actors such as TSOs, DSOs, ENTSOG, and representatives of final customers in regulation. Thus, reflexivity replaces the centred CAC regulatory system with a 'polycentric' one, enhancing the system's ability to address the uncertainties of transition. While the heavily centralised procedures of CAC legislation hinder its agility and responsiveness to rapidly evolving circumstances, self-regulation designates parts of regulatory tasks to the discretion of regulated entities (which may differ case by case[10]), allowing them to devise ad-hoc solutions within outlined procedures and without constant reference to central regulatory authorities. This makes reflexive law a more agile, flexible, and powerful regulatory approach in dealing with transition's intricacies.

For instance, if the EU grants derogations from unbundling regulations to those Member States whose hydrogen markets are developing, such markets need to be monitored to see if they reach a sufficient level of development, at which point the derogations are revoked to prevent market distortion. In a CAC approach, the market development level is assessed based on rigid criteria defined by central authorities, e.g., the EU Commission's concrete thresholds on market volume. In contrast, reflexive law aims at establishing a self-regulatory system involving local hydrogen undertakings, while incorporating more flexible criteria. It also involves delegating the assessment of market development to collaborative bodies, such as the GCG, thereby reducing the EU's regulatory burden and enabling more agile adoption or revision of regulations in different circumstances (see Section 3.2.2).

[10] Given the need to determine actors and entities' role in a self-regulatory structure on a case-by-case basis, this research exclusively focuses on applying reflexivity to ensure gas supply security during the transition era. In this section, the main outlines and applicability of reflexive law for the transition are explained, followed by an elaboration in Section 3 on the selected case. Therefore, the allocation of responsibilities in creating the regulatory system related to other transition cases could be the subject of further research. It should not be expected that a one-size-fits-all roadmap for establishing an energy reflexive regulation system is outlined in this study, or any single study for that matter.

The polycentric structure makes the regulatory system 'resilient' because it can effectively navigate a wide range of external stressors and disturbances that challenge its performance without necessitating a complete overhaul (Borchardt, 2023). This definition carries significant implications for regulations, determining their efficacy in providing legal remedies amidst unforeseen events without yielding to external pressures and avoiding collapse (Arnold & Gunderson, 2013). One can consider the established procedures for preparing the National Energy and Climate Plans (NECP) within the EU Green Deal an example of a polycentric structure. Member States are granted a certain level of autonomy in formulating their NECPs in collaboration with involved stakeholders at the national level (European Commission, 2024). Member States can consider various external factors that they deem relevant when drafting their NECPs and analysing the strategies and adjustments necessary to meet their climate obligations. These external factors may include geopolitical issues, technological advancements, and economic stimuli, among others. As the impact of potential stressors is assessed based on the perceptions of the stakeholders themselves, including regulated entities, it is expected that the NECPs will exhibit greater resilience against unforeseen challenges compared to centrally defined plans. Concurrently, the European Commission continuously monitors the effectiveness of the regulated NECPs and offers feedback for adjustments to ensure that they fully contribute to the achievement of climate objectives at both the national and Union levels.

Reflexivity entails 'self-learning', a complementary feature that facilitates the continual integration of regulated entities into regulatory procedures by enabling them to incorporate their latest experiences and feedback into the revision of regulations. Self-learning is also arguably crucial for regulating transitions, given the ever-evolving nature of the landscape. Conventional regulatory systems may indeed attempt to glean insights from past experiences, albeit within notable constraints primarily due to their centralised structure, which poses two key challenges. Firstly, not all actors are included in regulatory processes to freely share their experiences and learnings – for instance, regulated entities are excluded. Secondly, even among the involved stakeholders, the centralisation of the CAC system limits the system's capacity to absorb lessons and experiences from them. Unlike conventional regulatory practices, which typically exclude various actors, especially the regulated entities, self-regulation allows for the inclusion of lessons learned by these actors in the regulation and implementation of tailored rules. Incorporating such experiential knowledge harnesses collective intelligence to navigate uncertainties more effectively. By learning from others' experiences, actors can better address similar situations and continually adapt regulatory frameworks (Sanchez, 2006).

This framework of experience-sharing and continuous learning contributes to improving the efficiency of regulation through constant revising, particularly in addressing unforeseen situations. Hess (1999, p. 43) presumes such a feature is essential to reflexive law, and his definition of this legal approach revolves around it: "law is "reflexive" in that it encourages corporations to constantly re-examine their practices and reform those practices based on the most current information". Hence, self-regulation establishes a systematic approach to rulemaking, reinforcing the system's decision-making capacity through organisational learning, adaptation, and the reorganisation cycle. As an illustration, Hopman et al. (2014) showcase how Germany's self-learning played a vital role in evolving renewable energy policy, transitioning from an initial feed-in tariff system to supporting the development and integration of renewable energy into the grid. This evolution required formulating new regulations to address issues such as network stability, capacity, storage, and demand response, which were not adequately considered in the initial policy design.

While reflexive law provides procedures to empower the legal system in addressing the uncertainties of the transition era, it lacks the substantive element necessary to align with overarching climate objectives. The 'partial-openness' of reflexive law offers this potential if substantive elements are incorporated. To elaborate, Teubner conceptualises society as a collection of systems, including law, industry, and politics, and posits that legal systems are 'partly open'. This suggests that legal systems are receptive to input from other systems, such as politics, but they process the input according to their own internal dynamics, principles, and interactions. This 'self-referentiality' enables legal systems to remain dynamic, with flexible boundaries, and adaptable to external information while maintaining their autonomous operational procedures (Barton, 2006). Therefore, integrating substantive legal elements into reflexive law can effectively guide internal interactions towards overarching objectives, such as carbon neutrality, while also safeguarding other system functionalities, e.g., supply security. This raises the question of what form this substantive element should take.

The importance of choosing a substantive legal element becomes even more critical considering that the EU energy acquis has gradually evolved based on the three pillars of competition, security of energy supply, and sustainable development. Despite the initial intention that these three pillars would reinforce each other (Đorić & Obrenović, 2022), trade-offs between the various objectives have always been necessary. For instance, competition was prioritised in the 1990s, and security of supply was the primary focus in the 2000s, especially due to the rise of geopolitical concerns (Keypour & Ahmadzada, 2022). Therefore, it is important to realise how trade-offs within the energy acquis should be managed and steered in the right direction, adhering to the transition objectives, i.e., the carbon neutrality objective. To meet such a demand, this study proposes incorporating a complementary legal approach, i.e., adaptive law, to tackle this goal.

Derived from adaptive management, the concept of adaptive law has emerged to address the need for a legal framework capable of facilitating the adjustment of human communities to the challenges, situations, or disasters that may arise frequently, unpredictably, and abruptly due to climate change. Adaptive law acknowledges that climate change profoundly impacts society's regular functioning and its subsystems, including the legal system. As a result, it urges prioritising legal measures aimed at mitigating the consequences of climate change and authorising the state to implement corresponding decisions (Arnold C. A., 2018). For instance, in the realm of energy law, a maladaptive approach insists on the uniform application of unbundling regulations across all energy markets, even for emerging markets such as the hydrogen market. This implies that emerging hydrogen transmission systems must provide early-stage access to third-party undertakings. Conversely, the adaptive approach argues that such an approach can significantly hinder hydrogen infrastructure development. Thus, the adaptive approach advocates for a redefinition of our legal understanding of unbundling regulations, prioritising climate objectives and decarbonisation goals. This entails a gradual implementation of third-party access regulations, taking into account market maturity across various regions and Member States, among other considerations. This example highlights the adaptive approach's ability to adapt to different circumstances and changes in the energy sector, while the maladaptive approach may create unnecessary barriers and constraints on the way to meeting climate objectives (see Section 3.2.2).

By combining the reflexive and adaptive frameworks, one can effectively harness the benefits of both methodologies in guiding transitional processes and frame a hybrid legal approach that is flexible, self-regulatory, resilient, and adaptive to climate change implications. More precisely, while reflexivity delves into the augmentation of internal decision-making processes, the incorporation of adaptive procedures equips this hybrid system with the capability to concurrently consider external climate objectives and their influence on internal decision-making and regulations, thereby maintaining system adaptability and also resilience at an acceptable threshold. This is particularly pertinent in the domain of energy and transition, where we contend with a constantly changing and evolving environment during the transitional step.

A schematic representation of the reflexive-adaptive system is depicted in Figure 2. 'Self-regulation' empowers actors to actively participate in the regulatory process, allowing them to share experiences and feedback with the central government (arrows ending at the centre in Figure 2). Moreover, reflexivity grants the actors the benefits of 'self-learning' (illustrated for the central government only). Such a legal system remains partly open, making it capable of interacting and receiving data with other systems. Thus, the boundaries of the legal system are not stiff but flexible (illustrated by the blockchain line in Figure 2). However, adaptability implies prioritising environmental concerns in regulation-making, which is indicated by a thick green arrow contrasting with the thinner arrows representing interactions with other systems. Characterised as 'polycentric' and 'participatory', the legal system encourages collaborative efforts from all actors to contribute to effective regulation. The shapelessness of the image symbolically represents the qualities of 'flexibility' and 'resilience'.

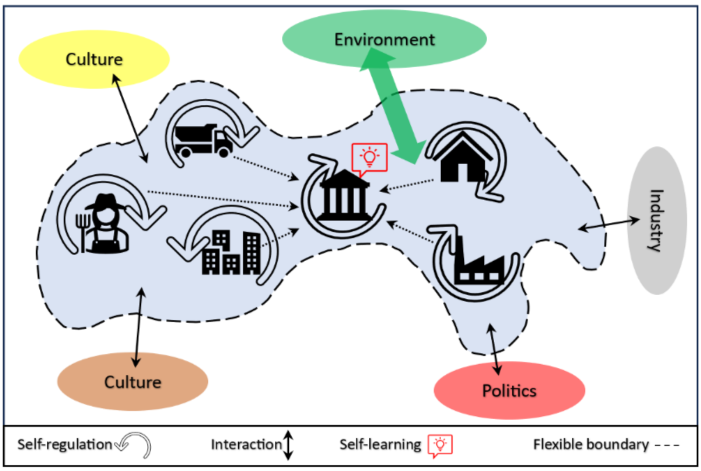


*Figure 2. A schematic illustration of the reflexive-adaptive energy legal system. Author's contribution.*

This section concludes by summarising the features of the constructed model. Illustrating the principles and outlines of this hybrid approach, compared to the traditional approach, can provide practical applications in addressing the triple legal challenges presented in the Introduction section. Therefore, the reflexive-adaptive law is outlined in Table 2.

*Table 2. Key Characteristics of the Reflexive-Adaptive Legal Approach in Comparison to Traditional Regulatory Systems. Author's contribution.*

| No | Traditional regulation | Reflexive-adaptive regulation | How does reflexive-adaptive law facilitate transition? |
|---|---|---|---|
| 1 | Punitive and preventative | Encouraging and providing guidance to actors | Entities are given the essential legal guidance and authority required to tackle complex issues arising from uncertainties, and they can manage it by applying their knowledge. |
| 2 | Centre-oriented regulatory system | Polycentric regulatory system | |
| 3 | Rigid rules and regulations with specific and pre-defined outcomes expected | Resilient rules and regulations, always possible to be revised based on the latest field facts | Resilience empowers it to seamlessly absorb abrupt and unforeseen transformations, including those arising from geopolitical events, without disrupting the legal system's normal operational state. |
| 4,5 | Central or market-based regulation and rulemaking | Self-regulation | Self-regulation facilitates agile communication and quick responses to ecosystem change, especially if it happens unexpectedly, as an inherent trait of the transition era.<br>Entities can establish sector-specific, tactical, and micro-level goals in alignment with the defined strategic climate objectives. |
| | | Participatory regulation and rulemaking | Collaboration formed on regulation makes the outcome more legitimate and practical, which means the set objectives are highly likely to be achieved. |
| 6 | Too static to consider the experience outside the central decision-making circle properly | Self-learning is the dominant style on account of provisioned experience-sharing structures | In contrast to CAC, it is possible to promptly revise the rules based on the most up-to-date information, shared experience, and obtained feedback, which is crucial in tackling unforeseen situations and selecting the best option from the known solutions, especially in transition |
| 7 | Considers environmental objectives with the same importance as other objectives | Prioritises climate change consideration and objectives over conventional legal biases | Aims to align the existing regulations with climate goals and transition necessities while maintaining energy systems' normal functionality. |

## 2. Methodology: document analysis and doctrinal legal research

Document analysis is a systematic process for the examination or evaluation of written materials to establish context through various forms of research information and validate data from alternative sources (Kwon & Park, 2019; Lunde, 2023). As proposed by Bowen (2009), it involves initially skimming through the documents to gain a general understanding. Subsequently, it entails reading to discern pertinent analytical categories encompassing the entire set of documents and ultimately interpreting the collective content of the documents.

Document analysis consists of three steps (Karppinen & Moe, 2019):

1. Identification of relevant documents: Selecting documents from various sources depends on the project's objectives. Document analysis, when applied in the legal or policy disciplines, deals with "copies of the law, rules, regulations, guidelines, and legal interpretations" (Murphy, 1980, p. 123). The current study evaluates the EU energy acquis, hence, the selected documents come from primary sources (including EU treaties, Regulations and Directives, European Commission communications, strategies, European Parliament resolutions and research service briefings, EU authorities' statements, EU Green and White papers, and EU supplementary website content) using the Eur-lex database. Moreover, secondary sources like journal articles, books, and critical opinions by energy experts on other media have also been used as ancillary sources.
2. Access, collection, and sampling: In the second phase, documents must be gathered covering the relevant timeframe and geographical scope. To ensure the data collected aligns with the specified timeframe and geographical area, Eur-lex and official and authenticated EU entities' websites were consulted. The timespan from 02/1992 (the signing of the Treaty on European Union (TEU)) to 10/2023 (when this research was undertaken) was selected. Documents were extracted and reviewed for their relevance, considering the aim of the study, especially those related to topics such as gas supply security, energy transition, renewable gases, hydrogen, and biomethane.
3. Analysis and Impact: As the final step, relevant content can be extracted, categorised, and analysed within the documents.

Although document analysis can be employed as an independent method, it is often advisable to enhance the method's effectiveness by employing a mixed-methods design (Denzin, 2017), and therefore, doctrinal analysis, also called library-based research, was incorporated into this research methodology. It primarily concerns the comprehensive evaluation and analysis of the current legal doctrines, rules, and principles within the existing legal framework. This methodology involves a systematic analysis of statutory provisions and other legal principles. It explains areas of difficulty while facilitating the interpretation and understanding of the existing law's content and the interrelationships among various provisions (Roy, 2023). This approach is particularly suited to the nature of legal documents, allowing for individual document evaluations and the assessment of their potential contributions to the goal of safeguarding gas supply security during the transition era while enabling the examination of interconnections between different documents, such as the Gas Directive, Gas Regulation, Solidarity Regulation, and Trans-European energy infrastructure (TEN-E), in developing the analysis.

Document analysis primarily entails the qualitative examination of specific texts or documents relevant to the research topic to identify prevalent themes within the content. In contrast, doctrinal research, focusing on concepts (and, if applicable, legal theories), relies on a comprehensive review of specialised literature and previous scholarship to establish a theoretical perspective and a logical framework within the context of the chosen document (Roy, 2023; Dalglish, Khalid, & McMahon, 2020).

Nevertheless, document analysis has limitations. Firstly, it may encounter challenges related to its validity, reliability, authenticity, motivated authorship, and lack of representativity. These issues can be addressed by employing established techniques to strengthen the qualitative robustness, such as triangulation (both within the documents and across various methods and theoretical perspectives), thorough examination of the documents, seeking input from involved individuals, obtaining feedback from peers, and so forth (Dalglish, Khalid, & McMahon, 2020). Thus, multiple sources of evidence should be consulted for corroboration. This means that, in addition to the original legal documents, other critical analyses that have addressed the terms can be utilised to cross-check if one's interpretation is accurate (Bowen, 2009). Within this research, a wide range of secondary resources, as listed above, have been scrutinised to reduce the potential biases that may arise in interpreting and analysing the matter of the research.

Doctrinal legal research can be divided into historical and comparative approaches. Historical research entails thoroughly examining historical circumstances to analyse the reasons underlying the adoption of current laws and the justification for including specific legal rules or provisions at the time. On the other hand, comparative research focuses on assessing and understanding the strengths and weaknesses of different legal systems and institutions in various jurisdictions related to a specific subject. A comparative approach is unnecessary because the current research concerns the EU energy acquis. Instead, the historical approach can provide valuable insights into how different legal documents were shaped within a broader context, especially by considering the previous version of a certain legal document, similar to the *travaux préparatoires* approach. It also provides an understanding of the considerations, limitations, and objectives behind each document, which is regarded as the second limitation of the 'document analysis method' (Bowen, 2009; Roy, 2023). Therefore, merging these two methods made it possible to cover the limitations of document analysis in this research.

# 3. Empirical findings and implications for preserving security of gas supply in the transition era

After identifying the challenges related to gas supply security during the transition period and presenting the necessary legal-policy analytical framework, this section will delve into addressing these challenges. The outlined reflexive-adaptive legal framework in Section 1 will serve as guidelines in formulating legal solutions for the three challenges introduced in the opening. This process will be carried out in connection with the three corresponding sub-research questions, utilising the insights derived from the relevant publications linked to this dissertation. This can establish the argumentative foundation for delivering a comprehensive and well-suited response to the main research question.

## 3.1. External aspects of security of gas supply

In line with the introduction (point A), there exists no legally binding definition within the EU energy acquis that would enable a systematic assessment of whether the decisions and actions of Member States and the Union are in alignment with the objective of safeguarding gas supply. The challenge of formulating a comprehensive definition of energy security is evident due to the lack of consensus regarding its precise scope (Ang, Choong, & Ng, 2015). Given the context-specific nature of the energy security definition (Kivimaa & Sivonen, 2021), it is imperative to provide a definition compatible with the research's core focus – preserving gas supply security during the transition era. Considering that Sovacool (2010) has previously observed considerable overlap among the 45 definitions he identified, it may be prudent to extract a definition from the existing array that can serve as a guiding tool for evaluating the policies and decisions in line with the aforementioned objective.

Two distinct approaches can be discerned in the formulation of energy security definitions: the negative/preventative and the positive/affirmative. The first approach asserts that new security concepts, such as energy security, should remain anchored within the traditional security studies framework. Baldwin (1997, p. 13) contends that new security dimensions can emerge by hyphenating adjectives to the security term. While security itself is defined as the 'low probability of damage to acquired values', introducing new security dimensions necessitates asking fundamental questions, including 'security for whom?' (The referent object), 'Security for which values?' and 'From what threats?'[11]. Expanding upon this perspective, Cherp and Jewell (2014) define energy security as the 'low vulnerability of vital energy systems' that underpin critical societal functions. Their definition considers both the exposure to risks and the resilience of these systems. A notable aspect of this viewpoint is its emphasis on 'threat', in the sense that it formulates the security concept rooted in warding off 'potential damage' to those values exposed to 'threats' (whether in traditional security studies, which primarily address national and military security, or in emerging security domains like energy security). Hence, this definition presents a preventive (negative) standpoint in which security is construed as the absence of threats.

[11] Even though this approach purports to remain faithful to traditional security frameworks, they acknowledge that newly emerging threats may not necessarily exhibit the characteristic elements of urgency and the need for extreme measures. This indicates a departure from the rigid frameworks of the realist security perspective and a shift towards liberal traditions in their approach (Buzan & Hansen, 2009, p. 13)

From an affirmative or positive approach, energy security should not necessarily adhere to traditional security frameworks or rely solely on the concept of threat. An example of such an approach is the widely recognised '4A' definition characterising energy security as the ability of an economy to ensure the availability, accessibility, affordability, and acceptability of its energy resources (Intharak, et al., 2007). Such a definition adopts an affirmative stance, meaning that instead of placing primary emphasis on repealing the 'threat' within the contours of energy security definition, it articulates the specific attributes that energy supply should possess to be categorised as 'secure'.

While these approaches are distinct, they do not inherently contradict each other and, thus, can be combined to formulate a definition encompassing elements from both approaches. Within our context and adhering to Baldwin's approach, the referent object is arguably the 'energy consumers' as we evaluate energy security for the EU, a net energy importer[12]. Consequently, it is imperative to mitigate threats to consumers' energy supply[13]. This implies that the energy system should possess the capability to provide a continuous and uninterrupted energy supply as a primary prerequisite.

In the subsequent steps, it becomes imperative to pinpoint the values and then assess the threats that impact energy consumers within the EU. One can categorise these values into social, economic, environmental, and political domains. Economic and social considerations can be simultaneously encapsulated as 'affordability' from the energy consumers' perspective, signifying the assurance of "access to energy services at the lowest cost with stable prices" (Sovacool & Mukherjee, 2011). While the political and environmental values of the EU have been broadly addressed within Articles 2, 3, and 22 of the TEU, the interpretation of these values and the corresponding strategies for their preservation, especially within sectors such as energy, are continually evolving and may vary amongst Member States. This evolving nature of interpretation also makes distinguishing threats problematic.

One can apply the reflexive-adaptive approach to address the dynamic nature of the environmental and political aspects for formulating the desired definition of energy security by which Member States' decisions can be evaluated. This means that such aspects should be reflected in the definition by flexible terms. Given the EU's status as a net energy importer, one can outline a basic definition of energy security, delineating it as the *'uninterrupted supply of energy to consumers congruent with the Union's evolving environmental rules and at an affordable price, taking into account the energy geopolitical considerations'.* This definition also ensures compliance with the changing environmental frameworks and regulations while energy is supplied without interruption. While such a definition can answer Baldwin's key questions (a preventative approach), it also explains what features a secure energy supply should have (an affirmative approach), showing that it harmonises with both the preventative and affirmative

[12] In the quest for a suitable response to the query "security for whom?" we contemplate energy security within the framework of importers versus exporters. This perspective has a well-established history among scholars. Our emphasis lies on the European Union, given its status as a net energy consumer. Consequently, our perception of energy security aligns with the concept of security of supply: Focusing on energy exporters, some researchers have conceptualised energy security as the "security of demand," with a., See For instance (Dike, 2013) for an OPEC perspective, Novikau's paper on Russia (2021), and his other general analysis of the security of demand and supply (2022).

[13] In reality, security is achieved and preserved by minimizing the threat as threat elimination is the ideal condition. Moreover, absolute security is not desirable because it means that we cannot even think about the existence of threats, which can potentially conflict with freedom (Baldwin 1997).

approaches. However, there remains a need to enhance the practicality of the definition, especially in striking a balance between the reflexivity and concreteness of the definition's terms (a vital element addressed in Section 3.1), particularly regarding the 'geopolitical considerations'.

Like environmental considerations, the Union's (energy) geopolitical values continuously evolve[14]. However, incorporating them into the aforementioned security of supply definition appears to be an even more formidable challenge due to the potential divergence in Member States' interpretations of the EU's energy geopolitical interests. For instance, Hungary may not perceive contentious relations with Russia to be in the EU's geopolitical interests. Such a perspective justifies Budapest's recent gas deal with Gazprom, particularly amid the ongoing war (Preussen, 2022). This underscores the potential for conflicting interpretations, leaving room for Member States' disagreements regarding what truly constitutes a secure energy supply.

Compelling Member States to modify their energy-related decisions within the confines of existing legal frameworks poses a substantial challenge, given that Article 194(2) of the TFEU underscores their rights to formulate their own energy policies. Yafimava (2017) highlighted this regarding the Commission's inability to intervene in Germany's Nord Stream 2 project decision in the late 2010s. However, this same article also underscores the imperative of ensuring energy supply security within the Union "in a spirit of solidarity between the Member States". With a specific emphasis on gas supply security, Article 3 of Regulation (EU) 2017/1938 defines it as a shared responsibility among Member States, the Commission, and natural gas undertakings. Additionally, the energy acquis obligates Member States to address the concerns of other parties in certain circumstances as part of their energy strategies[15], a perception which has been reinforced by CJEU's decision in OPAL case C-848/19 P (Germany v Poland, 2021). This necessitates our definition to provide guidelines for striking a balance between Member States' rights and the impacts of decisions on other parties, particularly when geopolitical considerations of energy security come into play.

To that end, one may propose the establishment of an index designed to evaluate stakeholder decisions, especially when viewed through the lens of energy geopolitics. Indicators can be used to examine whether a policy is in compliance with the desired goal (Carrera, 2008). The EU's extensive history of using scoreboards to assess Member States' compliance with core values can justify such an approach. These scoreboards are versatile tools, allowing for monitoring, measurement, supervision, and evaluation. They function as coordination frameworks between Member States, employing benchmarking, the exchange of best practices, and mutual learning processes at the EU level, particularly in addressing common challenges such as safeguarding gas supply security during transitions (Bárd, Carrera, Guild, & Kochenov, 2016). Regarding the security of gas supply in the transition era, having an index also helps tackle uncertainties by providing insight into the probable outcomes and impacts of different decisions policymakers may take.

[14] For instance, the Commission (2000c) recognised Russia as a reliable energy supplier in 2000, against the current situation in which it has been urging for ending Russian fossil fuel imports through REPowerEU, for instance.

[15] For instance, when seeking exemptions for significant new gas infrastructure, such as interconnectors, LNG terminals, and storage facilities, from certain specific provisions, Article 36(3)(a) of the Gas Directive mandates that the national regulatory authority of the constructing Member State must consult the regulatory authorities of the Member States whose energy markets may be affected by this new infrastructure before making a decision on granting an exemption.

Indicators serve as an effective means to mitigate conflicts of interest and facilitate the convergence of views among stakeholders. For instance, during the COVID-19 pandemic, Member States exhibited divergent opinions regarding the safety of unrestricted travel. The creation of an index could serve to align these varying perspectives, much as the COVID-19 index helped bridge disparities in Member States' viewpoints. While the COVID-19 index did not entirely eliminate differences in opinion, it did establish a framework for narrowing the divergence. Similarly, one can develop an index tailored to guide decision-making in the realm of geopolitical considerations within the energy sector. This approach aims to minimise the Union's vulnerability concerning energy geopolitical considerations, adhering to the central tenet of flexibility within the reflexive framework.

A Gas Supply Security Index (GSSI) was developed to serve as a benchmark for providing a quantified evaluation of the security of gas supply, especially from a geopolitics perspective (I). This comprehensive index incorporates pivotal elements, including the percentage of natural gas imports in gross domestic energy consumption, the feasibility of substituting imports with alternative measures in times of crisis, and assessments of political risk associated with gas suppliers and transit. While the first publication used a pre-calculated political risk of supply, it can be defined according to the self-regulation principles. In other words, it can be left to the discretion of the EU and national beneficiaries, e.g., similar to the way that Regulation 2017/1938 designates the GCG for drafting gas security-related guidelines and risk assessment methodologies (see Section 1).

The GSSI was subsequently applied to six major natural gas-importing Member States (I). Although it was conducted before the Russian invasion of Ukraine, the GSSI's dynamic capability to suggest an optimal energy import portfolio enables it to offer insights into the prevailing geopolitical concerns, in line with the reflexivity requirement. It is essential to note that introducing such indices does not confer ultimate decision-making authority to its appliers, e.g., the EU, but rather functions as decision-support tools. Analogous to using COVID-19 risk assessment indices during the pandemic, these tools provide valuable insights while deferring the final decision to policymakers who implement them within their specific contexts. Thus, together with the provided definition of energy security, decision-makers can apply the GSSI to quantify and assess the security of various gas supply options.

## 3.2. Hydrogen market establishment

The implications of the EU Green Deal for the natural gas system entail a gradual phasing out of natural gas to be replaced by renewable gases, such as biogas/biomethane and hydrogen. While the current natural gas regulations, notably the Gas Directive (2009/73/EC) and the Gas Regulation (No 715/2009)[16], apply to biomethane and natural

[16] The EU gas regulations encompass not only the Gas Directive and Regulation but also Regulation (EU) No 347/2013 (TEN-E), Regulation (EU) 2017/1938 concerning measures to safeguard the security of gas supply, Commission Regulation (EU) 2017/460 establishing a network code on harmonised transmission tariff structures for gas, and Commission Regulation (EU) 2017/459 establishing a network code on capacity allocation mechanisms in gas transmission systems. Furthermore, Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources and Directive 2014/94/EU on the deployment of alternative fuels infrastructure have addressed biogas and biomethane. They contribute to the regulatory landscape, each addressing specific aspects of these renewable gases. The EU Emissions Trading System (EU ETS) and the Biomethane Certification Scheme also play vital roles in shaping the gas market.

gas/hydrogen mixture systems, it is argued that they cannot be applied the yet-to-be-constructed hydrogen system, thereby indicating a legal void[17] demanding an appropriate regulatory framework (II)**.**

Crafting a regulatory framework for hydrogen presents a complex and multifaceted challenge. This complexity arises, in part, from the distinctiveness of hydrogen compared to the EU's previous experience with natural gas. In the case of natural gas, regulations have continuously adapted to shifting geopolitical, environmental, and technological dynamics. These adaptations have facilitated a dynamic interplay between economic considerations, security of supply, and sustainability, allowing the natural gas regulatory system to evolve incrementally in alignment with infrastructure development and market evolution requirements (Correljé, 2016). However, the regulation of hydrogen must be approached differently due to the nascent stage of its market and infrastructure. Moreover, with many Member States yet to formulate their hydrogen strategies to define the role of hydrogen within their future energy landscape and the absence of a developed hydrogen network in Europe, the EU's hydrogen market is shrouded in significant ambiguity.

One can propose amending the existing gas regulations, enabling them to regulate the emerging European hydrogen market(s). Such an approach aligns with the 'adaptive' law aimed at revising the Directive and Regulation to facilitate the Union's environmental objectives. Establishing a functional hydrogen market is in harmony with these environmental objectives and requires regulatory adjustments. Concurrently, the revised regulatory framework must be developed with reflexivity to effectively address the uncertainties inherent in the evolving hydrogen market. Furthermore, it should demonstrate the capability to revise itself by incorporating the continuous feedback obtained through the regulations' implementation. It must promote the formation and development of the hydrogen market while upholding fundamental Union values, including sustainability, competition, and security of supply. Given these expectations, it can be argued that the reflexive-adaptive approach is well-suited to achieve these objectives.

In light of the regulatory framework governing the EU gas market (see footnote 16) and the research outcomes critically addressing necessary rule amendments for establishing an EU hydrogen market, three distinct categories of necessary revisions can be distinguished, including 1) Establishing financial instruments for market development, 2) Unbundling and anti-monopoly measures, and 3) Integrated infrastructure planning (especially transmission network development) (Scheibe & Poudineh, 2023; Barnes & Yafimava, 2020; Mete & Reins, 2020; Khatiwada, Vasudevan, & Santos, 2022; Tanase & Anchustegui, 2023; II). Each of these categories will be discussed in detail in the following

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However, the Gas Directive and Gas Regulation, central components of the EU Third Energy Package (2009) (following its predecessors in 2003 and 1996/8), constitute the foundational pillars of the European Union's internal gas market which will be elaborated within the same section later. Serving as the primary legal reference points for market participants, regulators, and Member States, these two have significantly shaped the structure of the EU natural gas market.

[17] Given such a void, the Commission introduced a series of legislative proposals in late 2021, which included the revision of the Gas Directive and the Gas Regulation, aimed at facilitating the integration of renewable and low-carbon gases into the energy mix to bolster the Union's energy security (European Commission, 2021). However, as of the time of writing this passage, the finalisation of these revised proposals is still pending.

section, addressing the specific amendments required to facilitate the establishment of an EU hydrogen market[18].

### 3.2.1. Establishing financial instruments for market development

When examining the financial aspects, it is imperative to acknowledge that definitive demand in the hydrogen market is yet to materialise. Industrial applications, particularly within the chemical and refinery sectors, are anticipated to be the initial consumers of renewable hydrogen in the upcoming years, as they transition away from fossil-based hydrogen as part of their decarbonisation strategies (European Commission, 2020a). However, these facilities will likely produce and consume hydrogen on-site, primarily due to economy of scale considerations. Such a closed, decentralised hydrogen system is likely to be exempt from forthcoming EU regulations, as the current Gas Directive provides such a possibility to closed natural gas systems (see Recital 28 and Article 28 of the Gas Directive). Consequently, it can be argued that in the initial years, the emerging demand is unlikely to necessitate the development of national or cross-border regional public hydrogen networks. Given the initial lack of definitive demand in the hydrogen market, it is essential to recognise the need to implement necessary policies that can facilitate and expedite the establishment of the hydrogen market. This is particularly crucial in light of the prevailing market uncertainties, as industrial applications transition away from fossil-based hydrogen. State aid support for infrastructure development can catalyse demand growth and prevent market failure (Lavrijssen & Vitéz, 2020).

The importance of embracing facilitative policies in this context becomes evident due to the potential constraints that other international legal frameworks may impose on the EU's ability to enact supportive measures through alternative avenues. For instance, Mete and Reins (2020) explore the feasibility of introducing financial support policies or subsidies to foster hydrogen market development. However, the allocation of subsidies or preferential taxation in favour of renewable hydrogen development may encounter complications rooted in the intricacies of Article XX(b) of the General Agreement on Tariffs and Trade (GATT) (II)**.** This specific article deems subsidies exclusively targeted at renewable electricity (required for renewable hydrogen generation) as discriminatory and non-essential, rendering them impermissible. Likewise, there is a contention that the free allocation of emission allowances within the ETS might be construed as a subsidy, potentially posing challenges to its provision.

In contrast to the complexities associated with granting subsidies under WTO law, the EU state aid provisions offer a promising avenue for advancing hydrogen market development in the Union. The European State aid rules are based on Articles 107 and 108 of the TFEU. Article 107(2) TFEU defines specific categories of aid that "shall be", and Article 107(3) TFEU lists aid that "may be", compatible with the internal market not falling foul of Article 107(1) TFEU. The Commission's assessment in the former category is limited to "verify that the conditions for derogation are fulfilled" without being conferred any discretion as regards the evaluation of a category's compatibility with the internal market and where the assessment of the EC is therefore limited to verifying whether the conditions necessary to fall within one of the categories listed in Article 107(2) TFEU are met. Conversely, Article 107(3) TFEU equips the Commission with

[18] In addition to these aspects, some scholars have explored the role of legal frameworks, such as the Guarantee of Origin (GO) and Emissions Trading Scheme (ETS), as well as the harmonisation of gas quality standards. Given that these matters have been previously covered by (II) - a pertinent publication within the context of this doctoral thesis - they will not be reiterated in this section.

discretion (at least regarding the first four categories of aid). Additionally, according to Article 108(3) TFEU, any plans to grant or alter aid must be notified to the Commission prior to their implementation. At the same time, it must review all aid provision constantly.

The EU State aid law is not categorised with the specific divisions and areas elaborated in Article 107(2) and (3)[19]. Instead, they are defined by their purposes, such as regional investments, support for SMEs, employment, research, and environmental initiatives. Thus, the granted aid in an area, e.g., climate aid, can potentially fall into multiple categories, meeting both 107(3)(c) and (b). To distinguish the necessity of granted aid and practice its supervisory role within Articles 107 & 108 in the climate and energy area, the Commission is equipped with the so-called General Block Exemption Regulations (GBER[20]) and Guidelines on State aid for Climate, Environmental Protection and Energy (CEEAG). The Commission declares specific categories of state aid compatible with the Treaty provisions through BERs (herein, the climate, for instance), legally binding upon Member States. However, the Commission Guidelines provide a clarification tool as regards how the EC applies "Treaty and EU secondary law" and do, in principle, not qualify as legal rules[21] (Zelger, 2022).

One may raise questions regarding the extent to which the aforementioned state aid provisions conform to the reflexive-adaptive approach, as its necessity was discussed before. In response, the author contends that the recent iterations of state aid frameworks governing eligibility and allocation have made noteworthy progress towards harmonising with the reflexive-adaptive framework delineated in this research. Several key observations evidence this alignment:

I. The recent revision of GBER, introduced in June 2023, has incorporated hydrogen projects which can benefit from the state aid while being exempted from notifying the Commission prior to granting the aid as required by Article 108(3) of the TFEU if the aid complies with the conditions specified in Articles 42 and 43, in addition to those laid out in Chapter I of the regulation[22]. Article 48 of the regulation specifically addresses aid for gas infrastructure, including hydrogen transmission pipelines (characterised in Article 2(130)(c)), when it is dedicated to hydrogen and/or renewable gases or is used for the transportation

[19] The Article and its (a) and (b) paragraphs divide aid into certain categories, including aid for compensating natural disasters or exceptional occurrences repercussions, aid to facilitate economic development in certain areas of the Federal Republic of Germany affected by the division of Germany, or other areas where the standard of living is abnormally low or where there is severe underemployment, aid to promote the execution of an important project of common European interest or to remedy a serious disturbance in the economy of a Member State, aid to facilitate the development of certain economic activities or certain economic areas, aid to promote culture and heritage conservation and finally aid as may be specified by decision of the Council on a proposal from the Commission.

[20] GBER, Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in application of Articles 107 and 108 of the Treaty amended 30.6.2023, based on Council Regulation 2015/1588 (repealed the former Council Regulation No 994/98 of 7 May 1998)

[21] However, the guidelines are binding upon the Commission "to the extent that they do not depart from the rules in the TFEU" (Greece vs Commission, 2016, p. para 70) and notwithstanding the fact that they may, given specific circumstances, produce legal effects (36)). According to the General Court, the Guidelines act as "rules of conduct" for the Commission (Regione autonoma della Sardegna v Commission, 2017, p. para 177). It does not, however, exempt the Commission from its discretion (as outlined in Article 107(3) TFEU) to evaluate the State aid's conformity and deviate from the guidelines' principles, especially when a particular case warrants such deviation (Kotnik and Others, 2016).

[22] These conditions include, among other things, a limit of EUR 30 million per undertaking per project or EUR 300 million per year.

of over 50% hydrogen and renewable gases[23]. In addition to infrastructures, Article 41(3) exempts investment aid for hydrogen production, provided it is exclusively for the production of renewable hydrogen. Meanwhile, Article 36a provides an exemption for investment aid concerning recharging or refuelling infrastructure, provided that the beneficiary commits to supplying solely renewable hydrogen by 31 December 2035, and this infrastructure is not located in ports. Additionally, Article 41(7)(a) allows an aid intensity of up to 45% for renewable hydrogen production investments, with the possibility to reach 100% in competitive bidding processes that meet specific criteria as defined in Article 2, point (38).

Therefore, the GBER revision alleviates the burden of proof previously placed on Member States when awarding state aid to hydrogen projects in different parts of the hydrogen value chain. Such a development has been already proposed in one of the publications pertinent to this dissertation (see publication **II**, Section 4.1) indicating progress in achieving climate goals and can be considered within the adaptive law approach.

II. The GBER places significant emphasis on renewable hydrogen. For instance, Article 36a requires those recharging or refuelling infrastructure exempted from the notification requirement of Article 108(3) to solely supply renewable hydrogen, at the latest, by 31 December 2035. However, Article 36(1)(1b) offers provisions for exempting hydrogen that "does not qualify as renewable hydrogen" if specific emission conditions are met. This provision can facilitate the development of the hydrogen market, especially in its initial phase when natural gas still plays a substantial role and can be considered another positive enhancement for market establishment and growth.

III. While incorporating hydrogen in the GBER is a significant stride towards advancing the EU's hydrogen market, another regulation, i.e., the "Guidelines on State Aid for Climate, Environmental Protection, and Energy 2022" should also be considered. The Guidelines serve as a pivotal instrument for the European Commission to scrutinise whether Member States' aid, earmarked for environmental and climate protection, complies with the EU's state aid regulations. In a noteworthy departure from the previous version, tailored to the 2014-2020 period, the current version's Section 4.9.3.1, note (b)(iii), which elucidates the necessity test conditions for conferring state aid, now incorporates "the climate neutrality objectives of the Union" as an additional criterion alongside the existing requirement of "contributing to the security of energy supply in the Union." Such revisions demonstrate an adaptive approach in both Regulation 651/2014 and the Guidelines, aligning their provisions with the imperatives of the 2050 climate objectives.

IV. Finally, the intrinsic self-regulatory capability and provision for self-correction within specific timeframes are other essential features. Council Regulation (EU) 2015/1588 designates specific categories of aid compatible with the internal market in applying Articles 107 and 108 of the Treaty. Articles 5 to 8 of this Regulation establish a procedural framework for evaluating the application of this Regulation every five years, fostering a context for potential revisions to the regulations governing State Aid rules, including Regulation (EU) No 651/2014.

[23] The energy infrastructure that is partially or fully exempted from third-party access or tariff regulation in accordance with internal energy market legislation does not benefit from this exemption (Article 48 (2)).

Furthermore, Article 59 underscores this point by stipulating the Regulation's applicability until 31 December 2026, after which it necessitates a comprehensive review, thereby establishing a framework for ongoing learning and improvement.

V. Within Section 4.9.3.1 of the CEEAG, specific conditions are outlined that allow for the exemption from TFEU Article 108(3) if a proposal for state aid exceeds the threshold specified in Regulation 651/2014 Chapter I. The first condition has been modified to assess the necessity of the allocated aid to avert "market failure". Given the potential for shifting circumstances leading to market failure, this primary condition affords the Commission the essential discretion to align its determinations with the contemporary conditions at the time of decision-making. Similarly, the phrase 'to the extent' in the three stipulated requirements (i), (ii), and (iii) alludes to the decision-making process's inherent flexibility, empowering the Commission to adjust its determinations in response to shifting and uncertain conditions, firmly aligned with the tenets of Reflexive Law.

VI. Another noticeable change in the CEEAG is removing the requirement for individual notification of "large green projects" exceeding certain thresholds (stipulated in the former version under paragraph 20). This has been coupled with the Commission's authority to consider additional factors and impose ex-post evaluations or time limitations (Section 3.3 para 76), highlighting an intent to streamline administrative procedures, enhancing the flexibility and adaptability of aid measures' implementation. Such a modification underscores the CEEAG's responsiveness to evolving circumstances and its commitment to advancing environmental goals, making it more congruent with the adaptive framework. Moreover, reducing the administrative burden for granting the aforementioned measures increases the flexibility of aid allocation, which aligns with the reflexive approach.

As a result, these conditions not only expedite the attainment of the Union's climate and energy objectives (the adaptive approach), but also underscore their harmonious coexistence with the reflexive law outlines, rendering them a fitting instrument for shaping state aid regulations within the European Union.

### 3.2.2. Unbundling and anti-monopoly measures

In addition to the state aid regulations, it is crucial to create a conducive environment for the participation of private-sector investors and undertakings in the establishment and expansion of the European hydrogen market, including potential Transmission System Operators (TSOs). However, if the Gas Directive is amended to extend its jurisdiction over the emerging hydrogen market, TSOs would be subject to unbundling regulations delineated by the Gas Directive[24]. Moreover, the existing regulations do not allow natural gas undertakings to invest in hydrogen development plans, especially network

[24] Unbundling requires the entities responsible for producing the energy differ from those responsible for transporting and distributing it to the end-users to mitigate the risks associated with market failures, related information asymmetry, and the market power of natural monopolies The Gas Directive introduces three unbundling models including the Ownership Unbundling (OU), Independent System Operator (ISO), and Independent Transmission Operator (ITO). The OU model is the strictest, prohibiting investors with majority rights in a TSO from engaging in other energy value chain activities. ISO mandates a clear separation of grid ownership and operation. TSOs under the ITO model are independent companies that own and operate the grid, though they may have ties to other value chain sectors but are subject to compliance programs and oversight (Scheibe & Poudineh, 2023).

development (II). Imposing such strict regulations that have been applied to already well-established gas infrastructures for at least two decades can potentially hinder the hydrogen system's rapid extension in its embryonic stages, posing a threat to the security of gas supply in the transition era (Tubiana, et al., 2022). This is of particular significance considering that the existing unbundling regulations are structured upon the CAC model, rendering them relatively rigid and notably unsuitable for the initial phase of establishing sustainable hydrogen markets (Baumgart & Lavrijssen, 2023).

Scholars have discussed the importance of loosening the unbundling requirement for hydrogen systems during the transition era. In a recent study, Scheibe and Poudineh (2023) posited that effective unbundling regulations for hydrogen must address two essential dimensions. Firstly, regarding the prospective reuse of gas pipelines for hydrogen infrastructure, eligible existing gas network operators should be granted authorisation to transform into hydrogen TSOs. During a transitional phase, these operators might be allowed to simultaneously manage both natural gas and hydrogen grids, acting as the so-called 'hybrid TSOs' (flexible horizontal unbundling). Secondly, future hydrogen TSOs, whether arising from the transformation of existing natural gas TSOs or newly established entities, should be allowed, under stringent transparency regulations, to affiliate with vertically integrated energy companies during the transitional period (flexible vertical unbundling). The ITO model (see footnote 24) should remain a valid unbundling model within the hydrogen system to preserve the incentives for natural gas TSOs who seek to uphold their existing infrastructure while actively engaging in hydrogen transmission[25]. However, the proposed revision of the Gas Directive within the EU Hydrogen and Decarbonised Gas Market Package proposal aims at recognising ITOs by 2030 (European Commission, 2023).

Given the need to re-evaluate existing unbundling frameworks, this dissertation proposes the application of the reflexive-adaptive law approach. This implies that, while it may be permissible for vertically integrated companies to operate within a specific timeframe, e.g., until 2030/35, it should still be possible for hybrid TSOs to 'conditionally' remain vertically integrated if the hydrogen market in that specific Member State has not yet reached maturity. The implication of this flexibility can be subject to two conditions. Firstly, granting this derogation is extended periodically (e.g., every 3 or 5 years) and is contingent upon reassessment if the market is still immature. Secondly, all hydrogen undertakings must unbundle by the end of the transition period, i.e., by 2050, in any case. Alternatively, a stricter proposal could limit vertically integrated companies' operation only until 2030/35, but with a similar conditional framework, thus, the ITO model can still be recognised as a valid model for hybrid TSOs until the end of the transition period.

It is also important to involve hybrid TSOs in defining market development criteria while keeping the evaluation norms flexible and aligned with self-regulation. This also implies adopting the market assessment to collaborative bodies, such as the GCG, thereby alleviating the EU's regulatory tasks, as reflexivity necessitates. The periodic evaluations should aim to determine whether the system, once it reaches a certain level of maturity, must inevitably align itself with more stringent unbundling frameworks. Such

[25] As noted by Scheibe and Poudineh (2023), this issue impacts 19 Independent Transmission Operators (ITO-TSOs), including 11 in Germany. The potential discontinuation of the ITO model would necessitate the sale of these TSOs' hydrogen transport infrastructure to investors external to the vertically integrated energy companies that house the gas TSOs. Such a shift could have adverse effects on their motivation to participate in this sector.

thresholds include various elements. like the number of network participants, or alternatively, other market volume indicators, such as a particular amount of transported hydrogen. In any case, it is imperative to ensure the retention of regulatory oversight to strike a balance between fostering market development and safeguarding against monopolistic practices and ensuring healthy competition. Within the same perception, while the German competition authority, Bundeskartellamt, granted permission for several natural gas TSOs to cooperate in establishing hydrogen network infrastructure, it also articulated its right to reassess individual aspects of cooperation projects in the future considering the “undergoing dynamic development” of the hydrogen market (Bundeskartellamt, 2023).

In any event, it is imperative to highlight that the fundamental premise of both propositions is to avoid imposing a rigid deadline, which can jeopardise hydrogen market development. This is because some enterprises aiming to enter the hydrogen market might become sceptical about whether the market can mature enough by the proposed deadline, which could diminish their willingness to participate in the market establishment. Conversely, by recognising the necessity of aligning current laws and norms with climate objectives, enhancing their resiliency, enabling them to tackle unexpected situations agile, and establishing the legal framework based on self-regulation (considering the suggested supervisory roles for the NRAs and the Commission), the outlined proposal is constructed upon the reflexive-adaptive approach delineated in this study.

### 3.2.3. Integrated infrastructure planning

Article 13(3) of the Gas Directive allows TSOs to cover their network development plan costs through energy tariffs. At the same time, NRAs oversee the tariffs to guarantee that they are transparent, non-discriminatory and cost-reflective. The latter term means that the Directive currently prohibits the inclusion of hydrogen network development costs within the tariffs charged by natural gas TSOs (II)**.** Recognition of hybrid TSOs within gas market regulations – in accordance with the frameworks and conditions outlined based on a reflexive approach in the previous section – can also lay the legal groundwork for emerging natural gas and hydrogen network tariffs, thereby eliminating this constraint. It can benefit the establishment of the hydrogen market in two ways. Firstly, hybrid TSOs can leverage their expertise in effectively managing and expediting the development of the hydrogen network. At the same time, shrinking the natural gas network could increase the value of the remaining natural gas infrastructure and, consequently, gas tariffs for customers who continue to use it during the transmission era (e.g., in hard-to-abate sectors). Preliminary case studies, such as those in Germany, suggest that this tariff adjustment may provide the necessary financial resources for hybrid TSOs to expand the hydrogen network (Held, Nohl, Straßer, & Fimpel, 2020).

In addition to this recognition, other reflexive law features should facilitate infrastructure development planning during the transition period. To elaborate, Article 22(1) of the Gas Directive mandates TSOs to draft a ten-year horizon national network development plan (NDP) and submit it to their affiliated NRA. If the jurisdiction of this article extends to hybrid TSOs, effective collaboration should ensure the stakeholders in pure hydrogen network planning and/or retrofitting/repurposing the natural gas network for NGH2 transmission (as an interim solution during the transition) features.

NRAs play a critical role in this context. Firstly, they should aggregate NDPs received from TSOs, especially in Member States with multiple TSOs, and develop comprehensive national-level plans for network depreciation to minimise the risk of asset stranding, particularly in the transmission network. Consequently, NRAs should be vested with the authority to execute this responsibility. Secondly, NRAs are expected to assess the efficiency of repurposing assets or network segments. This entails recognising a certain level of 'self-regulatory' authority for the NRAs, allowing them to apply appropriate evaluation models based on their discretion. For instance, in the Netherlands, the natural gas TSO, GTS, employs a Cost-Benefit Analysis (CBA) to determine asset repurposing. When GTS intends to transfer assets below their Regulatory Asset Base (RAB) value, the Dutch NRA ACM evaluates user benefits versus costs to prevent cross-subsidisation (Grote, Nunes, Steinborn-Cheng, Paletar, & Anton, 2022).

Additionally, NRAs from different Member States should collaborate to coordinate network planning at cross-border points (or in small states requiring coordinated planning – see the next section). The ACER can serve as an apt platform for facilitating this collaborative endeavour and assisting in the development of necessary frameworks applicable to analogous scenarios akin to the procedures delineated in the network codes. Such a proposition resonates with the principles of reflexive law, which advocate for the decentralisation of authority across different tiers of actors, ranging from the national level (embodied by NRAs) to the supranational EU level (represented by ACER). Reflexive law further mandates that such frameworks undergo periodic reviews based on ongoing assessments while retaining the flexibility to empower regulated entities to devise optimal solutions autonomously.

Finally, as hydrogen infrastructure development is closely linked to the harmonious development of renewable electricity and gas supply systems, coordination between electricity and gas TSOs is crucial. This implies the need for strong alignment between ENTSO-E and ENTSO-G.

## 3.3. Prerequisites of security of gas supply in the small states: Baltic-Finland common gas market case

While energy security has been a pressing concern for EU Member States, the situation is particularly acute for small states like those in the Baltic region. Small EU states have demonstrated an amplified need to address energy security concerns and have actively advocated prioritising these issues within the Union (Crandall, 2014; Pinchuk, 2022). As indicated, the energy security of the small EU states, e.g., the Baltics, is more vulnerable than their larger counterparts. Research has demonstrated that the integration of markets across various energy carriers, such as natural gas, plays a vital role in enhancing the security of supply for Small States within the EU (III). This collaborative approach, particularly among neighbouring small states sharing similar concerns, offers a mutually beneficial strategy to enhance the security of supply for all participants.

In addition to security of supply concerns, the Baltic States's natural gas market integration in the transition era is also justified for economic and climate reasons. Firstly, the regional infrastructure capacity significantly exceeds each country's individual requirements. For instance, the Incukalns underground gas storage (UGS) facility has a total of 24 TWh, far surpassing Latvia's annual demand of 8-12 TWh (ACER, 2023a). Similarly, the Klaipeda LNG terminal has the potential to cover over 80% of the entire Baltic States' natural gas demand (Jakštas, 2021), despite its utilisation rate being less than 50% of what it was before the 2022 energy crisis (IGU, 2023). Market integration can enhance these rates by granting access to other Baltic States to benefit from these facilities, providing economic advantages for existing projects while the natural gas market size is shrinking in the transition era. This prevents overinvestment in building new natural gas facilities, reducing the carbon lock probability and supporting the energy transition goals (Belyi, 2019). Moreover, Belyi and Piebalgs (2020) have indicated that market integration in the Baltic region can foster the development of a competitive regional gas market, reducing its price and, therefore, curbing excessive reliance on polluting fuels such as oil shale in Estonia and facilitating (green) LNG usage in the maritime sector in the Baltic Sea. This means that gas market integration is also crucial for the Union's climate goals in the region.

The EU has already pursued the idea of integrating the natural gas markets of the Baltic States within a broader perspective, by including Finland. For this purpose, the Baltic Regional Gas Market Coordination Group (RGMCG) was established as the first four-country cross-border gas market merger (European Commission, 2023). The RGMCG reached a consensus that a common natural gas market would deliver substantial benefits to the region, including stable natural gas flow transportation, enhanced market liquidity, efficient congestion management, more competitive gas prices, and an elevated level of security of supply (Zemite, et al., 2021). The NRAs of Finland, Estonia and Latvia have jointly created the FinEstLat market since the beginning of 2020, with a single entry-exit zone including two balancing areas, i.e., Estonia-Latvia and Finland. Lithuania is expected to join the entry-exit zone, but no earlier than 2024 (ACER, 2023a). Also, the GET Baltic platform operates within this market as a licensed natural gas market operator, facilitating round-the-clock trading (Zemite, et al., 2021). Although the energy acquis, particularly Regulation 715/2009[26], Regulation 2022/869[27] (commonly referred to as TEN-E) and the Gas Directive[28], can be invoked to provide a legal framework for this integration, market integration is not always free from conflicts of interest or legal complexities.

Integration can potentially influence the energy plans of Member States, especially concerning their utilisation of indigenous energy resources. For example, in an integrated market, Finland, with substantial biomethane feedstock production, may need to produce beyond its domestic requirements to supply surplus biomethane to Member States lacking competitive biomethane production capabilities. This decision aligns with the need to maintain the utilisation rate of the Balticconnector during the energy transition as natural gas flow through the pipeline diminishes. These considerations have led Finland to adopt a strategy that differs from standalone planning for its domestic requirements. Such a hypothetical example can illustrate that, unless a Member State voluntarily decides to participate in market integration, for instance, based on cost-benefit calculations, enforcing market integration for reasons such as the Union's

[26] For instance, see Article 8(7) addressing network code development for market integration, Article 8(8) requiring ENTSO-G to monitor the network codes harmonisation for facilitating market integration, Article 9 (1) demanding ACER to facilitate market integration and also Article 12, which assigns regional TSOs to find the market-based solution for the integration of balancing mechanisms.

[27] This includes but is not limited to Recital 26, Articles 3, 13 and 16.

[28] Particularly, Article 6(1) of Directive 2009/73/EC states that "In order to safeguard a secure supply on the internal market in natural gas, Member States shall cooperate in order to promote regional and bilateral solidarity". Also, Article 7(1) says that "[...] In particular, the regulatory authorities where Member States have so provided or Member States shall promote and facilitate the cooperation of transmission system operators at a regional level, including on cross-border issues with the aim of creating a competitive internal market in natural gas, foster the consistency of their legal, regulatory and technical framework and facilitate integration of the isolated systems forming gas islands that persist in the Community."). The scope of this Article is expanded in the proposed revision aiming to include national hydrogen and methane gas markets at one or more regional levels and to create regional markets across the Union.

security of supply can be seen as conflicting with the state's rights outlined in Article 194(2). Thus, legal complexities can hinder top-down efforts to influence Member States' decisions in managing market integration in the EU.

Unlike the hypothetical case mentioned earlier, Lithuania's delayed accession to the Baltic entry-exit zone, for which a concrete timeline is still lacking, serves as a real-world example of incomplete integration primarily due to the absence of consensus on shared interests. To further illustrate, the establishment of a common entry-exit zone required an agreement to implement uniform tariffs at each entry and exit point within the region, along with the subsequent equitable distribution of the generated revenue among the involved parties. However, Lithuania's request for an exemption regarding the gas transmission line from Belarus to Kaliningrad faced resistance from other stakeholders. At one point, Lithuania even considered the possibility of participating in a different entry-exit zone with Poland. As a result, gas transfers between the existing FinEstLat entry-exit zone and Lithuania continue to incur tariffs at the Kiemėnai border (Belyi & Piebalgs, 2020). While discussions were ongoing to formulate an appropriate compensation mechanism, ongoing geopolitical tensions have created significant market instability. It has become evident that the previously envisioned compensation mechanism no longer accurately aligns with dynamic real-world circumstances and the vested interests of stakeholders (ACER, 2023b). Yet, the EU lacks a compelling legal obligation to compel these parties towards integration.

This study suggests the application of the reflexive-adaptive approach to overcome the 'interest lock' and expedite integration, crucial for upholding supply security in the transitional era. This approach necessitates Member States demonstrating flexibility in safeguarding their national interests while prioritising the achievement of climate objectives, as delineated in Article 194(2). Furthermore, it advocates for the efficient utilisation of the authority and powers vested in the Commission for the allocation of funds and the provision of financial support to projects within a regulatory framework, as further elaborated below.

As discussed in Section 1, in specific scenarios driven by climate-related concerns, adaptive law may prioritise necessary climate-favoured solutions over established legal principles without necessarily violating the law. Similarly, it can be argued that Member States are expected to prioritise climate goals over their individual energy planning rights or national economic interests when shaping a shared market. Consequently, in relying on regulations and directives that promote integration, Member States should simultaneously demonstrate the flexibility required to embrace a systemic, regional, comprehensive, and collaborative planning approach rather than solely pursuing individual rights, as stipulated in Article 194.

The concept of integrated planning, initially conceived as the adoption of a systemic approach to gas market development, necessitates the harmonisation of infrastructure development plans for both renewable electricity and renewable gas within the region. This harmonisation is essential to enable the production and transmission of renewable gases through the energy grid, reinforcing the prerequisites for integrated planning within the energy system. This requirement is particularly critical given that, among various factors, the absence of renewable electricity can disrupt the achievement of renewable hydrogen production goals, thus jeopardising the security of the gas supply. The implication of this for the Baltics and Finland is that they must act more flexibly and collaboratively, instead of adhering to individual separate energy planning and aligning with reflexive law outlines.

Integrated planning necessitates alignment of the NDPs of the Baltic States and Finland in terms of frequency, approval processes, scope, and content[29], among other things. Inconsistencies among NDPs may pose formidable challenges to realising integrated renewable gas development plans and their distribution within the region, thereby presenting a significant threat to supply security during the transitional period. The hypothetical scenario of surplus biomethane transportation from Finland could exemplify this. This alignment necessitates cross-border collaboration among their NRAs, especially concerning network codes proposed within EU energy regulations like the Gas Directive. The NRAs should be empowered to collectively approve and amend NDPs, while the TSOs should conduct joint cost-benefit analyses for investment projects.

In addition to the flexibility of Member States, the Commission must also play a role in promoting integration. One noteworthy tool, as outlined by the TEN-E, involves expedited permitting procedures and funding allocation through Projects of Common Interest (PCIs). PCIs benefit from accelerated permitting procedures and funding allocation within 'regional groups', guided by criteria such as enhancing market integration and security of supply. These criteria endow the Commission with a level of reflexivity in decision-making, allowing it to prioritise proposals from small states. For instance, if the Commission utilises the index introduced in Section 3.1 to assess the impact of their proposals on regional security of supply[30]. Given that small states often depend on EU funding due to financial constraints, the Commission can effectively utilise PCI to advance regional integration, enhance security of supply, and simultaneously avert overinvestment in natural gas projects, among other objectives.

Finally, establishing an entry-exit zone entails the creation of a single TSO responsible for the zone, much like the role of JSC Gaso in the cross-border operations of FinEstLat (Zemite, et al., 2021). Imposing inflexible unbundling requirements on these newly established TSOs, as detailed in Section 3.2, could leave them economically vulnerable and less appealing from a business model perspective. This underscores the crucial need for implementing flexible unbundling frameworks for these TSOs, particularly when addressing the adaptability required by small states. Such adaptability can significantly contribute to a seamless transition and preserve gas supply security.

[29] Variations in the structure of Member States' NDPs are evident in the Baltic region. Estonia publishes its NDP annually, while Latvia and Lithuania follow a biannual schedule. NRAs in Estonia provide non-binding opinions, while in Latvia and Lithuania, NRAs hold approval authority. The Estonian and Lithuanian NDPs are based on a single 10-year scenario, aligning with different EU plans, but cost-benefit analyses for investment projects are not used in any of the Baltic states' gas NDPs (ACER, 2022).

[30] Notably, this index can quantitatively illustrate the effect of a member's (especially a small state) access to the infrastructure of other members in enhancing the security of gas supply for the requesting state.

# 4. Conclusion and suggestions for further research

This study investigates the intersection of EU energy law, energy transition, and gas supply security. With the EU's commitment to achieving climate targets, fossil fuels, including natural gas, are being phased out. This means that while the EU's total gas demand is expected to decline due to electrification and energy efficiency efforts, natural gas should be replaced with decarbonised gases simultaneously. However, the sensitivity of this transition raises concerns about gas supply security during the transition era. These concerns are further heightened by the Russian invasion of Ukraine, prompting the EU to explore alternative natural gas suppliers.

The comprehensive evaluation of the EU energy acquis within this research underscores triple legal hurdles and substantive inconsistencies demanding resolution when safeguarding the security of gas supply in the transition era. Otherwise, threats to gas supply security in the Union may even jeopardise the EU's pursuit of carbon neutrality. Consequently, this dissertation aims to address such legal concerns. The main research question was formulated as "What principles and legal provisions can be formulated and put into practice to align the EU energy acquis with ensuring the security of gas supply during the energy transition?". The central argument of this dissertation is that flexibility, self-regulation, resilience, and adaptability, as the key attributes of the reflexive-adaptive legal framework, can provide the necessary guidelines for essential reforms within the EU energy acquis.

Within the scope of this research, three questions were formulated, each addressing a crucial aspect of the EU's security of gas supply from a legal perspective. The first question focuses on determining how the EU's energy acquis can evaluate gas supply security during the transition era. The study argues that utilising a guideline of evaluation, rather it merely existing, is crucial for maintaining collaboration between Member States and the EU in preserving the security of gas supply as their shared responsibility, delineated within Regulation 2017/1938. Therefore, this research developed an adaptive-reflexive definition and a corresponding formula that can assist the EU in evaluating its gas supply security to decide on the best course of action. This indicator can then be applied as a security of supply scoreboard for the EU.

The second question, "What legal changes are necessary to facilitate the introduction of decarbonised gases, particularly hydrogen, into the EU's gas market to ensure and safeguard gas supply security during the transition era?" addresses the crucial concern of legal adjustments required to accommodate decarbonised gases, specifically hydrogen, within the EU's gas market to enhance supply security. This research highlights the necessity of:

- A reflexive-adaptive regulatory framework addressing financial requirements of the EU hydrogen market development: The study argued that as hydrogen the market is still in its nascent stages, supportive policies, e.g., state aid for infrastructure, are needed for market development in the EU. State aid rules have adapted to support renewable hydrogen projects, aligning with climate objectives. Revised General Block Exemption Regulations (GBER) and State Aid Guidelines for Climate, Environment, and Energy enable financial support in line with the EU's climate goals.
- Unbundling and anti-monopoly measures: The existing regulations designed for natural gas may hinder the rapid expansion of the hydrogen system in its early stages. Therefore, an adaptive law approach, with periodic evaluations, would

allow vertically integrated companies to operate until the market matures, enabling a smooth transition to a more stringent unbundling framework. Ensuring a balance between market development and competition is essential, with regulatory oversight playing a crucial role in this transition. The proposal aligns with the reflexive-adaptive approach, allowing for flexibility while maintaining the ultimate goal of unbundling. It involves different national and EU regulators and regulated entities in defining the criteria of market maturity that are invoked and aligned with reflexivity.

- Integrated infrastructure planning: Recognition of hybrid TSOs and cooperative planning among stakeholders are vital to facilitate infrastructure development during the hydrogen market's transition. NRAs play a pivotal role in aggregating network development plans and assessing the efficiency of asset repurposing. Coordination at cross-border points and collaboration between electricity and gas TSOs are essential for a harmonious transition. Reflexive law principles, including continuous assessments and flexibility, should guide the development of frameworks to support efficient infrastructure planning in this evolving market.

By adhering to these principles and addressing the concerns raised in the discussion, the EU can foster a dynamic regulatory framework for the hydrogen market, facilitating its growth and aligning with environmental and energy objectives.

To address the third question posed – "What legal instruments are required to safeguard the gas supply security in small states during the transition period?" – the thesis demonstrates that addressing the vulnerability of small EU Member States' gas supply security during the transition period in the Baltic region necessitates additional legal measures. Strengthening market integration is imperative for attaining this objective. However, driving market integration through top-down regulation is infeasible, as it could potentially encroach upon the rights of Member States, as outlined in Article 194(2) of the TFEU.

Thus, Member States themselves should engage in market integration initiatives to safeguard their gas supply security, especially the smaller Baltic states, given their unique vulnerabilities. In accordance with the reflexive-adaptive approach, Member States should exhibit flexibility in their cost-benefit analysis of participating in a common gas market, such as the Baltic-Finland market. The study also recommends leveraging EU funds to incentivise Member States in this endeavour. Furthermore, integrated planning necessitates adopting a systemic approach to developing the gas market and aligning infrastructure development plans for both renewable electricity and renewable gas within the region.

To sum up, preserving the EU's gas supply security entails applying flexibility, resilience, self-regulation, and adaptability to make the EU energy acquis agile enough to tackle the uncertainties of the transition era. This could be addressed by the reflexive-adaptive approach framed within this study. Additionally, the case of small Baltic States highlights the need for complementary provisions ensuring a certain level of supply security.

The energy transition is a complex and uncertain process with far-reaching implications for various sectors. Furthermore, the EU's energy policies and strategies have been significantly influenced by the Russian invasion of Ukraine. As of the time of writing, the duration of the conflict remains uncertain, adding a layer of complexity to the situation. While the author attempted to explore various potential scenarios for

EU-Russia gas relations by 2050, it is acknowledged that predicting the future of bilateral relations is challenging.

Additionally, political and legal developments within the Union and its Member States, particularly the major ones, have consistently shaped EU energy policy directions. The upcoming European Parliament election in 2024 is anticipated to impact these policies substantially. Furthermore, critical aspects of EU energy legislation, such as the Gas Directive, are presently under review by EU authorities. This is in addition to ongoing technological advancements that could significantly influence the energy transition. Due to the path-dependency inherent in the energy transition, addressing the prerequisites for a seamless transition, especially from a legal and policy perspective, is significantly constrained by these uncertainties. Consequently, ongoing scrutiny of concepts, research, and their outcomes is necessary to ensure the practicability of the findings.

Moreover, this research endeavoured to tailor the reflexive-adaptive approach. striking a delicate balance between self-regulation – granting greater autonomy to regulated entities and national regulatory authorities, empowering them to make swift legal decisions in the face of unexpected circumstances – on the one hand, and the preservation of the concreteness of laws, standards, and law enforcement sanctions, on the other. However, the operationalisation of this idea and maintaining such a balance may not be straightforward. This challenge is further compounded when considering the ever-evolving nature of the EU energy acquis, raising questions about which entities should assume increased regulatory responsibilities in the EU energy sector and how they should do so. This is particularly significant given the limited capacities of specialised EU energy agencies, such as ACER, to undertake expanded regulatory functions. Hence, addressing these concerns necessitates incorporating the recommended legal approach in this study and considering governance approaches.

Finally, but no less significant, this research placed an emphasis on the small Baltic States, underscoring the necessity of market integration to ensure gas supply security. The viability of this concept and its legal challenges concerning other small states within the European Union could be subjects for separate discussions and dedicated research. The author previously provided a classification and definition of EU small states (III), which could provide the foundation for analysing the effectiveness of the reflexive-adaptive legal approach in expediting market integration in other small EU member states.

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## Abstract

## Applying reflexive-adaptive law for safeguarding the European Union's security of gas supply during the transition era

Fully replacing natural gas with non-gaseous energy sources and carriers across all sectors by the target time for EU carbon neutrality (2050) is not technically feasible. Consequently, a gradual transition from natural gas to decarbonised gases is essential during this period. This necessitates the preservation of gas supply security, i.e., the natural gas and alternative gases combination, even as the overall gas market size is anticipated to diminish during the transitional phase. Achieving this objective entails overcoming three legal obstacles within the EU energy acquis.

The primary concern revolves around the external dimension of security of supply, particularly given the EU's intention to cut Russian natural gas imports in the aftermath of the Ukraine invasion. The Union's objectives of reducing reliance on Russian gas while adhering to climate goals have led to divergent, and in some cases, contradictionary approaches, among Member States. For instance, while Estonia and Germany reduced Russian gas import, others have increaed Russian LNG import and Hungary extneded its deal with Gazprom. The discord arises from different interpretations of Article 194 TFEU, which grants Member States the discretion to choose their energy sources on one hand, while advocating for energy solidarity within the Union on the other. In the current situation the CJEU's legal interpretation of the energy solidarity principle has made it possible for the Commission and Member States to challenge thier counterparts energy decisions by invoking energy solidarity principle. These disputes have the potential to hinder cooperation among Member States, the EU Commission, and gas companies, all of which bear joint responsibility for ensuring gas supply security during the transition period as outlined in Article 3 of Regulation (EU) 2017/1938.

Secondly, in wake of the shrinking gas market during the transition era, the adaptation of the natural gas system for the transmission of alternative gases becomes imperative. However, existing regulations fail to address the allocation of costs for system retrofitting and the establishment of new gas systems. Moreover, given the gradual nature of this transition, some segments of the current natural gas infrastructure must remain operational until 2050, necessitating continuous investment for maintenance. Despite this necessity, uncertainties surrounding relevant regulations, such as the Taxonomy regulation, are likely to deter natural gas undertakings from further investment in infrastructure due to the risk of stranded assets. This underscores the existence of legal challenges in steering the decarbonisation of the EU's internal gas market.

The third concern pertains to the security of gas supply in small EU Member States. Given economy of scale considerations, replacing their shrinking natural gas market with a decarbonised one poses greater challenges for these states. Thus, encouragement for market integration has been notably emphasised by the EU in recent years, particularly in the small Baltic States, where energy security has been a significant concern. However, full realisation of this objective has yet to be achieved, primarily due to disagreements among these states regarding the equitable distribution of the benefits of market integration. Despite various efforts, top-down legal procedures have not been able to successfully advance this objective, as such measures may impede Member States' rights under Article 194 TFEU. This justifies adopting complementary regulations which can

safeguard the Baltic States' security of gas supply, especially in the early stages of the transition.

The study posits that the current EU regulatory framework, amalgamating market-based and CAC principles, is intended to ensure uninterrupted energy supply and foster a competitive energy market. However, this framework is not sufficiently equipped to address the intricacies and uncertainties of the energy transition, as it was not designed with such a constellation in mind. Consequently, confronting the triple challenges within the confines of the existing regulatory paradigm is deemed inadequate. Rather, there is a need for a new regulatory approach informed by the elements of reflexive and adaptive law – to accommodate the unique traits of the energy transition.

A reflexive legal system engages various actors and entities, particularly the regulated entities, alongside the state. The redistribution of regulatory responsibility establishes a self-regulatory framework that reduces dependence on central authority control, as is the case in the CAC systems. This allows for prompt and flexible adjustments to unforeseen challenges during the transition era, as not all decisions require sanctioning by a central authority. At the same time, the central authority ensures that decisions align with the defined overarching principles and objectives of the transition era. Reflexivity, as a procedural legal approach, can be exemplified in ISO 14001 or the procedural orders of risk assessment in Regulation 2017/1938. Furthermore, reflexive law makes regulatory responses better attuned to the operational challenges faced by regulated entities at lower levels that are more compatible with the conditions on the ground. This approach also promotes self-learning by actively involving regulated entities in regulatory processes, thereby enhancing the capacity of absorbing and applying the lessons learned in revising the regulations, another essential benefit in tackling the uncertainities of the transition era. This creates a polycentric regulatory system that enables Member States to adopt regulations that are more compatible and tailored to their local needs while simultaneously adhering to the primary climate objectives.

Reflexive law establishes a legal system that is 'partly open', allowing it to receive input, such as significant guidelines, from its environment, and then process this input according to its internal dynamics and regulatory principles. However, our legal approach needs to integrate a substantive element capable of driving the energy transition. Particularly, given that the EU energy regulatory system continuously makes trade-offs between competition, sustainability, and energy security, it is crucial to incorporate a complementary legal approach that ensures the energy system's persistent navigation toward climate goals while safeguarding the normal functioning of the energy system, for instance, by ensuring the security of supply. Therefore, this study suggests the incorporation of the adaptive law framework, which prioritises addressing environmental challenges in the transition era. This implies a reinterpretation of legal principles and provisions for adaptation. For instance, a new interpretation of unbundling and third-party access should be adopted to help establish the hydrogen market in the EU, a crucial element for achieving carbon neutrality by 2050. By combining these two approaches, a tailored reflexive-adaptive approach can provide the necessary guidance based on its major features of flexibility, self-regulation, resilience, and climate adaptability.

By adopting the reflexive-adaptive law approach, the study aims to propose solutions to the three legal challenges identified above. Firstly, it seeks to frame a flexible definition of security of supply. If this definition becomes legally binding, it would provide a tool for assessing the energy decisions of the EU and its Member States. Moreover, the study proposes a revision to the N-1 formula introduced in Regulation 2017/1938, which can then be applied to compare different external suppliers from the supply security perspective in the Member States. This new index, the GSSI, includes elements that can be defined by Member States and other involved actors within a group, thereby granting them some discretionary power alongside the self-regulatory essence. Such an index can function similarly to the EU's scoreboards, which serve as decision support tools and help mitigate conflicts of interest among stakeholders by quantifying the consequences of different energy decisions.

The reflexive-adaptive law approach is also applied to adapt unbundling and state aid regulations with the research objectives. Thus, the Gas Directive, General Block Exemption Regulation (GBER) and the Clean Energy for All Europeans Package (CEEAG) have been concentrated within the scope of this study. It identifies the necessity of more flexiblility and discretionary power of NRAs, accompanied with periodic evaluations of regulations to balance between market development and competition rules. Regulations should also facilitate integrated cross-border planning between neighbouring Member States and collaborative sectorial energy planning within the Member States where NRAs play a crucial role in. Moreover, there is a need for integrated infrastructure planning, enabling hybrid TSOs to emerge during the transition period. This can alleviate concerns of natural gas undertakings that investment in infrastructure may turn into stranded assets. Continuous assessments alongside flexibility, should guide the creation of an efficient infrastructure in this evolving market.

In response to the third question, an adaptive reflexive approach is necessary to advance market integration within small states. To achieve this objective, three actions are imperative. Firstly, governments should adopt a more flexible approach to entry and participation in integration, reinterpreting their rights and obligations under Article 194, with particular emphasis on cost-benefit calculations. Secondly, existing regulations should facilitate coordination among intersectorial planning processes, particularly between the electricity and gas sectors, while simultaneously enhancing cross-border synergy to expedite climate objectives.

Although this study has endeavoured to design a legal approach suitable to address the challenges of transitioning the energy acquis, some considerations warrant attention. Firstly, the future of EU-Russia energy relations remains uncertain, serving as a crucial, yet unpredictable factor along the transitional pathway. Moreover, forthcoming political shifts, including the outcome of the 2024 European Parliament election, and ongoing revisionary debates about the Gas Directive amendment, may significantly impact the transition. On another front, the reflexive-adaptive framework aims to empower the regulated entities while adhering to principles, standards, and climate objectives. While this approach is a necessary legal solution for the transition era, sustaining this equilibrium may not be entirely straightforward in reality. This is primarily due to the limited institutional capacity of the EU in energy regulation. Additionally, it should be noted that EU expertise agencies, such as ACER, also face limitations in their capacity to monitor such complexities and maintain the desired balance.

## Lühikokkuvõte

## Euroopa Liidu gaasivarustuse julgeoleku tagamiseks üleminekuperioodil kohanemisvõimelise ja refleksiivse õiguse rakendamine

Kogu loodusliku gaasi asendamine kõigis sektorites mittegaasiliste energiaallikate ja kandjatega Euroopa Liidu süsinikuneutraalsuse eesmärgiks seatud sihtajaks (2050. aastaks) pole tehniliselt teostatav. Seetõttu on sel perioodil hädavajalik loodusliku gaasi järkjärguline asendamine dekarboniseeritud gaasidega. See eeldab gaasivarustuse julgeoleku säilitamist, st loodusliku gaasi ja alternatiivsete gaaside kombinatsiooni, isegi kui üldine gaasituru suurus on eeldatavasti üleminekuperioodil vähenemas. Selle eesmärgi saavutamiseks tuleb Euroopa Liidu energia õigustiku (acquis) raamistikus ületada kolm õiguslikku tõket.

Peamine mure keskendub gaasivarustuse välismõõtmele, eriti arvestades ELi kavatsust vähendada Vene loodusliku gaasi importi pärast Ukraina invasiooni. Liidu eesmärkideks on sõltuvuse vähendamine Vene gaasist samaaegselt kliimaeesmärkide järgimisega, mis on kaasa toonud liikmesriikide lahkuminevad ja mõnel juhul vastuolulised lähenemisviisid. Näiteks, samal ajal kui Eesti ja Saksamaa vähendasid Vene gaasi importi, on teised suurendanud Venemaa LNG importi ja Ungari pikendas oma kokkulepet Gazpromiga. Vastuolud tulenevad erinevatest tõlgendustest Euroopa Liidu lepingu artiklile 194, mis annab liikmesriikidele vabaduse valida oma energiaallikad, samas kui toetatakse energia solidaarsust liidu piires. Kuigi praeguses olukorras laieneb liikmesriikide arusaam varustuskindlusest alternatiividele Vene gaasile, on Euroopa Liidu Kohtu (CJEU) õigustõlgendus energia solidaarsuse põhimõttest võimaldanud komisjonil ja liikmesriikidel energia solidaarsuse põhimõttele viidates otsuseid vaidlustada. (teisi),. Need vaidlused võivad takistada koostööd liikmesriikide, Euroopa Komisjoni ja gaasiettevõtete vahel, kes kõik jagavad ühist vastutust gaasivarustuse tagamise eest üleminekuajal, nagu on sätestatud määruse (EL) 2017/1938 artiklis 3.

Teiseks, gaasituru kahanemise tõttu üleminekuperioodil muutub loodusliku gaasi süsteemi kohandamine alternatiivsete gaaside ülekandmiseks hädavajalikuks. Siiski ei käsitle kehtivad õigusaktid vajalike kulude jaotust süsteemi ümberehitamiseks ja uute gaasisüsteemide loomiseks. Lisaks, arvestades selle ülemineku järkjärgulist iseloomu, peavad mõned praeguse loodusliku gaasi taristu segmendid jääma toimivaks kuni 2050. aastani, nõudes pidevat investeerimist nende hooldusesse. Vaatamata sellele vajadusele on asjaomaste õigusaktidega kaasnevad ebakindlused, nagu näiteks taksonoomiamäärus, tõenäoliselt takistuseks loodusliku gaasi ettevõtetele edasistele investeeringutele infrastruktuuri luhtunud varade riski tõttu. See rõhutab dekarboniseerimisest põhjustatud õiguslike väljakutsete olemasolu Euroopa Liidu gaasi siseturul.

Kolmas murekoht puudutab gaasivarustuse julgeolekut väikestes ELi liikmesriikides. Majanduslikel kaalutlustel toob kahaneva loodusliku gaasi turu asendamine dekarboniseeritud turuga nendele riikidele suuremad väljakutsed. Seega on Euroopa Liit viimastel aastatel rõhutanud turu integratsiooni soodustamist eriti Balti riikide näitel, kus energiajulgeolek on olnud oluline mure. Siiski ei ole selle eesmärgi täielik saavutamine veel õnnestunud, peamiselt riikidevaheliste arusaamatuste tõttu, mis on seotud turuintegratsiooni hüvede õiglase jaotusega . Vaatamata mitmetele jõupingutustele ei ole ülevalt alla suunatud õiguslikud meetmed suutnud seda eesmärki edukalt edendada, kuna sellised meetmed võivad takistada liikmesriikide õigusi vastavalt Euroopa Liidu lepingu artiklile 194. See õigustab täiendavate õigusaktide vastuvõtmist, mis võivad tagada Balti riikide gaasivarustuse julgeoleku, eriti ülemineku varajases faasis.

Uuring väidab, et praegune ELi õiguslik raamistik, mis ühendab turupõhiseid ja CAC-põhimõtteid, on mõeldud tagamaks katkematu energiavarustus ja soodustamaks konkurentsivõimelist energiaturgu. Siiski pole see raamistik piisavalt varustatud energia ülemineku keerukuste ja ebakindlustega tegelemiseks, kuna seda ei loodud sellist konstellatsiooni silmas pidades. Seetõttu peetakse kolmekordse väljakutsega silmitsi seismist olemasoleva reguleeriva paradigma piires ebapiisavaks. Pigem on vaja uut reguleerivat lähenemist, mis põhineb refleksiivse ja kohanemisvõimelise õiguse elementidel, mis arvestaksid energiasektori ainulaadseid omadusi.

Refleksiivne õigussüsteem kaasab riikide kõrval mitmesuguseid toimijaid ja üksusi, eriti reguleeritud üksusi. Reguleerimisvastutuse ümberjaotamine loob isereguleeriva raamistiku, mis vähendab sõltuvust keskvõimust, nagu on CAC-süsteemides. See võimaldab kiiret ja paindlikku kohanemist ettenägematute väljakutsetega üleminekuajal, kuna kõik otsused ei nõua keskvõimu sanktsioneerimist. Samal ajal tagab keskvõim, et otsused oleksid kooskõlas üleminekuajal määratletud põhimõtete ja eesmärkidega. Refleksiivsust, kui protseduurilist õiguslikku lähenemist, saab näidata ISO 14001-s või riskihindamise protseduurilistes käskudes määruses 2017/1938. Lisaks muudab refleksiivne õigus regulatiivsed vastused paremini kohandatavaks reguleeritud üksuste tasandil esinevatele operatiivsetele väljakutsetele, mis on rohkem kooskõlas kohapealsete tingimustega. See lähenemine soodustab ka enesetäiendamist, kaasates reguleeritud üksusi aktiivselt reguleerimisprotsessidesse, suurendades seeläbi võimet omandada ja rakendada reguleerimise läbivaatamisel saadud õppetunde, mis on veel üks oluline kasu üleminekuaja ebakindlustega tegelemisel. See loob polütsentrilise reguleerimissüsteemi, mis võimaldab liikmesriikidel vastu võtta regulatsioone, mis on rohkem kooskõlas ja kohandatud nende kohalike vajadustega, samal ajal järgides peamisi kliimaeesmärke.

Refleksiivne õigus seab sisse “osaliselt avatud” õigussüsteemi, mis võimaldab tal saada sisendit, näiteks olulisi juhiseid keskkonnast, ja töödelda seda sisendit vastavalt selle sisemistele dünaamikale ja regulatsiooni põhimõtetele. Siiski peab meie õiguslik lähenemine integreerima sisulise elemendi, mis suudaks juhtida energia üleminekut. Arvestades, et ELi energiaregulatiivne süsteem teeb pidevalt kompromisse turu, jätkusuutlikkuse ja energiavarustuse vahel, on oluline lisada täiendav õiguslik lähenemine, mis tagab energiasüsteemi püsiva suunamise kliimaeesmärkide poole, samal ajal tagades energiasüsteemi normaalse toimimise, näiteks tagades varustuskindluse. Seetõttu pakub see uuring välja kohanemisvõimelise õigusraamistiku, mis annab üleminekuajal prioriteedi kliimamuutustele vastamiseks. See eeldab õiguslike põhimõtete ja sätete uut tõlgendamist ja kohandamist. Näiteks tuleks vesinikuturu loomiseks ELis vastu võtta uus tõlgendus lahtisidumise ja kolmanda osapoole juurdepääsu osas. Kombineerides neid kahte lähenemisviisi, saab kohandatav refleksiivne-kohanemisvõimeline lähenemine pakkuda vajalikku juhendamist, lähtudes selle peamistest tunnustest, nagu paindlikkus, eneseregulatsioon, vastupidavus ja kliimamuutustele kohanduvus.

Refleksiiv-kohanemisvõimelise õiguse lähenemise rakendamisega püüab uuring leida lahendusi ülalnimetatud kolmele õiguslikule väljakutsele. Esiteks püüab see raamistada paindliku mõiste varustuskindlusest. Kui see mõiste muutub õiguslikult siduvaks, pakuks see vahendit ELi ja selle liikmesriikide energiaotsuste hindamiseks. Lisaks teeb uuring ettepaneku muuta määruse 2017/1938 alusel tutvustatud N-1 valemit, mida saaks rakendada erinevate väliste tarnijate võrdlemiseks varustuskindluse seisukohast liikmesriikides. See uus indeks, GSSI, hõlmab elemente, mis saaksid liikmesriikide ja teiste asjaosaliste poolt grupis defineerida, andes neile teatava kaalutlusõiguse isereguleerimise olemuse kõrval. Selline indeks võib toimida sarnaselt ELi hinnangulistele skeemidele, mis toimivad otsustusabisüsteemidena ja aitavad leevendada huvide konflikte erinevate energiaotsuste tagajärgede kvantifitseerimise kaudu.

Refleksiiv-kohanemisvõimelise õiguse lähenemist rakendatakse ka lahtisidumise ja riigiabiregulatsioonide kohandamisel uurimisülesannetega. Seega on käesoleva uuringu raames keskendutud Gaasidirektiivile, Üldise Blokivabastuse Määrusele (GBER) ja “Puhta Energia kõigile Eurooplastele” paketile (CEEAG). See tuvastab vajaduse NRAde suurema paindlikkuse ja kaalutlusõiguse järele , koos perioodiliste õigusaktide hindamistega turu arengu ja konkurentsieeskirjade tasakaalu saavutamiseks. Regulatsioonid peaksid samuti soodustama integreeritud piiriülest planeerimist naabruses asuvate liikmesriikide vahel ja sektoriaalsete energia planeerimisprotsesside koostööd liikmesriikides, kus NRA-del on oluline roll. Lisaks on vaja integreeritud infrastruktuuri planeerimist, võimaldades üleminekuajal tekkida hübriidsetel TSO-del. See võib leevendada loodusliku gaasi ettevõtete muret, et infrastruktuuri investeerimine võib muutuda luhtunud varadeks. Jätkuvad hindamised koos paindlikkusega peaksid juhendama selle areneva turu efektiivse infrastruktuuri loomist.

Kolmanda küsimusele vastates on turu integratsiooni edendamiseks väikeriikide seas vajalik kohanemisvõimeline ja refleksiivne lähenemisviis. Selle eesmärgi saavutamiseks on hädavajalikud kolm tegevust. Esiteks peaksid valitsused võtma vastu paindlikuma lähenemisviisi integratsiooni sisenemisel ja osalemisel, tõlgendades ümber oma õigusi ja kohustusi vastavalt Euroopa Liidu lepingu artiklile 194, rõhuasetusega kulude ja tulude arvutustele. Teiseks peaksid olemasolevad õigusaktid soodustama koordineerimist eri sektoritevaheliste planeerimisprotsesside vahel, eriti elektri- ja gaasisektorite vahel, samal ajal tõhustades piiriülest sünergiat kliimaeesmärkide kiirendamiseks.

Kuigi käesolev uuring on püüdnud kavandada õiguslikku lähenemisviisi, mis sobiks energiavaldkonna ülemineku väljakutsetega tegelemiseks, nõuavad mõned aspektid tähelepanu. Esiteks jääb Euroopa Liidu ja Venemaa energiasuhete tulevik ebaselgeks, olles oluline, kuid ettearvamatu tegur ülemineku teel. Lisaks võivad tulevased poliitilised muutused, sealhulgas 2024. aasta Euroopa Parlamendi valimiste tulemus ja käimasolevad arutelud Gaasidirektiivi muudatuste üle üleminekut märkimisväärselt mõjutada. Teisest küljest, kuigi refleksiiv-kohanemisvõimelise raamistiku eesmärk on anda reguleeritud üksustele volitusi, järgides samas põhimõtteid, standardeid ja kliimaeesmärke, ei pruugi selle tasakaalu säilitamine tegelikkuses olla täiesti lihtne. See on peamiselt tingitud Euroopa Liidu piiratud institutsionaalsest võimekusest energiaregulatsioonis. Lisaks tuleb märkida, et Euroopa Liidu ekspertagentuuridel, nagu ACER, on samuti piiratud võimekus jälgida selliseid keerukusi ja säilitada soovitud tasakaalu.

# Appendix 1

**Publication I**

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**Replacing Russian gas with the United States: A critical analysis from the European Union energy security perspective**

**Abstract**

The security of gas supply is one of the main concerns for the European Union (EU), especially when considering the EU's dependence on Russian gas. The idea of importing liquefied natural gas (LNG) from the United States has recently emerged as an alternative to lower EU dependency on Russia. However, the idea still needs to be evaluated, of the extent to which it is beneficial or practical for EU gas security. Composing an appropriate indicator, the risks to the EU gas supply, the current research attempts to evaluate the idea of substitution. The composed touchstone comprises critical elements, including political risks for gas supply and transit, the importance of natural gas imports in the gross domestic product, and fungibility of the import. This indicator has been then applied to six selected Member States. The results of our analyses indicate that importing gas from the United States improves supply security in five cases. Nevertheless, the benefits of substitution should be evaluated considering the limitations of available infrastructures and the economic factors. This could suggest that importing the US LNG can be a conducive policy for Poland and the Baltic States, however, not necessarily for Germany, Italy and especially France. Therefore, replacing the US LNG entails some prerequisites to be considered a beneficial alternative for EU gas security.

**Keywords:** United States' LNG, Russia, Energy security, Indicator

## 1. INTRODUCTION

The European Union (EU) is currently a net importer of natural gas, mainly from Russia. In fact, the Soviet-Austria gas deal signed in the 1960s paved the way for Russian gas to arrive in the European market. The deal was extended in the aftermath of the Soviet Union collapse. Russia was known as a reliable energy partner for the EU in the eyes of the Commission until the early 2000s (European Commission, 2000); however, the Russia-Ukraine gas disputes in 2006 and 2009 changed the scene. While even nowadays, the EU has remained dependent on Russian gas up to 43.6% of its import in 2020 (Eurostate, 2021), some EU Member States have been actively following policies to lessen their dependence on Russian gas in the aftermath of 2000s gas disputes. These policies mainly include diversification of supply sources or routes, and decreasing Russian gas import for improving resilience against potential interruptions in Russian gas flow.

Nevertheless, the EU could not find many reliable alternative gas suppliers to diversify its supply sources. Concluding gas deals with the significant Middle Eastern gas owners did not go beyond importing a limited number of liquified natural gas (LNG) cargos from Qatar, mainly due to security, political or economic difficulties. Moreover, the realization of the Eastern Mediterranean gas export to the EU still depends on overcoming critical commercial and legal challenges the region faces (Karbuz, 2021). Additionally, while Caspian basin gas resources looked very reliable for the EU in the early 1990s, it remained limited to one supplier, i.e. Azerbaijan, and the main gas transportation project, Trans-Caspian Gas Pipeline (TCGP), does not look to be accomplished soon to transfer giant gas volume to the EU (Gurbanov, 2018). Contrary to the mentioned resources, a light at the end of the tunnel emerged for the EU, when the US rapidly enhanced its LNG export capacity by virtue of the shale gas boom (Richman & Ayyılmaz, 2019). However, not all the Member States eagerly embraced the US LNG, as some of them, like Germany, even followed their policy to strengthen gas relations with Russia, including by construction of the controversial Nord Stream II pipeline.

Perceiving Russian gas as a threat to the EU has been the dominant rationale behind the idea of Russian gas replacement with other sources and potentially the US LNG (Bordoff & Houser, 2014). However, it is necessary to distinguish between two different types of threats when different scholars address Russian gas; a "geopolitical leverage" which Kremlin applies to bully the Union for the aim of influencing the neighbours (Collins, 2017; Smith, 2009), and as a threat against Member States' "energy security", considering EU's low resilience against gas interruptions, in general (Richter & Holz, 2015; Ruban, 2013). The first perception stands on political (or moral) principles to contemplate how Russian gas import can fuel Kremlin's foreign policy, and should be stopped. Comparatively, the second perspective tries to prove how fragile the security of the Russian gas supply is for the EU, especially reminding the Russia-Ukraine gas disputes of 2006 and 2009.

The purpose of this research is mainly to focus on the latter threat perception. It wants to assess the effectiveness of replacing the Russian gas with the US LNG to enhance the EU's security of gas supply, using quantitative methods. In other words, this research does not go through the idea of neutralising Russia's efforts in using its gas as political leverage. Instead, we scrutinise to determine to what extent substitution of the US LNG with Russian gas import will decrease the gas supply risks for significant importers of Russian gas within the Union. Therefore, it does not analyse to what extent Russian gas import can be politically a wise decision, but how much substitution of Russian gas with the US LNG is beneficial from a mere EU's security of gas supply perspective.

The importance of the research is proved from three different perspectives. First, Regulation 2017/1938 of the European Parliament and the Council calls upon the EU Member States “to take essential measures to safeguard the security of gas supply”. Therefore, the replacement policy should be evaluated if it is in line with the main outline of the Regulation, i.e. security of gas supply enhancement. Moreover, while the environmental aspects of the EU’s energy policy get more attention in resource allocation, especially after the EU Green Deal introduction, the geopolitical concerns of supply security have remained on the table; however, less important than before (Keypour & Ahmadzada, 2021). Hence, evaluating capital intensive solutions like the LNG substitution is critical in optimising the EU resources allocation when supply security is targeted. Finally, understanding the effectiveness of the replacement policy is essential for the Union to preserve an independent energy policy while the US tries to impact the EU-Russia gas relation. One can perceive such efforts of the United States in its sanction imposition against Nord Stream II.

EU-Russia gas relations have been studied from an energy security perspective before. Significant attention has been paid to discussing the impacts of Russian gas import on the EU, from the geopolitical perspective, e.g. whether Kremlin can use it as a weapon against the EU. Also, a part of other publications talks about the benefits of diversification of supply by relying on alternative resources, like Eastern Mediterranean, Iran, Central Asia, neglecting the extent these resources are accessible for the EU, or without offering a measuring stone to prove the point if such replacement can actually boost the EU's energy security. This study focuses on the US LNG, perceiving it as the currently available alternative for decreasing the EU dependence on Russian gas. Furthermore, while Regulation 2017/1938 has introduced the "N – 1 index" for measuring the risks threatening EU Member States' gas supply security, the current research aims to develop the index to include additional factors for assessing the security of supply. It provides a quantitative ruler for evaluating the efficiency of the US LNG replacement impacts on the EU energy security.

The central claim of this paper is that importing the US LNG is not conducive for all the Member States' energy security, and therefore, it should not be treated equally in all parts of the EU. Moreover, it discusses that even in the cases where the index proves the benefits of the US LNG, it may require the Member State to abdicate some advantages of Russian gas import, like the transit revenue. Therefore, the research question is: "to what extent replacing the US LNG with the Russian gas can enhance the EU security of gas supply?"

This article is divided into the four sections below. The following section provides a methodological background to develop the indicator for measuring gas supply security and how it differs from previously designed indices. The results section demonstrates how the value of the composed indicator can change in each selected EU Member States through the replacement of Russian gas with the US LNG using the latest available statistics. It stands to reason that since the COVID19 outbreak distorted the overall energy market, this research has used the last available data before the pandemic, i.e. 2019. Section 4, as the analytical framework, discusses the results to evaluate the possibilities and limitations of implementing the replacement policy. Finally, the paper ends with our conclusions, recommendations, and proposals for future research.

## 2. Methodology

### 2.1. Energy security: definition and indices

Although energy security is an issue of critical importance for many different stakeholders, no consensus exists about its definition among scholars (Ang, Choong, & Ng, 2015). However, many of these rendered definitions greatly resemble one another (Sovacool, 2011). This enables us to select one of these definitions according to our goal, while many others are still compatible with it. For the aim of this research, energy security is defined as providing affordable, accessible, available, and acceptable energy for customers (Kruyt B. , van-Vuuren, de-Vries, & Groenenberg, 2009). In this research, we mainly consider the 'accessibility' component corresponding to the geopolitical aspects of energy security. The other elements of this “4A” definition are classified into availability (geological existence of energy resources), affordability (the economic considerations) and acceptability (the environmental and societal issues). Considering our aim of focusing on accessibility, the components of the composed index will be explained in the following.

#### 2.1.1. Political Risks of supply ($PR_s$).

Since one of the most critical sources of geopolitical risk of supply comes from dependency and concentration in the energy consumption portfolio, we assume these risks are measurable using the Herfindahl-Hirschman Index (HHI) (Pavlovića, Banovacb, & Višticab, 2018):

(1) $\mathrm{HHI} = \sum_{i=1}^{n}(100\ x_i)^2$ , $x_i$: the market share of the $i^{th}$ gas supplier for a specific importer

HHI is an index used to measure competition (or diversity) instead of dependence as an indicator of risks relating to a particular source or supplier. The higher the HHI, the higher the concentration, which means the system being examined is less diverse (Rubel & J.Chalvatzis, 2015). Therefore, if the number of suppliers is infinite ($n \to \infty$), HHI ‘approaches’ zero. This represents a market with perfect competition, while HHI = 10,000 indicates a total monopoly (n=1), due to the existence of a single supplier.

Although HHI may appear to be a good indicator for measuring security of supply, it has some deficiencies; it attributes the same level of political risk to different suppliers. This fact has been missed in some of the previous main studies stipulating the importance of diversification in proposing an index for energy security (Vivoda, 2009; Stirling, 2011; Cohen, Joutz, & Loungani, 2011). One can revise the HHI formula somehow to include this risk relying on the available assessed quantified geopolitical risks of each supplier as follows:

(2) $\mathrm{PR}_s = \sum_{i=1}^{n}(pr_{s_i} * x_i^2)$

$pr_{s_i}$ shows the normalized $PR_{si}$, i.e. by dividing $PR_{si}$ by the highest $PR_s$ value (represented by the worst state in the reference source). While $PR_s$ includes political risks for different suppliers, $\sum x_i^2$can cover diversification concerns. Therefore, through equation (2), $PR_s$ meets the requirements for having both geopolitical risks and diversification (or dependence) indicators.

Not many studies have attempted to quantify the geopolitical risks required to estimate PRs according to equation (2). Some resources choose simple indicators, like the Human Development Indicator (HDI), as the reference, and others rely on more complex indices. Nevertheless, indicators like HDI look too straightforward for identifying geopolitical risks of energy supply (Kruyt B. , van-Vuuren, de-Vries, & Groenenberg, 2011). Munoz and colleagues have quantified the geopolitical dimension of energy risk for 122 sovereign states. The combination of geopolitical and social dimensions in a single risk vector is vital for the current research aims, and Munoz's research meets this criterion reasonably (Muñoz, García-Verdugo, & San-Martín, 2015). Although Munoz's research was made in 2014; however, even that was the time when tensions were high between Russia and Ukraine in the aftermath of the Crimea Annexation. Therefore, one can consider it still viable, as the tensions have been escalated again. Also, $x_i$ is extracted from ENTSOG (European Network of Transmission System Operators for Gas) and, if necessary, validated by provided data from BP (2020) and Gazprom (2020).

#### 2.1.2. Political Risks of transit ($PR_T$).

While sporadic piracy cases exist involving LNG tankers, there are examples of how transit counties may (pretend to) use energy flow as a political lever against the importers, like how Belarus threatened the EU with Russian gas in response to Brussels' efforts for imposing sanctions against Minsk (Aarup, 2021). Hence, it is logical to include the influence of political transit risks in the composing index. Le Coq and Paltseva tried covering this by proposing an indicator for gas transit risk, focusing on the Russian case as the supplier (Le-Coq & Paltseva, 2012). In their work, transit states are considered as having bargaining power commensurate to the volume of gas passing through their territory. While this is applicable for the transiting states to make concessions from the main supplier, it does not cover the geopolitical risks of supply or transit pointing to the final importer. Other research has attempted to focus on one specific European importers' security of supply, such as Croatia (Pavlovića, Banovacb, & Višticab, 2018) and Italy (Bompard, et al., 2017), or to evaluate the importance of the EU's infrastructure development for improving supply security through an economic rather than a political concept and approach (Abrell & Leo Chavaz, 2019).

Contrary to the research mentioned above, we prefer to concentrate on political risks rather than technical ones. Basically, the political risk raises a certain level of 'uncertainty' since interruptions caused by them are more challenging to predict than technically-induced blackouts or power cuts. Additionally, whenever they arise, it is not easy to estimate when they will disappear. Muñoz et al (2015) claimed that their rendered data could also estimate the geopolitical energy risk for entire energy corridors by aggregating the geopolitical energy risk of the exporting and transit countries.[31]Assuming the importing gas passes through some transit states (m), total political transit risk equals the aggregated transit risks caused by each country. When this is multiplied by the risk for each route, we compute and then add to the risks attributed to other transit states, finally resulting in total political risks of transit, $PR_T$. Therefore, the total political risks of transit ($PR_T$) is defined as follows:

(3) $\mathrm{PR}_T = \sum_{j=1}^{m} x_j * \sum_{i=1}^{n} pr_{s_i}$

While $x_j$ is the proportion of imported gas passing via the $j^{th}$ route (quoted by ENTSOG), $\sum_{i=1}^{n} pr_{s_i}$ adds up the political risk of transit states in the $j^{th}$ route (quoted by Muñoz et al (2015)).

The total political risk (TPR) of a hypothetical supplier across a certain route can be calculated by adding $PR_T$ to $PR_S$, as below:

(4) $TPR = PR_T + PR_S$

It is worth mentioning that since the range of both sub-indicators, $PR_T$ and $PR_S$, is from 0 – 1, and both terms are dimensionless, the two terms are consistent to be added.

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[31] One may debate that even bilateral relations between the supplier and all transit states need to be accounted for (especially due to the Ukraine-Russia crises of 2006 and 2009). However, such data is not available to the best of our knowledge.

### 2.1.3. Natural Gas Import Dependency

The importance and dependence of EU Member States on imported Russian gas is not the same. For instance, while Eastern and Baltic States are heavily dependent on Russian gas, Western EU states have diversified their gas imports portfolio. As a result, Member States economic vulnerability is different against disruptions to Russian gas. To calculate this concept, one can divide the net gas import from Russia to the Gross Domestic Product (GDP) based on purchasing power parity (PPP), as below:

(5) $$\text{Natural Gas Import Dependency (NGID)} = \frac{\text{Imported Russian Gas Volume}}{GDP}$$

In a sense, this may represent the financial possibility to switch from this source to others, as well. The imported Russian gas data has been extracted from ENTOSG, validated by two other sources of Gazprom and BP, as explained in 2.1. GDP is extracted from IEA (IEA, 2020), which quotes it based on OECD and World Bank.

### 2.1.4. Fungibility (F)

The EU Commission recommends that the Member States enhance their energy resilience, including strategic storage capacity, installing more LNG importing facilities, and constructing new interconnectors to boost the EU natural gas network in the reverse direction (EU Commission, 2014). This rationale has been reflected in enshrining the fungibility element in the rendered index. It indicates the functionality of the state against any gas supply disruption, relying on the state's infrastructure and alternatives available for meeting its gas demand via alternative methods. This also increases the bargaining power of a final customer in negotiations with a certain supplier in terms of the contract, particularly regarding pricing. For instance, when Lithuania launched its first LNG terminal in Klaipeda, it received a 20% discount from Gazprom, even though Gazprom had raised gas prices for the Baltic States in 2011 (Grigas, 2014).

In line with the Commission's recommendations, and the N – 1 formula, the higher the 'backup capacity', the higher the resilience is. The fungibility potential comes from the operational LNG importing facilities, Underground Gas Storage (UGS) capacity, and available Interconnectors (IC). We assume that the resilience of an importing gas state has a positive relationship with the availability of alternative supply options. The total capacity of all these facilities provided should be assessed compared to the demand volume to evaluate the usefulness and performance of these options in an emergency. Therefore, fungibility is determined as follows[32]:

(6) $$F = \frac{Available\ Capacity\ of\ (LNG + UGS + IC)}{Annual\ Natural\ Gas\ Demand}$$

Interconnector capacity and UGS capacities data were extracted from ENTSOG (2020). Corresponding data required for LNG was obtained from International Gas Union (IGU) and was validated with data provided from ENTSOG (2020).

Now, considering all the elements as mentioned above in 2.1.1 to 2.1.4, the composite aggregated Gas Supply Security Indicator (GSSI) is defined according to equation (7):

(7) $$\text{GSSI} = \frac{F}{TPR * NGID} * 100$$

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[32] It includes the storage capacity measured in billion cubic meter (bcm) and operational (regasification terminals and interconnections) capacity expressed in bcm/annum. One can assume the latter one is multiplied by one year.

The GSSI index can render an applicable ruler for the aim of our research. While the fungibility indicates the bargaining power against a supplier, it can also show the resilience level against any interruption of gas supply using the backup capacities. The two elements of NGID and TPR in the denominator can represent the level of vulnerability against both a supplier and its corresponding transit routes and on natural gas in general, based on the diversity of the supply portfolio. The relative importance of each component of GSSI is not apparent, and, therefore, equal weightings have been considered.

### **2.2.** Case selection

Russian gas is not distributed across the EU in the same vein and through one route. While Yamal-Europe pipeline passes through Belarus and Poland to reach Germany, Nord Stream lies on the Baltic Sea to arrive in Northern Germany, and the traditional route of Russian gas passes through Ukraine to be distributed in Central and Southern Europe. (Gazprom, 2020). Additionally, Netherlands and Norway supply a part of EU gas demand (BP, 2020). Due to the expanded connections in the European gas network, different suppliers' gas is mixed somehow that is difficult to distinguish which source the flowing gas in the pipelines comes from at any given time. However, relying on the provided data by ENTSOG, it is distinguishable to realise the dependence of the bigger Member States on Russian gas and where the Russian gas goes finally. For the aim of this research, we focus on the Member States which consume 80% of the total exported Russian gas to the EU in 2019. Table 1 indicates how much of the exported Russian gas ended to each member state in 2019. Considering this table, the six states of Germany, Italy, France, Poland, Austria and the Czech Republic consume almost 80% of the total Russian gas exported to the Union. These six states will be selected as the case studies for this research.

**Table 3- The share of Russian gas ends to each Member State. (Data source: statistica.com, Gazprom, BP and ENTSOG)**

| State | DE | IT | FR | PL | AT | CZ | NL | HU | SK | EL | FL | BG | HR | LV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Share of the state from total Russian gas export (%) | 32.99 | 24.96 | 8.02 | 6.03 | 4.38 | 4.21 | 3.14 | 3.01 | 2.55 | 2.04 | 1.78 | 1.65 | 1.46 | 0.91 |
| State | **RO** | **BE** | **LT** | **EE** | **SL** | **IE** | **ES** | **PT** | **SE** | **LU** | **MT** | **CY** | **DK** | |
| Share of the state from total Russian gas export (%) | 0.82 | 0.81 | 0.68 | 0.68 | 0.27 | 0.26 | 0.04 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | |

## **3.** Results and implications

Applying the extracted data from ENTSOG (2020), BP (2020) and Gazprom (2020), the flow of Russian gas through different routes to the six selected Member States is depicted in figure 1. The complete composition of Member States' gas source portfolio can be derived as demonstrated in annexe 1.

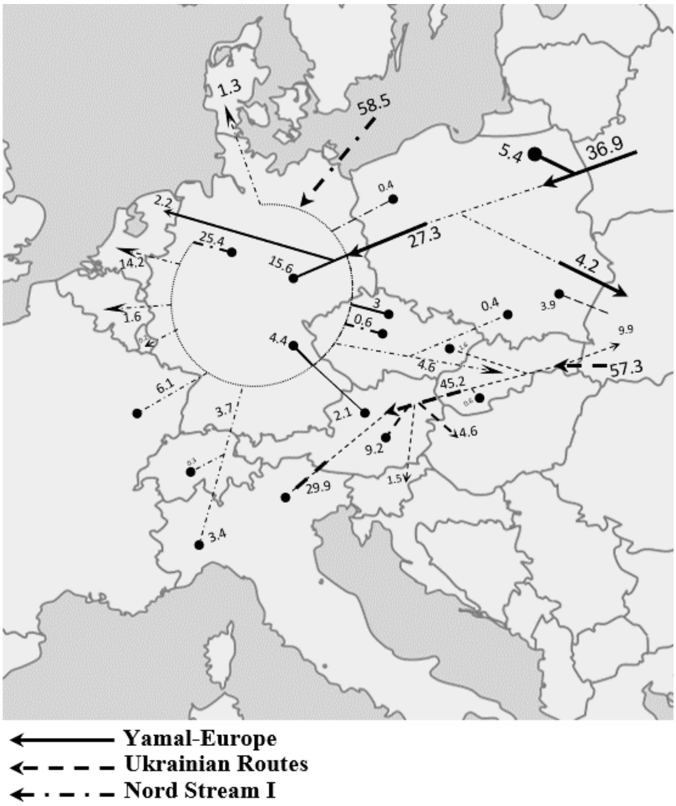


**Figure 3- the flow of Russian gas through different routes to the case states in 2019. (Filled circles show final destination)**

Using the provided data on the geopolitical risk of energy for each provider and transit state according to Muñoz et al. (2015) and considering the import gas portfolio in each selected state depicted in annexe 1 and figure 1, one can calculate the total political risk of supply, TPR according to equation (2), (3) and (4). The NGID can be calculated using equation (5) and having the capacity of interconnectors, UGS facilities and LNG terminals in each state; fungibility (F) can also be derived from equation (6). Finally, GSSI is obtained from equation (7). The corresponding data for the research cases are demonstrated in table 2.

**Table 4 - GSSI calculation details for the case studies**

| State | TPR | NGID | F | GSSI |
|---|---|---|---|---|
| **DE** | 0.36 | 85.21 | 2.81 | 9.16 |
| **IT** | 0.48 | 106.71 | 2.05 | 4.00 |
| **FR** | 0.07 | 44.72 | 2.49 | 80.93 |
| **PL** | 0.51 | 27.79 | 3.51 | 24.55 |
| **AT** | 1.08 | 66.08 | 7.29 | 10.26 |
| **CZ** | 0.19 | 76.73 | 8.99 | 60.58 |

**Source: Author calculation. Data extracted from IEA, BP, ENTSOG and IGU.**

One can repeat the calculation of GSSI once again to the situation where the vacant capacity of LNG terminals in these member states are used for importing LNG from the United States. It reads as removing the same volume of imported Russian gas from their

import portfolio. Therefore, the new derived GSSI index can indicate how replacing Russian gas with US LNG impacts the security of gas supply, considering the available facilities in reality. This could mean that Italy, Poland and France replace import 7.4, 1.5 and 6.1 bcm/annum of LNG from the United States, respectively, with Russian gas.
In the case of the landlocked states, i.e. the Czech Republic and Austria, one may assume that LNG can be imported by hiring the vacant capacity of neighbours' terminals and transferring the re-gasified LNG through the interconnectors. Such assumption is vividly acceptable given that the unutilised capacity of neighbours' LNG terminals suffices importing 9.2 and 1.6 bcm/annum gas for meeting Austrian and the Czech Republic demand. For Germany, which does not have any operational LNG terminal, a total of 20 bcm of Russian gas (15.6 + 4.4) was imported via transit routes (i.e. excluding the Nord Stream). One can assess the impact of 20 bcm replacement by the US LNG, given that Germany's neighbours' total unoccupied LNG capacity is sufficient for achieving this goal, according to the World LNG Report statistics. Additionally, ENTSOG data approves that transmission of the re-gasified LNG via interconnectors to Germany is possible from a technical perspective.
The new index, $GSSI_{US\text{-}LNG}$, is comparable with the GSSI in the reference scenario, as depicted in figure 2. The results show that such substitution can slightly enhance the GSSI of Italy and Poland, and more importantly, Germany and Austria and especially for Czechia. However, France experiences a fall in its GSSI as a consequence of this substitution.

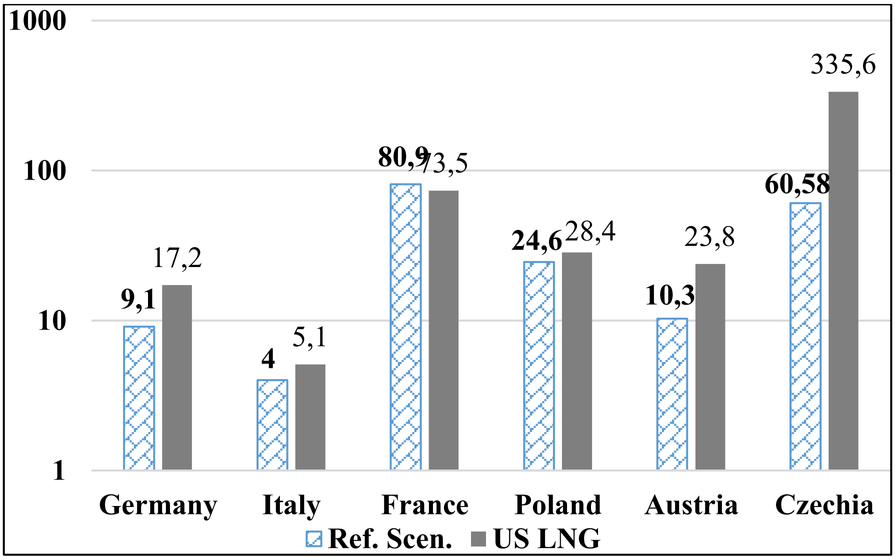


**Figure 4 - The GSSI of selected EU Member States in reference scenario and US LNG substitution with Russian gas**

## 4. Discussion

Considering the results of GSSI calculation, one can evaluate the effectiveness of LNG replacement policy for all the six member states, as follows.

### 4.1. Germany

The first noticeable fact about Germany is that Russian gas export to Germany no longer transits via Ukraine, but instead flow through Belarus-Poland (via the Yamal pipeline), or is transported directly via Nord Stream (Pirani & Yafimava, 2016). Thus, the geopolitical transit risk is attributed solely to the Yamal pipeline via Belarus, as the other route (Nord

Stream) connects Russia directly to Germany. Although Germany is the EU's biggest natural gas consumer and importer, its importing portfolio is relatively diversified as indicated in the annex 1; Norway (24.66%), Netherlands (25.57%), Russia (23.37+18.58%), and other EU nations (2.39%). Moreover, Germany benefits from the high connecting pipelines capacity, which can provide reliable backup and the available UGS facilities in the absence of any LNG terminal.

The results show that the US LNG replacement can improve Germany's security of gas supply as the $GSSI_{DE,\ US\ LNG}$ reaches 17.2 from the initial level of 9.1 in the reference scenario. The positive impact of the US LNG on German GSSI is compatible with the current field facts, as such alternation removes the political risks attributed to the Yamal pipeline for Germany. This connotes the future ambiguities around Yamal route operation under the influence of the uncertainties of the long-term gas transit contract between Europol Gaz and Gazprom, expired on May 18, 2020. Poland's PGNiG declared its reluctance to extend the long-term gas supply agreement with Gazprom on Yamal, and Gazprom had not expressed its interest in using Yamal capacity either (Pirani, Sharples, Yafimava, & Yermakov, 2020; Jakóbik, 2021). Therefore, the US LNG can alleviate Germany's energy transit concerns.

Nevertheless, the results should not be interpreted to the absolute advantage of the US LNG for Germany. First, Germany does not have an operating LNG terminal yet, which means US LNG should be imported through other neighbours, as mentioned before. While ENTSOG data proves that their LNG terminal and reverse flow capacities suffice to replace Russian gas imported to Germany via Yamal, conflict of interest may arise if these neighbours want to use their unbooked capacity to import LNG for other purposes, such as meeting their own needs. One solution is accelerating the planned LNG units in northern Germany, i.e. Wilhelmshaven and Brunsbüttel. However, such an idea is also problematic. According to German Uniper's CEO, Klaus-Dieter Maubach, "it is becoming difficult for LNG to be competitive in the German market due to the good supply situation through pipelines - and with Nord Stream II, another one is coming" (Wettengel, 2021).

Our complementary calculation affirms Maubach's statements; Germany's GSSI can reach 13.51 if substitution of NS II instead of Yamal is considered, which is a promotion contrary to the current value of 9.1. Although this is still lower than $GSSI_{DE,\ US\text{-}LNG}$, NS II can provide cheaper gas to Germany given that the US LNG cargos have been delivered to Germany's neighbours more expensive than the Russian gas to the German market (IEA, 2021). Additionally, NS II is expected to lower the price of Russian gas in Germany and Western Europe further (Goldthau, 2016; Günther & Nissen, 2019). This makes NS II even more advantageous for Berlin. In addition to economic considerations, NS II is a crucial project for enhancing Germany's role in the European gas market, as it increases the transit flow through Germany by 17 bcm, enhancing the liquidity of Central European gas hubs (Goldthau, 2016). Given the $GSSI_{DE,\ US\text{-}LNG}$, one can conclude that the US LNG is potentially beneficial for Germany's security of gas supply; however, it is not the best solution compared to other available options.

### 4.2. Italy

Among the six selected member states, Italy has the lowest GSSI. This is because Italy imports more than 42% of its gas needs from Russia, mainly through Ukraine-Slovakia-Austria (north-eastern route), while a small portion also comes via Germany-Switzerland (north-western route), as depicted in figure 1. While the former still plays a prominent role, the latter is expected to be utilised more if NS II is launched. Until then, Italy is vulnerable to supply interruptions (Pirani, 2018). The $GSSI_{IT,\ US\ LNG}$ shows little promotion compared with the reference scenario since the vacant capacity of LNG terminals is not magnificent, i.e. just 18% (IGU, 2019). This limits the manoeuvrability of Italy for replacing Russian gas with US LNG. Contrary to Germany, the possibility of importing LNG through the neighbours is highly curtailed for Italy due to the lack of enough reverse flow interconnectors with France. This can explain why $GSSI_{IT,\ US\ LNG}$ is not much higher than the reference scenario.

One may suggest expanding the capacity of the interconnector or considering new LNG terminals in Italy for the better of US LNG, especially using EU's financial aid. However, the EU's main focus in energy policymaking has been gradually switched to the climate targets rather than the security of supply (Keypour & Ahmadzada, 2021). The Commission is revising corresponding legal outlines of energy infrastructures development like the Trans-European Networks for Energy (TEN-E) Regulation and the Projects of Common Interests (PCI) framework in the same vein. Under the new TEN-E and PCI structure, it will not be easy to apply for the EU's financial aid to develop gas infrastructures, especially for enhancing gas supply security, like new LNG terminals in Italy. Therefore, within the available infrastructures, the positive impact of the US LNG replacement in Italy's gas market remains tiny.

### 4.3. Czech Republic and Austria

As indicated in figure 1, the Czech Republic meets almost one-third of its demand from the OPAL pipeline as an extension of the Nord Stream. It also received 1.6 bcm through Slovakia, which comes from Ukraine per se. Austrian dependence on the Ukraine route is higher than Czech, and its import portfolio is less diversified, increasing risks (see annexe 1). At first glance, LNG importation to the landlocked states of the Czech Republic and Austria seems non-existing ab initio due to their lack of access to the sea. Nevertheless, their relatively small market volume makes it possible to rely on the vacant capacity of the neighbours' LNG terminals, like Italy and Poland. The impact of this substitution on $GSSI_{CZ}$ is magnificent; it rises from 60.58 to 335.6. This sharp growth is justifiable due to two facts; the US LNG diversifies the Czech gas portfolio, decreasing $PR_S$ according to equation (2). It also reduces $PR_T$ as the Czech Republic becomes needless of Russian gas coming from Ukraine route. The same goes for Austrian GSSI.

While the positive impact of the US LNG on the Czech and Austrian gas supply security is undeniable, other factors may moderate policymakers' decision to lean towards the US LNG. First, the price of imported LNG may not look competitive; even less than the already described situation of Germany since the transit fee will be added to the importing LNG. Furthermore, given the Austrian and Czech Republic's involvement in the Central and Western European (Russian) gas-distributing, it is unlikely to expect these states to substitute Russian gas with US LNG significantly. Jirušek (2020) has shown how the Czech Republic reoriented its stance favouring NS II and closer to the market-oriented attitude in recent years, making any redirection of gas supply patterns unnecessary for Prague. This is discernible, especially after the 2017 Gazprom long-term deal on gas transit through the Czech Republic until 2050.

In addition to NS II, another newcomer rival for the US LNG, i.e. the Turkstream pipeline, should be accounted for. Gazprom started using this line to deliver gas to Turkey, Bulgaria, Greece, and North Macedonia in early 2020. This was followed by feeding Serbia, Bosnia and Herzegovina, and Romania. While the pipeline has not yet extended to central Europe, where Austria and the Czech Republic are, this can happen in the future. In that case, Ukraine's role in delivering gas to Central Europe would be diminished, as it has already happened in Southern Europe. According to Ukrainian authorities, the Trans Balkan Pipeline used to transfer Russian gas to Southern Europe via Ukraine was operating at less than 5% capacity in late 2020 (CRS, 2021). The extension of Turkstream to central Europe means that Austria and the Czech Republic can reduce the PRT needless of importing LNG from the United States via neighbours. Thus, US LNG can positively impact Czechia and Austrian gas supply security, yet it entails overcoming powerful rivals like Turkstream and NS II.

### 4.4. Poland

Figure 2 indicates that Poland can experience a slight improvement in its GSSI using the US LNG. Russia was the main gas supplier in Poland, with more than 53% of the total consumption in 2019 (see figure 1). Although Poland gets Russian gas via Belarus and Ukraine, Warsaw can receive gas from Germany via the Nord Stream extension, using the Mallnow gas station reverse flow at the German/Polish border (ENTOSG, 2020). The only Polish LNG Terminal in Świnoujście can also provide up to 5 bcm natural gas per year. However, as the role of Russian gas has been critical in the Polish gas supply, the $GSSI_{PL}$ is still low. Świnoujście did not work at full capacity, reaching 70% in 2019 (IGU, 2019). Thus, if Poland uses the terminal for altering Russian gas, an additional 1.5 bcm of Russian gas can be substituted by the US LNG, resulting in an improvement of GSSI to 28.4. One can also suggest utilising the vacant capacity of the Lithuanian terminal in Klaipeda, the Independence, which was used no more than 47% in 2019, to unload other LNG cargoes (IGU, 2019). This will further improve $GSSI_{PL}$ to 33.30 and is conducive to the Independence facilities economic performance.

Unlike other discussed cases like Germany, Poland has solid complementary political motivations to back the idea of Russian gas alternation in addition to the GSSI improvement. In fact, Warsaw has perceived the EU energy cooperation with Russia as a security threat due to its own long-standing conflictual interaction with Moscow (Siddi, 2020). In the aftermath of 2006,9 gas disputes, Poland has tried to portray Russian gas as a “weapon” in the hands of the Kremlin against the EU, ahead of some other Central and Eastern European Countries (CEECs). Therefore, diversification of gas supply sources is mainly justified by political intentions in the eyes of Warsaw (Bocse, 2020; Brown, 2018). Similarly, one can explain the US support for the EU’s energy infrastructure projects, considering the political aspects of EU-Russia gas relations, rather than pure economic interests. Given such a convergence in political approaches of the United States and Poland on Russian gas, one can expect Poland steps to reduce or moderate its reliance on Russian gas by relying on the US LNG. As our research indicated, such a decision can be backed by the GSSI promotion as well.

### 4.5. France

Contrary to the states mentioned above, France experiences a decline in its GSSI, if it alters Russian imported gas with the US LNG. This is justifiable considering France gas market structure. Currently, France benefits from diversified gas providers consisting of twelve states, and Russian pipeline gas has no significant role (no more than 12%, see annexe 1). Moreover, Russian gas is delivered to France needless of Ukraine transit route, according to the gas deal between Gazprom and French GDF SUEZ in 2006, when parties agreed to deliver gas via the Nord Stream until 2030 (Gazprom, 2013), as depicted in figure 1. Therefore, replacement of US LNG in France will not significantly improve the $PR_T$, but instead, it disturbs the diversification of the French gas portfolio resulting in higher $PR_S$ according to equation (2). Therefore, such policy lessens the $GSSI_{FR}$, and it does not look to be a rational choice for Paris.

## 5. Conclusion

This research analysed the impact of the United States' LNG advent in lowering risks to gas supplies in the European gas market. It is critical to assess this impact because United States LNG has been recognised as a rival for Russian gas, favouring EU gas supply security and diversifying the gas portfolio for European Union member states. Although the EU-Russia relationship has been studied, looking through the lens of gas supply security before, this research approached the topic relying on a quantitative method, considering geopolitical risks of transit and supply for different case studies. Thus, six EU Member States who receive more than 80% of total Russian gas export to the EU have been selected to study the impacts of the US LNG substitution on their security of gas supply. In order to evaluate supply security, an index for gas supply security index, called the GSSI, was composed.

Applying the GSSI indicator, this research shows that in the most straightforward case, United States' LNG is beneficial for Poland as it improves $GSSI_{PL}$ from 24.56 to 28.42. The same goes for Italy, Germany, the Czech Republic and Austria. Among these four member states, Italy is the only one that can count on its own LNG terminals, others have to open their market for the US gas using the available vacant capacity in their neighbours. Despite the positive impact of the US LNG on the GSSI of Germany, the Czech Republic and Austria, it stands to reason to assume that the political and economic considerations may prevent decision makers to move forward with the US LNG, in reality. Notably, if Nord Stream II pipeline becomes operational, Germany can achieve cheaper Russian gas, making it more attractive than United States' LNG. The implications of the possible extension of the Turkstream pipeline to Central Europe may appear as another rival for the US LNG in Czech Republic and Austria cases.

The outcomes of our analyses do not support the claim that the United States LNG is realised as the best operational option for the (selected member states of) EU to lower risks to supply. On the one hand, even though in most of the studied cases, the US LNG can enhance the security of gas supply index, i.e. GSSI, implementation of the idea may be restricted due to operational limitations, like available infrastructures or the capacity of the gas facilities. For instance, while we assumed that Germany, the Czech Republic and Austria could hire the unoccupied capacity of their neighbours LNG facilities, it may raise conflict of interests if their neighbours tend to use their vacant capacities for their own demand. One may propose that future developments may set the stage for higher capacities needed for importing additional LNG. However, the EU's gas infrastructure development plans are under review to comply with climate targets. Under such circumstances, using EU financial aid for gas projects will be problematic, especially if it is a matter of supply security rather than decarbonisation. The implication of such a climate approach could curtail the capacity expansion needed for importing additional LNG, including from the United States. Nevertheless, it is safe to say that the US LNG seems attractive to Poland compared to other countries in this study. Poland's political motivations back reducing dependence on Russian gas, including with the help of the US LNG.

Despite this research effort to compose a holistic index for measuring the security of gas supply, it is not easy to include and evaluate other essential factors in the same index. In a broader sense, while economic and technical considerations have been accounted for our analysis and interpretation of the GSSI results, environmental issues (i.e. the 'acceptability' element of the 4A energy security definition) have remained untouched. One can consider this as a general defect of all rendered indices since none of them are capable of measuring all energy security elements at once. This could mean that simultaneous quantifying environmental and supply security considerations within one aggregated index is problematic. Thus, the GSSI results should be interpreted considering that the United States LNG comes mainly from not-so-environmentally-friendly shale gas sources, and therefore, importing the US LNG may be perceived in breach with EU's climate policies.

Last but not least, the study limited the transit risk only to the political risks of transit states. Even though this is the main component of the transit risk used in a few previous studies, it can be extended to the direct impact of political disputes between transit states and suppliers as well. The required data can be gathered and quantified using a questionnaire-based data collection method in future studies. Moreover, fungibility was limited merely to other forms of gas alternation, neglecting the fact that in some cases, other fuels can be used in emergencies as well, such as coal to fuel power plants. This should be examined closely on a case-by-case basis, as the generalisation is not possible. Although implementing these two points further complicates the study, the result would be more precise and reliable. This aspect proves the diverse level of supply security for member states demand various solutions if higher security levels should be targeted. Finally, the considerable natural gas price gap between the US and Asian markets has historically enticed the American LNG exporters to send their cargos to the far East rather than other markets. Therefore, the issue of the US LNG availability should be considered in analysing the possibility of Russian gas replacement in the European gas market.

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**Natural gas import portfolio for the selected cases in percentage (%)**

| *From* / *To* | | IT | PL | DE | FR | AT | CZ |
|---|---|---|---|---|---|---|---|
| ***LNG*** | **Trinidad and Tobago** | 2.00 | -- | -- | 0.58 | -- | -- |
| | **Algeria** | 3.87 | -- | -- | 5.00 | -- | -- |
| | **Angola** | -- | -- | -- | 0.77 | -- | -- |
| | **Russia** | 0.13 | -- | -- | 13.27 | -- | -- |
| | **Norway** | 0.13 | 0.77 | -- | 2.88 | -- | -- |
| | **Nigeria** | 0.40 | -- | -- | 8.46 | -- | -- |
| | **Qatar** | 8.54 | 12.69 | -- | 3.65 | -- | -- |
| | **USA** | 2.14 | 5.22 | -- | 5.96 | -- | -- |
| | **Egypt** | 0.53 | -- | -- | 0.77 | -- | -- |
| ***Netherland*** | | 1.60 | -- | 25.57 | 16.92 | -- | -- |
| ***Norway PNG*** | | 3.60 | -- | 24.66 | 29.04 | -- | 29.73 |
| ***Russia*** | **UA route** | 39.92 | 21.43 | -- | -- | 81.42 | 21.62 |
| | **NS route** | -- | 2.20 | 23.37 | 11.73 | -- | 8.11 |
| | **Yamal route** | -- | 29.67 | 18.58 | -- | -- | -- |
| ***Other EU member states*** | | 5.07 | 2.20 | 2.39 | -- | 18.58 | 40.54 |
| ***Algeria PNG*** | | 13.75 | -- | -- | -- | -- | -- |
| ***Libya PNG*** | | 7.61 | -- | -- | -- | -- | -- |
| ***Domestic production*** | | 6.14 | 25.82 | 5.43 | 0.19 | -- | -- |
| ***Total*** | | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

**source: author calculation based on data from ENTSOG, BP and Gazprom**

# Appendix 2

**Publication II**

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**Critical Legal insight to EU Hydrogen Strategy**

Javad Keypour, Tanel Kerikmäe, Archil Chochia

## Introduction

Hydrogen is not an energy source in itself, but it has been introduced as a new energy carrier that, if it replaces fossil fuels, can facilitate carbon reduction in the future (Rosen and Koohi-Fayegh 2016). Since hydrogen does not have carbon atoms in its structure, its combustion does not emit carbon. Thus, hydrogen can provide energy in two pollutant energy sectors where decarbonization is challenging, i.e., transportation and power (and heat) generation (Edwards, Kuznetsov and David 2007). Additionally, hydrogen offers other benefits, including its effective energy conversion and the possibility of zero-carbon production (if produced from renewable energy sources), making it suitable for establishing a circular economy and higher electrification (Ishaq and Dincer 2020). Hydrogen can also be used for storing electricity in combination with renewable energy generation methods, e.g., solar and wind power production. This increases the performance of renewable power generation and covers their intermittency problems (Maleki, et al. 2017). Additionally, hydrogen may be integrated into traditionally independent sectors, namely electricity, heat, and transport, resulting in sector coupling (Parra, et al. 2019). This is beneficial for establishing an integrated energy market, among other things, in the EU.

Despite the potential of hydrogen to reduce carbon emissions, up to 96% of the hydrogen currently produced in Europe originates from natural gas, which is a source of $CO_2$ emissions. Hydrogen accounts for less than 2% of Europe's present energy consumption and is primarily used to produce chemical products, such as plastics and fertilizers, instead of acting as an energy carrier. The EU has addressed hydrogen in Directive 2018/2001, the so-called Renewable Directive (RED), as a green energy carrier if it originates from renewable sources. To enhance the share of renewable hydrogen, the EU Commission has developed "A hydrogen strategy for a climate-neutral Europe" or the EU hydrogen strategy, as it is called (European Commission 2020b). Moreover, due to the role of hydrogen in linking the electricity and gas sectors, it has also been addressed by the "EU strategy for energy system integration" (European Commission 2020a). It is expected that these two documents will pave the way for achieving the EU's climate targets in 2050 (European Commission 2021).

The EU hydrogen strategy classifies hydrogen into different types, including renewable/clean hydrogen, i.e., hydrogen generated via electrolysis using renewable electricity. It envisages raising the clean hydrogen production level rapidly to one Mt (million tons) and the installed capacity of electrolyzer to six gigawatts by 2024, reaching 10 Mt and 40 gigawatts (GW) in 2030. Despite the reduction in the cost of hydrogen production thanks to technological developments, these targets still look ambitious; the current EU electrolyzer capacity is well under one GW, and the largest electrolyzer under construction in Europe has a capacity of 10 MW. Thus, a more significant role for low-carbon hydrogen seems inevitable to form a smooth transition to renewable hydrogen in the perspective of 2050 (Lambert, 2020). Similarly, a smooth transition and the gradual decarbonization of natural gas look more realistic in achieving the EU Green Deal goals, in a broader perspective (Piebalgs and Olczak 2018, Belyi 2021). This means greater attention to low-carbon hydrogen is needed than the extent to which the EU hydrogen strategy is achieved.

A gradual transition to pure hydrogen has implications for its transmission. The EU hydrogen strategy assumes that hydrogen demand is initially met through on-site production, so the demand for new hydrogen-specific networks will remain limited. Even if transmission of pure hydrogen is needed, the current 1,600 km of hydrogen pipelines will not be sufficient as they cover only some parts of Germany, France, Belgium, and the Netherlands (Steen 2016, 271). This network should expand to 11,600 km by 2030, and then to the pan-European network with a length of 39,700 km by 2040, which shows a lot has yet to be done. Establishing such a network is capital intensive and time-consuming, estimated to cost $43-81 billion, especially for the optimizing compressors (Jens, et al. 2021). As a result, injecting hydrogen into the available natural gas network, which results in a natural gas-hydrogen mixture (NGH2), has been proposed as a beneficial solution in the transitional phase to create the demand and pave the way for establishing the final EU hydrogen market (Kleperis, et al. 2021).

The above-mentioned transition to the hydrogen economy and the establishment of the pan-European hydrogen market where hydrogen can flow freely across the EU (and certain neighbors) requires legal prerequisites. This is critical since the current EU legal frameworks should be assessed if they are to be applicable during the transition time and in the final EU hydrogen market. Thus, the main aim of this chapter is to talk about these legal prerequisites, posing the question: What main regulations are required on the way to achieving the EU hydrogen strategy goals? To this end, we discuss to what extent the current EU energy acquis is generally applicable to the hydrogen development plan's segments. Then, we discuss the more environmental aspects of the energy transition, such as the guarantee of origin and, finally, state aid. The latter issue will also be addressed beyond the EU legal frameworks, i.e., in terms of the World Trade Organization outlines. The legal challenges of hydrogen promotion have been discussed earlier, mainly from a technical perspective concerning the technical regulations needed for hydrogen transportation or production. However, this chapter looks at the topic from a more macro perspective to discuss what the EU and the member states should do. Each section will approach the topic critically and will end with recommendations. Finally, the conclusion will address the main areas of legal requirements. These prerequisites include the need for clearer Gas and Electricity Directives, reforming the guarantee of origin and state aid regulations.

## 1. Hydrogen and the current EU energy acquis

### 1.1. The applicability of the Gas Directive to NGH2 and hydrogen

Although the Lisbon Treaty of 2009 was the first treaty that explicitly addressed energy as a shared competence, the Commission had started to restructure the EU's natural gas market in the late 1990s when it ratified the First Energy Package. Functional unbundling and third-party access (TPA) to electricity and gas networks were among the critical issues included in Directives 96/92/EC and 98/30/EC (Talus & Aalto, Competences in EU energy policy, 2017, p. 16). The EU energy acquis then evolved into the Third Energy Package, encompassing Directive 2009/73/EC, the so-called Gas Directive. With the advent of hydrogen and consideration being given to using the existing natural gas network for its transmission, the question arises if the current EU legal framework applies to NGH2, and even pure hydrogen, systems in the future.

The Gas Directive explicitly talks about its conditional applicability to other gases under Article 1(2):

*The rules established by this Directive for natural gas, including LNG [liquified natural gas], shall also apply in a non-discriminatory way to biogas and gas from biomass or other*

*types of gas in so far as such gases can technically and safely be injected into, and transported through, the natural gas system.*
Accordingly, NGH2 is treated differently from pure hydrogen. Since NGH2 is obtained when hydrogen is safely injected into the operating natural gas pipeline and in compliance with the (harmonized) standards, the Gas Directive applies to it. In other words, a safe composition of NGH2 can be transmitted through the natural gas system and, therefore, it can be regulated by the Gas Directive. However, it is tricky to treat pure hydrogen legally, and even scholars are not unanimous about this. While Lengyel (2021) and Fleming and Fershee (2018) believe that the current directive should regulate pure hydrogen, Benrath (2020) limits the Gas Directive jurisdiction to those hydrogen pipelines integrated into natural gas systems. Conversely, a report by GEODE (2020) believes these EU rules only refer to natural gas networks but not to other gases, in practice. Similarly, Tarkowski et al. (2021) recognized an existing loophole preventing underground hydrogen storage as the Gas Directive does not apply to pure hydrogen gas systems.
The legal complexity of the hydrogen systems lies in the fact that a hydrogen system can be established in two forms: first, a natural gas system converted and optimized to handle pure hydrogen (for instance, following a modification of the compressors and pipelines), and second, a system designed and constructed from scratch to transmit pure hydrogen. In the first scenario, if hydrogen is safely injected into a system used to transport natural gas, the first condition enshrined in Article 1(2) is fulfilled. However, it is problematic when claiming that the requirements of Article 1(2) are met entirely for application to pure hydrogen. The directive stipulates its jurisdiction over other gases injected safely into the natural gas system, meaning that natural gas should be still there to essentially act as the carrier gas, considering the definition of the system rendered by Article 2(13). Otherwise, it is doubtful if a system handling pure hydrogen can still be considered a natural gas system (even if it is used as one). As a result, Article 1(2) will not be entirely applicable to hydrogen passing through a reformed natural gas system as the Directive has been drafted to regulate natural gas exclusively.
Nevertheless, the possible counterargument seems viable as well as there is no rigid criterion nor a clear threshold to distinguish a natural gas system against Article 2(13). It seems the current wording of Article 1(2) causes a Paradox of the Heap as the line of distinction is not evident in the transition from a natural gas network to a hydrogen one. It seems the current wording of Article 1(2) causes a *sorites paradox* as the line of distinction is not evident in the transition from a natural gas network to a hydrogen one. For instance, should we consider a system carrying a natural gas (1%) + hydrogen (99%) composition as a natural gas system? As it handles natural gas and another gas supposedly injected safely into the system, nothing hinders us from considering it to be a natural gas system from a legal perspective. Considering such a case as a natural gas system and rejecting a pure hydrogen transmission system just because it does not contain (the trace content of) natural gas will not make sense, mainly as safety considerations are at the same level. To prevent such confusion in our legal perception, one can argue that once a natural gas system is converted to another gas system, the last part of Article 2(1) becomes a negative proposition because of its subject being *non-existing ab initio* and, therefore, there is no further need to fulfill it. As a result, a natural gas system will remain under the jurisdiction of the Gas Directive even if its functionality changes to handling hydrogen. Thus, one can conclude the Directive is often overridden in relation to such a system.

Thinking about the second form, i.e., a system designed originally to handle hydrogen, the issue is still legally complicated. At first glance, the Gas Directive does not apply to such a system, mainly because the primary purpose of the Gas Directive was exclusively to regulate the natural gas market (or systems). However, one can argue that the lack of other gas markets at the time of ratification of the Gas Directive does not prevent it from being applied to them, primarily as Article 2(1) was intended to recognize the possibility of such markets existing (Fleming and Kreeft 2020, 110). Thus, the Commission may render a new extensive interpretation of the Directive to include hydrogen or other gases in the Gas Directive, arguing that they have taken some share of the energy market previously met by natural gas, and this should be now treated similarly. This extensive interpretation assumes that the capability of a gaseous energy carrier, e.g., hydrogen, to be safely injected into and transported through the natural gas system makes it eligible to become a matter for the Gas Directive universally (i.e., even if it passes through an independent system).

Nevertheless, even if we accept such an extensive interpretation, it might violate the non-retroactivity principle, making it problematic to apply the Gas Directive to a pure hydrogen system. Moreover, it is not expected that the Commission will initially render a new interpretation of an ongoing law on its own behalf as this procedure needs to commence by one Member State, and this has not occurred yet. Thus, it is most probably not applicable to such a newly established system. The different interpretations discussed above are summarized in Table1.

**Table 5- The applicability of the Gas Directive to different types of hydrogen systems. Source: authors contribution**

| Case | NGH2 | Converted NG system | Newly constructed $H_2$ system |
|---|---|---|---|
| **Applicability of the Gas Directive** | Yes | More often than not | Most probably not |

1.2. The Gas and Electricity Directive and hydrogen storage

Hydrogen can be stored using diverse physical forms (compressed or liquid state) or chemical methods (Niaz, Manzoor and Pandith 2015). However, underground hydrogen storage (UHS) looks to be the most promising method, both economically and technically. Hydrogen is injected and stored in depleted reservoirs or salt caverns (Zivar, Kumar and Foroozesh 2021). The UHS capacity of Europe is estimated at 84.8 PWh with Germany having the highest potential of 11.1% of total capacity (Caglayan, et al. 2020).

On the one hand, hydrogen storage can be perceived as gas storage, especially if hydrogen is obtained from fossil fuels. The same argument in Section 1 can be used to investigate if the Gas Directive applies to storing NGH2 or pure hydrogen. The applicability of the Gas Directive to hydrogen storage means TPA obligations (according to Recitals 23 and 24 and Article 33) and unbundled principles (addressed particularly in Article 15) should rule hydrogen storage. This can be especially the case for low-carbon hydrogen as it is produced from fossil fuels.

On the other hand, hydrogen can be stored as a method for electricity storage, especially when integrated into a renewable, particularly solar electricity production system. The former Directive 2009/72/EC on the internal electricity market did not address electricity storage using hydrogen or batteries as storage was mainly limited to mechanical means, i.e., pumped-storage hydroelectricity. Thus, some member states, like Germany, Italy, Spain and the UK, adopted their own approach to approving battery pilots in motivated cases where transmission system operators (TSOs) and distribution system operators (DSOs) were involved (Meeus and Bhagwat 2018). However, the Commission has since recast it to the new Electricity Directive 2019/944.

Article 2(59) of the Electricity Directive defines energy storage in the electricity system as "[…] the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier". According to Article 2(60), the device where the storage happens is known as an *energy storage facility*. This means the act of storing hydrogen produced from the electrolysis process is classified as energy storage. The Directive articulates energy storage in an electricity system instead of defining electricity storage, and it does not provide a clear definition of a system. Moreover, the definition includes three inextricably linked segments; conversion, storing and reconversion to energy. This implies that if the electrical hydrogen is used for non-energy application (for instance, as feedstock), it will not be considered as storage even if it was stored in the meantime.

The current approach of the EU energy acquis on hydrogen raises questions about the legal situation of some hypothetical cases. For example, which directive covers electrical hydrogen stored in a UHS facility part of the natural gas system, especially if it is stored for electricity network congestion management? One can argue that the Gas Directive applies since it is stored in the natural gas system. The counterargument recognizes it as electricity, converted to another form of energy and, therefore, should be ruled by the Electricity Directive. Under the second scenario, the legal situation of the UHS system after depleting hydrogen remains vague about whether such a storage facility remains an electricity system or not. It is especially the case because conversely to the Gas Directive, the Electricity Directive does not clearly define a *system*.

What if the reservoir was not previously part of the natural gas system and was initially prepared for hydrogen storage? While some electricity system operators can own the storage facility, could gas undertakings be prevented from owning or operating such a reservoir just because the stored hydrogen is a form of electricity? Moreover, since salt caverns can be used for hydrogen, natural gas, and carbon dioxide storage, this may set up a conflict of interest between gas and electricity operators. It is not entirely clear how these conflicts should be managed under current legal frameworks. This case can become more complicated because the efficiency of salt cavern UHS facilities is increased by injecting a cushion gas, such as methane, before injecting the main gas (here, hydrogen) (Zivar, Kumar and Foroozesh 2021). One can question whether the injection of methane (the main component of natural gas) has any legal consequences and whether it turns a UHS facility into a part of the gas system. Such an argument becomes even more vital if a gas undertaking performs the injection process.

Finally, we can talk about the direct conversion of solar energy to hydrogen. While the technology has only been developed at the pilot scale, it will likely be industrialized by 2030 (Radowitz 2021). In this method, solar energy is transferred directly to water to produce hydrogen without generating electricity. Regarding Article 2(59), storing such hydrogen cannot be considered electricity storage and, if it is stored in pressure vessels but not UHS, the Gas Directive will not apply either.

The above-mentioned cases indicate scenarios in which hydrogen is either under the concurrent jurisdiction of two directives or of none. The former is more complicated because the two directives have different approaches, although amended simultaneously most recently. The Gas Directive amendment was aimed at solidifying the unbundling outlines of the new gas pipelines coming from third countries to the EU (like the Nord Stream II). Conversely, recasting the Electricity Directive was a part of the clean energy for all Europeans package. Thus, recasting aligned it with EU environmental targets to integrate renewables more and, therefore, it elaborated explicitly on hydrogen storage. The concurrent jurisdiction is especially problematic as the Electricity Directive bans generators, and the distributors, in particular, from owning storage facilities (Fleming and Fershee 2018, Fleming and Kreeft 2020), while the Gas Directive allows this: however, only under certain circumstances. Additionally, the compliance of a gas undertaking handling hydrogen storage facilities with the Electricity Directive remains questionable and needs to become transparent.

This conclusion necessitates revising the Directives in line with the hydrogen development targets. While the Commission is reviewing the hydrogen and decarbonized gas market package to "ensure that the gas market framework is in line with our Fit for 55 ambition" (European Commission 2021), the new provisions should be outlined based on the gradual transition from the current gas network system to the desired hydrogen one. It should also clarify the legal status of a network handling NGH2 and pure hydrogen to safeguard the security of supply. Furthermore, the applicability of unbundling outlines and network operators' roles in hydrogen system development should become clear, as will be discussed next. However, without prejudice to the ongoing reform of the Gas or Electricity Directive, nothing will diminish the need for clarification of the legal status of hydrogen concerning the current energy acquis, a revision procedure that is expected to be time-consuming.

## 2. Hydrogen network development in the EU energy acquis

### 2.1. Legal challenges of hydrogen transmission system development

Assuming the necessity of NGH2 as a part of the transition phase on the way to establishing the EU (pure) hydrogen market, two actions seem necessary to be implemented simultaneously: the optimization of the existing natural gas network for NGH2 and the creation of a hydrogen transmission network (which can be the existing network, but adapted to handle pure hydrogen, partially or entirely). However, such a twofold strategy requires revisions in the current legal frameworks. To understand the aimed revisions, the existing legal outlines of the energy transmission sector needs to be examined first.

Before the restructuring of the EU energy market and during the monopoly era, the producers, merchant gas transmission companies (MGTCs) and local distribution companies (LDCs) cooperated in a vertically integrated structure to meet the demand. With privatization, liberalization and unbundling, the EU natural gas market has been fundamentally reshaped. Most importantly, the MGTCs have been replaced by the following:

a) Utilities: the gas (and power) assets owners, like gas-fired power stations and regasification terminals;
b) Mid-stream energy traders of gas and power;
c) Network companies, including DSOs and TSOs;
d) LDCs, which serve smaller customers in competition with a range of other suppliers, and
e) Storage owners and operators, some of which are owned by TSOs, and some are in independent ownership.

The Gas Directive unbundled the network; it turned the TSOs and DSOs into pure gas (and power) network companies, preventing them from engaging in energy supply (Stern 2017).

Despite the unbundling, the energy acquis kept the TSOs/DSOs responsible for developing the network to meet the demand and safeguard a secure and reliable energy supply. According to Article 22(1) of the Gas Directive, TSOs should draft a network development plan (NDP or NEP) in a ten-year horizon for their affiliated state and submit it to the national regulatory authority (NRA) after consulting all the relevant stakeholders. The plan should contain efficient measures to safeguard the system's adequacy to preserve the security of supply. Since cross-border trading is essential for the EU natural gas market to function, an EU-wide plan is also needed to harmonize the NDPs. Therefore, the European Network of Transmission System Operators for Gas (ENTSO-G) has adopted a non-binding community-wide ten-year NDP (TYNDP) according to Article 8(3)(b) Regulation 715/2009. The TYNDP includes a European supply adequacy outlook and should be updated every two years. It also must be consistent with the NDPs. Forecasting supply and demand and needed investment for developing the network, especially for building interconnections, is an intrinsic task of the TSOs, along with the help of the NRAs. While the ENTSO-G is a platform to facilitate cooperation between gas TSOs, the Agency for Cooperation of Energy Regulators (ACER) is a forum for coordination between the NRAs. This means that the NDPs, including the TYNDP, are formed and monitored based on close cooperation between ENTSO-G and ACER, and are reported to the European Commission (Hancher and Salerno 2017).

Additionally, to establish closer links between national and EU-wide markets and to accelerate the development of strategically important cross-border energy transmission projects, the EU parliament has ratified Regulation 347/2013 on guidelines for a trans-European energy infrastructure (TEN-E). It has defined eight priority energy corridors labeled Projects of Common Interest (PCIs) (Melgar 2017). The PCIs will deliver positive net welfare benefits for the EU member states as a subset of the projects listed in the TYNDPs. ACER has a central role in providing essential and comprehensive information for defining PCI lists and reviewing national, regional, and European network development plans (ACER 2021). Figure 1 demonstrates a brief scheme of natural gas development planning in the EU.

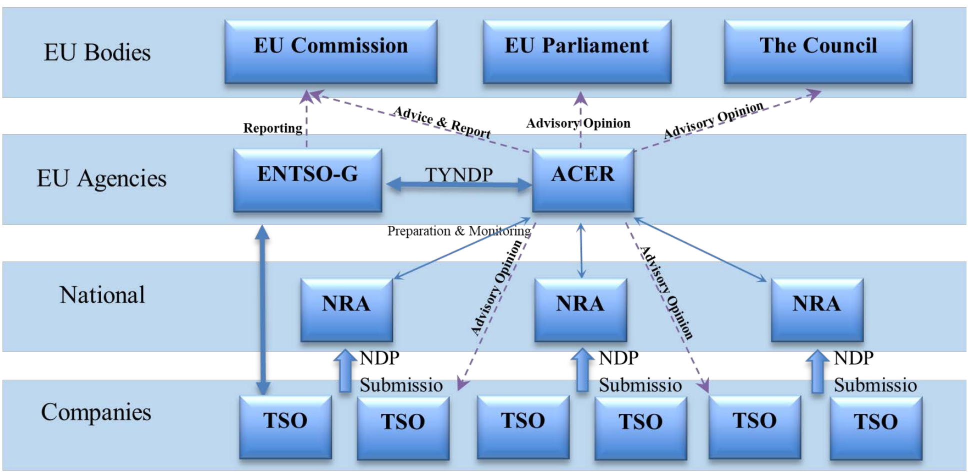


**Figure 5- A brief scheme of natural gas development planning in the EU.**
**Source: authors' contribution.**

Such a legal structure has been formed gradually over time. The European gas network was first formed based on a monopoly structure. Then, the above-mentioned legal framework was implemented on the pre-existing natural gas network over time to make it a competitive market where non-discriminatory access was granted to third parties. However, the EU Green Plan now targets decarbonization, which is not necessarily in line with the competition. In other words, regardless of whether the current energy acquis is applicable for establishing a new hydrogen network, it is more probable that it does not assure the decarbonization aims as it was designed to guarantee other targets.

Despite the inconsistencies, the principle of structural cooperation for harmonic network development is still needed for hydrogen networks. Thus, the fundamental question of who should bear the costs or plan the development remains open. This is important because network development plans for alternative gases, such as hydrogen, are not enshrined in the TYNDP or the NEP. Natural gas TSOs may be equally accused of breaching the law if they become involved in hydrogen network development. Additionally, developing a hydrogen network requires massive investment, while the law prohibits the provision of this through natural gas network fees (GEODE 2020). This indicates the existence of a legal void and the need to design a planning structure for the hydrogen network expansion.

In addition to pure hydrogen network development, financing the existing natural gas network optimization for NGH2 transmission is not without its challenges. Studies have shown that the addition of hydrogen to the gas composition requires increasing the flow rate to conserve energy per unit volume of the transported natural gas. This is costly since some of the network rotating equipment might need to be redesigned or reinforced. As depicted in Table 1, we assume that the Gas Directive applies to the NGH2 transmission network, meaning that the TYNDP and NEP can sketch the main outlines. However, it might be problematic for the DSOs. For instance, Italian DSOs counteract municipalities that do not currently account for hydrogen transportation (Saccani, Pellegrini and Guzzini 2020), and it should become clear how and who should afford the machinery adapted for handling NGH2.

### 2.2. Cross-border hydrogen transportation: the gas quality standard issue

The technical assessment shows that injecting up to 15% vol hydrogen into the existing EU natural gas network may require only modest technical modifications to the pipelines (Melaina, Antonia and Penev 2013). The obtained NGH2 is also compatible with standard metering instruments (Jaworski, Kułaga and Blacharski 2020) and has been assessed safe and compatible with the EU's home appliances (Isaac and Lewis 2021, European Commission 2017). However, blending can change the natural gas Wobbe Index (Fleming and Fershee 2018). As the member states have different thresholds for the Wobbe Index in their gas standards, this may hinder the cross-border movement of NGH2, the central element of the EU hydrogen market, between them.

Even in the early attempts to design the internal gas market, the European Parliament recognized unharmonized gas quality standards as a barrier causing uncertainty for companies who wanted access to the different national networks (Stiphout 2021). To address these concerns, the EU Commission issued mandate M/400 to the European Committee for Standardization (CEN) in 2007 to analyze the effects of changes in gas quality on consumer appliances. A later report (GL Noble Denton; Pöyry Management Consulting 2012) prepared for the Commission provided insights into the costs and benefits of gas quality harmonization, highlighting the vast array of issues and interests in gas quality specifications among the member states. The report reflected no consensus on how harmonization could be achieved, or even if it should be at all. Contrary to these efforts, the rejection of cross-border gas movement due to the incompatibility of gas quality between the two sides has rarely happened. Moreover, the proposed mandate was non-binding for the member states and, as a result, unifying gas quality standards has not been strictly pursued nor has it occurred.

In the absence of an EU-wide gas specification standard, Article 15(1) of the Commission Regulation 2015/703 considers TSOs responsible for reaching a joint proposal for solving the issues that may arise due to the gas quality differences in cross-border movement in cooperation with NRAs. Such a procedure has never been triggered as issues have been solved by cooperation between TSOs (Piebalgs and Olczak 2018). While the Commission previously pointed out the importance of "interoperability" under Article 6 of the Directive 2003/55/EC to issue the mandate M/400, harmonization of standards will become more of an energy security matter in the EU hydrogen market as time goes by. This is notably because Article 7(4)(b) of Regulation (EU) 2017/1938 classifies safety and gas quality considerations as the risks that affect the security of the gas supply and makes the member states responsible for taking necessary action to eliminate them. This implies that in a pan-European hydrogen market, cross-border gas movement may become a daily need that requires a more proactive ex-ante regulation instead of the current ex-post approach of Article 15 (1) Regulation 2015/703.

The current challenges of the transmission network in meeting the objectives of the EU hydrogen strategy require some legal reforms. This could include but is not limited to:

1) A comprehensive network development plan which encompasses and meets the demands of natural gas, NGH2 and hydrogen together is needed to safeguard the security of the gas supply in the transition era. Such a plan should find a balance between the fundamental rights of the member states to determine "their choice between different energy sources and the general structure of its energy supply", according to Article 194(2) of the Treaty of Functioning European Union (TFEU), and to promote hydrogen in line with the climate-neutrality general goals of the EU. The EU should meticulously manage this balance since the legal framework of TFEU does not allow for the compelling of a member state to give up a specific energy source due only to environmental considerations (Talus & Aalto, Competences in EU energy policy, 2017).

Additionally, affirmative and preventive measures and policies should guide investments to support the gradual shift to hydrogen. In other words, the existing gas network should not become a stranded asset unless the market is assured of the proper functionality of the new hydrogen network. For instance, the Belgian NRA has mandated the depreciation of the pipeline networks by 2050, and Austria has taken a similar approach, using weighted average cost of capital (WACC) as a lever (FSR 2021). Member states can also allocate their state aid to accelerating the hydrogen market establishment as a complementary measure (see Section 6). The EU should also outline TEN-E to support hydrogen more than fossil fuel projects; however, the considerations regarding the gradual shift to hydrogen must be observed.

2) The current gas network and its corresponding energy acquis has developed gradually. Even Poland and the Baltic States were given a moratorium to comply with the EU energy regulations to protect their markets from uninhibited seizure by Russian companies upon entry into the Union (Talus & Aalto, 2017). Thus, it is not logical to expect the under-construction hydrogen network to comply with the same legal outline from the beginning, especially the strict TPA or unbundling obligations. Instead, it is conducive to allowing TSOs/DSOs to contribute to constructing the new network. Such policy is

beneficial for both sides from a financial perspective; while it gives the grounds for the above-mentioned idea of gradual depreciation of gas facilities, it allows the EU to preserve a financial channel for running hydrogen development plans (Barnes and Yafimava 2020, GEODE 2020).

3) Although a unified gas specification standard is critical for the pan-European hydrogen network establishment, it may not be needed from the early stages significantly because not all the member states benefit from the same level of preparedness of using hydrogen. For instance, while the high capillarity of the natural gas network in Italy or Germany makes it ready to step into the hydrogen economy (Saccani, Pellegrini and Guzzini 2020), the island states of Malta and Cyprus do not yet benefit from an extended gas network in their territory (Papsch 2021, 584). Moreover, not all the member states have the same plans for utilizing hydrogen in the future as their energy demand and market volumes are not the same. For instance, Finland seems to see limited potential for the deployment of hydrogen, instead favoring nuclear electricity to decarbonize the energy sector (Costescu, et al. 2021). Thus, it is reasonable to assume that the regional gas exchanges between neighbors will soon look more realistic than EU-wide transportation.

Limitation of the movement of hydrogen to the local markets makes harmonization of standards simpler as, instead of targeting an EU-wide standard, one can focus on regional ones. This means that the harmonization of gas standards should first be implemented in areas where regional NGH2 exchanges are expected to be higher. This is important because the EU hydrogen strategy pays special attention to the production of hydrogen electrolysis in neighboring countries and its import into the EU, including through Ukraine. Therefore, it is necessary to remove technical barriers to the transfer of hydrogen production from priority routes, i.e., between the main production sites to important consumption centers.

## 3. Guarantee of origin (GO)

In recent years, growing attention to climate change has necessitated the compliance of power generation with the carbon abatement goals and higher facilitation of renewables. However, it is still difficult to guarantee the carbon-neutrality of the electricity delivered to a specific consumer since a liberalized market aims at providing the cheapest electricity, not the greenest. In other words, a liberalized market is characterized by the availability of competing electricity suppliers fed by diversified primary resources. Thus, it is problematic to identify where the electrons flowing to each consumer come from (renewable, nuclear, or fossil-based origins).

To solve this issue, Directive 2001/77/EC, drafted to promote electricity produced from renewable energy sources in the internal electricity market, addresses the question of guarantee of origin (GO). While Recital 10 introduced the idea, Article 5 defined a GO as a certificate issued upon a producer's request and confirms the content of the source and the time and place of power generation (and, if hydroelectric power, the plant's capacity). Shortly after, Directive 2003/54/EC attempted to outline "disclosure" of the electricity generation source; however, it did not refer to GO explicitly (Evercooren 2020, 203). The issuance of GO for eligible renewable energy sources was then reaffirmed in Article 15 of the Directive 2009/28/EC (the first Renewable Directive, RED I). Then, Recital 59 of the Directive (EU) 2018/2001 (RED II) extended the coverage of GO to gaseous renewable energy forms, including hydrogen, and even non-renewables. Moreover, Article 19 of RED II stipulates what information the GO should contain, including but not limited to the place of power generation, any dedicated investment support or national support scheme, facility commissioning time, and a unique identification number. Accordingly, the GOs "have the sole function of showing to a final customer that a given share or quantity of energy was produced from renewable sources".

There have been critiques on the efficiency of the GO system, primarily to attract additional investment, claiming that GO has failed to bring any additional investment for the European electricity system but has just added to the bureaucratic complexity of the market. The low price of the GO, as a result of its oversupply in the European market, is attributed mainly to Norwegian producers. Therefore, it has even been proposed to limit the access of Norwegian GOs to the EU market (Hamburger 2019).

Contrary to such claims, one can attribute the GO market oversupply to its developing status, which has changed in recent years for a better supply-demand balance. For instance, the Association of Issuing Bodies, as the most prominent and longest operating GO issuer, has reported the growth of market activity regarding GOs over time. By the end of 2019, 79% of GOs issued for electricity produced during 2018 and 49% of GOs issued for electricity produced in 2019 were reported as having been canceled. 6% of GOs issued for electricity produced in 2018 have expired, up from 3% the previous year (Pototschnig and Conti 2021). These statistics indicate how the GO is drawing more attention.

It is expected that the GO market will become more mature in the years to come due to consumers' more significant attention to the environmental footprint of power generation. This is expected to balance the market and solidify the GO system in the future. When writing this chapter, the Commission is reviewing RED II, including the certification mechanism that the "Member States will no longer be allowed to exempt GOs for supported electricity" (European Commission 2021). It is essential to regulate the GO market, along with the developing hydrogen market, by relying on complementary measures, as below, to avoid the adverse influences of market failure.

First, Article 19 of RED II simultaneously authorizes the states to issue GOs for non-renewable sources in addition to renewable gases, including hydrogen. As a result, both renewable and low-carbon hydrogen (derived from fossil fuels) can receive GOs. Such GOs must display the carbon footprint for the different types of hydrogen, including non-renewable ones. However, an important question will still be how to calculate the carbon footprint of fossil-based hydrogen, to include the carbon emission of the natural gas extraction step, as a source of non-renewable hydrogen production. This is even more difficult for the imported natural gas from non-EU sources.

One suggestion is to consider statistics declared by the producer or monitoring systems embedded in the European methane strategy (Piebalgs and Jones 2020). However, the reliability of self-declared data can be controversial. The efficiency of the proposed monitoring systems for imported gas is questionable as the emission level of major gas exporters, e.g., Russia, Norway, or the United States, are not the same. Russia has the highest associated natural gas flaring volume globally, making its emission per unit of produced gas the highest. Moreover, there are occasional disparities between the data provided by two sources, the Russian government and global authorities, such as the Global Gas Flaring Reduction Partnership (GGFR), using satellite monitoring methods (Taherifard, et al. 2019, 211). The emission of shale gas production in different regions of the United States is not the same, and different estimations with a significant range between high and low are available (Stern 2017). This makes taking such measurements more complex.

Additionally, how to verify if a non-EU gas exporter claims it recycles the released emission of natural gas extraction (for instance, via carbon capture units)? The same situation may arise if the exporter claims a certain carbon emission level of its fossil-based produced hydrogen. Although Article 19 (11) of the RED II has discussed the conditions of third-country GO recognition, due to the complexities of hydrogen GO issuance, the EU should elaborate on a fully-fledged verification mechanism for hydrogen produced in third countries. This is particularly important since Russia, the leading gas exporter to Europe, has planned to export 0.2 Mt of hydrogen by 2024 and 2 Mt by 2035 (Zabanova and Westphal 2021). Verifying hydrogen GOs from Norway could be included, given the current Norwegian GOs circulating in the European market and the transparency of Norwegian emissions data. Ultimately, the designed mechanisms must adhere to the principle of non-discrimination, which is mandatory for GO market expansion in the future (Abad and Dodds 2020).

Third, since GO does not have a fixed price, its value being determined by the law of supply and demand, customers should be stimulated to buy renewable electricity proofed by GOs to retain market balance. While in some countries, suppliers still have a monopoly position on GO, some other states have made it possible for consumers to buy GO directly from manufacturers. This has helped with attracting new customers, especially corporations (Evercooren 2020). Nevertheless, it is still necessary that the information provided in the GOs remains clear, reliable, efficient and, at the same time, easily understood by all customers; complicated or untrustworthy information will not create new GO demand. The implication of this requirement for hydrogen GO means the hydrogen taxonomy enshrined in the EU hydrogen strategy should be simply reflected in the GO, somehow understandable for (non-professional) customers, from the carbon emission perspective. Evidence from studies shows that a lack of understanding of the disclosure mechanisms in the Netherlands in 2019 has led to a lack of public trust in the "existence of green electricity", which may adversely impact GO performance (klimaatstichting HIER 2019).

Finally, expanding the GO market could become possible by facilitating cross-border exchanges. However, the current certificates are not the same content-wise, partly because the member states still have a significant role in regulating the content of GOs, and a standard form of GO is needed. While the RED II has underpinned the standardization basis, including setting the minimum required level of 1 MWh, expiration and validation time, it is still not enough. GO Standardization is especially vital for hydrogen as it is produced using different methods and from different sources, in which case certificates can differ and, therefore, be confusing. Therefore, it seems logical to design a standard certificate for the different specific steps in the production procedure, based on the applied technology and source of production. In a similar proposal, White et al. (2021) proposed the design of modular certificates based on the various components and technologies used in the hydrogen production process, considering the emission level of each step. Such modular certificates can harmonize the exchanges of hydrogen-based certificates and, thus, retain the market supply and demand balance.

## 4. State aid

State aid is known to be a conducive measure for developing new technologies, including renewables. The TFEU prohibits the competition-distorting state aid, particularly, Articles 107-109, which were elaborated in Commission Regulation 651/2014. These state that the member states have to inform the EU Commission of their decision to support firms in specific circumstances, defined in the mentioned frameworks, to assure the EU that their actions are not in breach of the fair competition rules. Additionally, as an external factor, the non-discriminative trade provisions of the World Trade Organization (WTO) curtail (but not entirely prohibit) state aid. Since both the EU and the member states are members of the WTO, the latter find themselves complying with the WTO rules per se and the EU's interpretation of them. Moreover, since the eligibility criteria of state aid support are complicated, it is up to the court to decide its legality in a disputed situation, if the case does not end in the hands of the Commission. As a result, state aid is classified as part of the field of case law, which is overwhelmed with documented cases. This limits the scope of our study to specific (hypothetical) situations of devoting state aid for the promotion of hydrogen.

### 4.1. State investment in infrastructures development

The first question is whether state aid can be allocated to hydrogen infrastructure development. According to the provisions of the TFEU and section 7 of Regulation 651/2014, it is possible to do so, contingent on the necessity of infrastructure to prevent market failure. The Commission has rendered three criteria for distinguishing the necessity: (i) the absence of such infrastructure should be detrimental for achieving the development plans, (ii) TPA is guaranteed, and (iii) the project will contribute to the security of the supply in the Union (Hancher and Salerno 2019, 857).

Achieving the ambitious goals of Europe's hydrogen strategy requires massive infrastructure development, including a significant leap in renewable electricity production, and gas and electricity network development and optimization. Given the recent analysis results by Belmans, Reis, & Vingerhoets (2021), there is little room for supplying the additional renewable electricity demand by 2030. Therefore, state aid is *necessary* to attain hydrogen strategy goals and preserve the EU security of the supply in the future. It means the EU Commission's criteria for state aid allocation will be met if the TPA is guaranteed in hydrogen infrastructures. Such development plans can be realized under PCIs and within the framework of the TEN-E regulations. This confirms the need to revise the TEN-E legal framework favoring renewables development, including hydrogen targets, as has already been discussed in Section 2.2.

While the three criteria seem helpful for understanding a case's legality, a lasting hydrogen development plan needs more straightforward solutions. The EU regulations should clearly outline the exemption circumstances regarding state aid so that the member states can implement their plans without following intensive bureaucracy, specifically for hydrogen development. This can be achieved, for instance, by granting a mid-term exemption for allocating state aid to these development plans. Such solutions will also enhance the certainty of investment. This would also lift the burden of proof from the member states' shoulders. Current regulations require them to demonstrate their compliance with the triple criteria. However, this can be assigned to the EU Commission to assess if there is a violation of competition or it can become the responsibility of the complainant, exclusively for renewable development plans.

Since renewable hydrogen costs more than fossil-based hydrogen, one may suggest subsidizing the electricity used by the electrolyzers to reduce the cost and make it more competitive. However, different aspects of competition regulations preclude this. Within the WTO, supportive measures for renewables, i.e. subsidies, might be justified under Article XX(b) of the General Agreement on Tariffs and Trade (GATT) in addition to the Agreement on Subsidies and Countervailing Measures (ASCM). These provisions are not easy to fulfill in this case. First, Article XX(b) of GATT has put the burden of proof of "necessity" on the party invoking it, which is practically impossible, more often than not.

Additionally, it is difficult to prove that renewable development is in line with environmental protection under the conventional jurisprudence of the WTO and, therefore, it is challenging to invoke Article XX exceptions in this case (Cottier, et al. 2011, 226). Even if proved, the applicability of the exceptions allowed by Article XX of GATT to the ASCM subsidies remains questionable to many trade lawyers (Rubini 2009, 195). Finally, such subsidization of the electricity delivered to electrolyzers would fall under the definition of specific subsidies, i.e., those explicitly dedicated "to an enterprise or industry or group of enterprises or industries," and it would be prohibited according to ASCM, Article 2. As a result, exclusive renewable electricity subsidies would be discriminatory and non-necessary and, therefore, prohibited.

Alternatively, the Emission Trading System (ETS) can be applied to incentivize the production of renewables and low-carbon hydrogen. The Commission aims to revise the ETS and prepare it for the fourth round of implementation, 2021-2030. The revised ETS scheme could include the dedication of free allowances to these two hydrogen types, or to other hydrogen types (Barnes and Yafimava 2020). Nevertheless, some European energy firms, like EnBW, have filed cases against the European Court of Justice, objecting to the allowance allocation system being a form of competitive distortive subsidies. While the Court of First Instance has treated the case cautiously so as not to challenge the whole scheme, such firms may find a way out of the stalemate by availing themselves of the rules of the ASCM. This is because the free allocation of allowance can be perceived as a form of subsidy. Therefore, some temporary exemptions should also be comprised in the ASCM, in addition to the ETS revision. For instance, it is proposed to implement a temporary exemption grandfathering of up to 20 per cent of the distributed allowances for industry sectors exposed to fierce international competition from regions that are not subject to an equivalent regulation of their carbon emissions (Cottier, et al. 2011).

### 4.2. Preferential taxation

If renewable hydrogen cannot be subsidized, can fossil-based hydrogen be taxed on its non-renewable electricity consumption base and carbon emissions (i.e., a carbon tax)? Such an idea may look destructive for developing hydrogen competing fossil fuels in the early years; however, it may look reasonable in the long term when empowering renewable hydrogen against other sorts of gases becomes logical. While the EU is reviewing the energy taxation law, imposing a tax, in this case, depends on other field facts. Particularly, if one of the two hydrogens is imported, it may potentially violate WTO regulations banning the imposition of different taxes on “like” products. The four criteria of the “likeness test” states that two goods are the same if they share (i) physical characteristics, (ii) end-uses of products, (iii) consumers’ tastes and (iv) preferences and tariff classification (Selivanova 2014, 282). One can argue that imposing different taxes, in this case, is only justifiable by citing differences in customer tastes. Accordingly, if some goods pose a higher risk to human health than others, the government may perceive and tax them differently. While this argument sounds logical, the Appellate Body and the Panel of the WTO are the final decision-makers who evaluate the solidity of the government's argument for proving the necessity of such policy for achieving the desired goal: i.e., health protection. This is mainly clarified on a case-by-case basis and, thus, it is difficult to be judged beforehand. However, if similar solutions, like the standardization of state aid allocation for renewables discussed in 4.2, are designed and adopted within WTO rules and regulations, they can facilitate the renewable development needless of time-consuming litigation processes.

### 4.3. Market expansion and the local content

The expansion of the hydrogen market requires new production capacity and expansion of the transmission networks. Since the network development will probably need more time, the EU hydrogen strategy foresees that most hydrogen production will be quickly consumed locally. However, if the local demand is not big enough, the production cost may rise due to the economies of scale. Can the government adopt policies to create additional local demand, for instance, by persuading some consumers to buy hydrogen from such producers, under national hydrogen policies?

Any enforcement of an undertaking to conclude such an agreement is in breach of Article 101 (e) of the TFEU, which prohibits "the conclusion of contracts subject to acceptance by the other parties of supplementary obligations". Nevertheless, using incentives can be assessed separately. For example, if such concessions include waiving the government's revenues, subsidization provisions can be applied. Additionally, the enjoyment of such a conditional concession may be restricted to the subject matter of local content regulations stated within Article III of the GATT. The implication of Article III means that no discrimination can be made between two enterprises on the pretext that one of them uses a locally produced product, even if it is for the better of renewable energy promotion. Such a situation has been experienced in the Canada Feed-In Tariff (FIT) Program case. Therefore, in this scenario, the government must consider any concession to any customer who consumes hydrogen, not just those who buy it from a local producer.

## 5. Conclusion

In this chapter, the main outlines of the EU hydrogen strategy have been discussed from a legal perspective. Given the assumption that a gradual transition to pure hydrogen is the only sustainable strategy to safeguard the security of the energy supply in the EU, using a hydrogen and natural gas mixture, NGH2 as a transition fuel is justified in the transition era. While the Gas Directive is currently under review to include hydrogen, the current legal situation of hydrogen and NGH2 should also be clarified. This must be realized if the TPA and unbundling regulations should rule the hydrogen networks and how the EU-wide hydrogen network development plans, and the unification of gas quality standards, should be implemented currently.

New regulations are also needed to ensure there is enough financial support to run development plans in the transition phase. The current legal frameworks of state aid as part of the EU competition law and WTO look too strict and bureaucratic to facilitate the achievement of the hydrogen development goals. Resolving this complexity necessitates designing a legal framework that assigns the burden of proof of competition violation on the complainant, with a clear framework to facilitate hydrogen infrastructure development by granting a mid-term exemption for allocating state aid, for instance. Such a framework should also eliminate any potential legal dilemma that may arise due to both the EU and the member states' membership in the WTO.

The results of this chapter show that in addition to the general outlines of the EU energy acquis' applicability to the transiting energy market, other environmental measures, like the GO scheme, need to be revised to hasten the EU hydrogen strategy, considering the elaborated taxonomy of hydrogen in the strategy that has been published. The necessity of this can also be proved when one considers the importance of low-carbon hydrogen usage in the transition era. While these documents should indicate the total released emission of fossil fuel-based hydrogen, such guarantees of origin should be standardized to make trade possible and to facilitate the mutual recognition of third state certificates.

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# Appendix 3

**Publication III**
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# European Union Energy Security: Constructing a 'Shelter' for Small States' energy security preservation[33]

Javad Keypour

**Abstract**

Energy security has been one of the most important issues in the European Union over the past few years. Although the debate has focused primarily on the approach of the main EU powers, this research aims at studying the impact of small Member States' size on their energy security in the EU. Then it provides proposals to safeguard the energy security of EU small countries by providing a comprehensive interpretation of the term alliance in shelter theory. Applying the composed "smallness" index and the quantitative method, the results imply a direct relationship between the small states' size and energy security in the first step. The study shows that such a relationship cannot be proven in non-small States. Although the EU has tried to strengthen collective energy security in Member States, such differences show that complementary policies are needed to ensure energy security in small countries. Given an extensive interpretation of "alliance" in shelter theory, this research proposes deep integration of the small states' energy infrastructure in order to ensure their energy security. In the aftermath of the Russian invasion of Ukraine, where the EU's energy security, especially in the small states, is more fragile than ever, adopting such a policy seems more vital.

**Keywords:** Energy security, Regional development, EU integration, Single energy market, Small states

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## Introduction

Energy is a vital element for the welfare and economic development of the European Union (EU). Given that people continued to aspire to energy-intensive life standards, demand for energy would be a continually rising in the future, and as a result, safeguarding the security of the energy supply would remain an essential need in the future (ESPON, 2017). The European Commission proposed the Energy Union structure to create a fully integrated European energy market in 2015, believing that establishing an integrated single energy market (SEM) could preserve the EU's energy security (Mišík, 2019). However, the harmonisation of Member States' energy policies, even within the Energy Union framework, has remained problematic, as Member States have different perceptions of the outlines of energy security (Talus, Aalto, 2017). Such an opinion gap is discernible between different groups of the Member States, for instance, between larger and smaller ones.

Although the EU's decision-making mechanisms are criticised for being significantly influenced by the interests of larger Member States (Wivel, 2010), it is believed that the role of small states will grow in the future, especially in the post-Brexit era (Thorhallsson, 2019). However, a few publications have discussed the energy security before. Most of these publications, as by Mišík (2019), have focused on the external threats to the energy security of small states. Some others, e.g. Juozas Augutis et al. (2020), Štreimikienė et al. (2016) and Zenga et al. (2017), followed a regional study approach, focusing on the Baltic States. Nevertheless, the domestic dimension of energy policymaking and its impact on the small states' energy security has remained almost untouched and needs scrutinising more than ever.

The purpose of this research is to study the impact of small Member states – small in their size - on their energy security in the EU. Nevertheless, the size factor does not negate or invalidate other factors as geography, climate, or indigenous resources. These elements show their influence, as the selected small states are located in different regions of the EU. In addition, this study does not seek to show the priority and relative importance of factors mentioned before and how they affect energy security of the EU member states, but will focus on assessing the "size" factor, specifically. It also aims to render suggestions for safeguarding EU small states' energy security in the end.

For the study's aims, the research question is 'how does the EU Member States' size impact their energy security, particularly in those classified as "small" states?' Moreover, the study tries to define "what measures can small states adopt to enhance their energy security within the framework of the EU policymaking?" The main claim of this research is that there is a direct relationship between EU small states' energy security and their size. However, such a relationship is not discernible in non-small states. While this research offers a new method for defining small states in the EU, diversity was measured as an index to assess supply security. Therefore, relying on the shelter theory, entering an alliance is the recommended policy for smaller EU states. However, instead of entering some alliances with major EU powers, as shelter theory may suggest, this research takes position that such alliances should be formed with small- states neighbouring countries, resulting in regional energy integration.

The importance of energy security for small EU countries can be discussed from two perspectives. From a general viewpoint, the role of small states is growing in the international scene contrary to the Cold War era, with realism neglecting small states as a dominant paradigm of international relations. However, smaller states have become

even more critical in the post-Cold War era, as they could pursue offensive foreign policy strategies without compromising their survival, especially in the EU (Thorhallsson, 2019). This makes the study of small states' behaviour a crucial issue for the time being. Viewed through the more specific lens of energy security, the 2004 EU enlargement resulted in the accession of small new states to the Union. Their energy security vulnerability was demonstrated in the 2000s when supplies of Russian gas were interrupted (Mišík, 2019). This resulted in recognising energy as a shared competence in the Treaty on the Functioning of the European Union (TFEU), where EU's energy security was aimed to be protected "in a spirit of solidarity between Member States" according to Articles 122 and 194. Given that the EU energy security, especially in the small states, has been exposed to unprecedented threats in the aftermath of the pandemic and the Russian invasion of Ukraine, the importance of this study becomes more accentuated.
In terms of structure, this article is delineated into four sections. The next part provides a literature review shedding light on the former relevant studies and the research gap. The second section discusses the applied method for measuring smallness and energy security. Then the Results and Discussion sections demonstrate correlation between small states' size and their energy security. Analytical framework enables solidifying small states' energy security with a special concern to their geographical classifications and based on the rendered extensive interpretation of the alliance concept in the shelter theory.

## 1. Literature review

The small state concept has been widely discussed in the previous scholarly literature and in three different approaches; namely arbitrarily listed states, qualitative definitions and quantitative ones, as follows, respectively.

During the early years of the Cold War era, there was a tendency to use term of 'weak state' instead of 'small state', especially regarding security studies. On some occasions, a weak state used to stand for any other state than the 'Big Five' (i.e. the five Permanent Members of the United Nations Security Council), especially (Schmidl, 2001). This approach was then repeated afterwards in the EU context, denoting all Member States "small", except the 'EU big six' of France, Germany, Italy, Poland, Spain, and the UK (Baldacchino, 2009). Other researchers, as Blockmans (2017), avoid rendering any particular definition and provide alternative lists of small states within the EU territory. However, given that the big states were impacted by the 2006 Russia-Ukraine gas dispute differently, one can argue that they are not at the same level of vulnerability within the energy security considerations. Thus, such available designed lists of small states cannot work for the aims of our study.

In an alternative method, qualitative approaches have been applied to define small states. Most of the rendered definitions within this method focus on the limitations of small states in applying their (military and political) power. For instance, Krause and Singer (2001) justified minor powers as states 'whose diplomatic and material resources are so limited that their leaders focus mainly on the protection of their territorial integrity rather than on the pursuit of more far-reaching global objectives'. Similarly, Small states are said to show limited involvement in international affairs, favour international governmental organisations and are less prone to the use of force, and, in general, have limited their foreign policy priorities, mostly those regional (Evans, et al., 1998). Tökölyová (2016) has taken the same approach classifying small states based on the specifications of the primary determinants of the foreign policy position of the state in the global political system, as well as on the understanding of the power potentials of enforcement and defence of own interests and goals. In addition to the difficulties of elaborating power dimensions, such qualitative approaches are criticised mainly as they fail to prove that the smallness - power correlation implies causation as well (Maass, 2009), and therefore, they appear less reliable for the aim of this study.

As an example of the quantitative style, Thorhallsson considered a combination of relevant indices to show smallness. This consists of the six variables of fixed size, sovereignty size, political size (including military and administrative capabilities), economic size (measured on the basis of Gross Domestic Product (GDP), perceptual size and preference size, linking definition and theory by considering the size of states and influence within the EU (Thorhallsson, 2006). Although such quantitative methods seem holistic, two prerequisites must be met for them to be effective. First, the included components should be selected for each application and topic in which the behaviour of small states is studied. This means that there is more than one "small state" definition. Secondly, a cut-off value of selected criteria or the aggregated index must be chosen to distinguish the border between small and non-small states. This means that an appropriate index must be composed specifically for the aims of this research.

In addition to the small states' definition, discussing previous energy security measurement research is crucial. Although energy security is an issue of critical importance to many different stakeholders, particularly policy makers and scholars, there is no consensus about its definition and each definition highlights very different notions of energy security to justify actions and policies on energy security grounds (Ang, et al., 2015). Therefore, the selected energy security definition depends on the context of the study, as the current research will also follow (see Section 2.2).

Like the energy security definition, corresponding indicators assess one particular energy security dimension depending on the context. However, a significant number of studies have attributed energy security to the diversification of energy sources (Sovacool, 2011; Vivoda, 2009; Stirling, 2011; Cohen, et al., 2011), especially with respect to energy security of the EU member states. Chalvatzis and Ioannidis (2017a) have studied the diversity of fuel mix among the EU Member States and perceived an emerging paradigm shift from dependence to diversity throughout the EU. They interpreted that as an improvement in energy security. Another study applies diversity as an indicator to assess the EU Member States' energy security and argues that enhancing the diversification of energy sources through renewable energy deployment is a more coherent strategy than using them for dependency reduction (Lucas, et al., 2016).

Studies also applied energy security diversity indices for assessing one specific Member State's condition as the pre-Brexit UK (Grubb, et al., 2006) and Poland (Czech, 2017) or a group of the EU Member States as Southern Europe and Ireland (Chalvatzis, Ioannidis, 2017b), Visegrad countries (Brodny, Tutak, 2021) and small states as the Baltic States (Augutis, et al., 2020; Štreimikienė, et al., 2016; Zenga, et al., 2017). While most of the publications discussing small states' energy security, as by Mišík (2019), have focused on the external threats, the domestic dimension of energy policy-making and its impact on energy security has remained almost untouched and needs to be scrutinised.

Different strategies, including balancing or bandwagoning, strategic hedging or neutrality, and seeking shelter, have been proposed to address the security concerns (Vaicekauskaitė, 2017). While the school of realism introduces the first two strategies regardless of the size of the states, Thorhallsson (2011) has elaborated on "shelter" seeking exclusively for small state cases. However, he reasons for the obligation of small states to provide a shelter to prevent economic and political risks, and the demand for a shelter within energy security studies has not been addressed yet. Considering this fact and given the abovementioned research gap on the domestic dimension of energy security in the EU small states, the current research tries to develop ideas and recommendations for addressing small states' energy security vulnerability by developing shelter theory.

**2. Methodology**

**2.1. Measurement of smallness**

So not to get lost in the quagmire of definitions, a measurement tool to distinguish 'smallness' must be introduced for the purpose of this research, considering that none of the above approaches introduced in Chapter 1. Here, the paper has discussed the smallness suitable for the energy security studies, as proved below. Therefore, the following paragraphs explore how to develop a definition that suits the energy arena by relying on a critical review of previously conceptualised formulas.
Considering previous relevant research, including those mentioned in Chapter 1, one can say that population, GDP and territory are repeatedly acknowledged as main factors for measuring the states' size. These factors are also relevant for energy studies, because:

- Although no consensus has emerged among various studies testing the causality between energy and economic growth among different sovereign states, general causality between aggregate energy consumption to GDP and GDP to energy consumption is prevalent in the OECD countries (Chontanawat, et al., 2006). Similarly, the population has a positive relationship with both primary and final energy consumption (Zaharia, et al., 2019). These justify considering GDP and population as a relevant factor for the aim of this study that focuses on the energy security of the EU member states.

- Although the amount of oil and gas reservoirs is similarly low in the EU member states (except for the falling gas production in the Netherlands, there are no significant oil and gas fields), the relationship between the territory and the possibility of renewable energy utilisation in Europe has been discussed (Bagliani, et al., 2010). The importance of this issue increases when the climate priorities of the European Union are considered in replacing renewable resources instead of using the fossil resources. One can assume that territory that is more extensive can potentially facilitate an access to free lands for installing wind turbines and solar panels. This means that the territory considered by the previous studies as an indicator for identifying small states is also relevant within this study.

Given the above facts, an aggregate index comprising the three indicators can provide a comprehensive measure that is applicable to the purpose of this study. However, composing an aggregate formula involves having elements of the same dimension. To equate the dimension of each indicator (e.g., population, territory, and GDP), the relative value of data in each case is derived by dividing each element by the average value (of the 27 EU Member States). This results in three dimensionless elements of $\frac{GDP_i}{GDP_{avg}}, \frac{Territory_i}{Territory_{avg}} and \frac{Population_i}{Population_{avg}}$ representing relative GDP, territory and population of the "i" Member State. While the first two factors influence a state's energy consumption, the third one represents the accessibility to energy resources, i.e. the supply. Thus, the dimensionless Small States' Index created for the $i^{th}$ Member State, $SSI_i$, is defined by equation (1), accumulating the three elements.

$$(1) \qquad \mathrm{SSI}_i = \frac{GDP_i}{GDP_{avg}} + \frac{Territory_i}{Territory_{avg}} + \frac{Population_i}{Population_{avg}}$$

GDP, territory and population are measured in billion euros, square kilometres ($km^2$) and person, respectively. However, since the numerator and denominator of all the three fractions are of the same type, each element is dimensionless, and thus, the $SSI_i$. Moreover, $SSI_i$ elements are given equal weighting since the relative importance of each component is presumed to be the same.

Using quantitative methods necessitates defining a threshold to distinguish the "small" versus "not small" states. While international organizations such as the World Bank or Commonwealth Secretariat introduced a list of small states by putting an 'absolute' threshold on territory, population size, GDP, or military expenditure (Baldacchino, 2009), they do not necessarily indicate how these caps were defined. For our research purposes, since formula (1) has applied a normalisation method for each element, the desired thresholds can be derived and applied from the standard normal distribution graph (the so-called bell curve). This means that after sorting the SSI data by value, a threshold line is drawn to divide them somehow that the cumulative SSI value of the smaller part stands at almost 31.8 per cent of the whole. Those states below this threshold are distinguished as the small states in this investigation.

### 2.2. Energy security measurement

Since this research focuses on the energy security of small states in the EU, it applies the definition of energy security by the European Commission as "providing reliable energy at affordable cost and conditions" (Sovacool, 2010, p. 4). Such definition stands on two pillars - pillar of reliability and pillar of price. Reliability implies the geopolitical dimension of energy security accentuated more in the aftermath of the Russian invasion of Ukraine in 2022 to the extent that the EU intended to import more expensive LNG to replace Russian gas to improve the reliability of its energy supply. This can justify our choice to focus on reliability rather than the price in this research as the core of energy security in the European Union.

Among different methods and indicators for measuring reliability, diversity indicators have drawn attention in energy security studies (Jang, et al., 2014; Cherp, Jewell, 2011). Diversity is believed to enhance reliability in different ways. First, it helps the energy system responding more resiliently to external changes and physical supply interruptions. Furthermore, it reduces the vulnerability of a single energy source to supply shocks and the market power of various energy supply sources (Chuang, Ma, 2013). Although generally, the higher the diversity, the more solidified the reliability is, given the two gas cutting experiences by Russia in 2006 and 2009, it makes sense to consider reliability as a relevant indicator particularly for measuring the EU's energy security.
Although diversity can be directly assessed, one can suggest measuring "concentration" instead. Thus, two indices are available correspondingly: Herfindahl-Hirschman Index (HHI) and Shannon-Wiener Index (SWI) (Pavlovića, et al., 2018).

(2) $$\mathrm{HHI} = \sum_{i=1}^{n}(100\ x_i)^2$$

(3) $$\mathrm{SWI} = -\sum_{i=1}^{n}\ x_i \ln(x_i)$$

Wherein $x_i$ is the market share of the '$i^{th}$' energy carrier (including coal, oil, gas, nuclear, renewable & biofuel and imported electricity). HHI is originally an indicator used in ecology and can be applied to energy security studies to assess the power of a monopoly supplier. The higher the HHI, the higher the concentration is, which means that the examined system is less diverse (Rubel, Chalvatzis, 2015). Therefore, if the number of suppliers is infinite ($n\rightarrow\infty$), HHI 'approaches' zero. This represents a market with perfect competition, while HHI = 10000 indicates a total monopoly (n=1) due to the existence of a single supplier. Conversely, SWI focuses on dependency rather than concentration. Thus, a low SWI value indicates high-energy dependence. It means that if a country depends on a single import source, the SWI 'equals' zero.

Researchers have various opinions about the pros and cons of HHI and SWI. While some scholars believe in the former (Stirling., 1998; Cohen, et al., 2011; Hickey, et al., 2010; Chalvatzis, Ioannidis, 2017a), some prefer the latter (Le-Coq, Paltseva, 2009) and a few others had mixed both indices (Grubb, et al., 2006). Generally, both indices have satisfactory consistency in their results. Since SWI includes the ln function, it reacts to the diversity changes considerably slower than the HHI. As a result, HHI works more sensitively, especially in our comparative study consisting of a few cases where differences are desired to be visualised more vividly.

**2.3. Evaluation of the SSI-HHI Relations and Recommendations**

Once the SSI of the EU member states is calculated, the small states are distinguished according to the method described in 2.1. To examine the impact of states' size on the energy security trend, the existence of meaningful relations between SSI and HHI indices should be evaluated. Therefore, SSI versus HHI graph is plotted. Using MS Excel, the trend line is drawn, and the correlation coefficient is then calculated. Finally, comparing the derived coefficient with the correlation, a look-up table (two-tailed) can imply the significance level of their relationship. When the relation is proved, the small states are classified on their geographical position. This gives the ground to us to evaluate how the alliance concept within the framework of the shelter theory can be interpreted and applied extensively for proposing some corresponding recommendations for consolidating the energy security of each small states cluster based on their existing infrastructures.

### 2.4. Data preparation

The statistics required for the means of the research were obtained from primary and secondary sources. Energy mix information of the Member States required calculating the HHI, which was extracted from the EU energy figures in the 2020 Statistical Pocketbook (European Commission, 2020b). Data are cross-checked and completed by the International Energy Agency (IEA, 2020), the US Energy Information Administration (EIA) brief country reports and statistics, and the European Spatial Planning Observation Network (ESPON) database and statistical reports from BP companies (2020). For data homogeneity, territory and population data were taken from Eurostat (2021). It stands to reason that since the COVID-19 outbreak influenced the EU's economy, this research has used the last available GDP values before the pandemic, i.e. 2019.

## 3. Results

Table 1 demonstrates the data acquired to calculate the SSI of each of the member states. Applying these data in equation (1) results in the corresponding SSI for each Member States, as visible in the first right column of Table 1. Applying this method described in section 2.1 for classifying the small states, nine member states were distinguished as small ones, including Malta, Cyprus, Luxembourg, Slovenia, Estonia, Latvia, Lithuania, Croatia, and Slovakia. These states are indicated in Table 1.

**Table 6:** The SSI value calculated for EU-27.

| Member states | Population (in 2019) | Area (km²) | GDP in 2019 (billion euros) | SSI |
|---|---|---|---|---|
| **Malta (MT)** | 493,559 | 316 | 13.20 | 5.75 |
| **Cyprus (CY)** | 875,899 | 9,251 | 21.90 | 15.46 |
| **Luxembourg (LU)** | 613,894 | 2,586 | 63.50 | 17.68 |
| **Slovenia (SL)** | 2,080,908 | 20,273 | 48.00 | 34.85 |
| **Estonia (EE)** | 1,324,820 | 45,227 | 28.00 | 42.35 |
| **Latvia (LV)** | 1,919,968 | 64,589 | 30.50 | 58.81 |
| **Lithuania (LT)** | 2,794,184 | 65,200 | 48.30 | 67.94 |
| **Croatia (HR)** | 4,076,246 | 56,594 | 53.90 | 71.28 |
| **Slovakia (SK)** | 5,450,421 | 49,035 | 94.20 | 82.58 |
| **Denmark (DK)** | 5,806,081 | 43,075 | 310.60 | 122.90 |
| **Bulgaria (BG)** | 7,000,039 | 110,994 | 60.70 | 125.05 |
| **Ireland (IE)** | 4,904,240 | 70,273 | 347.20 | 141.93 |
| **Hungary (HU)** | 9,772,756 | 93,030 | 143.80 | 146.46 |
| **Czechia (CZ)** | 10,649,800 | 78,866 | 219.90 | 157.47 |
| **Portugal (PT)** | 10,276,617 | 92,212 | 212.30 | 162.27 |

| | | | | |
|---|---|---|---|---|
| **Belgium (BE)** | 11,455,519 | 30,528 | 473.60 | 180.66 |
| **Austria (AT)** | 8,858,775 | 83,855 | 398.50 | 184.47 |
| **Greece (EL)** | 10,724,599 | 131,990 | 187.50 | 185.59 |
| **Netherlands (NL)** | 17,282,163 | 41,543 | 810.70 | 288.34 |
| **Finland (FI)** | 5,517,919 | 338,424 | 240.90 | 296.40 |
| **Romania (RO)** | 19,414,458 | 238,391 | 222.10 | 312.86 |
| **Sweden (SE)** | 10,230,185 | 449,964 | 474.70 | 441.54 |
| **Poland (PL)** | 37,972,812 | 312,685 | 527.00 | 531.73 |
| **Spain (ES)** | 46,937,060 | 504,030 | 1,244.80 | 847.48 |
| **Italy (IT)** | 59,816,673 | 301,338 | 1,787.70 | 901.15 |
| **France (FR)** | 67,177,636 | 632,833 | 2,419.00 | 1,280.00 |
| **Germany (DE)** | 83,019,213 | 357,386 | 3,435.80 | 1,397.00 |
| **Average** | 16,535,053.48 | 156,462.53 | 515.49 | -- |

Source: Author's calculation, data from the European Commission, 2020b and Eurostat, 2021.

Table 2 shows the data required for calculating the HHI index and the derived HHI by applying these data in equation (2) in the far-right column.

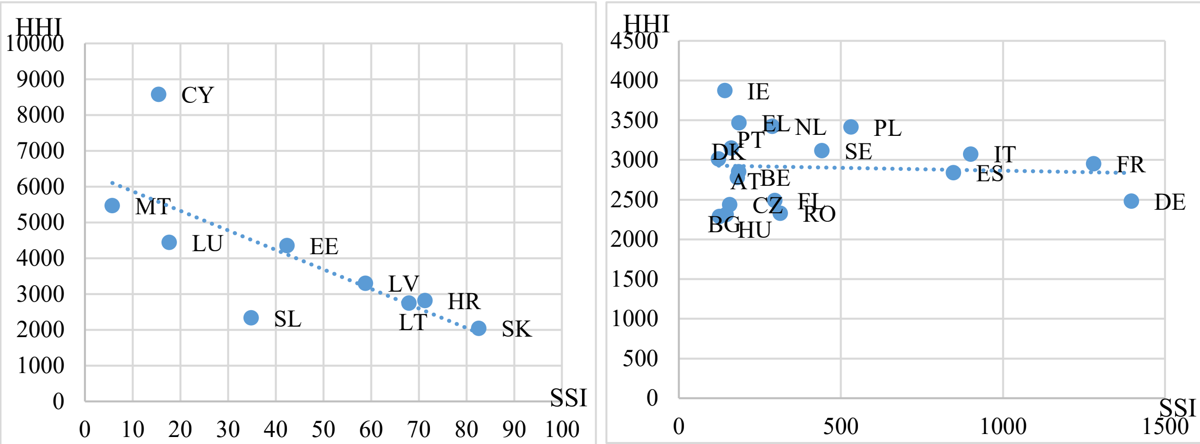
**Table 7: Energy mix of small EU states and the HHI index.**

| **No** | State | Market share of each energy carrier ($x_i$) in the energy sector Member States' energy mix (2019) to be applied in equation 2 | | | | | | The HHI calculated using equation 2 |
|---|---|---|---|---|---|---|---|---|
| | | **Coal** | **Oil** | **Gas** | **Nuclear** | **Renewable & Biofuel** | **Imported Electricity** | |
| **1** | Malta (MT) | 0.000 | 0.625 | 0.375 | 0.000 | 0.125 | 0.000 | 5,468 |
| **2** | Cyprus (CY) | 0.000 | 0.923 | 0.000 | 0.000 | 0.077 | 0.000 | 8,579 |
| **3** | Luxembourg (LU) | 0.000 | 0.644 | 0.156 | 0.000 | 0.067 | 0.111 | 4,440 |
| **4** | Slovenia (SL) | 0.159 | 0.362 | 0.101 | 0.203 | 0.159 | 0.014 | 2,335 |
| **5** | Estonia (EE) | 0.008 | 0.512 | 0.160 | 0.000 | 0.384 | 0.000 | 4,352 |
| **6** | Latvia (LV) | 0.000 | 0.333 | 0.250 | 0.000 | 0.396 | 0.021 | 3,302 |
| **7** | Lithuania (LT) | 0.027 | 0.413 | 0.240 | 0.000 | 0.213 | 0.107 | 2,747 |
| **8** | Croatia (HR) | 0.045 | 0.386 | 0.261 | 0.000 | 0.250 | 0.057 | 2,821 |
| **9** | Slovakia (SK) | 0.193 | 0.222 | 0.240 | 0.222 | 0.105 | 0.018 | 2,045 |

Data source: European Commission, 2020b, calculation by the author.

Using the calculated SSI (listed in table 1) and the HHI (presented in table 2), Graph 1 (on the left) is plotted, indicating the HHI vs SSI for the small states. The same can be repeated for the other Member States, as indicated in the graph on the right.

**Graph 6: The HHI-SSI Correlation in the EU "Small" States (left) and "Not Small" States (right).**




Source: author's contribution.

The correlation coefficient for both graphs can be derived using the Microsoft Excel CORREL function to evaluate the strength of the HHI-SSI relation. The results show that, for the small states, the correlation coefficient is -0.735. Looking up in the 'correlation look-up table (two-tailed)' as indicated in Table 3 and crossing the number of data in the N column and the significance of correlation in the top row (∝), it is apparent that the correlation between the HHI and SSI is significant at the 95% level, implying on a strong meaningful relation.

**Table 8: Critical Values for Pearson's Correlation Coefficient**

| N \ ∝ | 0.2 | 0.1 | 0.05 | 0.02 | 0.01 | 0.001 |
|---|---|---|---|---|---|---|
| 5 | 0.8000 | 0.9000 | 0.9500 | 0.9800 | 0.9900 | 0.9990 |
| 6 | 0.6870 | 0.8054 | 0.8783 | 0.9343 | 0.9587 | 0.9911 |
| 7 | 0.6084 | 0.7293 | 0.8114 | 0.8822 | 0.9172 | 0.9741 |
| 8 | 0.5509 | 0.6694 | 0.7545 | 0.8329 | 0.8745 | 0.9509 |
| 9 | 0.5067 | 0.6215 | 0.7067 | 0.7887 | 0.8343 | 0.9249 |
| 10 | 0.4716 | 0.5822 | 0.6664 | 0.7498 | 0.7977 | 0.8983 |

Source: (Verma, 2012, p. 462). Highlights added.

This proves the strong negative correlation between size and concentration of the energy mix, or the solid direct relationship between energy security and size in small states; the larger the small state, the greater the energy security. On the contrary, the right-hand graph shows that applying the same logic for not-small EU states results in a correlation coefficient of r = -0.064, which does not show any meaningful relationship between the HHI and SSI among "not small" states. Therefore, one can claim such a relationship is discernible exclusively in small states in response to the first research question.

One logical explanation for this relationship is considering the elements of the small state definition rendered in equation (1), as it encompasses aspects of population, economy, and territory. When it comes to policy-making, small states must sacrifice some issues. This is not necessarily due to limited resources but is due to other considerations as the economy of scale (Thorhallsson, Steinsson, 2017). For energy policy-making, due to the small size of the economy (indicated by GDP in equation (1)) and the small population, the size of the energy market is not significant. For example, statistics show that nine of the EU small states consumed 4.02% of total EU energy consumption in 2018, less than one-fifth of Germany's consumption as the largest EU Member State (European Commissionb, 2020). Therefore, even if different energy sources were available, the government preferred to rely on a few less expensive sources instead of diversifying its energy mix. Such an intention is reinforced by the size of the small territory, as a small state is less likely to possess and gain access to different energy resources across its territory. These factors result in higher concentrations in the energy mix of small states.

**4. Discussion and policy Recommendation**

In general, the lack of diversity in economic relationships of small states makes them vulnerable to fluctuations in market prices (Thorhallsson, 2019). Similarly, the low diversity of a small state's energy portfolio makes its energy security more vulnerable to external threats. Thus, one may suggest interconnecting a small state's energy market with another small state somehow to create an enlarged integrated market. Such regional energy market integration complies with the SEM rationale, i.e. allowing energy to flow through (under constructed) interconnectors without technical or regulatory barriers between the states (European Commission, 2021).

The abovementioned small-states deep integration also brings them benefits. Generally, states accept surrendering part of their autonomy when entering alliances so that their security is not further threatened by a third party (Wagner, et al., 1998). In the same way, the small states' deep integration means beneficiaries consider their mutual interests, limitations and concerns thoroughly in their energy policy-making. Additionally, since these states are of the same size and are grouped in the same geographical locations (as shown later), they share common concerns about energy security. Therefore, these small states partially relinquish their energy policy-making independence to acquire higher energy security collectively. Moreover, it makes their voice possible to be heard at the EU level without being under the shadow of major powers' domination.

One can justify such integration by relying on the context of Shelter theory. 'Shelter is an *alliance* relationship in which small states alleviate their political, economic, and social vulnerabilities by allying with large states and joining international or regional organisations' (Thorhallsson, Steinsson, 2017). Small states seek shelter to prevent probable upcoming crises and manage impacts of shocks that may occur, or recover from past catastrophes (Thorhallsson, 2019). The alliance concept is addressed in shelter theory more effectively, contrary to other theories, especially neorealism. This approach is crucial for two reasons. First, unlike neorealism, shelter theory assumes that small states have some significant capabilities, given their importance in the post-Cold War era, and it is more consistent with the purpose of this research. In addition, shelter theory assumes forming alliances is a response to internal weaknesses (e.g. infrastructure deficiencies) and external threats, while neorealism perceives only external ones (Mearsheimer, 2001, p. 146; Thorhallsson, 2019). The importance of this approach lies in the fact that disruption to the energy security of a highly concentrated energy mix can occur due to either external threats or internal weaknesses.

However, this research applies a broader meaning of alliance when the shelter theory is used since the theory focuses primarily on alliances with large states. This is because building an energy alliance in the EU is highly curtailed by geographical factors and the availability of regional infrastructures, especially interconnections and available cross-border network capacity. For instance, the transmission capacity inside the Baltics (Lithuania, Latvia, and Estonia) and also in the Iberian Peninsula (Spain and Portugal) and France is not well-developed yet (Pollitt, 2019). Under such circumstances, the foundation of an energy alliance between a small state as Estonia and a large one such as France seems meaningless. Furthermore, even though a small-large energy alliance may result in higher energy security for both, it is dangerous to turn any small state into a follower, especially in energy policy-making of the EU legislative bodies. Thus, contrary to the shelter theory, an alliance created between two or more small states may even look preferential if the geographical factor permits. Considering these facts, the discussion will continue to elaborate on the already defined regional integration concept by relying on the geographical location of small EU states (depicted in Table 4).

**Table 9:** Location of the EU Small States

| Region | Baltic[34] | Balkans | CEE | Other |
|---|---|---|---|---|
| **State** | Estonia, Latvia, Lithuania | Slovenia & Croatia | Slovakia | Cyprus, Malta, Luxembourg |

Source: author's classification

**4.1. Baltic States**

The Baltic States have long been known as the "energy island" within the EU, due to the lack of solid infrastructure connecting their energy network to the rest of Europe (Švedas, 2017). Although Lithuania sought to come up with solutions during the time of its EU presidency in 2013, and the Baltic Energy Market Interconnection Plan (BEMIP) has been proposed as part of the SEM idea (European Commission, 2020a), isolation is still a challenge for the region. Although great efforts have been made, to build or strengthen gas and electricity interconnectors between the Baltic and neighbouring states, at the same time it is crucial to enhance the integration of the Baltic States.

Each Baltic state is distinguished by its exclusive energy strengths (and weaknesses). For instance, while Estonia has a low dependency on external energy imports thanks to its shale oil resources, it also has a higher carbon intensity (Zenga, et al., 2017). Although Lithuania has the only Liquefied Natural Gas (LNG) and oil refinery among Baltic States (Matsumoto, et al., 2018), it has a higher rate of import dependency rate (Streimikiene, 2020) and the highest energy poverty (Jääskeläinen, et al., 2019). Furthermore, Latvia has the privilege of having the only underground gas storage facility (UGS) in the region, as backup for its gas distribution system (Augutis, et al., 2020). Thus, in line with the shelter concept and deep intra-Baltic integration of energy systems, the energy alliance provides equal access for all Baltic States to each other's energy facilities. This is also beneficial for the economic performance of these energy installations (i.e. refinery, LNG terminal, and UGS) and, at the same time, for the EU's trans-Baltic energy plans, such as BEMIP or even the European Union Strategy for the Baltic Sea Region (EUSBSR). Table 5 shows the distribution of these facilities across the Baltic States.

[34] For the aim of this research, Baltic States, Baltics and Baltic region indicate these three states unless specified differently.

**Table 10:** Baltic States' Energy Facilities.

| LNG Terminal | UGS | Electricity & gas interconnector[35] | Hydropower | Major domestic fossil resource | Oil refinery | Nuclear power plant |
|---|---|---|---|---|---|---|
| Lithuania | Latvia | Lithuania, Estonia | Lithuania, Latvia | Estonia | Lithuania | None (Estonia planned) |

Source: Augutis, et al., 2020; Matsumoto, et al., 2018; Amber Grid, 2021.

The future energy plans may also act as the driving force of this integration. Studies show that the integrity of the Baltic power grid is essential to cope with the side effects of leaving the electrical ring of Belarus, Russia, Estonia, Latvia and Lithuania (BRELL), as Baltic States declared their intent to do this in 2015 (Bompard, et al., 2017; Bahşi, et al., 2018). Additionally, Estonia is determined to end the use of its pollutant oil shale, in accordance with the EU climate targets (European Commission, 2018b). However, this could have implications for the security of supplies. A similar experience in the past showed that Lithuania adopted appropriate policies to compensate for the adverse effects of shutting down the Ignalina Nuclear Power plant, such as building an underwater power cable to Sweden, called NordBalt (Augutis, et al., 2012). Therefore, taking a similar approach to strengthening the interconnections infrastructure and commissioning alternative energy generation systems, such as renewable and nuclear, Estonia can manage the phasing out of shale.

We suppose that the intra-Baltic connectors are strengthened enough to allow energy to flow freely across the region and facilitate free access to the energy installations for all three states. In optimal case, the HHI level for all three Baltic States will then approach a single value. Assuming that the total energy consumption remains the same, the planned Estonian 300MW nuclear power plant becomes operational (Fermi Energia, 2020), and the Lithuanian LNG terminal works at full capacity, the hypothetical HHI will reach 2906. This shows a significant improvement compared to the current values depicted in Table 2. Additionally, this intra-Baltic initiative will pave the way for establishing the Baltic Sea Region Energy Supergrid that includes all the littoral states of the Baltic Sea, as already proposed by ESPON. The supergrid seeks to found a fully integrated network that interconnects power plants and brings higher energy independence to the Region (ESPON, 2019b). Furthermore, an integrated Baltic gas market can ensure economic competitiveness compatible with low-carbon solutions, as planned in accordance with the goals of the EU Green Deal (Belyi, Piebalgs, 2020).

### 4.2. Small Balkan states of Slovenia and Croatia

The HHI index of Slovenia and Croatia in Table 2 seems satisfactory. However, complementary measures must be adopted to maintain the diversity level of the energy mix in Balkan countries, if energy and climate policies should be implemented (Sekulić, et al., 2019). Thus, energy shelter seems a reasonable solution for small Balkan States, as they are essentially more vulnerable to drastic changes. Slovenia's energy network strengthening has been enshrined within the framework of projects of common interest

[35] Interconnector with non-Baltic EU Member States

(PCI) as part of the SEM Plan (Crnčec, et al., 2021; European Commission, 2018a). Therefore, in addition to the Croatia-Slovenia bond, one can discuss establishing an energy alliance with larger neighbours (e.g. Italy and Austria) or even non-EU states such as Serbia. However, the Slovenia – Croatia alliance is sufficiently supported by solid reasons, contrary to other options.

Firstly, the renewable options available to Croatia and Slovenia are limited, as the development of hydropower plants in both countries has been hampered by high costs and adverse impacts on ecology and tourism (Young, Brans, 2020; Crnčec, et al., 2021). Thus, they will need to focus on other energy options, which make their energy policy-making contexts more similar to each other. Second, Slovenia and Croatia still have the privilege of connected energy infrastructures, as parts of the former integrated state of Yugoslavia. For instance, the only nuclear power plant in Slovenia, named Krško, is still co-owned by Croatia and was built in 1981 when the countries were both part of Yugoslavia (Pumaneratkul, 2018). This integration can act as a driving force for the energy alliance. Third, the joint implementation of energy infrastructure development plans can improve the economic performance, for example, for Croatia's 1.9 million ton liquefied natural gas (LNG) project (IGU, 2021) is now under construction. The utilisation factor of Croatia's LNG terminal can be enhanced if it supplies a larger market, such as a wider Croatian and Slovenian market.

This benefits Slovenia's carbon abatement plans because in contrast to Croatia, which ceased to extract indigenous coal in the 2000's (Young, 2021), gradual phasing out of coal was not implemented in Slovenia. Closure of the only Slovenian thermal unit would severely affect the security of the electricity supply unless alternative solutions guarantee its supply security. Nevertheless, replacing gas with coal for electricity generation could be a short-term solution to reduce carbon emissions in Slovenia. Additionally, as it currently receives gas from Russia and the Baumgarten Hub (Crnčec, et al., 2021), LNG enhances Slovenia's energy security by diversifying its gas supply routes and energy mix.

**4.3. Slovakia**

Slovakia is distinguished as the 'largest state' in this research. Thus, it is not surprising that its HHI ranks lowest among others, and the urgency to establish an energy alliance is much less pressing than for others. Additionally, Slovakia has developed its oil refinery, UGS facility and nuclear power plants thanks to the size of its energy demand. This justifies the Slovakian perception of energy security that emphasises the self-sufficiency paradigm (Kratochvíl, Mišík, 2020). As a result, it was not unexpected for analysis of this research on Slovakia's HHI not to indicate any fall since 2000. However, Slovakia had to shut down the Bohunice V1 Nuclear Power Plant before acceding to the EU in 2004. In the same way, while Slovakia has followed the fundamental energy policies and has shown a great desire to integrate into the EU, it did not give up its national energy dreams. This is particularly discernible in its nuclear energy development policy, despite Austrian and German criticism (Mišík, 2019, p. 123; Mišík, 2015).

Slovakia has had a strategic place in the transiting of Soviet (and then following this, Russian) gas from Ukraine to Central and Western Europe, particularly Austria and the

Czech Republic (ENTOSG, 2020). In the beginning, Slovakia stood alongside the other seven EU leaders who objected to Nord Stream II (NS II) in March 2016, because its transition role was jeopardised by the threat of Ukrainian route closure under the influence of NS II operationalisation (Sziklai, et al., 2020). However, as the Czech Republic and, conversely to Poland, Slovakia has gradually moderated its approach toward a market-oriented attitude on NS II and became less strongly opposed (Jirušek, 2020). Such "heterogeneity" among V4 states is also visible in other aspects of their external energy policy, even in EU legislative bodies (Zapletalová, Komínková, 2020). Therefore, one can conclude that neither internal nor external factors force Slovakia to seek shelter to preserve its energy security. It is worth mentioning that this conclusion does not repeal the integration of Slovakia in the EU energy policymaking structure of the EU or active collaboration with other V4 states on energy grounds either.

### 4.4. Luxembourg, Malta and Cyprus

The situation for Luxembourg and Malta are similar with respect to the diversity of energy mix. Both states rely heavily on the energy infrastructures. Although Luxembourg managed to partially use renewable energy, Malta did not succeed significantly, although it was the state that introduced the Clean Energy for Islands initiative during the time of its EU Presidency (ESPON, 2019a). Thus, Malta's energy mix depended on oil and a little on electricity imports, until it launched its first floating storage regasification unit (FSRU) in 2017, that provides Malta's power plant fuel (IGU, 2021). Luxembourg imports 95 % of its energy needs, and its renewable development perspective highly vary, region by region. Thanks to Luxembourg's role as one of the founders of the European Coal and Steel Community, as the predecessor of the EU, it has participated in different regional energy networks, including the North Seas Energy Cooperation. However, Luxembourg is a *follower* of its neighbours' decisions for its energy pricing and policies (ESPON, 2020). The dependency on neighbours in these two small states is not limited to energy. Luxembourg relies heavily on Belgium for its foreign service, as sometimes Belgium even represents it at the EU meetings (Thorhallsson, 2006). These two cases may be fully-fledged examples of the shelter concept in energy policy because their energy security depends on their larger neighbours (namely Italy, Germany, Belgium, and France). Since large EU states carefully guard and protect their energy security, the dependence of small states on larger ones is not perceived as a threat. In contrast, it may even safeguard security of supply.

The situation is different for Cyprus, which according to the EU definitions (ESPON, 2019a) is the only 'island state' without any significant energy interconnector to the mainland. Although Cyprus has a 17.404 MWh/capita photovoltaic economic potential (at 8 c/KWh), which is considerable compared to its total energy consumption of 35.44 MWh/capita/year, solar power has not yet found a significant footing in Cyprus. The situation is not likely to change soon (ESPON, 2021). In 2018, more than 92% of Cyprus' energy was supplied by oil. Insularity results in greater autonomy in the formulation and implementation, which means reduced opportunities for the EU energy policies to act as a driving force (ESPON, 2018). One can realise the exemption of Cyprus from implementing market liberalisation laws in the Third Electricity Directive as a testimony to this (Papsch, 2021, p. 584), and expect Cyprus to lag behind in renewable energy production soon.

In general, barriers between regions increase the desire for energy independence to guarantee their supply security (Kruyt, et al., 2011, p. 292). In the case of Cyprus, these restrictions exclude the possibility of implementing the shelter concept. This means that the diversification strategy (including increasing resilience to physical interruptions caused by internal factors) should be implemented within the framework of the energy independence paradigm. Energy independence for Cyprus, especially when renewable development prospects are not clear, implies optimising decentralised energy production (ESPON, 2019a) and diversification of supply relying on natural gas utilisation. This strategy is compatible with the EU climate goals and can be achieved by relying on Eastern Mediterranean gas resources or even by constructing LNG import terminals (Tilliros, 2017).

**5. Conclusion**

The importance of small states in international relations has increased since the end of the Cold War era and, remarkably, within the European Union and after the 2004 EU enlargement, when new small states joined the EU. However, small states must compromise with their interests due to lower bargaining power at the international level. Therefore, it is not always easy for them to pursue and fully obtain their national interests in the EU policy and decision-making, contrary to bigger states. Since the Lisbon Treaty recognised energy as a shared competence, concerns about sacrificing energy security interests of small states under the influence of the larger EU states has become a serious matter.

This study aimed to investigate the relationship between the size of states and their energy security in the EU, and whether proper measures are applicable to improve small-states energy security levels. Since there is still none single definition for the small state, and the definitions rendered describe the smallness based on their aim, e.g. mainly political aspects, this research sought to introduce an index compatible with its context for energy security. The aggregated index that encompasses population, GDP, and territory distinguished nine small states in the EU. Furthermore, the Herfindahl–Hirschman diversity index (HHI), which can represent the resilience of a state to supply disruptions, was applied to measure the energy security. Accordingly, the survey results show a solid and direct relationship between energy security and state size in small EU states; the smaller the state, the lower the diversity and energy security. The results do not prove the existence of any similar relationship in small EU states. This could mean that energy diversification is a vital requirement for the EU small states by adopting appropriate policies. One can justify such a relation considering the smallness and lower population, as considered in the definition of small states in this paper. This results into a smaller market size than the critical mass needed to develop all energy carriers' infrastructure, including coal mines, oil refineries, LNG terminals, UGS facilities, electricity networks, nuclear power plants, and concentrated renewable power plants. In the lack of massive oil and gas domestic resources in the EU, which can potentially enhance their energy security, small states must allocate their resources to develop some energy choices. This undermines their energy mix diversity and, as a result, reliability and energy security according to the acquired definition.

While the construction of interconnectors between the EU Member States was previously discussed as a solution to increase resilience, especially against external supply threats, this research specifically focused on the idea of enhancing small states' energy security by creating/joining an alliance. According to the shelter theory, such an alliance alleviates small states' internal vulnerabilities during times of crisis, by leading them to join regional organisations. Additionally, small states establish an alliance if they find it beneficial for the majority of their society and the state's security. Furthermore, considering the HHI diversity index, the alliance is expected to diversify the small states' energy mix.

Since establishing an energy alliance is highly dependent on geography, one can divide small states into the four categories of Baltic States, the Balkans, the CEE, and very small surrounded and encircled states (including Luxembourg, Malta, and Cyprus). The results show that the definition of alliance in shelter theory applies perfectly for Luxembourg and Malta. These states can form an alliance with their bigger neighbours (as the alliance is defined in shelter theory) in order to preserve their energy security. Cyprus, however, is unable to implement such a strategy due to the remoteness and isolation of its energy system and its geographical location. This could suggest that energy diversification within the self-dependency paradigm is a suitable policy for this island state. This paradigm is the logical policy prescribed for the largest small state, Slovakia, but with a different rationale. This is mainly due to the development of energy facilities and infrastructure in Slovakia, as it benefits from a refinery, underground gas storage, and nuclear power plants. These possessions have enabled Slovakia to adopt an independent approach to external energy policy comparing to its V4 neighbours in various cases.

Shelter theory can be applied to render policy recommendations for improving the energy security of small Baltic and Balkan States if a broader definition of an alliance is intended. This could suggest alliances with other small neighbouring states instead of large states and establishing a regional institution rather than joining an already existing organisation. Formation of a regional alliance means further integration of the energy infrastructure within the Baltic States or between Croatia and Slovenia. This will provide partners with free access to existing energy facilities or facilities under construction of their counterparts (whether LNG, refineries, nuclear power plants or UGS). It enhances the economic performance of energy facilities for owners, increases diversity and, therefore, the energy security of all beneficiaries at the same time. Therefore, intra-Baltic and intra-Balkan connectors are as crucial as trans-regional interconnections planned within the EU single energy market. Additionally, formation of such regional energy alliances prevents small states, interests, concerns and considerations ignored by the major powers in energy policy-making at an EU level.

Overall, we may say that the policy of small states in establishing alliances to protect their energy security is mainly limited by geographical factors. The policy then requires a cost-benefit analysis that compares the achievements in exchange for a partial loss of autonomy. This means that having a well-developed energy infrastructure may raise the tendency for self-dependence rather than for an alliance. Therefore, while security concerns dominate the motivation as very small states of Luxembourg and Malta to seek shelter, the Balkans and the Baltic states can pursue their economic and security interests in a positive-balance game of energy alliance with smaller neighbours. Finally, since small

EU states try to support the Commission in general, their proposed solutions must align with the general orientations to create a synergy. This is compatible with the main idea, since it reinforced Baltic and the Balkan energy markets and integration of infrastructures. It can act as defined within the framework of the projects of common interest (PCI) as they aim to strengthen interconnections. Moreover, they can also be considered in line with the Commission-backed plans as Three Seas Initiative, the European Union Strategy for the Baltic Sea Region (EUSBSR) and also for the EU single energy market in a broader perspective.

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