Lund University
Department of Political Science

STVM23

“The networking power of energy corporations”

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A network analysis of the liquefied natural gas (LNG) network and its structural implications for the European Union’s energy security

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Word count: 19.996

Abstract

This research aims to examine the effects of the new LNG network structure on EU's energy security. The research question is as follows: How can the concept of Weaponized Interdependence (WI) inform EU's Energy Security? The concept of WI is used to reveal structural positions in the network which can be utilized to leverage political means. In addition, this research adopts a reinforcing understanding of structural and relational power in order to capture how the material and subjective system of energy security interacts in the EU.

This research conducts a network analysis to broadly inform the EU's LNG security. To further inform the EU's energy security, the network analysis reveals where central energy corporations can utilize the weaponized interdependence in the LNG network. By looking into the LNG terminals and its operators at this location, two energy corporations were revealed; Fluxys and Elengy. Lastly, the structural positions of these energy corporations in the EU's subjective LNG system were qualitatively reflected upon. This research found that these two energy corporations hold central positions within the material and subjective LNG system, which equips them with the possibility to maintain their central position: a networking power. The findings in this research suggest that the new LNG structure provides energy corporations with increased power to influence the EU's energy security in a way that benefits their interests in LNG which potentially slows down the transition towards greener energy systems in the long term.

Key words: *LNG; EU; Energy security; Network analysis; Weaponized Interdependence*

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Table of abbreviations

BC	Betweenness centrality
CC	Closeness centrality
DC	Degree centrality
EC	Eigenvector centrality
ENTSOG	The European Network of Transmission System Operators for Gas
EP	European Parliament
EU	European Union
EUCOM	European Commission
GIIGNL	The International Group of Liquefied Natural Gas Importers
IAG	Industry Advisory Group
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPE	International Political Economy
IR	International Relations
LNG	Liquefied natural gas
MS	Member states
PCI	Projects of common interests
SNA	Social network analysis
TEN-E	Trans-European networks of energy
TFEU	Treaty on the Functioning of the European Union
TNC	Transnational corporation
TSO	Transmission system operators
WD	Weighted degree
WI	Weaponized Interdependence

1. Introduction: Energy and Power in the EU

According to the EU's Energy Platform the access to liquified natural gas (LNG) contributes to enhanced energy security by diversifying gas supplies. Therefore, the Global LNG network is important to study to be able to inform the EU's energy security. The research question is as follows: How can the concept of Weaponized Interdependence inform EU's Energy Security? The European Commission argues that countries that have access to LNG terminals and the LNG market are more persistent in possible interruptions in supply. In other words, terminals in which LNG departs and arrives are important hubs in the LNG network. It is therefore important to understand what power relations these hubs play out in the EU. Domestic gas production is declining while in an energy crisis, Russia's invasion of Ukraine, and the need to implement renewable energy (EUCOM, 2024a). Due to the Russian-Ukraine conflict in February 2022, sanctions have been imposed by western alliances in which financial measures and import measures were included. However, sanctions against the energy export from Russia were not present in the very beginning. When restrictions were put in place, restrictions on natural gas were comparatively less and not that drastic compared to imports from crude oils in 2023 (Rokicki et al., 2023). The Russian gas which flows to Europe via pipelines has faced "unexplained" and "unexpected" problems, including sabotage by unknown actor(s). Through RePower EU, the EU aims to phase out Russian energy imports and diversify its energy supply. In accordance with the RePower EU plan, the EU worked to diversify its international partners to secure LNG imports. Once again the EU is trying to reduce its dependency on Russian gas, and now it aims to further develop partnerships with illiberal regimes such as Azerbaijan, Egypt and Qatar and that these partnerships are inconsistent with the EU's energy policy (Vezzoni, 2023; Sabadus, 2023;). During recent geopolitical events, it has become clear that energy plays a crucial role in shaping various actors' policy positions in the international system. Therefore, this research aims to explain how actors' structural positions in the new LNG network generate influence over energy security policy in the EU. Moreover, the Russian invasion in Ukraine shed light on the insecurities the EU faced with being independent on Russian gas. Before this event, the covid 19 crisis also highlighted how globalization did not only introduce greater benefits for human society, but it did also introduce more uncertainties through interdependence (Sheng, 2012). Therefore, interdependence will be evaluated within the LNG network to investigate its effect in asymmetric power relations. In addition, the increased role of TNCs in the global landscape has changed the role of state and

therefore it is also important to consider the power dynamics of TNCs within the LNG trade network.

The research question will be as follows: How can the concept of Weaponized Interdependence (WI) inform EU's energy security? The purpose of this research is to examine how WI can inform the EU's energy security by uncovering "the networking power of energy corporations", or strategic positions in the LNG network. In accordance with the definition of energy as "low vulnerability of vital energy systems", this research can approach the LNG network as a material LNG system and a subjective LNG system. Firstly, this thesis conducts network analysis measurements, in order to evaluate the overall energy security of the EU in the material LNG system. A key claim by Farrell and Newman is that WI exists in global economic networks where states in central positions can coerce others to gain political leverage. Therefore, secondly, this thesis will measure where WI is possible within the global LNG trade network to inform where there are certain strategically beneficial positions. These positions are called the chokepoint effect and the panopticon effect which are translated into the network measures "betweenness centrality" and "closeness centrality". When these positions have been pointed out, the LNG terminals and their operators (energy corporation) will be revealed in those positions in order to further evaluate their networking power in the EU's energy security policy, being the subjective LNG system. Lastly, this evaluation will be made by a qualitative reflection of the EU's LNG system which complement the quantitative findings of energy security and WI. Within the framework of WI in this research, the material and structural power is understood as reinforcing each other and actors which have the potential to control this reinforcing character are important to reveal in order to inform the EU's energy security policy. This reinforcing character of the LNG network is what this research will adhere to as the networking power of energy corporations in the EU. The thesis statement can be found on page number 53.

2. Literature Review: The role of LNG within the EU's energy security

This research will start with a review of the legal basis of EU's energy security and the role LNG has within the EU's energy security. Additionally, this section will review literature on the definition of energy security and explain why the approach of a material and subjective LNG is beneficial for the aim of this research.

2.1. The legal basis of EU's energy security

Within the EU, article 194 of the Treaty on the Functioning of the EU(TFEU) lays out the legal basis for the EU's energy policy (Ciucci, 2023). Specific provisions are found in different articles of the TFEU. The EU does not have the authority to determine the energy mix of Member states(MS), however, it has obligations based on the Treaty. These obligations are to ensure the functioning of the energy market; to ensure the security of energy supply; to promote energy efficiency and renewable energy; and to promote the energy network and their interconnection (TFEU: Article 194). In 2015, the Energy union formulated 5 objectives of the EU's energy policy:

> ***(1)*** *diversify Europe's energy sources, ensure energy security via solidarity and cooperation between member states.*
> ***(2)*** *ensure the functioning of a fully integrated internal energy market, to enable the free flow of energy across the EU through adequate infrastructure and without technical or legal barriers.*
> ***(3)*** *improve energy efficiency and reduce dependence on energy imports, reduce emissions and drive jobs and growth.*
> ***(4)*** *reduce carbon dioxide emissions from their economy and move towards a low-carbon economy in line with the Paris Agreement.*
> ***(5)*** *promoting research on low-carbon and clean energy technologies, and prioritizing research and innovation to drive the energy transition and improve its competitiveness* (Ciucci, 2024).

As several scholars argue, the Energy Union changed the energy policy towards considering hard security matters in the EU (Andersen et al, 2017). In addition, the energy security issues and regulations have clearly been connected with climate objectives as well. According to the

IEA, the energy sector accounts for more than two thirds of the greenhouse gas emissions globally, making it a key contributor to climate change (IEA, 2020).

The European Commission (EUCOM) can engage diplomatically and contribute to the establishment of international energy projects. Additionally, it can provide legal exemptions for energy infrastructure and support transport projects financially. By using legal instruments regarding the internal market and environmental policy, EUCOM can influence energy policy. As the Lisbon Treaty transformed energy policy into a competence shared between the EU and the MS, the role of EUCOM got strengthened. However, EUCOM relies on energy corporations to purchase gas and to build pipelines to the EU (Proedrou, 2012: Bocse, 2021). Bocse argues that the field of energy within the EU has shown neofunctionalism features where functional spillovers has occurred by supranational institutions which creates an attractive space for interest groups and advocacy coalitions to interact with EU institutions with the aim to influence EU energy policy (Bocse, 2021). The increased role of TNCs within the EU's energy security policy will therefore be examined in this research.

EU energy security, as a responsibility, is shared by the member states, the EU institutions, energy companies, and in some cases energy consumers:

" (...) security of gas supply is a shared responsibility of natural gas undertakings, Member States, notably through their Competent Authorities, and the Commission within their respective areas of activities and competence. Where appropriate, the national regulatory authorities, where they are not the Competent Authorities, should also contribute to security of gas supply (...) "(European Parliament and the Council, 994/2010: 23).

As Proedrou (2012) argues, corporations play an important role in the EU's energy security as they are operators in the energy field. They sign supply-contracts, create joint ventures, invest money in important transportation, and provides household and industries with energy (50).

" (...) in the event of a supply crisis, market players should be given sufficient opportunity to respond to the situation with market-based measures. Where the reactions of market players are not sufficient, Member States and their Competent Authorities should take measures to remove or mitigate the effects of the supply crisis. Only where these measures are insufficient should measures be taken at regional or Union level to remove or mitigate the effects of the supply crisis. (European Parliament and the Council, 994/2010: 24).

Corporations depend on the legislative framework that MS and the EU establish, which creates the rules for the operation of energy corporations (Bocse, 2021). However, it is only when their reactions are not sufficient that the MS should take measures to mitigate the effects of the supply crisis. In addition, if these actions are not considered to be sufficient, then the EU

can mitigate the supply crisis. However, as long as the corporates and the EU are on the same track with mitigating the supply crises, the state can be looked as to be somehow outside the strategy-making. Therefore, the energy corporations' capacity to influence the EU within the energy security domain is interesting to capture.

2.2. The role of LNG within EU's energy security

Liquefied natural gas (LNG) is a natural gas that has been cooled into a liquid. The process of cooling it down is made for enabling shipping and storage as it becomes about 600 times smaller in volume than in gaseous state. This process makes it possible to transport LNG to places where pipelines do not reach. Instead, LNG is shipped with specialized ships which arrive at terminals: liquefaction plants and regasification facilities. At the regasification terminals it is returned into its gaseous state and transported further through pipelines to be used by businesses and homes (EUCOM, 2024b).

In light of climate change, it has been shown that LNG should be part of a broader transition strategy towards a greener energy system, rather than being used alone. It is argued that there is a need for accelerating renewables while using LNG (Daudu et al., 2024). Studies, based on data from IPCC and IEA, have argued that coal is better for the climate than LNG, as LNG emits 15% more CO2 than surface-mined coal over a period of 20 years (Schernikau, 2022). However, the main argument against natural gas as a transition fuel is that the challenge of climate change is too significant and that we must entirely move away from fossil fuels. McJeon et al. (2014) and Myhrvold and Caldeira (2012) showed that natural gas as a transition fuel would not be enough to tackle climate change as it would take too long before achieving decent reductions in emission and temperature. Additionally, it is argued that including gas into energy systems will slow down the decarbonation process as investments are put into gas instead of low carbon resources and energy efficiency (Boersma & Jordaan, 2017; Davis & Shearer, 2014). The increased usage of and investments in LNG within the EU has faced extensive critique. Director of Green Peace Slovakia critiques new LNG projects as she states, "We cannot afford the construction of new fossil infrastructure if we want to keep the global temperature growth below 1.5 degrees Celsius by the end of the century" (Jenčová & Silenská, 2024). The intergovernmental Panel on Climate change stresses that LNG terminals are hard to shut down while put in place. They warn that the LNG infrastructure must be phased out soon, or it will make it impossible to keep global warming below 1.5 °C at the end of the century (IPCC, 2023). In addition, the IEA urges caution when investing in further LNG infrastructure as the rapid increase in investments exceeds the demand. They argue that building too many

LNG terminals delimit the climate commitments of the EU and the need to phase out fossil fuels (IEA, 2024b).

However, a quarter of the EU's energy consumption is represented by natural gas, and it is a key objective of the EU to have access to the LNG markets as it diversifies the gas supplies and, therefore, contributes to the energy security of the EU in the short term, while in the long term the goal is to implement more sustainable solutions reaching full decarbonization by 2050 (EUCOM, 2024b). 20% of the EU's energy import represented LNG in 2021, while in 2023 it was 42%. As of January 2024, there were 57 operational LNG import terminals in Europe as countries look for suppliers outside of Russia (Statista, 2024). This new structure is therefore interesting to study as the network of LNG has changed very much during the recent years in the EU.

To exploit shale gas has been and remains a contentious issue in Europe. Those supporting the use of fracking argue that regulations considering fracturing would hamper the development and become a regulatory burden. They also argue that shale gas contributes to the energy security of the Union (Bocse, 2021). NGOs and Green politicians were opposed to fracking and argued that renewable energy sources would rather enhance the energy security of the EU. However, the EU is not capable of imposing legal bans because the MS has the right: *"(...) to determine the conditions for exploiting its energy resources, its choice between different energy sources"* (TFEU: Article 194: 2).

Mazey and Richardson argue that due to early allocated lobbying resources in the policy debate of fracking shale gas, this produced larger pay-offs than if the resources were put in place in a later stage (2006: in Bocse, 2021). The EUCOM decided to only make recommendations on shale gas fracking, which could be argued, indicate that the pro-fracking coalition was more successful. This shows that even though there is a sharp division within the EU considering LNG, the ongoing regulations and energy security objectives are rather in line with the interest of the pro-fracking coalition.

As mentioned, REPowerEU plan in 2022 is a response towards the disruptions triggered by Russia's invasion of Ukraine with its aim to save energy, diversify energy supplies, and to produce clean energy. It strives to achieve a strategically resilient EU in terms of gas imports. In accordance with REPowerEU and its demand for increased and efficient use of LNG, EUCOM established the EU Energy Platform early in 2022. The three objectives of the platform are; "*demand aggregation and joint purchasing of gas*", "*most efficient use of existing infrastructure*", "*international outreach*" (EUCOM, 2024c). Aggregate EU is a mechanism within the Energy Platform, which is responsible for pooling gas demand, organizing infrastructure

usage, international negotiation, and planning joint gas purchases. AggregateEU is a new flagship initiative from EUCOM which implements demand aggregation. Importantly, it organizes and assists the purchasing of natural gas at EU-level. Its main objective was to contribute to diversified supply of gas during the winter 2023/202 and has been prolonged. Additionally, it works for decreasing the price volatility by delivering information on accessible gas supplies. It offers a channel in which gas demand and supply is being matched between buyers and sellers. In accordance with a study from the Oxford institute for energy studies and a policy brief from Stockholm school of economics (Barnes, 2023; Le coq & Paltseva, 2023), the evaluation of AggregateEU is hard to make as it can been used for the match-making, but then the negotiation and contract can be made outside of the platform. The study also concluded that EUCOM has proposed to make the mechanism permanent or extend it even further. The authors argue that this decision risks harming the competition between suppliers and disrupting the benefits from the liberal market. Within the Energy Platform and the AggregateEU, energy corporations, EU countries, and the energy community deliver proficiency and knowledge to EUCOM. Energy corporations work through the Industry Advisory Group (IAG), through which they provide expertise and advice on the industrial perspective on demand aggregation and the mechanism of joint purchasing (EUCOM, 2024c). They comment on options by EUCOM for LNG and how to ensure the EU's reduced dependency on Russian gas in accordance with the timeline outlined by the REPowerEU. In addition, the IAG assists EUCOM in its preparatory work of legislative proposals and policies and meets regularly since early 2022.

Furthermore, the European Network of Transmission System Operators for Gas (ENTSOG) was established in 2009 (EC/715/2009), to assist collaboration among the gas transmission system operators (TSOs), to guarantee the improvement of a pan-European transmission system and to encounter European Union energy and climate goals. ENTSOG and the TSOs should strive for achieving the target of net-zero decarbonization by 2050 (ENTSOG, 2024). Considering gas infrastructure and market regulation, ENTSOG has a significant influence in the formation of the internal EU gas market (Borchardt and Leoz Martin-Casallo, 2019; Staschus, 2019; Pototschnig, 2019). ENTSOG is therefore an important mechanism to examine as it is a part of the EU's LNG system.

Another interesting feature which aims to secure the supply of gas, is the solidarity mechanism introduced by regulation "EU/2017/1938". This mechanism should ensure that households and hospitals have access to gas even in a crisis. To ensure this EU countries must implement the technical, legal and financial provisions which support the flow of gas. Another important mechanism for the security of LNG supply is the Gas Coordination Group (GCG). This group shall coordinate security of supply measures and assist the EC to ensure that the right

measures are taken under Regulation “EU/2017/1938”. GCG should also work as a platform that exchanges information on security of gas supply between important stakeholders. Lastly, GCG oversees the security of supply and storage levels within the EU and meets regularly to examine and discuss these issues. All these mechanisms are governed by the political guidelines which state that “*Members of the Commission should seek to ensure an appropriate balance and representativeness in the stakeholders they meet*” (European ombudsman, 2015). The EUCOM’s horizontal rules on expert groups also endeavor for a balance in the various representation of these groups (EU/C/330).

Considering the LNG system within the EU, ENTSOG, AggregateEU, and IAG are important groups and mechanisms to study in order to evaluate the influence energy corporations might have in the EU’s LNG security policy. They will be a part of the analysis as a qualitative reflection which will complement the quantitative method’s finding of this research.

2.3. The definition of energy security

The international Energy Agency (IEA) is “(...) created to ensure secure and affordable energy supplies” (IEA, 2024c). The definition of energy security according to the IEA is “the uninterrupted availability of energy sources at an affordable price.” (IEA, 2024c). The IEA also makes a distinction between short-term energy security and long-term energy security. Short-term is the capacity of the energy system to react to unexpected changes in the balance on supply-demand. However, the long-term entails investments to supply energy in accordance with economic development and environmental aims. Keppler has criticized the use of affordability as it is argued to be impossible to evaluate whether the price is a response from a supply shortage or rise in demand (Keppler, 2007). This research will not evaluate the price as it is rather interested in how structurally beneficial positions in the network produce power to influence policy.

When reading under the heading “Energy security” on EUCOM’s website, it states that “The EU works to ensure that energy supplies from abroad are secure and affordable.” (EUCOM, 2022d). Compared to the definition by the IEA, the EU shows a great emphasis on the supplier side of energy security. When looking at the energy security website, it shows some headings: *“EU Energy platform, “Secure gas supplies”, “Gas storage”, Diversification of gas supply sources and routes, “Security of electricity supply”, “EU oil stocks”, “Offshore and gas safety”, Oil and gas licensing”, Critical infrastructure and cybersecurity”,* and *“Energy supply and pandemics”* (EUCOM, 2022e). When looking into what this information

really displays, it provides one with the definition of the short-term energy security from IEA: the capacity to react to unexpected changes in the supply-demand balance.

Within the geopolitical and material approach of energy security studies, the central question within the energy security literature is “How does control over energy resources affect state power and national security” (Jewell & Brutschin, 2021). However, the securitization approach, with its intersubjective base, accepts that anything can be understood as an energy security issue having its disciplinary roots in critical political studies (Buzan, 1983). According to the Copenhagen school, energy security issues relate to existential threats, where one analyzes the process of securitization. In securitization, social actors are believed to lift an issue out of the political realm and formulate it as an existential threat (Buzan et al, 1998). When applied to the energy security realm, the securitization approach has revealed a weakness that originates from their lack of detailed analysis of material realities of energy systems and their inability to foretell when a securitization action will be effective and why certain political concepts of energy security arise in different situations (Jewell and Brutschin, 2021). Within the classical approach to energy security there are four key parameters of energy security called the four As that have been considered since the 1970s: Availability, Accessibility, Affordability, Acceptability. La Belle argues that Russia used the shortage of gas supply in 2021 toward Europe as a leverage against MS. As a response, the EU decreased Russian access to the energy market to put pressure on Russia. Therefore, La Belle argues that the limit of the four As was evident, as the available and affordable energy was not acceptable any longer (La Belle, 2023: 19-22).

Within the deductive approach, the material and intersubjective coexists and aims to answer: “What are the conceptual foundations of energy security, and how do material factors interact with intersubjective perceptions of energy security?” (Jewell and Brutschin, 2021). This is the approach that the analysis of the thesis will base its understanding of energy security on. Within this approach, Cherp and Jewell (2014) define energy security as “low vulnerability of vital energy systems”. They argue that the definition would favor the comparison of energy security concerns in different contexts. This definition derived from a critical examination of the four As of energy security. Their definition is argued to be applicable in different scientific disciplines, support informed policy making and contribute to better policy analysis (Cherp and Jewell, 2014: 415). Jewell and Brutschin (2019: 249-250) argues that the definition as “low vulnerability of vital energy systems” creates a bridge between material and the intersubjective nature of the concept, where intersubjective is understood as the perceived meaning that exists between actors. Within the EU, the intersubjective meaning of energy security will be understood as the energy security policy in the EU. As a method, Cherp and Jewell (2014)

identifies the meaning of energy security in particular context. This is done by defining the meaning of “vulnerability”, “resilience” and “vital energy system”. These concepts will be put in a context in the next sections.

2.3.1. Vulnerability and resilience

The vulnerabilities of energy systems have been depicted as the combination of exposure to risk as well as their resilience (Cherp and Jewell 2014). If a state is dependent on an untrustworthy supplier (resulting in high risk) the vulnerability will become lower if the state switches to another energy source (which lessens the exposure to the disruption risk) or implements storage and mechanism to quickly change the demand to other resources (which maximized the resilience or the capacity to respond to disruptions) (Jewell, 2011).

One can understand the concept of resilience as Keohane and Nye (1977) defines it, where “sensitivity” reflects the exposure to risks and “vulnerability” is understood as the ability to respond to disruptions within this exposure. The IEA (International Energy Agency) makes a difference between domestic and external resilience (IEA 2011; Jewell 2011). The external resilience consists of alternative trade routes and suppliers which relieve risks from foreign supply. However, domestic resilience consists of such as production capacity and storage capacity (Yergin, 2006). The solidarity mechanism (EU/2017/1938) could be seen as a resilience measure where locations in the EU secure their access to LNG supply in a crisis. In addition, the overall efficiency of the LNG trade network is a measure of resilience in this sense.

2.3.2. The material and (inter)subjective energy systems

As Cherp and Jewell (2013) argues, energy systems can be described as consisting of resources, technologies, and the use of it linked by energy, material, and economic flows. These flows are stronger than the links outside of the system. The system can be outlined within geographical and sectoral boundaries. For example, a system can be the energy security of the EU. Examples of sectoral systems are such as energy infrastructure (Farell et al., 2004 and energy services (Jansen and Seebregts, 2010). Jewell and Brutschin understands the definition of energy systems as subjective as well where boundaries depend in part on values and worldviews (2019: 261). Within this logic, a country that depends on one big exporter, will become more resilient if it is a part of an international electricity or gas network system, such as within the EU. Several scholars argue for including the environmental

dimension into energy security issues as environmental issues, such as climate change, are argued to be entangled with the use of energy (Sovacool & Brown, 2010; Sovacool & Mukherjee, 2011).

The “vital” in vital energy systems, underscore that an energy security concern must mean that the system is being part of the critical social functions (Cherp et al, 2012). Energy security in this sense, can be argued to be about protecting national values and objectives (Yergin, 1988). Which will be TNCs “interest” within this research. These values and objectives are different in different societies, which is the reason for why states have different energy security priorities (Jewell and Brutschin, 2019: 261-262). Within the AggregateEU, ENTSOG and the IAG there are shared objectives which create the EU’s subjective LNG system. Even though the subjective LNG system within the EU could be argued to have its shared values and objective, this research does not assume these systems to lower the vulnerability of members. This research rather aims to examine how these systems can be used for political leverage.

The definition of energy security as “low vulnerability of vital energy systems” allows for the consideration of both material and intersubjective meaning. In order to evaluate the energy security of the LNG trade network, the concepts of vulnerability and resilience will be considered in the analysis to inform the EU’s material LNG system. This thesis will consider the LNG as the material flow and the LNG terminals as the energy infrastructure that outline the material boundaries of the energy system. When considering the subjective boundaries, the EU could be considered an international gas network with its shared values and strategies within the Energy platform, and particularly through the mechanism; AggregateEU, ENTSOG, and the industry advisory group (IAG). By investigating how the material and intersubjective network can be leveraged against by energy corporations, this research informs the EU’s energy security. The thesis now proceeds to broadly discuss conflict and cooperation in order to develop the dynamic of the LNG trade network and its relation to the concept of energy security.

3. Theory: Conflict and Cooperation in the Global Political Economy

This chapter will discuss three major perspectives: the economic nationalist perspective, the liberal perspective, and the critical perspective. This discussion is vital as it provides the thesis with an understanding of the developments in the global political economy and its relation to conflict and cooperation. As the aim is to understand the energy corporation's role in influencing the EU's energy security policy, it needs to understand the dynamic of the network and what development it produces in distribution of power.

3.1. The economic nationalist perspective: TNCs and their structural and relational power

Mercantilism, or realism in international relations (IR) theory, emphasizes the importance of the state when studying activities in international relations. It argues that there is only a limited amount of wealth and, therefore, states have to secure its own interests over others. Which is also known as the zero-sum game as the gain of one state is another state's loss (O'Brien & Williams, 2016: 8). Fredrick List (1885: O'Brien & Williams, 2016) argued that free trade policies were only advocated by strong economies as they would benefit from the weaker state's loss in the competition. From the nationalist economic perspective states should protect their industries against foreign rivals and should export more than they import in order to benefit domestic production. There are two major assumptions within the perspective of economic nationalism. One of them is the assumption that the international system is anarchical which presents states with the duty to protect its own interest. The second one is that the state is the central player, and it is also the instrument through which people can achieve their goals. The economic policies should therefore be used to establish as strong a state as possible. The economic nationalist perspective sees the market as subordinate to the state and the relations within the market are shaped by the political power (O'Brien & Williams, 2016: 9).

Within this perspective, market-based actors such as transnational corporations (TNCs) are recognized as important but subordinate to the state. Relations within the market are important and indicate the power and wealth of states, however, the market is considered as subordinate and governed by the state and the global economy is subordinate to the international political system. Scholars from the field of IPE argue that interest of the most

powerful states are reflected in the nature of the global political economy. Krasner (1976: O'Brien & Williams, 2016: 9) argued that when there is a single power that dominates the international system, free trade-systems are more likely to occur. The important role of this power is to absorb the short-term costs of a maintained free-trade regime. When the changes in the distribution of power occur between states, Gilpin (1981: O'Brien & Williams, 2016) argues that the probability of conflict increases.

When applying the economic nationalist perspective to the topic of this thesis, the world in which global energy trade exists within is anarchical and lacking central authority and states are the central players in the global energy trade system. As the aim of this thesis is to investigate the energy corporation's role in influencing EU's energy security, the nationalist's obsession with the state becomes unbeneficial. Since participation in the energy markets is not necessarily positive, states should control the energy policies and activities. In addition, states should not be reliant on the import of energy as economic nationalist would argue that this good might become unavailable in a time of conflict. The aim of this research is to investigate the LNG network without assuming the anarchical structure of the global economy and rather start with a focus on the relations between locations rather than the states as units.

Susan Strange takes a realist approach, with elements of power politics or economic nationalism, as it emphasizes the exercise of power and the policy's role in structuring the global economy(O'Brien & Williams, 2016: 11). However, her work is highly unorthodox as it argues for the important role markets and corporations have in changing the context of which states operate. Strange argued that the state authority was transformed by globalization (1996). This broad approach is present in her textbook from 1988 *States and Markets*, in which she expands the understanding of power from solely relational (A forces B to do A's will) towards structural power. Additionally, along with Dennis Pirages, she was advocating an "ecological approach" within IPE. They argued that our understanding of developments in IPE would be strengthened by considering the nature-human relationships.

Susan Strange developed an understanding of structural power as something that is not only dependent on material or ideational factors. The structures are resources of power for the actors, being states or non-state actors. She also acknowledges how systems and entire structures reflect dominating value sets (Germain, 2016: 5-6). Susan Strange argued that the power of the state has declined, especially within those basic matters which the market has never been able to provide by itself, such as infrastructures for transport and communication (Strange, 1996: 5). Strange and Stopford argued that states are now competing for market shares instead for territory. Within this new game, states are searching for allies such as foreign-owned firms, rather than states and international organizations, with the aim to gain

bargaining power. Firms might be persuaded to locate production of goods and services within the territory of the state in question, in exchange for access to the national market of the state (Strange, 1996: 9,91).

The work of Strange is beneficial for this thesis when trying to evaluate whom the structure benefits within the global energy trade. Where does power lie and in what form is it played out? For Strange, the relational power is the material and physical capabilities which are possible to measure and estimate. The relational power would be the amount of LNG that TNCs control. However, structural power refers to the "shape and determine the structures of the global political economy within which other states, their political institutions, and their economic enterprises and (not least) their scientists and other professional people have to operate" (Strange, 1994). Strange defines it as the power "to decide how things shall be done, the power to shape frameworks within which states relate to each other, relate to people, or relate to corporate enterprises" (Strange, 1994). She argues that power can control the outcomes within relations due to material and ideational factors but also through defining the structure which becomes a resource of power by framing the rules of the game in favor of the powerful actor.

For this thesis, the structural power would be the EU's energy security policies which determine the structure in which energy corporations operate within; AggregateEU, ENTSOG, and the IAG. She also understands relational power and structural power as closely related as structural power forms the global structure so that material relations are influenced in a way which benefits the actor who held the structural power. And reversely, the material advantage reinforces the structural power (May, 1996). Thus, those actors that control a large amount of the LNG in the LNG trade network would gain structural power, and the power to influence the EU's energy security policies in a way that, again, reinforces their control over LNG resources. Strange provides this thesis with a framework which allows it to look at the structural and material factors and how these operate and coexist. Strange's understanding of TNCs, and structural power therefore fits well with the definition of energy security in this research. However, Strange does not provide the thesis with a clear explanation of where this power of control is found and intentionally exercised. The next section will complement the framework by adding this understanding of where to find structurally beneficial positions in a network.

3.2. The liberal perspective: weaponized interdependence and power

Contrary to economic nationalist theories, the liberal perspective puts its focus on the individual or various actors. However, the individual is the key economic actor and the starting point of analysis. Importantly, they do not consider the state as a unitary and rather influenced by various factors. Liberalists do not see conflict as inevitable and focus on finding the conditions for cooperation. The world system is looked at as a system of interdependence instead of anarchy. In contrast to a zero-sum game, liberalists advocated a positive-sum game where everyone gains (O'Brien & Williams, 2016). In order to grasp the dynamic of the network, this thesis acknowledges in accordance with the liberalist perspective that interdependence is an important feature to consider. However, it does not assume that increased interdependence necessarily decreases risks as it seeks to understand how energy corporations might leverage political means towards the EU.

The economic nationalist thought of protectionism and restrictions in the economic market are argued to impoverish the state by liberal theorists. Adam Smith (1776: O'Brien & Williams, 2016: 12) argued for opening up commerce and expanding international markets to increase the wealth of everyone. Unlike economic nationalists who don't trust firms to a certain degree, liberals consider firms as generating economic wealth both for the home and host country. As states bring politics into the economic realm which brings costs to the participants in the market, liberalists view the state with hostility (O'Brien & Williams, 2016: 13). In terms of conflict and cooperation, liberal theorists view the political economy as cooperative. The liberal theory of comparative advantages has shown that even when a country is superior in production of goods and services, the trade between countries will benefit all. Contrary to Marxist theorists who condemn capitalism as a cause of war, liberalists argue that international interaction (and capitalism) results in prosperity and peace. International agreements and regimes are considered to maintain the economic order even when states are declining (Keohane, 1984).

Within "Power and interdependence: World politics in transition" by Keohane and Nye (1977), interdependence is explained as a situation in which "there are reciprocal (although not necessarily symmetrical) costly effects of transaction between parties." There is a distinction of sensitivity and vulnerability in the concept of interdependence where sensitivity shows how quickly one country is affected by changes in another country and how extensive the costs of this phenomena is. Vulnerability is understood as the capability to suffer costs imposed from outside events (1977: 33). Moreover, in terms of power, Nye established the concepts of soft

and hard power where hard power is *"the ability to get others to act in ways that are contrary to their initial preferences and strategies*" (Nye, 2011: 11). Contrary to hard power, soft power is the capacity to get "others to want the outcomes that you want" by "*the ability to achieve goals through attraction rather than coercion*" (Nye, 2004: 5). He believes that economic resources can produce soft power as, for example, a free trade economy will attract another actor into its model (2011:85). This is a rather bilateral way of thinking of power when compared to Strange's understanding of structural power.

Colgan, Keohane, and Graaf (2012), establish the concept of "regime complex" within the global governance literature and within the context of the increasingly fragmented world of oil and gas. They pinpoint the significance of path dependency and disruptive dynamics in global energy governance when explaining the phenomena of bilateral and dependent energy relations. This thesis finds their emphasis on path dependency and disruptive dynamics interesting for evaluating the LNG trade network, however, they are rather focusing on how to maintain the cooperative dynamic, rather than evaluating how actors leverage the ongoing asymmetric dynamic. Before this time, Keohane published his book "After Hegemony. Cooperation and Discord in the World Political Economy"(1984), in which he puts energy in the context of power and interdependence. This book is Keohane's attempt to integrate structural realism with complex interdependence. He bases his theory of cooperation on the functional expectation on states – where norms such as transparency, principles and rules assert that rational self-interested states cooperate in the long term despite changes in the balance of power. However, in accordance with Strange, this research argues that the rules which Keohane argues to increase the cooperation between states, are argued to be influenced by actors with structural power.

Within their work "Weaponized interdependence: How global economic networks shape state coercion" (2019), Henry Farrell and Abraham Newman explain the concept of weaponized interdependence (WI) as a different understanding of state power, which pinpoints the structural viewpoint of interdependence. They show how economic networks of interdependence cut across domestic institutions and norms to shape authorities' coercion. From their understanding, globalization has changed the liberal order, taking away the action from multilateral interstate negotiations toward networks of private actors. Due to this transformation, the location of state power in international politics has new meaning (Farrell & Newman, 2019: 44). The concept of WI contrasts itself with liberal concept of complex interdependence. The standard liberal account of interdependence emphasizes bilateral relations and tends to neglect the issue of power by putting the focus on mutual cooperative benefits. Farrell and Newman base their work on Susan Strange's structural power and network theory and links the literature on international political economy and security relations to reveal how economic power can be a product of structural characteristics of the global

economy. Farrell and Newman take a stand where a structural explanation of interdependence and network topography produce lasting power imbalances among states.

Network analysis allows one to investigate and measure the structures, patterns, relations and emergent characteristics among actors in a network. These can then determine, enable and constrain these actors. For clarification, a network in this research is "*a group of interdependent actors and the relationships among them*" (Mingus 2007: in Panzironi, 2017), which in an abstract sense look like a set of nodes linked by a web of interdependencies. Network theory challenges the traditional views of power by defining power as the ability of actors to strengthen their power by enhancing and exploiting their positions in the network, and the function of the network. Network analysis has great value for international relations as it has been able to precisely describe international networks, investigate network effects on important outcomes in the international arena, and to test network theory within international relation contexts (Hafner-Burton et al., 2009). Network theory has a relational focus which adds concepts which explain these relational dimensions. The presence or absence of ties between actors and the position of a country in the network goes beyond the realist perspective. Network theory does not approach the network as a holistic entity which allows one to zoom into the network and look at its processes that influence an actor's international behaviour. But most importantly, the network can reveal and explain the emergence of cooperation and conflict.

Liberalism does acknowledge the relevance of the relational approach. However, the effect of state membership in networks is treated as a characteristic. For example, Oneal et al. (2003) argues that states are less likely to get into conflict with each other if they are a member of the same international governmental organization. Within the realist perspective, the research embraces the ego. At the same time, relations "create networks that define the relative social position of states in the international system, which in turn create conditions for conflict or cooperation" (Hafner-Burton & Montgomery, 2006:6). Even though relations are important for liberalism, Farrell and Newman argue that it does not provide an appropriate theoretical basis to analyze the relational dimension of networks that produces conflict and cooperation. Therefore, network theory adds a valuable perspective when explaining international actor's behaviors within this research.

According to Farrell and Newman, some "nodes" (actors) in networks are more connected than others, which produce the capacity to WI, meaning that some nodes are capable to leverage interdependent relations to coerce others. Where states have political influence over central nodes, where goods, money or information flow, they can impose costs on others. States that control these nodes can leverage political means (Farrell & Newman,

2019:). There are two ways in which a state can benefit from powerful rewards from WI namely; the chokepoint effects and panopticon effects of networks. Within the panopticon effect, states take advantage of their network position to excerpt informational advantages in comparison to their opponents, which then can be used for political means. Through the chokepoint effect, states can cut off their opponents from flows within the network, which also can be used for political means (Farrell and Newman, 2019: 46). The concept of WI provides the framework of this research with an explanation of where and how actors can leverage political means within a network.

The ability of actors to employ either the choke point effect or the panopticon effect relies on the network structure (the degree of asymmetry) and the available institutions within them. To control via the structure, states must first, be a central importer/exporter, and second, states must physically or legally own hubs through central institutions. Lastly, if there is no physical or legal jurisdiction, the institution's key norms might become of importance for states to persuade through institutions, and ultimately into WI (Drezner, 2021:31-32). There are some obvious similarities between Farrell and Newman and Susan Strange as they were influenced by Strange's work. Both emphasize the structural position's significance in distribution of power and how the neoliberal globalized world has changed the role of the state. Both are bringing in non-state actors into the analysis and acknowledge the importance of both material and subjective resources.

The structure of the network and the state-private relationship are reproduced by market logics and actors (Drezner et al, 2021: 317). Asymmetrical networks might empower the state in its relations to non-state actors, but it might also be asymmetrical in a way that makes it hard for the state to exploit (Gjesvi, 2023: 726). In the state-market relationship, authority and power can reside with the state as much as with the market. As Strange argues, private enterprises can in many instances hold more "political authority over society and economy" than states (Strange,1996: 4). In addition, Strange considers the material and the subjective as reinforcing, which also becomes an interesting feature for this thesis as it aims to explain how TNCs influence the energy security policy in the EU. Therefore, the framework of WI by Farrell and Newman will be integrated in this thesis, but it will enhance Strange's influence to the concept of WI where the state analysis will be excluded and an increased emphasis of the subjective resources. This will also be beneficial as Farrell and Newman fail to describe how states use institutions to utilize WI.

The framework will be as follows; firstly, for WI to be possible, the network must be highly asymmetrical. Secondly, to be able to utilize WI through the chokepoint effect and the panopticon effect, TNCs must control the central nodes within the network (the hubs) through which LNG flows. Lastly, the structural power and the material position in the LNG trade

network will be considered as reinforcing. In other words, the structural power of TNCs shape and determine the structures of the global political economy within which other TNCs and their political institutions have to operate. For this thesis, the structural power will be evaluated within the EU's LNG system; AggregateEU, ENTSOG, and the IAG. This framework fits well with the understanding of energy security as a material and a subjective network.

To integrate Susan Strange even further into the framework of the thesis, the next section will aim to include Susan Strange's and Dennis Pirages's emphasis on bringing in the "ecological approach" within IPE to deepen the understanding of developments in IPE. The aim is to add value to the analysis by allowing to consider the impact the LNG network has on the environmental dimension of energy security policies.

3.3. The critical perspective: technopolitics and the environmental dimension

During the 19th century Marxism emerged as a reaction to the liberalist theories. Aa a critical approach, it moves away from the sole focus on the individual and the state towards other units. Rather than focusing on the state, Marxist theory considers class as the main "actor" in the global political economy. This perspective focuses on the interest and class of workers instead of the interest of the state. Class arises from one's position in the production structure and the firm is an instrument for exploiting the working class. Therefore, critical writers consider international economic relations as a zero-sum game. Imperialism is visible in the concentration and centralization of capital in TNCs, from which dominance is distinct in the global political economy (O'Brien & Williams, 2016: 17).

Environmentalism takes the environment and planet as key units to be focusing on. Within these critical theories, one examines how people are shaped by and shape the environment (O'Brien & Williams, 2016: 16). To separate the environmental issues from economic activities is argued to be unrealistic because the economy is embedded in nature. Within IPE, the focus is on human's misuse of natural resources which threatens the sustainability of the resources and results in unwanted problems such as increased pollution. Green theories critique the realist theories for being unsustainable in their focus on states and power. The analysis is considered to be limited by focusing on states and neglecting other important actors in the global political economy. In relation to relist theories, liberalism portrays a more realistic view of environmental politics by allowing non-state actors to take place in analysis. However,

liberals tend to disregard the role of power in shaping institutions and do not provide enough considerations of structural inequalities (O'Brien & Williams, 2016: 245-246). On the contrary, radical theorists emphasize structural patterns of dominance and dependence. However, it could be argued that they give too little attention to international actors. All these three paradigms within IPE commit to anthropocentrism and therefore fail to engage with environmental study debates.

Political ecology is related to political economy, having its roots in Marxist scholarship. (Sovacool 2016: 530, Robbins 2020). It is an interdisciplinary field in which a diverse set of bodies are accounted for and analyzed from a critical point of view. Political ecology emerged as a response to the apolitical and positivist understanding of ecology and nature-society relations (Perreault, Bridge & McCarthy 2015: 4-5). One of the beneficial features of political ecology is that the field is open to diverse theoretical standpoints which aims to explain inequalities, injustice and asymmetric power relations in the nature-human environment (Sovacool 2021: 3). As this thesis aims to explain asymmetric power relations in the LNG trade network and its effect in the EU's energy security policy, which is highly connected to environmental objectives in the EU, this thesis partly contributes to the field of political ecology.

The perspective of political ecology acknowledges power relations, policy structures and the market economy. In addition, it emphasizes that "politics is inevitably ecological, and that ecology is inherently political" (Robbins 2020: 3). Just like Strange, it "track(s) winners and losers to understand the persistent structures of winning and losing" (Robbins 2020: 87). Also similar to Strange, it tries to reveal dominating approaches towards the environment which favor corporate, state and international authoritative actors. In this regard, it seeks to demonstrate the unfavorable impacts of policies and market conditions. Within the realm of energy, political ecology becomes handy as it unveils social, ecological and political perspectives of energy systems. Within this perspective, energy systems are understood as producing winners and losers and enclosed resources. Enclosure in this sense, refers to such as privatization of public assets and the increased significance of a private actor within a public sector. Exclusion is when an energy project marginalizes stakeholders so that their access to resources is limited or that they are not included in decision-making. Exclusion is performed to delimit other actor's control over resources to gain more control. (Sovacool 2016: 544).

Within the field of political ecology, Technopolitics has been considered in order to reveal how technology and politics are interrelated. Edwards and Hecht (2010) define technopolitics as "hybrids of technical systems and political practices that produce new forms of power and agency". Technology and politics are entangled and exist within a co-constitutive dynamic process. They place power at the core of analysis to understand how technology is used for political purposes. As Edwards and Hecht argue "these technologies are not, in and

of themselves, technopolitics. Rather, the practice of using them in political processes and/or toward political aims constitutes technopolitics" (2010: 256–7). As Robert Falkner argues (2005), the innovative capacity of firms of "technological power" is a critical role in influencing environmental regulations. As Gjesvi argues, infrastructure studies have shown how infrastructure canalizes power relations into material objects which support exploitative and asymmetric power-relations (Goede, 2020; in Gjesvi, 2023). However, infrastructure does more than locating power. It can transform power as infrastructure changes the way core functions are played-out.

When including the perspective Technopolitics into the framework, it explains how asymmetric power-relations in the LNG network, seeming from the control of LNG terminals, produce inequalities between actors and allows some to affect the environmental policies in the EU. This perspective allows for a critical analysis of how the LNG trade network affects the transition towards greener energy systems. When integrating the concept of technopolitics into my framework of WI, enclosure is translated to the focus on TNCs control over central infrastructure, and exclusion will be the TNCs capacity to utilize the chokepoint effect and the panopticon effect of WI. The position of infrastructures is considered to transform the power of TNCs (which control the infrastructure) within the EU's energy security policy and, therefore, the environmental policy.

4. Framework: How will this research find the positions where WI is possible in the LNG network to inform EU's LNG security?

This thesis will evaluate the energy security of the EU with a focus on the energy corporations as they are the main operators of LNG terminals, sign trade contracts, and lobby against the EU. The definition of energy security as "*low vulnerability of vital energy systems*" allows for the consideration of both the material and subjective LNG system. In order to evaluate the energy security of the EU in the LNG trade network, vulnerability and resilience will be analyzed within the material LNG system. When considering the subjective LNG system, the EU could be considered an international gas system with its shared values and strategies within REPowerEU and the Energy Platform. However, the structure of energy corporations in the subjective LNG system is seen through the AggregateEU, ENTSOG, and the IAG. In order to investigate how energy corporations can leverage political means towards the LNG systems, the framework of Wi is applied. WI inform Strange's understanding of relational and structural power of where the influence, or leverage, of political means can occur.

The concept of WI is already based on Susan Strange's understanding of structural power and network theory. However, this thesis will add more of the Susan Strange-flavor into the WI framework by increasing the significance of the reinforcing character of the relational and structural power. Considering the LNG network, this framework allows us to understand the material and subjective LNG system to be reinforcing. TNCs will be considered to be able to utilize the WI and states will be excluded from the analysis when considering the distribution of power from within the network. Within the material LNG system, the framework will be as follows; to be able to utilize WI though the chokepoint effect and the panopticon effect, TNCs must control the central nodes within the network through which LNG flows. Based on the logics of network theory, the chokepoint effect and the panopticon effect are structural positions showing where WI is possible: *The panopticon effect* – wherein energy corporations are given access to more relevant and timely information about developments globally; *Chokepoint effect* – wherein energy corporations (threaten to) cut other states off from the economic networks they are dependent on (Farrell & Newman, 2019).

Within the subjective LNG system, the structural power of the energy corporations that have the possibility to utilize any of the two ways to WI will be evaluated within AggregateEU, ENTSOG, and the IAG. The positions within the material and the subjective LNG system will then be evaluated as reinforcing and analyzed by considering its influence on EU's LNG security. By adding the concept of technopolitics, the research is allowed to discuss what

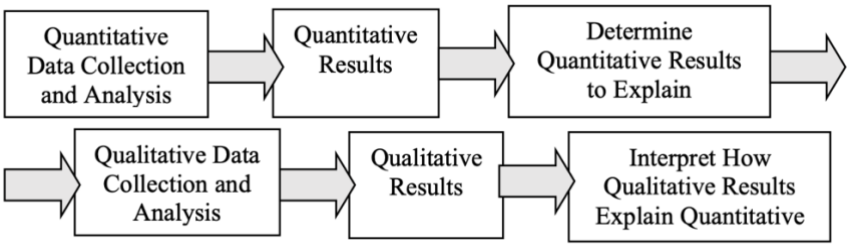
implications this reinforcing character might have on the transition towards a green energy system as it considers the material LNG system of LNG terminals to be power-generating.

This thesis will be guided by network theory, as WI is based on, and rely on the relational approach towards networks. Instead of dyadic relations, network theory relies on a structural approach to power where the position within the network generates power. The capabilities in the network rely on connections to other members in the network (Kahler, 2010:12). It allows the thesis to firstly look at the relations in the entire network, before zooming into specific locations and then actors in strategically beneficial or vulnerable positions. The framework fits well with the understanding of energy security in this research as it will reveal vulnerability and resilience in the LNG trade network. To answer the research question; the concept of WI will inform the EU's energy security by highlighting structurally beneficial positions in which energy corporations might leverage political means towards EU's energy security policy. In addition, the relational and structural power will further inform how these structural positions are maintained in the network which might be threatening the EU's LNG security; *the networking power of energy corporations*.

5. Method: Case study of the EU's LNG network

The thesis conducts a Case study as it will deeply analyze the structural aspects of EU's LNG security to reveal the power structures that might be damaging for the achievement of energy security in the EU (Clark et al, 2021). Just as in this thesis, case studies usually involve mixed methods research. In the first phase the location of interest will be all the EU-locations, as it is not known yet which locations, and therefore, which infrastructure and energy corporations to focus on in the EU. Furthermore, as this project will investigate an existing, given policy (LNG security policy), the research would be explanatory (Manners et al, 2015: 230) when trying to explain the relationship between the structural positions of energy corporations in the material LNG system and its effect on the subjective LNG system; the EU's energy security policy.

The overall approach to this research benefits from the use of a sequential explanatory mixed method approach as it aims to measure quantitative data to inform the EU's energy security and to reveal the concept of WI. In the second phase it will analyze qualitative data which aims to understand how and why the framework of WI and EU's energy security is related. The research starts with a large amount of data on imports between countries globally, before proceeding to an in-depth single case study in the structural positions that appears relevant through the lens of WI (Manners et al, 2015: 231).



Creswell, J.W. (2015). A concise Introduction to Mixed Methods Research, SAGE, 56

So, the quantitative data will be used to measure structural features of a large amount of data (Network Analysis) in the material LNG system, which then informs the qualitative method on which actors it should focus on in the EU's subjective LNG system. The qualitative data will be used to critically analyze the power position of energy corporations and what power it produces towards the EU's energy security policy.

This thesis argues that qualitative and quantitative methods represent different ends on a spectrum rather than being seen as rival dichotomies. The stance of this thesis is that mixed

methods in the analysis ultimately lead to additional insight beyond the information that the methods could do alone. Therefore, this research entails a pragmatic worldview without the belief in only one reality and system of philosophy and wish to provide the ultimate understanding of the research question (Creswell, 2018). The quantitative and qualitative data fits well with the framework of this research which argues that the relational and material resources are reinforcing and coexisting.

5.1. Network analysis

Network analysis, or social network analysis (SNA), is a quantitative methodology with a mathematical approach where statistical measures are used to calculate positional roles within a network. With the use of graph theory, algebraic and statistical models, along with a variety of concepts, SNA measures the global network structure, sub-structures, and individual's positions (Lewis & Chatzopoulou, 2015: 171-172). There are other models to capture trade relations within the realm of energy security. One example is the gravity model, capturing the direct trade relationship between trade partners. However, this thesis argues that there are indirect trade relations between countries that do not directly trade with each other within the network. The network method identifies these positions and roles, which allows the thesis to identify energy corporations' strategic positions within the LNG-network (Zhang et al, 2021: 2). There are other scholars who have used this method within their work on global energy trade (Jianping et al, 2016; Feng et al, 2024; Zhang et al, 2021). However, they are rather analyzing the competing relationships between countries within global energy trade, rather than evaluating how strategic positions might affect the energy security. This thesis aims to measure where certain structural positions exist in the network to reveal how these positions affect the ability of certain central energy corporations to leverage political means, where political means are interests within EU's energy security policy.

As argued by several scholars (Farrell and Newman 2019; Keohane and Victor 2011; Winecoff 2015), network analysis is highly beneficial when studying structures of interaction and to explore interdependencies. It is beneficial as it does not assume identical and independent distributed observations which are the core of linear regression models. In the same manner, network analysis focuses on the global structure instead of discrete national economies which are understood as occupied by mechanic firms and individuals. Scholars have shown that network analysis can reveal how positions in international networks affect grand strategy (MacDonald, 2014; Goddard, 2018: in Nexon, 2021). This is similar to the aim of this research;

to investigate how structural positions of energy corporations might influence the EU's energy security policy. Work that uses network analysis methods describes and compares the structure of different types of orders of relationships, such as political orders and organizations. In addition, it aims to describe and compare the network positions of actors in relation to each other (Hafner-Burton et al., 2009). It becomes beneficial for this research as network analysis allows one to picture, measure, and conceptualize structural context. By using this method, scholars have been able to explain the opportunities and constraints faced by states which depend on their positions within the network of relations (Avant and Westerwinter, 2016; Hafner-Burton, Kahler, & Montgomery, 2009; Wasserman & Faust, 1994).

The important structural measurement of quantitative network analysis are centrality measures, which shows the important actors in the network and the division of groups. These measurements and their correlation with the framework of this thesis will be described in the next chapter. Real-world networks tend to contain a high level of transitivity, the tendency of a friend of a friend to become a friend, which produces network communities with compact interdependence. The units that provide these pathways hold bridging or gatekeeping roles which can provide contextual forms of power and influence. Hafner-Burton et al. calls these "brokers" and argues that their relational power is determined by "its position in the network, defined by its persistent relationships with other nodes. Power is no longer derived solely or even primarily from individual attributes, such as material capabilities."(Hafner-Burton et al. 2009: 570). This broker-role will be measured with "betweenness centrality" as seen in the next chapter. Another interesting feature of network analysis which is beneficial for this research is the measurement of density, which is found by the number of ties available in the network (or within a community in the network) divided by all of the possible relationships that can occur (Wasserman & Faust, 1994: 101-103). The density measurement explains if actors within the network are tightly connected (Borgatti et al., 2018: 254). This measurement is interesting as networks (or communities) with high density are considered to be more efficient and advantageous in terms of coordination (Hawe et al., 2004). In a similar manner, James Samuel Coleman (1998; in Borgatti et al, 2018), argued that strong ties within a network are beneficial and have a positive effect on the social ties between actors. Strong ties are evidence of close contact and cooperation. However, in an asymmetric network, there are fewer stronger and centralized ties, which therefore results in vulnerability and worse cooperation.

5.2. Qualitative reflection of AggregateEU, ENTSOG, and IAG

Overall, information on IAG and ENTSOG will be found under “expert groups” on the EUCOM’s website showcasing their tasks, member, and meeting-documents (EUCOM, 2024f) Information of Aggregate EU and IAG will be taken from the “EU Energy Platform” on the EUCOM’s website (EUCOM, 2024c). The platform used for join-purchasing on gas is called PRISMA, and therefore this website will be looked into in order to reveal certain structural features of Aggregate EU (PRISMA, 2024). The information on ENTSOG will be found on the EUCOM’s website for ENTSOG as well as the independent website of ENTSOG (EUCOM, 2024g; ENTSOG, 2024). Lastly, the Transparency Register will be looked into at the EUCOM’s website in order to see what role these mechanisms have according to the Commission (EUCOM, 2024d). The framework of WI will be guiding the critical examination of these documents where central positions of energy corporations, which have been found to have a central position in the material LNG system, will be looked for.

5.3. Why network analysis along with a qualitative reflection?

In the first, quantitative phase, of this thesis information has been gathered on the network topology. The research has found out that the network is highly asymmetric, and it has identified the most central actors and which of those actors that might be capable of utilizing WI. The next step will be to complement this network with meaning: *what power relations do these central infrastructures generate to energy corporations in relation to the EU within its energy security policy?* So, the research has information on the nodes and the structure that connect them. However, it needs to explain the content of what these structures generate in the subjective LNG system. Rather than numbers and values, the investigation of the subjective system is interested in the structure that energy corporations operate within.

5.4. Limitations

It could be argued that the examination of the LNG network should be done in a dynamic network where the aspect of time is included. However, the aim of this research is rather to showcase how an asymmetric network can produce a certain powerful position for certain actors during the time of 2022 and 2023 when the new LNG structure took form in the EU. In

addition, there was some missing data from Germany within the data received from UNcomtrad. However, data on LNG is extremely expensive and hard to receive and, therefore, this research decided to disregard the missing data and conduct the research with the dataset as it was. In addition, one could argue that countries/locations have different demand in LNG and therefore an asymmetric network would not be surprising. However, this research also measures such as degree centrality, showing only the links without the volume of LNG. In accordance with the definition of EU's energy security and within this research locations should not be overly dependent on a few suppliers. Therefore, they should have several links even though they are not weighted with a lot of LNG volume.

6. Quantitative data and measurements of the LNG network

The data on the global LNG trade flows of 119 countries were downloaded from the UN Comtrade Database (Comtrade plus, 2024). There are 664 relations or links between the nodes within the network. The data indicate the trade volumes (kg) of LNG in the year of 2022 and 2023. The years of 2022 and 2023 were chosen as the EU decided to phase out Russian natural gas in 2022, and therefore earlier data will present the EU as more independent in Russia than it potentially is. Although the data is available in both export and import, this thesis only considers import data since it reflects the reality more accurately (Durand 1953; Linnemann 1966; in Sangmoon & Eui-Hang, 2002, The World Bank, 2010). In addition, a list of existing LNG terminals from the annual report made by the International Group of Liquefied Natural Gas Importers (GIIGNL, 2023) is used in order to locate the centralized LNG terminals, their operators, and their storage capacity in the LNG trade network. The software programme called Gephi was used in the first quantitative phase of this thesis. It is an open-source network analysis and visualization software package written in Java.

A network is made of two components: a list of the actors composing the network, and a list of the relations (the interactions between actors). As part of a mathematical object, actors will be called nodes, and the relations will be called edges. I transformed the data from UN Comtrade Database into an edge-list and a node-list.

The node-list

	A	B	C
1	Id	Label	Attribute
2	1	Algeria	
3	2	Andorra	
4	3	Angola	
5	4	Antigua and Barbuda	
6	5	Argentina	
7	6	Australia	
8	7	Austria	EU27
9	8	Bahamas	
10	9	Bahrain	
11	10	Barbados	
12	11	Belgium	EU27
13	12	Benin	

The node-list consists of all the participating states in the network. They are assigned an ID to inform Gephi what country every number adheres to. The nodes are the states within the

network and the edges are the trade volume of LNG between states. However, as argued within this thesis, states are not understood as autonomous. Even though there will be states as nodes within the network, the states will rather be used in a symbolic matter in order to know in what state I need to zoom into in order to investigate the structurally beneficial posited LNG terminal and its operator which will be the energy corporation. In addition, the attributes of the nodes (states) tell Gephi which countries belong to the EU and not: “EU27” or “Non-EU”. By telling Gephi which countries that are or are not EU countries, it will enable the thesis to create a community of the EU, making the network zoomed into only the EU-countries.

The edge-list

	A	B	C	D
1	Source	Target	Type	Weight
2	98	2	Directed	2557539
3	41	3	Directed	48
4	106	3	Directed	31189
5	109	4	Directed	585770
6	1	5	Directed	63261400
7	35	5	Directed	141523500
8	77	5	Directed	57295600
9	86	5	Directed	42394400
10	104	5	Directed	38561700
11	33	5	Directed	83813900
12	109	5	Directed	1244617000
13	23	6	Directed	8316
14	54	6	Directed	50

The edge-list of the network consists of all the connections in the network. The “source” is the exporter, and the “target” is the importer. As shown in the dataset, the network is “directed” as the data mentions from whom the LNG goes from and to whom it arrives. The edges are weighted (see “weight”), meaning that they are assigned the volume of LNG import(kg). This means that the links between the nodes(states) will have different weights in the network.

6.1. The structural parameters of the network analysis

There are six interesting structural parameters of the Global LNG trade network that I will measure to inform the EU's energy security and where WI is possible. The mathematical formula of these measurements is provided in the appendix of this research. However, here the research only provides the informational contribution of these measurements.

1. **Degree centrality**

There are two types of Degree Centrality (DC): the in-degree and the out-degree centrality. Logically, the in-degree measures the number of other nodes which are linked to the node in

question. The out-degree measures the number of edges that go out from the node in question (Borgatti et al., 2018). The degree of the country reflects the number of direct trade links that the country has. In accordance with the definition of energy security within this thesis, external resilience will be high if EU countries have alternative trade routes and alternative suppliers. In other words, they should not be too independent on one supplier, especially not on suppliers outside of the EU as they do not share the same system. From the demand-side perspective, countries' top priority is to determine how to spread energy import risks.

2. Eigenvector centrality

DC does not take into considerations the connection outside of itself. However, Eigenvector Centrality (EC) reflects the relations of one country to other important countries in the network. This indicator argues that if one country establishes a link to countries with a central status in the network, the value of the EC will increase (Borgatti et al., 2018). In terms of energy security, this measurement becomes important as your connections to other important actors will be considered as stronger than connections to less central players. Therefore, your resilience will be considered to be higher if you have connections to more central players.

3. Network Density

Another interesting feature of network analysis which is beneficial for this research is the measurement of density, which is found by the number of ties available in the network (or within a community in the network) divided by all of the possible relationships that can occur (Wasserman & Faust, 1994: 101-103). The density measurement explains if the actor within the network is tightly connected (Borgatti et al., 2018: 254). This measurement is interesting as networks (or communities) with high density are considered to be more efficient and advantageous in terms of coordination (Hawe et al., 2004). The density values go from 0 to 1. If the density measure should be considered as high or low depends on the context. Borgatti et al. explain how, for example, that in an academic department where the density measure of "who knows whom" is 0.345, should be considered as low as the context reveals that the probability of them all knowing each other is very high. Therefore, the number should be close to 1. A network with 50 nodes is still considered to be a small network, with a high probability to have the density value of 1 and therefore the EU 27 is considered to be a small network (Borgatti, 2018: 175). Within this research, the context will consist of the previous measurements. If they are showing low resilience, the density value shall be close to 1.

4. Weighted degree

The Weighted Degree (WD) of a country reflects the total trade volume of the country in the network. WD adds the volume on all the links and reveals in which nodes most of the flows go

through (Wasserman & Faust, 1994). Therefore, it reveals which node controls the most volume of the trade. The WD is suitable when measuring the global competitiveness of one exporting country.

In terms of energy security, this measurement becomes important as it will reveal which actors have the access to a large amount of LNG and therefore the potential to have higher degree of energy security. However, it depends on if the volume is spread out or if it flows from a small number of actors which are not trustworthy. This measurement is also important as it is one of the requirements for being able to utilize WI. In other words, you should have a large access to the market in order to be able to control it (a central importer/exporter). Again, the weighted in-degree will be of importance as the EU is mainly an importer of LNG. This reflects which EU country has a large access to the LNG market. For countries outside of the EU, the weighted out-degree will reveal the largest exporter.

5. Betweenness centrality

DC and EC measure how many actors one actor is connected to. Betweenness centrality (BC), on the other hand, measures how many actors are connected to each other via another actor in question. BC reflects the power of one country as a bridge in the network, which indicates the number of shortest paths through this country (Wasserman & Faust, 1994).

This measure reflects its power to act as an intermediary between other countries, being their resource control ability in international trade. BC will be one of the two structural measurements to determine where Weaponized Interdependence might be possible as it fits with the "Choke point effect"– wherein energy corporations (threaten to) cut other states off from the economic networks they are dependent on (Farrell & Newman, 2019). If the Chokepoint effect appears in country X, I will continue my qualitative research by examining the power structure of the terminal and operator which holds this possibility to WI.

6. Closeness centrality

The measure of "Closeness Centrality" (CC) reveals how many "steps" it takes to get from one actor to another. In other words, CC measures the average path length for a country in establishing a link with other countries, which reflects its distance from other countries in the network (Borgatti et al., 2018). In terms of importers, a country that has a high value of CC can easily access resources.

CC will be the second way to determine where Weaponized interdependence might be possible as it fits with the "Panopticon effect" – wherein energy corporations are given access to more relevant and timely information about developments globally (Farrell & Newman, 2019). Actors can utilize the panopticon effect by using their position in the network to extract informational advantages compared to the opponent.

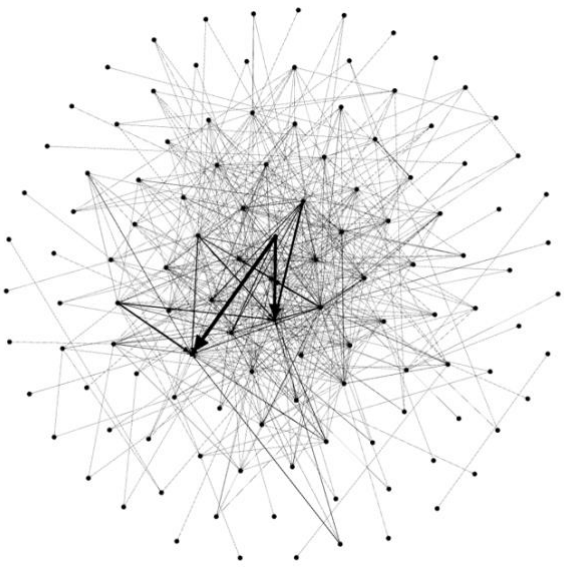
In accordance with the framework of WI in this research, the network needs to be asymmetric in order for WI to be possible. This feature will become evident by the *Fruchterman Reingold* function, which disposes the nodes in a gravitational way, where attraction and repulsion between nodes produce a network and shows potential groups in the network. In order to broadly inform the EU's energy security and its vulnerability and resilience, "degree centrality", "eigenvector centrality" and "density" will be measured. Then the requirements of WI will be tested by measuring the "weighted degree", which informs the research of the central importer/exporter. When this location is revealed, this location needs to have the highest value of the "betweenness centrality" or the "closeness centrality": the Chokepoint effect or the Panopticon Effect. If this is the case, the research will zoom into that location to reveal the LNG terminal and its operator (energy corporation). In the qualitative empirical case study, the structural power of this energy corporation will be examined in the subjective LNG system through AggregateEU, ENTSOG, and IAG. As the framework of WI in this research understands the subjective and the material systems as reinforcing within the LNG network, the structural positions of the energy corporations in the subjective LNG system must be evaluated in order to reveal the possibility of WI in the LNG network as a whole.

7. The results: Energy security in the material LNG network

This section will showcase the findings of the EU's overall LNG security. The definition of energy security as “low vulnerability of vital energy systems” allows for the consideration of both material and subjective LNG systems. However, in the quantitative part this research will only consider the material. In order to evaluate the energy security of the LNG trade network, the vulnerability and resilience will be evaluated within the LNG trade network, and specifically the vulnerability and resilience of EU locations. This thesis will consider the LNG as the material flow and the LNG terminals as the energy infrastructure that outline the material boundaries of the energy system. The nodes are assigned the countries names just for geographical clarification.

The node-list and the edge-list are imported into Gephi. The information in the datasets tells the software that it is a directed (see the arrows) and weighted (the thickness of the arrows) network. The thickness indicates the volume of LNG that flows in the assigned direction. To give more space to the graph but still maintain it in a decided area the layout-function called *Fruchterman Reingold* was used. This visualization disposes nodes in a gravitational way (attraction-repulsion, just as magnets) as you can see in Table 1 below. You are able to distinguish the asymmetric feature of the network where there are fewer and more connected nodes in the middle while the rest of the nodes are spread out in the outer sphere.

Table 1 – The Global LNG Network

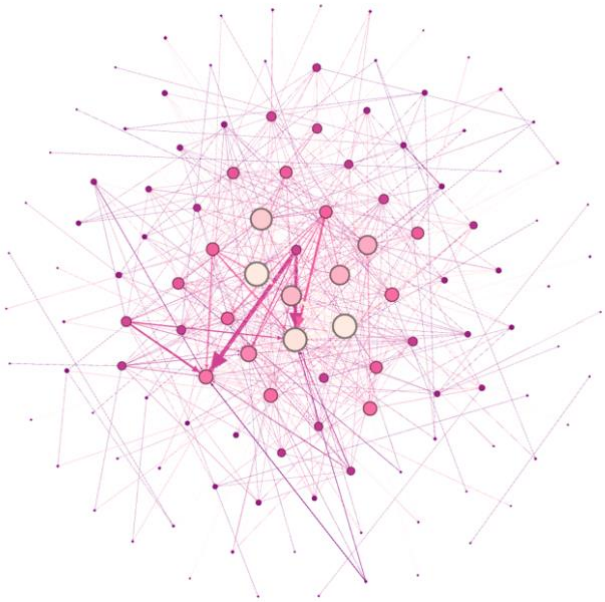


7.1. Degree Centrality

The measurement of “Degree Centrality” (DC) will reveal the actors with the highest number of direct trade links, which indicate a broad access to LNG from a diverse set of suppliers. In Table 2, the size of the nodes has been assigned the measurement of DC in order to capture where the nodes with the most connections are located. However, it was somehow visible with the *Fruchterman Reingold* function in the previous step. As seen in the graph, the smallest nodes are located in the outer range and the larger nodes with more DC are located in the center of the graph.

In order to make the graph even more visually beneficial, some color is added, where the nodes with the lowest number of DC are assigned a darker color (to make them more visible) and the larger nodes with higher DC a lighter color (see the table below). As we can see the biggest nodes are the lightest ones and the smallest ones are the darkest ones. The centrality measure is coherent with the location of the nodes, again showing the asymmetric feature of the network.

Table 2 – Spectrum of color in accordance with the node’s degree centrality



Now the research is interested in what locations these nodes are assigned to in order to better evaluate the network in the graph. As shown in Table 3 below, France, the US, and China are the biggest nodes and the lightest nodes in the network. Therefore, France, the US, and China are the locations with high resilience by having a diverse set of suppliers and partners and are important nodes in the LNG trade network.

Table 3 – The nodes are assigned their label/location

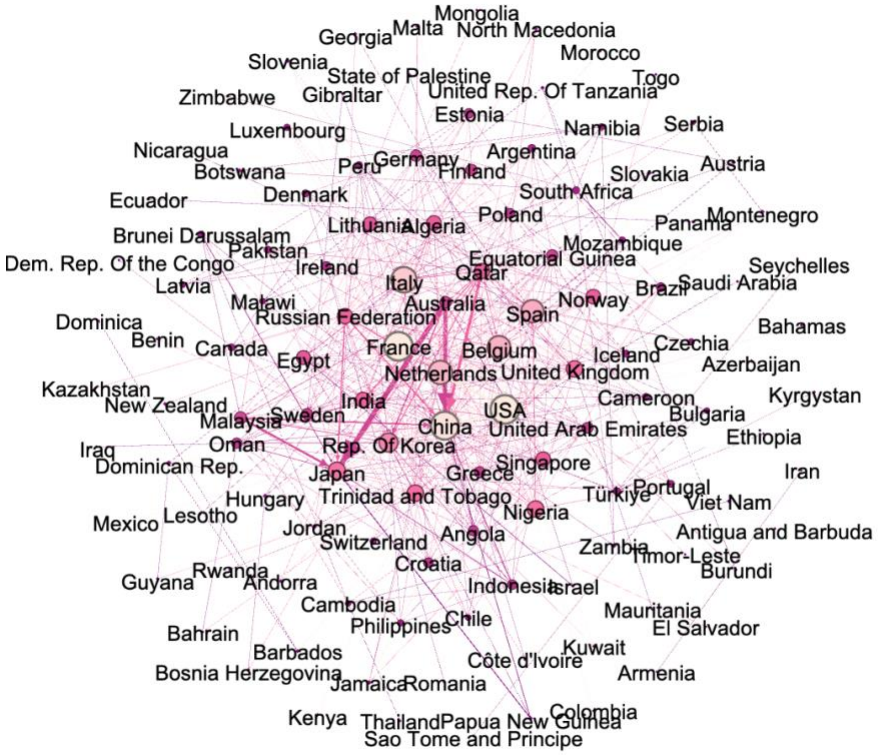


Table 4 – Statistics panel of degree centrality

Id	Label	attribute	In-Degree	Out-Degree	Degree
39	France	EU27	24	19	43
109	USA		4	39	43
23	China		26	16	42
52	Italy	EU27	28	10	38
73	Netherlands	EU27	19	16	35
11	Belgium	EU27	15	19	34
98	Spain	EU27	17	16	33
87	Rep. Of Korea		20	7	27
54	Japan		22	2	24
107	United Kingdom		16	7	23
76	Nigeria		0	23	23
104	Trinidad and Tobago		0	23	23
47	India		18	3	21
86	Qatar		0	21	21
88	Russian Federation		0	21	21
94	Singapore		15	5	20
77	Norway		8	12	20
1	Algeria		0	20	20

By looking in the statistics panel in the software programme (Table 4 above), we can easily see the numbers that build the graph. Here it becomes evident that Italy, Netherlands, Belgium and Spain are also assigned a high number of DC in the LNG trade network. However, France has 5 more connections than Italy and 10 more than Spain. In addition, the US and China are also two highly connected locations outside of the EU. When considering the energy security of the EU, it becomes evident that there are only a few locations in the EU which are far more

connected to the global LNG trade network than the rest of the LNG terminals in the EU. In consideration of resilience, France, Italy, Netherlands, Belgium and Spain are far more resilient locations in terms of disruption in supply and alternative trade routes. The EU as a whole could be argued to have a high vulnerability as it relies on a few important hubs in the LNG network. The locations with the fewest trade links in the EU are; Romania (1), Malta (3), Austria (3), Slovakia (4), Slovenia (4), and Hungary (4). They are the most vulnerable locations as they have the fewest suppliers. In order to increase its resilience, the trade-links of LNG should be spread out between the EU countries in order to become a more resilient LNG trade community. In addition, the USA and China are also considered to be the most resilient locations in the LNG network.

7.2. Eigenvector Centrality

DC captured the direct trade links between locations. In other words, one location could have a high degree of centrality but might be connected to other locations that hypothetically are not connected to any other node. However, the measurement of “Eigenvector Centrality” (EC) reveals the actors which are connected to other important, central actors in the network. This measurement is important as it reveals if the EU is dependent on other important actors or if it relies on weaker actors outside of the EU.

As seen in the Table 5 below, the results indicate that Italy and France have a high value of EC in the EU. However, compared to other countries, Finland, Ireland, Sweden, Czechia, Estonia, and Spain are all connected to other central actors in the network. However, Spain is having a fairly low value compared to Italy and France, which have a significantly higher number than the rest of the 8 countries.

In the light of resilience, as many locations in the EU should have a high value of EC. On the contrary, the data shows the EU’s vulnerability towards disruptions in supply. In addition, there are 18 other EU countries that are not having connections to other important and central players in the network and one EU country that is not even connected to the network. Again, Romania (0), Austria (0), Malta (0,03), and Hungary (0,08) are having some of the lowest values in the entire global LNG network.

Table 5 – Statistics panel of Eigenvector Centrality

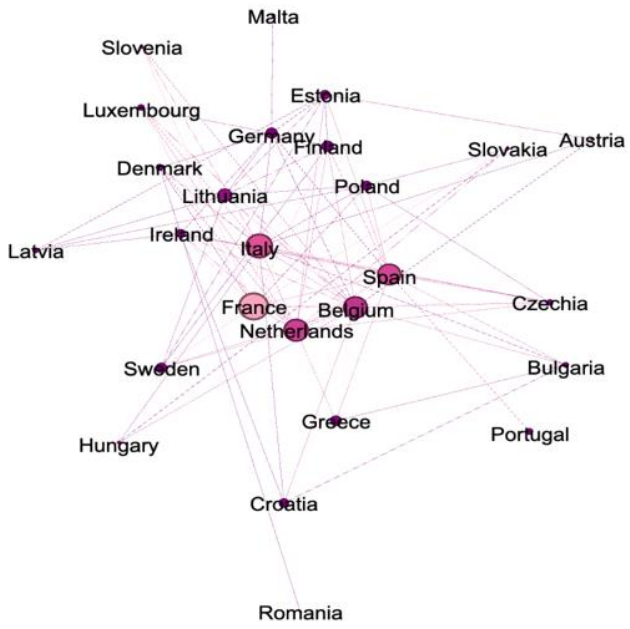
Id	Label	attribute	Degree	Eigenvector Centrality
52	Italy	EU27	38	1.0
39	France	EU27	43	0.84644
23	China		42	0.758839
38	Finland	EU27	15	0.682065
46	Iceland		8	0.681279
50	Ireland	EU27	11	0.67842
100	Sweden	EU27	14	0.602166
26	Czechia	EU27	7	0.588286
36	Estonia	EU27	12	0.570346
101	Switzerland		7	0.566315
77	Norway		20	0.55737
107	United Kingdom		23	0.547709
15	Brazil		11	0.524123
98	Spain	EU27	33	0.507555

However, this measurement might not be that important if the EU as a network has high efficiency in cooperation and trade which can be revealed with the density measure. The research will therefore cut off the network outside of the EU in order to get a better picture of how the EU's LNG trade network looks like in terms of its density.

7.3. Density of the EU's LNG network

In order to test whether the EC matters, the research will measure the density of the EU's LNG trade network. Density is found by the number of ties available in the network (or within a community in the network) divided by all of the possible relationships that can occur (Wasserman & Faust, 1994: 101-103). The density measurement explains if the actor within the network is tightly connected (Borgatti et al., 2018: 254). This measurement is interesting as networks (or communities) with high density are considered to be more efficient and advantageous in terms of coordination (Hawe et al., 2004). This measurement is interesting to conduct between the EU locations in order to evaluate the resilience of the EU's LNG security. Strong connection equals strong resilience in terms of chocks and potential disruptions in supply, which is in accordance with the definition of energy security in this thesis.

Table 6 – The EU's material LNG system



The density of 0,148 (see in appendices) of out 1 is a very low value of density considering the context of the EU being a small network and having the capacity to connect through shared energy security policies in the EU. When looking at table 6 above, it is no surprise that the density is low as we see a lot of nodes located in the outer sphere with few connections into the middle. In terms of vulnerability, we see that all the states in the outer sphere rely on the few states in the middle, again showing the vulnerability of the EU's energy security. However, locations in the outer sphere of the EU LNG network could easily make the network denser by importing LNG from locations outside of the EU and redistributing it within the EU network.

Another interesting feature of the network is that locations such as Romania, Portugal, Malta, and Austria, Croatia, Greece and Hungary only have 1-3 connections in the network. These locations are therefore considered to be the most vulnerable as they rely on few locations for LNG supply and would suffer the most from disruptions in supply within the EU. In addition, none of these locations have a high number of EC as seen in the previous measurement, meaning that they are not connected to other important locations outside of the EU either.

In addition, Romania, Portugal, Malta, Greece and Hungary have not signed any contract within the solidarity mechanism (EU 2017/1938), which will ensure the supply of LNG to households and hospitals in a gas crisis. Furthermore, Romania and Hungary do not have access to an LNG terminal (GIIGNL, 2023: 63-65) and therefore no possibility to store LNG. Therefore, their vulnerability appears to be the highest of them all.

7.4. Weighted Degree

The measurements so far have not taken the amount of LNG into consideration but only the connections. The measurement of "Weighted Degree" (WD) reveals the location through which the highest volume of LNG flows. In other words, it is the sum of the value of the links that goes into the node. As mentioned, the links are assigned the volume of LNG that is traded. In terms of energy security, this measurement becomes important as it will reveal which actors have the access to a large amount of LNG and therefore the potential to have higher degree of energy security.

The total Weighted Degree counts both the In-Degree and the Out-Degree, meaning that it counts both what goes out from and what goes into the node. As seen in Table 7 below, there are 8 locations outside of the EU where the largest amount of LNG flows.

Table 7 – statistics panel of the Total Weighted Degree

Id	Label	Interval	attribute	Eigenvector Centrality	Weighted In-Degree	Weighted Out-Degree	Weighted Degree
54	Japan			0.455341	138148435000.0	15030.0	138148450030.0
23	China			0.758839	134094789236.0	669998496.0	134764787732.0
6	Australia			0.249649	10049.0	122690429418.0	122690439467.0
109	USA			0.141296	1533725544.0	93699584828.0	95233310372.0
86	Qatar			0.0	0.0	82406549329.0	82406549329.0
65	Malaysia			0.115893	5065653000.0	42714398945.0	47780051945.0
87	Rep. Of Korea			0.399256	46394109415.0	11883288.0	46405992703.0
88	Russian Fed...			0.0	0.0	45034646410.0	45034646410.0
73	Netherlands		EU27	0.420293	35510868912.0	224614349.0	35735483261.0
39	France		EU27	0.84644	27261096086.0	385022391.0	27646118477.0
47	India			0.344461	20547117090.0	26423.0	20547143513.0
107	United Kingd...			0.547709	14821149414.0	2782408439.0	17603557853.0
48	Indonesia			0.0	0.0	16894397474.0	16894397474.0
11	Belgium		EU27	0.454562	15435755710.0	570949220.0	16006704930.0
76	Nigeria			0.0	0.0	14643088339.0	14643088339.0
78	Oman			0.018177	38083309.0	13390377591.0	13428460900.0
81	Papua New ...			0.0	0.0	13214030300.0	13214030300.0
52	Italy		EU27	1.0	11538059989.0	4129932.0	11542189921.0
104	Trinidad and ...			0.0	0.0	8625795348.0	8625795348.0
98	Spain		EU27	0.507555	7856225845.0	390137454.0	8246363299.0
33	Egypt			0.001705	3249216016.0	4774810248.0	8024026264.0

However, one can consider the network as exporters and importers. As the EU imports most of its LNG, the weighted In-Degree becomes interesting to measure in order to capture the EU locations' positions in the import LNG trade network.

Table 8 – statistics panel og the Weighted In-Degree

Id	Label	Interval	attribute	Eigenvector Centrality	Weighted In-Degree	Weighted Out-Degree	Weighted Degree
54	Japan			0.455341	138148435000.0	15030.0	138148450030.0
23	China			0.758839	134094789236.0	669998496.0	134764787732.0
87	Rep. Of Korea			0.399256	46394109415.0	11883288.0	46405992703.0
73	Netherlands		EU27	0.420293	35510868912.0	224614349.0	35735483261.0
39	France		EU27	0.84644	27261096086.0	385022391.0	27646118477.0
47	India			0.344461	20547117090.0	26423.0	20547143513.0
11	Belgium		EU27	0.454562	15435755710.0	570949220.0	16006704930.0
107	United Kingd...			0.547709	14821149414.0	2782408439.0	17603557853.0
52	Italy		EU27	1.0	11538059989.0	4129932.0	11542189921.0
98	Spain		EU27	0.507555	7856225845.0	390137454.0	8246363299.0
97	South Africa			0.025693	5781088413.0	23140596.0	5804229009.0
65	Malaysia			0.115893	5065653000.0	42714398945.0	47780051945.0
22	Chile			0.077227	4848434200.0	0.0	4848434200.0

As seen in Table 8 above, the Netherlands, France, Belgium, Italy and Spain are seen at the top 10. However, Belgium, Italy, and Spain are locations with considerably less amount than the Netherlands and France. It is not surprising considering the central position these locations have in the network. The Weighted In-Degree measurement reveals that those with the highest connection are also those locations with the highest trade volume of trade flow. This measurement reflects that the EU has a large access to the LNG market. However, as seen in the density measure, the volume of LNG is not efficiently distributed throughout the EU. WD also reveals that the Netherlands and France are locations where the majority of the EU import of LNG is arriving. Netherlands, France, Belgium, and Spain have not signed any agreement within the solidarity mechanism, and therefore the vulnerability of the rest of the EU location could be seen as high as they do not have secure access from these locations.

This measurement is also important as it is one of the requirements for being able to utilize WI. In other words, you should have a large access to the market in order to be able to control it (a central importer/exporter). This measurement reveals that the Netherlands and France are locations where LNG terminals exist which might be utilized to leverage political means towards the EU's energy security policy.

In addition, This measurement reveals that the locations of China, USA, Australia, the Russian Federation, and Qatar have the possibility to utilize WI against the EU with a considerably higher number of total WD than the rest of the locations in the LNG trade network. However, these locations must also fulfill the requirement of the chokepoint effect and the panopticon effect.

8. Measurements of Weaponized Interdependence

So far, the results have shown that the LNG trade network is highly asymmetric and centralized. This research has analyzed the EU's LNG security by conducting the previous structural measurements. In addition, it found that the Netherlands and France are the two locations within the EU where a majority of the LNG arrives. In accordance with the framework of WI applied in this research, two of the requirements for being a hub where WI can be utilized have been revealed; an asymmetric network and the existence of a central importer/exporter. However, WI can be utilized through the chokepoint effect and the panopticon effect. Therefore, the research must conduct these measurements in the network in order to find out which location these measurements are assigned to. If the Netherlands or France occurs in one of these positions those locations have the possibility to utilize WI. In addition, if China, USA, Australia, the Russian federation, and Qatar are assigned the highest value of the chokepoint effect or the panopticon effect, they will also have the possibility to utilize WI in the LNG trade network.

8.1. Closeness centrality: The Panopticon effect

Closeness Centrality (CC) will be the second way to determine where WI might be possible as it fits with the "Panopticon effect" – wherein energy corporations are given access to more relevant and timely information about developments globally (Farrell & Newman, 2019). Actors can utilize the panopticon effect by using their position in the network to extract informational advantages compared to the opponent.

The measure of CC reveals how many "steps" it takes to get from one actor to another. In other words, CC measures the average path length for a country in establishing a link with other countries, which reflects its distance from

other countries in the network. Contrary to the other measures, this measurement is a reverse measure of centrality, meaning that a low value correlates to a central location and a high value indicates a highly peripheral location. In other words, a low value indicates locations where the panopticon effect is possible. In terms of importers, a country that has a high value of CC can easily access resources. As seen in Table 9 below, none of the countries with the lowest CC have been identified by the previous measurement. Even though these nodes are given access to more relevant and timely information about LNG developments globally, they are not able to utilize WI through these locations.

Table 9 – Statistics panel of Closeness Centrality

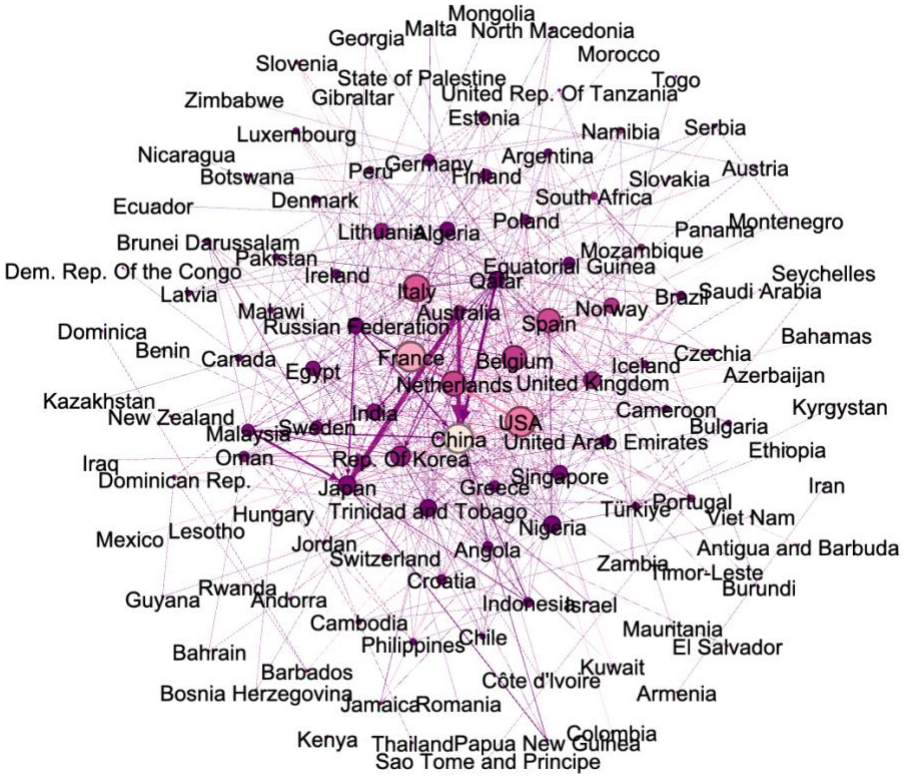
Id	Label	Interval	attribute	Closeness...	Harmonic Closeness...	Betweenness ...	Modularity...
2	Andorra			0.0	0.0	0.0	5
4	Antigu...			0.0	0.0	0.0	6
8	Baha...			0.0	0.0	0.0	6
10	Barba...			0.0	0.0	0.0	6
12	Benin			0.0	0.0	0.0	5
13	Bosnia...			0.0	0.0	0.0	2
15	Brazil			0.0	0.0	0.0	6
18	Burundi			0.0	0.0	0.0	4
19	Camb...			0.0	0.0	0.0	1
22	Chile			0.0	0.0	0.0	6
24	Colom...			0.0	0.0	0.0	6
28	Dem. ...			0.0	0.0	0.0	6
32	Ecuador			0.0	0.0	0.0	6
34	El Salv...			0.0	0.0	0.0	6
37	Ethiopia			0.0	0.0	0.0	2
40	Georgia			0.0	0.0	0.0	2
44	Guyana			0.0	0.0	0.0	6
46	Iceland			0.0	0.0	0.0	6

8.2. Betweenness Centrality: The chokepoint effect

Betweenness Centrality (BC) reflects the power of one country as a bridge in the network, which indicates the number of shortest paths through this location (Borgatti et al., 2018). This measure reflects its power to act as an intermediary between other countries, being their resource control ability in international trade. BC is one of the two structural measurements to determine where WI is possible as it fits with the "Choke point effect"– wherein energy corporations (threaten to) cut others off from the economic networks they are dependent on (Farrell & Newman, 2019). If the Chokepoint effect appears in country X, I will continue my qualitative research by examining the power structure of the terminal and operator which holds this possibility to WI in the subjective LNG system.

By changing the color of the nodes in accordance with BC instead of DC, we can easily detect where the lightest locations appear. It becomes evident that China, France, and the US are the lightest nodes in the LNG trade network. See table 10 below:

Table 10 – color of nodes is in accordance with their Betweenness Centrality



However, by looking in the statistics panel, we can see the list starting with the country with the highest BC in the top. In table 11 below, we see that China and France are the locations with considerably higher values of BC than the rest of the locations in the network. It is now clear that France is an EU location where the Chokepoint effect is possible to utilize; wherein energy corporations can (threaten to) cut others off from the LNG network to leverage political means towards EU's energy security policy (Farrell & Newman, 2019). In addition, it is now evident that the location of China is also a hub where the Chokepoint effect is possible outside of the EU as it fulfills the requirement of being a central importer/exporter and correlates to a high number of BC.

Table 11 – Statistics panel of Betweenness Centrality

Id	Label	Interval	attribute	Closeness Ce...	Harmonic Closeness ...	Betweenness ...
23	China			0.464286	0.551068	1627.382143
39	France		EU27	0.464286	0.558761	1205.605592
109	USA			0.629032	0.737179	919.38961
52	Italy		EU27	0.373206	0.450641	664.214069
98	Spain		EU27	0.450867	0.537393	587.034127
73	Netherl...		EU27	0.45614	0.540598	536.289177
11	Belgium		EU27	0.461538	0.559829	465.984848
77	Norway			0.39	0.478419	392.475289
72	Namibia			0.322314	0.359188	306.146465
107	United ...			0.364486	0.429274	283.601479
87	Rep. O...			0.346667	0.411325	208.807684
97	South ...			0.258278	0.313248	199.5

In order to reveal what actors can utilize the chokepoint effect, we must zoom into the location of France and identify the LNG terminal and the operator that controls the LNG terminal and the LNG that flows through. In accordance with the list of existing LNG terminals provided by GIIGNL there are four operating terminals in France; Dunkerque LNG, Fos Cavaou, Fos Tonkin, and Montoir-de-Bretagne. Dunkerque LNG has the capacity to store 600 000 , which is almost twice as much as the other 3 terminals together. These three terminals are operated and owned by a French energy corporation called Elengy. When looking into the Dunkerque LNG terminal owner, it is a Belgian gas company called Fluxys. In addition, the location of Belgium has a high value of weighted in-degree, and the LNG terminal Zeebrugge is also owned by Fluxys. According to the quantitative measurements of the LNG trade Network, Fluxys and Elengy have the possibility to utilize the chokepoint effect in order to leverage political means towards EU's energy security policies.

In accordance with the framework of WI the material and structural power are reinforcing each other and therefore we must look into the structural power these energy corporations hold. This will be done by the empirical qualitative case studies of potential participation in AggregateEU and ENTSO-G in the EU. By looking into these qualitative documents, we can use the critical framework of WI where the research will examine the structural position Fluxys and Elengy might have within the AggregateEU and ENTSO-G which might reinforce their material power.

9. Qualitative reflection of the subjective LNG system

In accordance with the framework of WI in this thesis, the qualitative documents will showcase the energy corporations' structural positions within the subjective LNG system. The qualitative reflection will be guided by the framework of WI in a qualitative sense where it aims to reveal whether the energy corporations, which are having the possibility to utilize the chokepoint effect, also have central roles within the mechanisms through which energy corporations operate within the subjective LNG system. These mechanisms are AggregateEU, ENTSOG, and the IAG.

1. AggregateEU

Within the AggregateEU the shared values and objectives are to; " *(...)contribute to sufficient and diversified gas supplies, (...) reducing price volatility and increasing predictability, by providing information on available energy supplies, whilst harnessing Europe's collective market weight. The mechanism offers an alternative channel to match gas demand and supply, whilst increasing transparency and offering new forms of cooperation."* (EUCOM, 2024c). As mentioned in the literature review of this research, this mechanism has been proposed to become permanent by the EUCOM. Therefore, this mechanism and its operational character must be evaluated in what ways it produces new structural implications for the EU's energy security.

AggregateEU provides matchmaking through its platform called PRISMA. Some of the requirements to be submitted to the AggregateEU as a company are; "*the minimum quantity required for demand aggregation for virtual liquefied natural gas (LNG) is 300.000 MWh and for National Balancing Point/Virtual Trading Point (NVP/BPT) it is 5.000 MWh)*"; "*have the necessary capabilities or expertise to transport gas or perform negotiations benefit from a high creditworthiness to buy enough gas on their own*". Therefore, the expression of interest was implemented, which is divided into two solutions called Agent-on-behalf and Central Buyers. Through Agent-on-behalf buyers entrust another company to provide them with services such as LNG terminals and transporting. Through the Central Buyers companies can have other energy companies to buy LNG for them. Aggregate EU has divided EU into two virtual regions which contain LNG terminals that can be chosen as points for delivery when making a contract at PRISMA. Fluxy's terminals and Elengy's terminals are all listed here along with 25 other LNG terminals (PRISMA, 2024). Even though there are a number of matches that have been made on PRISMA, the number of contracts made by firms is not known as the matching is not legally binding. These matches might be influenced by further negotiations.

However, with these features in mind while thinking in accordance with the logics of the concept of WI this mechanism appears quite concerning. As there is no proof of the Aggregate EU bringing together market participants, or that lower prices have been achieved, the competition effect of the mechanism can be questioned. As the LNG network is found to be highly centralized and asymmetric, the absence of legal commitment between the buyer and seller through Aggregate EU produces benefits for the stronger economic actor. The stronger economic actor can use the platform for match-making and then continue the negotiation outside of the platform. In addition, the tool of Central-Buyers would provide the Central Buyer with information on the company it acts for. But overall, this tool logically maintains the larger LNG actors' position in the LNG network. In accordance with the logics of WI, the interdependent relation on a central energy corporation is producing lasting power imbalances among the energy corporations in the EU. The more powerful central actor would weaponize this interdependence to gain political influence over the LNG network as a whole. One could argue that if the Aggregate EU is supposed to be considered successful, the material LNG system should not be this asymmetric in the EU.

2. ENTSOG

ENTSOG shares the goal to "(...) *facilitate and enhance cooperation between national TSOs across Europe, in order to ensure the development and coordinated operation of a pan-European gas transmission network that is capable of meeting Europe's current and future needs. In doing so, ENTSOG will contribute to the completion of the internal market for gas, help stimulate cross-border trade and access, and increase the interoperability of existing regional transmission systems***.**" (ENTSOG, 2024).

Both Fluxys and Elengy are directly or indirectly board members of ENTSOG representing 45 members of energy companies. However, Elengy gets indirect influence in ENTSOG as it is a subsidiary of GRTgaz, which is a board member of ENTSOG. In turn, GRTgaz has a parent company called "ENGIE" which is a part of the PRISMA platform as a Central Buyers and as Agent-on-behalf (PRISMA, 2024).

ENTSOG represents the EU gas industry but is listed as a public non-profit organization without any economic or private interests (European Union, 2024). However, the counterpart called ENTSOE (electricity), is listed as a lobbyist representing the business and professional associations. Gas Infrastructure Europe(GIE) is a lobby group representing the interest of the natural gas infrastructure in which half of ENTSOG group members are a part of, including Fluxys and Elengy (GIE, 2024). ENTSOG predicts the future demands of gas in Europe which, as mentioned in the literature review, have been criticized for being overestimated. Additionally, the EU requests a list of infrastructure developments needed to meet the

predicted demand. Governments shall agree to the list and demand and then the official list as a “Project of Common Interest” (PCIs) will be built by ENTSOG with money from the EU. The decarbonization of EU energy systems becomes a conflict of interest in ENTSOG as it is clearly not an interest of its gas industry members. The long-term interest of EU’s energy security to investments to supply energy in accordance with environmental aims, goes against ENTSOG’s members economic interest in extending and expanding the EU’s LNG infrastructure. In addition, the centralized LNG network it maintains disproportionately benefits the members of ENTSOG through the PCI list as this is only a handful of all gas companies that exist in the EU. Lastly, ENTSOG is a member of the Gas coordination groups which *“coordinating security of supply measures, especially during crises. The group assists the Commission on monitoring the adequacy and appropriateness of measures to be taken under the Regulation (EU) 2017/1938. In addition, the Gas Coordination Group continuously monitors the storage levels and security of supply throughout the EU and its neighbourhood”* (EUCOM, 2024e). When looking through the minutes from these regular meetings, ENTSOG starts off every meeting with an overview on the latest developments on “gas security of supply”.

3. Industry Advisory Group

As mentioned, the IAG “(...) *shall assist the Commission in delivering on the objectives identified in the RePower EU Communication and subsequent Plan*.” And “*Assist EUCOM in the preparation of legislative proposals and policy initiatives*”. Firstly, the way in which the IAG was selected and for what reasons, are not provided by the commission. When looking into the structure of IAG, as implemented within the Energy platform and to advise EUCOM on objectives identified in the RePower EU it shows that it only represents companies. As a body that influences the EU’s energy policy, while having control over LNG infrastructure, the group already receives relational power in the Material LNG system. As seen, EUCOM goes against its political guidelines which state that “*Members of the Commission should seek to ensure an appropriate balance and representativeness in the stakeholders they meet*” and which the horizontal rules on expert groups strive for (EUCOM, C/2016/3301), as there are no mix of representatives from NGOs, energy poverty groups, Trade unions, or climate and social advisors. It could be argued that EUCOM denies their horizontal policies for expert groups which state the commitment to maintain a balance of interest and composition in these types of groups. When looking at the “observer” status in the IAG, these are not either given to civil society groups or the academy. The eleven observers within the IAG are given to lobby associations with fossil fuel members, such as Shell, ENTSOG, and Eurogas. Here we see that both Fluxys and Elengy, through ENTSOG, have influence in the advisory group by having access to information which other actors are excluded from receiving.

When considering the position of Elengy and Fluxys in the IAG, Elengy influence through ENGIE, which is a representative of the industry's interest in IAG. Engie is a French group in which GRTgaz is a part of and to which Elengy is a subsidiary.

The structure of the IAG becomes problematic when looked at through the lens of the framework of Wi in this research. The material power in the LNG system reinforces the structural power in the subjective LNG system. Therefore, the structure of energy corporations in the IAG gives them the possibility to maintain their positions in the material LNG system by pushing for the continuous push for LNG investments and increased demand. In this case, the energy corporations have the capacity to weaponize towards the EU's energy security policy. When considering the concepts of technopolitics, the EU's climate targets and phase out of fossil fuels through the EU's European Green Deal, becomes hampered due to the asymmetric power given to these energy corporations through their control over central infrastructure hubs in the LNG network.

10. How can the concept of weaponized interdependence inform EU's LNG security?

In accordance with Farrell and Newman's understanding of WI, this research bases its ontology of the network on Strange's structural power and network theory. This framework reveals how economic power can be a product of structural characteristics of the global economy, and specifically EU's LNG network. This research suggests, in accordance with Strange, Farrell and Newman, that globalization has changed the liberal order and produced firms with the power to leverage their interest towards other actors within networks. As seen in the result the Global LNG network is highly asymmetric with a few central players in the center of the graph, and the rest of the countries spread out in the outer sphere of the network. Even though liberals acknowledge the relational aspect of complex networks, it does not allow for the analysis of where conflict appears within the network. Network theory has shown to be beneficial when analyzing how the relational dimensions of the material LNG system produces conflict in an asymmetric and centralized network which benefits just a few actors rather than all. Along with the qualitative reflection of the subjective LNG system, the concept of WI interdependence informs EU's energy security by revealing which energy corporations can leverage political means towards EU's LNG security policies.

In addition, it reveals the infrastructure as centralized hubs from where the power is generated. This research has also shown, along with Falkner's (2005) understanding of technopolitics, that the innovative capacity of firms plays a critical role in influencing environmental regulations. In addition, the LNG terminals canalize power to the controlling firms as they change the way core functions in the energy market are played out. By applying technopolitics to this research it can explain how the increased development of LNG infrastructure and mechanism, such as IAG and ENTSOG, has created winners and losers as it creates asymmetric power-relations in the LNG network where a few energy corporations can influence EU's LNG security policies. When considering technology and politics as interrelated, we see how LNG terminals become power hubs in the LNG network as they can be used through the mechanism of Aggregate EU and can be utilized through the chokepoint effect. In accordance with Strange, Farrell and Newman and the concept of technopolitics, this research is a critique towards the imperial world order and the centralization of capital in TNCs within the LNG network.

Susan Strange's understanding of TNCs becomes beneficial for the aim of this thesis: to explain how energy corporations can leverage political means towards the EU. According to this thesis and just as Susan Strange argues that globalization has shifted the world stage towards greater control for TNCs, the newly implemented mechanisms of AggregateEU, ENTSOG, and IAG are mechanisms which reveal this shift. Within this new game, as Strange argues, energy corporations gain bargaining power towards states and international organizations as they threaten to move their services within another territory. However, with the concept of weaponized interdependence, these threats are revealed by the chokepoint effect where they can threaten to choke off access to LNG towards other TNCs, states and even the EU. By integrating Strange understanding of structural power, this research shows that the position of energy corporations within the material LNG system provides them with the structural power "to decide how things shall be done, the power to shape frameworks within which states relate to each other, relate to people, or relate to corporate enterprises" (Strange 1988: 25). This power allows Fluxys and Elengy to shape and define structures within the EU's LNG security, which in turn becomes a resource for them in the material LNG system. This reinforcing character of power in the subjective and material LNG system reveals the asymmetric power relations which benefits a few central players the most.

The IEA's distinction between short-term energy security and long-term energy security shows that the EU's LNG policy is committed to short-term energy security. Short-term is the capacity of the energy system to react to unexpected changes in the balance on supply-demand. However, the long-term entails investments to supply energy in accordance with economic development and environmental aims. This research argues that the EU's short term energy security policy has facilitated energy corporations with the ability to hamper and slow down the long-term energy security. The increased development of LNG infrastructure in the EU changes the core functions played out (Bernards & Campbell-Verduyn; in Gjesvi, 2023) and hampers the long-term energy security of the EU.

From the economic nationalist perspective of IPE, the characteristics of the LNG network would be explained as asymmetric and centralized due to the limited amount of wealth which self-interested states compete over. The free trade policies that the network rests upon are argued to be advocated by strong economic energy actors as they benefit from the weaker actor's loss. The TNCs in the network would only be seen as tools through which states exploit other states. The mercantilist argument would be to increase the energy export and minimize the energy import of LNG in order to benefit from the domestic production in order to increase the security of the LNG network. The position of states within the material LNG system indicates their wealth with the global economy, which is subordinate to the international political

system. However, in accordance with the aim of this research, this perspective fails to understand how TNCs might have the power to control and influence the politics. In addition, this research shows how the political and the economic can be reinforcing rather than subordinated to the other.

From the liberalist perspective, the asymmetric feature of the network does not necessarily reveal any risks as cooperation within the EU minimizes the risk for conflict between states. It would be argued that the EU's efforts to establish stronger common energy policy, regulating the member states energy resources, would become an even stronger resilient measure to implement. Keohane argues that cooperation within international organizations, such as the EU, increases transparency and therefore states feel more secure to cooperate within the market, even though it is not symmetric. However, as noted in previous work on AggregateEU, the mechanism does not require corporates to fulfill the match with a contract through the platform. This issue together with the exclusion of other interest representatives in the IAG, makes the transparency to appear as quite lacking. In similar manner, the strong ties-theory from network theory argues that a high-density value show indicates efficient cooperation and resilience (Hawe et al., 2004). However, from this perspective the asymmetry of the network can be critiqued as generating inefficiency and vulnerability. However, the concept of WI would argue that a low-density results in the risk of producing actors that can utilize WI within the network as they are far more connected than the rest of the actors in the EU's LNG network, both internally and externally of the EU.

11. Conclusion: What are the strengths/weaknesses of the EU's LNG security?

Due to the increased investments in liquefied natural gas (LNG) as an energy security measure in the EU, this research aims to examine the effect this new structure has on the EU's energy security. The research question is as follows: How can the concept of Weaponized Interdependence (WI) inform EU's Energy Security? The purpose of this research was to examine how WI can inform the EU's energy security by uncovering "the networking power of energy corporations", or strategic positions in the LNG network. In accordance with the definition of energy as "low vulnerability of vital energy systems", this research approached the LNG network as consisting of a material LNG system and a subjective LNG system. The concept of WI is used to reveal structural positions in the network which can be utilized to leverage political means. Additionally, new mechanisms, such as Aggregate EU and the IAG have been implemented to assist the EUCOM within LNG security. Therefore, the new structure in which energy actors operate was evaluated in order to inform the EU's energy security. Accordingly, this research adopted a reinforcing understanding of structural and relational power and captured how the material and subjective system of energy security interacts in the EU.

By conducting a network analysis of the global LNG trade network, this research has found that the material LNG system is highly centralized and asymmetric. In accordance with the framework of WI in this thesis the chokepoint effect is possible to utilize by the energy corporations of Fluxys and Elengy. When looking into the structural positions of these energy corporations in the subjective LNG system of Aggregate EU, IAG, and ENTSOG; they have a central position here as well. Due to the reinforcing character of the relational and structural power, this research argues that these energy corporations hold the power to influence EU's energy security in a way that maintains their position in the network as well as slows down the EU's transition towards greener energy systems. By giving the industry representatives this networking power in the energy security policies in the EU, the phase out of fossil fuels can be argued to be slowed down. The new mechanism of Aggregate EU and IAG might become tools for influencing the EU's energy security in the long-term energy security goals as well.

When conducting the network analysis of the EU it shows that the vulnerability of the EU's LNG system is high and the resilience is only high for a few central locations, such as France,

Netherlands, and Belgium. It was shown that the density was low, resulting in low cooperation and efficiency, and therefore high vulnerability in time of a crisis. When considering the long-term energy security, the mechanism within the subjective LNG system has shown that the EU's energy security is vulnerable in terms of centralized power at the gas industry and therefore hampering the environmental aims of the EU. Therefore, this research suggests that these mechanisms should represent a broader variety of interests rather than solely the gas industry. In addition, the Aggregate EU could include renewable energy resources in order to include other domains and therefore still contribute to a competition in which environmental aims are considered. This would potentially flatten out the network in the long run as the subjective system would not continue to reinforce the material in a centralized manner. However, it is important that renewable energy resources do not become a network of the same centralized character, providing a few corporations with the power to influence the policy in the EU.

This research has shown how network analysis can be beneficial when evaluating the security of resource systems. In addition, it has shown how a narrow focus on TNCs instead of states, and a narrow focus on LNG instead of energy as a whole, produce findings which can reveal less-known actors in central positions. By narrowing down my thesis to LNG in this time when it is a critical resource for the EU, and by narrowing it down on critical hubs, we can identify companies that would not have gained the attention if we would have a broad focus on fossil fuels. Then Shell etc. would become the big players. Here we see that critical, central infrastructures generate power within the LNG energy system (material and intersubjective) where the material position reinforces the intersubjective in accordance with my framework. This shows how the energy companies Elengy and Fluxys utilize the chokepoint effect within the LNG trade network to leverage their interest in the EU's energy security policy which reinforces their position in the LNG trade Network. Fluxys and Elengy lobby for the increased usage of LNG and as a part of the industry advisory board, it can be assumed that they push for the continued investment in LNG projects. This research implies that Elengy and Fluxys is stagnating the transformation towards a green energy system in the EU by holding a material beneficial position in the LNG network which allows it to leverage its interest towards EU's LNG security policy by threatening to increase its operations outside of the EU rather than inside, which would mean that they choke off the supplies towards locations within EU.

This research acknowledges that the ownership structure within infrastructure and TNCs are different within different countries and within different TNCs. States might have the possibility to utilize WI through their TNCs while holding the majority of the shares in the infrastructure of within the TNC. However, this research has shown the possibility for TNCs to utilize WI and

has provided a framework for investigating this kind of power in resource-networks. This framework can be applied to other issues within the resource security domain in the EU and can be used to evaluate new structures as results from increased investments and imports of resources. Furthermore, as a master's student in European Affairs, it became interesting to see a kind of reversed "brussels effect" (Bradford, 2020) in this research, where the TNCs have the control to influence the policy within the EU while threatening to move their market power outside of the EU borders.

To conclude, further research can take a more critical stand while investigating the represented gender within energy corporations and mechanisms within the EU. Therefore, investigating the power structure between an individual and organizational level within the EU. Furthermore, this research finds the external aspect of the LNG network interesting as well. As found, China and the US hold structurally beneficial positions within the global LNG network as well. Which energy corporations from these locations might be able influence the EU's energy security in accordance with the Chokepoint effect and the panopticon effect?

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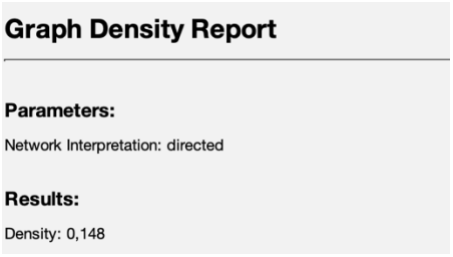
13. Appendices

1. **Density report for the EU's LNG network**



2. **"The solidarity mechanism " signed agreements under Regulation (EU) 2017/1938:**

   Germany, Italy and Switzerland (19 March 2024)

   Slovenia and Croatia (14 July 2023)

   Denmark and Sweden (8 May 2023)

   Finland and Estonia (25 April 2022)

   Italy and Slovenia (22 April 2022)

   Lithuania and Latvia (10 March 2022)

   Estonia and Latvia (4 January 2022)

   Germany and Austria (2 December 2021)

   Germany and Denmark (14 December 2020)

3. **The dataset on the "edges" and the "nodes" in the network is available, however they were excluded from the thesis as they were around 30 pages.**

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