Lisbon School of Economics & Management
Universidade de Lisboa

MASTER

INTERNATIONAL ECONOMICS AND EUROPEAN STUDIES

MASTER'S FINAL WORK

DISSERTATION

REPOWEREU AND EU ENERGY TRADE: REDUCING DEPENDENCY ON RUSSIA AND DIVERSIFYING SUPPLY

CAROLINA FERREIRA TIMÓTEO

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GLOSSARY

BAR: Brexit Adjustment Reserve

BCM: Billion Cubic Metres

BRI: Belt and Road Initiative

CN: Combined Nomenclature

CPI: Consumer Price Index

DiD: Difference-in-Differences

EID: Energy Import Dependency

EU: European Union

GAE: Gross Available Energy

HHI: Herfindahl-Hirschman Index

LNG: Liquefied natural gas

NGL: Natural gas liquids

PCI: Project of Common Interest

PMI: Project of Mutual Interest

PJ: Petajoule

RRF: Recovery and Resilience Facility

SGC: Southern Gas Corridor

SWI: Shannon-Weaver Index

TJ: Terajoule

ABSTRACT, KEYWORDS AND JEL CODES

The Russian invasion of Ukraine in 2022 exposed the European Union's structural dependence on fossil fuel imports from Russia, prompting an urgent policy response. In this context, the REPowerEU plan was launched to reduce the EU's reliance on Russian energy and accelerate the diversification of supply sources. This dissertation investigates the extent to which REPowerEU has reshaped the EU's external energy trade relations by decreasing imports of fossil fuels from Russia and increasing imports from alternative partners. Using a panel dataset of EU fossil fuel imports between the first quarter of 2017 and the first quarter of 2025, the study applies a Difference-in-Differences methodology to estimate the causal impact of the policy intervention. Findings indicate a statistically significant decline in Russian fossil fuel imports following the REPowerEU's implementation in petroleum oils, gaseous natural gas and solid fossil fuels. Crucially, however, liquefied natural gas (LNG) imports from Russia increased post-REPowerEU, highlighting a complex short-term dynamic. This shift was accompanied by a statistically significant increase in imports from alternative suppliers with which the EU signed energy agreements. The results suggest a shift in the EU's external energy trade landscape, largely succeeding in reducing Russian dependency over the period under analysis. However, the uneven transition across energy types, particularly with Russian LNG, underscores continued vulnerabilities. By providing empirical evidence on REPowerEU's effectiveness, the study contributes to the literature on energy security, trade diversification, and policy evaluation in the context of international economics.

KEYWORDS: REPowerEU; EU Energy trade; Energy security; Trade diversification; Difference-in-Differences.

JEL CODES: C23; F14; F51; Q37; Q48.

RESUMO, PALAVRAS-CHAVE E CLASSIFICAÇÕES JEL

A invasão da Ucrânia por parte da Rússia em 2022 expôs a dependência estrutural da União Europeia relativamente às importações de combustíveis fósseis provenientes da Rússia, o que exigiu uma resposta política urgente. Nesse contexto, foi lançado o plano REPowerEU com o objetivo de reduzir a dependência energética da UE face à Rússia e acelerar a diversificação das fontes de abastecimento. Esta dissertação investiga em que medida o REPowerEU transformou as relações comerciais externas de energia da UE, diminuindo as importações de combustíveis fósseis da Rússia e aumentando as importações provenientes de parceiros alternativos. Utilizando dados em painel das importações de combustíveis fósseis da UE entre o primeiro trimestre de 2017 e o primeiro trimestre de 2025, o estudo aplica a metodologia Diferença em Diferenças (*Difference-in-Differences*) para estimar o impacto causal da política. Os resultados indicam uma redução estatisticamente significativa nas importações de combustíveis fósseis russos após a implementação do REPowerEU, nomeadamente no petróleo, gás natural gasoso e combustíveis fósseis sólidos. No entanto, as importações de gás natural liquefeito (GNL) da Rússia aumentaram no período pós-REPowerEU, evidenciando uma dinâmica complexa a curto-prazo. Esta mudança foi acompanhada por um aumento estatisticamente significativo nas importações provenientes de fornecedores alternativos com os quais a UE celebrou acordos energéticos. Os resultados sugerem uma transformação no panorama do comércio externo de energia da UE, refletindo um sucesso geral na redução da dependência russa ao longo do período analisado. No entanto, a transição desigual entre os diferentes tipos de energia, em especial no caso do GNL russo, destaca vulnerabilidades persistentes. Ao fornecer evidência empírica sobre a eficácia do REPowerEU, este estudo contribui para a literatura sobre segurança energética, diversificação comercial e avaliação de políticas no contexto da economia internacional.

PALAVRAS-CHAVE: REPowerEU; EU Energy trade; Energy security; Trade diversification; Difference-in-Differences.

CLASSIFICAÇÕES JEL: C23; F14; F51; Q37; Q48.

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1. Introduction

The Russian invasion of Ukraine in February 2022 marked a defining moment in the European Union's energy policy. For decades, Russia had been the EU's main supplier of fossil fuels, namely natural gas, crude oil and coal, accounting for a significant share of total energy imports (European Commission: Directorate-General for Energy, 2023). This dependency was rooted in geographic proximity, long-standing infrastructure agreements and economic complementarities (Kaveshnikov, 2010; Siddi, 2018). When tensions escalated into full-scale war, energy dependence on Russia became not only an economic risk but also a pressing geopolitical liability.

In response, the European Commission launched the REPowerEU plan in May 2022. This ambitious policy framework aimed to reduce the EU's dependence on Russian fossil fuels through a combination of diversification of suppliers, accelerating investment in renewables and energy savings (European Commission, 2022). The plan was both a short-term emergency response and a long-term strategic shift.

This dissertation investigates the extent to which the REPowerEU plan has affected the EU's external energy trade, specifically by reducing fossil fuel imports from Russia and increasing those from alternative suppliers. This topic is highly relevant to both policymakers and academics. From a policy perspective, evaluating the effectiveness of REPowerEU is critical to assessing the EU's ability to respond strategically to external shocks. From an academic standpoint, this study contributes to broader debates on energy security, trade dependence and the role of supranational institutions in shaping international economic relations. The war in Ukraine did not create the EU's vulnerabilities, but accelerated a policy shift that had previously advanced only incrementally, even with the annexation of Crimea in 2014 (Rabinovych & Pintsch, 2024).

A considerable amount of academic work has explored related issues, offering context for this dissertation. First, the concept of energy security has been widely studied, particularly within the European context. Researchers such as Cherp & Jewell (2014) have highlighted the multidimensional nature of energy security, encompassing availability, affordability, accessibility, and acceptability. Other scholars have examined how diversification strategies contribute to energy resilience (Kim et al., 2025; Sovacool, 2013; Vivoda, 2019; Wani et al., 2024). Second, the EU’s dependency on Russian energy has been analysed extensively before 2022, with many authors emphasising the risk of supplier concentration and asymmetrical power in energy trade relations (Bahgat, 2006; Baran, 2007; Paillard, 2010; Casier, 2011; Mikulska & Finley, 2024). However, much of this work is either qualitative in nature or predates the Ukraine war. Third, while recent studies have addressed policy evaluation in the context of green transition and energy trade (Adan & Fuerst, 2016; Böhringer et al., 2009; Gürsan & de Gooyert, 2021; Pollitt, 2021; Tang et al., 2025), there remains a gap in empirical research that isolates the impact of REPowerEU on the EU’s energy trade flows. Existing institutional reports and academic research often rely on descriptive statistics without offering a rigorous econometric analysis (Istituto Affari Internazionali, 2023; Klecha-Tylec et al., 2024; Taydaş, 2024).

This dissertation seeks to contribute to the literature by filling this empirical gap. It applies a Difference-in-Differences approach to estimate the impact of REPowerEU on EU fossil fuel imports, comparing changes in imports from Russia (treatment group) to those from other external suppliers (control group) before and after the policy's introduction. The dataset used includes the EU’s quarterly fossil fuel imports from the first quarter of 2017 to the first quarter of 2025, capturing both pre- and post-policy dynamics.

While REPowerEU has been widely discussed, few academic studies have attempted to isolate its direct effect on trade flows using a clean identification strategy. This research offers new data-driven evidence on whether REPowerEU has achieved its objective of reducing energy dependence on Russia through trade diversification. It explores the REPowerEU as a quasi-natural experiment to estimate the effect on EU’s energy imports speaking to international political economy and policy effectiveness.

The dissertation is organised into six chapters. Following this introduction, Chapter 2 presents the policy background and the market context prior to the implementation of the REPowerEU. It begins by describing the EU’s energy import structure before 2022, then discusses the impacts of the Ukraine war in the energy markets and concludes by detailing the objectives and the mechanisms of the REPowerEU plan, especially in terms of supplier diversification. Chapter 3 reviews the existing literature on energy security, the EU’s historical vulnerabilities in energy trade, and relevant energy policy case studies, including their impacts and methodological approaches. It also identifies the main gaps in the literature on REPowerEU, justifying the relevance of the present study. Chapter 4 outlines the data and methodology used in the analysis. Chapter 5 presents the empirical results, beginning with descriptive statistics and moving to the econometric analysis, interpreting the main findings in light of the research question. Finally, Chapter 6 concludes by summarising the key insights of the study, discussing policy implications, acknowledging the study’s limitations and suggesting directions for future research.

2. LITERATURE REVIEW

2.1. Theoretical Perspectives on Energy Security and the connection to Dependence and Diversity

The concept of energy security is not new. Since early human history, securing a reliable source of energy, such as fire, was vital to meet basic human needs (Valentine, 2011). Over time, however, energy security has evolved into a more complex and strategically relevant issue. In the second half of the 20th century, oil became increasingly important not only for military purposes but also for sustaining core functions of industrialised economies such as transportation, electricity generation, mechanised agriculture and heating of buildings (Cherp et al., 2012).

Although academic research on energy security began to emerge in the 1960s (Lubell, 1961), it was the 1970s oil crises that brought the topic firmly onto political agendas. Willrich (1976) defined energy security as “the assurance of sufficient energy supplies to permit the national economy to function in a politically acceptable manner” (p. 747). Later, Deese (1979) conceptualised energy security as a condition rather than a policy, describing it as “a condition in which a nation perceives a high probability that it will have adequate energy supplies [...] at affordable prices” (p. 140).

Academic interest declined during the oil price stability of the 1980s and 1990s, but resurged in the beginning of the 21st century, driven by the growing demand in Asia, gas supply disruptions in Europe and the pressure to decarbonise the energy system (Cherp & Jewell, 2014). Since then, definitions have become more precise, multidimensional, with increased involvement of international organisations (Azzuni & Breyer, 2018). For instance, the International Energy Agency (2022) defines energy security as the uninterrupted availability of energy sources at an affordable price in line with the United Nations Development Programme (2000) emphasis on “continuous availability of energy in varied forms, in sufficient quantities, and at reasonable prices”.

Nonetheless, energy security is highly context dependent, shaped by historical, socio-political and economic characteristics of each country (Ang et al., 2015). Consequently, its assessment must reflect these characteristics and evolve with changing national circumstances and priorities (De Rosa et al., 2022).

Despite contextual differences, most academic discussions revolve around the four main dimensions of energy security, introduced by the Asia Pacific Energy Research Centre (2007), commonly known as the 4As: Availability, Affordability, Accessibility, and Acceptability. These dimensions provide a structured framework for evaluating energy security across diverse national contexts. Briefly, Availability refers to the immediate physical availability of energy resources within an economy. Affordability relates to the economic capacity of an economy to acquire the energy to meet projected energy demand, usually linked to energy prices. Accessibility involves the sustained connection between energy supply and demand (e.g. infrastructure for transport and transmission). Lastly, Acceptability encompasses the environmental, political, and societal aspects of the energy system (Sutrisno et al., 2021).

The literature presents a range of indicators that address one or more of these four essential dimensions of energy security, including factors such as supply diversity and dependence, economy and markets, investments, socio-political aspects, infrastructure and technologies, environmental issues and resilience (De Rosa et al., 2022; Sutrisno et al., 2021).

Among these, energy diversity and dependence are two of the most frequently studied aspects (De Rosa et al., 2022; Sutrisno et al., 2021). Dependence reflects a country's reliance on external sources for energy, while diversity refers to the range of options with the energy system. The main dimensions of diversity include variety of energy types and sources, the different means to make the energy available to end-users (e.g., technologies and transportation) and diversity of consumers (e.g., markets and sectors) (Azzuni & Breyer, 2018). High dependence on a single supplier is widely recognised as a major risk, as it increases vulnerability to external shocks. In contrast, diversification, sourcing energy from multiple suppliers or using a varied energy mix, enhances resilience and reduces exposure to temporary or permanent disruptions in supply. If one supplier is affected by natural disasters, terrorism, war, regime change or other adverse events, the impact on an importer's total supply can be significantly mitigated (Vivoda, 2009).

The global concentration of energy resources intensifies dependence risk, as around 80% of global oil reserves are concentrated in 12 countries and just three countries account for over half of gas resources. This concentration leaves import dependent countries vulnerable to external shocks, highlighting the importance of diversifying both supplier and energy sources (De Rosa et al., 2022; Sutrisno et al., 2021).

Understanding these key concepts of energy security, supplier dependency and diversity is crucial to contextualise the European Union's energy landscape. The EU's energy security has long been challenged by its high level of external dependence, particularly on a small number of fossil fuel suppliers. As highlighted earlier, supplier concentration increases exposure to external shocks.

Understanding the link between energy security, dependence, and diversity highlights the role of policy in shaping trade flows. The next section explores how countries respond to energy shocks through diversification strategies and introduces key methodological approaches to analyse such changes.

2.2. Energy Strategy and Trade Diversification: Cases and Methodological Approaches

In an increasingly volatile geopolitical context and with the accelerating transition away from fossil fuels, governments around the world are implementing a variety of energy policies to strengthen their energy security. External shocks, such as geopolitical crises or natural disasters, frequently act as catalysts for shifts in energy trade patterns, prompting urgent policy adjustments aimed at mitigating vulnerabilities and enhancing resilience.

Empirical studies have documented how countries respond to such challenges through long-term planning and crisis-driven diversification. For instance, Guilhot (2022) analysed China's energy policy from 1981 to 2020, highlighting a shift from heavy dependence on coal, which accounted for 70.8% of its energy mix in 2011 vs 56.6% in 2020, to a more diversified portfolio that included renewables and nuclear energy, which together reached 15.6% by 2020 vs. 7.4% in 2011. National planning tools such as the Twelfth and Thirteenth Five-Year Plans and the Renewable Energy Law in 2006, supported large-scale investments in wind, solar and hydro, enabling China to emerge as the world's leading renewable energy producer. Additionally, Madani (2021) analyses how the Belt and Road Initiative (BRI) impacts China's energy security, indicating that deepening of energy cooperation with BRI countries, can lead to energy import routes diversification, mitigating supply risk and strengthening China's voice in international energy negotiations and global energy governance.

In contrast, Japan's energy trade patterns were reshaped by the sudden external shock of the 2011 Fukushima nuclear disaster. Hayashi & Hughes (2013) examined how the accident influenced both short and long-term energy policy aimed at preserving energy security. They found that fossil fuel use increased in the short-term, raising electricity costs, while long-term policies focused on reducing electricity consumption, lowering fossil fuel costs and expanding renewable energy by promoting technological development. Similarly, Vivoda (2012) analysed Fukushima's impact on energy security and argued that Japan's reliance on imported oil, coal and LNG would rise in the short to medium-term to compensate for the sharp decline in nuclear power production.

The cases of China and Japan demonstrate how energy strategies directly influence trade flows, supply routes and import dependencies. To systematically evaluate such impacts researchers must rely on methodological tools that allow for the empirical analysis of energy trade patterns, policy effects and diversification outcomes.

From a methodological standpoint, two widely used data structures in empirical energy research are time series and panel data. Time series data, which track a single unit, such as country or region, over time are particularly useful for studying country specific dynamics (Wooldridge, 2013). For instance, Kartal (2022) used non-linear Autoregressive Distributed Lag models to analyse the asymmetric effects of energy security on economic growth in Turkey between 1980 and 2018. In contrast, panel data combine both cross-sectional and time series dimensions, allowing researchers to observe multiple units (e.g., countries or regions) over time. This structure is commonly used in econometric models such as fixed effects or random effects regressions (Wooldridge, 2013). For example, Török (2025) used panel data to evaluate how GDP per capita, energy intensity, investment rate, and government subsidies influenced the share of renewable energy in EU Member States.

When the goal is to identify causal inferences of specific policy interventions, one of the most widely applied approaches is the Difference-in-Differences (DiD) methodology. For instance, Adan & Fuerst (2016) used DiD to assess how energy efficiency measures reduced household energy consumption in the UK, comparing retrofitted dwellings to similar non-retrofitted ones. Lin & Li (2011) applied DiD to measure the mitigation effect of carbon taxation on CO_2 emissions in Sweden, Denmark, Finland, Norway, and the Netherlands. More recently, He et al. (2024) used a spatial DiD model to study how environmental regulation, more specifically the Pollution Levy policy, influenced carbon emission efficiency across China.

To measure energy diversification and concentration, researchers often rely on indices such as the Herfindahl-Hirschman Index (HHI) or Shannon-Weaver Index (SWI). These indices quantify the concentration or diversification of energy imports across different source countries or energy types (De Rosa et al., 2022). Rubio-Varas & Muñoz-Delgado (2017) developed an Energy Mix Concentration Index based on the HHI to analyse European countries' diversification of primary energy basket over the past two centuries. More recently, Lekavičius et al. (2024) applied an extended version of the HHI to assess the diversification of EU imports of both energy and energy-related technologies in the period between 2013 and 2023. Additionally, Streimikiene et al. (2023) introduced an Energy Import Diversification and Security Index to measure countries' energy security level associated with energy import dependency and diversification.

The comparative cases from China and Japan show that energy strategies, whether long-term or crisis-driven, can significantly reshape trade patterns. Evaluating those effects requires appropriate methodological tools, including time series and panel data analysis, causal inference techniques such as DiD, and diversification indices like the HHI.

With these methodological tools established, the following section of the literature review examines the emerging academic studies on REPowerEU. While it offers valuable insights from geopolitical, environmental and legal perspectives, it reveals a notable gap: few studies have conducted empirical analyses, and none have applied a DiD framework to assess REPowerEU's effect on the reconfiguration of EU energy trade. This gap sets the empirical agenda for the analysis that follows.

2.3. State of the Literature: Multidimensional Perspectives on REPowerEU and Gaps in Empirical Analysis

The REPowerEU plan emerged as an urgent response to the energy crisis triggered by Russia's invasion of Ukraine. The academic literature on REPowerEU is still evolving, covering a wide range of perspectives, from geopolitical and economic to environmental and legal dimensions.

Diverse studies have explored the broader context and strategic intentions of the policy. Taydaş (2024) and Klecha-Tylec et al. (2024) offer contextual analyses, with the latter providing an overview of the EU's key energy metrics.

Istituto Affari Internazionali (2023) examines how the implementation of REPowerEU may reshape the EU's external energy strategy by altering longstanding energy and political relations and restructuring the global energy flows, thereby posing both risks and opportunities for the EU.

Siddi (2022) highlights contradictions in the REPowerEU strategy, particularly the coexistence of ambitions for a green transition with the short-term reliance on alternative fossil fuel suppliers and infrastructure, such as LNG terminals. Similarly, Vezzoni (2023) warns about lock-in effects of new fossil investments and potential raw materials dependency, including partnerships with undemocratic regimes.

From a legal standpoint, Famà (2023) discusses how REPowerEU is embedded within the Next Generation EU framework, while Jendroska & Anapyanova (2023) express concern about the policy's alignment with other EU environmental policies. Schramm & Terranova (2024) examine REPowerEU from an EU budgetary governance perspective.

The environmental and technological dimensions of REPowerEU are also addressed in recent works. Labianca et al. (2024) develop a model to identify optimal rural locations for an agro-biomethane plant, highlighting biomethane as a viable alternative to natural gas imports. In contrast, Magnolo et al. (2024) caution that reliance on manure as feedstock for biomethane may establish unsustainable agricultural practices and foster animal feed dependency from other continents. Dinca et al. (2023), focusing on Romania, analysed administrative, market and technological obstacles to the deployment of renewable energy technologies.

Regarding domestic consumers, Popa et al. (2023), Petrariu et al. (2023), Stancu et al. (2023) explore behavioural aspects, such as citizens' willingness to adopt smart energy solutions and energy efficiency practices.

Ah-Voun et al. (2024) adopt a model-based approach to estimate REPowerEU's impact and found that the plan could reduce EU gas demand by 133 bcm compared to the national energy and climate plans, enough to eliminate reliance on Russian gas by 2030, though seasonal vulnerabilities remain, especially during extreme winters.

On the topic of diversification, de Jong (2024) develops a preliminary empirical framework to assess the evolution of EU gas policy from 2000 to 2022, using indicators such as gas import dependency, diversification and gas intensity. The findings revealed that, following the invasion of Ukraine, EU became more diversified, more import dependent and less gas intensive. However, the author notes that the improvement of gas intensity was likely related to higher prices and Russia's actions rather than from REPowerEU itself. As for the increase in import dependency, de Jong attributes it to the unique market conditions within EU and on the LNG spot market in the period preceding the invasion.

Beyond specific literature about REPowerEU, several studies have explored the relation between renewable energy consumption and international trade. For example, Ilechukwu & Lahiri (2022) analyse how trade is affected by a country's dependence on renewable energy consumption in its total energy use during the period from 1990 to 2014. They find that in OECD countries, increasing renewable energy use is associated with higher exports, while in non-OECD countries the reverse happens, higher dependency on renewables corresponds to a decrease in exports. Similarly, Lu et al. (2022), using data from 36 OECD countries between 1966 and 2016, find that trade gains are positively related to renewable energy consumption. Additionally, the study shows that higher per capita income, increased per capita CO_2 emissions and rising energy prices contribute to greater demand for renewable energy.

Despite growing academic interest, empirical assessments of REPowerEU remain limited. Most existing studies focus on policy overviews, scenario modelling and descriptive statistics. A notable gap exists in the academic literature concerning quantitative and causal assessment of REPowerEU's impact, particularly on the reconfiguration of trade flows and shifts in energy suppliers. To date, no known studies have applied DiD analysis to evaluate the effect of REPowerEU policy.

This dissertation aims to contribute to filling this gap by applying econometric techniques to assess the effect of REPowerEU on the reconfiguration of EU energy partners. In doing so, it complements the existing literature with an empirical and causal perspective.

3. Contextual Framework

3.1. Overview of EU's Energy Imports before 2022: Dependency on Fossil Fuels and Key Suppliers

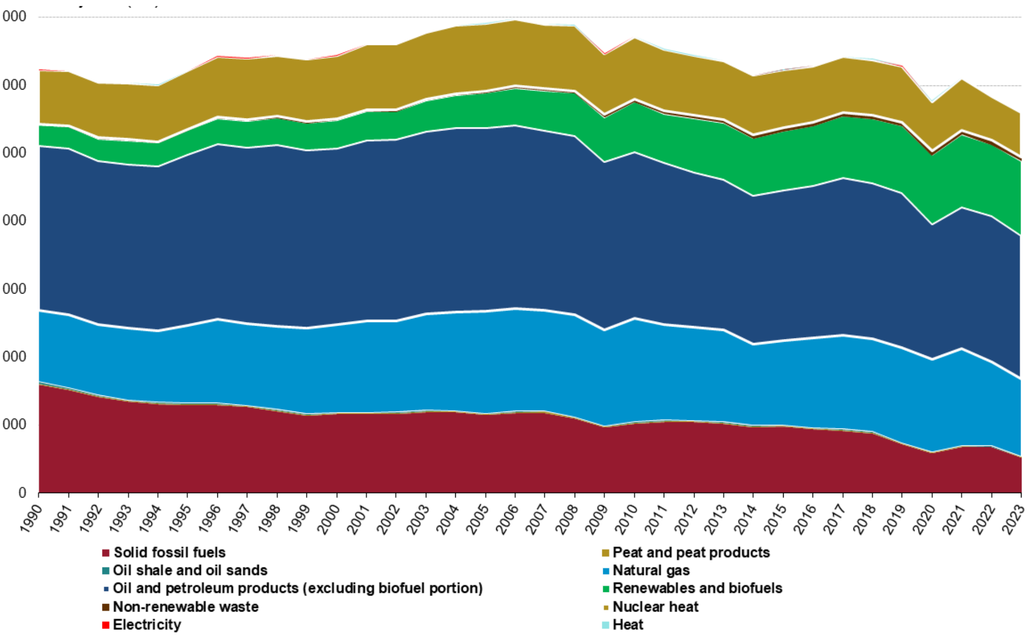
Before the implementation of the REPowerEU plan, the European Union's energy system was characterised by a high dependence on fossil fuel imports and a declining trend in domestic energy production. The Energy Import Dependency (EID) ratio, defined as net imports over gross available energy (GAE), increased from 50% in 1990 to 58% in 2023, peaking at 63% in 2022. This rising dependency is rooted in the decline of domestic energy production and historically high levels of energy consumption (Sterling et al., 2025).

In 2021, renewable energy accounted for the largest share of primary energy production in the EU (43%), followed by nuclear heat (28%), solid fossil fuels (16%), natural gas (6%), oil and petroleum products (3%), and non-renewable waste (2%). Between 2012 and 2022, primary energy production in the EU saw significant declines across multiple sources, with natural gas production decreasing by 65%, oil and petroleum products by 38% and solid fossil fuels by 39% (Eurostat, 2024). Over the broader period of 1990-2023, energy production steadily declined, particularly after 2015 (Sterling et al., 2025).

This structural decline in domestic production led to an increased reliance on energy imports. By 2022, natural gas imports had more than doubled compared to 1990, reaching 14,056 PJ, the highest level ever recorded. Crude oil remained the most imported energy source, with 20,320 PJ imported in 2022 (Eurostat, 2024). Notably, oil import dependency has remained close to 100% since the mid-1990s, while natural gas import dependency has climbed by 30 percentage points since 2014 (Guarascio et al., 2025). This growing reliance on external suppliers reflected the EU's increasing exposure to geopolitical risks in its energy supply chain.

Regarding GAE in 2021, oil accounted for 32% of the EU's total, followed by natural gas at 24%. Notably, renewable energy sources had already risen to 18%, surpassing solid fossil fuels (11%) (European Commission: Directorate-General for Energy, 2023). Despite this progress on renewable energy, coal, oil and gas still accounted for 67% of GAE in 2023 (Figure 1; Eurostat, 2024).

FIGURE 1 - Gross available energy by fuel in EU (PJ), 1990-2023



Source: Eurostat (2024)

Within this context, Russia emerged as the European Union's main energy trade partner, supplying the largest share of fossil fuel imports from non-EU countries. In 2021, Russia accounted for approximately 44% of the EU's natural gas, 25% of crude oil and Natural Gas Liquids (NGL), 53% of hard coal and 17% of LNG imports (European Commission: Directorate-General for Energy, 2023). However, this dependency varied across Member States. Central and Eastern European countries were particularly vulnerable. In 2020, Czech Republic, Latvia and Hungary were almost entirely dependent on Russian natural gas, while Germany, Italy, Poland, Bulgaria and Finland sourced over 40% of their gas imports from Russia (Perdana et al., 2022).

These differences at country level are reflected in EID ratio, which ranged from 6% in Estonia to almost 100% in Malta in 2022, with eight countries between 70–80%. While half of the EU countries have reduced their dependency during the past decade, with Sweden achieving the highest reduction (-12%), the remainder experienced increases. Most gas and oil EID ratios approached or exceeded 100%, with exceptions like Romania, Denmark and the Netherlands, reflecting their domestic production (Guarascio et al., 2025).

The EU’s dependence on Russian energy was reinforced by a set of major gas pipelines, like Nord Stream 1 and 2, Yamal-Europe, and TurkStream, which established strong logistical ties between Russia and EU. These pipelines are owned and operated by Gazprom, Russia’s state-controlled gas giant, which holds a monopoly over pipeline gas exports. Although Nord Stream 2 was completed, it never entered into service, but was expected to significantly expand Russia's export capacity to the EU (European Parliament, 2021).

Though the EU heavily depended on Russian energy, the dependence was mutual, as 73% of Russian gas exports were destined for the EU, in 2021. Despite some diversification efforts on both sides, such as the EU’s Southern Gas Corridor and Russia’s Power of Siberia pipeline to China, no alternative market matched the scale and infrastructure integration of the EU-Russia energy trade. LNG provided an additional diversification route, but, in 2021, represented only 20% of total EU gas imports, due to infrastructure constraints, higher prices and competition from Asia (European Parliament, 2021; Siddi, 2019).

Beyond Russia, the EU had relied on a range of external suppliers to meet its fossil fuel needs. In 2022, for natural gas, key partners included Norway (16% of extra-EU imports), Algeria (12%), United States (6%) and Qatar (4%). In terms of LNG, the United States was the leading supplier (26%), followed by Qatar (20%), Nigeria (15%), and Algeria (11%). Crude oil and NGL imports were more diversified, with Norway (10%), the United States (8%), Kazakhstan (8%), Libya (8%), and Iraq (7%) being the main suppliers. For hard coal, Australia (17%) and United States (15%) led imports (European Commission: Directorate-General for Energy, 2024).

The EU’s dependence on fossil fuel imports, especially from Russia, exposed critical vulnerabilities in its energy security. The escalation of the Russo-Ukrainian conflict, in 2022, brought these risks into focus, triggering severe supply disruptions and price volatility across energy markets.

3.2. Geopolitical context: War in Ukraine and its impact on energy markets

The Russo–Ukrainian War is an ongoing international conflict that began in February 2014, escalating dramatically with Russia's full-scale invasion of Ukraine in February 2022. This military escalation has had profound consequences not only for the geopolitical order but also for global energy markets, with Europe being particularly exposed due to its high dependence on Russian fossil fuels.

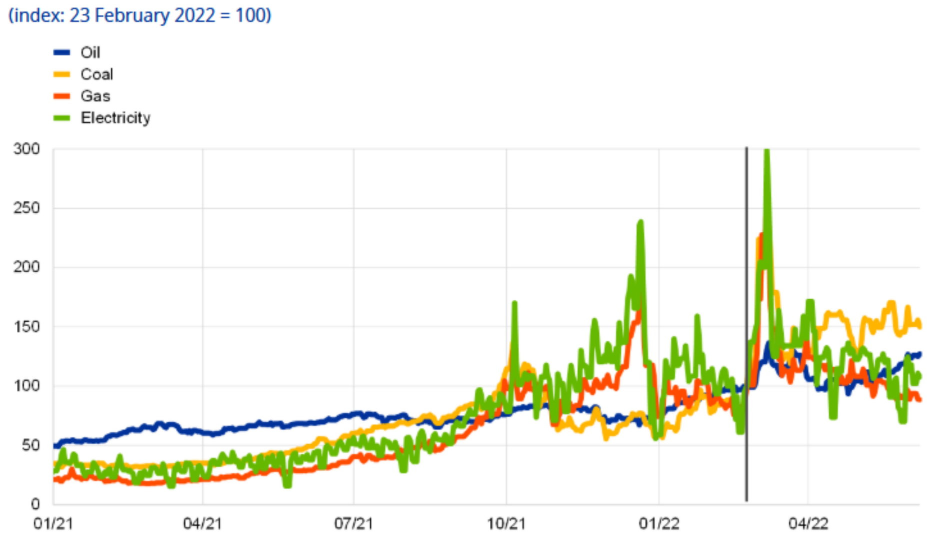
In response to the invasion, the EU imposed extensive sanctions against Russia, including a commitment to phase out Russian oil and gas imports. Simultaneously, Russia has strategically reduced or cut gas supplies to several EU Member States, including Poland, Bulgaria, Finland, Latvia and the Netherlands, and indefinitely closed the Nord Stream 1 pipeline in September 2022. These developments exposed the EU's vulnerabilities, highlighting two critical realities: first, that despite the ongoing green energy transition, fossil fuels remain the pillar of Europe's energy consumption; and second, that the EU had maintained a high dependence on Russian energy even after the 2014 Crimea invasion (Kuzemko et al., 2022).

The energy crisis that followed the invasion intensified existing vulnerabilities in the European energy system. Energy prices, already on the rise in 2021 due to post-pandemic demand recovery and years of underinvestment in the energy sector, surged dramatically. Given Russia's crucial role in global energy markets, accounting for about 20% of global natural gas, 10% of crude oil and 5% of coal exports, the risk of supply disruptions translated almost immediately into sharp price increases (Ari et al., 2022).

Within the first two weeks of the invasion, prices for oil, coal and natural gas increased by approximately 40%, 130%, and 180%, respectively (Figure 2). This surge contributed to increases in wholesale electricity prices across the euro area, driven largely by the sharp increases in gas prices given the fuel's central role in power generation (European Central Bank, 2022). By the end of the first quarter of 2022, crude oil prices had doubled compared to early 2021, coal prices had tripled, and natural gas prices had increased more than fivefold. Carbon allowances in the EU's Emissions Trading System also doubled, reaching approximately €75 per metric ton of CO_2, as the EU adopted more ambitious emissions reduction targets. As a result, energy items accounted for half of the annual

Consumer Price Index (CPI) inflation rate in May 2022, despite representing only 5% to 15% of CPI basket (Ari et al., 2022).

FIGURE 2 - Energy prices before and after the invasion of Ukraine



Source: European Central Bank (2022), p. 47.

Although energy prices moderated somewhat by mid-2022, with oil and coal prices standing 27% and 50% respectively above pre-invasion levels, while natural gas prices declined to about 11% below pre-invasion levels, price volatility persisted. The EU's embargo on most Russian oil imports combined with increasing global demand, especially after China's easing of COVID-19 restrictions, exerted upward pressure on prices once again. Wholesale electricity prices remained volatile, influenced by fluctuating fuel prices and a range of policy measures implemented to alleviate the impacts on consumers and businesses (European Central Bank, 2022).

In response to this complex crisis, European policymakers adopted a dual approach: mitigating the immediate consequences while accelerating the transition towards a more resilient and sustainable energy system. The war emphasised the critical risks of overdependence on a single supplier, prompting initiatives such as the REPowerEU plan, which aims to diversify energy imports, increase renewable energy deployment, and improve energy efficiency to reduce vulnerability to future shocks (European Central Bank, 2022; Kuzemko et al., 2022).

In sum, the war in Ukraine profoundly disrupted European energy markets through severe supply shocks and historic price volatility. These disruptions have had far-reaching economic and social consequences and have propelled a major reorientation of European energy policies towards diversification, sustainability and long-term resilience.

3.3. The REPowerEU Plan: Overview and Supplier Diversification

The REPowerEU Plan, introduced by the European Commission in May 2022, is the European Union's strategic response to the global energy crisis triggered by Russia's invasion of Ukraine in February 2022 (European Council, 2025b). The invasion of Ukraine prompted a new set of EU sanctions, expanding on earlier measures adopted after the illegal annexation of Crimea in 2014. By July 2025, a total of 18 sanctions packages had been adopted, several of which targeted the energy sector.

These sanctions evolved over time. The fifth package, introduced in April 2022, imposed an embargo on coal and other solid fossil fuels. It was followed by the sixth package in June 2022, which included a partial embargo on crude oil and refined petroleum products, with a temporary exemption for pipeline crude oil supplied to certain Member States heavily dependent on Russian oil. The restrictions took effect in December 2022 for crude oil and in February 2023 for other refined petroleum products, while the pipeline exemption ended for Poland and Germany in June 2023 and for Czechia in July 2025. Croatia continues to benefit from a temporary derogation for imports of Russian vacuum gas oil. In October 2022, the eight package introduced a price cap on oil. More recently, the fourteenth package, launched in June 2024, banned the re-export of Russian LNG in EU facilities and new investments in Russian LNG projects, while the eighteenth package adopted in July 2025 imposed a full transaction ban on Nord Stream 1 and 2 pipelines (European Council, 2025c; European Council, 2025d; Batzella, 2024).

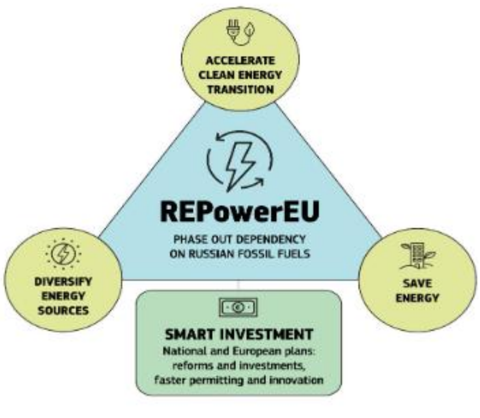
The REPowerEU Plan builds on the Fit for 55 package supporting the EU goal to reduce net greenhouse gas emissions by at least 55% by 2030 and to reach climate neutrality by 2050, in line with the European Green Deal. The primary objective of the REPowerEU is to rapidly reduce the EU's dependence on Russian fossil fuels, while accelerating the transition towards a secure, affordable and clean energy system (European Council, 2025b).

In December 2022, the Council and the European Parliament agreed on the revision of the Recovery and Resilience Facility (RRF) regulation, allowing Member States to add dedicated REPowerEU chapters in their recovery and resilience plans. These chapters should include reforms and investments aligned with the REPowerEU goals (European Council, 2025b).

Funding for the plan includes up to €225 billion in unused loans from the RRF. Up to an additional €20 billion in grants is funded through the innovation fund (60%) and sales of emission trading system allowances (40%). Furthermore, Member States can transfer up to 10% of their Cohesion Policy funds for the 2014-2020 period and up to 7.5% of their Cohesion Policy funds for the 2021-2027 period. Lastly, transfers up to €5.4 billion from the Brexit Adjustment Reserve (BAR) to the RRF are also allowed (European Council, 2025a).

REPowerEU is structured around four main pillars: Energy savings; Diversification of energy supplies; Substitution of fossil fuels and acceleration of the clean energy transition; and the Strategic combination of investments and reforms (Figure 3; European Commission, 2022). Given the focus of this dissertation on the reconfiguration of energy trade partners, particular attention is paid to the second pillar.

FIGURE 3 - REPowerEU Pillars



Source: European Commission (2022)

Diversification in energy supplies reduces vulnerability to disruptions. Strengthening trade relations with reliable partners and diversifying the energy mix are key to enhancing the resilience of the EU energy system. In the context of the second pillar of the REPowerEU Plan, the European Union has prioritised four key areas: joint purchasing of gas and demand aggregation; investment in energy infrastructure; reduction of nuclear dependency; and the reinforcement of international partnerships.

To advance coordinated gas procurement, the European Commission launched the EU Energy Platform in December 2022. This platform has three main objectives: facilitate demand aggregation and joint purchasing of gas; optimise and ensure the utilization of existing gas infrastructure; and strengthen international energy outreach. Building on this platform, the AggregateEU mechanism was established in April 2023 to pool gas demand from EU and Energy Community companies and match it with competitive supply offers. Following the matching of demand with supply, companies can voluntarily conclude purchasing contracts with gas suppliers, either individually or jointly. Purchasing contracts between companies and gas suppliers remain voluntary, and outside AggregateEU. Between April 2023 and March 2025, seven matching rounds were conducted, of which five classified as short-term and two as mid-term, aggregating more than 119 bcm of gas demand from European companies and receiving 191 bcm in supply offers. From these rounds, nearly 100 bcm were matched to help meet European gas demand (European Commission, 2025a; European Commission, n.d.a).

Additionally, the European Union has prioritised enhancing its energy infrastructure by finalising or upgrading cross-border interconnections and LNG terminals, which are crucial for diversifying gas supply sources (European Commission, n.d.d). As a result, the EU's LNG import capacity increased by 70 billion cubic metres (bcm) between 2023 and 2024, with an additional 60 bcm expansion expected between 2025 and 2030 (European Commission, n.d.c).

Several of these LNG infrastructure projects are classified as Projects of Common Interest (PCIs) and Projects of Mutual Interest (PMIs), funded through the Connecting Europe Facility. PCIs are key cross-border infrastructure projects within the EU, while PMIs involve cooperation with non-EU countries (European Commission, n.d.b). Notable examples of PCIs include the Baltic Pipe, inaugurated in September 2022, which enhances energy security in this region (European Commission, n.d.f), and the new LNG facility in Alexandroupolis, Greece, approved in June 2021, aimed at reducing dependence on Russian supplies (European Commission, 2021).

The nuclear sector has also required special attention, as five Member States (Bulgaria, Czechia, Finland, Hungary, Slovakia) operate water-cooled-water-moderated-energy (VVER) reactors that currently depend exclusively on Russian fuel. Since 2022, four of these five countries signed supply contracts for alternative fuel, but national testing and licensing processes need to be completed before these alternatives can be used. Moreover, the capacity for uranium conversion and enrichment is limited, with European facilities currently unable to meet overall demand. To address this, new European enrichment and conversion installations are expected to be operational by 2027 and 2030, respectively. Until then, Europe remains dependent on international cooperation, namely with G7 partners (European Commission, n.d.d).

Finally, to reduce dependence on Russia, the EU has strengthened its international partnerships in the natural gas sector. In 2022, the EU and the US launched a Task Force on Energy Security and two joint statements were signed with Norway, in June and October. Additionally, the EU established two Memoranda of Understanding, with Egypt and Israel, as well as with Algeria (Table I). Although many of these agreements deepen existing relations with suppliers such as the US, Norway, Algeria and Azerbaijan, the trilateral partnership with Egypt and Israel marks a new path for diversifying gas imports and reducing supply risks (Jerzyniak, 2024).

TABLE I - Overview of the agreements in Natural Gas

Country	Date of signature	Type of document*
United States	March 2022	JS
Norway	June 2022	JS
Egypt / Israel	June 2022	MoU
Azerbaijan	July 2022	MoU
Algeria	October 2022	MoU

* Joint Statement (JS), Memorandum of Understanding (MoU).

Source: European Council on Foreign Relations (2024)

Other agreements were made concerning critical minerals and clean energy, including hydrogen. Since this thesis focuses on studying the reduction of the EU's dependency on Russia and the resulting reconfiguration of its energy suppliers, with the primary dependency on Russia being fossil fuels, these additional agreements will not be discussed.

These initiatives led to significant shifts in the EU's energy trade landscape. According to the European Commission official assessment published in 2025, which marked three years since the launch of REPowerEU, the EU has completely banned imports of Russian coal through sanctions and the share of Russian gas, both pipeline and LNG, in total EU imports dropped from 45% in 2021 to 19% in 2024. Similarly, Russian crude oil imports accounted for only 3% of EU imports in 2024, down from 27% in 2022 (European Commission, n.d.d).

However, a partial rebound in Russian gas imports was observed in 2024, which led the Commission to present a roadmap in May 2025 to fully end the EU's dependence on Russian energy. This roadmap includes actions to stop all gas imports from Russia by 2027, through enhanced transparency, monitoring and traceability of Russian gas across the EU markets. Specifically, it proposes to ban imports under new contracts and existing spot contracts by the end of 2025, and under existing long-term contracts by the end of 2027. In the oil sector, EU plans to continue imposing and enforcing sanctions to dismantle Russia's "shadow fleet", meaning vessels used by Russia to evade sanctions and transport oil. Additionally, new nuclear supply contracts co-signed by the Euratom Supply Agency involving Russian uranium and other materials will be restricted (European Commission, 2025b, n.d.e).

In summary, through the REPowerEU Plan and its emphasis on diversification, infrastructure development and strategic international partnerships, the EU has taken decisive steps to reduce its dependence on Russian fossil fuels and reshape its external energy trade relations.

4. Data and Methodology

4.1. Methodology

This dissertation uses REPowerEU policy as a quasi-natural experiment and adopts a DiD approach to assess its impact on the reconfiguration of EU fossil fuel import patterns. The DiD methodology is well suited to identify causal effects by comparing the evolution of energy imports from Russia (the treated group) with those from non-Russian suppliers (the control group), before and after the introduction of REPowerEU, in May 2022.

The analysis relies on a panel dataset of quarterly imports of fossil fuels ranging from the first quarter of 2017 to the first quarter of 2025, as described in detail in the following section. By exploiting both temporal and cross-sectional variation in trade flows, the DiD framework isolates the effect of the policy by controlling for unobserved group and time fixed effects.

To strengthen the robustness of the analysis, the empirical model includes fixed effects for product, exporter country and time. The product fixed effects account for structural differences across fossil fuel products, country fixed effects control for persistent characteristics specific to each external supplier and time fixed effects absorb global shocks that may affect all trade flows in a given period, such as international price fluctuations or geopolitical tensions (Egger et al., 2022). These controls ensure that the estimated effects of REPowerEU are not confused with other underlying trends.

Further details on the data used are presented in section 4.2, while section 4.3 discusses the empirical design and model specifications applied.

4.2. Data and Variables Description

The empirical analysis in this dissertation is based on trade data obtained from Eurostat, using the COMEXT platform, which provides harmonised and detailed statistics on the European Union's international trade in goods. The dataset includes quarterly import values (in euros) of selected fossil fuels (petroleum oils, natural gas, both gaseous and liquefied, and solid fuels) by exporter country (extra-EU trading partner), covering the period from the first quarter of 2017 to the most recent complete quarter, first quarter of 2025.

The analysis focuses on fossil fuels as these represent the segment in which the EU's dependency on Russian energy was historically most pronounced. These categories are central to the EU's energy consumption and have been particularly targeted under the REPowerEU plan, which seeks to reduce dependency on Russian fossil fuels and accelerate the energy transition. The classification of energy products under the group of Combined Nomenclature (CN) codes used in this study follows the methodology applied by the Eurostat team in recent official energy trade reports (Eurostat, 2025), ensuring consistency with established analytical frameworks.

Specifically, petroleum oils include CN codes 27090010 (petroleum oils from natural gas condensates) and 27090090 (petroleum oils and oils obtained from bituminous minerals, crude); natural gas comprises CN codes 27111100 (liquefied natural gas) and 27112100 (natural gas in gaseous state); and solid fuels cover CN codes 2701 (coal), 2702 (lignite), 2703 (peat), and 2704 (coke).

Several key explanatory variables were created to capture the effects of the REPowerEU policy on EU fossil fuel imports. The variable *Post* is an indicator for the period after the policy implementation, assigned a value of 1 starting from the first full quarter following the policy launch (e.g., Q3 2022, since the policy was announced in May 2022 and Q2 was not fully covered). The variable *Russia* identifies fossil fuel imports originating from Russia, taking the value 1 for Russia and zero for other trading partners. *Alt_Suppliers* is an indicator for imports from alternative suppliers with which the EU has signed bilateral or trilateral agreements (US, Norway, Egypt, Israel, Azerbaijan and Algeria). Additionally, dummy variables were created for each individual country included in the *Alt_Suppliers* category to account for country-specific effects. For *Alt_Suppliers* and the dummy variables for individual alternative suppliers, a value of 1 is assigned starting from the first full quarter when these agreements came into effect, so it is country-time specific.

The dependent variable used in all models is the natural logarithm of EU fossil fuel imports (*ln_imports*), as is standard in the literature.

4.3. Empirical design

To analyse the effects of REPowerEU on energy imports, several econometric models with fixed effects were estimated. The dependent variable is the natural logarithm of imports, as mentioned in the previous section. The analysis uses panel data with three dimensions, namely partner country (c), energy product (p) and time (t).

Model 1: This model analyses the impact of the REPowerEU on imports from Russia by including the interaction term between *Russia* and *Post*. Using the natural logarithm as the dependent variable allows to interpret changes in imports in percentage terms, which is useful to capture proportional changes. α_c , γ_t and δ_p represent country, time and energy product fixed effects, respectively.

$$(1)\ ln\ (imports_{cpt}) = \beta 0 + \beta 1\ (Russia_c \times Post_t) + \alpha_c + \delta_p + \gamma_t + \varepsilon_{cpt}$$

Model 2: This model replaces the variable Russia by *Alt_Suppliers*, a dummy indicating whether imports come from the countries with which the EU has signed energy agreements, as mentioned in the section 2.3. This specification allows assessment of whether imports from these alternative suppliers increased following the agreements.

$$(2)\ ln\ (imports_{cpt}) = \beta 0 + \beta 1\ Alt\_suppliers_{ct} + \alpha_c + \delta_p + \gamma_t + \varepsilon_{cpt}$$

Model 3: Including the *Russia* and *Post* interaction as well as the *Alt_Suppliers* dummy in the same model allows for the assessment of the policy's effect on reducing Russian imports and increasing imports from alternative suppliers.

$$(3)\quad ln\ (imports_{cpt}) = \beta 0 + \beta 1\ (Russia_c \times Post_t) + \beta 2\ Alt\_suppliers_{ct} + \alpha_c + \delta_p + \gamma_t + \varepsilon_{cpt}$$

Model 4: In this regression, the *Alt_Suppliers* variable is replaced by country-specific dummies for those suppliers (US, Norway, Egypt, Israel, Azerbaijan and Algeria), which allows the identification of the countries that played a more significant role in substituting Russian energy imports following REPowerEU.

$$(4) \quad ln\,(imports_{cpt}) = \beta0 + \beta1\,(Russia_c \times Post_t) + \beta2\,US_{ct} + \beta3\,Norway_{ct} + \beta4\,Egypt_{ct} + \beta5\,Israel_{ct} + \beta6\,Azerbaijan_{ct} + \beta7\,Algeria_{ct} + \alpha_c + \delta_p + \gamma_t + \varepsilon_{cpt}$$

These specifications were estimated for total imports of those energy products as well as separately for each energy product, namely petroleum oils, natural gas in gaseous state, LNG and solid fossil fuels. This allows evaluation of how the policy's impact varies across different energy products.

5. Empirical Results

5.1. Descriptive Statistics

This section presents descriptive statistics to contextualise the EU's fossil fuel imports from extra-EU countries between the first quarter of 2017 and the first quarter of 2025. The aim is to provide insight into the dataset's structure and, consequently, on the distribution of trade flows, the role of Russia and alternative suppliers with which the EU has signed energy agreements.

The dataset comprises 20,592 observations including observations with zero imports, where no imports were recorded in a particular quarter from a given country, reflecting the heterogeneous nature of EU fossil fuel trade. The high share of zero trade values affects basic summary statistics such as the mean and standard deviation and should be taken into account when interpreting aggregate figures.

The econometric analysis focuses only on positive trade flows. The dependent variable, EU fossil fuel imports, is transformed using the natural logarithm. Observations with zero imports are automatically excluded from the regression models, as the logarithm of zero is undefined.

Table II and Table III provide detailed descriptive statistics of the main variables, divided into two tables to deepen the understanding of the data's structure. Table II includes all 20,592 observations, while Table III focuses exclusively on the 4,090 observations with positive import values, which form the basis of the estimation sample for the regressions.

The analysis of Table II confirms the extreme skewness of the import data. The median import value of €0 highlights that approximately 80% of observations record zero trade flows, confirming the high prevalence of zeros in the dataset. This contrasts with a mean of €127.5 million and a maximum of €18.3 billion, indicating a concentration of trade value in a limited number of large transactions. The variable limports is only available for the 4,090 observations with positive values.

TABLE II - Summary statistics for all observations

	N	Mean	Median	Min	Max
imports	20592	1.275e+08	0.000	0	1.828e+10
limports	4090	14.112	16.931	0	23.629
post	20592	.333	0.000	0	1
Russia	20592	.006	0.000	0	1
Alt_Suppliers	20592	.012	0.000	0	1
US	20592	.002	0.000	0	1
Norway	20592	.002	0.000	0	1
Egypt	20592	.002	0.000	0	1
Israel	20592	.002	0.000	0	1
Azerbaijan	20592	.002	0.000	0	1
Algeria	20592	.002	0.000	0	1

Focusing on Table III, only considering positive imports, the average import value rises substantially to €642.1 million, with a median of €22.5 million. This marked difference compared to Table II statistics highlights the large number of zero observations and offers a more realistic perspective of actual trade flows.

Dummy variables mean values reflect their relative proportions in each sample. For instance, the share of observations in the post-REPowerEU period increases from 33% to 38% in the positive trade sample. Similarly, Russian partner observations constitute 3.1% of positive trade flows, a notable increase compared to 0.6% in the full sample. Alternative suppliers represent a share of 1.2% in the full sample and 4.6% in the positive trade subsample. This highlights Russia's role as a major supplier.

TABLE III - Summary statistics for positive trade flows

	N	Mean	Median	Min	Max
imports	4090	6.421e+08	22545368.500	1	1.828e+10
limports	4090	14.112	16.931	0	23.629
Post	4090	.383	0.000	0	1
Russia	4090	.031	0.000	0	1
Alt_Suppliers	4090	.046	0.000	0	1
US	4090	.01	0.000	0	1
Norway	4090	.011	0.000	0	1
Egypt	4090	.009	0.000	0	1
Israel	4090	.004	0.000	0	1
Azerbaijan	4090	.006	0.000	0	1
Algeria	4090	.007	0.000	0	1

Table IV shows that following the launch of REPowerEU in 2022Q2, the EU significantly reduced its reliance on Russian fossil fuels, with Russia's share dropping from 28.0% to 8.4%. At the same time, the EU increased its reliance on alternative suppliers. The United States expanded its share of fossil fuels from 7.9% to 17.4% and Norway's share also increased rising from 8.4% to 12.1%. Other partners such as Algeria and Azerbaijan experienced moderate but still notable increases in their shares.

TABLE IV - Share of fossil fuel imports, before and after REPowerEU

	Pre-REPowerEU	Post-REPowerEU
Russia	0.280	0.084
US	0.079	0.174
Norway	0.084	0.121
Egypt	0.009	0.007
Israel	0.000	0.001
Azerbaijan	0.043	0.047
Algeria	0.054	0.070
Others	0.451	0.497

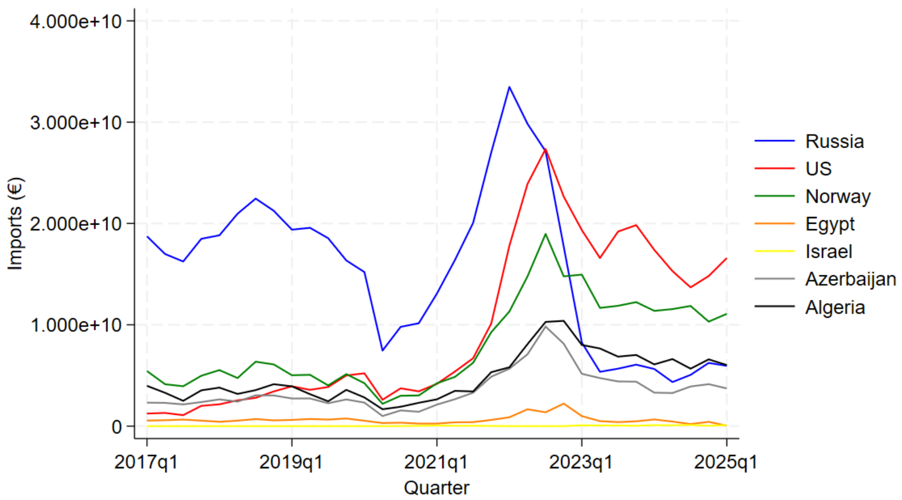
Table V provides further insights by disaggregating by energy product. Russia's dominance declined across all energy products particularly in solid fossil fuels and gaseous natural gas. In contrast, the US strengthened its position in LNG, while Norway and Algeria gained shares in both pipeline and LNG. The "Others" category also expanded in all fuel types, reflecting EU's broader strategy in diversifying its energy imports.

TABLE V - Share of fossil fuel imports by product, before and after REPowerEU

	Petroleum Oils		Gaseous Natural Gas		Liquefied Natural Gas		Solid Fossil Fuels	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Russia	0.263	0.050	0.428	0.195	0.152	0.144	0.380	0.020
US	0.063	0.148	0.000	0.003	0.291	0.421	0.179	0.244
Norway	0.082	0.129	0.169	0.202	0.040	0.048	0.001	0.001
Egypt	0.009	0.005	0.000	0.001	0.024	0.022	0.000	0.000
Israel	0.000	0.001	0	0	0	0.000	0.000	0.000
Azerbaijan	0.048	0.043	0.055	0.133	0	0	0	0.000
Algeria	0.031	0.035	0.188	0.248	0.109	0.077	0.000	0.000
Others	0.504	0.589	0.159	0.219	0.385	0.288	0.439	0.736

Lastly, Figure 4 shows the evolution of total quarterly import values for Russia and the alternative suppliers considered in *alt_suppliers* dummy. Imports from Russia declined sharply in 2022, reflecting a significant reduction in dependency from Russia. Meanwhile, imports from alternative suppliers have increased during and after this period, indicating a diversification of supply sources as the EU shifted away from Russian energy. While this suggests a diversification strategy and reconfiguration of import patterns, some residual effects from global disruptions, including COVID-19 pandemic's aftermath, may also have influenced trade flows during this time.

FIGURE 4 - EU fossil fuel import values by supplier, 2017Q1-2025Q1



5.2. Results interpretation

Table VI presents the estimation results for Models 1 to 4, where the dependent variable is the natural logarithm of import values. Given the logarithmic transformation, regression coefficients are interpreted as percentage changes in imports and the precise percentage effect can be calculated using the formula: [exp(β) - 1] x 100.

Model 1 estimates the baseline DiD specification, capturing the overall effect of the REPowerEU policy on energy imports from Russia. The interaction term between *Russia* and *Post* dummies is negative and statistically significant, indicating that, after the implementation of REPowerEU, energy imports from Russia declined by approximately 84%, compared to other countries. This decline is partially driven by EU sanctions, which banned imports of Russian coal, crude oil and refined petroleum products. However, since LNG and gaseous natural gas were not subject to embargoes during the period analysed, the reduction in imports may also reflect the REPowerEU objective of decreasing dependency on Russian energy.

Model 2 introduces a dummy for alternative suppliers, with a positive but not statistically significant coefficient, suggesting that the overall shift to alternative suppliers is not strong enough to produce a clear effect in this regression. Model 3 combines the *Russian* x *Post* interaction and the *Alt_suppliers* dummy. The reduction in Russian imports after the policy period remains significant and similar in magnitude, while the coefficient on alternative suppliers remains statistically insignificant.

Model 4 disaggregates the alternative suppliers into country specific variables. Among these, only the United States shows a statistically significant and positive coefficient, indicating a more than fourfold increase (422%) in energy imports from the US after the energy agreement. Other countries, including Norway, Algeria, Israel, Egypt and Azerbaijan, do not exhibit statistically significant effects.

TABLE VI - Regression models estimation (All energy products)

	(1)	(2)	(3)	(4)
Dependent variable:	ln_imports	ln_imports	ln_imports	ln_imports
Products included:	All	All	All	All
Russia	6.767*		6.733*	6.740*
	(2.03)		(2.04)	(2.04)
Post	0.00279		-0.0608	-0.0603
	(0.00)		(-0.10)	(-0.10)
Russia # Post	-1.845**		-1.785**	-1.785**
	(-2.72)		(-2.62)	(-2.62)
Alt_Suppliers		0.522	0.463	
		(1.32)	(1.17)	
US				1.653*
				(2.43)
Norway				0.514
				(0.96)
Egypt				-1.185
				(-1.01)
Israel				2.612
				(1.26)
Azerbaijan				-0.535
				(-0.50)
Algeria				0.260
				(0.45)
Constant	15.51***	15.58***	15.55***	15.55***
	(4.63)	(4.71)	(4.67)	(4.67)
N	4090	4090	4090	4090
R-squared	0.592	0.592	0.592	0.593
p-value	.	.	.	.
Fixed Effects	Product, Country, Time	Product, Country, Time	Product, Country, Time	Product, Country, Time

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

To understand the policy's varied impact across different energy products, the models were re-estimated for each energy product category (Tables VII-X). In Table VII, the *Russia* x *Post* interaction is negative and statistically significant for petroleum oils, gaseous natural gas and solid fossil fuels, indicating a decline in imports following REPowerEU of 90% for petroleum oils, 69% for gaseous natural gas and 100% for solid fossil fuels, relative to other countries. These reductions are largely moved by EU sanctions, including bans on Russian coal, crude oil and refined petroleum products. The fact petroleum oils did not experience a 100% reduction may be related to the temporary exemption for pipeline crude oil supplied to certain Member States that were highly reliant on Russian oil.

Interestingly, the coefficient for LNG is significant and positive, showing an increase of 345% in LNG imports from Russia post-policy. This highlights the high EU reliance on Russian LNG imports, and that it has not been able to reduce reliance on Russian gas after the war and the REPowerEU. This aligns with recent news of record-high Russian LNG imports to the EU in 2024 (Niranjan, 2025).

TABLE VII - Regression models estimation (Model 1 by product)

	(5)	(6)	(7)	(8)
Dependent variable:	ln_imports	ln_imports	ln_imports	ln_imports
Products included:	Petroleum Oils	Natural Gas Gaseous	Natural Gas Liquefied	Solid Fossil Fuels
Russia	5.424***	0.785***	9.727***	14.12***
	(12.30)	(4.77)	(13.07)	(32.31)
Post	1.114	0.413	1.917*	-1.193
	(1.62)	(0.59)	(2.26)	(-1.93)
Russia # Post	-2.306***	-1.182***	1.494*	-10.15***
	(-7.14)	(-3.78)	(2.25)	(-5.34)
Constant	17.50***	21.40***	8.323***	7.779***
	(28.37)	(63.80)	(9.40)	(13.00)
N	1922	371	501	1296
R-squared	0.836	0.891	0.752	0.824
p-value	.	.	.	.
Fixed Effects	Country, Time	Country, Time	Country, Time	Country, Time

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table VIII, which introduces the *alt_suppliers* dummy, reveals significant increases in imports of gaseous natural gas (319%) and LNG (110%) from alternative suppliers after the respective agreements, indicating some substitution away from Russian pipeline gas. The effects for petroleum oils and solid fossil fuels remain statistically insignificant.

TABLE VIII - Regression models estimation (Model 2 by product)

	(9)	(10)	(11)	(12)
Dependent variable:	ln_imports	ln_imports	ln_imports	ln_imports
Products included:	Petroleum Oils	Natural Gas Gaseous	Natural Gas Liquefied	Solid Fossil Fuels
Alt_Suppliers	0.874	1.432**	0.736*	-0.586
	(1.93)	(2.66)	(2.16)	(-1.23)
Constant	17.51***	21.17***	8.319***	7.984***
	(28.37)	(62.97)	(9.05)	(12.93)
N	1922	371	501	1296
R-squared	0.836	0.894	0.752	0.812
p-value	.	.	.	.
Fixed Effects	Country, Time	Country, Time	Country, Time	Country, Time

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table IX jointly estimates the impact of *Russia* x *Post* and alternative suppliers per product. The results are consistent with the previous two tables: imports from Russia declined significantly for petroleum oils (89%), gaseous natural gas (53%) and solid fossil fuels (100%), while alternative suppliers import significantly increased for gaseous (279%) and liquefied natural gas (144%).

TABLE IX - Regression models estimation (Model 3 by product)

	(13)	(14)	(15)	(16)
Dependent variable:	ln_imports	ln_imports	ln_imports	ln_imports
Products included:	Petroleum Oils	Natural Gas Gaseous	Natural Gas Liquefied	Solid Fossil Fuels
Russia	5.420***	1.006***	9.700***	14.21***
	(12.24)	(5.05)	(12.97)	(32.27)
Post	1.017	-0.0173	1.693*	-1.118
	(1.47)	(-0.02)	(1.98)	(-1.78)
Russia # Post	-2.221***	-0.753*	1.736*	-10.23***
	(-6.80)	(-2.26)	(2.54)	(-5.38)
Alt_Suppliers	0.831	1.332*	0.893*	-0.800
	(1.83)	(2.40)	(2.56)	(-1.68)
Constant	17.50***	21.16***	8.352***	7.691***
	(28.39)	(61.92)	(9.45)	(12.72)
N	1922	371	501	1296
R-squared	0.836	0.894	0.755	0.824
p-value	.	.	.	.
Fixed Effects	Country, Time	Country, Time	Country, Time	Country, Time

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Lastly, Table X disaggregates alternative suppliers dummy into country-specific variables, offering a more granular picture. For petroleum oils, the United States again stands out, with a significant positive coefficient, corresponding to an increase of about 139% in imports from the US after signing the energy agreement. Israel also shows a statistically significant increase in imports after the agreement (42,695%). In contrast, Egypt displays a significant decline in petroleum oil exports to the EU (64%). In gaseous natural gas, Azerbaijan shows a massive increase (2,951%), reflecting its rising strategic role as an alternative supplier post-agreement. For LNG, the US again shows a significant increase of 535%, while Israel exhibits a decrease of about 100%. In solid fossil fuels, Algeria surged by 86,423%, a figure likely driven by low baseline levels.

TABLE X - Regression models estimation (Model 4 by product)

	(17)	(18)	(19)	(20)
Dependent variable:	ln_imports	ln_imports	ln_imports	ln_imports
Products included:	Petroleum Oils	Natural Gas Gaseous	Natural Gas Liquefied	Solid Fossil Fuels
Russia	5.432^{***}	0.786^{***}	9.699^{***}	14.16^{***}
	(12.02)	(5.76)	(12.88)	(32.37)
Post	1.007	0.0678	1.674^{*}	-1.121
	(1.49)	(0.10)	(1.97)	(-1.78)
Russia # Post	-2.221^{***}	-0.771^{*}	1.735^{*}	-10.24^{***}
	(-6.74)	(-2.27)	(2.53)	(-5.38)
US	0.870^{**}	3.115	1.848^{***}	-0.220
	(3.24)	(0.94)	(4.30)	(-0.82)
Norway	0.249	0.408	0.833	-1.311
	(1.12)	(1.20)	(1.52)	(-1.93)
Egypt	-1.007^{**}	0.0431	0.473	-0.759
	(-3.18)	(0.05)	(0.59)	(-0.60)
Israel	6.059^{*}		-5.948^{***}	-3.437^{*}
	(2.50)		(-9.75)	(-2.40)
Azerbaijan	-0.425	3.418^{*}		2.381
	(-1.90)	(2.27)		(0.87)
Algeria	-0.231	0.505	0.206	6.763^{***}
	(-0.97)	(1.35)	(0.55)	(7.91)
Constant	17.51^{***}	21.32^{***}	8.368^{***}	7.741^{***}
	(28.53)	(65.01)	(9.46)	(12.85)
N	1922	371	501	1296
R-squared	0.838	0.899	0.756	0.826
p-value	.	.	.	.
Fixed Effects	Country, Time	Country, Time	Country, Time	Country, Time

t statistics in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

From this empirical analysis can be concluded that REPowerEU policy marked a pivotal shift in the EU’s strategy, aiming to reduce its dependence on Russian fossil fuels in response to geopolitical tensions and accelerate the transition toward a more secure and autonomous energy system. The empirical results presented confirm a significant decline in imports from Russia across various energy categories, including petroleum oils, gaseous natural gas and solid fossil fuels. The reductions in coal and petroleum oils were largely driven by EU embargoes: Russian coal imports were banned in August 2022, seaborne crude oil in December 2022 and refined petroleum products in February 2023. Notably, a temporary exemption was granted for pipeline crude oil supplied to certain Member States.

However, an increase in imports of LNG from Russia was observed, suggesting that despite the political intentions, certain forms of dependency remain, possibly due to logistical constraints or limited alternatives and mostly due to lower prices and more flexibility. This raises concerns about the EU's continued dependence on Russian energy and also its potential impact on climate goals.

At the same time, the EU intensified its trade relations with alternative suppliers, namely the US in petroleum oils and LNG, Israel in petroleum oils, Azerbaijan in gaseous natural gas, potentially facilitated by the SGC, and Algeria in solid fossil fuels. However, the increased imports from these alternative suppliers may reflect a shift in dependency rather than diversification, as the EU expanded trade primarily with existing partners to compensate for declining Russian supplies. These shifts indicate that while REPowerEU has had a tangible impact on reshaping the EU’s energy trade flows, the diversification process is still ongoing and influenced by complex structural and geopolitical factors.

6. Conclusion

The launch of REPowerEU in May 2022 represented a significant policy shift in the European Union's approach to energy security. Following the geopolitical shock of Russia's invasion of Ukraine, the plan aimed to end the EU's historical overreliance on Russian fossil fuels while accelerating the green transition and securing alternative sources of supply.

Using a panel dataset of EU energy imports and applying a DiD methodology, the analysis assessed the evolution of trade flows before and after the implementation of the policy. The focus was placed on both the contraction in imports from Russia and the expansion of trade with alternative suppliers with which EU signed energy agreements. The results provide evidence of a significant shift in the EU's external energy trade landscape following REPowerEU's launch.

First, the findings confirm a significant decline in imports from Russia in several energy categories. Most notably, Russian exports of petroleum oils, gaseous natural gas and solid fossil fuels to the EU fell sharply. The reduction in coal and petroleum oils were largely driven by EU embargoes, including bans on Russian coal, seaborne crude oil and other refined petroleum products, alongside a temporary exemption for pipeline crude oil supplied to certain Member States. In contrast, the decline in gaseous natural gas imports reflects the EU's commitment to reduce dependency on its dominant energy supplier, as no embargos on gas were imposed during the period analysed. However, the case of LNG represents a notable deviation, with the imports from Russia increasing after REPowerEU, suggesting a short-term substitution effect.

In contrast, this analysis identified increased imports from several key partners. The United States emerged as a major supplier, particularly of petroleum oils and LNG, reinforcing its role in transatlantic energy cooperation. Israel saw a notable rise in petroleum oil exports to the EU and Algeria increased its role in supplying solid fossil fuels. Additionally, there was an increase in gaseous natural gas imports from Azerbaijan, which may be related to the SGC, a strategic infrastructure project aiming to deliver Caspian gas directly to Europe. It is important to note that this increase does not necessarily indicate genuine diversification. Instead, it may represent a shift in dependence, as the EU expanded trade volumes with countries with which it already had established energy relations, primarily to compensate for the decline in Russian imports.

Despite these positive developments, the study has limitations that must be acknowledged. First, the short time frame following REPowerEU's implementation limits the scope of analysis to immediate responses, rather than longer-term structural changes, as energy infrastructure, contracts and supply chains evolve over time and the full effects of the policy may only become apparent in the following years.

Another limitation concerns the scope of the data, as it does not cover intra-EU trade or domestic production, meaning the findings are exclusively related to external trade reconfiguration. Additionally, while REPowerEU includes strong components related to renewable energy, efficiency and demand reduction, this study focused solely on fossil fuel trade flows, leaving this part of energy transition out of the equation.

Second, the use of the DiD methodology, while robust for estimating treatment effects, has inherent limitations when it comes to fully isolating the impact of a specific policy such as REPowerEU. The studied period was marked by overlapping global disruptions, including post-COVID recovery, supply chain turbulence and extreme volatility in global energy markets. Although fixed effects help control for many unobserved variables, it remains challenging to attribute causality solely to REPowerEU. Furthermore, the actual implementation of REPowerEU measures varies across Member States and the timeline of impact may differ depending on infrastructure, bilateral agreements or national energy strategies.

Future research could address these gaps in several ways. A valuable extension would be a longitudinal study using updated trade data over multi-year horizon to assess persistence and the magnitude of the diversification trend. Another path would be to assess whether REPowerEU has led not only to changes in suppliers but also to progress in energy efficiency, domestic energy production and energy savings. Another promising direction would be to analyse the geopolitical consequences of shifting dependency from Russia to other countries, considering both strategic opportunities and potential new vulnerabilities, particularly with regard to exporters who may not fully align with EU values or environmental standards.

In conclusion, this dissertation finds that REPowerEU has played a meaningful role in reshaping EU energy trade by reducing dependency on Russia and fostering supplier diversification. However, the transition is still ongoing and uneven across energy types. LNG imports from Russia remain a vulnerability and the long-term success of the policy will depend on sustained politics, infrastructure development and coordination among Member States. Moreover, the increased imports from alternative suppliers may reflect a shift in dependency rather than diversification, as the EU expanded trade with existing partners primarily to compensate for declining Russian energy supplies. These findings emphasize that achieving strategic autonomy and energy security is a complex, long-term process requiring sustained commitment and perspective.

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