Wind of change: the impact of REPowerEU policy reforms on gas security

Abstract

The Russian invasion of Ukraine was a shock to the EU gas market, as Russian gas supply dwindled and prices spiked. Previous exogenous shocks to the gas market resulted in policy reforms aimed at diversification and reducing dependency on Russian gas. However, their effectiveness was reduced. This study seeks to examine the policy changes under REPowerEU in light of gas security post-invasion. To examine this, three indicators - import dependency, diversification, and gas intensity – are used and examined the REPowerEU policy elements –reduced Russian gas, increased renewables and energy efficiency targets, gas storage requirements, demand reduction and a joint purchasing mechanism. This preliminary analysis highlights similarities in approaches, but also find that the severity of the crisis contributed to more support. The early effectiveness of the policy reforms is questioned, as change appear driven by other factors, such as decisions made by Russia and high gas prices.

Keywords: energy policy, natural gas, diversification, European Union, Ukraine, energy security, exogenous shocks

Introduction

The outbreak of the war in Ukraine represented an exogenous shock to the European energy system and had far-reaching consequences for its gas sector with supply uncertainty and price hikes. Since the invasion, LNG imports have skyrocketed and Russian pipeline gas imports have been reduced (Eurostat, 2023b; IEA, 2022b). Shortly after the invasion, the European Union (EU) proposed its REPowerEU plan, which included numerous policy reforms, such as gas demand reduction and renewable energy targets. Although Kuzemko, Blondeel, Dupont, and Brisbois (2022) and Vezzoni (2023) have addressed the implications of REPowerEU, they have not done so from a gas security perspective. This study aims to fill this void through a preliminary analysis of the policy elements in gas, using gas import dependency, diversification and gas intensity. In sum**,** it seeks to examine the policy changes related to gas security post-invasion.

This study is organized as follows: first, three exogenous shocks to the EU gas market are discussed to provide an overview of how they have impacted policy. Second, three gas security indicators are introduced and operationalised. In the third section, the indicators are applied to the period 2000-2022 and five policy measures from REPowerEU, as well as a few national reforms, are discussed in the aftermath of the invasion. Finally, a discussion and the outcomes of this study are provided. Before continuing, it is important to note that the EU is examined as a whole. The gas market is too interconnected to examine individual countries or even regions within the EU.

Responses to past exogenous shocks on the EU gas market

In the past, exogenous shocks have influenced energy markets and elicited diverse policy responses. This section explores three shocks - 1) 2006 supply disruption, (2) 2009 supply disruption, and (3) the annexation of the Crimea - and measures at the EU level, and focuses on the EU-Russia gas relation. This means that, for example, the oil shocks, hurricanes Katrina and Rita, and the COVID-19 demand shock are not included, and neither are the EU-Russia nuclear or oil relations.

On the first of January 2006, Gazprom cut off supply to Ukraine, which also impacted gas deliveries to EU countries. Hungary reported a 40% loss in gas deliveries in the following days, while Austria,

Slovakia and Romania announced a one-third drop in gas supplies in the middle of winter (Stern, 2006). Similarly, in January 2009, Russian gas deliveries were halted when Russia and Ukraine failed to reach a new agreement on gas transit. Gazprom promised to continue gas deliveries to Europe, but days later, Russia accused Ukraine of stealing gas and terminated deliveries completely (Stern, Pirani, & Yafimava, 2009). Twelve EU countries were impacted. Bulgaria and Slovakia lost their only source of gas. These supply disruptions were brief, as gas flows were restored within four and twenty days respectively.

Both supply disruptions necessitated national measures and included temporary gas conservation. These measures were localised in the impacted countries, such as Croatia and Bulgaria (Kaderják, 2009). Practically, this meant that large gas consuming industries were disconnected from the gas grid. However, this was not the only measure. For Bulgaria, the shock resulted in the construction of an interconnector between Bulgaria and Romania, in order to secure other routes of imports (Maltby, 2015). Still, Bulgaria remained on good standing with Russia and supported the construction of the Gazprom pipeline South Stream, later redesigned into TurkStream. Poland had been hawkish towards Russian gas supply even before the 2006 supply disruption (Judge & Maltby, 2017). In line with this anti-Russia position, the construction of the Świnoujście LNG terminal started shortly after the 2009 gas disruption. Hungary, which is known for its close ties with Russia, was heavily impacted by the disruptions, but continued its energy relation with Russia. In March 2009, it approved the expansion of the nuclear power plant Paks, awarding the contract to Russian Rosatom, It also supported Russian gas projects in the region (Aalto, Nyyssönen, Kojo, & Pal, 2017; Jirušek, 2020).

At the EU level, these crises were a wake-up call. The Commission pushed for a more comprehensive energy policy, while citing dependency on Russian gas as a major threat (Judge & Maltby, 2017; Natorski & Surrallés, 2008). The idea that energy needed to be left to the market, which was pushed in the 1990s and early 2000s, was replaced by more geopolitical approach (Casier, 2011). The third gas directive, which was negotiated in 2007 and enter into force in 2009, was influenced by the increased dependency on Russian gas caused by the eastern expansion and concern following the 2006 disruption. The directive included the so-called "Gazprom-clause" that stipulated that gas infrastructure could not be owned or operated by the producer or supplier (Boussena & Locatelli, 2013). In addition, there were proposals for a common energy policy, but they failed to materialize because of the short interruptions and the localized impact (McGowan, 2011; Natorski & Surrallés, 2008). Instead, the EU promoted route and supplier diversification through priority projects, later called Projects of Common Interest (PCI). These projects could benefit from permitting advantages and loans via the EU. Examples include the failed Nabucco pipeline project from Central Asia to Austria, as well as the Southern Gas Corridor's Trans Adriatic Pipeline supplying gas from the Greek-Turkish border to Italy (Baev & Øverland, 2010; European Commission, 2013). The EU also supported interconnectivity between EU countries to increase security of supply. The Bulgarian-Romanian interconnector is an example of this.

However, this EU pursuit for diversification and a preference for non-Russian gas was not followed by all member states. Many were not impacted by the disruptions, and Italy, the Netherlands, Germany, France, and others were more inclined to strengthen national energy policies. Germany notably continued to support new Russian gas projects, such as the Nord Stream project which was commissioned in 2011-2012 (Siddi, 2019). Also, the South Stream project could count on substantial support from Hungary and Italy (Natorski & Surrallés, 2008).

Half a decade later, the Russian annexation of the Crimea and the Kremlin-backed insurgency in Donbas did not have an impact on Russian gas imports, but it did result in a more security-based energy perspective (Szulecki & Westphal, 2018). In response to the annexation, the EU imposed

sanctions targeting the Russian oil industry. Additionally, the European Commission used its regulatory powers to impact the functioning of OPAL, an EU pipeline owned by Gazprom (Council of the European Union, 2014; Goldthau & Sitter, 2015). At the same time, the EU continued its support for the development of non-Russian importing infrastructure, for example the LNG Gdansk (Poland), Shannon LNG (Ireland), and Krk LNG (Croatia) (European Commission, 2019). The tripartite pipeline project Southern Gas Corridor, which was already under construction, received new impetus after the annexation.

Following the annexation, the European Energy Union was accepted, which aimed to strengthen the energy policy through energy security, internal market integration, energy efficiency and decarbonization (Szulecki, Fischer, Gullberg, & Sartor, 2016). However, the original proposal of the Unio also included measures that were rejected, such as a common gas purchasing mechanism (Zachmann, 2015). Besides the Energy Union, the EU managed to increase its role in intergovernmental agreement (IGA) negotiations between member states and third countries. Not only did this expanded the EU's competences, it also ensured that IGAs signed with Russia complied with EU regulations (Thaler & Pakalkaite, 2020). In 2019, the Commission managed to extend its regulatory hold over pipelines between EU countries and third countries through amendments to the gas directive (de Jong & Van de Graaf, 2021). Both actions were designed to curb the influence of Russia on the EU gas market.

At the national level, efforts to move away from Russian gas were taken. In 2014, the Floating Storage and Regasification Unit Independence arrived in Klaipeda, Lithuania. A gas connector between Estonia and Finland, the Balticconnector, was built in the years following the annexation. The Baltic pipe, a gas pipeline between Norway and Poland, took shape in this period, although the project was originally proposed in 2007. The same applies to the gas interconnector between Greece and Bulgaria, which was planned before the annexation, but construction started afterwards.

Still, not all EU countries shared this anti-Russia attitude and even expanding gas relations with the gas producer (Casier, 2020). Germany, Austria, Italy, Hungary, and others continued business as usual in the aftermath of the annexation. Germany and Austria supported the construction of Nord Stream 2, while Bulgaria facilitated the EU connection of TurkStream via its territory. The Netherlands, which lost almost 200 citizens in the MH17-disaster above Donetsk, was also keen on keeping its energy relation with Russia intact in light of the dwindling Groningen gas production (NOS, 2023).

In all three shocks there was a discrepancy between EU countries' responses, which can be explained by a few factors. First, not all countries were impacted by the disruptions, because their dependency on Russian gas varied. Some countries were 100% dependent on Russian gas via Ukraine, others imported it via Belarus (Yamal) or in minimal quantities and there are also countries that importing zero Russian gas (e.g. Spain). Second, EU countries had their own national energy policies, favouring different energy sources and different suppliers. For example, France had developed a strong nuclear sector following the 1973 oil crisis, the Netherlands heavily leaned on gas after the discovery of the Groningen gas field, and Poland based its energy sector on its coal reserves. Many eastern EU countries relied, and still rely, on a vast gas network from Russia, which dated back to Soviet times. They were influenced by path dependency, as their gas infrastructure (e.g. power plants or gas boilers) made switching to other sources or suppliers costly. Third, EU countries consumed vastly different quantities of gas. Bulgaria has the smallest gas consumption with 3.4 bcm, while Germany and Italy consumed 95 and 86 bcm in 2006 (Eurostat, 2023c). Both Germany and Italy had national energy champions (e.g. ENI, Uniper and Wintershall) that helped fostered a privileged relation with Russia (Natorski & Surrallés, 2008; Schmidt-Felzmann, 2011). Fourth, liberal countries preferred to leave

market issues to private companies, instead of taking a more state-led approach. This liberalized approach was pushed by the EU through the gas directives.

However, it were not only these factors that drove this divergence. Siddi (2019) highlighted that identity perspectives contributed to the differences in Polish and German attitudes towards Russia. Poland, and also the Baltic States, viewed Russian gas as undesirable for historic reasons, while Germany saw energy as a tool to foster cooperation with and democratisation of Russia, so-called Ostpolitik (Gens, 2019).

Finally, the role of the EU needs to be addressed. Currently, the EU has shared competences in energy. Before 2009, the EU lacked formal competences and used its competition powers to organize the internal energy market. The 2009 Lisbon treaty provided shared competences in the energy domain between member states and the EU. The EU countries remained in charge of their energy mix. This meant that they remain free to choose their own energy sources (e.g. oil, coal, gas, nuclear) and their suppliers. This continues to provide for some interesting dynamics between the EU and its members. Since 2009, the EU has managed to expand its competences which impedes on the powers of the countries (see Gazprom-clause, IGA expansion and the amended gas directive).

In sum, after each shock, the EU attempted to developing a joint policy response by promoting diversification in order to reduce dependency on Russian gas and used regulatory tools to limit the power of Gazprom on the internal market. However, these EU policy endeavours were limited by the shared competences in energy, and they were undermined by the national preferences of some to continue Russian gas imports. On the national level, temporary gas savings policies were imposed and some countries diversified their gas supply by building interconnectors and LNG terminals.

Methodology and data

Three indicators are used to highlight changes in the gas relation post-invasion. There is an abundant literature on indicators for energy, or gas, security (see for example Månsson, Johansson, and Nilsson (2014), Ang, Choong, and Ng (2015), Bompard et al. (2017), and Kruyt, van Vuuren, de Vries, and Groenenberg (2009)). For this study, three indicators are selected based on this literature and in line with the research objective - to assess policy changes in relation to gas security post-invasion. The quantitative indicators are combined with a qualitative assessment, which has previously been done by Vivoda (2010), Checchi, Behrens, and Egenhofer (2009) and Brown, Wang, Sovacool, and D'Agostino (2014).

The first is import dependency. This indicator is frequently used (see for example Jansen, Arkel, and Boots (2004), Berk and Ediger (2018), Martchamadol and Kumar (2013) and Gupta (2008)). For this study, import dependency is relevant, as it can highlight increased or decreased vulnerability. This indicator reflects the share of gas consumption that is imported.

The second indicator is diversification. Risks can be minimize by diversification (i.e. having more equal market players) (Augutis, Krikštolaitis, Martišauskas, Pečiulytė, & Žutautaitė, 2017; Berk & Ediger, 2018; Duan & Wang, 2018; Frondel, Ritter, & Schmidt, 2012; Gupta, 2008; Jewell et al., 2013; Vivoda, 2019, 2022). This indicator can highlight how gas supplies have changed. A simplistic version of diversification is the higher number of suppliers the safer. However, this does not address differences in volumes supplied. Therefore, for this indicator, the Herfindahl-Hirschman index (HHI) is used. HHI is a frequently used tool to examine the supply concentration of a market (Pavlović, Banovac, & Vištica, 2018; Rodriguez-Fernandez, Carvajal, & de Tejada, 2022). The formula for calculating the HHI is:

$$HHI = \sum_{i=1}^{I} \rho\iota^2$$

The numerical outcome of the HHI is subsequently linked to a qualitative value. As can be seen in **Error! Reference source not found.**, a lower score is indicative of a more diversified market.

Table 1: Level of diversification as measured by HHI

1.000–0.666	Highly concentrated
0.666–0.444	Concentrated
0.444–0.222	Neither concentrated nor diversified
0.222–0.111	Diversified
0.111–0.000	Highly diversified

Source: Vivoda (2022)

Admittedly, the HHI does not reflect any route diversification (there are multiple routes for Russian, Norwegian and even Algerian gas to the EU, which also have different capacities), transit risk (e.g. Ukraine, Tunesia, Turkey, and Georgia), or differentiation between LNG versus piped gas. The reason for opting for a more simplistic and broadly accepted indicator is to highlight overall changes, as the objective of this study is not to develop a comprehensive new indicator. However, by adding a qualitative analysis some of these more complex issues can be addressed.

The third indicator is gas intensity. This is the amount of gas needed to produce one unit of economic output. So, the volume of gas (cubic metres) needed to produce one Euro worth of products. This indicator is also rooted in the research on energy indicators and has been used by Cabalu (2010), Gnansounou (2008), World Energy Council (2009) and others (Martchamadol & Kumar, 2013; Radovanović, Filipović, & Pavlović, 2017; Sovacool & Mukherjee, 2011). This indicator can provide information on how gas dependent a country, or region, is. A higher gas intensity will indicate its importance for society and the economy. Changes in the gas intensity can indicate structural changes to the energy system, that can make the energy system more secure.

Eurostat (2023a, 2023b, 2023c) is used as the main data source for these indicators. For the policy changes post-invasion, press releases and documents from the EU-institutions and national governments, as well as news reports are used.

Results

The results are divided into two sections: gas security based on the indicators between 2000-2022 and policy measures.

Gas security

Net import dependency

Import dependency has increased, as presented in Table 2. Over the years, domestic gas production has dropped with the closing of the Groningen gas field and the aging of other fields, making the EU more import dependent. In contrast, consumption has only increased. This increase is partly caused by the gas industry promoting gas as a transition fuel in the energy transition. For example, gas is to assist Germany in the phasing out of its coal and nuclear fleet.

Table 2: Import dependency, 2000-2022

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009

Import dependency	65%	63%	67%	68%	68%	73%	74%	72%	75%	75%
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Import dependency	74%	76%	69%	70%	74%	76%	77%	75%	71%	76%
	2020	2021	2022							
Import dependency	76%	77%	98%							

Source: Eurostat (2023b)

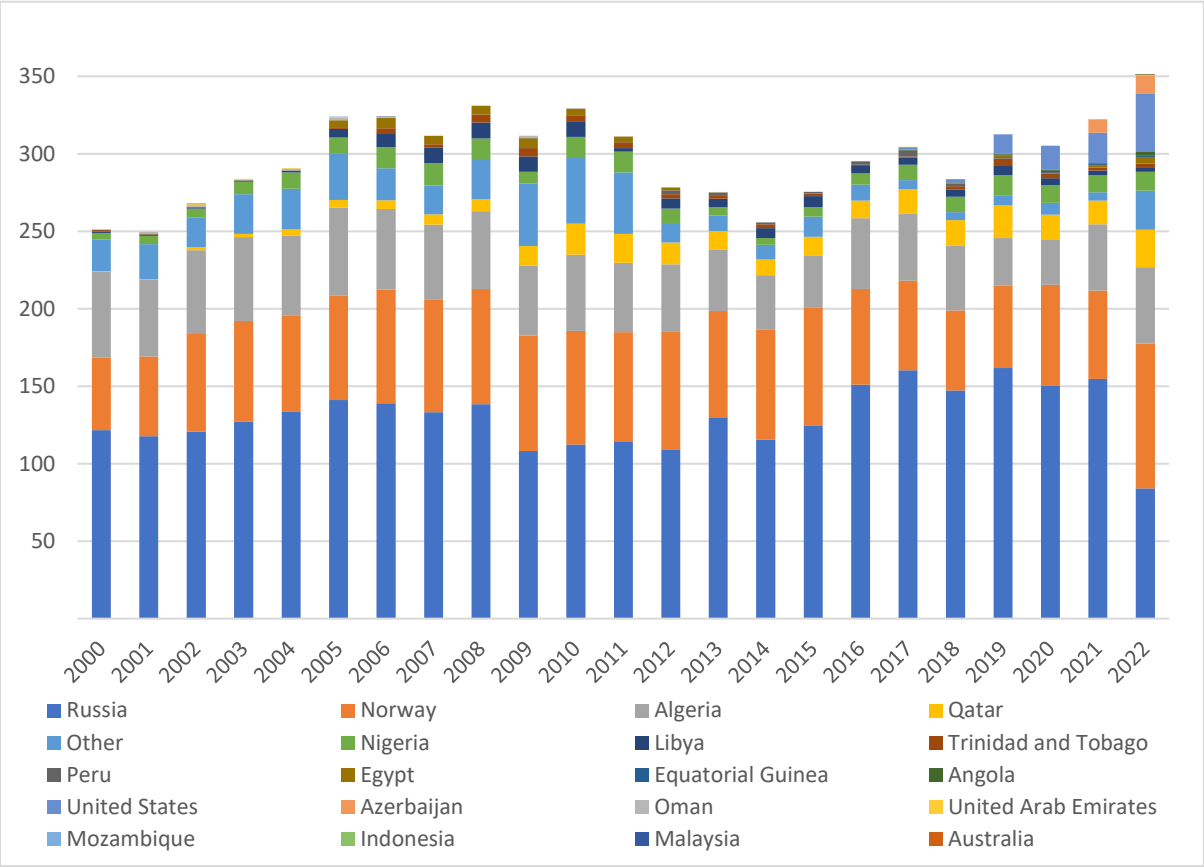
The previous crises and policy changes did not result in significant changes in import dependency. This can possibly be explained by the localized impact of the past crises. 2022 shows a significant increase. While gas consumption dropped by 14.3%, gas imports increased. This increase can be explained by the reduced deliveries from Russia in 2021, as Gazprom only supplied contractually obligated volumes. This meant that EU gas storages were emptier than usual in early 2022 and more gas was needed to fill them up. The high imports are also related to the new legal requirement to fill gas storage to 80% by the first of November (European Council, 2022). This forced companies to buy gas even if prices were high.

Diversification

EU gas imports have originated from more countries, as can be observed from Figure *1*. The number of suppliers increased from ten to eighteen. This increase can be attributed to the actions of the EU and some EU countries which were discussed in the previous section. For example, Azerbaijani gas reached the EU via the Southern Gas Corridor in 2020 and the construction of LNG terminals across the EU provided supply opportunities from geographically distance producers, such as Qatar, Nigeria, Australia, Angola, Malaysia, and Indonesia. In 2018, the US started exporting LNG, adding another player to the EU's expanding gas portfolio. However, despite the EU and national efforts to diversify, Russia remained the dominant supplier and by 2022 had four major networks delivering gas to the EU: Ukraine, Yamal, Nord Stream and TurkStream.

Figure 1: Gas imports of the EU per supplier, 2000-2022, in bcm[1]

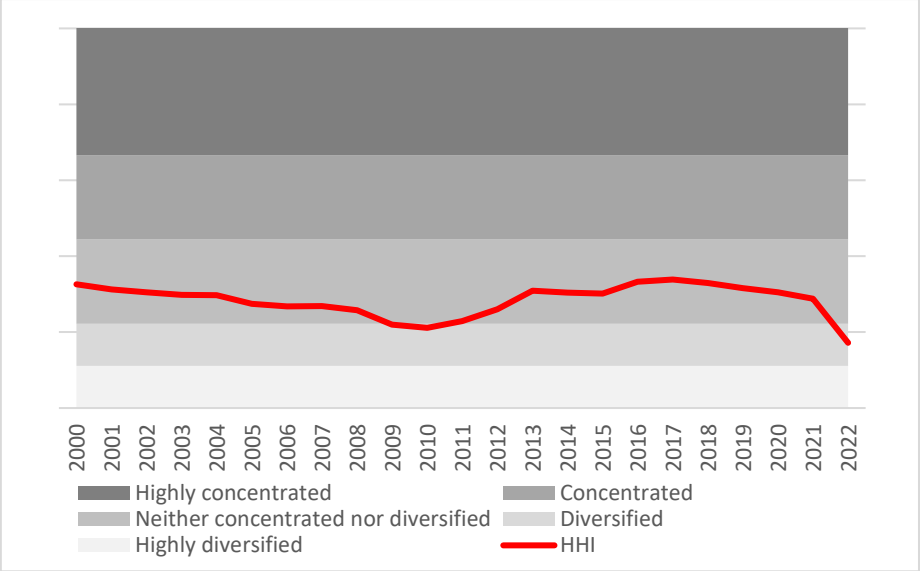
[1]The intra-EU trade is not included, as this includes re-exports. Examples of re-exports are Switzerland. The re-exports from the United Kingdon (United Kingdom and Gibraltar) are added under "other", as this is gas from different suppliers. Azerbaijan is the combined volume of Azerbaijan and Turkey (transit country). Likewise, Algeria and Tunisia (transit) to represent the cumulative volume of gas from Algeria and Russia is the cumulative of Russia, Moldova, Belarus, Ukraine.



Source: Eurostat (2023b)

The HHI hovered between diversified and concentrated, see Figure 2. The EU's diversification efforts are not reflected in this figure. In 2009 and 2010, gas imports become "diversified", as well as in 2022. In 2009 and 2010, Russia supplied less gas, which can be attributed to the gas shock of 2009. Instead, Oman, Equatorial Guinea and Qatar delivered more gas. In addition, the economic crisis can be considered an attributing factor in the reduced consumption of gas and the relative increased importance of the other suppliers. After 2010, the HHI became more concentrated, as EU countries remain largely dependent on a few large gas producers, e.g. Russia and Norway.

Figure 2: HHI, 2000-2022



Source: author's own, based on data from Eurostat (2023b) and Vivoda (2022).

In 2022, the HHI became "diversified" again, which can be attributed to a drop in Russian imports. Flows via the Yamal and Nord Stream pipelines were halted and the supplies via the Ukraine route were reduced for political reasons by Russia. The drop in Russian gas was offset by piped gas from Norway and Algeria, and the rapid rise of LNG imports, including LNG from Russia. This rise of LNG was assisted by the high gas prices and the spot market for LNG, which allowed EU countries – companies – to buy sufficient volumes. This resulted in a changed gas portfolio with more equal market shares, and hence a better HHI. However, this shift from piped Russian gas to more LNG comes with its own set of vulnerabilities. The EU is now more dependent on the global gas market. Concretely, this means that the EU might experience more price fluctuations, as became evident when strikes in Australian LNG terminals were announced (Reuters, 2023a). Also, the EU will also become more dependent on international bottlenecks (e.g. the Strait of Hormuz) and geopolitical hotspots for its LNG. The HHI does not reflect this.

Gas intensity

Table *3* illustrates that gas intensity has dropped over the last two decades. This is mainly caused by climate ambition and renewable deployment. In the aftermaths of the 2006, 2009 and 2014 crises, no significant drop is detected. On the contrary, in 2010 gas intensity temporarily increased; the winter of 2009-2010 was colder than usual (Cattiaux et al., 2010). This absence of impact is probably related to the short duration and the localized effect of these crises, as well as the fact that no fuel-switching took place. The most notable drop in gas intensity happened in 2022. High gas prices resulted in reduced gas consumption, as citizens lowered thermostats and explored alternative ways of heating their homes. Also, fuel-switching – removing production restrictions on coal-fired power plants in France and the Netherlands – contributed to this drop in gas intensity (IEA, 2022a). Although questions can be asked if this gas-to-coal switching is good for our climate ambition and whether this represents any structural change. The 2022 drop was driven by behavioural changes and not by changing the heating or electricity generating infrastructure.

Table 3: Gas intensity, 2000-2022, cubic meter/Euro

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Gas intensity	0.0487	0.0482	0.0467	0.0475	0.0466	0.0462	0.0435	0.0404	0.0398	0.0392

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Gas intensity	0.0406	0.0361	0.0352	0.0342	0.0295	0.0296	0.0304	0.0312	0.0295	0.0294
	2020	2021	2022							
Gas intensity	0.0297	0.0287	0.0226							

How has the EU responded?

For gas security, the past crises did not have a significant impact, but the 2022 crisis showed significant changes. In response to the invasion, the EU has proposed many measures via REPowerEU. Also, embargoes were implemented against Russian coal imports and oil imports, although admittedly some piped Russian oil imports are exempted. No gas or nuclear embargo was imposed. Some of the EU's REPowerEU policy responses - phasing out of Russian gas, a joint gas purchasing platform, increased renewables and efficiency targets, gas storage requirements, and gas consumption reduction - are discussed considering the indicators and the previous crises. Obviously, these are not the only measures taken on the EU-level. Besides these measures, the EU approved state aid, windfall profit taxation and a contentious price cap for gas.

One month after the invasion of Ukraine, the EU announced its intention to phase-out Russian gas by 2030 and to reduce Russian gas imports by two-third at the end of 2022 (European Commission, 2022). The EU's anti-Russia stance also characterized the previous crises, although this did not result in a reduction of Russian gas. This 2022 policy objective was however achieved, but not because of Brussels. It was Moscow who reduced flows, and it were the EU countries that started a panicked global search for alternatives. While the EU has signed six gas deals since the start of the invasion, the EU countries have 55 deals inked (ECFR, 2023). Hungary even made a new deal with Russia. Questions can be asked if EU countries would have switched as quickly if Russian gas flows had continued. It remains to be seen if all EU countries will, and want to, halted Russian imports by 2030. Hungary, for example, makes no secret of its desire to continue Russian gas imports. The import of Russian LNG is considered a major issue. Energy Commissioner Kadri Simon called for restrictions on them, but currently, there are no regulations that prohibit Russian gas imports (piped or liquid) (Reuters, 2023b).

Towards the end of 2022, a joint purchasing platform, called AggregateEU, was approved (European Commission, 2022). AggregateEU is part of the diversification effort and move away from Russian gas. It facilitates the purchase of 15% storage capacity by acting as a connector between buyers and non-Russian sellers. AggregateEU is not involved in the negotiations and there is no obligation to reach an agreement. A similar mechanism was proposed after the annexation of the Crimea, but there was insufficient support for this mechanism as EU countries preferred to remain in control (Zachmann, 2015). Currently, the impact of AggregateEU on diversification is uncertain, but the non-obligatory nature and the small share of gas suggest a limited one. Still, the Commission's Vice-president Šefčovič has called the platform "a remarkable success" (Šefčovič, 2023).

The war in Ukraine also contributed towards higher renewables and energy efficiency targets, which can help reduce gas intensity. The EU accepted a new 42.5% renewables target (previous target was 32%) and an energy efficiency target that involved 11.7% less energy consumption than projected by 2030 (previously the target was 9%) (European Commission, 2023; European Parliament, 2023b). While the EU already had renewables and energy efficiency targets, the invasion and its consequences increased its ambition (Giuli & Oberthür, 2023). Renewables can substitute gas for electricity production, for heating (through heat pumps) and for cooking, and should thus reduce gas intensity level by 2030. Currently, these structural plans are not yet reflected in the data. In combination with

these targets, the EU has also accepted legislation to accelerate renewables deployment (European Parliament, 2023a). During previous crises, the renewable and energy efficiency targets were not increased, although the Energy Union did mention decarbonisation and energy efficiency. The focus appeared to be more on diversification and interconnectivity. This current addition of renewables and energy efficiency policies can be linked to the climate crisis.

After the invasion, the gas storage regulation was accepted. Although this is unlike to have an impact on the three indicators, it should make gas consumption more secure in winter months when gas demand is the highest. Gas storage needed to be at least 80% full before the first of November 2022 and for 2023, this target was increased to 90% (European Council, 2022). Both times the requirement was met. This storage rule is a direct reaction to the war in Ukraine and gas security concerns. The requirement obligates European companies to procure gas during summer months, even if gas prices are elevated. There was a fear that private companies would refuse to buy expensive gas to fill storages and hence would increase the likelihood of shortages in winter months. This storage requirement is accompanied by a solidarity mechanism, as member states do not have similar storage capacities. For example, Belgium only has gas storage capacity for twelve days, while Austria has a storage capacity of half its annual consumption. It is unlikely that without EU regulations storages would be filled by these high percentages in 2022 and 2023. Previous crises did not result into storage requirements.

In addition, the EU set a voluntary target to reduce gas consumption by 15% between August 2022 and March 2023. A mandatory reduction did not receive sufficient support from EU countries, but remained an option after consultation in the European Council (Taylor, 2022). This voluntary measure was imposed because of concerns for gas shortages (Reuters, 2022). This temporary measure has been extended for another year from April 2023 to March 2024, as experts continue to warn for potential gas shortages in the winter of 2023-2024 (Abnett, 2022; European Council, 2023). This measure is meant to reduce gas intensity and put less strain on gas imports. The intensity indicator shows that for 2022 this was reduced. This reduction was achieved because of high prices and it remains to be seen if similar results can be reached without them. For the crises of 2006 and 2009, this was not an option as their impact was localized and limited in time.

National measures

National measures were also taken. Unfortunately, the scope of this study does not allow for an extensive analysis of national measures, so only a few are addressed here. The most significant policy break came from the Germans and their Ost- and Energiepolitik. They had stanchly continued their Russian piped gas deals, such as the Nord Stream 2 project, after the other crises (Siddi, 2016; Stent, 2022). Despite being the largest gas consumer in the EU and one of the wealthiest member states, Germany did not have an LNG terminal and had made minimal efforts to diversify its gas supply, unlike its neighbour Poland. The war in Ukraine forced a pivot to LNG. Within months, five LNG importing terminals were proposed: three floating and two onshore, with a total capacity of more than 30 bcm (Gas Infrastructure Europe, 2023). Three of which are currently operational. German chancellor Scholz embarked upon international visits to Qatar, United Arab Emirates, Senegal, Canada and US in order to secure LNG (Brower, Sheppard, & Tani, 2023; Dennison, Piaskowska, & Zerka, 2023). This switch to LNG represents the end of a policy era for Germany.

However, this pivot for non-Russian gas also occurred in other countries. Italy, a large consumer of Russian gas, reached out to Algeria, Azerbaijan, Libya, Qatar, Congo, Angola and Mozambique for (more) gas supplies (AP News, 2022). Paris contacted the governments of Algeria, Qatar, and UAE for gas deals. Lithuania and Latvia signed a deal for Norwegian LNG. This scramble was successful in

ensuring that there were no shortages in the EU. Yet, it lacked coordination between EU countries, or better said companies, which meant that they were in direct competition with each other and driving up prices. The AggregateEU platform (cf. supra) was created in part to minimize this intra-EU competition.

Furthermore, the construction of new onshore LNG importing terminals and renting of floating storage and regasification units (FSRU) boomed. One month after the invasion, the Dutch Gasunie signed a 5-year deal to rent a FSRU (GasUnie, 2022). Finnish Gasgrid Oy signed a 10-year contract to rent the FSRU Exemplar, while Italian SNAM purchased Golar Tundra (GasGrid, 2022). These are just a few examples of newly proposed LNG infrastructure projects approved by national governments post-invasion.

In Bulgaria, a tax was levied on Russian transit gas, in line with EU plans to reduce Russian gas imports (Dunai, 2023). This tax is a break of Bulgaria's mild position on Russian gas projects in the past. This tax was not well-received in Hungary, pro-Russian country. The Central European country has reaffirmed its commitment to Russian gas since the invasion.

More national measures were taken, such as energy tax reductions, providing fixed or variable compensation to gas consumers, or reducing energy prices for low-income households.

Discussion

Conclusions can be drawn between previous shocks and the policy consequences of the war in Ukraine. Similar to the previous crises, the EU continued to push for diversification and less Russian gas imports but was more successful this time. The 2022 crisis and the other crises differed in impact and length, which appeared to impact the willingness for common solutions. Previous crises were limited in duration and in scope. The 2022 energy crisis had a broad, and continuing, impact on gas supply. This helped shift policies in Germany, Austria, Italy, and others which had previously maintained a positive position on Russian gas. During past crises, they undermined the effectiveness of EU diversification efforts by promoted the construction of new Russian pipelines. The gravity of the situation, combined with the interconnectedness of the gas market, provided the EU with a window of opportunity to push for common policy measures that usually would be rejected. The gas purchasing mechanism AggregateEU is the clearest example of this, as a similar platform, part of the Energy Union, was rejected in 2017. Crises thus appear to contribute to the advancement of the EU energy policy, if their impact is broad enough.

Questions can be asked if the changes in the security indicators are caused by the REPowerEU policies, or other factors. The filling of gas storage to 80% and 90% can clearly be attributed to the EU's actions, although this does not have a direct impact in the indicators. The improved HHI can be attributed to the actions of Russia and national endeavours to find non-Russian gas supplies. The involvement of the EU is minimal. There are no regulations that prohibits the import of Russian gas (piped or liquid) currently or in the near future, and Hungary continues to support Russian gas. In the future, Russian piped gas can unknowingly be imported via Azerbaijan or Turkey, as both countries provide connections to the EU and have connections to Russian gas networks. This potential policy leakage will be difficult to solve if the EU remains indirectly connected to the Russian gas network.

The improved HHI is also driven by the extreme and unique market situation in the EU and on the LNG spot market. LNG from Malaysia, Indonesia, Mozambique, and Australia usually does not reach the EU market, but high gas prices made it profitable to ship LNG over these long distances. At the same time, the US had been expanding its LNG producing capacity and was thus able to deliver more in 2022. Also, for some of the other policy reforms, the direct impact can be questioned. Gas consumption

dropped, but this was because gas became unaffordable for many households and industry reduced or halted production because it was no longer economically viable. Gas consumption did not decrease because the EU made it a voluntary target. It will therefore be interesting to see of a similar reduction is achieved in 2023.

However, it is also too early to suggest that these policies were ineffective. Some of them will require more time to become visible in the data, such as gas intensity. The increased renewables and efficiency targets will substitute gas consumption and structurally bring down gas intensity over time.

Furthermore, questions can be asked if the HHI provides a realistic representation of the importing situation. The HHI does not consider different importing pipelines from a single origin country or considering the increased dependency on LNG transit routes (e.g. Suez Canal, Strait of Hormuz, or Strait of Bab al-Mandab). In that regard, it does reflect potential risks to gas imports. The sabotage of the Nord Stream pipelines, and more recently the Baliticconnector, indicates that imports remain vulnerable. The qualitative addition to the HHI provides room to discuss this.

Conclusion

This study sought to examine the REPowerEU policy reforms related to gas security post-invasion. In doing so, three crises in 2006, 2009 and 2014 and their policy changes were discussed. Next, a three-indicator method was used to assess the EU's gas importing portfolio from 2000-2022. The findings revealed that the crisis has helped the EU become more diversified, more import dependent and less gas intensive following the invasion of Ukraine, but not after the previous crises. It is worth noting that the positive changes in gas security - diversification and gas intensity - were not necessarily achieved through these policy measures. It was either market factors (e.g. high prices) or political actions taken in Moscow that forced citizens and companies to reduce their gas consumption and look for gas elsewhere. The higher dependency can be explained by the unique market situation preceding the invasion, which impacted its import dependency.

This study provided a preliminary assessment of the policy changes and gas security implications of the war in Ukraine. Currently, it is too soon to indicate whether the discussed measures have actually positively impacted gas security of the EU, as other factors appear to have played a role (e.g. decisions of the Kremlin and high gas prices). In the future, more comprehensive conclusions can be draw from the crisis and its many policy measures. The three-metric index employed in this study effectively captured the changes in the EU's gas importing portfolio and gas security following the war in Ukraine. However, the method does have its limitations, as it does not allow to examine individual member states. To address this issue, a more extensive set of indicators that includes intra-EU gas infrastructure might solve this issue, although the interconnectedness of the EU will make this difficult.

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