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POLICY ANALYSIS OF THE GERMAN GAS STORAGE LEVY AT CROSS-BORDER POINTS: IMPLICATIONS FOR FLOWS, PRICES, AND REGIONAL MARKET INTEGRATION

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ABSTRACT. This paper examines the German Gas Storage Levy (Gasspeicherumlage, GSU), enacted in response to the 2022 energy crisis that followed Russia's invasion of Ukraine. By requiring Trading Hub Europe (THE) to inject substantial gas volumes into storage at soaring prices and then recoup costs via a levy, Germany effectively secured sufficient storage levels to avert a winter supply emergency. However, the application of the levy to cross-border flows provoked legal and political tensions with neighbouring member states, who argued that the measure undermined EU market integration and energy solidarity principles. Through legislative analysis, market data breakdown, and econometric testing, this paper shows how the GSU reshaped cross-border gas flows, created structural price breaks above certain levy thresholds, and ultimately forced a rollback of the charge on exports. The study concludes that while the GSU was successful in securing Germany's gas supply, its unintended regional consequences highlight the need for a coordinated EU-level approach to crisis responses and cost recovery mechanisms.

Keywords: gas storage levy, energy security, energy crisis, cross-border flows, market integration, energy solidarity, EU gas markets, CEE gas markets

Introduction

The German Gasspeicherumlage (gas storage levy, or GSU) was introduced in 2022 as a response to an unprecedented energy crisis that reverberated across Europe. Russia's invasion of Ukraine severely disrupted long-standing gas supply patterns, and Russian deliveries previously covered approximately 40% of the gas demand prior to the conflict. Germany, in particular, faced heightened risks because Russian imports traditionally satisfied more than half of its annual consumption, averaging around 1,800 GWh/day in the first half of 2022 (Bundesnetzagentur, 2023). When wholesale gas prices increased, as shown in Figure 1, from an average of €25-30 per MWh in winter 2021 to more than €120 per MWh in the first half of 2022 due to gas flow disruptions from Russia and depleted storages, German legislators raced to secure adequate storage levels, recognising that insufficient inventories could potentially compromise both industrial production and residential heating in the upcoming winter seasons.

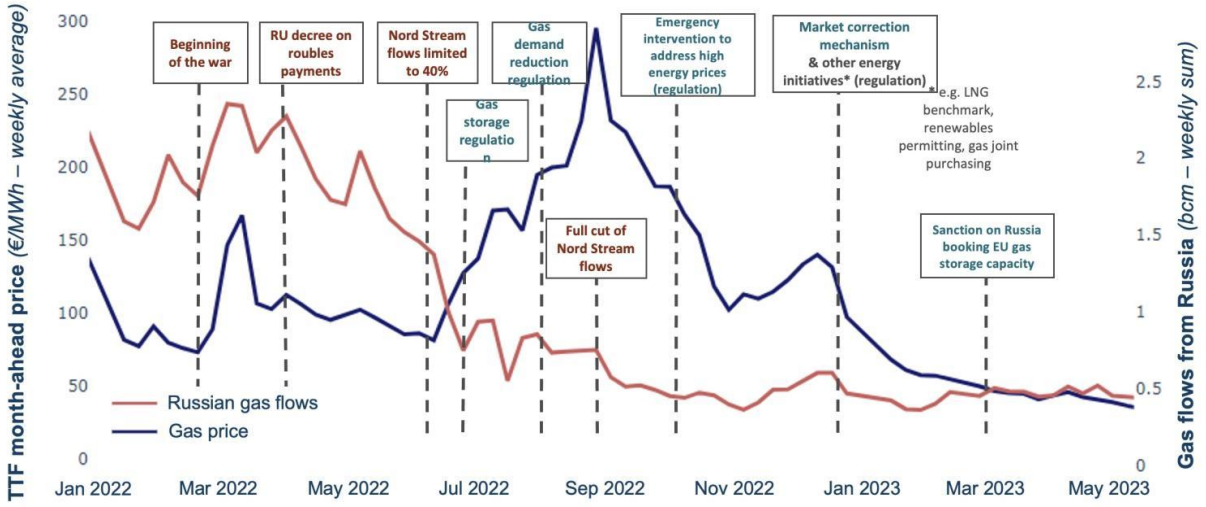


Figure 1. Russian weaponization of gas supply & EU energy policies
Source: Tertre et al. (2023)

At first glance, the GSU delivered on its most urgent objective: Germany successfully reached historically high storage levels ahead of the 2022/2023 winter period, averting the looming energy crisis. However, from its inception, this policy proved controversial. Neighbouring states criticised Germany for extending the levy to cross-border exit points, thereby raising the cost of gas transiting through Germany into their own markets. These countries saw the tax as a unilateral move that clashed with the commitment of the European Union to a single energy market and the principle of energy solidarity that mandates mutual support and cooperation between Member States during supply crises. Mounting legal and political pressure prompted Germany to drop the cross-border element of the levy by January 2025, though the core measure remains in place for domestic customers until March 31, 2027.

The impact on regional trade has been profound, underscoring the intricate ways in which national-level interventions can disrupt gas flows in an interconnected market. Data suggest that once the levy surpassed certain price thresholds, long-standing import routes from Germany to CEE countries became less attractive, prompting these neighbours to diversify toward alternative sources. Although supporters of the levy maintain that it upheld Germany's energy security at a critical time, critics warn that the prolonged cost recovery, largely borne by German industry and residential consumers, risks undermining competitiveness, increasing

the tax burden further decreasing labour productivity (Hajek, 2021), fuelling energy poverty, and weakening Germany's central role as a gas transit hub.

Research on this policy measure and its broader implications for the EU gas market has been limited so far. This article provides a general analysis of the GSU, while focussing on cross-border gas trade, market integration, and gas flow dynamics in the EU. Following this introduction, Section 1 revises the literature, and traces the legal foundations of the policy and explains how Germany's Energy Industry Act (EnWG) empowered THE to intervene on a scale to meet the mandatory fill levels. Furthermore, it analyses stakeholder reactions, contrasting views within Germany, where industrial players worry about eroding competitiveness, with the criticisms of neighbouring states facing higher transit costs. Section 2 describes the methodology of the study. Section 3 presents the results. In subsection 3.1 we quantify the economic burden of the levy, showing its uneven distribution between German domestic consumers and its cross-border trading partners. Subsection 3.2 narrows down to the CEE region, identifying specific flow redirections and supply routes that have emerged in response to increasing GSU rates. Subsection 3.3 provides the econometric results related to market stability, assessing whether previously integrated price signals in Germany, Austria, the Czech Republic and Poland experienced significant breaks after the introduction of the levy. Next, Section 4 provides a discussion of the results, drawing broader lessons on how crisis-driven policy interventions can simultaneously solve one set of challenges while creating new distortions in an interconnected market. Finally, the last section concludes the study.

1. Literature review

1.1. The integration of European gas markets

Scholars have devoted increasing attention to the integration of European natural gas markets since the late 1990s, when the European Union launched its liberalisation agenda. Successive waves of liberalisation, reinforced by pro-competition regulation and targeted investment in cross-border infrastructure, have laid the institutional and physical foundations for a unified European gas market. Hudak (2024) observes that the seminal papers by Asche et al. (2001, 2013) were the first to apply cointegration techniques to show price convergence among pipeline-connected countries such as France, Germany, and Belgium. Their work established the analysis of price convergence as the dominant methodological approach in subsequent studies of gas-market integration.

A further stream of the literature is the recent works of Heather (2019, 2023, 2024), widely regarded as the most comprehensive analysis of European gas-hubs. Heather documents the rise and consolidation of virtual trading points, most notably the Title Transfer Facility (TTF) and the National Balancing Point (NBP), which now serve as the principal price benchmarks in Western Europe in the last 15 years. In the current market, the TTF has emerged as the dominant reference for European gas trading (Jotanović & D'Ecclesia, 2021).

Bastianin et al. (2019), Hudak (2024, 2025) and Jotanović and D'Ecclesia (2021) all document a clear trend towards price convergence across western European gas markets. Hudak (2024) attributes this integration to successive liberalisation measures, the expansion of cross-border infrastructure, and the rise of highly liquid virtual hubs. Marked regional asymmetries persist, particularly in southern and Central Europe, where trading volumes are thinner and market integration remains incomplete, a situation largely traceable to infrastructure gaps and slower reform trajectories.

On the methodological front, the field has evolved from classical cointegration techniques (e.g. Johansen tests, VECM) to more flexible frameworks, such as time-varying-

parameter VAR models with stochastic volatility (TVP-VAR-SV) and network-based connectedness measures that capture shifting price linkages and the transmission of external shocks. Recent studies have also examined systemic events such as the COVID-19 pandemic and Russia's 2022 invasion of Ukraine, finding that the core architecture of European gas-market integration has proved surprisingly resilient (Hudak, 2025; Triantafyllidou et al., 2024; Streimikiene, 2022,2024; Gasimov et al., 2023).

1.2. Legislative foundations

The legal foundation of the GSU was laid by Germany's Energy Industry Act (Energiewirtschaftsgesetz, EnWG), notably through amendments that took effect in May 2022. Part 3a requires storage facilities to maintain prescribed fill levels by specific deadlines, such as achieving 85% fill by October 1st, 95% by November 1st, and 30% by February. Under §35b EnWG, storage operators must meet interim targets throughout the summer injection season, with Trading Hub Europe (THE) tasked to monitor compliance. If it appears that industry participants are not injecting sufficient volumes, §35c EnWG empowers THE to deploy an intervention scheme.

Central to Germany's storage policy is a flexible model that can escalate interventions as fill levels lag behind statutory targets. THE, in coordination with the Federal Ministry of Economic Affairs and Climate Action (BMWK) and the Federal Network Agency (BNetzA), decides which stage(s) to deploy. Stage 1 introduces strategic storage-based options (SSBOs). These are auction incentives that pay a premium, averaging €10.4/MWh in 2022, to encourage gas injections ahead of the usual storage curve. Data from THE's initial two rounds show that more than 84 TWh of SSBO contracts were awarded in 2022, costing the system nearly €900 million collectively.[1] Stage 2 occurs if Stage 1 proves insufficient to meet the fill mandates. Here, THE may conduct additional SSBO rounds, typically at higher premiums to attract faster injection. Stage 3 represents the most direct form of market intervention, where THE purchases gas outright to meet storage mandates. A key instance of this intervention occurred in June 2022, when a ministerial decree ordered THE to fill the Rehden storage facility, a critical component of Germany's gas storage portfolio.[2] Between June and October 2022, THE injected gas to mandated storage at an average rate of 250–300 GWh/day. Although effective in bolstering storage levels, this action significantly increased pressure on the day-ahead (DA) market, as increased demand for injections influenced spot prices. Furthermore, THE's ability to hedge exposures was delayed until October 2022, making it vulnerable to considerable market price volatility during the injection period. In the summer of 2022, THE's overall procurements amounted to approximately €8.6 billion for around 49.7 TWh of gas, reflecting an average purchase price of about €180/MWh (THE, 2024). These purchases, although extraordinarily costly, were considered essential to ensure sufficient storage levels before the beginning of winter. By the late November of 2022, Germany's storage facilities approached 100% of their capacity, providing a buffer against potential energy shortages during peak winter demand. However, winter 2022/2023 was milder and left enough gas in storages. In turn, the decreased demand for injections during summer 2023 depressed prices, which combined with another mild winter in 2023/2024 drove price levels in the second quarter of 2024 below €25/MWh. This significantly decreased the total value of the THE stored gas portfolio,

[1] Complete overview of the SSBO tenders are available at: *https://www.tradinghub.eu/en-gb/Publications/Security-of-Supply/Results-tender-SSBO-level-1* [Last accessed 12.1.2025]
[2] Note on this mandate is available at: *https://www.tradinghub.eu/en-gb/Services/SSBO-supplier/Storage-filling-by-THE* [Last accessed 12.1.2025]

increasing the pressure on levy adjustments to cover the losses from selling gas at costs below the initial procurement.

Given the large sums expended by THE during these storage interventions, policymakers envisaged that the costs could not be fairly absorbed by a single entity or by the federal budget alone. Instead, they enacted §35e EnWG, which authorizes a levy (the GSU) to pool and recover these amounts over time. The levy revenues flow into a dedicated 'Umlagekonto', which tracks funds spent on SSBO premiums, direct procurement, operational overhead, and any storage gas disposal.[3] The levy is charged at exit points in the German gas system, encompassing households (SLP exit points), large industrial users (RLM exit points), and, crucially, until December 31, 2024, also at the cross-border connections. The last category has provoked disapproval from neighbours like Austria, the Czech Republic, and Slovakia, who claimed that being obliged to pay a German levy for volumes simply passing thro ugh Germany violated the notion of EU energy solidarity, a concern echoed also by the EC (European Parliament, 2024). Data from pipeline operators show that Germany transported an important share of its domestic consumption annually to these countries prior to the crisis. With transit flows still vital for landlocked nations, applying the levy to their gas imports increased their import costs.

To date, the cumulative costs recovered through the levy stand at approximately €3.7 billion from mid-2022 to early 2025.[4] Originally, these requirements and their cost-recovery mechanisms were set to expire by April 1, 2025. However, due to persistent uncertainties, price declines, and the massive financial burden of 2022 emergency gas procurement (exacerbated by an incomplete hedging strategy), Germany decided to extend the validity until March 31, 2027, thus prolonging both the obligations and the cost-sharing arrangement. From January 1, 2025, it will be charged only to domestic consumers.

1.3. Domestic and cross-border receptions

Within Germany, reactions to GSU have varied. Residential consumers have felt the pinch in monthly bills, which have risen compared to pre-crisis levels, although not all of this increase is attributable to levy alone. Soaring global market prices for gas, VAT adjustments, and broader inflationary trends also played a critical role. However, consumer advocacy groups emphasised that levy created an additional burden to low-income households. Industrial users, particularly in energy-intensive sectors such as chemicals, steel, and glass, have protested that persistent high gas costs erode their competitiveness compared to manufacturers in regions where gas remains cheaper. Germany's industrial gas consumption normally hovers around 27-30 bcm per year, which means even a modest increase in the levy can translate into millions of euros in additional expenses for affected industry or even to single facilities, such as BASF in Ludwigshafen (Seeliger, 2023). Some trade associations warned that extended reliance on expensive gas could accelerate offshoring of production sites, threatening jobs and long-term investment. By prolonging the measure until 2027, the government is distributing these costs over an extended timeline, which aims to mitigate immediate shocks but also prolongs higher-cost environments for companies and households alike.

The extension of the GSU to cross-border points generated considerable debate across the European Union, particularly among neighbouring Member States that rely on gas volumes transiting through German territory (Argus, 2024a; European Parliament, 2024). Critics alleged

[3] This account is available at: https://www.tradinghub.eu/de-de/Ver%C3%B6ffentlichungen/Umlagekonten/Gasspeicherumlagekonto

[4] In February 2023 the negative balance was €9.329 billion which was reduced by December 2024 to €5.613 billion. https://www.tradinghub.eu/de-de/Ver%C3%B6ffentlichungen/Umlagekonten/Gasspeicherumlagekonto#

that by applying a storage-related levy to these cross-border flows, Germany may be violating key EU law principles, including the free movement of goods (Articles 28(1) and 110 TFEU) and the obligation to uphold energy solidarity (Article 194 TFEU). A central element of these objections involved the principle of energy solidarity, a core feature of the EU energy legislation reinforced by the Court of Justice of the European Union (CJEU) in the *OPAL pipeline* cases (Case T-883/16 and subsequent appeal C-848/19 P). In those rulings, the Court made clear that any measure that affects gas flows, whether enacted by a member state or the EU itself, must thoroughly evaluate how it impacts neighbouring countries' security of supply and broader market conditions. If one Member State's policy disproportionately disadvantages others' access to gas or imposes unnecessary cost burdens, it risks violating the solidarity principle embedded in Article 194 of the TFEU.

Observers who challenged the GSU pointed to parallels with *OPAL*: just as the Court in *OPAL* criticised insufficient consideration of cross-border impacts, so too, they argued, might have Germany failed to account for how its levy affects transit-dependent neighbours. By imposing the levy on cross-border volumes (in addition to domestic consumption), Germany may have created market distortions or raised new barriers that primarily safeguard its own supply security, potentially at the expense of other EU countries.

Beyond energy solidarity, additional legal points arise under the TFEU's provisions governing the free movement of goods and protection against discriminatory measures (Articles 28(1) and 110 of the TFEU). Should the levy effectively raise import costs for end users in other Member States, national authorities and the European Commission could view it as a fiscal or trade barrier, particularly if it deters cross-border trade or creates imbalances in regional gas markets. Energy regulators at the EU level have echoed these concerns. In a joint report from March 2024 the Agency for the Cooperation of Energy Regulators (ACER) and the Council of European Energy Regulators (CEER) warned that cost recovery mechanisms for gas storage "*should not include charges and levies imposed at cross-border borders*." Such fees, the report suggests, risk distorting market signals, rerouting flows in economically suboptimal ways, and undermining the broader integration of the EU's internal gas market. Alongside the general principles of the TFEU, specific EU regulations establish the obligations of Member States to consider cross-border effects when crafting storage or supply security policies. Under Regulation (EU) 2017/1938 (Article 6(2)), Member States must account for potential cross-border implications of measures taken to protect gas supply. Regulation (EU) 2022/1032 (Article 6b (2) – (3)) further clarifies national responsibilities for maintaining adequate storage without jeopardising the integrity of the European gas market (Eurogas, 2024).

The German GSU has sparked wider discussions about similar storage cost-recovery schemes across the European Union. Several Member States pursued or considering levies of their own, aiming to recoup the financial outlays they incurred in 2022 when gas prices soared, and mandatory storage fills became urgent.

One of the most prominent examples came from Italy, where the energy regulator Arera proposed a 'neutrality charge' to offset losses sustained by the state energy agency (GSE). During July–September 2022, GSE procured 17.88 TWh of gas for a total cost of €4 billion, averaging about €224/MWh. Initially, Italy chose not to apply any storage charge to international exit points, citing potential conflicts with European solidarity and single-market rules. However, in light of the German GSU, Arera revisited its stance and drafted a proposal to introduce the neutrality charge on cross-border flows as well as domestic consumption (EFET, 2024). According to Arera's consultation documents, the indicative rate was at €2.19/MWh (Argus, 2023), but it was eventually not adopted. Energy market participants in neighbouring countries, especially Austria, have raised concerns that extending the Italian levy

to cross-border volumes could make Italian exports less competitive and further fragment the internal gas market.

Meanwhile, Austria was examining potential changes to its transmission tariffs, which could lead to significantly higher fees at certain interconnection points (Argus, 2024b). Although precise figures were not confirmed, Austrian officials have signalled that any move to impose or increase charges on border flows would be motivated by a desire to recoup storage-related costs and ensure fair cost allocation among all market participants.

Parallel development is occurring in the Netherlands, where the government is preparing a new levy starting in 2026 to recuperate the expenditures associated with filling the Bergermeer gas storage facility since 2022. The Dutch plan aims to generate around €146.7 million per year at least until 2029, reflecting the scale of state-supported purchases to maintain secure stock levels. Although the specific methodology for applying the levy has not yet been finalised, particularly whether it will affect cross-border gas, the Dutch government indicated to continue to examine how best to integrate this charge into the existing market framework (Argus, 2024c).

Taken together, these initiatives in Italy, Austria and the Netherlands illustrate a broader trend of Member States adopting levies or tariffs to recover extraordinary costs incurred during the 2022 gas crisis (Argus, 2024c). However, they also highlight the risk of a patchwork approach that may complicate cross-border trade, create cost disparities between different routes, and undermine the principle of free movement within the single energy market. As more countries seek to defray the security of supply or storage costs by imposing new charges, the European Commission and national regulators face a challenging task: balancing the need of each member state to finance strategic reserves against the EU's overarching objectives of market integration and energy solidarity.

2. Methodology

2.1. Research objective

The main objective of this research is to analyse the impacts of the German gas storage levy, Gasspeicherumlage (GSU), the levy introduced by the German government in 2022, on the integration of the natural gas markets in CEE, with a focus on the legal, commercial, and economic effects of the application at the cross-border exit points of the German market. The paper aims to answer the question of whether and to what extent the GSU has distorted regional gas flows and price relationships between national markets, generating structural breaks in the equilibrium of interconnected markets.

2.2. Research methods

1) The first pillar of the methodology consists of a qualitative analysis of the national and European legal framework. The relevant provisions of the Energiewirtschaftsgesetz (EnWG) were examined, in particular Articles 35b-35e, which confer powers on the operator of the Trading Hub Europe (THE) to purchase gas and apply a cost recovery tax. This analysis was complemented by an examination of the legal framework of the European Union, including: Article 194 TFEU (energy solidarity), Articles 28(1) and 110 TFEU (free movement of goods), Relevant EU Regulations (2017/1938 and 2022/1032), as well as the case law of the CJEU in cases such as OPAL (C-848/19 P). The purpose of this analysis was to identify potential conflicts between the GSU and the principles of the functioning of the EU single energy market.

2) The second pillar consists of a quantitative assessment of the economic impact of the GSU on gas flows and generated revenues. For our calculations, we used the net values of German gas exports to the respective countries (Bundesnetzagentur, 2025). In practice, there may be some minor variations, as export values represent net flows across all border points, but the aim is to illustrate the overall impacts. For example, in the case of the Czech Republic, the presence of multiple border points and complex connections with the German network may slightly alter the values. Similar complexities apply to Austria and Holland due to their connections to gas storage facilities such as Haidach and Jemgun, which interconnect two market areas.

The data was extracted from official sources, as follows:

- Trading Hub Europe (THE) – reports on GSU revenues and storage costs
- Bundesnetzagentur (BNetzA) – statistics on daily and monthly gas flows
- ACER and CEER – reports on European gas markets
- ENTSOG and national TSOs (Net4Gas, E-Control, GTS Poland) for validation of cross-border flows.

The period analysed covers Q3 2022 – Q1 2025, with a focus on the quarters in which the GSU level reached critical thresholds (€1.00/MWh, €1.45/MWh, €1.86/MWh and €2.50/MWh). The key economic indicators analysed include net export volumes, transmission tariffs, GSU level, and financial contributions from neighbouring states (Austria, Czech Republic, Poland, Netherlands). Graphical models were used to highlight flows redirection and the decrease in the competitiveness of the German gas transport route.

3) Econometric analysis: cointegration and market stability

To assess the impact of the GSU on the convergence of prices on the natural gas spot market, an econometric approach based on cointegration tests was used. Spot prices for the relevant hubs (THE, CZ VTP, CEGH AT, POL GAZ-SYSTEM) were collected for the period between October 2022 – December 2024, with a daily frequency.

The analysis was carried out in three stages: i) Statistical pre-testing: checking the stationarity of the time series (ADF and KPSS tests), selection of optimal lags (AIC/BIC criteria); ii) Johansen tests to identify multiple cointegration relationships between hubs; iii) Gregory-Hansen tests for detecting structural breaks caused by the introduction of the GSU or its significant changes.

3. Results

3.1. The economic burden of GSU in cross-border gas trade

The detailed analysis of the economic costs borne by natural gas exporting countries, following the application of the German gas storage levy (GSU), was carried out based on data on cross-border trade flows and related transport tariff levels. The results of this investigation are summarised and graphically presented in Figures 2-7, which highlight the different impacts on the main affected countries, as well as the redistributive dynamics generated by the tax at the regional level.

Figure 2 presents the aggregate payments made by selected European countries under the German gas storage levy (GSU). The amounts, expressed in millions of euros, represent the immediate fiscal burden placed on foreign shippers that rely on German infrastructure for natural gas transit. The Czech Republic paid the largest charge, exceeding €150 million, a figure that reflects its substantial dependence on the German gas transit network (related largely to LNG regasification capacities booked in the Netherlands) and, by extension, its exposure to Germany's unilateral tariff policy. The Netherlands and Austria follow with payments of

roughly €110 million and €70 million, respectively, consistent with their roles as major transit and trading nodes in the regional supply network. Switzerland, Poland, and Denmark incur significantly lower amounts, indicative of the more modest use of German gas transition network, while France and Belgium record negligible or zero payments, suggesting either a shift toward alternative supply routes or limited integration into supply chains that rely on German storage assets (which are largest in the EU).

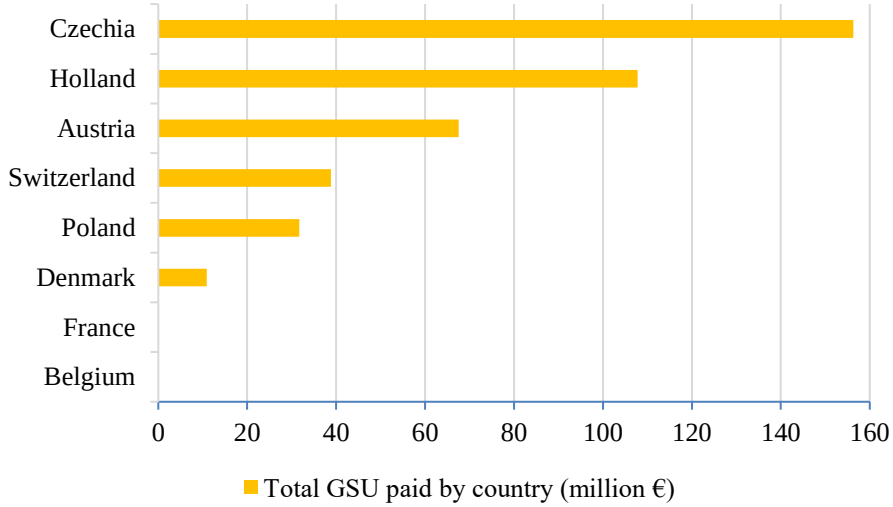


Figure 2. Total GSU paid by country
Note: Total GSU paid by country. This figure highlights the total GSU contributions paid by each country in 2022-2024.
Source: *own research*

Figure 3 illustrates the percentage distribution of the total contributions made by the European states affected by the introduction of the German gas storage levy (GSU) in cross-border gas flows. The fiscal burden is distributed unevenly between member states. This asymmetry underscores the regressive and uncoordinated design of the GSU and raises concerns about market fragmentation and potential breaches of the principle of energy solidarity of the European Union.

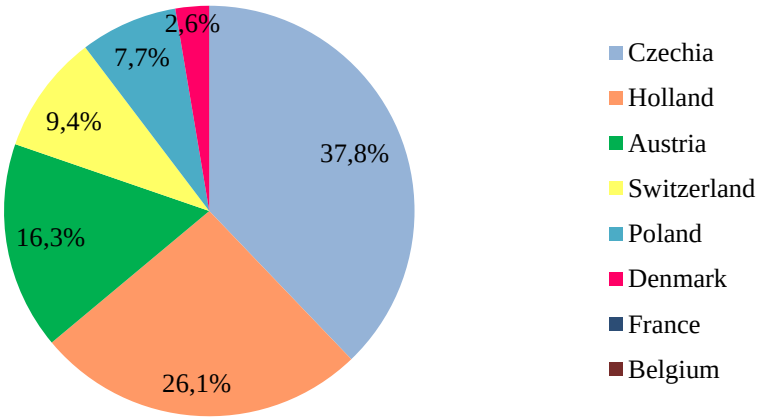


Figure 3. Share of total GSU paid by country
Note: Each slice shows the percentage contribution from the total amount from collected levy.
Source: *own research*

Despite these nuances, net export values accurately reflect overall trends and economic impacts. Our analysis reveals an aggregate net loss of € 413 million in the region, largely attributed to increased transport costs and reduced flow flexibility. Consumers in the Czech Republic and the Netherlands bore a significant portion of this burden because of their heavy dependence on cross-border gas transit from Germany. Higher transport costs, lower trade volumes, and higher levies translated into higher end-user prices in some of these markets. Especially Czechia and Poland became premium markets. In Figure 6, we observe that overall gas flows have gradually decreased with time. However, revenues from the GSU were maintained primarily through higher levy rates. This trend underscores the cyclical and redistributive dynamics in gas exports, as reflected in the gradual rise of contributions from countries like the Netherlands and Austria, while Czechia's dominance diminished over time. Seasonal and structural changes also played a role, with peaks in Q4 periods driven by increased demand. When examining the contributions from exports, we find that the total contribution until the end of 2024 amounts to approximately € 413 million, a relatively modest figure compared to the €3,3 billion contributed by domestic consumers. By the end of 2025, an estimated €5.6 billion remains to be recovered via levies on domestic consumers, with full recovery expected by April 2027. At the current levy rate of € 2.99 per MWh, these costs are projected to be fully covered within the designated timeline.

Figure 4 clearly highlights that the Czech Republic and the Netherlands played a decisive role in the total payments made, recording the highest and most constant contributions throughout the period analysed. Two significant peaks in the cumulative contributions are observed, in Q3 2023 and Q3 2024, periods most likely associated with higher levy imposed for the forthcoming period, lack of flexibility to adapt to higher levy and increased seasonal demand. Other states, such as Austria, Poland, or Switzerland, had lower but visible contributions, while France, Belgium, and Denmark remain marginal in the overall distribution indicating gas transport optimalisation. This evolution shows not only a disproportion in the tax burden, but also a temporary dynamic closely linked to seasonality and trade adjustments of the countries affected by the GSU.

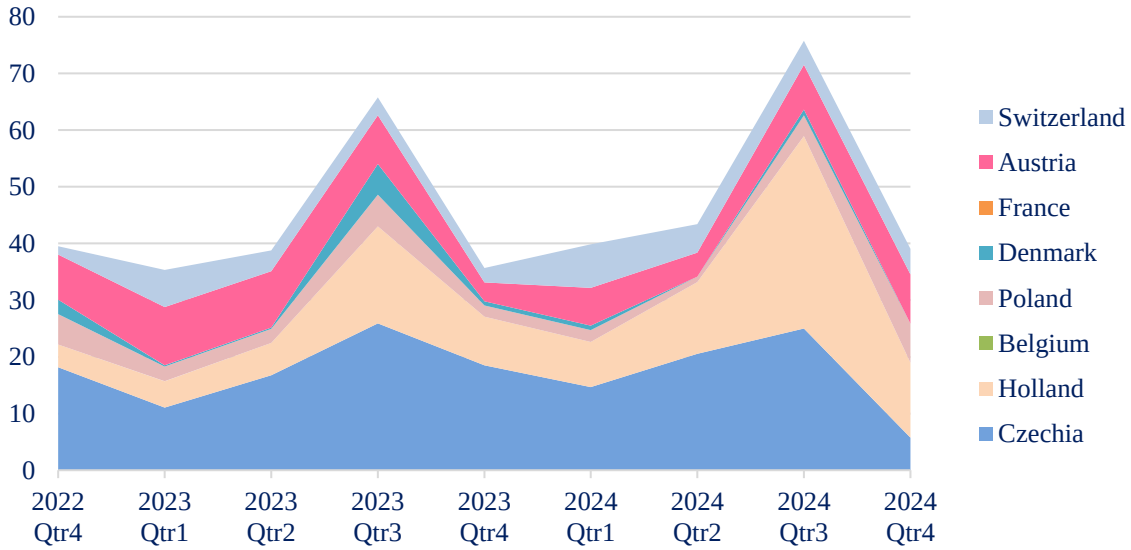


Figure 4. Cumulative GSU contributions paid by country (million euros)
Note: The area visually represents the cumulative contributions by country over time.
Source: *own research*

Figure 5 presents, in the form of a heat map, the quarterly evolution of contributions to the German gas storage levy (GSU) for each country analysed, between Q4 2022 and Q4 2024. Darker colours indicate higher payments, and the distribution highlights clear fluctuations over time and significant differences between countries. The Czech Republic and the Netherlands stand out with high and constant contributions, with a significant peak in the case of the Netherlands in Q3 2024 (€33.9 million). Austria has a constant but more moderate presence, while other countries, such as France, Denmark, and Belgium, have almost zero involvement.

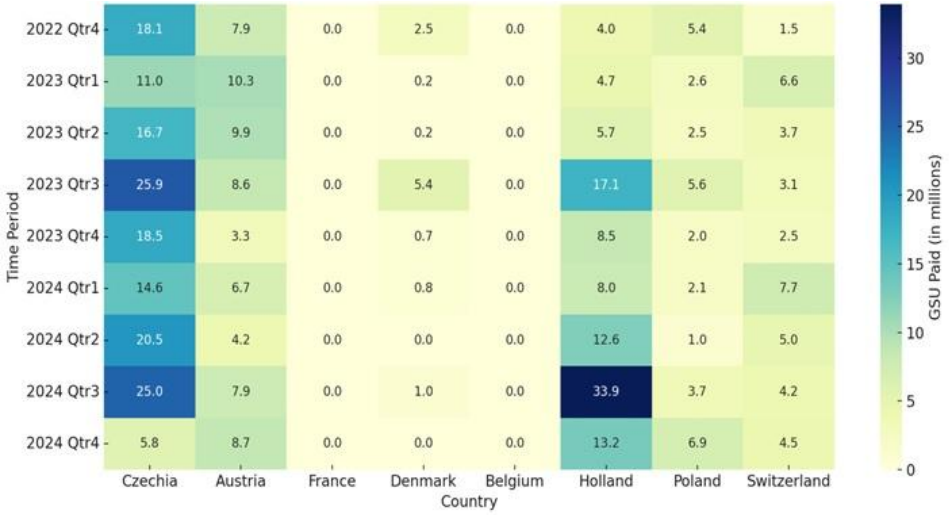


Figure 5. Heatmap of GSU payments by time and country
Note: The heatmap visually depicts GSU payments by country over time, with darker shades representing higher values. The high contributions are consistent in earlier periods, while Holland and Austria stand out in later periods.
Source: *own research*

The study highlights important regional trends and contributes to understanding the functional differences between the Central and Western European gas markets in the context of actual physical flows and their portfolio optimisations. Additionally, Figure 6 shows the cumulative evolution of the average daily natural gas flows (expressed in GWh/day) recorded by different European countries in the period between 2022 Q4 and 2024 Q4. The data highlight a significant decrease in total flows after 2023 Q2, with a slight recovery in 2024 Q2 and Q3. The Czech Republic stands out with a consistently high contribution throughout the period, followed by the Netherlands and Switzerland, which complete the main sources of gas flow. Countries such as Belgium, Poland, France and Austria had a smaller but visible role in supporting the total volume.

Eventually, this analysis reveals the overwhelming reliance on German consumers to absorb the economic costs associated with the gas market intervention. The modest export contribution of €413 million, compared to the €3.7 billion recovered so far, underscores the limited role of exports in addressing the financial burden. From this perspective, lifting the GSU at export cross-border points in December 2024 was a reasonable and necessary action, particularly given the potential legal risks and challenges that could have arisen if the levy had been maintained and further increased through 2027.

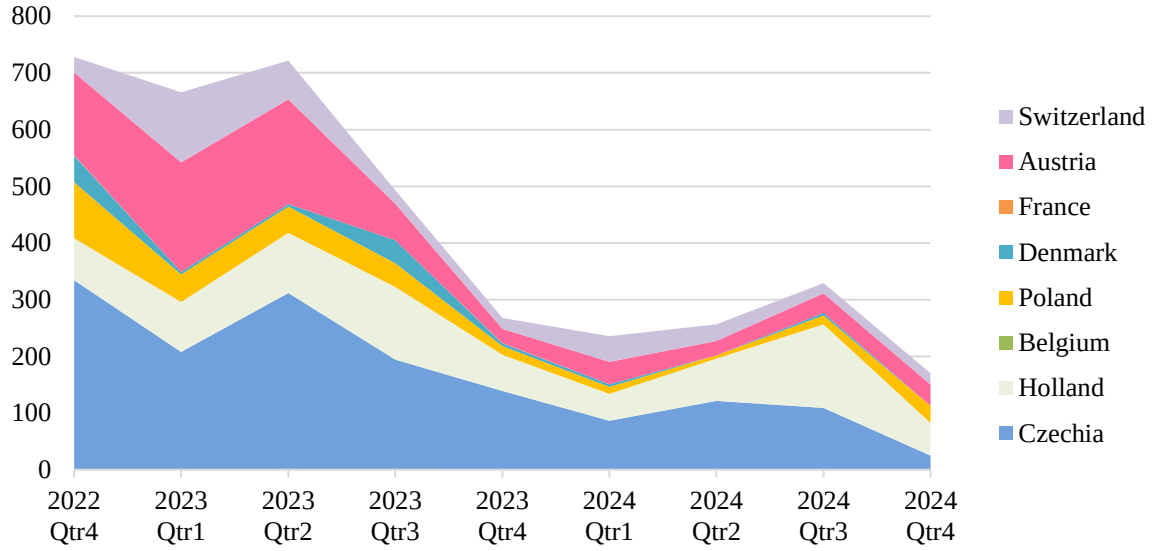


Figure 6. Cumulative average gas flow by country over time
Note: The area chart visualizes cumulative average gas flows (GWh/day) for each country over time. The stacked layers highlight each country's contribution to the total gas flow during each period.
Source: *own research*

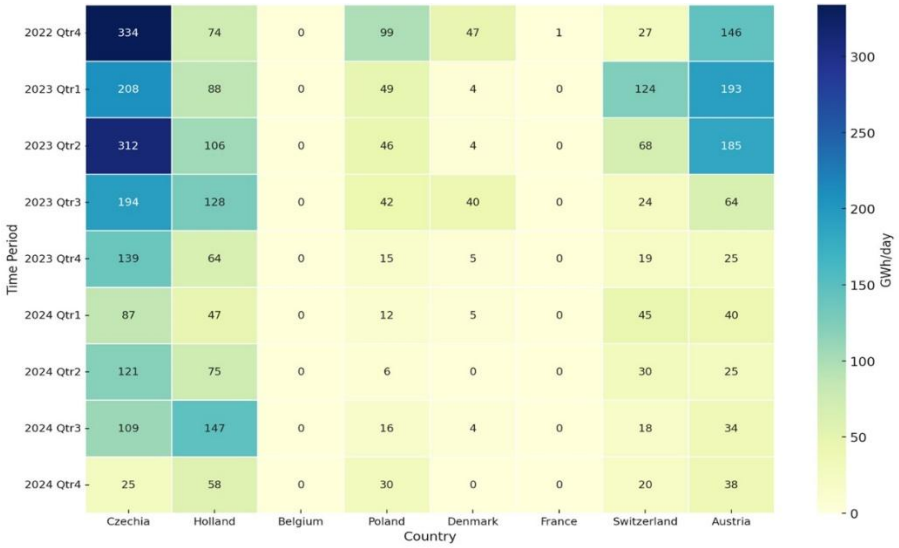


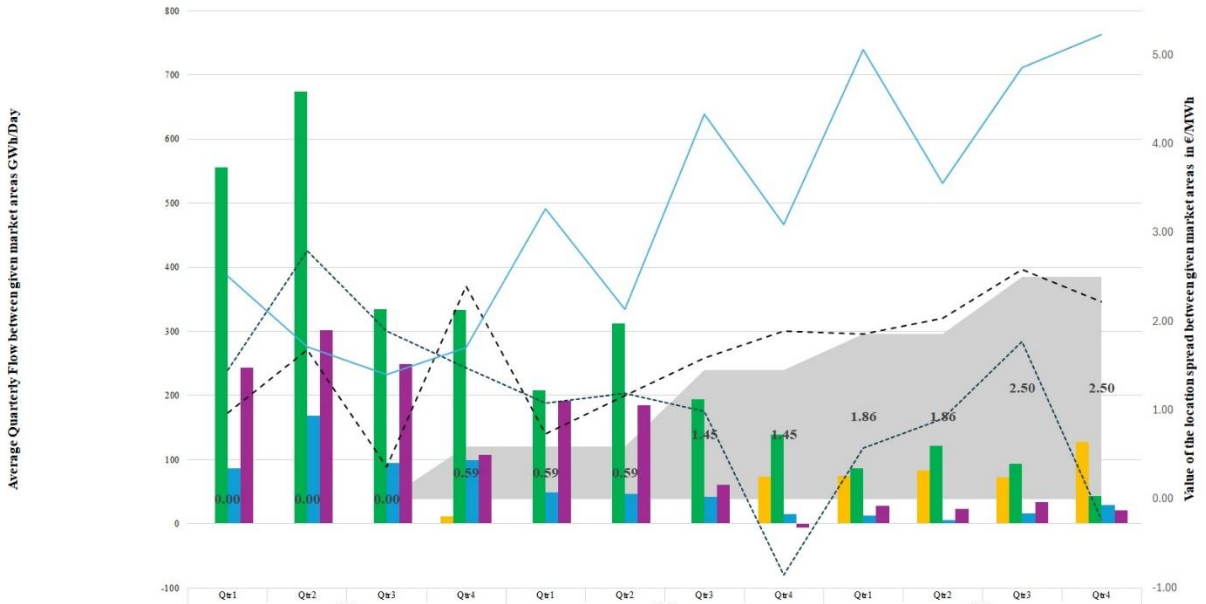
Figure 7. Heatmap of average gas flow by country and quarter
Note: This heatmap visualizes the average gas flows (GWh/day) by country across different time periods. The colour intensity represents the flow values.
Source: *own research*

3.2. Flow and GSU revenue analysis regional impacts on CEE

Given that the most significant impacts of the GSU were in the CEE region and the CEE countries were the most outspoken critics of the levy (Argus, 2024a), we will zoom in just to this region for further analysis. The introduction of the GSU on 1 October 2022, starting at relatively low levels and gradually increasing to €2.50 by July 1, 2024, has reshaped gas trading patterns across the CEE. Figure 8 profoundly illustrates these changes, highlighting quarterly

flows between Germany (DE), the Czech Republic (CZ), Austria (AT), and Poland (PL), as well as evolving cross-border spreads and incremental increases of the GSU. Although the GSU was intended to cover storage-related costs in Germany, its impact on regional flows and price dynamics proved more extensive than some policymakers in Germany probably anticipated.

When the GSU was first introduced at a low rate on October 1, 2022, many observers expected minimum market distortions. Indeed, Q4 2022 data (covering flows and spreads) show that Germany remained a key supplier for neighbouring markets such as the Czech Republic, with volumes driven by LNG regasification capacity booking in the Netherlands and existing pipeline capacity. Austria imported part of its gas via Oberkappel or stored it at the Haidach storage site, relying on the route as long as it was more cost-efficient than alternatives (for example, transiting via Italy). At the same time, Austria maintained supply from Russia through Slovakia, reflecting the country's diverse sourcing strategy. Poland received comparatively lower volumes from Germany. The availability of LNG imports (especially once the Świnoujście terminal ramped up regasification capacity) and the 2022 Lithuania–Latvia interconnector reduced Poland's need to source gas from German points. Despite incremental increases in GSU in the early 2023 (moving toward €1.45), the net effect on cross-border flows was initially muted. Figure 9 suggests that the transport tariffs did not always align perfectly with the real marginal cost of gas shipping. As a result, significant volumes still flowed from Germany into Czechia and, to some extent, into Austria, where overall prices declined because of new supply routes from the east and the Balkans.



	Qtr1	Qtr2	Qtr3	Qtr4	Qtr1	Qtr2	Qtr3	Qtr4	Qtr1	Qtr2	Qtr3	Qtr4
	2022				2023				2024			
GSU Value in €/MWh	0.00	0.00	0.00	0.59	0.59	0.59	1.45	1.45	1.86	1.86	2.50	2.50
Avg. flow SK to CZ in GWh/d	0	0	0	11	0	0	0	73	75	83	72	127
Avg. flow DE to CZ in GWh/d	556	674	334	333	208	312	194	139	87	121	93	44
Avg. flow DE to PL in GWh/d	87	168	95	99	49	46	42	15	12	6	16	29
Avg. flow DE to AT in GWh/d	243	302	249	107	191	185	61	-6	28	23	34	21
Avg. spread CZ-THE in €/MWh	0.97	1.68	0.36	2.40	0.74	1.16	1.59	1.90	1.86	2.04	2.58	2.22
Avg. spread CEGH-THE in €/MWh	1.45	2.79	1.89	1.48	1.08	1.19	0.98	-0.85	0.57	0.91	1.77	-0.23
Avg. spread PL-THE in €/MWh	2.51	1.72	1.40	1.71	3.27	2.14	4.33	3.10	5.06	3.56	4.86	5.23

Figure 8. Gas flow developments, the GSU and location spreads 2022 – 2024
Source: *own research*

In Q2 and Q3 2023, the GSU had climbed above €1.45, edging toward €1.86 before reaching € 2.50 in July 2024 (Figure 8). This escalation triggered notable changes in supply choices. The Czech Republic was traditionally a net importer from Germany, also sending gas eastward on occasion. However, once the GSU passed €1.00–€1.45, more competitive supply options emerged, particularly from Hungary or other eastern routes. The data show a reduction

in Germany-to-Czech Republic (DE→CZ) gas flows and an increase in imports from alternative sources whenever the GSU eroded Germany's price advantage. Austria's imports from Germany dropped to minimal levels by mid-2023, concurrently with the GSU rising beyond €1.45. Austria's price advantage came from increased supply flexibility, evident in the chart, where Austrian inflows from the Balkans or direct Russian routes through Slovakia replaced some of the more expensive German gas. Haidach storage remained an important facility; however, by the time the GSU reached €2.50, Austrian importers could secure lower-cost gas through other pipelines, underscoring how quickly markets respond to levy-based price signals. Although Poland's flows from Germany were already modest, the further increase in GSU made German gas even less attractive. Poland leveraged LNG cargoes, with the Świnoujście terminal seeing stronger utilization, and anticipated supply from the Baltic Pipe carrying gas from Norway via Denmark. Figure 8 corroborates that Poland's dependence on German routes diminished steadily as alternative infrastructure projects matured. In summary, Q2 to Q3 2023 marks an inflection point: as soon as Germany's GSU surpassed the threshold that negated its usual transport-cost advantage, regional market players took advantage of cheaper routes, whether from the east, from Russia through Slovakia or via LNG terminals.

Once the GSU reached € 2.50 (1 July, 2024), quarterly data reveal dramatic cuts in DE→CZ and DE→AT flows. German export volumes to neighbouring markets hit record lows, since other corridors became decisively "in the money." Figure 8 and the accompanying graph confirm that at the end of 2023, the gap between Germany's offers and those of alternative suppliers widened sufficiently to deter cross-border transit through Germany. Traders could source cheaper molecules in Hungary, Slovakia, or LNG in Poland, undercutting German gas despite deeper market liquidity in Germany. These dramatic impacts are also notable from Figures 4 and 6 that break down overall levy cash flow and gas export from Germany. Interestingly, Poland shows a continuing pattern of low DE inflows, presumably due to diversified supply (including the new Baltic pipeline from Denmark and domestic LNG expansions) and the developing infrastructure of the Baltic region (Lithuania-Latvia-Estonia). Meanwhile, the Czech Republic underwent a more sudden shift: flows from Germany plummeted once it became cheaper to import gas from the southeast.

The data underscore that policymakers may have underestimated how profoundly the GSU would shape location spreads and reroute flows. Had the GSU remained below €1.00, these disruptive shifts might have been far less pronounced. Instead, a steep climb to €2.50 gave rise to arbitrage, when traders exploited alternative routes, profiting from price differentials that the GSU exacerbated shifting the revenues away from Germany. Furthermore, countries with robust diversified pipeline networks or LNG capacity, such as Austria and Poland, could circumvent the German route when GSU costs became prohibitive. Such developments highlight the benefits of an interconnected EU gas market, where participants quickly adapt to any local or national policy that changes competitive balances.

Table 1 shows that flows from Germany dipped notably in November 2024, then rebounded in January 2025 after changes to the GSU were applied at cross-border points. While in November 2024 with the GSU at € 2.50, cross-border volumes collapsed as alternative routes maintained a cost advantage. However, in January 2025 the GSU structure was lifted, making German exports viable again. At this point, the difference between the GSU-driven spreads and the day-ahead (DA) tariffs at VIP Brandov converged, bringing some flows back to the DE→CZ route. This pattern of rapid withdrawal and equally rapid return demonstrates how sensitive cross-border gas flows are to marginal cost factors such as transport levies or pipeline tariffs. As soon as the financial equation tips, whether from a lowered GSU, improved tariff terms, or changing price spreads in nearby hubs, volumes can swing significantly.

Table 1. Cross-border transport capacities and sample daily flows in 2024 and 2025

To / From	DE	SK	CZ	AT	PL
AT	**199**/8/106	**1570**/231/10	n/a	n/a	n/a
CZ	**2253**/5/113	**395**/142/0	n/a	n/a	0
DE	n/a	n/a	**961**/0/0	**160**/0/0	**931**/0/0
PL	**326**/1/1	**174**/0/0	**28**/26/0	n/a	n/a
SK	n/a	n/a	**1399**/0/0	**247**/0/0	**145**/0/0

Notes: Bold are total capacities at the given border points in GWh/Day. Second number represents the gas flow in the given direction on 3.12.2024 and the third number represents the flow on 10.1.2025. For AT we account just for Oberkappel (no Lindau, KF, or Ueberackern). SK received 411 GWh from UA and 95 GWh from HU on 3.12.2024 and 93 GWh/d on 10.1.2023.
Data source: *https://transparency.entsog.eu/#/map*

Figures 9, 10 and 11 compare the evolution of the day-ahead spreads between the Polish, Czech, and Austrian markets vis-à-vis Germany (THE), correlated with the evolution of the German Gas Storage Levy (GSU) value and the transmission tariffs (annual and monthly) from Germany to these markets. It is observed that as the GSU increased (in steps), the price differences with respect to THE stabilised around the GSU + transmission tariff values, confirming that the GSU has become a structural determinant in the formation of cross-border prices. In the case of Poland (Figure 9), the spreads increased significantly after 2023, sometimes reaching very high values, pointing to a strong desynchronisation and reduction in flows. In Figure 10, the relationship with the Czech Republic reflects a higher sensitivity to GSU changes, and the spreads tend to decrease after 2024, suggesting a possible adjustment of trade routes. In contrast, in Figure 11, the Austrian market shows a more balanced evolution, but here too the increase in GSU after Q3 2023 seems to have influenced the increase in price differences. In general, the graphs indicate a clear correlation between the increase in GSU and the loss of price convergence at the border points, highlighting the role of GSU as an obstacle to maintaining regional gas market integration.

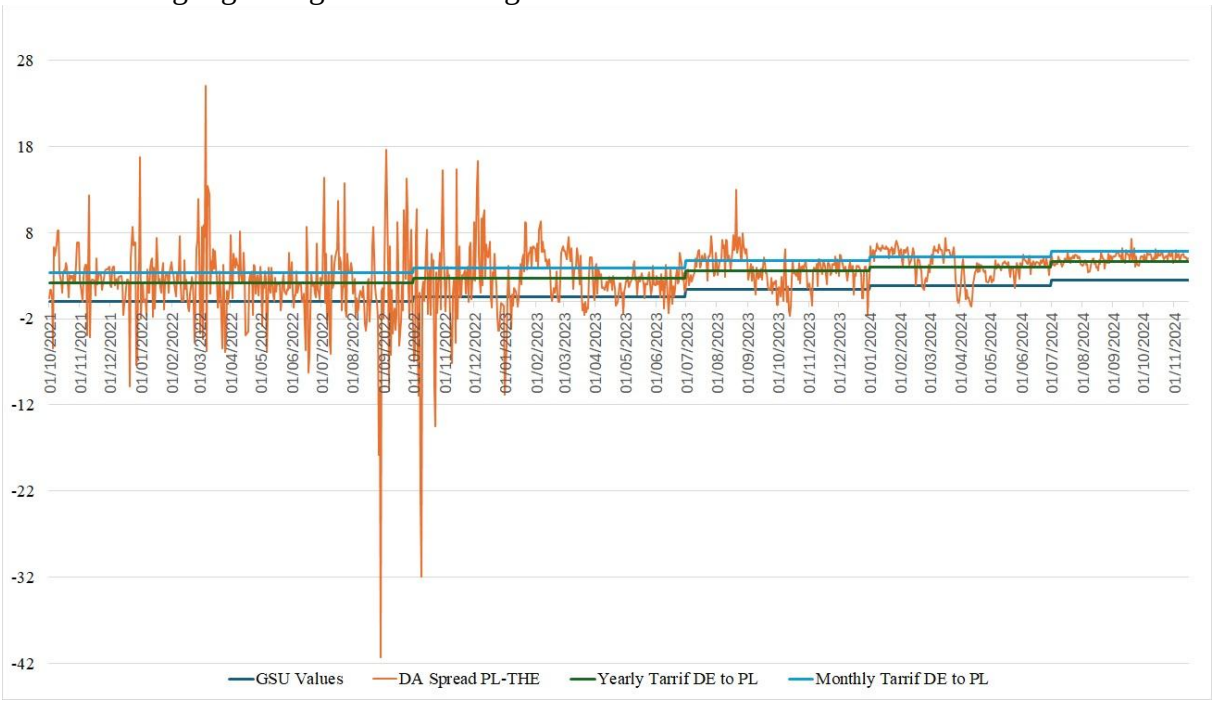


Figure 9. Polish spread
Source: *own research*

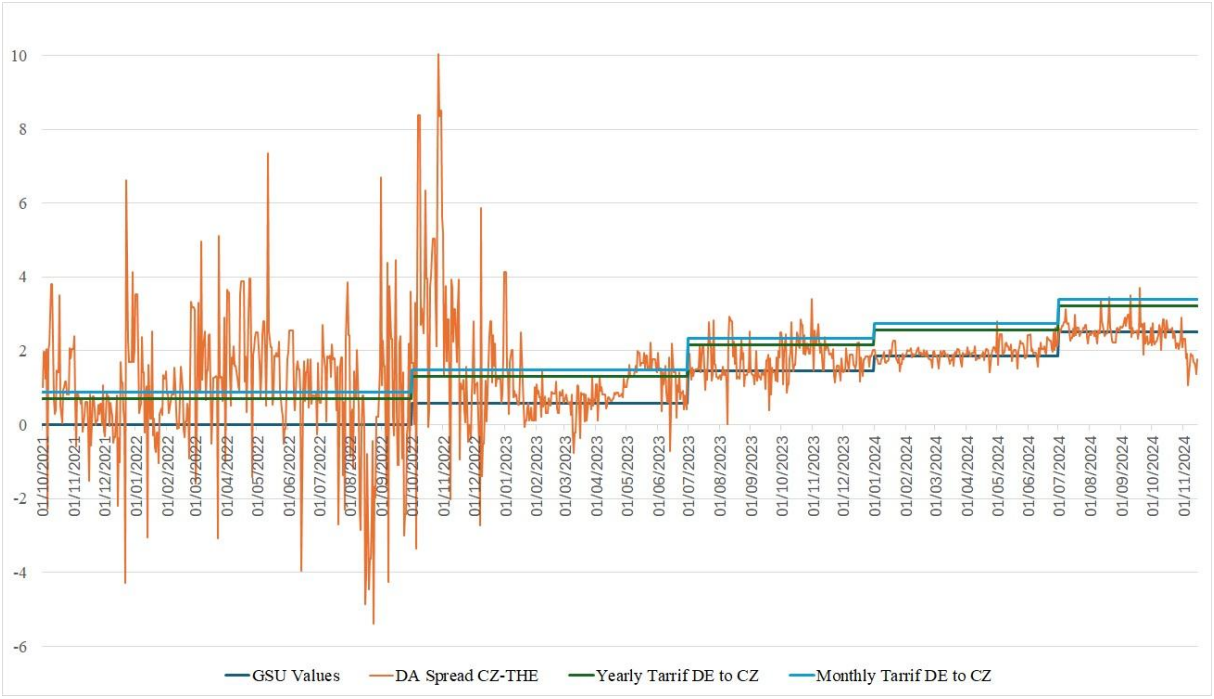


Figure 10. Czech spread
Source: *own research*

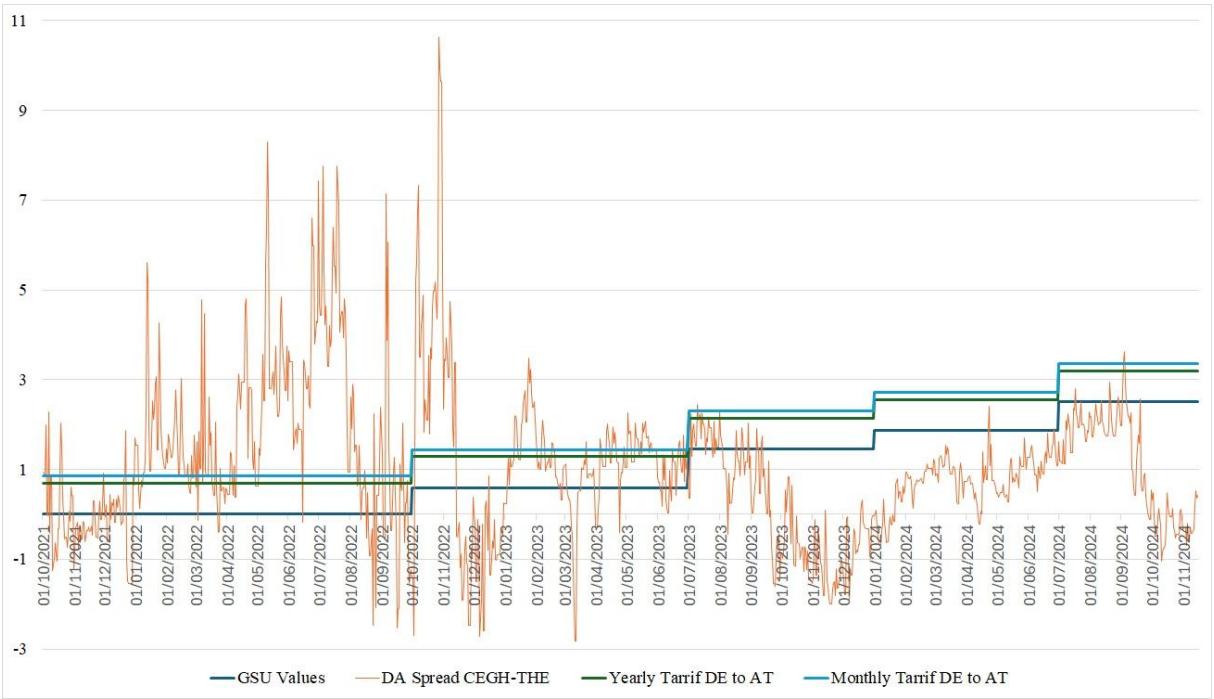


Figure 11. Austrian spread
Source: *own research*

3.3. Econometric results: The impact of GSU on price convergence and gas market integration in the CEE

To further examine how the GSU influenced market dynamics and stability in the CEE, we conducted an econometric analysis centred on day-ahead (DA) prices. The DA market

captures near-immediate cost changes, making it especially sensitive to policy measures like the GSU. By applying cointegration tests, including checks for potential structural breaks, we sought to determine whether price relationships among key markets remained stable or whether the GSU disrupted previously established long-term equilibria.

Cointegration analysis assesses whether two or more time series variables share a stable, long-run equilibrium relationship. It is widely used in the literature on gas markets convergence (Asche et al., 2001, 2002, 2013; Bastianin et al., 2019; Chevallier & Ielpo, 2013b, 2013a; Ciferri et al., 2019, 2020; Dukhanina et al., 2019; Dukhanina & Massol, 2018; Gebre-Mariam, 2011; Hudak, 2025; Hupka et al., 2023; Jotanovic & D'Ecclesia, 2021; King & Cuc, 1996). If the GSU significantly destabilised market integration, we would expect the cointegration relationship to break down following the introduction or subsequent increases. This would imply price divergence among the CEE markets, leading to increased arbitrage and potential break coinciding with major changes in the GSU.

We ran our cointegration tests over five separate periods, plus a whole period capturing the tumultuous crisis environment from late 2022 into end 2024. Key GSU thresholds, namely €1.45, €1.86, and €2.50 were noted as possible breakpoints. The tests are conducted with the Johansen procedures for cointegration checks and with the Gregory-Hansen tests to detect structural breaks in the cointegration relationship. Tables 2 and Table 3 report the standard pretesting (variable summary, stationarity checks, lag selection criteria), while Table 4 shows the main cointegration outcomes.

Across the entire sample (including high volatility in the late 2022–2023), prices still exhibit a long-term relationship, suggesting that overall the CEE markets remained interlinked despite the crisis. The Gregory-Hansen test detected at least one structural break around the time the GSU rose to €1.45. Beyond that point, some pairs of markets that had been closely co-integrated began to decouple. For instance, flows at Lanzhot (on the Czech - Slovak border) showed diminishing eastward movement from the Czech Republic, likely because the Germany → Czech Republic → East transit became less attractive under the higher levy. A second wave of structural pressure occurred near €1.86, when flows from the east picked up towards Czechia, further shifting the flow balance. During this time, flows via Brandov (Germany → Czech Republic) gradually approached zero, underscoring a rerouting of supply. In the final subperiod (with €2.50), the test indicates no stable market equilibrium among the four markets under study. Rising transport costs led to significant declines in flows on the Germany–Poland border, with Poland increasingly relying on alternative routes (LNG, Baltic Pipe). The Austria–Germany flows diverged as well. At some stages, Austria even exported gas into Germany, a reversal of traditional patterns tied to cheaper supplies from the east and Russia via Slovakia. Czech flows went to almost zero, a sheer contrast to the 2021-2023 period (the flow between Czechia and Germany was maintained after the Nord Stream disruption at a 150 GWh on average, and this flow descended following Q1 2024).

Before GSU or at low GSU levels, market integration was relatively strong, with quick arbitrage in Germany, Czech Republic, Austria, and Poland. As the GSU rises, the cost of moving gas from Germany outward noticeably dampens cross-border trade. When GSU reached €1.45, structural break tests confirmed that price alignment faltered. Poland and Austria distanced themselves from German gas. At high levels of the GSU (€ 2.50), some corridors nearly shut down. Gas flow in the Czech Republic partially shifted to alternative routes (for example, Slovakia and Hungary), and Poland's dependence on Germany continued to shrink.

Table 2 summarises the descriptive statistics for natural gas spot prices expressed in €/MWh in four relevant regional markets. Austria, the Czech Republic, Germany, and Poland. The mean and median values indicate a relative convergence of the markets, with a slight upward trend in the case of Poland (€65.08/MWh on average), suggesting a higher level of asset

or regulatory driven costs. The high dispersion of the values is highlighted by the consistent standard deviations (around €49/MWh) and the coefficient of variation (between 74.88% and 79.35%), reflecting price volatility in the analysed period. Positive skewness (skewness > 1.9) and high kurtosis values (above 7) indicate the presence of extreme price episodes, most likely during the 2022 energy crisis. Overall, these statistics support the hypothesis of an integrated but tense market, affected by common shocks and, possibly, by temporary distortions caused by political factors such as the German gas storage levy (GSU).

Table 2. Summary statistics for CEE prices in €/MWh

	Austria	Czechia	Germany	Poland
Mean	62.96	63.44	62.14	65.08
Median	40.94	42.23	40.64	44.21
Max.	312.57	312.34	313.55	311.99
Min.	16.00	16.58	15.99	17.08
Std. deviation	49.63	49.11	49.31	48.73
Skewness	1.94	1.95	1.97	1.94
Kurtosis	7.14	7.18	7.28	7.06
Coef. of var.	78.84	77.42	79.35	74.88
Obs.	1415	1415	1415	1415
Start date	01/01/2021	01/01/2021	01/01/2021	01/01/2021
Start date	15/11/2024	16/11/2024	17/11/2024	18/11/2024

Data source: CEGH/AT, VTP CZ, THE/DE spot prices are the EGSI index published daily by EEX on *https://www.eex.com/en/market-data/market-data-hub/natural-gas/spot*. Polish gas prices are based on the spot index TGEGASDA published by the TGE daily on *https://tge.pl/gas-dam*. Prices from the same sources are used across the whole study.

Table 3 presents the results of the unit root tests applied to the series of price values of natural gas in the markets of Austria, Czech Republic, Germany, and Poland markets, using three established methods: Phillips-Perron, Augmented Dickey-Fuller (ADF), and KPSS. The purpose of these tests is to assess the stationarity of the time series, a necessary condition to justify the use of cointegration analyses in the subsequent stages. The results show that, for all markets and scenarios (with trend and/or constant), the test statistics do not reach the critical values at the 1% level, which confirms the non-acceptance of the null hypothesis of stationarity for Phillips-Perron and ADF, so the series have a unit root in level and are integrated of order one (I(1)). In parallel, the KPSS tests, which start from the opposite hypothesis (stationarity as the null hypothesis), also reject this hypothesis at the same significance level. Thus, the convergence of the results of the three methods confirms that all four series are non-stationary in level but become stationary after differentiation, an essential condition for the valid application of the Johansen and Gregory-Hansen cointegration tests.

According to the results presented in Table 4, in the absence of GSU or at low levels (0.59 €/MWh), the test identifies three cointegration relationships, suggesting solid integration between the analysing markets. However, as the GSU increases, the number of cointegration relationships decreases significantly: At a level of 1.45 €/MWh and 1.86 €/MWh only one relationship appears, and at 2.50 €/MWh no significant relationship is detected (0 ranks), indicating a complete disintegration of the market.

Table 3. Unit root tests for corresponding spot natural gas markets

	Phillips-Perron test				Augmented Dickey-Fuller test				KPSS test for stationarity			
Market area	**Scenario**	**Test Statistic Level**	**Test Statistic *I*(1)**	**1% Critical Value *I*(1)**	**Scenario**	**Test Statistic Level**	**Test Statistic *I*(1)**	**1% Critical Value**	**Scenario**	**Test Statistic Level**	**Test Statistic *I*(1)**	**1% Critical Value**
Austria	Trend	-2.227	-33.276	-3.960	Trend	-2.147	-17.172	-3.960	Trend	4.520	0.0378	0.216
	Constant	-2.079	-33.284	-3.430	Drift	-1.974	-17.17	-2.329	Without trend	5.540	0.0633	0.739
Czechia	Trend	-2.195	-34.063	-3.960	Trend	-2.121	-16.848	-3.960	Trend	4.440	0.0367	0.216
	Constant	-2.075	-34.072	-3.430	Drift	-1.976	-16.848	-2.329	Without trend	5.310	0.0605	0.739
Germany	Trend	-2.230	-32.440	-3.960	Trend	-2.146	-16.805	-3.960	Trend	4.420	0.0370	0.216
	Constant	-2.082	-32.449	-3.430	Drift	-1.971	-16.804	-2.329	Without trend	5.600	0.0603	0.739
Poland	Trend	-2.332	-37.844	-3.960	Trend	-2.180	-16.558	-3.960	Trend	4.330	0.0365	0.216
	Constant	-2.219	-37.853	-3.430	Drift	-2.049	-16.558	-2.329	Without trend	5.220	0.0591	0.739

Note: The lag length is set to 4 based on the SBIC criterion

Evidence indicates that the GSU operates as a destabilising force, undermining the ability of interconnected markets to sustain consistent price links. Its introduction and subsequent increases have widened price differentials between the studied regional hubs, thereby impairing market efficiency and stimulating arbitrage activity. The accompanying table corroborates the view that unilateral national measures directed at cross-border export points can, even in an otherwise converging energy-market landscape, materially compromise the cohesion and optimal performance of the regional market.

Table 4. Johansen test for cointegration for spot gas prices

Reference market area	**Cointegrating Relationships**	**Trace Test Result***
No GSU	3	4.29 < 9.42
GSU 0.59 €/MWh / 1.10.2022	3	6.35 < 9.42
GSU 1.45 €/MWh / 1.7.2023	1	34.80 < 34.91
GSU 1.86 €/MWh / 1.1.2023	1	28.97 < 34.91
GSU 2.50 €/MWh / 1.7.2024	0	42.44 < 53.12
Whole Period	3	4.38 < 9.42

Notes: Lags set by SBIC to 4. Tested with restricted constant. *Trace test shows the first test statistic that fails to reject H0 (at 5% critical value). GSU 1.86 - trace test at 1% critical value finds 0 ranks.

Results of the Gregory–Hansen test (Table 5) reinforce the patterns already evident in trade flow data: the GSU has introduced structural breaks into Central and Eastern European (CEE) gas prices, weakening convergence, and triggering a realignment of trade routes. All three test statistics, ADF, Zt, and Za, exceed their critical values of 1%, 5%, and 10%, signaling a break in the long-run cointegration relationship. The estimated break dates, 17 February 2022 for the ADF statistic and 10 July 2023 for Zt and Za, align with two pivotal events: (i) the market turmoil following Russia's invasion of Ukraine and (ii) the rise of the GSU to €1.45 /MWh. These findings support the hypothesis that successive GSU hikes have fragmented the regional gas market and disrupted previously stable price linkages among the examined hubs.

Table 5. Gregory-Hansen test for cointegration with regime shifts for spot gas prices

Test	**Test Statistic**	**Breakpoint Date**	**Critical Values**
ADF	-10.35	17-Feb-22	1%: -6.51, 5%: -6.00, 10%: -5.75
Zt	-15.13	10-Jul-23	1%: -6.51, 5%: -6.00, 10%: -5.75
Za	-426.71	10-Jul-23	1%: -80.15, 5%: -68.94, 10%: -63.42

Note: Lag set by BIC at 4

4. Discussions and public policy implications

The results of this study demonstrate that Germany's gas-storage levy (Gasspeicherumlage, GSU), applied at cross-border interconnection points, has had notable economic, commercial and institutional repercussions for regional gas market integration. While the levy achieved its immediate strategic aim, rapidly replenishing German storage during the 2022 energy crisis, it was conceived and implemented unilaterally, without a systematic assessment of cross-border spillovers or coordination with EU partners. Econometric tests and trade-flow evidence reveal three principal unintended consequences: distortions in regional price signals, rerouting of import flows, and a measurable decline in market convergence.

The GSU thus provides a valuable case study for any state considering levies to recover extraordinary crisis-related costs generated by public policies. While the levy bolstered supply security at a critical moment, it also generated complex legal, economic, and political consequences that should inform future policy design. A first lesson concerns the avoidance of "tariff shocks." Germany introduced the GSU at a modest rate, but as wholesale prices fell the surcharge increased rapidly to €2.00–2.50 /MWh. These abrupt hikes distorted cross-border prices and encouraged importers to seek cheaper alternatives, exemplified by the diversion of flows from Slovakia to the Czech Republic once the levy neared €1.86 /MWh. Levies of this type should therefore be gradually phased in and calibrated to prevailing market conditions to limit arbitrage.

A second lesson relates to the EU principles of energy solidarity and free movement of goods. By extending the GSU to transit volumes, Germany provoked legal objections from neighbouring states, who argued that the measure contravened EU law. Policymakers must distinguish clearly between domestic consumption and transit flows and conduct rigorous cross-border impact assessments before introducing any charge with regional implications.

Third, clarity on the levy's scope and duration is essential. Germany could have supplemented, or partially replaced, the GSU with alternative instruments, such as a solidarity contribution from energy firms that earned windfall profits while benefiting from the public intervention to protect integrity of the market in times of the extreme supply disruption event that could have trigger rapid credit related events, or a market-area usage fee levied on commercial shippers. These options would have offered greater protection to vulnerable households and critical industries. Effective cost recovery also requires a robust hedging framework. Germany's delay in Trading Hub Europe (THE) hedging its exposure led to substantial losses, despite seasonal spreads that exceeded € 100 / MWh in October 2022. A flexible market-indexed tariff, linked, for example, to THE's spot index, would have allowed automatic adjustments and preserved economic efficiency.

Comparable challenges now face other member states, including Italy, the Netherlands, and Austria, which likewise seek mechanisms to recoup storage costs. The German experience underscores the need for ex ante cross-border assessments, transparent formulae, and EU-coordinated compensation mechanisms. Over the longer term, common fiscal instruments, such as a European strategic-storage fund or a harmonised levy, would promote coherence, equity, and predictability in future energy crises.

In sum, the GSU proved effective within Germany but, in the absence of a cooperative European framework, produced commercial fragmentation, legal disputes, and distributive inequities. Any future replication should therefore be embedded in a common energy-governance architecture that preserves flexibility, solidarity, and market integration.

Conclusion

GSU emerged in 2022 as a swift policy response to Germany's unprecedented gas supply emergency, helping to secure storage levels when Russian pipeline deliveries decreased. Its core mechanism, allowing THE to procure gas at whatever prices and then recoup costs through a levy, played a decisive role in averting a deeper crisis over the winter of 2022/2023 having impact on firms and consumers opening a robust debate on energy poverty (Hromada, 2024). However, the measure also ignited controversies, particularly over its application to cross-border flows, which neighbouring countries argued undermined the EU principles of market integration and energy solidarity.

As demonstrated in this paper, the legislative underpinnings and its three-stage storage intervention scheme effectively increased fill levels, but at the expense of increasing costs. The subsequent levy extended these costs to both industrial and residential consumers, with marginal contributions from transit volumes. Econometric analysis also revealed that once the levy reached certain thresholds (notably above €1.45–€2.50), it contributed to structural price breaks and reconfigured gas flow patterns in Central and Eastern Europe. These disruptions underscored how a national cost recovery tool could reshape entire regional markets, especially in an interconnected EU framework. It also underscores the resilience of an interconnected EU gas market that attracts price arbitrage, while it additionally revealed Germany's diminished role as a major transit state, especially once the tax increased cross-border fees above competitive thresholds.

Furthermore, the application to transit volumes spurred disputes and accusations of undermining energy solidarity, ultimately forcing Germany to exempt cross-border exit points from the levy by January 2025. Domestically, households and industrial users shoulder most of the remaining costs, projected to be recouped by March 2027. Although extending the GSU reduces the near-term shock, it prolongs a higher-cost environment in Germany and could drive some energy-intensive industries to relocate.

Overall, the GSU was instrumental in ensuring Germany's gas security during a critical time, but it has come at a high financial cost and has tested the limits of the rules of the EU market. Therefore, a key policy lesson is the importance of balancing national security of supply measures with broader market integration principles. As more Member States adopt levies to recover their own storage-related costs, a cohesive EU-level framework could reduce market distortions and reinforce solidarity. For Germany, the path forward involves carefully recalibrating the GSU rate, now primarily for domestic users, so as not to prolong the financial burden indefinitely while maintaining sufficient flexibility to address any renewed supply threats.

Policy recommendations

The findings of this study indicate that the application of Germany's GSU at cross-border exit points produced market distortions, negatively affecting price convergence, disrupting established trade flows, and weakening long-term equilibrium relationships in the CEE gas markets. Although the cross-border application of the GSU was discontinued at the end of 2024, this experience highlights several crucial policy lessons and recommendations for future regulatory design at both national and EU levels.

i) **Avoid cross-border application of national levies and clearly define the domestic scope of crisis-related charges.** The GSU's extension to cross-border flows sought to shift a disproportionate fiscal burden onto neighbouring states, notably the Czech Republic, the Netherlands, and Austria, undermining

principles of nondiscrimination, market integration, and solidarity as stipulated by the EU law. Therefore, it is recommended that any future tax or market-support mechanism explicitly differentiates between domestic consumption and transit volumes, clearly restricting the levy's scope of the tax to national market boundaries. Furthermore, prior to implementation, Member States should carry out rigorous cross-border impact assessments in accordance with Article 194 TFEU and consult with affected neighbouring countries and the European Commission to ensure compliance with the provisions of the internal market and solidarity.

ii) **Harmonise energy-security funding mechanisms at the EU level: the** GSU case demonstrates the adverse market effects arising from fragmented national approaches to strategic gas storage funding. To ensure coherent and equitable cost sharing throughout the Union, it is recommended to establish a common EU financing mechanism for strategic gas reserves, potentially modelled on existing frameworks such as the EU strategic petroleum reserve system while effectively combining it with joint procurement instruments (Regulation (EU) 2022/2576). Costs should be allocated proportionally, either based on net consumption, peak demand exposure, or a clearly defined solidarity contribution reflecting national risks and benefits.

iii) **Strengthen ACER's monitoring role and establish an EU-level early warning system for national energy policies with regional impact: Given** the disruptive potential of unilateral national policy measures, it would be advisable to strengthen the mandate of the Agency for the Cooperation of Energy Regulators (ACER) mandate to include explicit powers for continuous monitoring, early warnings and prompt intervention regarding national regulatory measures with potential cross-border impacts. This system should be integrated within the existing ACER regulatory oversight framework (for example, Regulation (EU) 2019/942 and Regulation (EC) 715/2009) and include regular market impact assessments conducted jointly by ACER, ENTSOG, and national regulatory authorities (NRAs).

iv) **Establish common governance arrangements for critical gas storage and transport infrastructure:** The GSU example has underlined the importance of coordinated governance in strategic gas infrastructure management to avoid unilateral decisions that could destabilise regional market dynamics. Therefore, it is recommended to explore and progressively implement common governance structures, such as European storage consortiums or regional infrastructure partnerships, in line with existing models such as the European Hydrogen Backbone initiative. Such frameworks could encompass shared ownership, access terms and transparent pricing mechanisms regulated through coordinated EU guidelines, building on existing EU energy policy instruments and principles outlined in Directive (EU) 2019/692 (Gas Directive Amendment) and Regulation (EU) 2022/1032 on gas storage obligations. Preferable routes, discounted transport tariff schemes and simplification of the transport tariffs in general for TSO and LNG regas, especially if several TSO are used to transport the gas (to avoid 'pancaking'), could bring significant support to market integration, optimised idle transport capacities, and ultimately benefit consumers.

The German GSU experience underscores the need for clearly defined and EU-coordinated policy instruments and common governance frameworks that fully respect internal market principles, energy solidarity, and the need for predictable regulatory conditions. Therefore, future national policies should be carefully aligned with EU market rules and undergo thorough regional impact assessments, supported by stronger EU-level oversight.

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