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Energy Trade Reconfiguration in Central and Eastern Europe After the Russia–Ukraine War: Evidence From PPML and GAP Analysis

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Abstract

This article analyses how the energy-related foreign trade structure of Central and Eastern European (CEE) EU Member States has evolved since the Russia–Ukraine war. The study focuses on the diversification of import sources and the geographic reorientation of exports, using detailed HS27 data at the HS4 level for eleven CEE countries. The empirical approach combines a Poisson Pseudo-Maximum Likelihood gravity model with a Supply-Gap Replacement Analysis to identify which partners substituted for lost imports from Russia and Belarus. A new indicator Re-Export Potential is also introduced to capture potential intra-regional energy flows and emerging distribution hubs.

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The findings show a reduction of more than 99% in direct HS27 imports from Russia and Belarus after 2022 and a major reshaping of supply patterns. Norway, the Gulf states, the United States and North Africa became the main substitutes, while several Western European states acted as key transit and refining hubs. In contrast, CEE countries achieved only limited reorientation of their energy exports, reflecting higher production costs and constrained adjustment capacity after the loss of Russian crude.
The Re-Export Potential results point to new regional energy corridors in the Adriatic, Baltic and Black Sea regions. Overall, the study shows that the transformation of CEE energy trade is structural and likely to persist, reshaping the region's role within Europe's energy supply chains.

Keywords: CEE energy trade, trade reorientation, PPML, supply-gap analysis, energy security, re-export potential, sanctions

JEL: C33, F14, F51, Q41, Q48

Introduction

The Russia–Ukraine war has become a major turning point for the European economy, with particularly strong effects on Central and Eastern Europe (CEE). Due to their geographical location and historical ties, CEE countries once maintained long, deep trade relations with Russia and Belarus. However, the introduction of sanctions, disruptions to traditional transport routes and new geopolitical risks forced a rapid restructuring of their external economic relations. The energy sector was affected most severely: sanctions effectively banned energy imports from Russia and Belarus, while soaring prices, higher transport costs and uncertainty over alternative suppliers further accelerated the need for adjustment.

Since mid-2025, the structural reorientation of Europe's energy supply has been further consolidated at the institutional level. With EU energy ministers deciding on 20 October 2025 to phase out imports of Russian oil and gas by 1 January 2028, and to refrain from concluding new long-term gas contracts from 2026 onwards, there is now a formal policy framework for the transformation process already observable since 2022 (Abnett 2025; Council of the European Union 2025a). This decision confirms a reduction in the dependence on Russian energy carriers that is visible in the empirical data, with Russia's share in EU gas imports falling to around 12 per cent and its share in oil imports to below 2 per cent by the first half of 2025 (Council of the European Union 2025b; Eurostat 2025; International Energy Agency 2025a).

At the same time, the most recent developments highlight the heterogeneous adjustment capacity within Europe: while most member states have been able to diversify their supply structures, several CEE countries – in particular Hungary and Slovakia – remain structurally tied to legacy pipeline infrastructures such as the Druzhba system and selected transit agreements (Levi et al. 2025). These persistent dependencies shape regional vulnerability during the transition phase and mark those states in which reorganisation processes proceed more slowly due to limited alternatives.

In light of these developments, it is likely that the tendencies observed since 2022 will continue to strengthen over the coming years. This is because the ongoing transformation of Europe's energy system is not merely reactive but structural in nature: it is anchored in new regulatory commitments, reinforced by investment decisions and supported by growing integration within the internal energy market. Increasing diversification of supply sources, the emergence of new distribution hubs and persistent infrastructure constraints in parts of CEE all indicate that adjustment trajectories across the region will become increasingly differentiated, raising the importance of analysing the evolving patterns of energy-related trade flows.

In view of the above, this article examines how foreign trade patterns evolved after 2022 in eleven CEE EU member states, with a particular focus on energy products (HS27). By analysing both imports and exports, the study captures two complementary dimensions: the reorientation of energy supply sources and the shifts in export destinations for energy-related goods. Based on theory and prior findings, two hypotheses are proposed: **(H1)** the geopolitical shock of 2022 led to a structural reallocation of CEE HS27 imports away from Russia and Belarus; **(H2)** sanctions and supply disruptions caused a sharp decline in CEE HS27 exports to Russia and Belarus, with only a limited redirection of outflows to other markets.

The empirical approach combines the Poisson Pseudo-Maximum Likelihood (PPML) gravity model with a Supply Gap Replacement Analysis (GAP), which tracks changes in CEE import and export structures after 2022. To capture intra-regional dynamics and the emergence of distribution hubs, a new indicator Re-Export Potential (RP) is introduced, linking the PPML and GAP perspectives. Overall, the study contributes to the debate on how the war has reshaped trade patterns, energy security and the resilience of CEE economies.

Literature Review

The economic repercussions of the war in Ukraine have been widely analysed, generating both preliminary assessments and more extensive studies. Early contributions highlight its severe and lasting effects on global commerce, including supply and price shocks in commodity markets and major disruptions to supply chains (Roubini 2022; World Bank 2022). Researchers also note that the magnitude of these shocks depends heavily on countries' capacity to diversify suppliers (Borin et al. 2022), while forecasts predict that global trade may decline by around 1% (Ruta 2022). Given the key role of Russia and Ukraine as suppliers of energy and industrial commodities such as oil, natural gas, wheat, neon, titanium and palladium the conflict has generated substantial turbulence in global markets (Cohen and Ewing 2022; Mbah and Wasum 2022; Wiseman 2022). The blockade of Ukrainian exports and sanctions against Russia have reshaped trade in non-precious metals, energy, minerals and agricultural goods (Bentley et al. 2022). According to the United Nations (2022), the war has disrupted not only energy and food markets but also global financial systems, exacerbated by persistent supply bottlenecks and rising transport costs.

These findings are consistent with Zhou et al. (2023), who show that the conflict has induced cascading failures in global energy and food trade networks, producing price spikes and heightening the vulnerability of import-dependent states.

A growing strand of research examines the conflict through bilateral and multilateral trade flows. Evidence indicates that sanctions and reduced access to energy commodities particularly affect Europe, whose dependence on Russian and Ukrainian imports exceeds that of other major economies (Bhattarai, Romm, and Siegel 2022; International Monetary Fund 2022). Furthermore, Hallová, Savov, and Horská (2024) document disruptions in EU agricultural trade, driven by heightened market volatility and policy changes. Using an Autoregressive Distributed Lag (ARDL) framework, they demonstrate that geopolitical risk strongly affects agricultural prices, thereby prompting the EU to seek alternative suppliers and strengthen domestic production.

A substantial part of the literature underscores that CEE countries are among the most vulnerable, particularly those with strong pre-war ties to Russia. Their exposure stems from geographical proximity and a trade structure in which Russia's share exceeds the EU average (Prohorovs 2022). For instance, the Baltic States were among the first to experience the effects of declining trade and rising energy prices (Noack and Brady 2022). Meanwhile, Korosteleva (2022) argues that Poland, Czechia, Hungary, Slovakia and Bulgaria need to diversify energy imports, despite substantial economic and logistical constraints.

Expanding the scope of analysis, Kulikova and Sinitsina (2023) analyse how geopolitical instability reshapes CEE trade relations with Russia, showing that sanctions and the energy shock disrupt economic ties, including through rerouting attempts to bypass restrictions. Further insights are provided by Kos-Łabedowicz and Talar (2024), who apply the Trade Vulnerability Index (TVI) to assess CEE resilience to wartime disruptions. Their results indicate considerable initial resilience, though vulnerabilities increased in the Baltic States and Poland in 2023. Crucially, they find no clear correlation between trade vulnerability and resilience to shocks.

Given Ukraine's role as a major exporter of agricultural and industrial goods, several studies analyse the conflict's impact on global agri-food and resource markets (Bułkowska and Bazhenova 2023; Aizenman et al. 2024). Habova (2024) situates these developments within a broader geopolitical context, arguing that intensified great-power rivalry most notably the Russia–Ukraine conflict constrains prospects for deeper CEE trade cooperation with China.

Regarding the assessment of trade flows, it is important to note that the European gas and liquefied natural gas (LNG) market has stabilised further since 2024. Price convergence between pipeline gas and LNG, together with expanded infrastructure and the growing role of LNG terminals in Northern and Central Europe, has strengthened internal market integration (Agency for the Cooperation of Energy Regulators 2025; International Energy Agency 2025, recent policy and analytical reports highlight increasingly interconnected and diversified supply chains (Council of the European Union 2025b; Levi et al. 2025). At the same time, they indicate that regional re-export dynamics especially through major EU distribution hubs remain shaped by political decisions, logistical constraints and persistent cross-country differences (Bartha 2025).

Nevertheless, although the literature offers valuable insights into the early effects of the war on CEE economies, important gaps remain. Many studies focus only on the initial phase of the conflict or rely on short time spans, and few provide detailed, geographically comprehensive analyses. As a result, to better understand the magnitude and nature of these ongoing changes, a closer examination of CEE trade relations with key partners is required. This study helps fill this gap by analysing developments in the energy sector.

Research Contribution

This study makes several important contributions to the literature on wartime trade disruptions and post-shock realignment. First, it looks at trade flows from 2017 to 2024 to give a medium-term view of the Russia–Ukraine war. This is in contrast to the short observation windows used in most existing research. This extended timeframe facilitates the differentiation between the initial shock phase and the ensuing restructuring dynamics, encompassing the gradual replacement of suppliers and the development of novel regional trade patterns.

Second, the analysis is performed at a more advanced level of data disaggregation than is typical in the literature. Most studies use 2-digit or sectoral statistics, but this work examines HS27 energy products at the HS4 level using bilateral flows. This method makes it possible to find product-specific substitution pathways and shows differences that would be missed with more general classifications, especially in fuel oils, coal, and gas-derived condensates.

Third, the paper presents an innovative two-step empirical design that connects identification and descriptive mapping. The gravity model estimated through PPML measures the size of trade reallocation caused by sanctions and supply shocks after 2022. The Supply-Gap Replacement (GAP) analysis, on the other hand, describes the size and direction of partner substitution. This combination lets us tell the difference between statistical proof of trade reorientation and its real-world effects on import and export volumes.

Fourth, we add the Re-Export Potential (RP) indicator to these methods. This indicator shows the physical limits of moving goods around within CEE. Current research primarily examines external trade partners or composite indices of vulnerability and resilience; conversely, the RP approach illustrates that the region's ability to absorb and redistribute energy supplies is simultaneously limited by the availability of imports and the demand for exports. This gives a more structural view of trade patterns after the war than accounts that only look at prices or policies.

Lastly, the paper looks at CEE energy trade from both the import and export points of view. The literature has recorded the decline of Russian energy imports; however, there has been insufficient focus on the redirection of CEE energy exports in the absence of pre-war downstream markets. By looking at these two pressures, we show that import substitution and export reallocation follow different paths of adjustment, which are affected by the availability of alternative markets, transportation capacity, and refinery feedstock constraints.

Research Methodology

The empirical analysis relies on a gravity model using the PPML estimator, now standard in empirical trade research (Santos Silva and Tenreyro 2006; 2011; Steinbach 2023). The model is applied to bilateral trade flows between CEE EU Member States and all trading partners, using HS27 and HS4 product-category data. The dependent variable measures the annual value of bilateral trade in each product (t).

The specification includes a sanctions indicator that identifies trade with Russia and Belarus after the introduction of sectoral restrictions, as well as global energy price variables (oil, gas, coal) matched to product categories through product-specific price indices. Standard errors are clustered at the CEE partner-country level, consistent with the fixed-effects structure and PPML's statistical properties.

Limited post-2022 variation in some country–product pairs and singularity issues prevented estimation of a fully saturated fixed-effects model (with exporter–year, importer–year, country-pair and product–year fixed effects). Thus, we employ an empirically feasible but fully identifiable design that includes a fixed effect for the CEE Member State – on the importing side (variant A) or exporting side (variant B) and a year fixed effect. This structure controls for all time-invariant characteristics of CEE economies and captures global shocks affecting energy trade.

The use of PPML mitigates heteroskedasticity concerns, accommodates zero trade flows, and preserves the log-level interpretation of coefficients, whereby the estimated parameters (β) can be interpreted as approximate percentage changes in trade values. Following Santos Silva and Tenreyro (2006), the estimated coefficients are interpreted as semi-elasticities, with exp(β) – 1 providing an approximate percentage change in trade flows. The empirical model is represented by the following equation (1):

$$\begin{gathered}\mathrm{Trade_{ijkt}} = \exp(\beta_1 \mathrm{Sanction_{ijkt}} + \beta_{\mathrm{Br}} \mathrm{Brent_t} \times 1\{\mathrm{k} \in \{2709, 2710\}\} \\ + \beta_{\mathrm{Gas}} \mathrm{TTF_t} \times 1\{\mathrm{k} = 2711\} + \beta_{\mathrm{Coal}} \mathrm{Coal_t} \times 1\{\mathrm{k} = 2701\} \\ + \mathrm{FE_{side}} + \mu_t),\end{gathered} \tag{1}$$

where:

$\mathbf{Trade}_{ijkt}$ – the value of the trade flow (variant A/B) between country (*i*) and its trading partner (*j*), for product (*k*[1]) (HS27) in year (*t*) (data source: United Nations Comtrade 2025); two equation variants are employed:

- **variant A:** the importer (*j*) is a CEE country, while the exporter (*i*) is an external partner;
- **variant B:** the exporter (*i*) is a CEE country, while the importer (*j*) is the trading partner;

$\mathbf{Sanction}_{ijkt}$ – a binary variable equal to 1 if product (*k*) (HS27) is traded with Russia or Belarus in year (*t*) (on the export side in variant A and on the import side in variant B) and is included in the list of goods subject to sectoral sanctions from the year of their introduction; 0 otherwise;

$\mathbf{Brent}_t \times \mathbf{1}\{k \in (\mathbf{2709,2710})\}$ – the Brent crude oil price index assigned to HS2709 (crude oil) and HS2710 (refined petroleum products) (data source: World Bank, 2025a, via FRED);

$\mathbf{TTF}_t \times \mathbf{1}\{k = \mathbf{2711}\}$– the natural gas price index for HS2711 (natural gas) (data source: World Bank 2025b, via FRED);

$\mathbf{Coal}_t \times \mathbf{1}\{k = \mathbf{2701}\}$ – the coal price index applied to HS2701 (coal) (data source: World Bank 2025c, via FRED);

1 Only HS codes 2701 and 2709–2711 are included in the analysis, as these categories are directly linked to Brent, TTF and Coal price indices. The remaining HS27 subheadings (2712–2716) are excluded due to their marginal share in total imports – collectively accounting for between 0.45% and 2.91% of total HS27 imports across the eleven CEE countries in the sample (average: approximately 1.7%; United Nations Comtrade 2025) – and the absence of a clear relationship with global fossil fuel markets (Authors' note).

$\mathbf{FE}_{side}$ – a fixed effect controlling for the CEE country; its form depends on the estimation variant ((*j*) in variant A and (*i*) in variant B);
μ_t – a year fixed effect controlling for global shocks and time trends affecting energy trade (e.g., global energy price cycles, broad macroeconomic conditions).

To complement the PPML results and to identify how the geographical structure of CEE imports and exports has evolved since 2022, an additional original procedure Supply-Gap Replacement Analysis is employed. The conceptual design of the GAP analysis is consistent with recent approaches in the literature on trade diversion and supply-shock substitution, where *pre*- and *post*-sanctions trade structures are compared to identify new trading partners (Wang and Hannan 2023; Darvas, Léry Moffat, and McCaffrey 2024). The objective of the method is to determine which countries replaced the lost energy imports from Russia and Belarus, and to which destinations CEE countries redirected their energy exports.

The procedure divides the sample into two periods: a *pre*-war phase, characterised by stable energy trade (2017–2021), and a *post*-war phase, marked by sanctions and diversification efforts (2022–2024). This approach is fully consistent with the logic of both PPML variants, as it relies on the same bilateral structure i–j: in the import analysis, this corresponds to variant A, whereas in the export analysis, it corresponds to variant B. The GAP analysis is conducted separately for each trading partner (country/region), using the following configurations:

- Variant A: the importer is a CEE country (j∊CEE), and the trading partner (*g*) acts as the exporter (*i* = *g*), excluding Russia and Belarus; HS4 ∊ {2701, 2709, 2710, 2711}.
- Variant B: the exporter is a CEE country (i∊CEE), and the trading partner (*g*) acts as the importer (*j* = *g*), excluding Russia and Belarus; HS4 ∊ {2701, 2709, 2710, 2711}.

For each trading partner (*g*), the total volume of trade in the *pre*-war (2; 4) and *post*-war (3; 5) periods is calculated using data from the United Nations Comtrade database (2025):

$$\mathrm{Im}_g^{\mathrm{pre}} = \sum_{j\in \mathrm{CEE}} \sum_{i=g} \mathrm{Imports}_{ij,HS27,2017-2021}, \tag{2}$$

$$\mathrm{Im}_g^{\mathrm{post}} = \sum_{\mathrm{j}\in \mathrm{CEE}} \sum_{\mathrm{i=g}} \mathrm{Imports}_{ij,HS27,2022-2024}, \tag{3}$$

$$X_g^{\mathrm{pre}} = \sum_{i\in \mathrm{CEE}} \sum_{j=g} \mathrm{Exports}_{ij,HS27,2017-2021}, \tag{4}$$

$$X_g^{\mathrm{post}} = \sum_{i\in \mathrm{CEE}} \sum_{j=g} \mathrm{Exports}_{ij,HS27,2022-2024}, \tag{5}$$

where:
$\mathbf{Im}_g^{\mathbf{pre}}$ – the total value of HS27 imports from partner (*g*) to all CEE in the period (2017–2021);
$\mathbf{Im}_g^{\mathbf{post}}$ – the total value of HS27 imports from partner (*g*) to all CEE in the period (2022–2024);
$X_g^{\mathbf{pre}}$ – the total value of HS27 exports from CEE to partner (g) in the period (2017–2021);
$X_g^{\mathbf{post}}$ – the total value of HS27 exports from CEE to partner (*g*) in the period (2022–2024).

Changes in imports (6; 7) and exports (8; 9):

$$\Delta\,\mathrm{Im}_g = \mathrm{Im}_g^{\mathrm{post}} - \mathrm{Im}_g^{\mathrm{pre}}, \tag{6}$$

$$\Delta \mathrm{Im}_g\% = \left(\Delta \mathrm{Im}_g / \mathrm{Im}_g^{\mathrm{pre}}\right) 100\%, \tag{7}$$

$$\Delta X_g = X_g^{\mathrm{post}} - X_g^{\mathrm{pre}}, \tag{8}$$

$$\Delta X_g\% = \left(\Delta X_g / X_g^{\mathrm{pre}}\right) 100\%, \tag{9}$$

where:
$\Delta \mathrm{Im}_g$ and ΔX_g – the absolute change in imports and exports, calculated as the difference between *post*-war and *pre*-war trade values;
$\Delta \mathrm{Im}_g\%$ and $\Delta X_g\%$ – the percentage change in imports and exports, calculated relative to *pre*-war trade values.

The use of cumulative sums rather than averages is consistent with the logic of the GAP analysis, whose purpose is to reconstruct the actual magnitude of the supply gap created by the loss of Russian and Belarusian energy deliveries. This gap is quantitative in nature and refers to missing physical volumes; therefore, comparing the total import and export volumes in the *pre*- and *post*-war periods makes it possible to identify which countries effectively replaced the lost supply, and to what extent. The sum of values also allows us to distinguish ordinary economic growth from genuine structural realignments in the geography of trade.

The differing lengths of the *pre*- and *post*-war periods reflect the adoption of the same time horizon used in the PPML gravity models, ensuring methodological consistency across approaches. In this way, the GAP analysis complements the PPML estimations: it separates temporary price-driven effects from persistent structural adjustments and identifies the real substitutes for Russian and Belarusian energy flows. Together, both methods provide a comprehensive and robust picture of post-2022 adjustments in CEE energy supply chains. It should be emphasised that GAP is a descriptive tool: it measures changes in observed trade flows and does not identify causal substitution effects.

To complement the PPML gravity models and the GAP analysis, an additional analytical tool the RP indicator is introduced to capture intra-regional energy flows in CEE that may have arisen due to the abrupt redirection of supply sources after 2022. Such flows are not directly observable in the PPML framework, which focuses on trade volumes and price effects, nor in the GAP analysis, which examines shifts in import patterns. Therefore, the RP indicator serves as a complementary instrument that enables a reconstruction of the potential redistribution of energy products within CEE.

The RP indicator is a simple but conservative measure of the maximum physically plausible scale of flows that could take the form of intra-CEE re-exports. Because it relies on official import and export statistics, it cannot precisely identify movements resulting from fuel mixing, refinery blending, or transit shipments recorded differently across customs systems. RP should, therefore, be interpreted as a potential measure rather than an estimate of realised re-exports – an upper bound of possible intra-CEE flows rather than a direct measure of physical movements. This approach helps assess whether a given CEE country could have acted as a trading hub for HS27 products.

The indicator uses a minimum operator, reflecting physical constraints on commodity flows: no country can re-export more than it imports from non-CEE suppliers (supply constraint) or more than it exports to CEE partners (demand constraint). This construction is consistent with flow-accounting logic in analyses of energy transit and supply-chain routing, where indirect flows are bounded by available imports or maximum onward exports (Lahr 2005; Singh and Eisenmenger 2010; Dietzenbacher et al. 2013; Los, Timmer, and de Vries 2016).

$$\mathrm{RP}_{i,t} = \min\left(\mathrm{Im}_{i,t}^{\mathrm{nonCEE}}, X_{i,t}^{\mathrm{CEE}}\right), \tag{10}$$

$$\mathrm{Im}_{i,t}^{\mathrm{nonCEE}} = \sum_{j \notin \mathrm{CEE}} \mathrm{trade\_value}_{j,i,t}, \tag{11}$$

$$\mathrm{X}_{i,t}^{CEE} = \sum_{j \in CEE, j \neq i} trade\_value_{i,j,t}, \tag{12}$$

where:

$\mathrm{RP}_{i,t}$ – the potential re-export of energy products by country (*i*) in year (*t*);

min (•) – a logical operator indicating that the potential re-export ($\mathrm{RP}_{i,t}$) is simultaneously constrained by the volume of available imports from outside the CEE region and by the volume of exports to other CEE countries;

$\mathrm{Im}_{i,t}^{\mathrm{nonCEE}}$ – the value of HS27 energy imports of country (*i*) from non-CEE partners in year (*t*);

$X_{i,t}^{\mathrm{CEE}}$ – the value of HS27 energy exports from country (*i*) to other CEE countries in year (*t*).

For any variable $\mathrm{Z}_{i,t} \in \{Im_{i,t}^{nonCEE}, X_{i,t}^{\mathrm{CEE}}, \mathrm{RP}_{i,t}\}$, average annual changes were calculated for the *pre*-war period (2017–2021) and the *post*-war period (2022–2024). To ensure comparability between periods of unequal length, variable values were expressed as annual averages. Accordingly, (T_{pre}) denotes the number of years in the pre-2022 period, while (T_{post}) denotes the number of years in the post-2022 period. The average annual value of variable ($Z_{i,t}$) was therefore computed as (13; 14):

$$\mathrm{Z}_i^{pre} = (1/\mathrm{T}_{pre}) \sum_{t \in pre} \mathrm{Z}_{i,t}, \tag{13}$$

$$\mathrm{Z}_i^{post} = (1/\mathrm{T}_{post}) \sum_{t \in post} \mathrm{Z}_{i,t}. \tag{14}$$

The level change (15) and the percentage change (16) of indicator (Z_i) were then defined as:

$$\Delta Z_i = Z_i^{\mathrm{post}} - Z_i^{\mathrm{pre}}, \tag{15}$$

$$\Delta Z_i^{(\%)} = \left[\frac{Z_i^{\mathrm{post}} - Z_i^{\mathrm{pre}}}{Z_i^{\mathrm{pre}}}\right] \times 100\% \ \left(\text{undefined if } Z_i^{\mathrm{pre}} = 0\right). \tag{16}$$

This construction reflects the economic logic of energy distribution within the CEE region: a country cannot act as an intermediary to a greater extent than allowed by its import position and its capacity to export within the region. Consequently, the RP indicator functions as a measure of regional hub potential, enabling the identification of economies that may have played a central role in redistributing energy commodities. It also provides insight into the extent to which intra-regional supply chains were reconfigured following the loss of Russian and Belarusian supplies.

Empirical Results

Table 1 presents the PPML estimation results for the import of energy products (HS27) to CEE countries (model variant A). The most important finding concerns the impact of EU sanctions imposed on Russia and Belarus from 2022 onwards. Specifically, the coefficient on the *Sanction* variable is strongly negative and highly statistically significant (β = –5.0872, p < 0.001). In the log-linear interpretation of the PPML model, this corresponds to a reduction in import flows of approximately 99.4%. This indicates that the introduction of sectoral sanctions led to an almost complete cessation of energy trade between CEE countries and the sanctioned partners. Consequently, these findings provide clear empirical evidence of the abrupt collapse of energy imports from Russia and Belarus after 2022.

Table 1. PPML gravity model estimates for import flows of energy products (HS27) – model variant A (CEE as importers)

Variable	Coefficient	Std. Error	Z-stat	p-value	95% CI (lower)	95% CI (upper)
Constant	17.4653***	0.237	73.731	0.000	17.001	17.930
$\mathrm{Sanction}_{ijkt}$	−5.0872***	0.390	−13.060	0.000	−5.851	−4.324
$\mathrm{Brent}_t \cdot 1\{k \in \{2709, 2710\}\}$	0.0166***	0.003	5.698	0.000	0.011	0.022
$\mathrm{TTF}_t \cdot 1\{k = 2711\}$	0.0538***	0.013	4.284	0.000	0.029	0.078
$\mathrm{Coal}_t \cdot 1\{k = 2701\}$	0.0007	0.002	0.447	0.655	−0.002	0.004
Country FE: Croatia	−0.0841	0.197	−0.428	0.669	−0.469	0.301
Country FE: Czechia	0.4584**	0.191	2.394	0.017	0.083	0.834
Country FE: Estonia	−0.9374***	0.219	−4.284	0.000	−1.366	−0.509
Country FE: Hungary	0.5554***	0.195	2.848	0.004	0.173	0.938
Country FE: Latvia	0.7086***	0.223	3.173	0.002	1.146	0.271
Country FE: Lithuania	0.4887**	0.208	2.355	0.019	0.082	0.896
Country FE: Poland	1.1829***	0.193	6.139	0.000	0.805	1.560
Country FE: Romania	0.2709	0.194	1.397	0.162	−0.109	0.651
Country FE: Slovakia	0.2359	0.196	1.202	0.229	−0.149	0.621
Country FE: Slovenia	−0.3958*	0.221	−1.790	0.073	−0.829	0.038
Year FE: 2018	−0.0398	0.209	−0.190	0.849	−0.450	0.371
Year FE: 2019	0.0140	0.203	0.069	0.945	−0.383	0.411
Year FE: 2020	−0.1460	0.207	−0.706	0.480	−0.551	0.259
Year FE: 2021	−0.1565	0.207	−0.755	0.450	−0.563	0.250

Variable	Coefficient	Std. Error	Z-stat	p-value	95% CI (lower)	95% CI (upper)
Year FE: 2022	− 0.2034	0.298	− 0.683	0.494	− 0.787	0.380
Year FE: 2023	− 0.0104	0.214	− 0.049	0.961	− 0.430	0.409
Year FE: 2024	− 0.0790	0.208	− 0.380	0.704	− 0.486	0.328

Notes: ***, **, and * indicate significant at the 1%, 5% and 10% levels, respectively. Bulgaria serves as the reference category for the country fixed effects; its coefficient is absorbed by the model intercept. Model fit: $N = 9{,}298$; $df = 21$; Log-Likelihood = -2.9199×10^{12}; Deviance = 5.8397×10^{12}; Pearson $\chi^2 = 1.84 \times 10^{13}$; Pseudo $R^2 = 1.000$.

Source: authors' calculations.

Energy price indices also have a statistically significant effect on import volumes. Higher Brent crude prices are associated with increased imports of crude oil and refined petroleum products (HS2709–2710), with the coefficient of 0.0166 ($p < 0.001$) indicating that a one-unit rise in the Brent index raises imports by roughly 1.7%. A comparable pattern emerges for natural gas (TTF, HS2711): the coefficient of 0.0538 ($p < 0.001$) implies that a one-unit increase in the gas price index boosts imports by about 5.5%. These results reflect limited short-run demand elasticity in CEE, where supply-security needs especially during mandatory storage-filling periods override short-term price responsiveness. By contrast, the coal price index (HS2701) is not statistically significant, suggesting no measurable price sensitivity in coal imports during the period studied.

The country fixed effects confirm substantial structural heterogeneity within the CEE region. Specifically, Poland, Latvia, Hungary, Lithuania and Czechia display significantly positive fixed effects, reflecting persistently higher import levels driven by industrial demand, economic scale and their roles in regional energy markets. In contrast, Estonia and Slovenia exhibit negative fixed effects, indicating structurally lower import needs. This highlights the importance of accounting for country-specific characteristics to obtain reliable estimates.

The year fixed effects are statistically insignificant, suggesting that once sanctions and global energy prices are included, no additional time-specific shocks influence HS27 import flows. Thus, post-2022 changes are primarily driven by sanctions and global price dynamics rather than broader temporal trends.

Overall, the results show that the geopolitical shock of 2022 and the EU sanctions regime fundamentally reshaped CEE energy imports, confirming both the collapse of trade with sanctioned suppliers and the region's continued sensitivity to global energy prices. The positive fixed effects for Hungary and, to a lesser extent, Slovakia, capture their overall dependence on energy imports; however, external evidence indicates that both countries remain disproportionately reliant on Russian supplies a pattern not fully identifiable within the PPML framework (Sabadus 2025).

Table 2 summarizes the GAP analysis (variant A), illustrating changes in CEE energy imports (HS27) after 2022 and identifying the main suppliers that expanded deliveries to the region. These increases reflect both direct substitution for Russian inputs and the growing importance of European energy hubs whose additional imports largely represent re-export activity.

Table 2. GAP analysis results for energy imports (HS27) to CEE countries – variant A

Partner country/region	Pre-2022 (USD billion)	Post-2022 (USD billion)	Δ Change (USD billion)	Δ Change (%)
Norway	2.9409	27.1699	24.2289	823.9
Gulf countries	9.3599	34.9368	25.5769	273.3
USA	6.0170	21.1688	15.1518	251.8
North Africa	1.0562	3.1992	2.1430	202.9
Netherlands	1.4025	3.6981	2.2957	163.7
UK	1.8576	4.7789	2.9213	157.3
Belgium	1.3155	2.4135	1.0971	83.5
Italy	5.5599	8.4341	2.8742	51.7
Germany	12.1998	18.0890	5.8892	48.3
France	0.7333	0.8228	0.0895	12.2

Notes: Gulf includes Saudi Arabia, the United Arab Emirates, Qatar, Kuwait, Oman and Bahrain. North Africa includes Algeria and Libya.
Source: authors' calculations.

The results clearly confirm a substantial reorientation of energy imports in CEE countries after 2022. The strongest substitution effect is observed for Norway, whose deliveries increased more than eightfold (to over USD 27 billion), making it the principal supplier of pipeline gas to the region. Gulf countries expanded their exports to CEE by more than USD 25 billion, becoming the key replacement for Russian crude oil particularly for refineries in Poland, Lithuania, and Romania. The United States recorded an increase of approximately USD 15 billion, strengthening its position as the dominant supplier of LNG to regional terminals, such as Świnoujście in Poland and Krk in Croatia.

The results also point to a significant rise in trade flows between CEE countries and selected Western European economies after 2022, reflecting the redirection of energy supply routes following the interruption of imports from Russia and Belarus. The largest increases are associated with countries that function as major European energy hubs through which "new molecules" of gas, oil, and LNG originating mainly from the United States, Norway, Qatar, and North African exporters entered the EU market.

The principal distribution nodes include the Netherlands (the Port of Rotterdam and the Gate LNG terminal), Belgium (the Zeebrugge terminal), Italy, and France, all of which played a central role in receiving, regasifying, and forwarding these supplies towards CEE markets. For example, imports from the Netherlands increased by over 160%, reflecting its role as a hub for LNG and refined petroleum products. The United Kingdom and Germany also partially fulfilled similar functions, acting as intermediaries in transit and blending operations.

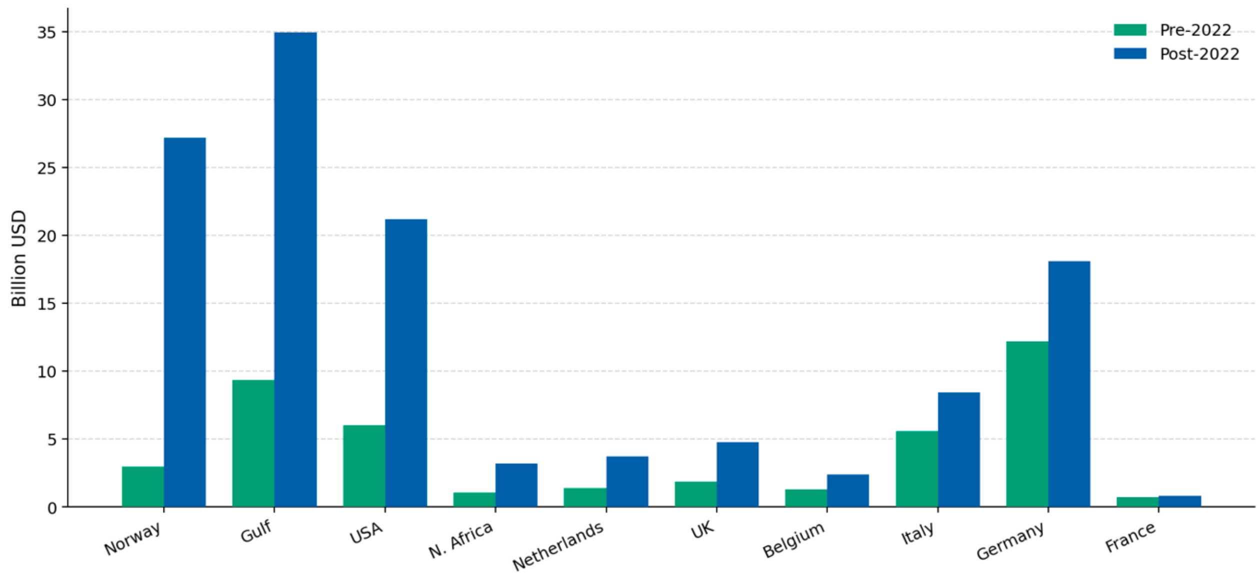
Overall, the findings indicate a profound restructuring of the geographic composition of energy imports, marked by a decisive shift away from Russia towards a diversified network of global suppliers dominated by LNG exporters (the United States, the Gulf region, North Africa) and Norway as the principal provider of pipeline gas. The scale and asymmetry of these shifts are illustrated in Figure 1, which shows the pre- and post-2022 import volumes for each partner group.

Table 3. PPML gravity model estimates for export flows of energy products (HS27) – variant B (CEE as exporters)

Variable	Coefficient	Std. Error	Z-stat	p-value	95% CI (lower)	95% CI (upper)
Constant	16.847***	0.273	61.633	0.0	16.311	17.383
$\mathrm{Sanction}_{ijkt}$	− 2.4128***	0.311	− 7.77	0.0	− 3.021	− 1.804
$\mathrm{Brent}_t \cdot 1\{k \in \{2709, 2710\}\}$	0.0154***	0.003	5.136	0.0	0.01	0.021
$\mathrm{TTF}_t \cdot 1\{k = 2711\}$	0.0489***	0.013	3.793	0.0	0.024	0.074
$\mathrm{Coal}_t \cdot 1\{k = 2701\}$	0.0027*	0.002	1.758	0.079	− 0.0	0.006
Country FE: Croatia	0.0873	0.235	0.371	0.71	− 0.374	0.548
Country FE: Czechia	− 0.8165***	0.235	− 3.472	0.001	− 1.277	− 0.356
Country FE: Estonia	− 0.7523***	0.25	− 3.007	0.003	− 1.243	− 0.262
Country FE: Hungary	− 0.3531	0.228	− 1.552	0.121	− 0.799	0.093
Country FE: Latvia	− 1.2919***	0.262	− 4.933	0.0	− 1.805	− 0.779
Country FE: Lithuania	0.1362	0.251	0.542	0.588	− 0.357	0.629
Country FE: Poland	− 0.412*	0.231	− 1.783	0.075	− 0.865	0.041
Country FE: Romania	0.1178	0.242	0.487	0.626	− 0.356	0.591
Country FE: Slovakia	− 0.0852	0.259	− 0.329	0.742	− 0.592	0.422
Country FE: Slovenia	− 0.3252	0.268	− 1.216	0.224	− 0.849	0.199
Year FE: 2018	− 0.0963	0.228	− 0.422	0.673	− 0.544	0.351
Year FE: 2019	− 0.1374	0.226	− 0.609	0.543	− 0.58	0.305
Year FE: 2020	− 0.3623	0.219	− 1.657	0.097	− 0.791	0.066
Year FE: 2021	− 0.3368	0.228	− 1.48	0.139	− 0.783	0.109
Year FE: 2022	− 0.2882	0.324	− 0.89	0.374	− 0.923	0.347
Year FE: 2023	− 0.1417	0.239	− 0.594	0.552	− 0.609	0.326
Year FE: 2024	− 0.1262	0.232	− 0.544	0.586	− 0.58	0.328

Notes: ***, **, and * indicate significant at the 1%, 5% and 10% levels, respectively. Bulgaria serves as the reference category for the country fixed effects; its coefficient is absorbed by the model intercept. Model fit: N = 10,823; df = 21; Log-Likelihood = -1.0295×10^{12}; Deviance = 2.0590×10^{12}; Pearson $\chi^2 = 9.96 \times 10^{12}$; Pseudo R^2 = 1.000.

Source: authors' calculations.



Note: Pre-2022 values represent cumulative imports for 2017–2021; post-2022 values cover 2022–2024. Gulf includes Saudi Arabia, the United Arab Emirates, Qatar, Kuwait, Oman and Bahrain. North Africa includes Algeria and Libya.

Figure 1. Changes in CEE energy imports by partner country/region before and after 2022 (HS27, billion USD)
Source: authors' calculations based on United Nations Comtrade 2025.

The PPML gravity model estimated for export flows (variant B, Table 3) indicates a very sharp decline in CEE exports to Russia and Belarus following the introduction of sanctions. The coefficient on the *Sanction* variable is negative and highly statistically significant (–2.4128, $p < 0.001$), corresponding to an export reduction of approximately 91% relative to the pre-sanction period. Energy price indices exert a positive and statistically significant effect on exports of crude oil (Brent) and natural gas (TTF), while the coal price index shows a weaker and only marginally significant effect.

The fixed effects at the country level reveal heterogeneous baseline levels of exports across CEE economies. Latvia, Czechia and Estonia display the lowest export levels, indicating that these countries were already sending relatively small volumes of energy products to Russia and Belarus before the sanctions. The model, therefore, reflects underlying structural differences rather than sanction-related declines in these specific cases.

The year fixed effects remain statistically insignificant, confirming that the sharp contraction in export flows is driven primarily by the sanction regime rather than by general trade-trend dynamics.

Table 4. GAP results: partner countries/regions to which CEE energy exports (HS27) changed the most after 2022 – model variant B

Partner country/region	Pre-2022 (USD billion)	Post-2022 (USD billion)	Δ Change (USD billion)	Δ Change (%)
Gulf	1.0457	0.3480	− 0.6977	− 66.72
France	0.6557	0.3264	− 0.3293	− 50.22
Norway	0.2490	0.1495	− 0.0995	− 39.94
Caspian	0.1591	0.1044	− 0.0547	− 34.36

Partner country/region	Pre-2022 (USD billion)	Post-2022 (USD billion)	Δ Change (USD billion)	Δ Change (%)
UK	1.0179	0.6804	− 0.3375	− 33.15
Belgium	0.9837	0.6820	− 0.3018	− 30.68
Germany	4.9596	3.4435	− 1.5161	− 30.57
North Africa	0.9065	0.6522	− 0.2543	− 28.05
Spain	0.3394	0.3271	− 0.0123	− 3.63
Other	170.1257	177.3252	7.1995	4.23

Notes: Caspian includes Kazakhstan and Azerbaijan; Gulf includes Saudi Arabia, the United Arab Emirates, Qatar, Kuwait, Oman and Bahrain; North Africa includes Algeria and Libya; Other covers all remaining countries not assigned to the specified groups.

Source: authors' calculations.

The selection of countries and regions in Table 4 follows the same logic as in the import-side GAP analysis: it includes the CEE countries' key trading partners and the major regional energy-market clusters that played an important role in HS27 trade prior to 2022. This set of partners allows for a direct comparison of changes on both the supply side (imports) and the demand side (exports), enabling an assessment of whether CEE countries were able to redirect their sales toward the same markets from which they sourced substitutes for Russian supplies.

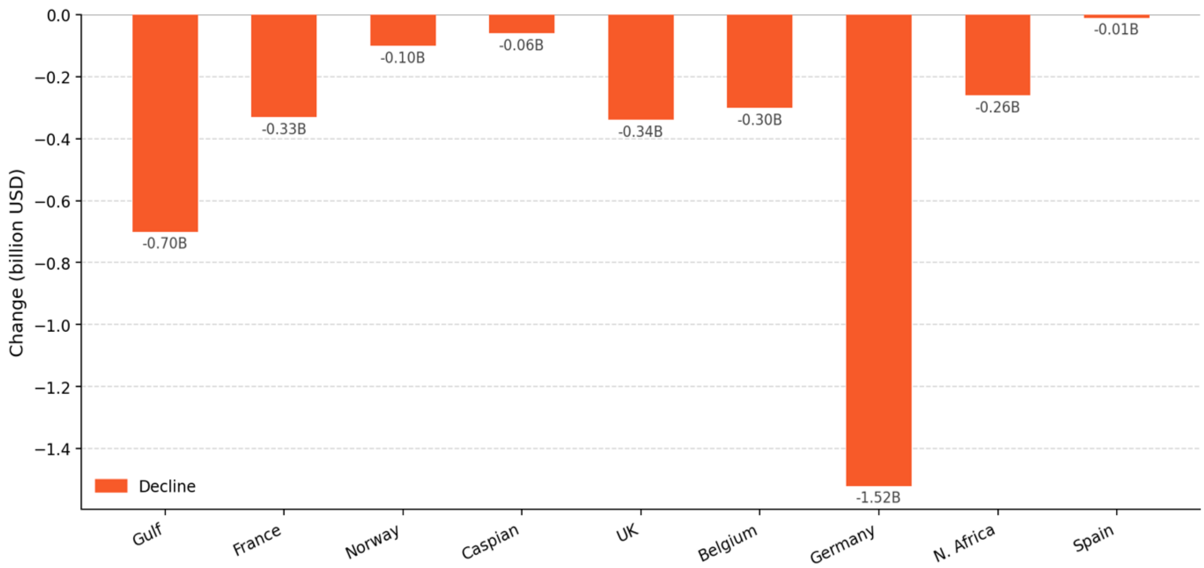
The GAP analysis of changes in CEE energy export destinations (HS27) shows that, following the loss of Russian and Belarusian markets, CEE countries were largely unable to significantly redirect their exports to other destinations. In contrast to import patterns, export adjustments are modest and, in many cases, clearly negative. The only group of destinations exhibiting an increase is the "Other" category representing markets outside the major trading partners where exports grew by just 4.23%. All other destinations recorded substantial declines in CEE export values, with the largest contractions observed for the Gulf region (–66.7%), France (–50.2%), Norway (–39.9%), the Caspian region (–34.4%), the UK (–33.2%), Belgium (–30.7%) and Germany (–30.6%). These results reflect the structural dependence of CEE refineries on low-cost Russian crude oil prior to 2022. Once access to Russian crude was restricted, production costs rose, and feedstock availability declined naturally leading to reduced export volumes of fuels and refined petroleum products to both European and global markets. Figure 2 illustrates the contrast between import-side and export-side adjustment: whereas imports expanded substantially across most partner groups, export flows declined almost universally, with only marginal gains recorded in the "Other" category.

Table 5. Re-export potential in CEE countries (in billion USD)

CEE country	Imports from non-CEE		Exports to CEE		Re-export Potential		Re-export Potential (Δ)	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	USD	%
Bulgaria	8.131	13.184	0.171	0.65	0.171	0.65	0.478	**279.0**
Croatia	4.566	12.336	0.414	1.339	0.414	1.339	0.925	**223.7**
Estonia	2.659	3.262	0.063	0.178	0.063	0.178	0.116	**184.7**

CEE country	Imports from non-CEE		Exports to CEE		Re-export Potential		Re-export Potential (Δ)	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	USD	%
Slovenia	4.74	9.285	0.438	1.139	0.438	1.139	0.701	**159.9**
Romania	10.888	18.374	0.602	1.51	0.602	1.51	0.908	**151.0**
Lithuania	10.439	18.534	1.417	3.07	1.417	3.07	1.653	**116.6**
Latvia	2.09	3.898	0.256	0.552	0.256	0.552	0.295	**115.3**
Czechia	15.42	27.687	0.889	1.418	0.889	1.418	0.529	**59.6**
Poland	33.756	58.917	0.83	1.256	0.83	1.256	0.426	**51.3**
Slovakia	11.04	17.429	1.332	1.655	1.332	1.655	0.323	**24.2**
Hungary	12.992	22.022	0.724	0.792	0.724	0.792	0.068	**9.3**

Source: authors' calculations.



Note: The "Other" category (pre-2022: USD 170.1 billion; post-2022: USD 177.3 billion) is excluded from the figure to preserve scale readability. Caspian includes Kazakhstan and Azerbaijan. Gulf includes Saudi Arabia, the United Arab Emirates, Qatar, Kuwait, Oman and Bahrain. North Africa includes Algeria and Libya. Pre-2022 values represent cumulative exports for 2017–2021; post-2022 values cover 2022–2024.

Figure 2. Changes in CEE energy export values by destination before and after 2022 (HS27, billion USD)

Source: authors' calculations based on United Nations Comtrade 2025.

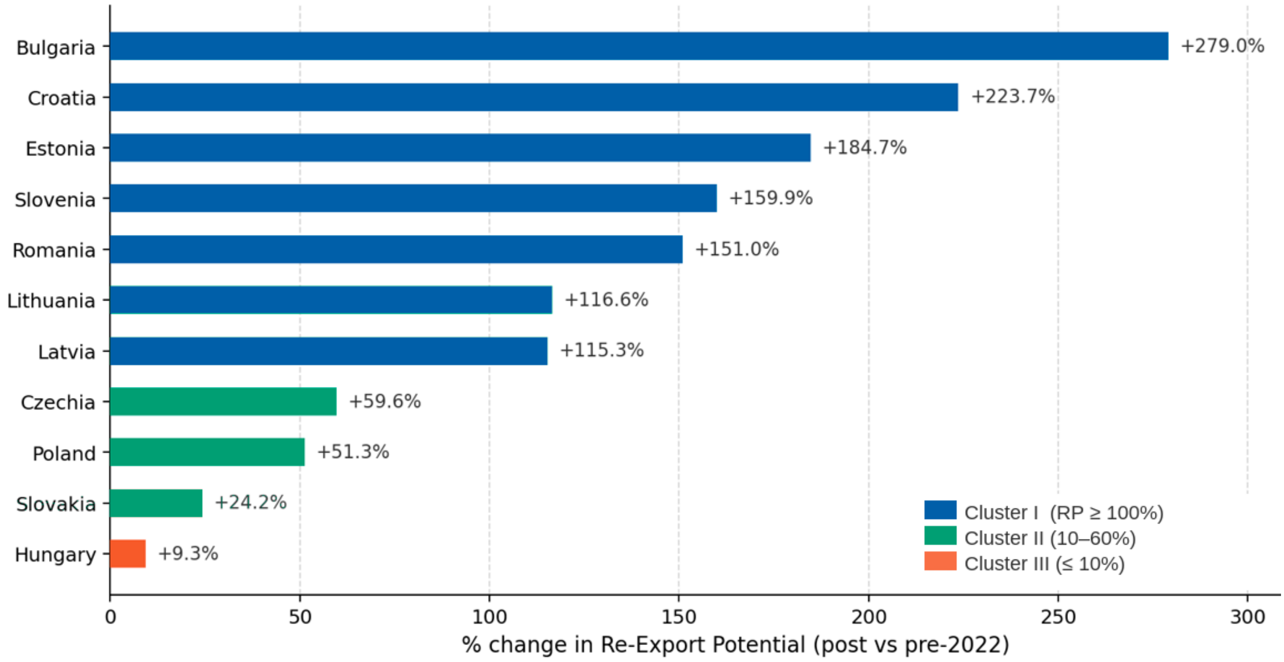
The analysis of the RP indicator reveals substantial differences in how CEE countries adapted to the reshaping of the regional energy landscape after 2022 (Table 5). Applying a clustering approach based on RP dynamics distinguishes three groups of countries that responded differently to the disruption of traditional import routes from the Russian Federation.

Cluster I (RP ≥ 100%): Bulgaria, Croatia, Romania, Slovenia, Lithuania, Estonia, and Latvia. Countries in this cluster recorded the largest increases in RP, exceeding 100% relative to the pre-2022 period. This reflects a simultaneous intensification of imports from outside the CEE region and an expansion of intra-regional exports. Particularly strong increases are observed in Bulgaria (+279%) and Croatia (+224%), which corresponds to the rising importance of the Black Sea and Adriatic corridors as key diversification routes. Bulgaria's exceptionally high RP growth is primarily due to its hosting the largest refinery in the Balkans. After 2022, Bulgaria was the only CEE country allowed to continue importing Russian crude oil by sea under an EU exemption, which enabled it to maintain high production levels and increase exports of refined petroleum products to neighbouring CEE markets (Trusewicz 2025). As a result, Bulgaria effectively acted as a regional fuel hub reflected directly in its RP values. Croatia, in turn, is transforming into a regional energy hub for CEE. The floating LNG terminal on the island of Krk plays a pivotal role as an additional supply source and as a distribution point for gas flows to Hungary, Slovenia, and Romania. Combined with increasing investments in renewable energy, Croatia is strengthening its position as one of the region's main infrastructure nodes (Vienna Institute for International Economic Studies & Friedrich-Ebert-Stiftung 2023).

The strong dynamics observed in the Baltic states (Lithuania, Latvia, Estonia) are consistent with their complete phase-out of Russian imports and the intensive use of the LNG terminal in Klaipėda, Lithuania, which became the main entry point for non-Russian gas into the region after 2022. Infrastructure integration among the Baltic states also supports growing intra-regional exchange: Estonia has increased its flows to Lithuania, while Latvia sends substantial volumes of gas to Lithuania, part of which is subsequently directed to Poland. Collectively, the Baltic countries now function as a coherent and interconnected distribution corridor, which is directly reflected in their rising RP (International Energy Agency 2023; 2025b; Paszkowski 2025).

Cluster II (RP 10–60%): Czechia, Poland, and Slovakia. Countries in this cluster exhibit moderate yet statistically significant increases in RP. These economies have a large domestic demand and relatively high baseline values, which naturally limit relative growth. Czechia (+59.6%) and Poland (+51.3%) expanded imports from outside the CEE region, in line with European Commission (2024) data highlighting the growing role of LNG terminals and interconnections with Western European markets. Slovakia (+24.2%) maintains a stable transit role, consistent with reports on the sustained use of its transmission infrastructure (International Energy Agency 2024). The slower pace of adjustment in Slovakia and Hungary reflects not only domestic policy choices but also binding infrastructure constraints: both countries remain dependent on the Druzhba pipeline system, which lacks viable short-term alternatives and limits the speed at which supply diversification can be achieved.

Cluster III (RP ≤ 10%): Hungary. Hungary recorded the lowest RP dynamics (+9.3%), indicating a marginal role in energy redistribution. Despite increasing non-CEE imports, intra-regional exports did not rise, suggesting the predominance of domestic consumption. These results reflect Hungary's continued strong energy ties with Russia and its limited speed of diversification (Levi et al. 2025; Sabadus 2025). Figure 3 summarises the RP dynamics across all eleven CEE countries, highlighting the three-cluster structure and the markedly divergent adjustment trajectories within the region.



Note: Re-Export Potential (RP) is defined as the minimum of a country's HS27 imports from non-CEE partners and its HS27 exports to other CEE countries. Values reflect average annual figures for 2017–2021 (pre-2022) and 2022–2024 (post-2022). RP represents an upper-bound measure of potential intra-regional re-export flows, not an estimate of realised physical movements.

Figure 3. Re-export potential in CEE countries: percentage change between pre- and post-2022 periods (HS27)
Source: authors' calculations based on United Nations Comtrade 2025.

The RP results confirm a structural reshaping of the geographical distribution of energy flows within the CEE region. The most dynamic developments are observed in emerging Balkan, Adriatic and Baltic hubs, whereas the region's largest economies exhibit stable and moderate growth. Hungary continues to stand out as the country that most strongly deviates from regional diversification trends. The clustering outcomes fully reflect the direction of transformation described in institutional reports and the broader literature on Europe's energy security.

Policy Implications

The results of the study have a number of implications for energy policy in CEE. First, the almost complete stop of HS27 imports from Russia and Belarus shows that long-term supply relationships can be broken almost overnight. Diversification strategies should include pipeline supplies, LNG capacity, storage, and a wider range of crude and refined products. Second, the GAP results show that replacing imports has not been consistent across products and partners. Therefore, diversification policies should consider the technical limits of specific products in refineries and power systems.

Third, the limited redirection of CEE energy exports reflects structural weaknesses in refinery configuration and downstream market access. Policies for industry and energy should encourage investments that make it easier to use non-Russian feedstocks and boost regional demand that can absorb extra production. As the RP indicator represents an upper-bound measure of possible intra-regional flows rather than an estimate of realised re-exports, policy conclusions regarding hub capacity should be interpreted accordingly.

Fourthly, the fact that few CEE hubs have a lot of potential for re-export shows how important cross-border infrastructure and coordinated EU-level planning for terminals, pipelines, and interconnections are for regional energy security. Finally, the structural vulnerabilities identified in this study extend beyond the current Russia–Ukraine context. Future geopolitical shocks whether affecting LNG supply routes, Gulf exporters, or key transit infrastructure could rapidly expose the remaining dependencies of CEE energy systems, reinforcing the case for continued diversification and regional coordination.

Conclusion

The analysis conducted in this study provides clear and consistent evidence addressing the research question and confirms both hypotheses formulated in the introduction.

First, the PPML model results support Hypothesis 1, demonstrating that EU sectoral sanctions and associated supply shocks after 2022 led to a profound reorientation of energy import structures in CEE countries. Following the introduction of EU sectoral sanctions, energy imports from Russia and Belarus declined by more than 99%, evidencing a profound disruption of prior trade linkages. GAP analysis further confirmed that this supply gap was filled by alternative suppliers primarily Norway, the Gulf states, the United States and North African exporters as well as by Western European energy hubs. Consequently, the import structure of the region underwent not only a rapid but also a structural and enduring transformation.

Second, the PPML estimates and GAP results also confirm Hypothesis 2, concerning changes in the export structure of energy products from CEE countries. Following the sanctions, exports to Russia and Belarus fell by more than 90%, while the region was largely unable to redirect its energy exports to alternative markets aside from a modest increase in the "Other" category. This indicates that, unlike imports, exports were not successfully diversified, reflecting higher production costs after the loss of Russian crude oil and the limited structural flexibility of CEE refineries.

A complementary analysis of the RP reveals that, after 2022, the region not only reconfigured its import sources but also underwent an internal reorganisation, forming new intra-regional energy distribution corridors. The strongest RP dynamics were recorded in the Balkan, Adriatic and Baltic states, which began to function as emerging regional hubs. These findings confirm that the transformation of energy trade in the CEE region is systemic in nature and is leading to the emergence of new economic functions within the region.

Taken together, recent policy developments, current import trends and the most up-to-date analytical assessments reinforce the empirical findings in this study. Europe's energy system has moved from short-term crisis management to a long-term structural transformation increasingly embedded in regulatory commitments and market practices. At the same time, persistent regional differences, especially in terms of continued infrastructural constraints affecting several CEE economies, remain crucial for understanding future re-export patterns, adjustment capacities, as well as individual member states' vulnerabilities.

In sum, this study provides coherent and robust evidence that the Russia–Ukraine war and the EU sanctions regime have become key drivers in the geographical reconfiguration of energy trade in CEE. This directly addresses the research question and confirms both hypotheses: the region successfully diversified its energy imports, while its capacity to restructure energy exports remained limited. The resulting transformation is structural in nature and likely to persist over the medium term, forming a new basis for further research into energy security and economic resilience in Central and Eastern Europe.

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