

Energy security and economic growth: Lessons from recent energy shocks in the EU

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ABSTRACT

Ongoing geopolitical disruptions—most notably the war in Ukraine and the escalation of the Middle East conflict—have intensified efforts to enhance energy independence and stability in the European Union (EU). Building on the policy narrative developed in the ESM Blog, this brief examines the relationship between energy security and economic growth in the EU over the period 1995–2024, using a recalculated Energy Supply Security Index (ESSI), and a Nonlinear Autoregressive Distributed Lag (NARDL) model. The findings indicate a consistent long-term relationship between GDP, capital, and labour. However, ESSI exerts asymmetric effects on most member states over time. A decrease in energy security generally results in reduced economic activity, whereas an increase does not yield correspondingly positive outcomes within the same time framework. Such asymmetry is indicative of underlying structural factors: sudden disruptions in energy supply often have an immediate adverse impact on growth, whereas improvements in supply and security may yield benefits more gradually, owing to prolonged implementation periods and substantial transitional costs.

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Introduction

Energy security is critical to the EU's economic resilience. Over the past two decades, it has strengthened across most euro area member states, driven in part by progress in developing renewable energy sources. Recent geopolitical disruptions, such as the war in Ukraine, have pushed efforts to improve energy independence and stability. As a result, the European Union has shifted toward a strategy that focuses more on security during its energy transition. This approach reinforces the link between energy security, economic resilience, and the EU's overarching strategic objectives (Marhold, 2023). Energy security is considered an element that can contribute to economic growth, although its impact depends on broader national and regional factors.

The literature suggests that the growth-enhancing effects of enhanced energy security are particularly pronounced in low- and middle-income countries (Le & Nguyen, 2019; Kang, 2022). At the same time, some analyses indicate that positive and negative changes in various energy components do not affect economic performance in the same way. For instance, Kartal (2022) concludes that only increases in energy security risk - rather than improvements - affect Turkey's economic growth. Dritsaki and Dritsaki (2025) identify partial asymmetry regarding renewable energy impacts in Greece, while Georgescu and Kinnunen (2025) highlight pronounced asymmetry associated with nuclear output declines in Finland. Additionally, panel evidence from 17 Asia-Pacific economies demonstrates symmetric long-term benefits from renewables but substantial short-term negative effects from non-renewable sources (Paul, Behera & Sahoo 2022). Taken together, the significant differences in empirical findings indicate a need for thorough analysis that examines both the direction and broader impacts of the energy security-growth nexus.

Although modern growth theory acknowledges energy as an essential production input, the mechanisms linking energy security to growth are still only partially understood and require deeper empirical investigation. This paper addresses a research gap by using multidimensional energy security indicators and examining asymmetric relationships between energy and growth in EU countries. The findings indicate that declines in energy security considerably constrain economic growth. The recent example of Germany also underscores this point: due to the country's heavy dependence on Russian gas and limited alternative infrastructure, it became particularly exposed to unexpected supply interruptions (Lan et al., 2022). Consequently, when Russian gas supplies ceased entirely, Germany experienced major and sustained declines in manufacturing, accompanied by a declining energy security index.

Why we looked at energy security

Energy security has emerged as a defining strategic challenge for the EU, directly shaping its economic competitiveness, strategic autonomy, and long-term growth model. Demertzis et al. (2025) highlight that energy remains one of Europe's key input dependencies, with disruptions in global energy markets feeding directly into higher prices and undermining the EU's economic security. Nunzi (2025) argues that the EU's continued reliance on external energy suppliers has exposed deep systemic vulnerabilities, a pattern starkly demonstrated during the COVID-19 crisis and Russia's invasion of Ukraine.

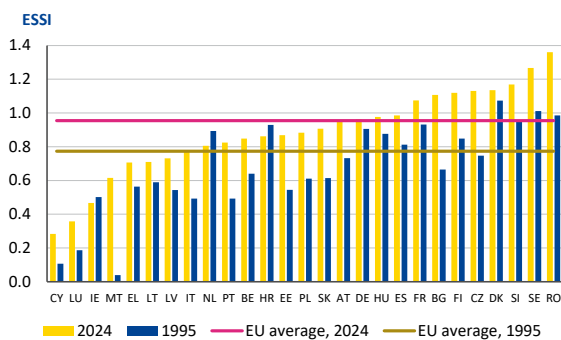
These shocks highlighted shortcomings in the Union's capacity to guarantee supply security, preserve price affordability, and maintain economic autonomy. Europe's energy prices are driven up by a combination of factors, including structural flaws in market design and policy-related elements, as

taxes and network fees all add to the final costs for consumers (Draghi, 2024). Achieving lasting price stability, improving system efficiency and strengthening energy security will therefore require the EU to fully implement the Electricity Market Design (EMD) package¹, expand joint purchasing frameworks, and further invest in cross-border grids.

Assessing the determinants of energy security and identifying indicators of supply risks, geopolitical challenges, and limited diversification is essential for understanding how the EU can protect its economy, strengthen autonomy, and maintain growth in a volatile global energy market. Jansen et al. (2004) developed a multidimensional index to assess energy supply security, incorporating factors such as the diversity of energy sources, import dependence, geographic distribution, and risk from unstable supplier regions (see Annex, Formula 1). This composite approach is consistent with a broader methodological tradition in the literature, illustrated, for example, by the frameworks of Stavtyskyy et al. (2018) and Le and Nguyen (2019), that relies on comparable indicators to evaluate cross-country energy security.

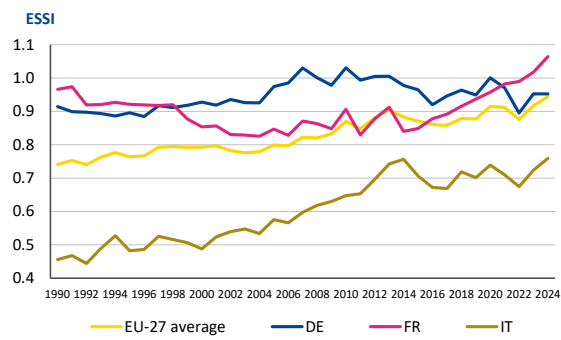
Over the past two decades, the ESSI, calculated using the aforementioned methodological approach, shows a broad improvement in energy security across most EU Member States (see Figure 1). However, the EU energy market faced major disruptions in 2022 due to geopolitical tensions, most notably Russia’s invasion of Ukraine and instability in the Middle East. This, alongside extreme weather events, drove up prices and strained supply chains. The EU responded by actively rolling out emergency measures to diversify energy sources, speeding up investments in renewable energy (Klyviene & Sušec, 2024).

Figure 1.
Energy Security Index: 1995 vs. 2024



Source: ESM calculations.
Note: Lower values correspond to higher risk; The averages are weighted by population share using Eurostat data.

Figure 2.
Energy Supply Security Dynamics: EU-27 and the Three Largest Economies



Source: ESM calculations.
Note: Lower values correspond to higher risk. The averages are weighted by population share using Eurostat data.

While diversification is crucial, other factors also matter: dependence on domestic sources, the geographic distribution of energy imports, and reliance on politically stable regions. Political instability and conflict, such as the war in Ukraine or tension between Algeria and Spain, can cause additional

¹ The EMD (split up into a [directive](#) and a [regulation](#)) was published in the Official Journal of the EU on 26 June and entered into force on 16 July 2024.

disruptions to supply chains. Conflict-driven disruptions in 2022 led to a decline in ESSI values across most EU countries, underscoring vulnerabilities in the energy system and the importance of resilient policies (see Figure 2).

By 2024, the expansion of renewable energy and diversification of imports had reduced reliance on Russian energy and improved energy security, as reflected by the ESSI. A key takeaway from recent shocks is that a strong renewable energy base has enhanced energy resilience in countries like Portugal and Spain, helping to cushion the impact of disruptions originating in the Middle East. While diversification and renewables generally boost security, they may also create new vulnerabilities. For example, hydropower is threatened by climate change and droughts, while the expansion of nuclear power and certain renewable technologies increases dependence on critical minerals from geopolitically unstable regions with limited supply (Kim et al., 2024). However, the ESSI does not fully capture these emerging vulnerabilities, as it does not directly account for climate-related risks or the growing dependence on critical or rare minerals required for nuclear and renewable expansion.

Evidence from the recent energy crisis shows that negative gas supply shocks were both highly significant and economically damaging across Europe, triggering stagflationary pressures, marked by falling output and sharply rising prices, as documented by Alessandri and Gazzani (2023) for the euro area. This damage was amplified by the severe price and supply disruptions observed in Germany following the suspension of Russian gas flows (Lan et al., 2022; Güntner et al., 2024). Expanding on this, another key question is whether achieving energy security through diversification, greater reliance on renewables, and more stable market structures promotes sustained growth in the long run, or whether transition strategies introduce new complexities into the energy security–growth nexus?

International Experience and Empirical Strategy

Efforts to strengthen Europe’s energy security involve substantial long-term costs. The Draghi Report (Draghi, 2024) highlights several key challenges to energy-related competitiveness. Among these are persistently elevated energy prices, high reliance on gas imports, and ongoing issues with bottlenecks in energy infrastructure networks. The European Commission’s State of the Energy Union 2024 (European Commission, 2024) notes that although the EU has made considerable progress in decreasing its dependence on Russian fuels, significant investment requirements, particularly those concerning integrated cross-border energy infrastructure, continue to pose challenges for many Member States.

This Brief analyses annual data from 27 EU countries (1995–2024) to evaluate the impact of energy security on economic performance. It examines GDP and gross fixed capital formation, both adjusted for real values, along with the labour force, and ESSI², utilising the extended Cobb–Douglas production framework proposed by Stern and Cleveland (2004) (see Annex, Formula 2).

The NARDL approach facilitates the analysis of both long-term dynamics and short-term fluctuations, allowing for the assessment of whether variations in energy security have asymmetric effects on

² All variables are log-transformed, except ESSI, which has already been expressed in logarithmic form; therefore, no further transformation is required.

economic outcomes³ (see Annex, Formula 3). The model employs a pooled mean group (PMG) estimator, which presumes that countries exhibit common long-run relationships while permitting differences in their short-run responses. To reflect the interconnectedness of EU countries and shared shocks, the model applies common correlated effects (CCE)⁴ using the methodology of Pesaran (2006). Prior to estimating the model, several statistical checks are performed (see Annex, Tables 1 to 5).

Results: Losses loom larger than gains

The findings detailed in Table 1 demonstrate a strong relationship between economic growth and energy security, capital investment, and labour within the EU. Looking at the long-run elasticities, the findings are consistent with economic theory and previous research. Capital is positively and robustly associated with GDP in the long run and contributes to short-run dynamics (Vollrath, 2024). The labour force is positive in the long run but may display short-run adjustment costs, such as temporary mismatches between skills and job opportunities, consistent with the literature showing that economies require time to absorb increases in labour supply (Hamermesh, 1981).

Table 1. Long-run coefficients, dependent variable: $\Delta \ln Y_{(it)}$ (log real GDP)

Variable	Explicit definition	Coefficient	T-stat	Prob. (p-value)
$\ln LF_{it}$	Log labour force	0.081	2.07	0.039**
$\ln CF_{it}$	Log real gross fixed capital formation (investment)	0.345	32.57	0.000***
$ESSI^+_{it}$	Cumulative positive changes in energy security index	0.021	0.98	0.328
$ESSI^-_{it}$	Cumulative negative changes in energy security index	-0.082	-4.55	0.000***
C	Constant	2.284	0.46	0.646

Note: the significance levels are indicated as follows: *** for $p < 0.01$, ** for $p < 0.05$, and * for $p < 0.10$.

Source: ESM calculations.

A key finding is that energy security exerts an asymmetric impact on economic growth. Unexpected disruptions in supply, especially when supply diversity is low and sources are from politically unstable regions, can substantially reduce long-term GDP. A one-unit reduction in the ESSI implies, *ceteris paribus*, an 8.2% decrease in the long-run level of GDP. As the ESSI ranges only from 0 to 1.5 in the sample, empirically relevant changes are substantially smaller. For example, a deterioration of 0.1 units is associated with an estimated long-run GDP decline of approximately 0.82%. The estimated effect is broadly consistent with findings in earlier studies using composite energy security indicators, although strict numerical comparison is difficult, given differences in indicator construction, functional form, and sample composition (e.g., Stavtysky et al. 2018; Kang 2022). NARDL symmetry tests show significant short-term asymmetric effects of energy security in Belgium, Slovenia, Slovakia, and Latvia

³ The NARDL approach (Shin et al., 2014) models asymmetry by decomposing regressors into positive and negative changes, allowing for differential short- and long-run effects.

⁴ Common correlated effects (CCE) take into account shocks and developments that affect all countries at the same time, such as global energy price movements or geopolitical events.

(see Annex, Table 7). These countries also face short-term energy security challenges, suggesting that more tailored policy responses may be needed⁵.

Positive change in the index is markedly smaller and remains statistically significant in the pooled long-run estimates. This trend is consistent with wider findings suggesting that the advantages of energy security and clean energy investments may be realised over a longer period. Americo et al. (2023) show that shifting to clean, domestic-oriented energy systems requires substantial upfront investment, including grid upgrades and increased demand for critical minerals, which can raise costs and even generate stagflationary pressures in the transition phase. However, as renewable capacity expands, countries ultimately benefit from more stable energy prices, reduced import reliance, stronger trade balances, and productivity gains that support long-term growth.

To make sure the long-run results are reliable, the analysis was repeated using different methods and smaller samples. The model was re-estimated using the 21 countries for which long-run cointegration among the variables can be established. The central idea remains unchanged: Increased capital and labour contribute to economic growth, whereas disruptions in energy security create challenges for economies in a more uneven manner than enhancements in energy security.

In summary, long-term impacts of changes in energy security within the EU energy market are asymmetric. When negative energy shocks occur, such as a sudden reduction in Russian gas pipeline flows to the EU due to war, they spread to the economy by raising costs, increasing risk premiums, and forcing an immediate reallocation of resources. By contrast, the growth effects of energy security improvements are often counterintuitive: even positive developments take time to materialise and depend heavily on country-specific factors before translating into sustained economic gains. The fact that short-run symmetry prevails in most countries suggests that standard stabilisation tools are typically sufficient to mitigate transitory energy shocks, although the exceptions listed above warrant enhanced readiness.

What should policymakers do?

This paper demonstrates that energy security and economic growth in the EU are closely interrelated, with a clear asymmetry in impacts: deteriorations in energy security impose far larger and more immediate economic costs, whereas improvements generate benefits only gradually as infrastructure, storage capacity, and interconnections adjust. While most countries exhibit symmetric short-run responses, a small group appears more vulnerable and require targeted policy interventions. The findings underscore the need for proactive, resilient, and coordinated energy policies to safeguard growth and stability amid an uncertain global environment.

The results carry evident implications for the EU energy policy. First, strengthening resilience to negative energy shocks is crucial, as such events can undermine energy security and often result in prolonged adverse effects on economic growth that outweigh the advantages gained from enhanced energy security. This underscores the need to invest in diversified and stable energy sources, building domestic capacity, while maintaining robust contingency plans. These findings strongly support

⁵ A significantly negative error-correction term signals rapid adjustment toward the long-run equilibrium, while common correlated effects capture the role of shared shocks and spillovers across EU countries.

sustaining the expansion of renewables, as greater penetration improves diversification and reduces vulnerability to external gas and oil shocks.

Second, countries experiencing significant short-term imbalances should strengthen their rapid-response strategies, for example, by maintaining strategic reserves or implementing emergency demand reduction plans. This mitigates the immediate effects of adverse shocks. While these measures can buffer against sudden disruptions, they are often expensive and may disrupt markets if relied upon excessively. Therefore, robust energy security policies should balance long-term diversification with the continued application of short-term protective measures.

Finally, the significance of common shocks and spillovers highlights the importance of policy coordination at the EU level. Joint actions, such as upgrading interconnections, coordinating crisis management, and sharing data, can help manage systemic risks and enhance resilience across the Union.

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