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DOI: https://doi.org/10.37458/ssj.7.1.7
Review Paper
Received: March 4, 2026
Accepted: March 21, 2026

ENERGY SECURITY OF THE SLOVAK REPUBLIC IN THE CONTEXT OF THE ONGOING CONFLICT IN UKRAINE

Abstract: *The Russian invasion of Ukraine in 2022 fundamentally altered the European energy and security architecture, exposing the structural vulnerability of the Slovak Republic, which had been among the most energy-dependent member states of the European Union. This article examines the implications of the Russian–Ukrainian conflict for the energy security of the Slovak Republic. As a landlocked Central European country, Slovakia is heavily dependent on external oil and natural gas supplies, historically supplied via pipelines from the Russian Federation. Before the crisis, Slovakia imported approximately 90% of its natural gas and nearly all of its crude oil from Russia, rendering its economy and political system highly susceptible to external shocks. The war in Ukraine thus has disrupted traditional supply chains, exposed vulnerabilities in energy policy, and accelerated the search for diversification and sustainable alternatives. By analyzing the strategic, political, and economic dimensions of Slovak energy security, this study highlights the interplay between domestic policies, EU frameworks, and geopolitical shifts. The article concludes that Slovakia's long-term energy security depends on diversifying supply routes, developing renewable energy sources, fostering regional cooperation, and adapting to EU decarbonization goals.*

***Keywords:** Energy security, Ukraine conflict, Energy geopolitics, REPowerEU*

1. Introduction

Energy security has long been recognized as a cornerstone of both domestic stability and foreign policy autonomy (Goldthau & Sitter, 2020). For small and medium-sized states without significant domestic energy resources, dependence on external suppliers can represent a structural vulnerability with profound economic and political consequences (IEA, 2022). Slovakia, which gained independence in 1993 following the dissolution of Czechoslovakia, exemplifies this dilemma. Its geographic location at the heart of Central Europe and its lack of domestic fossil fuel resources have historically tied it closely to Russian energy supplies (Eurostat, 2023; Ministry of Economy of the Slovak Republic, 2023). The Russian Federation's invasion of Ukraine in February 2022 has reshaped the European security and energy environment (European Council, 2022; Energy Community Secretariat, 2022). It disrupted traditional supply routes, heightened the geopolitical salience of energy, and placed extraordinary pressure on governments to protect consumers from soaring prices (IMF, 2023; OECD, 2023). Slovakia, which imported approximately 85–90% of its gas and oil from Russia before the war, faced a dual challenge: securing alternative supplies while protecting households and industries from the economic shock (SPP, 2023; Globsec, 2022). Given Slovakia's historically high dependence on Russian energy supplies and the systemic shock triggered by Russia's 2022 invasion of Ukraine, the country represents a critical case for examining energy security under conditions of geopolitical disruption. While existing literature has addressed the geopolitical and economic dimensions of European energy dependence (Goldthau & Sitter, 2020; Van de Graaf & Colgan, 2021), less attention has been paid to how small, highly dependent states manage systemic vulnerability within a Security Science framework of risk and resilience.

This article, therefore, addresses the following primary research question: How has the Russian invasion of Ukraine activated structural vulnerabilities in Slovakia's energy system, and to what extent have the country's policy responses enhanced systemic resilience from a Security Science perspective? To operationalize this inquiry, the study further explores three sub-questions:

1. What structural security vulnerabilities characterized Slovakia's energy system before 2022?
2. How did the war in Ukraine transform these vulnerabilities into concrete security risks across economic, infrastructural, and social dimensions?

3. Have Slovakia's diversification measures, fiscal interventions, and institutional responses reduced long-term systemic risk, or merely mitigated short-term instability?

By addressing these questions, the article aims to contribute to the broader discussion of energy security by shifting the analytical focus from interstate power politics towards vulnerability management, risk management, and national resilience.

This study employs a qualitative case study research design to examine how the Russian invasion of Ukraine has affected Slovakia's energy security and how policy responses have addressed systemic vulnerabilities. The case study approach is appropriate because it enables an in-depth analysis of a complex real-world phenomenon within its specific political, economic, and infrastructural context. The research is conceptually grounded in the interdisciplinary field of Security Science, which emphasizes vulnerability analysis, risk assessment, and resilience of critical societal systems.

The research design directly corresponds to the main research question by applying a structured analytical framework consisting of four stages: identification of security vulnerabilities, identification of security endangerment, risk assessment, and scenario analysis. First, structural vulnerabilities in Slovakia's energy system before 2022 are identified through analysis of energy supply structures, infrastructure dependencies, and economic exposure using data from institutions such as Eurostat, the International Energy Agency, and the OECD. Second, the study evaluates how the Russian invasion of Ukraine activated these vulnerabilities and generated new forms of security endangerment. Third, a qualitative risk assessment examines the probability and potential consequences of supply disruptions, price volatility, and infrastructure threats. Finally, scenario analysis is applied to explore alternative trajectories of Slovakia's energy security development under different policy and geopolitical conditions. Methodologically, the analysis relies on document analysis, secondary statistical data, and policy review, including national energy strategies, EU policy documents, and reports from international organizations. This approach allows the study to systematically link empirical observations with the theoretical framework of Security Science and to evaluate whether Slovakia's policy responses have strengthened systemic resilience or merely mitigated short-term crisis effects.

2. Theoretical framework and concept of Energy Security

Energy security is a multifaceted concept, commonly defined by the International Energy Agency as the uninterrupted availability of energy sources at an affordable price (IEA, 2022). Yet this seemingly simple definition masks a complex set of dimensions: availability (physical supply), accessibility (geopolitical and infrastructural reach), affordability (economic sustainability of prices), and sustainability (environmental and long-term viability) (World Bank, 2023). Each of these dimensions has been tested by the Ukraine war (European Commission, 2022). From the perspective of international relations theory, three dominant schools provide useful insights. Realist approaches underscore the centrality of power politics and the use of energy as a strategic instrument (Mearsheimer, 2014). Russia's repeated use of natural gas as a tool of coercion against transit states—most notably in the gas disputes of 2006 and 2009—illustrates this logic (Szulecki, 2022). Liberal institutionalism, in contrast, highlights cooperation through international regimes, shared markets, and institutions such as the EU's Energy Union, arguing that interdependence can mitigate vulnerabilities (Keohane & Nye, 2012; European Council, 2022). Constructivist perspectives stress the role of ideas and norms, such as the European Green Deal and the EU's climate-neutrality commitments, in shaping policy beyond narrow security calculations (Goldthau & Sitter, 2020; European Commission, 2023). The theoretical framework outlined above conceptualizes energy security through the analytical lens of security science, emphasizing vulnerability analysis, risk assessment, and systemic resilience of critical infrastructures. While traditional approaches within International Relations often interpret energy security primarily through geopolitical competition and interstate power dynamics, the Security Science perspective broadens the analytical focus to include structural weaknesses, socio-economic sensitivities, and the capacity of institutional systems to respond to crisis events.

Applying this framework to Slovakia reveals a particularly relevant analytical context. Slovakia is a small, open, and highly industrialized economy located within the European Union's integrated energy market. At the same time, the country has historically exhibited a high degree of structural dependence on Russian fossil fuel supplies, particularly natural gas and crude oil. This dependence was largely shaped by the historical configuration of pipeline infrastructure developed during the Soviet period, including the Druzhba oil pipeline and the Brotherhood gas transit system, which embedded Slovakia

within East–West energy transit corridors across Central and Eastern Europe. From the perspective of security science, such infrastructural path dependency constitutes a structural vulnerability because it reduces diversification capacity and increases exposure to geopolitical shocks. The vulnerability became particularly evident following the Russian invasion of Ukraine, which fundamentally altered the geopolitical environment of European energy markets. The conflict transformed previously latent vulnerabilities within Slovakia's energy system into concrete security risks affecting supply stability, price levels, fiscal sustainability, and social welfare. The relevance of the security science approach, therefore, lies in its ability to capture the systemic character of energy insecurity. In Slovakia's case, energy security challenges cannot be interpreted solely as a problem of supply availability. Instead, they involve the interaction of several interconnected dimensions: external geopolitical exposure, domestic infrastructural limitations, economic sensitivity of energy-intensive industries, and social vulnerability related to household energy affordability. These factors interact within a complex risk environment that requires coordinated policy responses at both national and European levels. The analytical framework applied in this study consists of four interconnected components:

Identification of security vulnerabilities

In security science, vulnerability refers to structural weaknesses that increase a system's susceptibility to harm when exposed to a threat (Aven, 2015; Renn, 2008). Vulnerability is shaped by exposure, sensitivity, and adaptive capacity (Cherp & Jewell, 2014). Prior to 2022, Slovakia's energy system displayed several structural vulnerabilities: concentrated import dependence; infrastructural path dependency; technological dependence in the nuclear sector; economic sensitivity; social vulnerability and energy poverty; and Fiscal fragility.

Identification of security endangerment

Security endangerment occurs when a concrete threat activates existing vulnerabilities, transforming structural weaknesses into operational instability (Aven, 2015). The Russian invasion of Ukraine in February 2022 represented a multidimensional threat event affecting supply chains, market stability, and geopolitical relations (European Council, 2022; Szulecki, 2022). From a Security Science perspective, the conflict functioned as an exogenous shock triggering a risk cascade:

- Politicization and reduction of Russian gas exports;
- Disruption risk of transit via Ukraine;
- Escalation of wholesale gas and electricity prices;
- Regulatory uncertainty related to sanctions and oil embargo exemptions.
- Increased concerns about hybrid threats targeting critical infrastructure (NATO, 2022; Umbach, 2022).

This activation effect aligns with systemic risk theory, which posits that interdependent infrastructures amplify the transmission of shocks across sectors (Renn, 2008). Energy insecurity rapidly extended into macroeconomic pressure, fiscal stress, industrial contraction risks, and social vulnerability (OECD, 2023).

Energy security thus shifted from the economic policy domain to a core national security concern.

Risk assessment

Risk in Security Science is defined as a function of the probability of occurrence and the magnitude of consequences (Aven, 2015). Risk analysis must therefore integrate physical, economic, social, and political dimensions.

For Slovakia, several key risk categories emerged:

1. Physical Supply Interruption Risk
2. Price Volatility Risk
3. Critical Infrastructure Disruption Risk
4. Strategic Dependence Persistence Risk
5. Social and Political Destabilization Risk

Energy poverty, subsidy allocation inequality, and sanction fatigue may fuel public dissatisfaction and political radicalization (Globsec, 2023; Eurobarometer, 2023).

These layered risks illustrate that energy security cannot be reduced to mere supply availability; it constitutes a multidimensional national resilience challenge (Cherp & Jewell, 2014).

Scenario analysis

Scenario analysis is a core method in strategic risk governance (Renn, 2008). Rather than predicting outcomes, it explores alternative plausible pathways under uncertainty.

- Scenario A: Resilient Transformation

Successful oil diversification, nuclear fuel supply shift, renewable expansion, infrastructure modernization, and efficient EU fund absorption.

→ High resilience and reduced external vulnerability.

- Scenario B: Managed Vulnerability

Gradual diversification with persistent fiscal constraints and slower renewable deployment.

→ Stability is maintained, but structural risks decline slowly.

- Scenario C: Structural Regression

Political fragmentation, reform delays, underinvestment in infrastructure, and prolonged oil dependence.

→ Renewed high vulnerability and exposure to geopolitical leverage.

Scenario logic aligns with resilience pathway theory, which holds that adaptive governance determines long-term security outcomes (Cherp & Jewell, 2014).

Integrated Analytical Model

The Security Science framework applied in this study conceptualizes energy security as a dynamic sequence:

Structural vulnerabilities → Threat activation → Risk amplification → Policy response → Resilience or systemic destabilization. This systemic model integrates critical infrastructure protection theory (Umbach, 2010), risk governance (Renn, 2008), and energy security scholarship (Sovacool, 2011; Cherp & Jewell, 2014). It expands beyond classical IR paradigms by embedding geopolitics within a broader framework of societal resilience and national stability.

3. Slovakia's Energy Profile before 2022

Slovakia's energy profile before 2022 was defined by a high degree of import dependence, low diversification, and structural reliance on hydrocarbons sourced from Russia (Eurostat, 2023; IEA, 2022). This pattern emerged from historical legacies of the Soviet era, when extensive infrastructure was constructed to link Central Europe to Soviet energy fields. The Druzhba oil pipeline and Brotherhood gas pipeline both cross Slovak territory, embedding the country into east–west supply chains (Eustream, 2022). Slovakia's energy system was designed around this orientation, leaving few alternatives when disruptions arose (Globsec, 2022). By 2021, natural gas accounted for roughly 24% of

Slovakia's total primary energy consumption, while oil accounted for 20%, nuclear for 25%, coal for 15%, and renewables for about 16% (Eurostat, 2023). Almost 87% of natural gas and virtually 100% of crude oil originated in Russia (Ministry of Economy of the Slovak Republic, 2023). While nuclear energy reduced reliance on gas for electricity, it created another strategic reliance—on Russian nuclear fuel (Westinghouse, 2023; Framatome, 2023). Slovakia's renewables lag behind EU averages, with hydropower dominating and wind and solar contributing less than 2% (IRENA, 2022).

Table: Slovakia's Electricity Generation Mix (2024)

Energy Source	**Share of Electricity Generation**
Nuclear	~61–63%
Hydropower	~15–20%
Natural Gas	~8–10%
Biomass / Waste	~3–5%
Solar	~1–3%
Wind	<1%
Coal / Lignite	~1–2%

Source: International Energy Agency – Slovak Republic Energy Policy Review (2024); Enerdata Energy Market Report – Slovakia

Energy Dependency Structure (Import Dependence)

Slovakia has limited domestic fossil resources, making it highly dependent on imports for several energy carriers.

Table: Import Dependence by Energy Source

Energy Source	**Import Dependence**	**Notes**
Oil	~100% imported	Minimal domestic production. Historically supplied mainly from Russia.
Natural Gas	~90–100% imported	Historically supplied mainly from Russia
Coal	Mostly imported	Domestic mining is largely phased out
Nuclear Fuel	100% imported	Used in nuclear power plants and imported from Russia
Renewables	Mostly domestic	Hydro and biomass are local sources

Source: Enerdata Country Energy Profile – Slovakia; International Energy Agency Energy Policy Review

Slovakia's dependence on Russian energy was not only an economic issue but gradually evolved into a strategic security problem. The infrastructure inherited from the Soviet period aligned Slovakia's energy system with Russian supply routes, limiting diversification and increasing its geopolitical exposure. When the war in Ukraine began in 2022, these structural conditions transformed into a direct security challenge. The conflict

disrupted traditional energy trade patterns, heightened market uncertainty, and highlighted the potential for energy supplies to be used as a geopolitical instrument. As a result, Slovakia faced several immediate risks:

- possible interruption of oil and gas supplies
- rapid increases in energy prices
- uncertainty regarding gas transit through Ukraine
- pressure to adapt national energy policy to new geopolitical realities

Infrastructure also shaped this dependency. Gas storage capacity represented around 3.5 billion cubic meters—sufficient for about 90 days of consumption (Eustream, 2022). However, these reserves were usually filled with Russian gas. The lack of LNG terminals within Slovakia's borders led to dependence on neighboring countries for alternative imports (European Commission, 2022). Electricity interconnectors linked Slovakia with Austria, Czechia, Hungary, and Poland, but gas interconnections remained limited until 2022 (ENTSOG, 2022). Thus, Slovakia entered the Ukraine war with few alternatives and high vulnerability (Energy Community Secretariat, 2022). Slovakia's industrial base compounded these vulnerabilities. Energy-intensive sectors, especially metallurgy, petrochemicals, and automotive, relied on cheap Russian gas (OECD, 2023). The Slovnaft refinery in Bratislava, for instance, processed crude from Russia via the Druzhba pipeline, supplying fuels to domestic and regional markets (Slovnaft, 2022). Any disruption risked undermining industrial competitiveness, employment, and economic stability (IMF, 2023; World Bank, 2023). The crisis, therefore, demonstrated that infrastructural dependence on a single external supplier can turn energy supply chains into strategic vulnerabilities. Consequently, strengthening Slovakia's energy security now requires diversifying supply routes, greater integration into the European energy market, and increased development of alternative energy sources within the European Union's energy framework.

4. The Ukraine war and its impact

The Russian invasion of Ukraine in February 2022 marked the most significant rupture in the European security environment since the end of the Cold War (Mearsheimer, 2014; European Council, 2022). For Slovakia, which borders Ukraine directly and has historically relied on Russian energy imports, the conflict created unprecedented geopolitical and economic shocks (Globsec, 2022; Ministry of Economy of the Slovak Republic, 2023). The escalation of the Russian invasion of Ukraine thus significantly

altered the security environment of European energy systems. For Slovakia, the war activated structural vulnerabilities that had developed over decades of infrastructural and supply dependence on Russian energy resources. Within the analytical framework of Security Science, this geopolitical shock can be understood as a triggering event that transformed latent vulnerabilities into concrete systemic risks affecting energy supply stability, economic performance, and social welfare. Energy security scholars emphasize that such shocks reveal the degree of resilience embedded in national energy systems and highlight the importance of diversification, institutional preparedness, and infrastructural flexibility (Cherp & Jewell, 2014; Sovacool, 2011; Goldthau & Sitter, 2020). This section examines the immediate and medium-term impacts of the war on Slovak energy security, focusing on gas, oil, electricity, nuclear fuel, prices, industries, and households (IEA, 2022; OECD, 2023). It also incorporates case studies that illustrate the depth of the crisis (Energy Community Secretariat, 2022; IMF, 2023).

4.1 Natural Gas Disruptions

Before the war, Slovakia imported roughly 87% of its gas from Russia, transported primarily through the Brotherhood pipeline crossing Ukraine (IEA, 2022; Eurostat, 2023). When Russia reduced and later largely cut flows in retaliation for EU sanctions, Slovakia's gas supply position became precarious (European Commission, 2022).

- **Transit Dependence:** As a transit country, Slovakia earned substantial revenues from gas transported westward. In 2021, Eustream's transit fee revenues were estimated at €500 million (Eustream, 2022). With flows dropping by more than half in 2022, revenues collapsed, putting strain on both the energy company and the state budget (IMF, 2023).
- **Supply Security:** Slovakia's storage capacity of about 3.6 billion cubic meters—enough for three to four months of winter consumption—became a lifeline (Energy Community Secretariat, 2022). Emergency EU rules in 2022 required member states to fill storage to 80–90% by winter, which Slovakia managed with support from neighboring Austria and Czechia (European Commission, 2022).
- **Price Effects:** Wholesale gas prices in Europe peaked above €300/MWh in August 2022, compared to €20/MWh in early 2021 (OECD, 2023). Slovak industries and utilities faced cost explosions, and the state intervened with subsidies (Ministry of Finance of the Slovak Republic, 2023).

4.2 Oil and the Slovnaft Refinery

Oil dependence was similarly acute. Slovakia imported nearly 100% of its crude oil from Russia via the southern branch of the Druzhba pipeline (Eurostat, 2023; Energy Community Secretariat, 2022).

- **Sanctions Exemptions:** While the EU banned most Russian oil imports in 2022, landlocked states such as Slovakia, Hungary, and Czechia negotiated temporary exemptions (European Council, 2022). Slovnaft, owned by the Hungarian MOL Group, continued refining Russian Urals crude under these exemptions (MOL Group, 2022; Slovnaft, 2022).
- **Refinery Challenges:** Adapting Slovnaft's technology to process non-Russian blends requires significant investment. Reports estimate modernization costs at over €200 million (Globsec, 2022). Until diversification is complete, Slovakia remains reliant on Russian oil flows (OECD, 2023).
- **Export Constraints:** Slovnaft exports significant volumes of refined products (diesel, gasoline, jet fuel) to neighboring countries. EU restrictions on the re-export of Russian-origin products further complicated the refinery's business model (European Commission, 2022; IMF, 2023).

4.3 Electricity and Nuclear Fuel Security

Electricity security was less directly affected by the war, but vulnerabilities emerged (IEA, 2022).

- **Nuclear Dependence:** Slovakia generates over half of its electricity from nuclear power, supplied by Russian fuel rods from TVEL (Rosatom) (Ministry of Economy of the Slovak Republic, 2023). After the invasion, concerns about nuclear fuel supply chains grew. Although immediate disruptions did not occur, Slovakia began working with Westinghouse and Framatome to diversify fuel sources for the Mochovce and Bohunice plants (Westinghouse, 2023; Framatome, 2023).
- **Grid Stability:** Integration with the European Network of Transmission System Operators for Electricity (ENTSO-E) provided resilience (ENTSO-E, 2022). Slovakia could import power from Austria or the Czech Republic in emergencies, though high regional prices created affordability issues (OECD, 2023).

- **Mochovce 3 Launch:** The delayed third reactor at Mochovce was finally connected to the grid in early 2023, boosting domestic capacity and reducing the need for imports (Slovenské elektrárne, 2023).

4.4 Energy Prices and Economic Impact

The energy price shock of 2022–2023 reverberated across the Slovak economy (OECD, 2023; IMF, 2023).

- **Industrial Sector:** Energy-intensive industries such as U.S. Steel Košice (metallurgy), Duslo Šaľa (fertilizers), and chemical plants faced existential threats. At one point, U.S. Steel reported that energy costs had quadrupled compared to pre-war levels. Some production was curtailed to manage losses (U.S. Steel Košice, 2022; Globsec, 2022).
- **Households:** Slovakia's median household energy expenditure rose by more than 30% in 2022, even with state interventions. Without subsidies, the increase would have exceeded 200% (Eurostat, 2023). The government allocated over €6 billion in 2022–2023 to cap electricity and gas prices, equivalent to nearly 6% of GDP (Ministry of Finance of the Slovak Republic, 2023).
- **Energy Poverty:** Surveys indicated that around 15% of Slovak households faced difficulties paying energy bills, highlighting social fragility (OECD, 2023). Vulnerable groups included pensioners, low-income families, and residents in poorly insulated housing stock (Energy Community Secretariat, 2022).

4.5 Case Studies

Case Study 1: U.S. Steel Košice: As one of Slovakia's largest employers (about 10,000 workers), U.S. Steel Košice illustrates the industrial vulnerability to energy shocks. In late 2022, the company temporarily suspended some operations due to soaring electricity and gas costs. Management called for government aid and EU measures, arguing that competitiveness against U.S. and Asian producers was collapsing (U.S. Steel Košice, 2022; OECD, 2023).

Case Study 2: Slovnaft Refinery: Slovnaft, a strategic refinery in Bratislava, faced both technical and regulatory challenges. While benefiting from temporary exemptions to use Russian crude, it faced mounting pressure to modernize its facilities to handle non-Russian crude blends. Simultaneously, EU restrictions on exports of refined products complicated its logistics. Slovnaft thus became a focal point in the debate on balancing economic

continuity with geopolitical alignment (Slovnaft, 2022; MOL Group, 2022; European Commission, 2022).

Case Study 3: Household Energy Poverty: The war highlighted structural weaknesses in Slovakia's residential energy efficiency. Much of the housing stock consists of panel buildings (paneláky) from the socialist era, which are characterized by poor insulation. Combined with reliance on natural gas heating, households became highly vulnerable to price spikes. Government subsidy schemes prevented mass defaults, but long-term solutions require large-scale retrofitting programs supported by EU funds (Globsec, 2022; Ministry of Economy of the Slovak Republic, 2023; European Commission, 2023).

4.6 Political and Public Opinion Dimensions

The energy crisis also reshaped domestic politics and public opinion. Surveys in 2022–2023 revealed polarized views: while many Slovaks supported EU sanctions against Russia, others blamed sanctions for rising costs (Globsec, 2022; Eurobarometer, 2023). Political parties exploited these divisions, with some populist actors calling for renewed dialogue with Russia to secure cheaper energy (OECD, 2023; Szulecki, 2022). Energy thus became a frontline issue in domestic electoral politics (Ministry of Foreign and European Affairs of the Slovak Republic, 2023).

4.7 Medium-Term Adjustments

By late 2023, Slovakia had begun adapting, though dependence persisted (OECD, 2023; IMF, 2023).

- **Gas Storage and LNG:** Cooperation with Czechia, Poland, and Austria enabled Slovakia to access LNG imports via terminals in Świnoujście (Poland), Klaipėda (Lithuania), and Italian ports (ENTSOG, 2023; European Commission, 2023).
- **Oil Diversification:** Preparations advanced to allow Slovnaft to process non-Russian blends, though full diversification was expected only after 2025 (Slovnaft, 2023; MOL Group, 2022).
- **Nuclear Resilience:** With Mochovce 3 online and nuclear fuel diversification underway, Slovakia bolstered its electricity security (Slovenské elektrárne, 2023; Westinghouse, 2023; Framatome, 2023).

- **EU Solidarity:** The EU's joint purchasing mechanism and financial support packages helped Slovakia weather the worst shocks (European Commission, 2022; Energy Community Secretariat, 2022).

4.8 Summary

Despite ongoing diversification efforts, Slovakia's energy system continues to exhibit structural vulnerabilities rooted in its historical infrastructure. Much of the country's oil and gas transport infrastructure was originally designed to deliver energy resources from Russia to Central Europe. The Ukraine war exposed the depth of Slovakia's structural energy dependence and the fragility of its energy security. Gas and oil imports from Russia, reliance on nuclear fuel, and limited renewable capacity combined to create a perfect storm. Emergency subsidies shielded households and industries, but at a high fiscal cost. Case studies of U.S. Steel Košice, Slovnaft refinery, and household energy poverty illustrate the social, industrial, and geopolitical dimensions of the crisis (Slovnaft, 2022; U.S. Steel Košice, 2022; Energy Community Secretariat, 2022). Medium-term adjustments are underway, including diversification of gas and oil supplies, strengthening of nuclear resilience, and EU-supported solidarity mechanisms (European Commission, 2022; ENTSOG, 2023). Yet Slovakia's vulnerability remains a pressing policy challenge, particularly as debates over energy transition, climate neutrality, and fiscal sustainability intensify (Goldthau & Sitter, 2020; Keohane & Nye, 2012). Long-term resilience will require not only infrastructural investment but also political consensus and societal support for diversification and green transformation.

5. Policy responses of the Slovak Republic

The outbreak of the war in Ukraine and the subsequent collapse of established energy arrangements confronted Slovakia with one of the most serious policy challenges since its independence (European Commission, 2022; IEA, 2022). As one of the EU's most energy-dependent member states, Slovakia had limited room for maneuver, but the government pursued a combination of emergency interventions, diversification strategies, nuclear expansion, and renewable energy initiatives (OECD, 2023; Ministry of Economy of the Slovak Republic, 2022). This section analyzes these policy responses in detail, highlighting their design, implementation, and implications (Goldthau & Sitter, 2020).

5.1 Emergency Subsidies and Market Interventions

The most immediate response was the introduction of large-scale state subsidies to shield households and businesses from extreme energy price spikes (OECD, 2023; IMF, 2023).

- **Household Protection:** The government capped household electricity prices at around €61/MWh in 2022–2023, despite wholesale market prices exceeding €300/MWh at the peak of the crisis (European Commission, 2022). Natural gas tariffs were similarly frozen. Without intervention, many Slovak households—particularly those in poorly insulated apartment blocks—would have faced unaffordable bills (Ministry of Finance of the Slovak Republic, 2023).
- **Fiscal Burden:** These subsidies were among the most expensive government interventions in the country's post-1993 history. By early 2023, commitments amounted to more than €6 billion, or about 6% of GDP (IMF, 2023). Critics warned that such spending was fiscally unsustainable and risked crowding out investments in long-term energy transition measures (OECD, 2023).
- **Industrial Support:** Energy-intensive industries were granted targeted compensation. For example, U.S. Steel Košice and Duslo Šaľa fertilizer plant received direct support to prevent layoffs and production shutdowns (U.S. Steel Košice, 2022; Duslo, 2022). While necessary in the short term, such interventions sparked debate over fairness, as SMEs and non-industrial firms received less generous aid (Globsec, 2023).

5.2 Gas Supply Diversification

Reducing reliance on Russian natural gas became a top priority (IEA, 2022; European Commission, 2022).

- **Reverse Flows:** Slovakia invested in reverse-flow infrastructure after the 2009 gas crisis, allowing imports from Austria and Czechia (Energy Community Secretariat, 2022). These capacities proved vital in 2022, as Slovakia accessed gas stored in Baumgarten (Austria) and Czech storage facilities (ENTSOG, 2023).
- **EU Solidarity Mechanism:** Under the EU's Gas Storage Regulation, Slovakia participated in joint purchasing initiatives and benefited from financial support to secure alternative supplies (European Council, 2022). By the winter of 2022–2023,

Slovak gas storage was more than 90% full, ensuring Security of supply (Ministry of Economy of the Slovak Republic, 2023).

- **LNG Access via Neighbors:** Although Slovakia has no direct LNG terminal, it indirectly accesses LNG through Poland's Świnoujście terminal, Lithuania's Klaipėda facility (via interconnections), and Italian ports (IEA, 2023). These flows provided crucial diversification but were more expensive than Russian pipeline gas (OECD, 2023).
- **Contracts with Western Suppliers:** Slovenský plynárenský priemysel (SPP), the state gas utility, signed contracts with non-Russian suppliers, including Norwegian and LNG traders (SPP, 2022). However, prices remained volatile, and long-term contracts were politically controversial due to climate commitments (Globsec, 2023).

5.3 Oil Sector and Slovnaft's Predicament

Slovakia's oil dependence posed specific challenges (IEA, 2022; European Commission, 2022).

- **Sanctions Exemptions:** Slovakia successfully negotiated temporary exemptions from the EU's oil embargo due to its landlocked position. This allowed continued imports of Russian crude through Druzhba (European Council, 2022).
- **Modernization Needs:** Slovnaft refinery, a subsidiary of Hungary's MOL, required significant technological upgrades to process non-Russian blends. Estimated costs exceeded €200 million, with financing partly sought from EU funds (Slovnaft, 2022; MOL Group, 2022).
- **Policy Dilemma:** While exemptions protected short-term energy security and jobs, they perpetuated dependence on Russian oil. This created a policy dilemma: how to maintain refinery operations, safeguard employment, and simultaneously align with EU decarbonization and diversification goals (Goldthau & Sitter, 2020; OECD, 2023).

.4 Nuclear Energy Expansion and Fuel Diversification

Nuclear power emerged as both a pillar of resilience and a challenge due to fuel dependence (IAEA, 2022; OECD, 2023).

- **Mochovce 3:** The long-delayed third unit of the Mochovce nuclear power plant was connected to the grid in January 2023, increasing domestic electricity generation capacity by 471 MW. This reduced reliance on gas-fired electricity and bolstered self-sufficiency (SEPS, 2023; European Commission, 2023).
- **Fuel Supply Diversification:** Until 2022, Slovakia relied exclusively on TVEL fuel rods from Rosatom. The war prompted urgent efforts to diversify. Cooperation with Westinghouse (U.S.) and Framatome (France) began, with test assemblies planned for 2024–2025. This mirrors similar diversification efforts in the Czech Republic and Finland (Westinghouse, 2022; Framatome, 2022; IEA, 2023).
- **Small Modular Reactors (SMRs):** Slovak policymakers also expressed interest in SMRs as part of a long-term strategy. Pilot projects were discussed with U.S. and Canadian partners, though commercial deployment remains a decade away (IAEA, 2022; World Nuclear Association, 2023).

5.5 Renewable Energy Development

While nuclear and diversification measures provided immediate relief, renewables were seen as the cornerstone of long-term energy security and climate alignment (European Commission, 2022; IEA, 2023).

- **EU Funding Opportunities:** The Recovery and Resilience Facility (RRF) allocated significant funds to Slovakia, with a portion earmarked for green transition projects. Additional financing came from the Modernisation Fund and Cohesion Funds (European Commission, 2022; Ministry of Economy of the Slovak Republic, 2022).
- **Solar Expansion:** Slovakia announced tenders for large-scale solar projects, aiming to triple solar capacity by 2030. However, administrative bottlenecks and grid connection delays hindered progress (IEA, 2022; OECD, 2023).
- **Wind Energy Potential:** Despite favorable conditions in parts of western Slovakia, wind capacity remains negligible. New regulatory reforms in 2022 aimed to ease permitting processes (Ministry of Economy of the Slovak Republic, 2022; Energy Community Secretariat, 2022).
- **Energy Efficiency:** Building retrofits became a national priority. The *Obnov dom* (Renovate Your House) program offered subsidies for insulation and energy-efficiency upgrades, funded by EU grants. However, uptake was slower than

anticipated due to bureaucratic hurdles (Slovak Innovation and Energy Agency, 2022; Globsec, 2023).

5.6 Institutional and Governance Reforms

Energy crisis management also required governance changes (OECD, 2023; European Commission, 2022).

- **SPP Repositioning:** The state utility SPP became a central actor, responsible for securing alternative gas contracts and ensuring storage levels (SPP, 2022; Ministry of Economy of the Slovak Republic, 2022).
- **Regulatory Adjustments:** The Regulatory Office for Network Industries (ÚRSO) was tasked with balancing affordability with market realities, leading to the introduction of new tariff-setting mechanisms (ÚRSO, 2022; IEA, 2023).
- **Public Communication:** The crisis tested government communication strategies. While subsidies prevented immediate unrest, public trust in the government's energy policy declined, particularly amid political instability and frequent cabinet changes during 2022–2023 (Globsec, 2023; Transparency International Slovakia, 2023).

5.7 Evaluation of Policy Responses

Slovakia's responses reflected both strengths and weaknesses (Goldthau & Sitter, 2020; IEA, 2023).

- **Strengths:** Rapid action on subsidies prevented social unrest. Reverse flows and EU solidarity ensured supply security. Nuclear expansion boosted resilience (European Commission, 2023; OECD, 2023).
- **Weaknesses:** Heavy fiscal spending created budgetary risks. Oil exemptions prolonged dependence. Renewable deployment lagged behind EU peers (IEA, 2022; Agora Energiewende, 2023).
- **Strategic Trade-Offs:** Slovakia's short-term Security came at the cost of long-term fiscal sustainability and climate commitments. The ability to rebalance these trade-offs will determine the success of the energy transition (Ministry of Finance of the Slovak Republic, 2023; Van de Graaf & Colgan, 2021).

5.8 Summary

Slovakia's policy response to the Ukraine war was multifaceted: **emergency subsidies** shielded society from the worst price shocks; **gas diversification** reduced

immediate vulnerability; **oil exemptions** provided short-term continuity but perpetuated dependence; **nuclear expansion** strengthened electricity security; and **renewable initiatives** began to chart a long-term path. Yet significant challenges remain. Policy responses highlight the difficult balancing act between **Security, affordability, and sustainability** that defines energy governance in small dependent states.

6. Regional and international dimensions

Slovakia's energy security cannot be analyzed in isolation. As a small, landlocked state embedded in the European Union (EU) and NATO, its energy security depends heavily on regional cooperation, European solidarity, and transatlantic ties (Balmaceda, 2021; Van de Graaf & Colgan, 2021). The war in Ukraine accelerated integration but also highlighted divergences among Central European states (European Council, 2022; Szulecki, 2020). This section explores regional dynamics, EU mechanisms, and international partnerships that shaped Slovakia's energy security during and after the outbreak of war.

6.1 Regional Cooperation in Central Europe

Central Europe represents one of the most energy-dependent regions of the EU, with strong historical reliance on Russian hydrocarbons (Balmaceda, 2021; European Commission, 2022). Yet states have pursued divergent strategies since 2022.

- **Poland:** Warsaw moved most decisively to reduce its reliance on Russian energy. It opened the Świnoujście LNG terminal in 2015, expanded its capacity, and inaugurated the Baltic Pipe with Norway in 2022 (IEA, 2022; Szulecki & Overland, 2020). By contrast, Poland accelerated coal use to buffer short-term shortages (Umbach, 2023).
- **Czechia:** Like Slovakia, Czechia relied heavily on Russian oil and gas. However, its closer integration with Germany enabled faster diversification, including access to LNG via German terminals (OECD, 2023; Siddi, 2022).
- **Hungary:** Hungary under Viktor Orbán pursued a pro-Russian stance, extending long-term gas contracts with Gazprom and lobbying for exemptions from oil embargoes. This created political friction with Slovakia, though both countries shared reliance on the southern Druzhba pipeline (European Council, 2022).

- **Austria:** Austria, geographically and economically close to Slovakia, retained high levels of gas dependence on Russia, though it sought to leverage its Baumgarten hub to diversify (Austrian Federal Ministry for Climate Action, 2022; Stern, 2022).

Slovakia's position lies between Poland's diversification and Hungary's continued reliance, with Czechia serving as an important partner for reverse flows (Kuzemko et al., 2022).

6.2 EU Energy Solidarity and Integration

The EU played a central role in cushioning the shock for member states like Slovakia (European Commission, 2022a; Siddi, 2022).

- **Joint Gas Purchasing:** The EU introduced a joint purchasing mechanism (*AggregateEU*) to strengthen bargaining power vis-à-vis global LNG suppliers. Slovakia participated, securing part of its 2023 gas needs through this platform (European Council, 2022; Goldthau, 2022).
- **Storage Regulation:** A binding regulation required all EU countries to fill gas storage to 80% (later 90%) before winter. Slovakia complied, reaching 92% in October 2022, which ensured winter security (European Commission, 2022b; IEA, 2022).
- **REPowerEU Plan:** The Commission launched the *REPowerEU* strategy to end dependence on Russian fossil fuels before 2030. Slovakia's national plan included investments in renewables, energy efficiency, and electricity interconnections, financed partly by EU Recovery and Resilience funds (European Commission, 2023; OECD, 2023).
- **Financial Support:** EU emergency funds supported Slovakia's subsidy schemes and infrastructure investments. Cohesion and Modernisation Funds were redirected to accelerate clean energy deployment (European Investment Bank, 2022; Umbach, 2023).

For Slovakia, EU solidarity was not only about resources but also about political legitimacy: it could present energy security measures as part of a collective European strategy (Kuzemko et al., 2022).

6.3 NATO and Security of Infrastructure

While NATO does not directly manage energy markets, it plays a role in protecting critical infrastructure (NATO, 2022a; Smith Stegen, 2015).

- **Hybrid Threats:** Concerns about sabotage, cyberattacks, and disinformation increased following the 2022 Nord Stream pipeline explosions. Slovakia, with extensive pipeline networks and nuclear facilities, strengthened coordination with NATO on infrastructure protection (European Council on Foreign Relations, 2022; NATO, 2022b).
- **Military-Energy Nexus:** NATO exercises began including scenarios of energy disruption, testing the resilience of allied logistics and supply chains. For Slovakia, this cooperation provided reassurance, given its exposed position near Ukraine (Belyi, 2023; Umbach, 2022).

6.4 Transatlantic and Global Partnerships

Slovakia's diversification efforts also relied on suppliers outside Europe.

- **United States:** U.S. LNG exports to Europe surged in 2022–2023, covering more than 40% of EU imports. Although Slovakia lacks a direct LNG terminal, reverse-flow agreements allowed indirect access. U.S.–Slovak relations deepened, with Washington framing LNG as both a commercial and geopolitical instrument (U.S. Department of Energy, 2023; Hafner & Raimondi, 2022).
- **Norway:** Norwegian gas became a major substitute for Russian flows in Central Europe, including Slovakia. Contracts through Czech and Polish intermediaries enabled Slovakia to access this supply (IEA, 2022; Øverland, 2023).
- **Middle East and North Africa:** Qatar, Algeria, and other producers expanded LNG deliveries to Europe. Slovakia indirectly benefited through EU diversification, though price competition with Asia remained a constraint (BP, 2023; Tagliapietra, 2022).
- **Ukraine:** Ironically, despite the war, Slovakia increased energy cooperation with Ukraine, exporting electricity and coordinating gas storage. This reflected solidarity and mutual interdependence in crisis conditions (Naumenko & Obydenkova, 2023; European Commission, 2023).

6.5 Regional Infrastructure and Connectivity

Physical interconnections were crucial to energy diversification.

- **Gas Pipelines:** Slovakia completed interconnectors with Hungary (2015), Poland (2022), and expanded reverse-flow capacities with Czechia and Austria. These

investments, initiated after the 2009 gas crisis, proved critical in 2022 (European Commission, 2022; Szulecki, 2020).

- **Electricity Interconnections:** The Slovak grid is closely integrated with those of Czechia, Austria, and Hungary, enabling cross-border balancing. Plans exist to strengthen links with Poland to access Baltic offshore wind in the future (ENTSO-E, 2022; IEA, 2022).
- **Oil Flows:** While Druzhba remains dominant, discussions intensified about expanding the Adria pipeline via Croatia and Hungary to reduce dependence on Russian crude. However, financing and political alignment remain challenges (IEA, 2023; Goldthau & Sitter, 2020).

6.6 Regional Politics and Diverging Interests

The crisis also revealed political divergences within Central Europe.

- **Slovakia vs. Hungary:** While both relied on Druzhba, Slovakia moved more decisively to align with EU sanctions, whereas Hungary resisted. This strained the Visegrád Group's unity (Boduszyński & Kemoklidze, 2022; European Council on Foreign Relations [ECFR], 2023).
- **Slovakia vs. Poland:** Relations improved due to Poland's support for diversification, LNG sharing, and defense cooperation (Grgas & Ociepka, 2022; Ministry of Foreign Affairs of Poland, 2023).
- **Regional Cohesion:** The V4 (Visegrád Four) lost cohesion, while new groupings such as the Three Seas Initiative gained relevance for infrastructure investment. Slovakia sought to position itself as a bridge-builder (Dangerfield, 2021; Kaczmarski & Matuszak, 2023).

6.7 Summary

Within the framework of Security, regional dynamics are particularly relevant because vulnerabilities in critical infrastructure systems often arise from interactions between national networks and international supply chains. The resilience of Slovakia's energy system, therefore, depends not only on domestic policies but also on the stability and cooperation of regional energy partners within the European Union's integrated market.

Geopolitical Consequences of Energy Diversification

Slovakia's diversification of energy sources represents a significant shift in the geopolitical structure of energy relations in Central Europe. Historically, the region was strongly integrated into an east–west energy supply system dominated by imports from Russia. The reduction of this dependence has important geopolitical implications for both regional energy governance and the balance of influence among energy suppliers. First, diversification strengthens the strategic autonomy of Central European states by reducing their vulnerability to political pressure associated with energy supply concentration. Second, the shift toward alternative supply routes contributes to the gradual restructuring of European energy geopolitics. Increased imports of liquefied natural gas, expansion of pipeline interconnections, and deeper market integration within the European Union reduce the centrality of traditional Russian energy corridors. However, diversification also creates new geopolitical dynamics. As European states compete for access to alternative energy resources, new dependencies on global energy markets and external suppliers may emerge. In this sense, the transition away from Russian energy does not eliminate geopolitical risk but rather redistributes it across a more complex network of international relationships.

Slovakia's Strategic Position in the Central European Energy Network

Slovakia's geographic location in the centre of Europe gives it an important role within the regional energy system. Situated between Poland and Hungary and connected to energy networks in neighbouring countries such as the Czech Republic and Austria, Slovakia serves as an important transit and interconnection hub in Central European energy infrastructure. Recent developments in European energy policy have gradually transformed Slovakia's role within the regional system. The expansion of cross-border interconnections—such as gas links with Poland and Hungary—has increased the flexibility of energy flows and strengthened regional market integration. These connections allow Slovakia to access alternative supply routes, including liquefied natural gas terminals located in Northern Europe and other parts of the European energy network. From a strategic perspective, Slovakia's position between Poland and Hungary provides several advantages. It enables the country to participate actively in regional energy cooperation initiatives and to contribute to the development of a more interconnected and resilient Central European energy system. In addition, stronger interconnection infrastructure enhances regional states' capacity to support one another during supply disruptions through

reverse-flow mechanisms and emergency solidarity arrangements. Nevertheless, Slovakia's role as a transit and interconnection hub also implies certain responsibilities and risks. Critical energy infrastructure located on Slovak territory remains vulnerable to external shocks, including geopolitical tensions, cyber threats, or physical disruption. Ensuring the protection and resilience of this infrastructure, therefore, represents an important component of national and regional energy security.

Regional Cooperation and Energy Security

Regional cooperation plays a central role in addressing the structural vulnerabilities identified in this article. Energy security challenges are increasingly transnational, and effective responses often require coordinated action among multiple states and institutions. Within the European Union's policy framework, mechanisms such as cross-border infrastructure investment, shared strategic reserves, and coordinated emergency planning have strengthened the collective resilience of European energy systems. These initiatives aim to ensure that disruptions affecting one member-state do not escalate into wider regional crises.

Implications for the Regional Energy Security Architecture

From a security perspective, Slovakia's energy policy transformation aims to enhance systemic resilience by reducing critical vulnerabilities and strengthening adaptive capacity within regional infrastructure networks. Slovakia's strategic geographic position between Poland and Hungary positions the country to play a potentially important role in this evolving system, both as a transit hub and as a participant in regional energy cooperation initiatives. In the long term, the effectiveness of these transformations will depend on the continued development of cross-border infrastructure, coordinated energy policy among Central European states, and sustained investment in resilient and sustainable energy technologies. The regional and international dimensions of Slovakia's energy security highlight both vulnerability and resilience. EU solidarity mechanisms provided critical lifelines, while NATO enhanced protection of infrastructure (European Commission, 2022; North Atlantic Treaty Organization [NATO], 2022). Partnerships with the U.S., Norway, and global LNG suppliers diversified supplies, even if indirectly (Henderson & Mitrova, 2022; U.S. Department of Energy, 2023). Regional cooperation with Czechia and Poland strengthened resilience, while Hungary's divergence complicated solidarity (Grgas & Ociepka, 2022; Boduszyński & Kemoklidze, 2022). Overall, the crisis

deepened Slovakia's integration into European and transatlantic structures, while underscoring the political complexities of Central Europe (Goldthau & Sitter, 2020; Kaczmarski & Matuszak, 2023).

7. Challenges and opportunities

The energy crisis triggered by the war in Ukraine has not only exposed Slovakia's vulnerabilities but also created space for strategic realignment. The country faces a set of interrelated challenges—fiscal, infrastructural, political, and social—while also possessing opportunities to accelerate diversification, modernization, and the green transition (European Commission, 2023; International Energy Agency [IEA], 2023). This chapter examines both dimensions, highlighting key dilemmas and scenarios (Goldthau & Sitter, 2020; Siddi, 2022).

7.1 Fiscal Sustainability

Slovakia's emergency subsidies prevented social unrest but at a high fiscal cost.

- **Budgetary Burden:** With spending surpassing €6 billion in 2022–2023, the state's fiscal deficit widened significantly. Analysts warned of risks to debt sustainability if high subsidies persist (OECD, 2023; International Monetary Fund [IMF], 2023).
- **Trade-Offs:** Money spent on short-term relief reduced resources available for renewable energy investments, grid upgrades, or nuclear modernization (IEA, 2023; European Commission, 2023).
- **Opportunity:** EU funds under REPowerEU and the Modernisation Fund offer partial relief. If properly absorbed, they could offset domestic fiscal pressures (European Commission, 2022; Ministry of Finance of the Slovak Republic, 2023).

7.2 Infrastructural Dependence

Despite progress in diversification, Slovakia remains tied to certain legacy infrastructure.

- **Gas Transit Role:** As a transit country for Russian gas to Europe, Slovakia earned significant fees. Declining Russian flows reduce revenue, requiring reorientation of gas infrastructure toward regional interconnections and hydrogen readiness (Eustream, 2023; Pirani, 2022).
- **Oil Infrastructure:** Heavy reliance on Druzhba persists. Until the Adria pipeline is expanded and Slovnaft is upgraded, dependence will remain (IEA, 2023; MOL Group, 2022).

- **Opportunity:** Modernizing transit networks could be leveraged to establish hydrogen corridors, making Slovakia a hub in the emerging European hydrogen economy (European Commission, 2023; Agora Energiewende, 2022).

7.3 Political Fragmentation and Governance Challenges

The energy crisis unfolded amid political instability.

- **Frequent Government Changes:** Cabinet reshuffles and early elections in 2023 weakened strategic consistency. Energy policy risked being politicized, with parties offering unrealistic subsidy promises.
- **Public Trust:** Confusing communication around tariffs and subsidies eroded confidence (OECD, 2023; Transparency International Slovakia, 2022).
- **Opportunity:** The crisis also raised energy security to the top of the political agenda. A cross-party consensus around diversification and nuclear expansion could form the basis of a more stable strategy (European Commission, 2023; Goldthau & Sitter, 2020).

7.4 Social Dimension: Energy Poverty

Slovakia faces significant risks of energy poverty.

- **Households at Risk:** Around 10–15% of households spend more than a quarter of their income on energy. Apartment blocks built during socialism are often poorly insulated, compounding vulnerability (European Commission, 2022; Šubová, 2021).
- **Regional Inequalities:** Eastern Slovakia suffers from higher unemployment and energy poverty rates (Institute for Energy Economics and Financial Analysis [IEEFA], 2022; OECD, 2023).
- **Opportunity:** Programs like *"Obnov dom"* (Renovate Your House) and EU-funded efficiency schemes can reduce energy poverty while cutting emissions. With proper targeting, they could transform the housing stock (Ministry of Environment of the Slovak Republic, 2022; IEA, 2023).

7.5 Long-Term Decarbonization and Climate Goals

Slovakia must reconcile immediate security needs with long-term EU climate commitments.

- **Current Path:** Heavy reliance on nuclear reduces emissions but complicates diversification of fuel supply (IEA, 2023; World Nuclear Association, 2023).

- **EU Fit for 55:** Slovakia must cut emissions by 55% by 2030 compared to 1990 levels. Without stronger deployment of renewable energy, this target will be difficult to meet (European Commission, 2021; OECD, 2023).
- **Opportunity:** If solar and wind projects are accelerated, Slovakia could position itself as a low-carbon economy supported by nuclear baseload. The challenge is to streamline permitting and grid development (Ministry of Economy of the Slovak Republic, 2022; Agora Energiewende, 2022).

7.6 Scenarios for the Future

To illustrate the uncertainties, three broad scenarios can be sketched:

- **Optimistic Scenario (Resilient Slovakia):** By 2030, Slovnaft fully adapts to non-Russian crude, nuclear fuel is diversified, and Slovakia becomes a net electricity exporter based on nuclear and renewables. EU funds are effectively absorbed, reducing energy poverty and modernizing infrastructure (European Commission, 2022; IEA, 2023; Ministry of Economy of the Slovak Republic, 2022).
- **Realistic Scenario (Slow Transition):** Slovakia reduces dependence on Russian energy but struggles with renewable deployment and fiscal pressures. Subsidies decline gradually, but structural reforms move slowly. Security is maintained, though leadership opportunities are missed (OECD, 2023; Agora Energiewende, 2022).
- **Pessimistic Scenario (Entrenched Dependence):** Political instability and limited investment prevent diversification. Subsidy burdens persist, EU funds are underutilized, and dependence on Russian oil continues. Energy poverty deepens, and Slovakia becomes a laggard in the EU's green transition (Goldthau & Sitter, 2020).

These scenarios underscore the importance of political will, EU solidarity, and strategic foresight.

7.7 Strategic Opportunities

Despite challenges, the crisis has created opportunities for Slovakia to reposition itself:

- **Energy Hub Potential:** With upgraded interconnections, Slovakia could serve as a regional hub for gas, electricity, and eventually hydrogen flows (European Commission, 2022; ENTSO-E, 2023).

- **Nuclear Leadership:** By diversifying fuel and investing in SMRs, Slovakia could become a regional leader in nuclear technology (IAEA, 2022; World Nuclear Association, 2023).
- **Green Transition:** Leveraging EU funds for solar, wind, and efficiency could create jobs, reduce emissions, and alleviate energy poverty (OECD, 2023; Agora Energiewende, 2022).
- **Geopolitical Positioning:** By aligning firmly with EU and NATO partners, Slovakia could strengthen its role as a reliable ally in a region often divided by energy politics (NATO, 2023).

7.8 Summary

Slovakia's energy security stands at a crossroads. The challenges - fiscal strain, infrastructural dependence, political instability, and social inequality - are profound. Yet the opportunities - green transition, nuclear expansion, and regional hub potential - offer a path toward resilience and leadership. Whether Slovakia emerges as a resilient, integrated, and low-carbon economy, or as a dependent and lagging state, will depend on how it manages this critical decade.

8. Conclusion

The energy crisis following the Russian invasion of Ukraine revealed the structural vulnerabilities of energy systems in Central Europe that had developed during decades of dependence on imports from Russia. For Slovakia, the crisis exposed the risks associated with supply concentration, infrastructural path dependency, and geopolitical exposure linked to traditional east–west energy corridors. As a result, future Slovak energy policy will likely continue to prioritize diversification of energy sources, expansion of domestic energy production, and stronger integration into the European Union's energy market.

From a regional perspective, these policy adjustments contribute to a broader restructuring of the energy security architecture in Central Europe. Greater interconnection of energy infrastructure among states such as Poland, Hungary, the Czech Republic, and Austria increases the flexibility of energy flows and enhances the regional system's capacity to respond to supply disruptions. Energy security research suggests that such regional integration reduces the vulnerability of individual states by creating more diversified supply networks and enabling solidarity mechanisms during crises (Cherp & Jewell, 2014;

Goldthau & Sitter, 2020). At the same time, the transformation of energy policy in Slovakia and across Central Europe has broader geopolitical implications. The gradual reduction of reliance on Russian fossil fuels weakens the traditional energy leverage that Russia historically exercised over parts of Europe. However, diversification toward global energy markets and new technological supply chains may also generate new forms of strategic dependence, particularly in relation to liquefied natural gas markets and renewable energy technologies (Sovacool, 2011). This paper shows that Slovakia responded with a mix of emergency interventions, diversification strategies, and long-term investments. Subsidies prevented a social crisis but placed immense strain on public finances. Gas diversification through reverse flows, LNG access via neighbors, and EU joint purchasing reduced dependence, while oil imports remained constrained by refinery limitations. Nuclear expansion, especially Mochovce 3, provided resilience, but dependence on Russian nuclear fuel required urgent diversification. Renewable development, though strategically vital, still lags behind EU peers due to administrative and infrastructural barriers.

The regional and international context proved decisive. EU solidarity mechanisms—joint purchasing, storage targets, REPowerEU funding—were lifelines for Slovakia. Cooperation with Czechia, Austria, and Poland facilitated diversification, while Hungary's divergent path complicated regional unity. NATO and transatlantic partners contributed to protecting critical infrastructure and alternative supply channels, underscoring Slovakia's embeddedness in Western alliances. Looking ahead, Slovakia faces a triple challenge: (1) ensuring fiscal sustainability after massive subsidies, (2) modernizing infrastructure to reduce dependence on Druzhba and Russian gas transit, and (3) aligning its energy system with EU decarbonization targets. At the same time, significant opportunities exist: EU funds can accelerate renewable energy deployment and building retrofits; nuclear diversification can strengthen low-carbon security; and Slovakia's location could make it a regional hub for gas, electricity, and eventually hydrogen flows. Three possible futures emerge. In the optimistic scenario, Slovakia consolidates diversification, expands renewables, and emerges as a resilient, low-carbon economy. In the realistic scenario, Security is maintained, but fiscal strain and slow reforms limit progress. In the pessimistic scenario, political instability, fiscal exhaustion, and infrastructural dependence keep Slovakia vulnerable to external shocks. The outcome will depend on political leadership, the ability to absorb EU resources effectively, and the consistency of policy implementation. What is clear is that

energy security will remain at the heart of Slovakia's economic, social, and geopolitical stability for the next decade.

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