



Policy persistence vis-à-vis a crisis: the curious case of Slovak energy policy after the Russian invasion of Ukraine

Matúš Mišík · Veronika Oravcová

Received: 22 March 2023 / Accepted: 12 March 2024 / Published online: 2 April 2024
© The Author(s) 2024

Abstract The Russian invasion of Ukraine that started on 24 February 2022 has had a dramatic impact on the energy policy of the European Union and its member states. Nonetheless, not all EU members have radically overhauled their energy sectors and policies. Looking at the period between February 2022 and December 2023, this paper argues that Slovakia's energy sector has remained unchanged in comparison to developments within the EU and beyond. Slovakia has continued to purchase natural gas from Russia, having negotiated an exemption from the EU sanctions on Russian oil, and gas consumption decreased only minimally in the winter of 2022/2023. Furthermore, it maintained at best a lukewarm position on renewable energy sources and even struggled to implement those energy efficiency measures that were included in the post-pandemic recovery plans. Slovakia also did not reconsider its coal phase-out deadline of 2023 and its (already very supportive) nuclear policy. We explain this policy persistence with the help of a revised lock-in concept which, in the case of Slovakia, is mostly connected to nuclear energy ('nuclear lock-in'), which locks out alternative energy sources, especially renewables.

Keywords Critical juncture · Energy efficiency · Lock-in · Natural gas · Nuclear · Renewables

Introduction

The Russian invasion of Ukraine that started on 24 February 2022 has had a dramatic impact on the European Union (EU) and its member states. Insofar as energy policy is concerned, the invasion exacerbated the high energy prices that had been harming the EU economy since mid-2021 (Kotek et al., 2023) and highlighted EU dependency on Russian fossil fuels (record-low levels in the storage facilities controlled by Gazprom, especially when compared to extremely low levels of overall EU underground gas storages; Bruegel, 2022), forcing many member states to prioritise energy security concerns over climate goals (Mišík, 2022). The COVID-19 pandemic had already interrupted the EU's decarbonisation plans agreed in December 2019 (European Council, 2019) and presented in the European Green Deal (Skjærseth, 2021), although it had developed tools to support the green (and digital) post-pandemic recovery (Crnčec et al., 2023). Similarly, the Commission had argued back in spring 2022 that the EU's response to the Russian invasion and the related energy and climate policy challenges should be 'green': strengthening the decarbonisation goals through greater deployment of renewable sources of energy, and energy-saving measures should help the EU to decrease dependency

M. Mišík (✉) · V. Oravcová
Department of Political Science, Comenius University
in Bratislava, Slovakia Gondova 2, Bratislava 811 02,
Slovakia
e-mail: matus.misik@uniba.sk

on fossil fuel imports, especially from Russia (European Commission, 2022a).

The EU's response to the Russian invasion included a series of short-term energy measures. Cognisant of the challenges presented by the winter of 2022/2023, the Commission suggested voluntary reductions in natural gas consumption (15 percent between August 2022 and March 2023, compared to the 5-year average for 2017–2022) to prepare the EU for expected interruptions to Russian supplies (European Commission, 2022b). Moreover, the member states agreed on a series of sanctions aimed at several sectors of the Russian economy, including coal and oil. Therefore, for most EU member states, EU-level activities relating to the Russian invasion of Ukraine meant having to implement dramatic changes in the energy sector—they had to find new fossil fuel suppliers, radically reduce natural gas consumption, look for domestic reserves (including coal; Financial Times, 2022), and accelerate the development of renewable energy sources and fuel-switching (including heat pumps; Rosenow et al., 2022).

However, this was not true for all EU member states, with some revising their energy policies much less than others. Slovakia is one such country, and this paper examines the development of its energy policy between the start of the Russian invasion in February 2022 and December 2023. Slovakia imports almost all its fossil energy from third countries, mainly Russia. Back in spring 2022, the Slovak Prime Minister proclaimed that the aim was to end reliance on Russian energy sources (TASR, 2022), and yet its energy sector remains almost untouched by the consequences of the invasion. Preliminary data shows that its main natural gas stakeholder continued to purchase natural gas from Russia; moreover, under an exemption from EU sanctions, Slovakia was allowed to keep importing Russian oil. What is more, Slovak gas consumption decreased only minimally in the winter of 2022/2023, and the country did not reconsider its coal phase-out deadline of 2023 nor its (already very supportive) nuclear policy. Furthermore, Slovakia's position on renewables remained lukewarm at best, and it struggled to implement even those energy efficiency measures that were included in the post-pandemic recovery plans.

This paper presents a detailed examination of Slovak energy policy following the Russian invasion of Ukraine. The next section discusses Slovakia's

position on EU sanctions relating to Russian coal and oil, while the third section looks at Slovak preferences on reducing natural gas consumption in the EU. The fourth section examines energy efficiency measures, the fifth gives an overview of the Slovak nuclear sector, and the sixth focuses on the coal phase-out planned for the end of 2023. The penultimate section provides an explanation for Slovakia's energy policy persistence vis-à-vis the energy crisis by arguing that what we termed a 'nuclear lock-in' supported only minimal changes to this policy and locked out major changes, especially those linked to the higher employment of renewables. The last section presents the conclusions and policy implications.

Slovak positions on EU energy sanctions against Russia

Coal was the first Russian energy source to be sanctioned by the EU. The ban on all types of Russian coal was part of the fifth package of sanctions agreed by the European Council in April 2022 (European Council, 2022). Since coal does not require complex infrastructure and supplies from Russia were easy to replace, it was relatively unproblematic for EU member states to reach an agreement on a ban. Slovakia adopted a supportive position on coal sanctions, with both the government and industrial players, including the steelmaker US Steel Košice, claiming they could cope with any potential coal shortages caused by the sanctions (Jenčová, 2022d). Steel producers are the main hard coal consumers in Slovakia so US Steel's position on the sanctions was crucial. Before the Russian invasion of Ukraine, hard coal was imported mostly from the Czech Republic, Russia, and Poland (3.3 Mt in 2021; Eurostat, 2023a, b, c). Dependence on Russian hard coal was below the EU average, accounting for 30 percent of all coal imported in 2020, whereas the EU average was 46 percent (Eurostat, 2023a). Throughout 2022, the steel industry was able to substitute Russian coal with imports from the USA (Funtíková, 2022).

When it came to the oil sanctions, the situation was far more complicated. Following Ursula von der Leyen's announcement of the intention to ban Russian oil, Slovakia and the Czech Republic called for a 3-year postponement, and Hungary planned to veto the proposal. The final agreement was a

compromise approved by EU leaders in June as part of the sixth package of sanctions (European Commission, 2022d). Only seaborne oil imports were banned; Slovakia, Hungary, and the Czech Republic were granted an exemption and could continue to buy Russian crude oil supplied via the Druzhba pipeline until the end of 2023. The Slovak refinery Slovnaft—owned by Hungary’s MOL Group—was the key stakeholder in this discussion and required time to make adjustments to its oil processing technology (Hudec, 2022). The refinery supplies Slovakia but also exports almost two-thirds of its production to neighbouring countries (Kullová, 2023). The refinery is connected to the Adria pipeline, which has since 2015 connected the Omišalj seaport in Croatia to the Southern Druzhba, thanks to EU funding for Projects of Common Interest (Official Journal of the European Union, 2013). The refinery claims that it is not capable of processing non-Russian oil without substantial technical upgrade, although it has access to it via this pipeline. Back in 2016, it began testing non-Russian oil processing (SITA, 2016) but argued that non-Russian oil is more costly, and additional investments of around €200 million would be needed to switch to alternative sources (ČTK, 2023).

The Slovak parliament reacted to Slovnaft’s advantageous market position, gained as a result of processing cheaper Russian oil, by proposing a windfall tax. Companies that generate at least 75 percent of their turnover from business activities in the oil, natural gas, coal, and refinery sectors are required to pay a so-called ‘solidarity contribution’ based on higher profits. Since Russian oil is significantly cheaper than Brent oil, the state plans to use this additional income to compensate households for the high energy prices. Originally, a rate of 70 percent of the companies’ extra income was proposed, ultimately though a final tax of 55 percent was agreed in December 2022 amid energy company lobbying and the threat of arbitration against Slovakia (National Council of the Slovak Republic, 2022; TASR, 2023b). As a result, Slovnaft paid €625 million, the highest tax in Slovak history, from its 2022 profits (Tvardzík, 2023). In March 2023, the windfall tax was increased to 70 percent, and its applicability was prolonged by another year (i.e. 2023) (National Council of the Slovak Republic, 2023).

Slovak reaction to the voluntary reduction in natural gas

Unlike oil, Russian natural gas has not been sanctioned yet, nor has there been discussion on this in the EU, despite calls for one from several stakeholders (Mišík & Nosko, 2023). The discussion around natural gas during the summer of 2022 focused on ensuring the EU could survive the coming winter if Russia were to stop supplying Europe. The very low levels of stored natural gas across the EU at the beginning of 2022 pointed to potential difficulties with natural gas supplies in the upcoming winter. The Commission, therefore, proposed a voluntary 15 percent reduction in natural gas consumption from August 2022 to March 2023 in comparison with the 5-year average for 2017–2022 as part of its Save Gas for a Safe Winter Plan (European Commission, 2022b). Member states agreed on this overall goal; nevertheless, a series of complex negotiations resulted in compromises and derogations (Council of the EU, 2022). The Czech presidency of the Council of the EU praised the outcome as a means of ensuring that each member state contributes its fair share to the EU-wide goal (Mathis et al., 2022).

Slovakia was one of the countries that managed to negotiate derogations and was allowed to use more natural gas during the winter of 2022/2023 than it had in the reference period (Jenčová, 2022a). Although the measure was voluntary, it indicated member states’ ability to save gas vis-à-vis the energy crisis and their preparedness to support other member states that would need emergency supplies. Indeed, the data for August 2022 to January 2023 show that the EU managed to save more gas (19 percent) than proposed under the mechanism (15 percent). However, the ability of individual member countries to save gas varied substantially, with Finland reducing its consumption by more than 50 percent and most member countries saving more than the proposed 15 percent. Conversely, gas consumption rose in two countries: Malta and Slovakia—in the latter by almost 5 percent (Eurostat, 2023b). This number was challenged by the Slovak Ministry of Economy, which argued that, due to incorrect methodology, Eurostat significantly underestimated the decrease in Slovak consumption (Ministry of Economy of the Slovak Republic, 2023a). During the whole period (August 2022–March 2023), the EU’s gas consumption dropped by 17.7 percent,

with Finland keeping its leading position thanks to a 55.7 percent consumption decrease and Malta as the only country which increased its consumption (by 12.7 percent). Slovak consumption decreased by 1.0 percent (Eurostat, 2023c).

Slovakia continued to import Russian natural gas, although the exact figures were not known at the time of writing. According to the largest Slovak gas company, with more than 60 percent of the market, Russian gas represented approximately 60 percent of its gas demand at the beginning of 2023. The company has no plans to change its strategy as it has a long-term contract with Gazprom until 2034 (Funtíková & Grečko, 2023). Gas infrastructure is to play a crucial role in the coming period with plans to increase domestic extraction and infrastructure capacity (underground gas storages, removing bottlenecks) as well as to integrate hydrogen into the transmission network (Ministry of Economy of the Slovak Republic, 2023b).

Although Slovakia spent more than a decade diversifying its natural gas supply infrastructure following the 2009 gas crisis, no major changes were made in terms of the diversification of energy suppliers, as Russia remained the main trade partner. The first Slovak efforts to diversify sources appeared only after the Russian invasion of Ukraine; however, the country has not delivered on the promises made by the Ministry of Economy to substitute two-thirds of Russian gas for other sources (Ministry of Economy of the Slovak Republic, 2022a). Moreover, Slovakia has been an important transit country, as the Brotherhood pipeline that crosses Slovak territory remains the only direct transit route for Russian gas into Europe following the cessation of supplies via the Yamal and Nord Stream I pipelines. However, transit volumes have dropped substantially: in 2019, 69 bcm of natural gas was transited via Slovakia, but in 2022, the figure was only 26 bcm (Marko, 2023).

Energy efficiency

After the fall of Communism, Slovakia was able to decouple its economic growth from energy consumption. Nonetheless, energy efficiency has remained relatively stable over time in all economic sectors (Eurostat, 2023d). Thermal insulation of residential buildings is Slovakia's energy efficiency flagship. The

most important programmes supporting the renovation of multi-apartment buildings fall within the jurisdiction of the Ministry of Transport (previously the Ministry of Transport and Construction) and include the Housing Development Program (providing subsidies) and the State Housing Development Fund (providing loans) (Ministry of Transport, 2020a). These programmes have been in place since the 1990s and resulted in approximately 70 percent of renovated multi-apartment buildings, which are going to play a key role in the renovation in the coming years (Ministry of Economy of the Slovak Republic, 2023b). Several support schemes have reduced the energy consumption of buildings by one-third over the last 20 years (Slovak Innovation & Energy Agency, 2020).

Despite the relatively good numbers, the renovation has not been complex. Indeed, the Commission in its 2022 country report emphasised that Slovakia should 'focus on deep and green renovations' including increased use of renewables in buildings (European Commission, 2022a, b, c). Individual heating has been a particular problem resulting into poor air quality, which has been among the worst in the EU (European Environment Agency, 2023) due to improper heating using old and inefficient furnaces and improper use of wood. Moreover, only half of family houses have so far been renovated without any systematic support. That is why a substantial share of the funding for Slovakia's Recovery and Resilience Plan—about €528 million—will go on upgrading up to 30,000 older family houses by 2026. However, there are many obstacles, including slow administration procedures, although the Ministry of Environment has been considering simplifying these (Frantová, 2023).

The situation regarding public buildings is even more of a problem. According to the Supreme Audit Office, public building renovations carried out between 2014 and 2021 were unsystematic, and the fragmented funding and inaccurate data collection may have affected the reliability and quality of the data reported. There is no national monitoring database, and Slovakia has not succeeded in reducing energy consumption in public buildings (Supreme Audit Office of the Slovak Republic, 2022). Therefore, in 2022, the government launched several campaigns on energy efficiency measures for public buildings to attempt to achieve energy savings of 15

percent (Government Office of the Slovak Republic, 2022; Ministry of Environment of the Slovak Republic, 2022). Despite the requirement for monthly reports, there is a lack of data monitoring and tracking of these savings. The Ministry of Economy and the Slovak Innovation and Energy Agency initiated their own energy-saving campaigns, thus also gaining media attention, with energy analysts offering advice on reducing energy expenses in both households and offices (SAIA, 2022). In fact, a survey showed that only half of households are willing to save energy by using energy-efficient appliances or alternative energy sources (TASR, 2023a); moreover, there are significant differences in energy-saving efforts stemming from political party preferences (Hrivňák, 2022).

Since 2022, the debates have been focused on energy prices rather than energy savings. This discussion was driven by proposals for a windfall tax on nuclear electricity production, resulting in a Memorandum of Understanding signed by the Minister of Finance and the Minister of Economy, as well as the shareholders of Slovenské elektrárne (operator of Slovak nuclear power plants (NPP)) in February 2022. The ministers agreed to stabilise household electricity prices at €61.21 per MWh (excluding VAT) until 2024 (Ministry of Finance, 2022). The government made decisions in the ‘general economic interest’ to align the legislative framework with the Memorandum, which was also approved by the European Commission (Ministry of Economy of the Slovak Republic, 2022b). By the end of 2022, the Slovak government established a compensation mechanism for higher energy bills, prioritising households, municipalities, and businesses. Compensations cover 80 percent of eligible costs, calculated as the difference between the purchase price and a €199/MWh ceiling for electricity and €99/MWh for natural gas (Ministry of Economy of the Slovak Republic, 2023c).

On the other hand, Slovakia exceeded the EU recommendations regarding the nearly zero-energy building (nZEB) standards when implemented the Energy Performance of Buildings Directive. nZEB has become a standard practice in Slovakia, applicable since 2018 for all newly constructed public buildings and from 2021 for primarily residential buildings (Attia et al., 2022). When it comes to the implementation of the Energy Efficiency Directive, Slovak buildings should achieve a 40 percent reduction in energy

consumption by 2050 compared to 2020 leading to emissions decrease by 79 percent compared to 2020 and 87 percent compared to 1990. Achieving this goal requires a substantial shift from partial renovations to widespread deep renovations; Slovak government therefore aims for a 40 percent share of deep renovations in overall building renovations by 2050, which will be further supported by funding schemes (Ministry of Transport, 2020b).

Although energy efficiency is one of the main pillars of the EU climate and energy policy, Slovak efforts do not reflect this, especially when it comes to public buildings. ‘Energy efficiency first’ was not at the forefront of Slovak discussions on the consequences of the Russian invasion on the energy sector where the emphasis was on financial compensation for end consumers. Moreover, Slovakia lacks specific goals and policies in its long-term strategy for building renovations. Support schemes are not systemic or cost-effective, and those adopted by the Slovak government by the mid-2023 did very little to encourage energy saving. Moreover, the government’s decision to compensate the energy process distorts the market and fails to encourage energy-saving efforts.

Low-carbon energy sources

For some member states, both renewable energy sources and nuclear energy are key to achieving energy security and climate goals. Slovakia is a strong supporter of nuclear energy, seeing it as guaranteeing energy security and favouring it over renewable energy sources (Kratochvíl & Mišík, 2020). However, its position on renewables is lukewarm at best. Slovakia had difficulty meeting its 2020 goal until the methodology for calculating the share of biomass was changed, causing a sharp increase in the proportion of renewables in the energy supply (Mišík, 2021). Similarly, its National Energy and Climate Plan contained only a modest 2030 renewables goal that was revised upwards following the Commission’s review of the plan; nonetheless, at 19.2 percent, it was still well below the percentage (24 percent) recommended by the Commission (European Commission, 2020; Slovak Ministry of Economy, 2019). Even the 2023 update of the National Energy and Climate Plan did not reach the recommended share of renewables, nor did it reflect the higher share of renewables within the

REPowerEU strategy aiming for 42.5 percent. The updated Plan proposes a 23 percent share of renewables by 2030.

There has been a lack of systematic support for the deployment of renewables in Slovakia. In the case of solar energy, the main barrier was known as the ‘stop status’: distribution companies practically refused to connect new installations arguing that the national grid does not have sufficient capacity. Although this barrier was removed in 2021 after the Slovak–Hungary cross-border interconnection was completed (Ministry of Economy of the Slovak Republic, 2021), other regulatory and administrative barriers still persist, particularly in the form of new grid capacity limits imposed by Slovakia’s electricity transmission system operator (Slovak Association of Photovoltaic Industry and RES, 2023). In the case of wind energy (Slovakia currently has only two functioning wind turbines), the main obstacle is the process of environmental impact assessment, negative public perceptions surrounding wind energy projects, and the absence of comprehensive land-use planning on the part of municipalities (Slovak Association of Photovoltaic Industry and RES, 2023).

There are also several barriers that need to be overcome to build local sources and energy communities, including the absence of sufficient battery storage capacity, the complicatedness of administrative procedures, and access to financing for low-income households (Jenčová, 2022b). However, the emergence of intelligent battery storage in the energy market is supported by the Ministry of Economy’s initiative, aiming to achieve up to 68 MW of storage capacity by 2026 (Jenčová, 2022c). Moreover, the successful certification of the first stand-alone battery storage unit that can also be utilised to balance the network by providing ancillary services was accomplished in 2022 (Energie-portal.sk, 2022).

Although there were no plans for a new nuclear power plant following the Russian invasion of Ukraine, two new units are being completed after more than a decade of delays (originally planned for 2011, Unit 3 of Mochovce NPP has been commissioned in 2023, while Unit 4, which was originally to be commenced in 2012, is reaching completion), and another unit is being developed on the site of the existing Jaslovské Bohunice NPP (SITA, 2023). Slovakia is one of the signatories of the 2023 declaration of countries to triple nuclear capacity by 2050 and

also is a member of the pro-nuclear group within the EU. However, Slovakia’s nuclear sector is closely tied to Russia’s nuclear industry as it relies on Russian technology, as do many reactors in Central and Eastern Europe (Szulecki & Overland, 2023). Reliance on Russian nuclear fuel is the most visible aspect. Moreover, Slovak nuclear units are of the VVER-440 type and Russia’s TVEL has a (near) monopoly on the nuclear fuel for this type of reactors (Pan, 2023), since Westinghouse, the main alternative supplier of this type of fuel, currently does not have the capacity to increase production to cover all reactors of this kind in the EU.

There have been efforts to diversify nuclear fuel supplies for Russian-type reactors and these have been partially successful but apply mostly to VVER-1000 reactors (Vlček, 2016). Slovakia therefore continued importing Russian nuclear fuel in 2022. Five shipments of nuclear fuel were flown in that year. There are no sanctions on the Russian nuclear industry, and nuclear fuel shipments are exempted from the sanctions on the Russian aviation sector (JAVYS, 2023). The shipments were made under a contract signed in 2018 for the period 2022–2026 following an international tender, where the US fuel producer Westinghouse was the only competitor to TVEL. The latter won on price. There has been discussion on the diversification of nuclear fuel supplies to Slovakia, and concrete steps have been undertaken to find an alternative supplier of nuclear fuel (for example, the operator of Slovak NPPs joined a project focused on developing alternative fuels (APIS, 2023)).

Coal phase-out

Following the Russian invasion of Ukraine, EU member countries have adopted different approaches to enhancing energy security and reducing reliance on external energy suppliers, including revising positions on domestic coal. For example, Germany added an extra 10 GW of installed coal capacity to its energy mix (IEA, 2022), and several other member countries including the Czech Republic and the Netherlands began re-assessing their energy policy in favour of coal (Kuzemko et al., 2022). The Slovak coal phase-out deadline of 2023 was not changed even though energy security had been used as

grounds for generous subsidies for domestic coal producers (Mišík & Prachárová, 2023).

In 2004, Act No. 656/2004 Coll. on the Energy Sector introduced the concept of ‘general economic interest’, enabling the Ministry of Economy to ask electricity producers to prioritise domestic brown coal and to enable preferential access to the electricity for the distribution system operator. The government issued several decisions specifying the amount of electricity that could be generated this way for given periods. The last one was adopted in 2015 and was for an annual volume of 1350 GWh (Ministry of Economy, 2015). This electricity subsidy amounted to approximately €100 million annually (Ministry of Environment, 2017) and is applied to the electricity company. But as it had to generate a certain amount of electricity from domestic brown coal, in reality, the subsidy went to Slovak coal mines. The poor quality of the domestic brown coal meant they could not compete on the international market, as admitted in a government report from 2011 (Government of the Slovak Republic, 2012). Consequently, by 2016, there was only one coal mine left in Slovakia, and almost all the coal it produced went to a near-by coal-fired power plant. In 2018, it was decided that domestic brown coal subsidies would terminate in 2023 (Reuters, 2018).

While energy security issues were often cited as the reason for supporting local brown-coal-fired electricity generation, social issues associated with the coal mines were another factor. However, neither argument was used to reconsider the coal phase-out, even when natural gas and electricity gas prices started to exert pressure on industry and households, and questions began to emerge over natural gas availability in the spring of 2022. The issue of re-assessing the coal phase-out at the end of 2023 did not enter the mainstream public discourse, and there was just a handful of separate discussions in which both the government and the coal mining company supported the existing phase-out deadline. For example, the Minister of Environment argued that temporary operation of the coal-fired plant made no sense given climate concerns over the poor quality of domestic brown coal (Rádio Slovensko, 2022). Similarly, the coal mines claimed they were unable to continue mining without government subsidies (Funtíková & Kováč, 2022). Energy security concerns had been behind many of the Slovak government’s previous

energy policy decisions (Mišík, 2019) but were not raised as a reason for re-assessing the role of brown coal in Slovakia’s electricity mix following the Russian invasion of Ukraine.

Preliminary explanation

Existing scholarship offers two perspectives on the discussion about policy change vs policy persistence. When it comes to the former, the concept of critical juncture claims that a crisis can serve as a catalyst for policy development, which, in the case of the EU, can lead to the deepening of integration. Crises can help the Commission persuade sceptical member countries that integration is the answer to the challenges at hand (Hogan, 2019). This has been argued in connection to many EU policies (Verdun, 2015), including climate and energy policy (Maltby, 2013; Wolff & Ladi, 2020). On the other hand, explanations of policy persistence within the EU (and also broader) are in line with the path dependency argumentation: a path is taken and the future development of a policy will reflect this path, i.e. it will not deviate from it significantly. The carbon lock-in concept that is linked to such a line of argumentation claims that energy systems are difficult to change because carbon-based energy sources (i.e. fossil fuels) are embedded in the existing energy system and therefore lock out alternatives, especially renewable energy sources (Bessi et al., 2021; Unruh, 2000). This is why energy transition is slow and why fossil fuels dominate energy mixes although their negative consequences for the climate and therefore humankind are clear.

This paper claims that the lock-in concept can explain the persistence of Slovak energy policy vis-à-vis the ongoing energy crisis. However, this is not a carbon ‘type’ of lock-in, even though carbon energy sources are also locked in. At the heart of the Slovak lock-in lays nuclear energy, which is why we have termed this ‘nuclear lock-in’. By prioritising nuclear energy over other types of energy sources (especially renewables, but also others), Slovak energy policy is locking out some alternative energy sources and limiting the utilisation of others. This mostly concerns electricity generation, but the situation spills over into other areas of the energy system as well, since they are mutually interconnected.

While intermittent renewables are challenging to combine with the high share of base-load nuclear and are therefore locked out directly, the position of other energy sources is stable because they complement nuclear energy. For example, natural gas is an energy source very suitable for secondary and tertiary regulation and therefore fits well into a profile dominated by nuclear generation. In an electricity system dominated by nuclear energy—in 2022, Slovakia produced more than 69 percent of its electricity from nuclear (OKTE, 2022), even though Mochovce Unit 3 was at that time still not at its full capacity—there is very little room for other sources. This limited room is filled by those sources that support nuclear energy via regulation functions. Renewable energy sources that are unable to provide regulation in the same way that fossil fuels do (Al-Shetwi et al., 2020) and in some cases require backup generation or more complex systems, including storage or smart solutions (Kalair et al., 2021), are not always the best fit for such a system.

Nuclear power plants are currently being built to last several decades (their current life expectancy is 60 years, but 80 years are being discussed (Krivanek, 2020)) and therefore have the potential to impact energy policy in a long-term perspective. At the same time, energy policy needs to reflect this fact and therefore a reaction to an immediate issue (like a crisis) has to take into account the long-term nature of nuclear energy. Therefore, even external shocks do not have to present a strong enough incentive to change a policy whose crucial element will exert its impact in the decades to come. Nuclear lock-in thus has an impact on energy transition and the employment of renewable energy sources (we acknowledge the fact that many consider nuclear to be part of the transition towards a carbon-neutral economy).

Moreover, in contrast to a carbon lock-in, which has an impact on energy transition but not the nature of the energy system, a nuclear lock-in also impacts the overall architecture of the energy system and distribution of electricity. Nuclear sources are huge by nature (even small modular reactors have the capacity of hundreds of MWs) and therefore require a complex distribution system that allows electricity to be delivered from NPPs to the end consumers. However, energy transition towards renewables assumes the development of an alternative model of energy production and consumption with much smaller units and an island model of electricity distribution. A nuclear

lock-in can negatively influence the development of such alternative electricity distribution regimes as they would have to function parallel to the main transmission and distribution systems that require NPPs.

Conclusion and policy implications

The Russian invasion of Ukraine revealed the vulnerability of the European Union's energy sector and its dependence on Russian energy sources. Member states were hesitant to introduce energy sanctions against Russia, despite the invasion being largely funded out of energy profits. At the same time, it was understood that the EU energy sector had to change and that a new perspective on energy security was required. While the Commission and several member states highlighted the need to increase the share of renewable energy sources and reduce overall energy consumption through energy savings and energy efficiency measures, other members decided to rely on their existing domestic sources—especially coal—despite the negative consequences for climate policy. However, not all member states' energy sectors underwent significant changes in 2022.

Although the high dependency on Russian energy sources has been discussed since the gas crisis of 2009 (Kratochvíl & Mišík, 2020), the crisis following the Russian invasion of Ukraine did not significantly alter Slovakia's energy policy. The country's energy sector remained almost unchanged despite developments within the EU and beyond. Although we do not yet have all the data for 2022, the existing information points to surprising continuity in Slovak energy policy following the Russian invasion. No major changes were made to energy policy on natural gas, oil, coal, nuclear, or renewables, thanks to the exceptions and derogations from common EU positions (oil and natural gas), unproblematic source replacement (coal), long-term support for an energy source (nuclear), or the lukewarm approach towards other sources, especially renewables. However, according to the REPowerEU proposal, renewables are supposed to be at the heart of the EU's efforts to reduce its dependency on Russian energy supplies (European Commission, 2022c). The Commission even criticised Slovakia for not doing enough to increase its share of renewables (Hudec, 2023). Indeed, the share of renewables

increased very slightly—to 17.5 percent in 2022 from 17.42 in 2021 (Eurostat, 2024).

Slovakia has never been very proactive when it comes to energy efficiency and has found it difficult to implement even measures already adopted as part of the post-pandemic economic recovery. Our preliminary explanation of this situation points towards the existence of a path dependency within Slovak energy policy, which may account for its persistence. We argue that the high share of nuclear energy in the Slovak energy mix (currently being increased with the commencement of Mochovce Unit 3 and, in a few years, Mochovce 4 as well) caused a ‘nuclear lock-in’ that locked out alternative sources, especially renewables.

This brings us to several important policy implications. First, the Slovak energy sector is rather inflexible and hard to change. Although some of the aspects of the long-term evolution of the Slovak energy sector have reduced reliance on Russian fossil fuels—especially the completion of Unit 3 at Mochovce NPP—new dependencies have emerged as a result (on Russian nuclear fuels). However, there were no major changes to oil and natural gas imports from Russia in 2022. The rigidity of Slovak energy policy explains—at least partly—the difficulty of introducing more renewable energy sources into the Slovak energy mix.

Second, the EU has the potential to drive the change in Slovakia’s energy sector, as experienced especially within the diversification of energy infrastructure following the 2009 gas crisis (Prontera & Plenta, 2020). During the past decade, several infrastructural projects have been completed thanks to EU support that enabled Slovakia to build interconnections with its neighbours and gain access to alternative gas supply routes, which proved crucial during the previous year. This indicates that the EU and its financial support played a decisive role after the previous crisis—indeed, no new major infrastructure has been built without the EU funds. Therefore, we can expect Slovak energy policy to change after this energy crisis, especially if there is EU funding for the post-crisis recovery. Third, the Russian invasion of Ukraine highlights the need to decouple from Russian energy sources and fossil fuels more generally. The country’s focus on nuclear as a low-carbon nuclear source may bring results in the mid- to long-term, but even this energy source presents a series of financial, technical, and other challenges. Therefore,

Slovakia needs to accelerate the deployment of renewables or initiate effective energy efficiency measures to reduce overall energy consumption.

Fourth, electrification holds the potential to reduce energy demand and increase the deployment of renewables, while is expected to have a significant impact, particularly on the industry and transport sectors (Ministry of Economy of the Slovak Republic, 2023b). In transport, Slovakia anticipates a notable growth in the adoption of battery electric vehicles—from 1.7 percent in 2022 to an anticipated 10 percent by 2025 (Ministry of Economy, 2022). This shift presents several opportunities for innovative energy companies entering the market, as evidenced by the emergence of companies building battery storages and introducing innovations such as the aggregation of flexibility.

Our research has several limitations that are connected to possible future avenues of research. The main one is connected to the fact that we do not have all the data for the studied period since they have not yet been published by the authorities. Future research should therefore look into official statistics once they will be made available. Similarly, an overview such as this one does not purport to go into fine details as its main goal is to present more general observations in the wake of a major event (i.e. the Russian invasion of Ukraine). A deeper look into particular issues, for example, energy efficiency measures and their impact on Slovak energy policy (and energy security) could produce further information. Moreover, our theoretical examination is limited by the previous two points and although it can shed light on the overall development of Slovak energy policy since February 2022, future analyses should be based on a more complex research design.

Acknowledgements The authors would like to thank Catriona Menzies and Nada Kujundžić for the language editing.

Author contribution Conceptualisation, MM; methodology, MM and VO; formal analysis, MM and VO; writing—original draft preparation, MM and VO; writing—review and editing, MM and VO; supervision, MM; funding acquisition, MM.

Funding Open access funding provided by The Ministry of Education, Science, Research and Sport of the Slovak Republic in cooperation with Centre for Scientific and Technical Information of the Slovak Republic This research was funded by Slovak Research and Development Agency grant no. APVV-20-0012.

Declarations

Conflict of interest The authors declare no competing interests.

Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if changes were made. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit <http://creativecommons.org/licenses/by/4.0/>.

References

- Al-Shetwi, A. Q., Hannan, M. A., Jern, K. P., Mansur, M., & Mahlia, T. M. I. (2020). Grid-connected renewable energy sources: Review of the recent integration requirements and control methods. *Journal of Cleaner Production*, 253, 119831. <https://doi.org/10.1016/j.jclepro.2019.119831>
- APIS. (2023). Accelerated program for implementation of secure VVER fuel supply. <https://apis-project.eu/>. Accessed 18 July 2023.
- Attia, S., Kurnitski, J., Kosiński, P., Borodinecs, A., Deme Belafi, Z., István, K., et al. (2022). Overview and future challenges of nearly zero-energy building (nZEB) design in Eastern Europe. *Energy and Buildings*, 267, 112165. <https://doi.org/10.1016/j.enbuild.2022.112165>
- Bessi, A., Guidolin, M., & Manfredi, P. (2021). The role of gas on future perspectives of renewable energy diffusion: Bridging technology or lock-in? *Renewable and Sustainable Energy Reviews*, 152, 111673. <https://doi.org/10.1016/j.rser.2021.111673>
- Bruegel. (2022). *European natural gas imports*. Brussels. <https://www.bruegel.org/dataset/european-natural-gas-imports>. Accessed 10 March 2023.
- Council, E. (2019). *European Council meeting (12 December 2019) – Conclusions*.
- Council of the EU. (2022). *Council Regulation (EU) 2022/1369 of 5 August 2022 on coordinated demand-reduction measures for gas*. Brussel. <https://eur-lex.europa.eu/eli/reg/2022/1369>. Accessed 10 March 2023.
- Crnčec, D., Penca, J., & Lovec, M. (2023). The COVID-19 pandemic and the EU: From a sustainable energy transition to a green transition? *Energy Policy*, 175, 113453. <https://doi.org/10.1016/j.enpol.2023.113453>
- ČTK. (2023). *Ropovod Adria by zásobování Česka nemusel zvládnout, varuje Slovaft*. Novinky. <https://www.novinky.cz/clanek/ekonomika-ropovod-adria-by-zasobovani-ceska#nemusel-zvladnout-varuje-slovaft-40422007>. Accessed 10 March 2023.
- Energie-portal.sk. (2022). Spustili prvé batériové úložisko v krajinách V4 certifikované na podporné služby. <https://www.energie-portal.sk/Dokument/bateriove-ulozisko-certifikovane-pre-podporne-sluzby-ipesoft-108469.aspx>
- European Commission. (2020). Assessment of the final national energy and climate plan of Slovakia. https://commission.europa.eu/energy-climate-change-environment/implementation-eu-countries/energy-and-climate-governance-and-reporting/national-energy-and-climate-plans_en#national-energy-and-climate-plans-2021-2030. Accessed 3 October 2023.
- European Commission. (2022a). REPowerEU: Joint European Action for more affordable, secure and sustainable energy. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en. Accessed 10 March 2023.
- European Commission. (2022b). Save gas for a safe winter. https://ec.europa.eu/commission/presscorner/detail/en/IP_22_4608. Accessed 10 March 2023.
- European Commission. (2022c). *REPowerEU: Joint European Action for more affordable, secure and sustainable energy*. Brussels. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511. Accessed 10 Mar 2023.
- European Commission. (2022d). Russia's war on Ukraine: EU adopts sixth package of sanctions against Russia. https://ec.europa.eu/commission/presscorner/detail/en/ip_22_2802. Accessed 13 March 2023.
- European Commission. (2022e). Recommendation for a COUNCIL RECOMMENDATION on the 2022 National Reform Programme of Slovakia and delivering a Council opinion on the 2022 Stability Programme of Slovakia. https://commission.europa.eu/system/files/2022-05/2022-european-semester-csr-slovakia_en.pdf. Accessed 10 March 2023.
- European Council. (2022). EU adopts fifth round of sanctions against Russia over its military aggression against Ukraine. <https://www.consilium.europa.eu/en/press/press-releases/2022/04/08/eu-adopts-fifth-round-of-sanctions-against-russia-over-its-military-aggression-against-ukraine/>. Accessed 13 March 2023.
- European Environment Agency. (2023). Air pollution. <https://www.eea.europa.eu/themes/air>. Accessed 10 March 2023.
- Eurostat. (2023a). Imports of solid fossil fuels by partner country. https://ec.europa.eu/eurostat/databrowser/view/NRG_TI_SFF__custom_5280731/default/table?lang=en. Accessed 10 March 2023.
- Eurostat. (2023b). *EU gas consumption decreased by 19%*. European Commission. <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230221-1>. Accessed 25 February 2023.
- Eurostat. (2023c). *EU gas consumption decreased by 17.7%*. European Commission. <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/DDN-20230419-1>. Accessed 3 October 2023
- Eurostat. (2023d). Final energy consumption by sector. <https://ec.europa.eu/eurostat/databrowser/view/ten00124/default/table?lang=en>. Accessed 10 March 2023.
- Eurostat. (2024). Share of energy from renewable sources. <https://ec.europa.eu/eurostat/web/products-eurostat-news/w/ddn-20231222-2>. Accessed 3 January 2024.
- Financial Times. (2022). Germany fires up coal plants to avert gas shortage as Russia cuts supply. <https://www.ft.com>

- [com/content/f662a412-9ebc-473a-baca-22de5ff622e2](https://www.euractiv.com/content/f662a412-9ebc-473a-baca-22de5ff622e2). Accessed 10 March 2023.
- Frantová, E. (2023). *Dotácie na obnovu domov sú fiasko. Idú zmeniť pravidlá*. SME. <https://index.sme.sk/c/23139739/dotacie-obnova-domov-zmena-pravidla.html>. Accessed 10 March 2023.
- Funtíková, D. (2022). Dovoz ruského uhlia je už zakázaný. Slovenské podniky ho nahradili bez problémov. *Denník N*. <https://e.dennikn.sk/2966188/dovoz-ruskeho-uhlia-je-uz-zakazany-slovenske-podniky-ho-nahradili-bez-probl-emo>. Accessed 10 March 2023.
- Funtíková, D., & Kováč, J. (2022). Dopyt po uhlí stúpa, ale ťažbu už nevieme zvýšiť, hovorí manažér hornonitrianskych baní. *Denník N*. <https://e.dennikn.sk/3128986/dopyt-po-uhli-stupa-ale-tazbu-uz-nevieme-zvysit-hovori-manaazer-hornonitrianskych-bani/>. Accessed 10 March 2023.
- Funtíková, D., & Grečko, T. (2023). Zmluva s Gazpromom platí do roku 2034, dovtedy musíme za ruský plyn platiť, hovorí šéf SPP. *Denník N*. <https://e.dennikn.sk/3210323/zmluva-s-gazpromom-plati-do-roku-2034-dovtedy-musime-za-rusky-plyn-platit-hovori-sef-spp/>. Accessed 10 March 2023.
- Government Office of the Slovak Republic. (2012). *Aktualizácia analýzy fungovania štátnej podpory baníctva*. Bratislava. <https://rokovania.gov.sk/RVL/Resolution/6308/1>. Accessed 10 March 2023.
- Government Office of the Slovak Republic. (2022). *Desatoro riešení pre správcov verejných budov*. https://www.plano-bnovy.sk/site/assets/files/2987/desatoro_rieseni_pre_spravcov_verejnych_budov.pdf. Accessed 10 March 2023.
- Hogan, J. (2019). The critical juncture concept's evolving capacity to explain policy change. *European Policy Analysis*, 5(2), 170–189. <https://doi.org/10.1002/epa2.1057>
- Hrivňák, T. (2022). Prieskum: Voliči Smeru a Republiky sa najviac boja drahých energií, no ich šetrenie chcú bojkotovať. *Denník N*. <https://e.dennikn.sk/3032472/prieskum-volicu-smeru-a-republiky-sa-najviac-boja-drahych-energiu-no-ich-setrenie-chcu-bojkotovat/>. Accessed 3 October 2023.
- Hudec, M. (2022). Business as usual for Slovakia as EU oil embargo comes into effect. *Euractiv*. <https://www.euractiv.com/section/politics/news/business-as-usual-for-slovakia-after-eu-oil-embargo-comes-into-effect/>. Accessed 10 March 2023.
- Hudec, M. (2023). Slovakia failed to inform Commission about energy, climate plan progress. *Euractiv*. <https://www.euractiv.com/section/politics/news/slovakia-failed-to-inform-commission-about-energy-climate-plan-progress/>. Accessed 4 October 2023.
- IEA. (2022). *Coal 2022. Analysis and forecast to 2025*. <https://www.iea.org/reports/coal-2022/executive-summary>. Accessed 10 March 2023.
- JAVYS. (2023). Spoločnosť JAVYS uskutočnila v roku 2022 päť preprav vyhorieťho jadrového paliva a zabezpečovala päť preprav čerstvého jadrového paliva. <https://www.javys.sk/sk/informacny-servis/aktuality-tlacove-spravy-napis-alio-nas/tlacove-spravy/2057-spolocnost-javys-uskutocnil-av-roku-2022-pat-preprav-vyhoreteho-jadroveho-paliva-azabezpecovala-pat-preprav-cerstveho-jadroveho-paliva>. Accessed 27 February 2023.
- Jenčová, I. (2022a). Európa bude šetriť plynom za cenu veľkých ústupkov. *Euractiv*. <https://euractiv.sk/section/energetika/news/europa-bude-setrit-plynom-za-cenu-velkych-ustupkov/>. Accessed 10 March 2023.
- Jenčová, I. (2022b). Aké sú hlavné výzvy rozvoja samovýroby zelenej energie? *Euractiv*. <https://euractiv.sk/section/budovy/news/ake-su-hlavne-vyzvy-rozvoja-samovyroby-zelenej-energie-anketa/>. Accessed 3 October 2023.
- Jenčová, I. (2022c). Rezort hospodárstva podporí uskladňovanie obnoviteľnej energie. V hre sú vodík aj batérie. *Euractiv*. <https://euractiv.sk/section/energetika/news/rezort-hospodarstva-podpori-uskladnovanie-obnovitelnej-energie-v-hre-su-vodik-aj-baterie/>. Accessed 3 January 2024.
- Jenčová, I. (2022d). Ako je na tom Európa s uhlím? Zákaz jeho dovozu z Ruska domáci priemysel neohrozí. <https://euractiv.sk/section/dekarbonizacia-priemyslu/news/ako-je-na-tom-europa-s-uhlim-zakaz-jeho-dovozuz-ruska-domaci-priemysel-neohrozi/>. Accessed 10 March 2023.
- Kalair, A., Abas, N., Saleem, M. S., Kalair, A. R., & Khan, N. (2021). Role of energy storage systems in energy transition from fossil fuels to renewables. *Energy Storage*, 3(1), e135. <https://doi.org/10.1002/est2.135>
- Kotek, P., Seleš, A., Takácsné Tóth, B., & Felsmann, B. (2023). What can the EU do to address the high natural gas prices? *Energy Policy*, 173, 113312. <https://doi.org/10.1016/j.enpol.2022.113312>
- Kratochvíl, P., & Mišík, M. (2020). Bad external actors and good nuclear energy: Media discourse on energy supplies in the Czech Republic and Slovakia. *Energy Policy*, 136, 111058. <https://doi.org/10.1016/j.enpol.2019.111058>
- Krivánek, R. (2020). Factors limiting lifetime of nuclear power plants with pressurized-water reactors. *Nuclear Engineering and Design*, 370, 110872. <https://doi.org/10.1016/j.nucengdes.2020.110872>
- Kullová, Z. (2023). Čierne zlato nabralo nový kurz. Slovaft zmenil nákupné trasy i export, trh je ostrážitý. *Trend*. <https://www.trend.sk/financie/cierne-zlato-nabralo-novy-kurz-slovaft-zmenil-nakupne-trasy-export-ostrazitost-jenamieste>. Accessed 13 March 2023.
- Kuzemko, C., Blondeel, M., Dupont, C., & Brisbois, M. C. (2022). Russia's war on Ukraine, European energy policy responses & implications for sustainable transformations. *Energy Research & Social Science*, 93, 102842. <https://doi.org/10.1016/j.erss.2022.102842>
- Maltby, T. (2013). European Union energy policy integration: A case of European Commission policy entrepreneurship and increasing supranationalism. *Energy Policy*, 55, 435–444. <https://doi.org/10.1016/j.enpol.2012.12.031>
- Marko, M. (2023). Preprava ruského plynu cez Slovensko dramaticky klesla. Doplatí na to aj štát. *HN Online*. <https://hnonline.sk/finweb/ekonomika/96063144-preprava-ruskeho-plynu-cez-slovensko-dramaticky-klesla-doplati-na-to-aj-stat>. Accessed 10 March 2023.
- Mathis, W., Ainger, J., & Tugwell, P. (2022). EU deal to cut gas use is full of carve-outs to keep unity. *Bloomberg*. <https://www.bloomberg.com/news/articles/2022-07-26/eu-deal-to-cut-gas-use-is-full-of-carve-outs-to-keep-unity>
- Ministry of Economy of the Slovak Republic. (2015). *Rozhodnutie č.23/2015 Ministerstva hospodárstva SR*. <https://a-static.projektn.sk/2015/11/rozhodnutie-ministerstva.pdf>. Accessed 10 March 2023.

- Ministry of Economy of the Slovak Republic. (2019). Integrated national energy and climate plan for 2021 to 2030. <https://www.economy.gov.sk/energetika/integrovaný-narodný-energetický-a-klimatický-plan-na-roky-2021-2030/navrh-integrovaného-narodného-energetickeho-a-klimatickeho-planu?csrt=3851191655588536744>. Accessed 10 March 2023.
- Ministry of Economy of the Slovak Republic. (2021). Končí sa stop-stav na pripájanie nových zdrojov na výrobu elektriny, budeme mať viac zelenej energie. <https://www.economy.gov.sk/top/konci-sa-stop-stav-na-pripajanie-novych-zdrojov-na-vyrodu-elektriny-budeme-mat-viac-zelenej-energie>. Accessed 3 October 2023.
- Ministry of Economy of the Slovak Republic. (2022a). Dodávky plynu má Slovensko zabezpečené do konca budúceho roku. <https://www.mhsr.sk/top/dodavky-plynu-ma-slovensko-zabezpecene-do-konca-buduceho-roku>. Accessed 3 October 2023.
- Ministry of Economy of the Slovak Republic. (2022b). Rezort hospodárstva dostal potvrdenie EK k memorandu so Slovenskými elektrárňami. <https://www.mhsr.sk/top/rezort-hospodarstva-dostal-potvrdenie-ek-k-memorandu-so-slovenskymi-elektrarnami-komisija-potvrdila-ze-nema-vyhrady-voci-aplikacii-memoranda-pre-slovenske-domacnosti?csrt=15398638737516938577>. Accessed 3 October 2023.
- Ministry of Economy of the Slovak Republic. (2022). *Návrh Akčného plánu rozvoja elektromobility v Slovenskej republike* (2022). Enviroportal. <https://www.enviroportal.sk/dokument/f/akcny-plan-rozvoja-elektromobility-v-sr-2023.pdf>. Accessed 10 March 2023.
- Ministry of Economy of the Slovak Republic. (2023a). Zníženie spotreby plynu Slovenska za mesiac január až na úrovni 23%. <https://www.mhsr.sk/top/znizenie-spotreby-plynu-slovenska-za-mesiac-január-az-na-urovni-23>. Accessed 3 October 2023.
- Ministry of Economy of the Slovak Republic. (2023b). *Draft update of the integrated national energy and climate plan for 2021–2030*. European Commission https://commission.europa.eu/publications/slovakia-draft-updated-necp-2021-2030_en. Accessed 3 October 2023.
- Ministry of Economy of the Slovak Republic. (2023c). Dotácie na energie pre hospodárske subjekty. <https://energodotacie.mhsr.sk/>. Accessed 3 October 2023.
- Ministry of Environment of the Slovak Republic. (2017). *Revízia výdavkov na životné prostredie. Záverečná správa*. https://www.minzp.sk/files/iep/zaverecna_sprava_zivotne_prostredie.pdf. Accessed 10 March 2023.
- Ministry of Environment of the Slovak Republic. (2022). Verejná správa ide príkladom. <https://www.minzp.sk/files/aktuality/verejna-sprava-ide-prikladom.pdf>. Accessed 10 March 2023.
- Ministry of Finance of the Slovak Republic. (2022). Memorandum o porozumení o implementácii mimoriadnych opatrení na elimináciu dopadu nárastu cien elektrickej energie na vybrané skupiny odberateľov. www.mfsr.sk/files/sk/media/tlacove-spravy/domacnosti-usetria-elektrine-1-miliardu-eur/memorandum-porozumeni.pdf. Accessed 10 March 2023.
- Ministry of Transport. (2020a). *Dlhodobá stratégia obnovy fondu budov*. Bratislava.
- Ministry of Transport of the Slovak Republic. (2020b). *Dlhodobá stratégia obnovy fondu budov*. European Commission. https://energy.ec.europa.eu/document/download/b8e058af32e4ee1-a9b9-63d84871a51c_en?filename=sk_2020_ltrs.pdf. Accessed 3 October 2023.
- Mišík, M. (2019). *External Energy Security in the European Union. Small Member States' Perspective*. Routledge.
- Mišík, M. (2021). When the accession legacy fades away: Central and Eastern European countries and the EU renewables targets. *International Spectator*, 56(3), 56–70. <https://doi.org/10.1080/03932729.2021.1932137>
- Mišík, M. (2022). The EU needs to improve its external energy security. *Energy Policy*, 165, 112930. <https://doi.org/10.1016/J.ENPOL.2022.112930>
- Mišík, M., & Nosko, A. (2023). Each one for themselves: Exploring the energy security paradox of the European Union. *Energy Research & Social Science*, 99, 103074. <https://doi.org/10.1016/j.erss.2023.103074>
- Mišík, M., & Prachárová, V. J. (2023). Coal is a priority for energy security, until it is not : Coal phase-out in the EU and its persistence in the face of energy crisis. *Sustainability*, 15(8), 6879. <https://doi.org/10.3390/su15086879>
- National Council of the Slovak Republic. (2022). Vládný návrh zákona o solidárnom príspevku z činností v odvetviach ropy, zemného plynu, uhlia a rafinérií a o doplnení niektorých zákonov. <https://www.nrsr.sk/web/Default.aspx?sid=zakony/zakon&ZakZborID=13&CisObdobia=8&CPT=1332>. Accessed 10 March 2023.
- National Council of the Slovak Republic. (2023). Zákon, ktorým sa mení a dopĺňa zákon č. 519/2022 Z. z. o solidárnom príspevku z činností v odvetviach ropy, zemného plynu, uhlia a rafinérií a o doplnení niektorých zákonov. <https://www.slov-lex.sk/pravne-predpisy/SK/ZZZ/2022/519/>. Accessed 3 October 2023.
- Official Journal of the European Union. (2013). Commission Delegated Regulation (EU) No 1391/2013 of 14 October 2013 amending Regulation (EU) No 347/2013 of the European Parliament and of the Council on guidelines for trans-European energy infrastructure as regards the Union list of projects of common interest. <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R1391>. Accessed 10 March 2023.
- OKTE. (2022). Národný energetický mix. <https://www.okte.sk/sk/zaruky-povodu/statistiky/narodny-energeticky-mix/>. Accessed 3 October 2023.
- Pan, Y. (2023). Managing the atomic divorce : The challenges of East Central Europe ' s nuclear energy decoupling from Russia. *The Electricity Journal*, 36(1), 107241. <https://doi.org/10.1016/j.tej.2023.107241>
- Prontera, A., & Penta, P. (2020). Catalytic power Europe and gas infrastructural policy in the Visegrad countries. *Energy Policy*, 137, 111189. <https://doi.org/10.1016/j.enpol.2019.111189>
- Rádio Slovensko. (2022). K podpore ťažby hnedého uhlia sa nevrátime. *Slovak Radio*. <https://slovensko.rtvs.sk/clanky/spolocnost/295858/k-tazbe-hnedeho-uhlia-sa-nevratime>. Accessed 3 October 2023
- Reuters. (2018). Slovakia to pull plug on coal subsidies for 2023. <https://www.reuters.com/article/idUSKCN1NO1XS/>. Accessed 10 March 2023.

- Rosenow, J., Gibb, D., Nowak, T., & Lowes, R. (2022). Heating up the global heat pump market. *Nature Energy*, 7(10), 901–904. <https://doi.org/10.1038/s41560-022-01104-8>
- Slovak Innovation and Energy Agency. (2022). Podme šetriť spolu. Ministerstvo hospodárstva a SIEA spúšťajú informačnú kampaň. <https://www.siea.sk/podme-setrit-spolu-ministerstvo-hospodarstva-a-siea#spustaju-informacnu-kampan/>. Accessed 3 October 2023.
- SITA. (2016). Slovnafť sa chystá testovať inú než ruskú ropu. <https://www.energia.sk/slovnafť-sa-chysta-testovat-inu-nez-rusku-ropu/>. Accessed 10 March 2023.
- SITA. (2023). Slovensko môže mať nový jadrový reaktor. Firma JESS podala žiadosť. Pravda. <https://ekonomika.pravda.sk/energetika/clanok/657309-slovensko-moze-mat-novy-jadrov-y-reaktor-firma-jess-podala-ziadosť/>. Accessed 10 March 2023.
- Skjærseth, J. B. (2021). Towards a European Green Deal: The evolution of EU climate and energy policy mixes. *International Environmental Agreements: Politics, Law and Economics*, 21(1), 25–41. <https://doi.org/10.1007/s10784-021-09529-4>
- Slovak Association of Photovoltaic Industry and RES. (2023). Slovak renewable electricity market report 2022. <https://www.sapi.sk/files/Slovak-Renewable-Electricity-Market-Report-2022.pdf>. Accessed 10 March 2023.
- Slovak Innovation and Energy Agency. (2020). Ročná správa o pokroku pri dosahovaní národných cieľov energetickej efektívnosti za rok 2019. https://www.siea.sk/wp-content/uploads/monitorovaci_system/monitorovacie_spravy/Sprava_efektivnost_2019.pdf. Accessed 10 March 2023.
- Supreme Audit Office of the Slovak Republic. (2022). Správa o výsledku kontroly 2022: Obnova verejných budov. <https://www.nku.gov.sk/documents/10157/1407476/Spr%C3%A1va+Obnova+verejn%C3%BDch+budov/feacdcee-92b2-4b20-9da1-1df68695dae7>. Accessed 10 March 2023.
- Szulecki, K., & Overland, I. (2023). Russian nuclear energy diplomacy and its implications for energy security in the context of the war in Ukraine. *Nature Energy*, 8, 413–421. <https://doi.org/10.1038/s41560-023-01228-5>
- TASR. (2022). Heger: Slovensko by sa mohlo úplne odstihnúť od ruských energonosičov. Ceny sú už teraz extrémne vysoké. *HN Online*. <https://hnonline.sk/finweb/ekonomika/23499978-heger-slovensko-by-sa-mohlo-uplne-odstrihnut-od-ruskych-energonosicov-ceny-su-uz-teraz-extremne-vysoke>
- TASR. (2023a). Prieskum: Zvýšenie cien energií zasiahlo 90 percent domácností. *Forbes*. <https://www.forbes.sk/prieskum-zvysenie-cien-energii-zasiahlo-90-percent-domacnosti/>. Accessed 3 October 2023.
- TASR. (2023b). Mimoriadna daň pre rafinérie by sa mohla zvýšiť a platiť aj v tomto roku. *Trend*. <https://www.trend.sk/spravy/mimoriadna-dan-pre-rafinerie-mohla-zvysit-platit-aj-tomto-roku>
- Tvardzík, J. (2023). Štyristo miliónov od Slovnafťu bol prinízky odhad. Rafinéria zaplatila oveľa viac. *SME*. <https://www.sme.sk/minuta/23189906/styristo-milionov-od-slovnafťu-bol-prinizky-odhad-rafineria-zaplatila-ovela-viac?ref=sharebox>. Accessed 3 October 2023.
- Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy*, 28(12), 817–830. [https://doi.org/10.1016/S0301-4215\(00\)00070-7](https://doi.org/10.1016/S0301-4215(00)00070-7)
- Verdun, A. (2015). A historical institutionalist explanation of the EU's responses to the euro area financial crisis. *Journal of European Public Policy*, 22(2), 219–237. <https://doi.org/10.1080/13501763.2014.994023>
- Vlček, T. (2016). Critical assessment of diversification of nuclear fuel for the operating VVER reactors in the EU. *Energy Strategy Reviews*, 13–14, 77–85. <https://doi.org/10.1016/j.esr.2016.08.006>
- Wolff, S., & Ladi, S. (2020). European Union responses to the COVID-19 pandemic: Adaptability in times of permanent emergency. *Journal of European Integration*, 42(8), 1025–1040. <https://doi.org/10.1080/07036337.2020.1853120>

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.