przegląd krytyczny
critical review

Speed versus resilience in Poland's energy transition

PRZEGLĄD KRYTYCZNY
2026 / 8(1): 25–40
ISSN: 2657–8964
DOI: 10.14746/pk.2026.8.1.2

Mariusz Baranowski[1]

[1] Adam Mickiewicz University, Poznań. Faculty of Sociology, Szamarzewskiego 89 C, 60-568 Poznań, Poland. ORCID: 0000-0001-6755-9368, Email: mariusz.baranowski@amu.edu.pl

ABSTRACT: The Polish energy transition represents one of the most complex cases of power sector decarbonisation in Central and Eastern Europe. Moving away from a socio-technical regime historically entrenched in hard coal and lignite towards a diversified low-carbon energy mix raises fundamental questions regarding temporal dynamics and socio-technical resilience. This article critically evaluates the projected trajectories of electricity generation in Poland up to 2040, drawing on empirical forecasts of gross power production in terawatt-hours, alongside the corresponding shares in the generation mix. The analysis demonstrates that whilst the projected decline in coal's share from 87% in 2015 to 9% in 2040, combined with the expansion of renewable energy sources to 53%, indicates a profound structural transformation, the pace of decarbonisation remains constrained by regulatory inertia and legacy infrastructure. Simultaneously, the emerging configuration introduces novel vulnerabilities, notably a tripling of gas-fired power generation that risks establishing a new form of carbon lock-in, and an ambitious reliance on nuclear power after 2030 that carries significant risks of megaproject execution. The article outlines key implications for transition governance, emphasising that accelerating decarbonisation must be coupled with grid resilience, energy storage expansion, and spatial justice to achieve a stable and equitable energy transition.

KEYWORDS: energy transition, socio-technical resilience, decarbonisation, just transition, renewable energy, nuclear power, gas lock-in

1. INTRODUCTION: THE LEGACY OF CARBON LOCK-IN AND THE EUROPEAN DECARBONISATION IMPERATIVE

Decarbonising national energy systems involves far more than substituting generation technologies. It requires the comprehensive reconfiguration of socio-technical regimes, encompassing institutional arrangements, market rules, physical infrastructures, and societal practices (Bridge et al., 2013; Geels, 2014). In Central and Eastern Europe (CEE), and in Poland in particular, this process is shaped by a deep historical legacy of industrial reliance on solid fossil fuels (Cichocki et al., 2026; Verma et al., 2023a; Widera et al., 2024). The Polish power sector has operated under an extreme form of carbon lock-in, serving as a classic example of path dependence in which technological infrastructure, state institutions, and political narratives mutually reinforced the dominance of domestic coal (Kuchler & Bridge, 2018; Unruh, 2000). Decades of coal-centric industrialisation established an institutional hegemony that tied national energy security to the mining sector and shaped regional economies around extraction (Bluszcz et al., 2023).

This entrenched socio-technical alignment now confronts intense pressure from the European Union's (EU) climate framework. Driven by the European Green Deal, the Fit for 55 policy package, and the overarching objective of climate neutrality by 2050, Poland faces strict regulatory timelines and rising carbon costs under the EU Emissions Trading System (EU ETS) (Brauers et al., 2020; Jankowska & Ancygier, 2017; Ziółkowski et al., 2024). Moreover, the geopolitical shocks following the Russian invasion of Ukraine in 2022 have fundamentally altered European energy security priorities (Baranowski, 2023; Baranowski & Jabkowski, 2026). The necessity of eliminating Russian fossil fuels has forced a re-evaluation of transition pathways, highlighting supply chain vulnerabilities and challenging the long-term viability of fossil gas as an unconstrained bridge fuel (Baranowski, 2024; Kuzemko et al., 2022; Magyari, 2023).

These converging pressures raise a critical research question: Is the projected trajectory of the Polish energy transition progressing at a pace sufficient to meet European decarbonisation mandates, and does the emerging socio-technical mix possess the resilience to withstand geopolitical and operational shocks? Answering this question requires moving beyond simple balance sheet metrics to examine the temporal dynamics, systemic vulnerabilities, and distributional impacts of Poland's evolving energy architecture. This energy architecture, which until recently in fact constituted a Polish coal monoculture, is today unsustainable for many reasons, including technological, economic, and environmental ones.

2. EMPIRICAL TRAJECTORIES OF THE POLISH ELECTRICITY MIX (2015–2040)

A rigorous assessment of the Polish energy transition requires a detailed empirical examination of both the relative share of generation sources and the absolute volumes of gross electricity production measured in terawatt-hours (TWh). It is all the more significant a task that even a journal as eminent as The Proceedings of the National Academy of Sciences (PNAS) publishes an article in 2026 stating false information, claiming that Poland is among the countries most dependent on Russian energy imports. In the work of Meng at al. (2026), we can read that "Eastern EU countries such as Poland, Latvia, Slovakia, and Hungary are more reliant on Russian imports and exhibit the largest benefits, highlighting their sensitivity to energy strategy choices." The authors chose not to mention, for example, that France imports vast quantities of LNG from Russia (Raghunandan et al., 2026), while providing false information about Poland. Lamenting the quality of the editorial and peer-review process at PNAS, let us proceed to a more detailed analysis of the energy transition towards renewable energy sources in Poland.

2.1. FROM COAL MONOCULTURE TO INITIAL DIVERSIFICATION (2015–2023)

In 2015, the Polish electricity sector exhibited an almost absolute coal monoculture, with hard coal and lignite accounting for 87% of gross power generation. Renewable energy sources (RES) contributed a modest 10%, dominated by onshore wind and biomass co-firing, while natural gas accounted for merely 3%, and nuclear power was absent entirely despite attempts to open one (Fig. 1). Between 2015 and 2023, the first structural shifts became evident. Coal's share contracted by 24 percentage points to 63%, driven by the rising price of carbon allowances and the aging fleet of subcritical coal-fired units. Concurrently, renewables expanded to 27% of the generation mix, largely propelled by an unprecedented boom in distributed prosumer solar photovoltaics and onshore wind farms (Tomczyk & Łapniewska, 2025). The use of gaseous fuels also increased, reaching 10% of total production, as energy companies sought flexible capacity to balance variable generation.

In 2024, Polish RES reached 30%, increasing to 31% the following year, and by mid-2026, it had already reached almost 32%. Between 2023 and 2024, a further decline in the share of coal was recorded, from 63% to 58%, a noteworthy development. The trend line for coal, indicated by the dashed black line in Fig. 1, suggests a decrease in the share of this fossil fuel as a source of electricity in Poland. Although Poland's energy mix has historically been based on hard and lignite coal (Fig. 2), in recent years we have seen a systematic move away from fossil fuels towards renewable energy sources (Igliński et al., 2022; Rusin & Wojaczek, 2023).

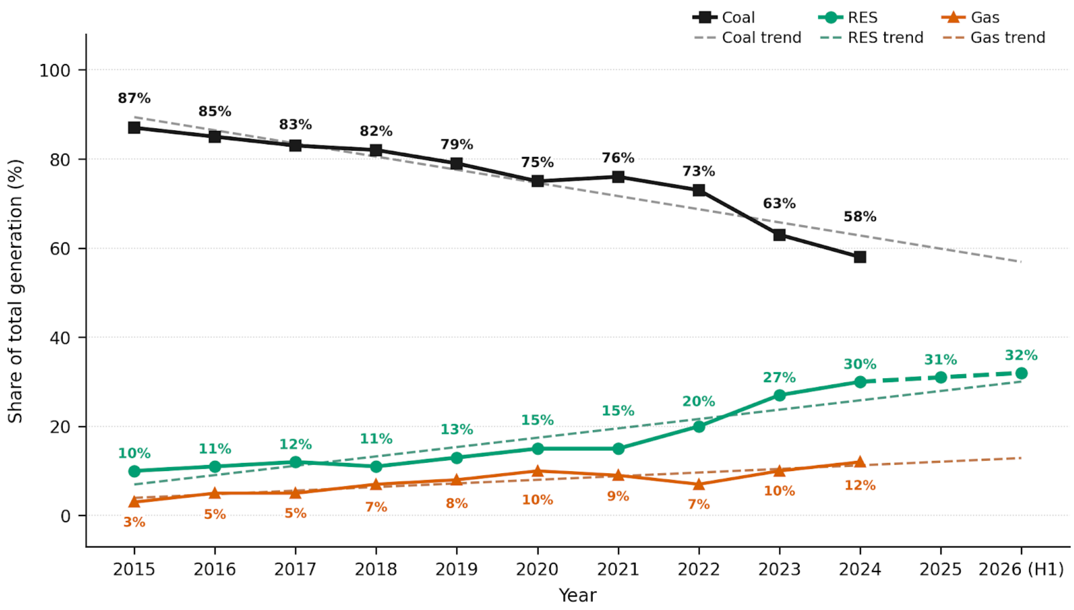

Fig. 1. Poland's share of electric power sources from 2015 to 2026 (H1)

Source: Author's own elaboration based on Urząd Regulacji Energetyki; Polskie Sieci Elektroenergetyczne; Agencja Rynku Energii Spółka Akcyjna (2015 to 2024). For years 2025-2026 (H1): Forum Energii (2026)

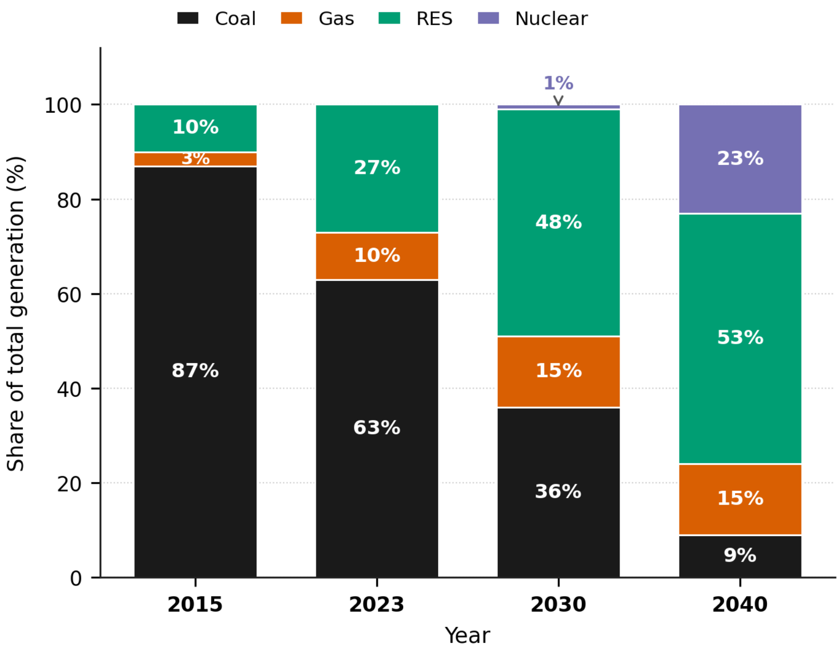

Fig. 2. Poland's forecast share of electric power sources in Poland from 2015 to 2040.

Source: Author's own elaboration based on Urząd Regulacji Energetyki; Polskie Sieci Elektroenergetyczne; Agencja Rynku Energii Spółka Akcyjna (2015 to 2040) https://www.statista.com/statistics/1458134/poland-forecast-of-energy-mix/

The transition away from fossil fuels is occurring neither without problems nor at a breakneck pace, which is a consequence of the aforementioned Polish coal monoculture, deeply rooted in the social, political, and economic realities of this country.

2.2. PROJECTIONS FOR 2025–2030: ACCELERATED REALIGNMENT

Projections for the remainder of the 2020s indicate an acceleration of structural realignment. As shown in Fig. 2, coal's contribution to the electricity mix is forecast to drop to 36% by 2030, marking the loss of its majority position. Renewable energy is projected to supply nearly half of national electricity demand at 48%, while gas-fired generation will increase to 15%, and nuclear power will make an initial entry at 1%.

The absolute production volumes depicted in Fig. 3 explain the underlying generation dynamics. Gross electricity generation from hard coal is forecast to decline from 72.30 TWh in 2025 to 63.10 TWh in 2030. In contrast, lignite-based generation exhibits notable short-term persistence, moving from 50.40 TWh in 2025 to 49.90 TWh in 2030. This stagnation reflects the continued operational reliance on major mine-mouth power plants, such as Bełchatów and Turów (Kucharska, 2023; Thielemann & Berrocal, 2024), to provide baseload capacity during the initial phase of coal phase-out. Combined coal generation thus declines from 122.70 TWh in 2025 to 113.00 TWh in 2030.

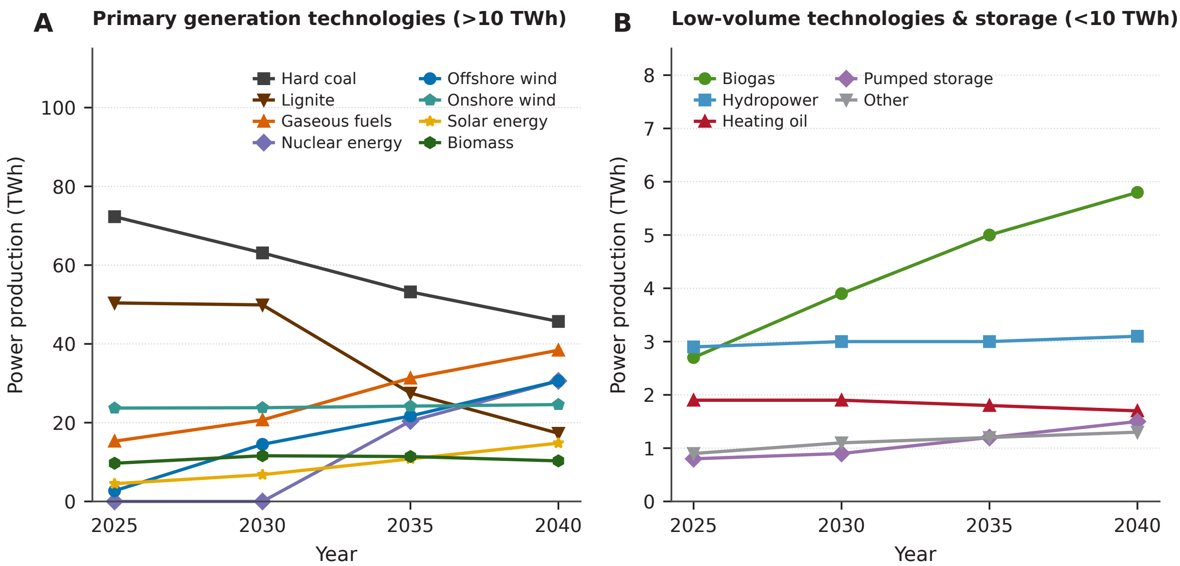

Fig. 3. Poland's forecast gross power production from 2025 to 2040, by source (in TWh)

Source: Author's own elaboration based on Ministry of Energy (Poland); 2025 to 2040, https://www.statista.com/statistics/1039567/poland-power-production/

During the same five-year interval, electricity generation from gaseous fuels rises from 15.30 TWh to 20.70 TWh. Within the renewable energy category, onshore wind generation remains virtually static, shifting from 23.70 TWh in 2025 to 23.80 TWh in 2030, a direct consequence of historical regulatory restrictions, notably the 10H distance rule (Jurasz et al., 2025). Growth in the RES sector is instead sustained by solar energy, which increases from 4.50 TWh to 6.80 TWh, biomass, which reaches 11.60 TWh, and the initial deployment of offshore wind, which expands rapidly from 2.70 TWh in 2025 to 14.50 TWh by 2030.

2.3. THE 2035–2040 HORIZON: NUCLEAR DEPLOYMENT AND DEEP DECARBONISATION

The decade between 2030 and 2040 is structured as a phase of deep socio-technical reconfiguration. By 2040, coal's share of the generation mix is projected to fall to just 9% (Fig. 2), representing a total marginalisation of the resource that supplied nearly nine-tenths of the country's power twenty-five years earlier. Renewables are projected to become the dominant generation pillar at 53%, while gas maintains a steady 15% share, and nuclear energy grows to represent 23% of total production.

Analysing these shifts in terms of volume (Fig. 3) reveals crucial technological transitions. Lignite generation undergoes a steep decline after 2030, dropping from 27.50 TWh in 2035 to 17.30 TWh in 2040 as fuel reserves deplete and carbon liabilities escalate under EU ETS rules (Fig. 3). Hard coal generation decreases further to 45.70 TWh by 2040. Offshore wind becomes the largest single renewable technology, expanding to 21.70 TWh in 2035 and 30.60 TWh in 2040. Solar power generation increases steadily to 14.80 TWh in 2040, whereas onshore wind remains largely stagnant at 24.60 TWh.

The most substantial structural addition after 2030 is utility-scale nuclear power (Bartela et al., 2025). The projections assume that the first commercial nuclear reactors will supply 20.40 TWh of electricity in 2035, rising to 30.60 TWh in 2040—an amount equivalent to the entire projected output of the offshore wind sector that year. Meanwhile, pumped storage and hydro-based flexibility facilities experience very modest expansion, growing from 0.80 TWh in 2025 to 1.50 TWh in 2040.

3. THE SPEED DILEMMA: HISTORICAL ACCELERATION VERSUS CLIMATE TARGETS

Evaluating the speed of the Polish energy transition depends significantly on the chosen analytical benchmark. When judged against the historical inertia of Poland's coal regime, the projected reduction of coal's share from 87% in 2015 to 36% in 2030 and 9% in 2040 (Fig. 2) represents a rapid structural shift. Historical studies of socio-technical transitions emphasise that major energy reconfigurations typically unfold over several decades (Sovacool, 2016). In this context, the Polish trajectory appears as an instance of accelerated regime decay and substitution.

However, when evaluated against international climate imperatives and EU target frameworks (Lal et al., 2026; Salim et al., 2026), the temporal adequacy of this trajectory becomes far more questionable.

The persistent volume of coal generation in the absolute production profile (Fig. 1) demonstrates significant systemic resistance. Even in 2040, when coal represents only 9% of the mix (Fig. 2), the power system is projected to generate 63.00 TWh of coal-fired electricity (45.70 TWh from hard coal and 17.30 TWh from lignite). This volume exceeds the total individual outputs of offshore wind (30.60 TWh) or nuclear power (30.60 TWh) in the same year (Fig. 3). Maintaining this level of coal generation well into the 2030s and 2040s exposes electricity producers to escalating EU ETS carbon costs, raising wholesale power prices and placing an economic burden on industrial consumers (Thlon, 2026). Furthermore, operating coal plants at low capacity factors to provide backup power creates substantial stranded asset risks and necessitates ongoing state support mechanisms, such as capacity market payments, which can distort market signals and draw public criticism (Surma et al., 2026; Turnheim & Geels, 2012).

The slow growth projected for onshore wind illustrates how institutional and regulatory barriers can impede the speed of the transition. As shown in Fig. 3, onshore wind output stabilises at roughly 24 TWh through 2040. This stagnation reflects the long-term impact of regulatory decisions, specifically the 2016 spatial distance restrictions (the 10H law). Although subsequent amendments eased these rules, the lingering administrative complexity continues to suppress onshore wind development (Geels, 2014). Despite rapid progress in solar PV (14.80 TWh in 2040) and offshore wind (30.60 TWh in 2040), a total RES share of 53% by 2040 positions Poland behind many other EU member states that aim for near-complete power sector decarbonisation prior to 2040 (Boitier et al., 2023; Madsen et al., 2025). CEE (also referred to by researchers as Eastern Europe) is lagging behind in implementing the renewable energy transition compared to other European regions, particularly Northern and Western Europe (Ball-Burack et al., 2025, p. 11). Poland is no exception here, as confirmed by the figures above on the country's energy mix and the estimated future scenario.

4. THE RESILIENCE DILEMMA: STRUCTURAL VULNERABILITIES IN THE EMERGING CONFIGURATION

Socio-technical resilience refers to the capacity of an energy system to absorb external disruptions, adapt to shifting operational conditions, and maintain reliable service without establishing new, unmanageable dependencies (Fohr, 2026; Smith & Stirling, 2010). An examination of Poland's projected generation mix reveals that as coal dependence diminishes, new systemic vulnerabilities are emerging. Let us now examine the potential directions of these systemic weaknesses.

4.1. NATURAL GAS EXPANSION: A SECONDARY LOCK-IN RISK

Electricity generated from natural gas is forecast to increase from 15.30 TWh (10% of the mix) in 2025 to 38.40 TWh (15% of the mix) in 2040 (Figs. 2 and 3). Over this fifteen-year period, gas-fired production will more than double in volume. While natural gas provides flexible capacity to compensate for the variability of wind and solar power, overreliance on gas as a bridge fuel poses critical risks (Abban & Nuta, 2026; Kardaś, 2025).

Although Poland has diversified its gas supply infrastructure through the Baltic Pipe and expanded LNG import capacity in Świnoujście, natural gas remains an imported fossil fuel subject to international market dynamics. Relying on gas for 15% of electricity generation leaves the power sector vulnerable to international price volatility and geopolitical disruptions in global LNG supply chains (Berling et al., 2024; Rybak et al., 2022). Additionally, constructing long-lived combined-cycle gas turbine (CCGT) plants creates a secondary carbon lock-in. These capital-intensive assets risk becoming stranded if tightening European carbon constraints require their premature phase-out or retrofitting with costly carbon capture technologies before the end of their operational lifespans (Emanuelsson et al., 2025; Unruh, 2000; Verma et al., 2023b).

4.2. THE NUCLEAR BET: EXECUTION RISKS OF CAPITAL-INTENSIVE MEGAPROJECTS

The most striking structural feature of the post-2030 projection is the introduction of nuclear power (Bartela et al., 2025; Bohdanowicz et al., 2023). Nuclear energy is expected to rise from a 1% share in 2030 to 23% in 2040 (Fig. 2), supplying 30.60 TWh of baseload electricity by the end of the forecast period (Fig. 3).

From a socio-technical perspective, this rapid integration assumes an optimistic timeline for the delivery of nuclear megaprojects. Research on large infrastructure projects demonstrates that nuclear power construction frequently suffers from cost overruns and schedule delays (cf. Flyvbjerg, 2014). Recent civil nuclear construction in Europe and North America—such as Olkiluoto 3 in Finland, Flamanville 3 in France, and Vogtle in the United States—demonstrates the operational and regulatory complexities involved in establishing first-of-a-kind nuclear facilities (Locatelli, 2018).

If Poland's initial nuclear reactors experience construction delays extending into the late 2030s or early 2040s, a critical capacity gap will open. With lignite generation falling sharply from 49.90 TWh in 2030 to 17.30 TWh in 2040 due to coal field depletion and environmental constraints, any delay in nuclear commissioning would force the system to increase natural gas consumption or rely more heavily on electricity imports to maintain grid stability. This, in turn, could act as a brake on achieving the EU targets for 2050 and on implementing low- or zero-emission energy sources in Poland. At this point, attention should also be drawn to Russia's role in nuclear technologies, an issue often overlooked in strategic analyses and studies. As Kacper Szulecki and Inga Overland (2023, p. 413) rightly noted:

> While the Russian shelling and takeover of Ukrainian nuclear power plants has caused an outcry, Russia's portfolio of foreign orders, including reactor construction, fuel provision and other services, spans 54 countries and is claimed by Rosatom to be worth more than US$139 billion over a ten year period and has thus far not been covered by Western sanctions.

This fact, along with Russia's potential role in the EU's energy transition, including Poland's, following the end of the war in Ukraine, must be taken into account in Warsaw's plans to develop nuclear energy.

4.3. GRID FLEXIBILITY AND STORAGE DEFICITS

Transitioning to an electricity system where renewables supply more than 50% of annual generation (including 30.60 TWh from offshore wind and 14.80 TWh from solar in 2040) requires a significant increase in grid flexibility and storage capacity. However, the empirical data highlight a major discrepancy between growth in variable generation and storage development (Przedworska et al., 2025).

As shown previously in Fig. 3, power generation from pumped-storage and hydro facilities increases modestly from 0.80 TWh in 2025 to 1.50 TWh in 2040. This slow expansion underscores a deficit in utility-scale energy storage assets. Without large-scale battery storage, expanded pumped hydro capacity, smart grid infrastructure, and active demand-side response (DSR) mechanisms, the Polish power system will face operational challenges (Bachanek et al., 2025). These include curtailment of renewable generation during periods of oversupply and supply tightness during prolonged periods of low wind and solar output ("Dunkelflaute") (Kittel et al., 2026).

5. JUST TRANSITION AND THE SOCIO-SPATIAL DISTRIBUTION OF COSTS

Energy transitions reconfigure local labour markets, regional economies, and social structures, creating distinct spatial patterns of costs and benefits (Ball-Burack et al., 2025; McCauley & Heffron, 2018; Newell & Mulvaney, 2013). The projected contraction of coal generation in Poland introduces major energy justice challenges across distributional, procedural, and recognitional dimensions (Martin & Broughel, 2025; Tarasova, 2024, 2025).

The reduction in hard coal generation between 2025 and 2040, combined with the fall in lignite production (Fig. 3), will require the downsizing of mining operations and coal-fired power plants. In Upper Silesia, the traditional heartland of Polish hard coal mining, this shift will affect employment in mining enterprises and supply chain industries (Christiaensen et al., 2022; Frankowski et al., 2023). Similarly, in lignite mining regions such as Bełchatów, Turów, and Konin, a reduction in generation exceeding 65% by 2040 poses structural economic challenges for local communities that have historically depended on mine-mouth power complexes. Without targeted economic diversification, these regions face risks of depopulation, local economic decline, and social disruption (Widera et al., 2016).

At the same time, the substantial capital costs of building offshore wind farms, nuclear power plants, and transmission grid infrastructure will influence consumer electricity tariffs. In a country where a notable portion of households experience energy poverty, rising retail energy prices could exacerbate social inequalities and trigger resistance to climate policies (Bouzarovski & Tirado Herrero, 2017; Zoll, 2022). Achieving a just transition in Poland requires moving beyond simple financial compensation for displaced workers. It demands proactive regional industrial strategies, support for local supply chains in green technologies, and targeted consumer protections to shield low-income households from rising energy costs.

6. DISCUSSION AND POLICY IMPLICATIONS FOR TRANSITION GOVERNANCE

The empirical projections for Poland's electricity sector up to 2040 outline a fundamental, yet tension-filled, socio-technical transition. The projected collapse of coal's dominant position confirms an irreversible departure from legacy fossil fuel dependency (Fig. 2). Concurrently, the substantial expansion of renewable generation—driven primarily by offshore and onshore wind deployment and solar photovoltaics—demonstrates a decisive structural shift towards a low-carbon power regime (Hebda et al., 2024; Lew et al., 2021).

However, the analysis also highlights critical limitations concerning both the pace and systemic resilience of this transition pathway. The speed of decarbonisation remains constrained by the persistence of substantial coal-fired generation late into the forecast period, leaving Poland among the last major coal-reliant power producers in the EU. Furthermore, the emerging socio-technical regime substitutes historic carbon lock-in with novel vulnerabilities. An expanding dependence on gaseous fuels increases exposure to geopolitical and price instability, whilst the post-2030 decarbonisation trajectory relies heavily on the flawless execution of capital-intensive nuclear megaprojects. Simultaneously, the slow deployment of utility-scale energy storage assets poses growing operational risks as variable renewable generation expands. To address these challenges, transition governance in Poland should focus on several integrated policy priorities described below.

Directing regulatory support toward onshore wind development by simplifying spatial planning and administrative procedures can revive low-cost, land-based renewable generation. Simultaneously, prioritising grid modernisation and establishing dedicated frameworks for utility-scale battery storage, pumped hydro expansion, and demand-side flexibility will be essential to integrate a 53% share of variable renewables without incurring excessive curtailment. Currently, there are significant gaps and shortcomings in this area in Poland, which could cause serious disruptions in the transition away from hydrocarbons towards low- or zero-emission solutions.

Regarding baseload generation, managing the execution risks of the nuclear energy programme requires developing realistic contingency plans (Pieńkowski, 2024; Tajduś & Tokarski, 2020). Establishing flexible renewable and storage capacity as a hedge against potential nuclear construction delays can prevent capacity deficits as lignite facilities are retired (in this regard, Germany should serve as a warning).

Finally, ensuring that the transition is socially and spatially equitable requires integrating regional economic (re)development with national energy policy. Supporting local value creation in renewable energy supply chains and protecting vulnerable consumers from rising energy costs are necessary conditions for maintaining public support for decarbonisation. Balancing the speed of emissions reductions, the stability of electricity supply, and social equity will ultimately determine whether Poland's energy transition develops into a secure, resilient, and sustainable socio-technical system. As the experiences of European countries show, in the context of the Russian war in Ukraine or the armed conflict between the USA and Israel with Iran, the unexpected disruptions to the energy transition process are more than just the social or technological challenges currently facing Poland.

FUNDING: This work was supported by the National Science Centre, Poland, under grant agreement No. 2023/51/B/HS6/00418.

REFERENCES

Abban, O. J., & Nuta, A. C. (2026). Geopolitical risks and energy affordability in Europe: Spatial econometric evidence for policy. *International Journal of Sustainable Development & World Ecology*, 1–23.

Bachanek, K. H., Drożdż, W., & Kolon, M. (2025). Development of Renewable Energy Sources in Poland and Stability of Power Grids—Challenges, Technologies, and Adaptation Strategies. *Energies, 18*(8), 2036.

Ball-Burack, A., Baranowski, M., Jabkowski, P., & Kammen, D. M. (2025). Renewable energy employment and progress toward a just transition in the US and EU. *Society Register, 9*(4), 7–24.

Baranowski, M. (2023). The Paradox of Two Wars in Ukraine: Between Independence and the Social Welfare of Others. *World Affairs, 186*(1), 226–234.

Baranowski, M. (2024). Forces of energy welfare in Central Europe: The Russian war in Ukraine as a game changer. *Hungarian Geographical Bulletin, 73*(1), 89–101.

Baranowski, M., & Jabkowski, P. (2026). The Russian War in Ukraine and the Visegrád Group: What Impact on Energy Transformation? *East European Politics and Societies, 40*(1), 114–133.

Bartela, Ł., Homa, D., Haneklaus, N., Ochmann, J., Gładysz, P., Chmielewska-Śmietanko, D., Miśkiewicz, A., Smoliński, T., Tuka, J., Qvist, S., & Sidło, A. (2025). Assessment of sites for coal-to-nuclear transition in Poland. *Journal of Cleaner Production, 521*, 146256.

Berling, T. V., Surwillo, I., & Slakaityte, V. (2024). Energy Security Innovation in the Baltic Sea Region: Competing Visions of Technopolitical Orders. *Geopolitics, 29*(3), 765–795.

Bluszcz, A., Manowska, A., Tobór-Osadnik, K., & Wyganowska, M. (2023). Poland's energy security during the transformation process in comparison with the EU countries. *IOP Conference Series: Earth and Environmental Science, 1132*(1), 012001.

Bohdanowicz, Z., Łopaciuk-Gonczaryk, B., Gajda, P., & Rajewski, A. (2023). Support for nuclear power and proenvironmental attitudes: The cases of Germany and Poland. *Energy Policy, 177*, 113578.

Boitier, B., Nikas, A., Gambhir, A., Koasidis, K., Elia, A., Al-Dabbas, K., Alibaş, Ş., Campagnolo, L., Chiodi, A., Delpiazzo, E., Doukas, H., Fougeyrollas, A., Gargiulo, M., Le Mouël, P., Neuner, F., Perdana, S., van de Ven, D.-J., Vielle, M., Zagamé, P., & Mittal, S. (2023). A multi-model analysis of the EU's path to net zero. *Joule, 7*(12), 2760–2782.

Bouzarovski, S., & Tirado Herrero, S. (2017). Geographies of injustice: The socio-spatial determinants of energy poverty in Poland, the Czech Republic and Hungary. *Post-Communist Economies, 29*(1), 27–50.

Brauers, H., Oei, P.-Y., & Walk, P. (2020). Comparing coal phase-out pathways: The United Kingdom's and Germany's diverging transitions. *Environmental Innovation and Societal Transitions, 37*, 238–253.

Bridge, G., Bouzarovski, S., Bradshaw, M., & Eyre, N. (2013). Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy, 53*, 331–340.

Christiaensen, L., Ferré, C., Gajderowicz, T., Bulmer, E. R., & Wrona, S. (2022). *Towards a Just Coal Transition Labor Market Challenges and People's Perspectives from Silesia*. World Bank Group.

Cichocki, P., Baranowski, M., & Jabkowski, P. (2026). Who owns the transition narrative?

BERTopic text mining of Polish press discourse on the energy transition (2015–2023). *Energy Research & Social Science, 132*, 104554.

Emanuelsson, A. H., Rootzén, J., & Johnsson, F. (2025). Deployment of carbon capture and storage in the cement industry – Is the European Union up to shape? *International Journal of Greenhouse Gas Control, 146*, 104442.

Flyvbjerg, B. (2014). What you Should Know about Megaprojects and Why: An Overview. *Project Management Journal, 45*(2), 6–19.

Fohr, G. (2026). Energy Resilience as a Participative Process. In D. van Doren, B. Droste-Franke, & G. Fohr (Eds), *Towards Energy System Resilience: Theory, Governance and Practice* (pp. 155–173). Springer Nature Switzerland.

Forum Energii. (2026). June 2026—Solar PV at its peak. https://www.forum-energii.eu/en/monthly-magazine-1

Frankowski, J., Mazurkiewicz, J., & Sokołowski, J. (2023). Mapping the indirect employment of hard coal mining: A case study of Upper Silesia, Poland. *Resources Policy, 83*, 103693.

Geels, F. W. (2014). Regime Resistance against Low-Carbon Transitions: Introducing Politics and Power into the Multi-Level Perspective. *Theory, Culture & Society, 31*(5), 21–40.

Hebda, W., Leśniak, K., & Stolorz, M. (2024). Wind energy in Poland: A successful restart or another false start? In M. Mišík & A. Figulová (Eds), *EU Energy and Climate Policy after COVID-19 and the Invasion of Ukraine* (pp. 195–210). Routledge.

Igliński, B., Pietrzak, M. B., Kiełkowska, U., Skrzatek, M., Kumar, G., & Piechota, G. (2022). The assessment of renewable energy in Poland on the background of the world renewable energy sector. *Energy, 261*(Part B), 125319.

Jankowska, K., & Ancygier, A. (2017). Poland at the renewable energy policy crossroads: An incongruent Europeanization? In I. Solorio & H. Jörgens (Eds), *A Guide to EU Renewable Energy Policy: Comparing Europeanization and Domestic Policy Change in EU Member States* (pp. 183–203). Edward Elgar Publishing.

Jurasz, J., Dąbek, P. B., Bochenek, B., & Ostraszewski, M. (2025). On-shore wind power potential in Poland: A GIS-Based analysis of distance regulations. *Energy Conversion and Management: X, 28*, 101370.

Kardaś, S. (2025). Poland's strategic energy partnerships: Key to success long-term energy security. *Stosunki Międzynarodowe–International Relations, 61*, 29–62.

Kittel, M., Roth, A., & Schill, W.-P. (2026). Long-duration electricity storage needs for coping with Dunkelflaute events in Europe. *Nature Communications, 17*(1), 4210.

Kucharska, P. (2023). Preparing for the Just Transition from Local Economies' Perspective: Belchatow Brown Coal Basin Case Study (Central Poland). *Journal of Econom-*

ic Issues, 57(3), 974–993.

Kuchler, M., & Bridge, G. (2018). Down the black hole: Sustaining national socio-technical imaginaries of coal in Poland. *Energy Infrastructure and the Fate of the Nation, 41*, 136–147.

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.

Lal, A., Tavoni, M., Preuss, N., & You, F. (2026). Aligning EU energy security and climate mitigation through targeted transition strategies. *Nature Communications, 17*(1), 875.

Lew, G., Sadowska, B., Chudy-Laskowska, K., Zimon, G., & Wójcik-Jurkiewicz, M. (2021). Influence of Photovoltaic Development on Decarbonization of Power Generation—Example of Poland. *Energies, 14*(22), 7819.

Locatelli, G. (2018). Why are Megaprojects, Including Nuclear Power Plants, Delivered Overbudget and Late? Reasons and Remedies. *arXiv: Physics and Society*, 1–28.

Madsen, T., Kountouris, I., Bramstoft, R., Koundouri, P., & Keles, D. (2025). European or national-level emission reduction policy? Effectiveness and energy system implications. *Applied Energy, 388*, 125672.

Magyari, J. (2023). Decarbonization challenges and opportunities in the Central European energy sector: Implications for management. *Society and Economy. In Central and Eastern Europe, 45*(4), 451–471.

Martin, M., & Broughel, A. (2025). Just energy transition: Navigating Poland's transition away from coal mining. *Progress in Energy, 7*(2), 023001.

McCauley, D., & Heffron, R. (2018). Just transition: Integrating climate, energy and environmental justice. *Energy Policy, 119*, 1–7.

Meng, W., Nieto, J., Guan, D., Meng, J., Sander, R., Pöschl, U., Hubacek, K., Su, H., Tao, S., & Cheng, Y. (2026). Rethinking energy transition strategies for the European Union amid rising energy prices. *Proceedings of the National Academy of Sciences, 123*(23), e2609606123.

Newell, P., & Mulvaney, D. (2013). The political economy of the 'just transition'. *The Geographical Journal, 179*(2), 132–140.

Pieńkowski, D. (2024). Is nuclear energy really sustainable? A critical analysis on the example of the Polish energy transition plan. *Energy for Sustainable Development, 78*, 101376.

Przedworska, K., Hadasik, B., Krawczyńska, D., Ryczko, A., & Kubiczek, J. (2025). Concerns regarding the sustainable development of energy—opportunities and challenges for RES adoption in Poland. *International Journal of Management and Eco-*

nomics, 61(5), 56–67.

Raghunandan, V., Katinas, P., & Wickenden, L. (2026). January 2026—Monthly analysis of Russian fossil fuel exports and sanctions. Centre for Research on Energy and Clean Air. https://energyandcleanair.org/january-2026-monthly-analysis-of-russian-fossil-fuel-exports-and-sanctions/

Rusin, A., & Wojaczek, A. (2023). Changes in the structure of the Polish energy mix in the transition period to ensure the safety and reliability of energy supplies. *Energy, 282*, 128831.

Rybak, A., Rybak, A., & Kolev, S. D. (2022). The import of energy raw materials and the energy security of the European Union–the case of Poland. *Gospodarka Surowcami Mineralnymi–Mineral Resources Management, 38*(4), 29–48.

Salim, S. S., Luxembourg, S. L., Smekens, K., Dalla Longa, F., & van der Zwaan, B. (2026). Pathways to climate neutrality: Europe's energy transition under the Green Deal. *Renewable and Sustainable Energy Reviews, 226*(Part B), 116272.

Smith, A., & Stirling, A. (2010). The Politics of Social-ecological Resilience and Sustainable Socio-technical Transitions. *Ecology and Society, 15*(1), 11.

Sovacool, B. K. (2016). How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Transitions in Europe: Emerging Challenges, Innovative Approaches, and Possible Solutions, 13*, 202–215.

Surma, T., Olczak, P., Zamasz, K., & Dąbrowski, J. (2026). Analysis of cooperation between cogeneration power plants and renewable energy sources to enhance the stability of the National Power System: Case study of Poland. *Energy Reports, 15*, 109069.

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*(4), 413–421.

Tajduś, A., & Tokarski, S. (2020). Risks related to energy policy of Poland until 2040 (EPP 2040). *Archives of Mining Sciences, 65*(4), 877–899.

Tarasova, E. (2024). Rethinking justice as recognition in energy transitions and planned coal phase-out in Poland. *Energy Research & Social Science, 112*, 103507.

Tarasova, E. (2025). Exploring intersectional energy justice based on the case of planned hard coal phase-out in the Silesian Voivodeship in Poland. *Applied Energy, 396*, 126237.

Thielemann, N., & Berrocal, M. (2024). Framing the Energy Transition: The Case of Poland's Turów Lignite Mine. *International Journal of Strategic Communication, 18*(1), 56–74.

Thlon, M. (2026). Poland and selected EU countries (2010–2025): Evolution and determinants of the household electricity price gap. *Utilities Policy, 102*, 102262.

Tomczyk, D., & Łapniewska, Z. (2025). Solar panels on every rooftop? Photovoltaics boom in Poland and the role of the European Union funds. *Energy Research & Social Science, 125*, 104107.

Turnheim, B., & Geels, F. W. (2012). Regime destabilisation as the flipside of energy transitions: Lessons from the history of the British coal industry (1913–1997). *Special Section: Past and Prospective Energy Transitions—Insights from History, 50*, 35–49.

Unruh, G. C. (2000). Understanding carbon lock-in. *Energy Policy, 28*(12), 817–830.

Verma, P., Chodkowska-Miszczuk, J., Lewandowska, A., & Wiśniewski, Ł. (2023a). Local resilience for low-carbon transition in Poland: Frameworks, conditions and opportunities for Central European countries. *Sustainable Development, 31*(3), 1278–1295.

Verma, P., Chodkowska-Miszczuk, J., Lewandowska, A., & Wiśniewski, Ł. (2023b). Local resilience for low-carbon transition in Poland: Frameworks, conditions and opportunities for Central European countries. *Sustainable Development, 31*(3), 1278–1295.

Widera, M., Kasztelewicz, Z., & Ptak, M. (2016). Lignite mining and electricity generation in Poland: The current state and future prospects. *Energy Policy, 92*, 151–157.

Widera, M., Naworyta, W., & Urbański, P. (2024). Polish energy sector's dependence on lignite mining: The process of transition. *Journal of Sustainable Mining, 23*(4), 397–406.

Ziółkowski, M., Drozdowski, R., & Baranowski, M. (2024). *A Sociological Approach to Commodification: The Case of Transforming the Post-Socialist Society in Poland*. Routledge.

Zoll, M. (2022). Energy Governance in the Republic of Poland. In M. Knodt & J. Kemmerzell (Eds), *Handbook of Energy Governance in Europe* (pp. 923–958). Springer International Publishing.