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COAL AND GAS: THE TWO PILLARS OF BALANCING THE NATIONAL ENERGY SYSTEM OF POLAND BY 2040

In 2025, the share of electricity from renewable sources in Poland exceeded 30% of the national energy mix. To maintain the stability of the national grid, the operator was forced during that period to reallocate a total of approximately 1 TWh of energy from weather-dependent sources. Restrictions on feeding energy into the grid during periods of overproduction are accompanied by rapid growth in new capacity from wind and solar power sources. An analysis of subsequent drafts of the National Energy and Climate Plan, as well as planning documents of the national grid operator PSE, indicates that despite ongoing investments, a significant capacity gap in controllable capacity may emerge in the national system after 2032. As a result of decisions in the capacity market, new gas-fired units have been contracted, whose capacity is to exceed 12 GW in 2030. Further gas projects are currently in the preparation phase; however, their attractiveness to investors depends solely on the 15-year revenue stream from the capacity market. At the same time, the national grid embraces hard coal and lignite-fired units that can continue operating beyond 2035 and provide controllable capacity to the system operator without the need for serious capital expenditures, and at a lower cost than new gas-fired units. Given the risks associated with the availability and price of imported natural gas, which stem from the escalation of regional conflicts, the guiding principle of the state's energy strategy should be to balance the national grid using coal and natural gas during periods when energy from weather-dependent sources is unavailable. A roughly proportional share of these two fuels in filling the power gap and balancing the system until the first nuclear power plant is connected to the grid should ensure energy independence and resilience to regional energy crises.

Keywords: Energy; weather-dependent RES; controllable backup capacity; pick power demand; gas and coal plants

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1. Introduction

The global economy entered 2026 with the one-year record of Donald Trump's administration in the U.S. and the European Commission under the leadership of Ursula von der Leyen in the EU. While for the U.S. president this meant withdrawing from the Paris Climate Agreement as early as the beginning of 2025, the European Commission (EC) upheld the implementation of its existing climate policy stemming from the Green Deal [1], as well as the specific targets negotiated in the *Fit for 55* regulatory package [2]. Furthermore, on February 26, 2025, the Commission presented the *Clean Industrial Deal* [3], in which it declared the continuation of the Green Deal policy for the entire European industry. Although, as a result of Mario Draghi's Report [4], a number of measures aimed at lowering energy prices and restoring the competitiveness of companies exporting to global markets were announced in the document, some specific instruments still require further refinement. At the end of 2025, in its *Conclusions of December 10* [5], the European Council adopted a 90% interim target for reducing carbon dioxide emissions by 2040, relative to 1990 levels. Detailed guidelines for achieving the 90% interim target will be set out in the *European Climate Law* [6]. This agreement also postponed the entry into force of the ETS2 emissions trading system [7], covering emissions from transportation and building heating, by one year, i.e. from 2027 to 2028.

Poland held the presidency of the Council of the EU during the first half of 2025. According to the Polish Government's statement [8]: *the goal of the presidency would be to ensure Europe's security in the broadest sense; primarily military, internal, economic, energy, information, food, and health security*. Energy security, listed as one such crucial objective – particularly if we consider, among other things, incidents of Russian drones violating the airspace of Poland and other EU countries, additionally reinforced by concerns pertaining to sovereignty and resilience in the event of crises – formed the core of European policy during this period. Such a stance translated, among other things, into a continued move towards reducing dependence on energy imports from Russia.

In the first half of 2025, work was underway on the conclusions of the public consultation on the National Energy and Climate Plan (NECP) [9], in its version as announced in October 2024. This document is required under the Regulation of the European Parliament and of the Council on the Governance of the Energy Union of December 11, 2018. As a result, in July 2025, the Polish Ministry of Climate and Environment presented a revised version of the National Energy and Climate Plan (NECP) featuring adjusted (delayed) timelines for the implementation of nuclear energy, however with more ambitious climate targets [10]. Further work on the draft was entrusted to the newly established Ministry of Energy. As a result of these efforts, the Minister of Energy published his proposals in December 2025 and simultaneously submitted them to the Council of Ministers for consideration. This draft outlines two development scenarios and their associated indicators for emissions reductions, the share of renewable sources in the national energy mix, and efficiency gains, i.e. the existing policies scenario (WEM) and the additional measures scenario (WAM). The actual achievement of climate targets should fall within the ranges set out in these scenarios (Poland's contribution to the implementation of European policy has been declared in ranges).

In 2025, consultations were underway regarding the update of the document "Polish Nuclear Energy Program" [11], while intensive negotiations were also taking place to notify the European Commission of state aid for the construction of the first nuclear power plant in Choczewo-Kopalino. On December 18, 2025, the European Commission issued a decision

opening an extended investigation into the granting of state aid for Poland's first nuclear power plant [12], thereby confirming its necessity for the further implementation of the project to launch the first nuclear power station in Poland.

In December of that year, the Polish Transmission System Operator (PSE) held its final auction for the provision of capacity services to the National Power System (KSE) for delivery in 2030. As a result of the auction [13], 6.9 GW of new capacity was contracted, and the highest price to date of as much as PLN 465 kW/year was achieved. Also in this auction, capacity services were contracted for a minimum of 15 years from three new open-cycle gas turbine (OCGT) power plants, each with a capacity of 600 MW (Dolna Odra Gryfino, Rybnik, Jaworzno), as well as five-year contracts for three modernised 200-MW coal-fired units at the Połaniec Power Plant, Enea. The total capacity contracted to date for 2030 amounts to 21,755 MW.

In the same time, on December 18, the President of the Energy Regulatory Office (URE) announced the results of the auction for electricity from offshore wind farms [14]. A total of 3,435 MW of capacity was contracted from three farms: 1) 476.88 PLN/MWh – Baltic East Offshore Wind Farm, 2) 489.00 PLN/MWh – Baltica 9 Offshore Wind Farm, 3) 492.32 PLN/MWh – Bałtyk I Offshore Wind Farm. Electricity delivery is scheduled for December 2032.

On December 4, 2025, the Amendment Act on the Operation of Hard Coal Mining and Certain Other Acts [15] was published in the Official Journal, which – among other things – provides for the payment of benefits to employees of coal mines undergoing liquidation. This legislation enables a real reduction in coal production, the shutting down of the least efficient mines, and a reduction in employment in the mining industry. Such measures will make it possible to maintain the necessary production at the lowest possible cost, thereby ensuring the continuity of electricity supply to the national grid throughout the transition period.

The conclusion of auctions for the construction of offshore wind farms, an increasingly clear vision for financing the construction of the first nuclear power plant, and a significant increase in electricity generation from gas-fired sources all point to an inevitable decline in the importance of hard coal and lignite in the national energy mix. Nevertheless, the risks associated with the complex investment process, particularly in technologies unfamiliar to the domestic contexts, such as nuclear power or offshore wind farms, require maintaining full reserve capacity in existing technologies and generation capabilities until the complete reliability of supply from new sources is assured. In terms of dispatchable generation technologies, we have access to coal- and gas-fired sources.

This paper attempts to assess the feasibility of the assumptions set forth in the already published National Energy and Climate Plan (NCEP), particularly with regard to the timeline for replacing fossil fuels with renewable sources and nuclear energy, as well as, on a transitional basis, with natural gas. The aim of the analysis is to estimate to what extent the balancing of the national energy system can rely on imported gas, and to what extent domestic coal resources and existing coal-fired power plants should be utilised.

2. Energy mix forecast in the draft National Energy and Climate Plan (NECP)

The process of revising the National Energy and Climate Plan (NECP), starting with the draft published in October 2024, through the July 2025 version of the Ministry of Climate and Environment revised after public consultations, and finally the December 2025 draft of the Ministry of Energy, has resulted in three projections of the energy mix and the related investment program.

It should be noted that the December version still remains only a draft, which may be subject to some change as a result of deliberations in the Council of Ministers of the Polish Government. The latest draft clearly outlines two development scenarios: existing policies (WEM) and additional measures (WAM), along with the resulting targets for emissions reductions, the share of renewable energy, and energy efficiency improvements.

A comparison of the three projects in the WAM scenario reveals significant adjustments made to the forecast for electricity demand in 2040. (TABLE 1), where the forecast between the October 2024 scenario and the December 2025 scenario was reduced from 307 TWh to 270 TWh, a decrease of 37.4 TWh. Furthermore, in the energy mix structure for 2040, coal-fired generation was reduced from 4.1 TWh to zero, while gas-fired generation increased from 9.9 TWh to 15.8 TWh. The highest gas-based generation occurs in all projects in 2030 and amounts to 30.8 TWh, 41.6 TWh, and 34.6 TWh, respectively.

TABLE 1

Comparison of the capacity and electricity mix in the NECP drafts of October 2024, July 2025, and December 2025

Years	2025		2030		2035		2040	
NECP draft	Installed capacity [GW]	Gross production [TWh]	Installed capacity [GW]	Gross production [TWh]	Installed capacity [GW]	Gross production [TWh]	Installed capacity [GW]	Gross production [TWh]
X 2024	69.6	180.2	96.1	192.6	111.2	228.3	135.7	307.9
VII 2025	74.6	180.1	96.6	193.6	126.4	220.6	155.8	287.2
XII 2025	74.5	178.1	98.8	196.5	131.4	223.8	154.0	270.5

The generation capacity mix in 2040 shows an increase from 135.7 to 154.0 GW; in other words, whilst the forecast for electricity demand is decreasing, the forecast for installed capacity in the National Power System is increasing. This directly implies that the unit capacity utilis ation of new generating units is decreasing, which exposes investors to stranded costs. A detailed analysis of the Polish power generation mix indicates a downward revision of the 2040 capacity forecasts for the following technologies: photovoltaic – from 51.2 GW to 43.0 GW, and offshore wind farms – from 18.0 GW to 16.1 GW, onshore wind farms – from 34.6 GW to 28.8 GW. In contrast, installed capacity has increased for the most expensive technologies: nuclear power – from 3.5 GW to 5.9 GW, energy storage – from 8.5 GW to 19.1 GW, and peak energy units (primarily gas) – from 7.0 GW to 11.4 GW.

3. Analysis of Energy Mix Forecasts in PSE Documents

The PSE (Polish Transmission System Operator) Development Plan for Meeting Current and Future Electricity Demand for 2025-2034 (PRSP) [16] indicates that net electricity demand in 2040, under a dynamic transformation scenario, will amount to approximately 235 TWh. In the baseline scenario, demand is estimated at 215 TWh net. It is important to note the difference between net and gross values, which are treated differently in PSE planning and in the work on the NECP, resulting in certain difficulties in interpretation and comparison. At the same time, a forecast of peak power demand for the National Power System (KSE) was prepared, which is projected to increase to 37 GW by 2040 (Fig. 1).

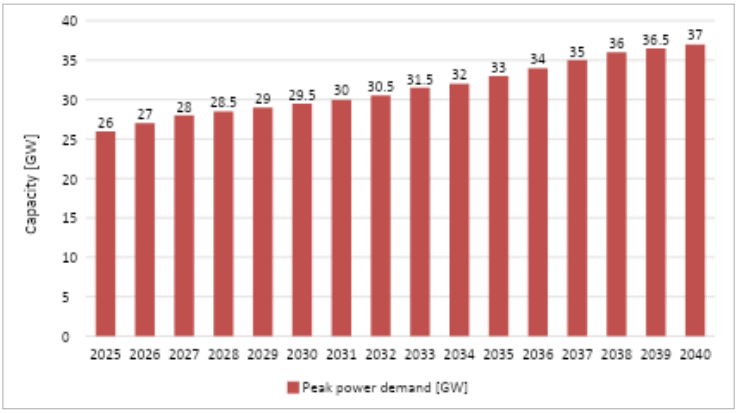

Fig. 1. Expected peak power demand in the National Power System [GW]. Forecast based on PSE data

National Resource Adequacy Assessment 2025–2040 (NRAA) [17], required by energy law, presents an analysis of the national grid's capacity to supply electricity in accordance with European standards and the resulting indicators, including the LOLE (loss of load expectation) index, i.e. total time of energy outage during the period. The target value for the LOLE index should be less than 3 hours per year. In order to prepare the adequacy analysis, a survey was conducted on the availability of existing generating units throughout the entire period, taking into account their technical condition, planned outages, and profitability in the energy market. The survey indicates a significant reduction in generation capacity starting as early as 2028, following the end of capacity market support for coal-fired units and their virtually complete decommissioning (except for 1,000 MW-class units with long-term contracts).

The analysis was conducted for the baseline scenario and a scenario with an additional generation capacity mechanism, which assumes compensation for those units that will not be profitable in the energy market. The results of the analysis indicate that the LOLE index will not be met after 2028 in the baseline scenario. For the scenario with the additional mechanism, the index can be met by providing additional compensation for both existing units, mainly coal-fired, and new mechanisms for the balancing units that need to be built. Unfortunately, there is currently a lack of any information whatsoever regarding the form that such support might take, for which units it could apply, and under what conditions it would be provided.

4. The generation power gap of controllable units in the national grid

Subsequent drafts of the National Energy and Climate Plan (NECP) and forecast documents of the Polish Transmission System Operator (PSE) contain slightly different assumptions, as well as different results of modelling the capacity mix and electricity generation. The NECP draft from December 2025 forecasts gross electricity production of 270.5 TWh in the WAM scenario (249.2 TWh gross in the WEM scenario), whereas in PSE's forecasts, the baseline variant is 215 TWh net. When expert adjustments are made to the production volume according to PSE, the result is only approximately 235 TWh. A difference of approximately 35 TWh for WAM

(or 15 TWh for WEM) in electricity demand results in either excessive overinvestment or, if underestimated, a serious shortage of generation capacity. However, it is not energy, but the issue of a potential capacity gap in controllable capacity in the national grid after 2030 that poses the main risk to the system's uninterrupted operation.

The two NECP scenarios presented in December 2025 have not yet been adopted by the Government. Therefore, an analysis of the available capacity in the National Power System (KSE) from the perspective of the year 2040 was conducted based on the July 2025 draft of the NECP, using the following assumptions:

- due to the lack of information regarding support mechanisms, it was assumed that unprofitable coal-fired units would be permanently shut down after 2028, in accordance with a PSE survey conducted in November 2024,
- installed capacity and electricity generation – in accordance with Annex 1 to the NECP, July 2025,
- national power demand – in accordance with the PSE document, National Resource Adequacy Assessment 2025–2040, November 2024 (NRAA),
- availability de-rating factors (KWD) for individual generation technologies – in accordance with the Regulation of the Ministry of Climate and Environment, August 2020, including updates,
- a period of several consecutive days, occurring several times a year, of stagnant high pressure (the so-called *dunkelflaute*) was assumed, with a duration of 96 hours, during which wind and solar power are unavailable,
- energy storage capacity (MEE) with 4-hour availability is calculated as 4/96 x MEE (capacity in accordance with the NECP as of July 2025),
- capacity of coal- and gas-fired combined heat and power plants – installed capacity; the actual capacity available from these units in condensing mode is unknown,
- data on capital expenditures and costs of generation sources – in accordance with the NRAA, prepared by PSE,
- the availability of nuclear power (both large-scale and SMR) was not taken into account.

The analysis yielded a graph of available controllable capacity (Fig. 2) and a curve showing the national system's demand, which indicates that a capacity deficit will occur in the National Power System (KSE) around 2032, meaning that the continuity of electricity supply cannot be guaranteed during certain periods. Although according to the draft NECP, the installed capacity in the KSE system will exceed 96 GW by 2030, a controllable capacity gap will emerge after 2032, growing from zero to approximately 7.4 GW by 2040.

In order to ensure the continuity of supply, the capacity gap must be filled by building new peaking units or extending the operational life of existing dispatchable generation capacities, primarily coal-fired. Another option is to store a sufficient amount of electricity to cover the anticipated unavailability of weather-dependent sources for a period of 96 hours. Assuming, for illustrative purposes, that the capacity gap will amount to 7.4 GW and that weather-dependent sources will be unavailable for four consecutive days, approximately 710 GWh of electricity would need to be stored. The capacity of the four-hour storage facilities currently under contract would need to be 178 GW, which, given the current capital expenditures (CAPEX) of approximately PLN 1 million per MWh of stored energy, would amount to an expenditure of around PLN 710 billion. The magnitude of the capital expenditures, overcapacity, and the associated fixed costs clearly dictate the rejection of this option. Two scenarios for filling the capacity gap, i.e. coal and gas, were subjected to further analysis. TABLE 2 presents a comparison of these solutions.

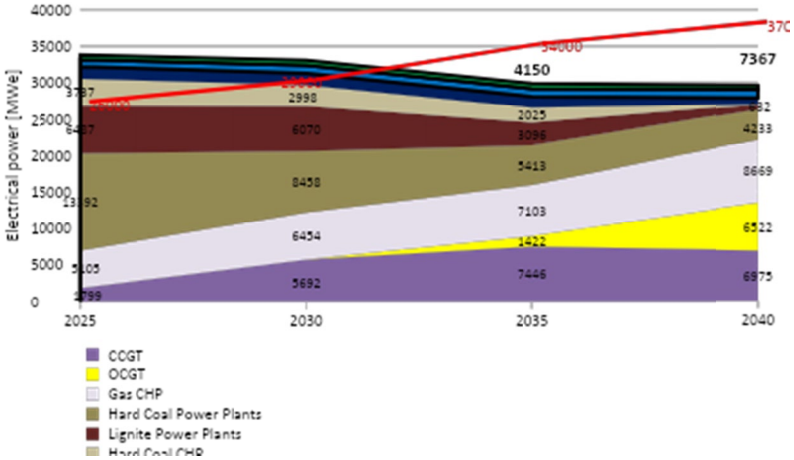

Fig. 2. Power generation gap in the National Power System (KSE). Expert forecast prepared by the Polish Power Plants Association (TGPE), 2025, unpublished conference materials [18]

TABLE 2

Comparison of capital expenditures and costs for filling the power gap using OCGT gas-fired units and existing coal-fired units; analysis prepared by TGPE; unpublished conference materials [18]

		Coal	**Gas (OCGT)**
By 2035 for the gap of 4,150 MW	CAPEX	0	**PLN 17.8 bln**
	Fixed costs	200k-160k PLN/MW/year **1.34 bln PLN/year**	250k PLN/MW/year **1,04 bln PLN/year**
	Variable costs	400 PLN/MWh	440 PLN/MWh
By 2040 For the gap of 7,367 MW	CAPEX	0	**PLN 32 bln**
	Fixed costs	**2.35 bln PLN/year**	**1.85 bln PLN/year**
	Variable costs	400 PLN/MWh	PLN/MWh

* Data on capital expenditures and costs in accordance with NRAA

The key difference between the options lies in the need to incur significant capital expenditures for new gas-fired units, whereas no such expenditure is required under the coal option. Extending the operational life of certain coal-fired units beyond 2035 is possible by covering fixed costs of approximately 200,000 PLN/MW/year, assuming they will not be subject to further environmental restrictions (other than carbon dioxide). The above analysis points to the use of existing coal-fired units to cover the capacity generation gap after 2032. This will also help to achieve a certain balance between the installed gas and coal-fired capacity.

The charts below (Fig. 3) show the percentage share of various power generation technologies in the controllable capacity mix for 2035 and 2040, as planned in the July 2025 version of the NECP. The following were classified as “other” controllable technologies: hydroelectric power plants, pumped-storage power plants, 96-hour storage facilities (MEE 96), biogas, hydrogen, and biomass sources. It is recommended to cover the entire capacity gap with coal-fired sources due to their lower cost and better assurance of the power balance and security of the National Power System (KSE), as well as to increase resilience to crisis situations. If nuclear power capacity

becomes available before 2040, it will be possible to phase out coal-fired units and avoid stranded costs that could arise from the construction of additional gas-fired units.

While for the year 2035, after covering the power gap solely with coal-fired sources, the gas-to-coal ratio stands at 47%/36%, by 2040, this ratio will have risen to 59%/32%. A lack of balance at around 50%/50% between gas and coal represents significant exposure to risks of imbalance and insecurity in the National Power System, as well as uncontrolled increases in energy prices, in the event of disruptions in the global gas market.

Gas-fired power plants, Gas CHP– gas-fired combined heat and power plants, OCGT – open-cycle gas turbine peaking power plants, Others – hydroelectric power plants, pumped-storage power plants (PSP), 96-hour storage facilities (MEE 96), sources for biogas, hydrogen, and biomass, Hard coal power plants, Llignite power plants, Gap – controllable capacity gap in the National Power System (KSE)

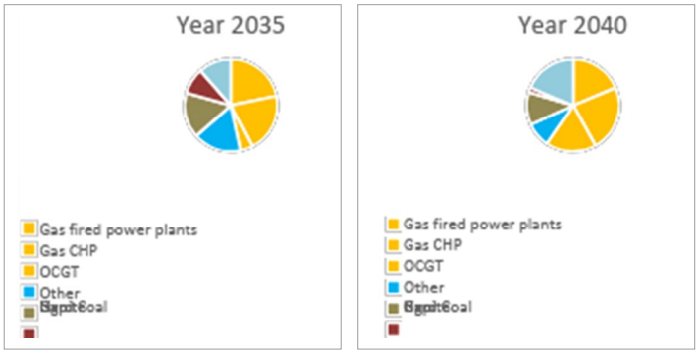

Fig. 3. Share of generation technologies in the controllable capacity of the National Power System (KSE) according to the TGPE analysis [18]

5. Summary

Balancing the National Power System (KSE) during the transition period should be based on two pillars: coal and gas. Only the introduction of significant nuclear capacity into the national energy mix could change this principle. Maintaining regulatory coal- and gas-fired generation capacity will ensure independence from fluctuations in energy commodity markets, particularly regarding gas imports. The December 2025 version of National Energy and Climate Plan (NECP), WAM scenario, assumes an increase in electricity production from gas sources to 34.6 TWh in 2030 (peak production), followed by a decline to 15.8 TWh in 2040, and a decline in coal-fired generation from the current 88.2 TWh to 44.9 TWh in 2030, including 30.1 TWh from hard coal-fired sources and 14.8 TWh from lignite-fired sources. In the following years, the share of coal and gas will decline; however, in the WAM scenario, the decline in coal is faster, while in the WEM scenario, both fuels maintain a similar share in balancing the system until 2040. The authors conducted research on the national energy mix adopted in the 2021 energy policy (currently in effect), as well as the risks associated with implementing the investment schedule for new generation sources [19,21,23], pointing to the risk of a capacity gap emerging and defining alternative scenarios for this circumstance. The publications [19,21] and [23] analysed the de-

mand for energy fuels, including domestic coal, particularly in the context of ongoing regional crises and the growing risk of supply chain disruptions. Taking the above into account, as well as the military operations in the Persian Gulf in early 2026 and their impact on shaping a secure domestic energy mix, the following conclusions are presented:

- A significant portion of the existing 200 MW and 360 MW hard coal-fired units, as well as the 360 MW lignite-fired units, could, from a technical standpoint, remain operational after 2035 and be used to balance the national grid,
- Maintaining coal-fired units avoids the need to incur high investment costs and risks associated with new gas-fired capacity, which has a low capacity utilisation rate and high capacity maintenance costs resulting from capacity auction outcomes,
- It seems essential to urgently identify the needs for dispatchable coal-fired capacity (which is PSE's responsibility!), specifying the location, capacity, and the timeframe during which the system operator can utilise it. These units can partially fill the capacity gap, whilst the remaining coal-fired units can be slated for decommissioning, or permanently shut down and kept in deep cold reserve in case of global disruptions in the gas market,
- Following the latest capacity auctions, the capacity of gas-fired units, taking into account existing contracts, will double from 6 to 12 GW by 2030,
- To ensure the KSE's regulatory capacity, contracting new CCGT units is not justified, given the expected annual operating hours,
- Consideration should be given to locating new OCGT units at convenient junctions of the power and gas systems, including gas storage facilities,
- As soon as possible, and no later than 2028, the coal-fired units necessary for power balancing and for regulating operations in the KSE should be selected and included in the balancing/strategic reserve mechanism, which will ensure they receive the necessary financial revenue,

The demand for thermal hard coal, depending on the scenarios assumed in the NECP, should be estimated at approximately 15-20 million Mg in 2030 and approximately 10 million Mg in 2040.

The adoption of a doctrinal principle, in energy policy or another national strategy document, regarding the maintenance of a dual-fuel regime for balancing the national grid, during the coming years of the energy sector's transition toward renewable sources, is a prerequisite for preserving energy security and sovereignty. This principle should remain in effect until at least the full capacity of the first nuclear power plant in Poland is connected to the grid.

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