# Electric Power Sector - Energy Sovereignty of Kazakhstan

## Introduction

Energy sovereignty, the capacity of a state to ensure reliable, independent, and strategically controlled access to electricity, has become one of the defining challenges of Kazakhstan's economic development agenda. As the country's electricity consumption grows at 3.5-4.5% per year, driven by industrial expansion, urbanization, and the rapid emergence of energy-intensive digital infrastructure, the adequacy and resilience of the electric power sector can no longer be taken for granted.

Kazakhstan's generation fleet is heavily concentrated in aging coal-fired assets, many of which have exceeded their normative service life. Its national grid is actually fragmented into three zones with limited inter-zonal transmission capacity. And its operational dependency on imports from Russia introduces a geopolitical dimension that sits uncomfortably alongside the country's multi-vector foreign policy. The relevance of this geopolitical dimension has been sharpened by recent events beyond Kazakhstan's borders: the escalation of the war conflict involving Iran has clearly demonstrated that energy infrastructure is a primary target in modern geopolitical confrontations. Strikes on energy facilities across the Middle East have disrupted electricity supply to millions of civilians and caused cascading failures across interconnected grids.

A wave of investment in new generation, grid infrastructure, and regulatory reform is underway, with the Ministry of Energy projecting that Kazakhstan will fully cover domestic electricity demand by the end of Q1 2027 and achieve a stable surplus by 2029. The strategic decisions made on fuel mix, grid architecture, nuclear partnerships, and demand governance will shape the country's energy sovereignty for decades.

This article examines Kazakhstan's electric power sector in two parts. The first provides a factual overview of the sector's current state: installed capacity, the 2025 electricity balance, and the forecast balance through 2032. The second analyzes the sector through four dimensions of energy sovereignty: diversification, infrastructure integrity and capacity management, geopolitical and physical security, and demand-side management.

# Electric Power Sector in 2024-2025 and Beyond

As of January 1, 2025, Kazakhstan's Unified Power System [UPS] comprised 236 power stations with a total installed capacity of 25.31 gigawatts [GW] and an available capacity of 21.04 GW. The gap between these two figures, approximately 4,280 megawatts [MW], reflects the scale of physical degradation across the generation fleet, the majority of which was commissioned during the Soviet era and has long exceeded its normative service life.

The electric power sector of Kazakhstan is discussed in detail in the National Energy Report KAZENERGY 2023. The generation fleet is dominated by thermal power stations [TPPs], which account for the bulk of both installed capacity and actual output, generating 91.7 billion kilowatt-hours [kWh] in 2025, or 74.4% of total electricity production. Gas turbine plants provide a secondary baseload and peaking function, contributing 13.5 billion kWh, or 11.0% of total electricity production. Hydropower, concentrated on the Irtysh cascade in the East and the Shardara hydro power plant in the South, contributed 10.5 billion kWh (or 8.5% of total electricity production). Renewable energy sources [RES], comprising wind, solar, and biogas facilities, generated 7.5 billion kWh and accounted for 6.1% of total output.

**Electricity balance of Kazakhstan, billions kWh**

| Source | 2022 | 2023 | 2024 | 2025 | % change 2024-2025 |
|---|---|---|---|---|---|
| Termal power plants | 88.6 | 87.4 | 88.4 | 91.7 | 3.7% |
| Gas turbine plants | 10.9 | 11.0 | 11.9 | 13.5 | 13.2% |
| Hydropower | 9.2 | 8.8 | 11.2 | 10.5 | -6.5% |
| Renewables (wind, solar, biogas) | 4.2 | 5.7 | 6.4 | 7.5 | 16.6% |
| **Total generation** | **112.9** | **112.8** | **117.9** | **123.1** | **4.4%** |
| **Total consumption** | **112.9** | **115.1** | **120.0** | **124.6** | **3.8%** |
| **Net power flow: (+) deficit/import, (-) surplus/export** | 0.1 | 2.3 | 2.1 | 1.5 | -28.1% |

Source: *Samruk Energy JSC, KEGOC*

The most notable shift in the generation mix was the strong growth of gas turbine plants, whose output rose by 13.2% to 13.5 billion kWh, and renewables, which grew by 16.6% to 7.5 billion kWh. TPPs remained the dominant source, contributing 91.65 billion kWh or 74.4% of total generation with output up 3.7% year-on-year. Hydropower was the only declining source, falling 6.5% in 2025 to 10.5 billion kWh.

Kazakhstan's power plants generated 123.1 billion kWh of electricity in 2025, an increase of 5.2 billion kWh, or 4.4%, compared to 2024. Total consumption rose in parallel to 124.6 billion kWh, up 3.8% year-on-year, leaving a net deficit of 1.5 billion kWh - a 28% narrowing of the gap relative to 2024's deficit of 2.1 billion kWh.

Despite the narrowing deficit, Kazakhstan remained a net importer in 2025. Imports from Russia covered the bulk of the shortfall, with the Northern zone drawing on synchronous parallel operation with Russia's UPS. The Southern zone continued to rely on transit from the North and on flows from Central Asian neighbors, reflecting its persistent structural generation deficit.

The national grid is operated by KEGOC JSC, the system operator responsible for centralized dispatch management and the maintenance of the National Electric Grid - 83 electric power substations and approximately 28,000 km of 220–500 kilovolt [kV] transmission lines. The UPS is organized into three structurally distinct zones: the Northern zone, which is the system's generation core and connects synchronously with Russia's UPS; the Southern zone, which has a structural generation deficit; and the Western zone, which currently operates as an isolated energy island.

The Forecast Balance of Capacity and Electricity of the UPS of Kazakhstan for 2026–2032 [the Forecast Balance], approved by the Ministry of Energy, projects a fundamental shift in the country's supply-demand position over the coming years. After the period as a net importer, Kazakhstan is expected to achieve self-sufficiency and transition to a structural surplus within this period.

**Forecast electricity balance of the Kazakhstan's UPS for the period 2026-2032, billions kWh**

| | Generation | Generation Year-to-year change, % | Consumption | Consumption Year-to-year change, % | Net power flow: (+) deficit/import, (-) surplus/export |
|---|---|---|---|---|---|
| 2026 | 126.5 | n/a | 127.9 | n/a | 1.4 |
| 2027 | 134.1 | 6.0% | 132.8 | 3.8% | -1.3 |
| 2028 | 143.4 | 6.9% | 138.5 | 4.3% | -4.9 |
| 2029 | 162.1 | 13.0% | 144.5 | 4.3% | -17.6 |
| 2030 | 173.8 | 7.2% | 150.7 | 4.3% | -23.1 |
| 2031 | 177.9 | 2.4% | 157.0 | 4.2% | -20.9 |
| 2032 | 182.0 | 2.3% | 163.6 | 4.2% | -18.4 |

*Source: Ministry of Eneregy of Republic of Kazakhstan, adapted by ENERGY Insights & Analytics*

The transition from deficit to surplus is driven primarily by the commissioning of new generation capacity: approximately 2.6 GW is expected to come online in 2026 alone, followed by further large tranches in 2028-2029 as combined-cycle gas turbine [CCGT] projects, modernization programs for coal-fired plants, and RES facilities reach completion. The Ministry of Energy projects full domestic self-sufficiency by the end of Q1 2027 and a stable surplus by 2029, which would for the first time create meaningful export potential.

However, the aggregate balance includes persistent structural imbalances. The Forecast Balance identifies a flexible (dispatchable) generation[1] deficit of 1.25 GW in 2026 and 0.82 GW in 2027, even as total installed capacity grows. The Southern zone is projected to remain in deficit throughout the forecast period, dependent on North-South transit and Central Asian imports until the High-Voltage Direct Current [HVDC] transmission line and new Southern generation assets are commissioned. These structural constraints define the agenda for the second part of this article.

# Sovereignty of the Electric Power Sector

There are structural imbalances confronting Kazakhstan's electricity sector, including an aging, heavily coal-dependent generation fleet, a fragmented national grid, and a persistent supply deficit covered by imports. They cannot be understood merely as engineering challenges that require incremental capacity additions or grid upgrades. Rather, they represent a multidimensional risk to energy sovereignty that operates across several interconnected domains. Assessment of energy sovereignty in the electric power sector is structured around four pillars established by methodological framework in ENERGY Insights & Analytics article on energy sovereignty: the diversification of the generation mix, which determines the sector's resilience against concentration risk and the volatility of a single dominant energy source, e.g. Ekibastuz GRES-1 that generated 24.5 billion kWh in 2025, equivalent to roughly 20% of the country’s entire electricity production; infrastructure integrity and capacity management, which ensures that available generation can physically meet demand at any moment, including under peak and emergency conditions; geopolitical and physical security, which protects against external pressures and deliberate disruptions; and demand-side policy, which shapes consumption patterns, governs the emergence of large new energy-intensive users, and manages the balance between supply availability and the evolving needs of the economy.

## Diversification

Diversification in the context of energy sovereignty refers to the strategic distribution of production sources, import and export routes, market destinations, and energy resource types to minimize dependence on single points of failure and enhance resilience against external shocks. In the context of electricity systems, diversification refers to reducing

[1] Flexibility (dispatchability) refers to the ability of a generation source to rapidly ramp up or ramp down the volume of electric power generation in response to demand fluctuations.

structural dependence on a dominant fuel and/or generation source. For Kazakhstan, that source is coal, which accounted for 74.4% of total generation in 2025. This concentration operates at two levels. At the fuel level, any supply-side shock, whether driven by price, logistics, or regulatory pressure on coal, directly propagates into risk across the entire system. At the facility level, the exposure is even more acute: Ekibastuz GRES-1 alone generated 24.5 billion kWh in 2025, representing approximately 20% of the country's total electricity output, meaning that the operational status of a single TPP has critical consequences for national energy security. True diversification creates redundancy and optionality, enabling the system to absorb shocks in any single supply chain without cascading failures across the entire network.

*Constraints.* The principal structural constraint is the inertia of the existing coal infrastructure. Kazakhstan's 153 RES facilities, with a combined installed capacity of approximately 3 GW, contributed only 6.1% of total output in 2025, while TPPs retain an installed base of roughly 18 GW. Renewable generation is also intermittent by nature; its output cannot be dispatched on demand, which means that without adequate energy storage systems [ESS], its real contribution to system balancing remains limited. A further constraint is the weakness of inter-zonal transmission: the Southern zone, where the greatest potential for solar and wind generation is concentrated, remains physically isolated from the surplus-generating North.

*Risks.* The central risk is that accelerating RES deployment without commensurate investment in flexibility infrastructure will compound rather than resolve balancing[2] problems. As the share of intermittent generation grows, the residual load on TPPs as a dispatchable generation reserve actually increases, creating a paradox in which faster RES growth, absent storage, deepens dependence on the very assets it is meant to replace.

*Strategic options.* The strategic response is embodied in the draft law on the development of alternative energy sources, presented to the Mazhilis on February 25, 2026. Deputy Minister of Energy Sungat Yesimkhanov identified its core innovation: a new regulatory framework for ESS through capacity market auctions. In his words, energy storage systems "reduce the need to import electricity from Russia, improve energy supply reliability, and do not lead to higher electricity prices for end consumers". The target is 3 GW of ESS: 1.8 GW through a mandatory requirement for large RES projects to install storage equivalent to 30% of their capacity, and the remaining 1.2-1.5 GW through market mechanisms. By 2035, the Energy Sector Development Plan targets a generation mix of 24.4% RES, 25.8% natural gas, 34.3% coal, and 4.7% nuclear - a structural diversification that, if realized, would reduce coal's share by roughly 40 percentage points from its current level.

[2] Balancing is the process of matching the volumes of power generation and consumption within a grid.

## Infrastructure integrity and capacity management

Infrastructure integrity and capacity management within the energy sovereignty framework involves the physical reliability, technical resilience, and operational continuity of critical energy assets. For Kazakhstan's electric power sector, infrastructure integrity is defined by the ability of the generation fleet and grid to meet consumer demand at any given moment (including peak load and emergency conditions) without interruption. Infrastructure integrity determines whether capacity exists only «on paper» or can be reliably deployed when needed, particularly during stress scenarios.

*Constraints*. The central constraint in Kazakhstan's system is the critical deterioration of the generation fleet. The approximately 4.3 GW gap between installed capacity of 25.31 GW and available capacity of 21.04 GW reflects the scale of physical depreciation. The majority of TPPs were commissioned during the Soviet era and have long exceeded their normative service life, with average equipment wear standing at 61%. The Forecast Balance identifies a dispatchable generation capacity deficit of 1.25 GW in 2026 and 0.82 GW in 2027, meaning the system lacks precisely the flexible (dispatchable) generation it needs most, not raw capacity in aggregate.

*Risks*. The scale of risk exposure of operating under current conditions was illustrated on December 18, 2025, the annual system peak day, when demand reached 17,724 MW, and the system simultaneously required imports from Russia (597 MW), North–South transit (1,941 MW), and consumer load restrictions (209 MW), as recorded in KEGOC's 2025 operational data. Any unplanned outage of a major generating unit or grid element under such conditions could trigger a cascading failure. The longer-term risk is the retirement of aging capacity without the timely commissioning of replacement assets.

*Strategic options.* First, the National Project for the Development of Coal Generation, initiated by presidential instruction in January 2026, envisages the construction of six new large-scale power facilities, such as Ekibastuz GRES-3 (2.6 GW), and stations in Kurchatov, Kokshetau, Semey, Ust-Kamenogorsk, and Zhezkazgan, alongside the technical renovation of existing plants, with a combined clean-coal program covering 7.6 GW. Second, the parallel expansion of flexible generation: four CCGT projects totaling approximately 1.8 GW are underway in Turkistan, Ulytau, Kyzylorda, and Almaty. Third, the abovementioned draft law on the development of alternative energy sources introduces a dedicated regulatory framework for ESS. The total ESS requirement is assessed at 3 GW: approximately 1.4 GW under intergovernmental agreements, with the remainder selected through capacity market auctions on long-term contracts for up to 15 years. ESS will enable peak-hour dispatch and reduce imports from Russia without raising consumer tariffs. The draft law also requires RES facilities under B2B contracts to provide dispatchable generation capacity of at least 30%, directly addressing the system's flexibility deficit. Underpinning all three tracks is the conventional principle of capacity adequacy: a reliable power system requires a reserve

margin to absorb unplanned outages, scheduled maintenance, and demand spikes without resorting to emergency imports or load shedding.

## Geopolitical and physical security

Geopolitical and physical security, within the energy sovereignty framework, addresses the vulnerability of energy systems to external political pressures, territorial disputes, sabotage, accidents, and natural disasters. In the electric power sector, this dimension refers to resilience against both infrastructure-level disruptions, such as grid failures, cyberattacks, and extreme weather events, as well as external political dependencies that could be leveraged to constrain a country's freedom of action. True security requires not only physical protection of assets but also diplomatic and commercial arrangements that preserve operational autonomy even amid a shifting geopolitical landscape.

*Constraints.* Kazakhstan imported approximately 2.5 billion kWh from Russia in 2025 - a dependency that is not merely commercial but structural, given that the UPS of Kazakhstan operates in synchronous parallel with Russia's UPS. This means Kazakhstan's system frequency is co-managed with Russia, creating a form of technical interdependence that goes beyond bilateral trade. The binding physical constraint is the North-South transmission bottleneck. The Southern zone, which is home to the country's largest population centers - Almaty and Shymkent, has a structural generation deficit and relies on transit from the North, with the existing 500 kV corridor operating near its limits. In 2025, North-South transit reached 1,941 MW on the peak day. The Western zone remains isolated from the UPS, operating as an energy island.

*Risks.* Any deterioration in Russia-Kazakhstan relations or the imposition of external pressure on Russia's energy exports could directly affect Kazakhstan's system stability. The fragmentation of the national grid into three zones means that a failure in any single inter-zonal link can immediately translate into regional blackouts with no alternative routing.

*Strategic options*. At the physical security level, protecting critical generation assets is a top priority. Ekibastuz GRES-1, which alone accounts for approximately 20% of national electricity output, exemplifies the category of facilities whose disruption would have immediate, system-wide consequences; accordingly, such assets are subject to heightened physical security measures and are classified as critical infrastructure objects. KEGOC is implementing the construction of a 500 kV "North-South" HVDC line with 2,000 MW transmission capacity, designed to eliminate the inter-zonal bottleneck and enable large-scale RES integration from the South. Integration of the Western zone with Kazakhstan's UPS via a 600 km, 500 kV line from Karabatan to Ulken is scheduled for completion in 2027, unlocking the flexible gas-fired capacity of the West as a balancing resource for the entire system. On the geopolitical front, Kazakhstan is deliberately diversifying its nuclear

partnerships: Rosatom is leading construction of the first 2.4 GW nuclear power plant [NPP-1] in the Zhambyl district of the Almaty region, with estimated commissioning in 2035, while China's CNNC has been awarded NPP-2 in the same Zhambyl district. This represents a dual-vendor strategy explicitly designed to prevent single-country leverage.

## Demand-side policy

Demand-side policy (including strategic regulation of exports) within the energy sovereignty framework encompasses the regulatory, fiscal, and institutional mechanisms that shape consumption patterns, manage demand during supply constraints, and align market behavior with energy security objectives. For the electric power sector, this includes shaping, forecasting, and, where necessary, redistributing consumption across time and geography. Effective demand-side policy creates system flexibility, enabling authorities to manage consumption during shocks without resorting to electricity rationing or market disruptions.

*Constraints.* The principal structural challenge is the expected continuing growth of energy-intensive demand, including digital one. Kazakhstan's electricity consumption is growing at 3.5-4.5% per year, with a significant share of that increment driven by cryptocurrency mining and data center expansion. Unregulated mining (which is less common now) generates unpredictable load spikes that the system cannot anticipate in advance planning, while the broader digitalization of the economy (AI infrastructure, cloud computing, e-government) is creating a new category of large, concentrated consumers with distinct load profiles. These demand pressures are further complicated by a persistent geographical mismatch: generation is concentrated in the North, while demand growth is fastest in the South and West. The Southern zone remains a structural net importer, and new energy-intensive facilities tend to be located independently of generation availability, placing additional stress on inter-zonal transmission.

*Risks.* The risk lies in the mismatch between the speed of (planned) ~~digital~~ demand growth and the pace of grid and generation investment. Concentration of significant new loads in specific nodes, without commensurate network reinforcement, creates localized capacity deficits and increases the system's vulnerability to point failures. If left unmanaged, this demand growth could absorb the projected generation surplus of 2029–2032 faster than the system can respond.

*Strategic options*. The strategic response is the "Valley of Data Centers" project in Ekibastuz - a large-scale digital hub spanning 1,400 hectares, designed to attract international

hyperscale[3] and BigTech operators. The anchor element is a Greenfield zone with pre-provisioned capacity of up to 100 MW and scalability to 1 GW; infrastructure will meet the Tier III standard with a PUE of 1.25. Four AI-focused data centers, each 50 MW, are planned in successive phases. The project represents an attempt to convert unstructured digital demand into a managed, predictable format: replacing dispersed, unlicensed mining with concentrated, licensed, energy-efficient infrastructure with a foreseeable consumption profile. Ekibastuz is strategically well-chosen, as it sits at the heart of the Northern zone's coal generation cluster, minimizing transmission losses and grid stress. This spatial logic is reinforced by a parallel shift toward smart grid management: Kazakhstan's National Project for Modernization of the Energy Sector targets 100% metering and automated accounting coverage by 2026, supported by 695.5 billion tenge in digitalization investment over 2025-2029. Smart Grid tools, such as automated load management, real-time monitoring, and demand-response systems, are intended to make large loads predictable and controllable, reducing the system's exposure to unplanned consumption spikes.

# The Bottom Line

Kazakhstan’s electric power sector has historically operated in deficit, dependent on aging Soviet-era infrastructure and on imports from Russia, and is now mobilizing for a new wave of generation and grid investment. The projected transition from net importer to surplus producer by 2027–2029 is not a bold forecast but is backed by a concrete pipeline of projects already under construction or under contract.

Yet the four dimensions of energy sovereignty reveal that the path from investment pipeline to true sovereignty is neither linear nor guaranteed. On diversification, the concentration risk operates at two levels (coal's 74.4% share of total generation and Ekibastuz GRES-1's remarkable 20% contribution to national electricity output), meaning that the 3 GW ESS target and the new regulatory framework for alternative energy, while the right instruments, will not materially alter the system’s structural exposure until the early 2030s. On infrastructure integrity, the dispatchable generation capacity deficit of 2026-2027 is the most immediate operational risk: the system’s reserve margin is eroded by the technical depreciation of a significant share of installed capacity, leaving the effective buffer considerably narrower, and the commissioning timeline for new flexible generation is tight. On geopolitical and physical security, the HVDC “North-South” line and Western zone integration are game-changing projects, but both carry execution risk; until they are complete, the Southern zone's vulnerability, the dependency on Russia's UPS, and the exposure of critical assets such as Ekibastuz GRES-1 to physical disruption remain structural features of the system. For demand-side policy, the “Valley of Data Centers” is a promising

[3] Hyperscale refers to the ability of a technology architecture or system to scale in response to increasing demands on a single business process.

model for converting chaotic digital demand into a governable load, and the Smart Grid program provides real-time visibility needed to manage it; but success depends on regulatory speed and grid investment that must run in parallel with the project's phases.

Kazakhstan's energy sovereignty is achievable within the current decade, but it is not automatic. It requires the simultaneous execution of generation investment, grid modernization, regulatory reform, and demand governance - four tracks that have historically advanced at different speeds and under different institutional owners. The degree to which these tracks can be coordinated, and the degree to which the investment pipeline can be protected from cost overruns, financing gaps, and geopolitical friction, will determine whether the surplus projected for 2029 becomes a durable foundation for energy independence or a temporary statistical artifact.

# ENERGY Insights & Analytics

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