Research

Country Energy Outlook: Kazakhstan

Foundations, Current Dynamics, and Future Prospects

Issue 1

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Content

Summary

Kazakhstan is Central Asia's largest energy producer and exporter, endowed with vast reserves of oil, gas, coal, and uranium. The oil and gas sector remains the backbone of the economy, generating about 60% of export revenues and a significant share of GDP (UNCTAD, 2024). With proven oil reserves exceeding 30 billion barrels and gas reserves of 2.3 trillion cubic meters, Kazakhstan ranks 12th globally in oil reserves and 20th in gas (IEA, 2022). Its three largest fields, Tengiz, Kashagan, and Karachaganak, are operated by international consortia involving Chevron, ExxonMobil, Eni, Shell, and state-owned KazMunayGas. In 2023, oil production reached roughly 90 million tonnes, of which 80% was exported primarily through the Caspian Pipeline Consortium (CPC) to Russia's Novorossiysk port on the Black Sea (Komakhia, 2025). Russia's invasion of Ukraine underscored Kazakhstan's vulnerability to Russian transit dependence, prompting diversification efforts through the Trans-Caspian corridor, the Baku-Tbilisi-Ceyhan pipeline, and upgrades at the ports of Aktau and Kuryk (Komakhia, 2025).

Coal remains central to Kazakhstan's domestic energy system, supplying about 70% of electricity generation in 2024. The country holds more than 25 billion tonnes of reserves, concentrated in the Ekibastuz and Karaganda basins (The Times of Central Asia, 2024a). While coal provides reliable baseload power and underpins energy security, it is the largest source of Kazakhstan's greenhouse gas emissions and local air pollution (Zhunussova et al., 2020). Natural gas plays an expanding role in power generation and household heating, especially in western and southern regions, but processing bottlenecks and underinvestment have limited refined product availability despite ample reserves (UNCTAD, 2024). To address delays and ensure supply security, the government recently tasked KazMunayGas with overseeing key processing projects (The Times of Central Asia, 2024b).

Kazakhstan is also the world's leading uranium producer, accounting for over 40% of global output in 2024. State-owned Kazatomprom manages most of the 13 mines, frequently in joint ventures with partners from Canada, France, China, Japan, and Russia (World Nuclear Association, 2024). Although Kazakhstan has no operational nuclear power plants, the government has increasingly debated nuclear generation to meet rising demand and climate targets. A 2024 referendum signaled public openness to nuclear energy after decades of skepticism rooted in Soviet-era nuclear testing, and plans now aim to install 2.0 GWe of nuclear capacity by 2050 (World Nuclear Association, 2024).

Renewables are expanding as part of Kazakhstan's pledge to reach carbon neutrality by 2060. By 2023, renewable sources provided 5.9% of electricity generation, with wind contributing 57%, followed by solar and hydropower (IRENA, 2024). The country's vast steppe offers immense wind potential, supported by fixed tariffs, guaranteed priority dispatch, and auction systems to attract investors (Mouraviev, 2021). Integration remains challenging: the grid is still optimized for coal-fired baseload, leading to curtailment of renewable generation and limiting efficiency gains (IEA, 2022). With support from international financiers such as the EBRD and the Asian Development Bank, Astana has moved to expand competitive auctions and invest in transmission modernization to support further deployment (EBRD, 2023).

Yet the green transition faces persistent barriers. Kazakhstan's Emissions Trading System (KazETS), launched in 2013, has been weakened by free allocations and limited market liquidity, failing to create meaningful incentives for decarbonization (UNDP, 2024). Subsidized fossil fuel tariffs, inconsistent enforcement, and volatile investment conditions have further slowed progress. The government introduced the "Concept for Energy Saving and Energy Efficiency 2023-2029" to upgrade industrial processes and improve demand-side efficiency, while international pressure, particularly from the EU's Carbon Border Adjustment Mechanism (CBAM), has increased urgency to accelerate reforms to protect carbon-intensive exports like steel and oil (UNCTAD, 2024).

Historical Background

1991: After the collapse of the Soviet Union, Kazakhstan inherited vast oil, gas, coal, and uranium resources. The energy infrastructure was out-dated and heavily integrated into the Soviet and subsequently Russian system, requiring restructuring and foreign investment.

1990s: Kazakhstan signed production-sharing agreements with major international oil companies (Chevron, ExxonMobil, Total, etc.). Development of the **Tengiz and Kashagan oil fields** began, laying the foundation for Kazakhstan's role as a key global oil exporter.

Early 2000s: Completion of the **Caspian Pipeline Consortium (CPC) pipeline** in 2001, providing a major export route from the Tengiz oil field to the Russian Black Sea port of **Novorossiysk**. Opening of the **Atasu-Alashankou pipeline** in 2006, establishing Kazakhstan's first direct oil export route to China. Construction and expansion of the **Central Asia–China gas pipeline (2009)**, linking Turkmen and Kazakh gas supplies to China. Rapid growth in crude oil production, making Kazakhstan one of the world's top 20 oil producers.

2012: Recognition of over-dependence on fossil fuels led to investments in renewable energy. Adoption of the **"Kazakhstan 2050" strategy** aimed at achieving 50% renewable and alternative energy by mid-century.

2014: Establishment of the Ministry of Energy to unify oversight of oil, gas, electricity, and renewables. Adoption of the **Green Economy Concept** (2013), setting targets for renewable energy share (3% by 2020, 10% by 2030, 50% by 2050). Launch of **renewable energy auctions in 2018**, replacing fixed tariffs with competitive bidding and attracting international investors.

2022: The Russia–Ukraine war disrupted Kazakhstan's reliance on Russian pipelines pushing Astana to diversify export routes via the Caspian and China. In January 2022, the **"Black Tuesday"** blackout almost triggered significant political unrest. Kazakhstan has also revived discussions on building its first nuclear power plant, with Russian and Chinese firms among the main contenders to construct it.

Kazakhstan Energy Capacity and Consumption Development

Kazakhstan's electricity system blends Soviet-era industrial planning with post-independence market reforms.

Infrastructure:

- The country operates over 200 power plants, concentrated mainly in the northern and central industrial regions (IEA, 2022).
- KEGOC oversees a 25,000 km high-voltage transmission network linking generation hubs, demand centers, and neighboring countries (KEGOC, 2023).

Electricity demand:

- Consumption has grown by 3-4% annually since 2010 (IRENA, 2024).
- Industrial users, particularly metallurgy, mining, and petrochemicals, account for over half of total demand (IEA, 2022).
- Residential consumption is rising due to urbanization and rural electrification programs (UNDP, 2024).
- Winter peaks for heating strain aging coal and gas plants, emphasizing the need for flexible and diversified supply.

Generation trends:

- Northern regions generate surplus electricity, while the south faces chronic shortages, prompting imports and ongoing grid investments.
- Modernization of coal-fired units at Ekibastuz and Aksu has improved efficiency and extended plant lifespans (Samruk-Energy, 2023).
- Wind and solar installations have expanded rapidly, especially in the south, adding thousands of megawatts since 2017, while small hydropower projects in eastern Kazakhstan enhance distributed generation (IRENA, 2024).

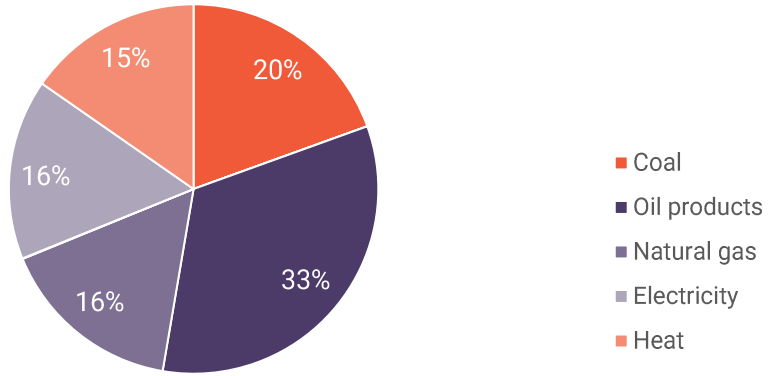
Regional integration:

- Kazakhstan trades electricity with Russia, Kyrgyzstan, and Uzbekistan under the Eurasian Economic Union and bilateral agreements (World Bank, 2021).
- The country typically exports surplus northern power in summer but imports in winter to cover southern deficits (IEA, 2022).

Future outlook:

- National targets call for renewables to reach 15% of generation by 2030 and 50% by 2050, supported by competitive auctions and foreign investment (UNDP, 2024).
- Efficiency initiatives aim to reduce energy intensity in industry, which remains high by global standards, and in transport and residential sectors (PAGE, 2020).

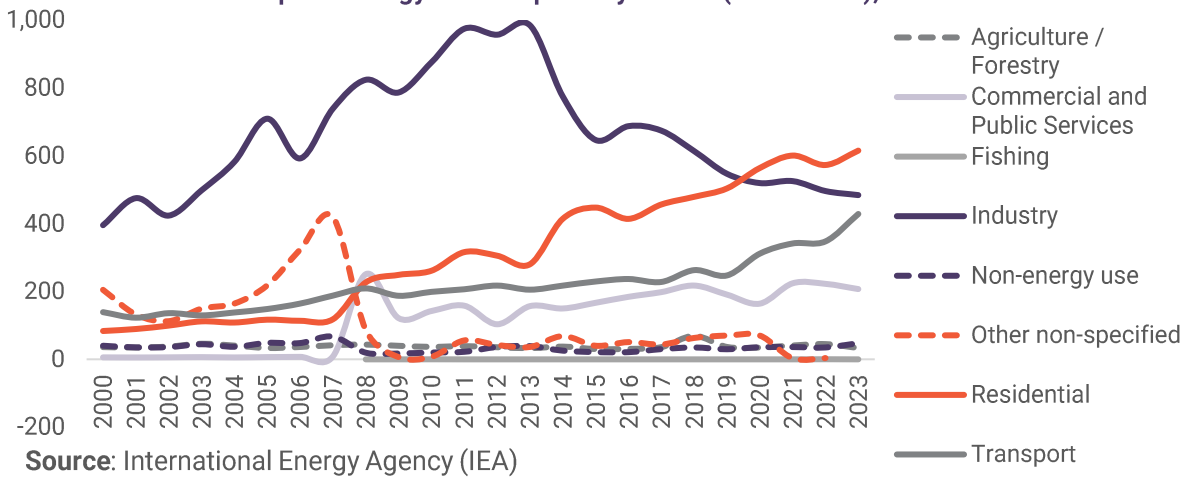
Graph 1: Energy Consumption by Source (2023), %



Source: International Energy Agency (IEA)

***Note**: Electricity and heat are counted separately from fuels like coal, oil, and gas to avoid double counting and distinguish direct fuel use from converted energy use.*

Graph 2: Energy Consumption by Sector (2000-2023), thousand TJ



Source: International Energy Agency (IEA)

Coal Sector

Despite Kazakhstan's commitment to carbon neutrality by 2060, coal continues to dominate its power system. In 2024, coal-fired plants generated approximately **75% of the country's electricity**, and coal accounted for nearly **half of total primary energy consumption** (Samruk Energy, 2024; Statistics Committee of Kazakhstan, 2024). The domestic economy remains structurally reliant on coal, with most consumed locally and the remainder exported primarily to Russia, China, and the European Union (The Times of Central Asia, 2024a). Coal is also central to thermal energy production and underpins key industries such as metallurgy, cement, and chemicals.

Market Profile and Industrial Role

- Coal provides stable, low-cost energy for industry, with about half of domestic use in steel, cement, and fertilizer production (The Times of Central Asia, 2024a).
- **Coking coal** fuels blast furnaces in steelmaking, while thermal coal powers cement kilns and generates process heat for chemical feedstocks such as syngas and ammonia.
- Although the coal sector contributes only about **1% to GDP** and **0.7% to national employment** (~40,000 workers), investment in fixed assets has risen sharply, from **86 billion tenge (177 million USD) in 2021** to **156.8 billion (321 million USD) in 2023** (Government of Kazakhstan, 2023).

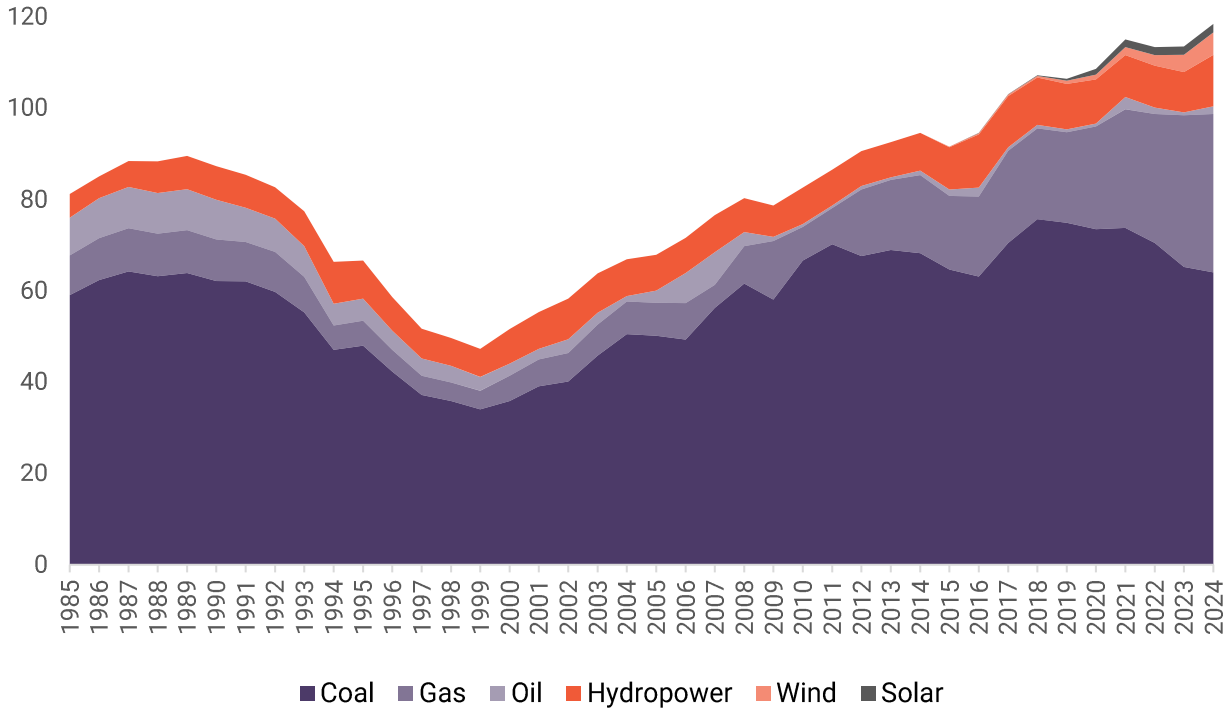
Capacity Expansion and Policy Direction

- The Ministry of Energy plans to add 4-5 GW of new coal capacity by 2035 through expansions at Ekibastuz GRES-1 and 2 and new plants in Kokshetau, Semey, and Ust-Kamenogorsk (Government of Kazakhstan, 2023; Kursiv Media, 2025).
- Despite policy goals to reduce coal's share of power generation from roughly **70% today to around 40% by 2035**, absolute coal generation is projected to decline only marginally, suggesting a **slow and uneven phase-down** (Agora Energiewende, 2024).
- Analysts warn that new capacity may **lock in fossil-fuel dependence** and expose investors to long-term asset and regulatory risk as global energy markets shift (Agora Energiewende, 2024).

Investor Implications

While coal remains a cornerstone of Kazakhstan's industrial energy security, it presents growing **transition and regulatory risks**. Long-lived assets built today may become stranded under tightening policy frameworks, especially as renewable deployment accelerates. Although short-term returns from coal assets remain attractive due to low domestic fuel costs and stable demand, long-term investors face rising uncertainty over pricing, export markets, and potential carbon-related trade barriers.

Graph 3: Kazakhstan Energy Production by Source (1985-2024), TWh



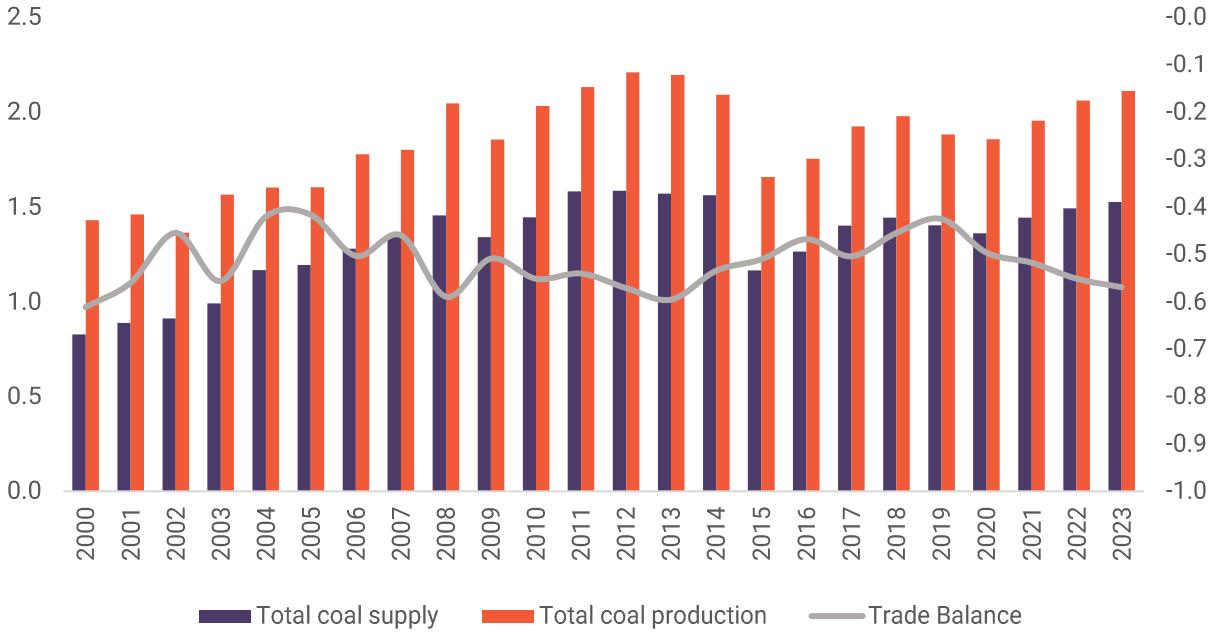
Source: Ember Energy Research CIC

Coal Sector Maps

Kazakhstan contains an estimated **25-34 billion tonnes of proven reserves**, ranking 8th globally, with sufficient supply to last 200-300 years at current extraction levels (The Times of Central Asia, 2024b; Invest in East Kazakhstan Region, n.d.). About one-third of reserves are high-quality hard coal, with the rest brown coal of lower calorific value. The **largest coal basins are Ekibastuz, Karaganda, and Turgai**, which together account for nearly **78% of proven reserves** (Invest in East Kazakhstan Region, n.d.).

Kazakhstan's coal market is quasi-state controlled; roughly 38% of total national output comes from **Bogatyr Komir LLP, jointly owned by Samruk-Energo JSC and Russia's RUSAL**. In 2023, Bogatyr Komir produced ~42.9 million tonnes of coal, equivalent to over 62% of the Ekibastuz basin's production (Samruk-Energy, 2023). Other major producers include Shubarkol Komir, EEC, and Qarmet, with around 75% of Kazakhstan's coal production concentrated among the four (The Times of Central Asia, 2024b).

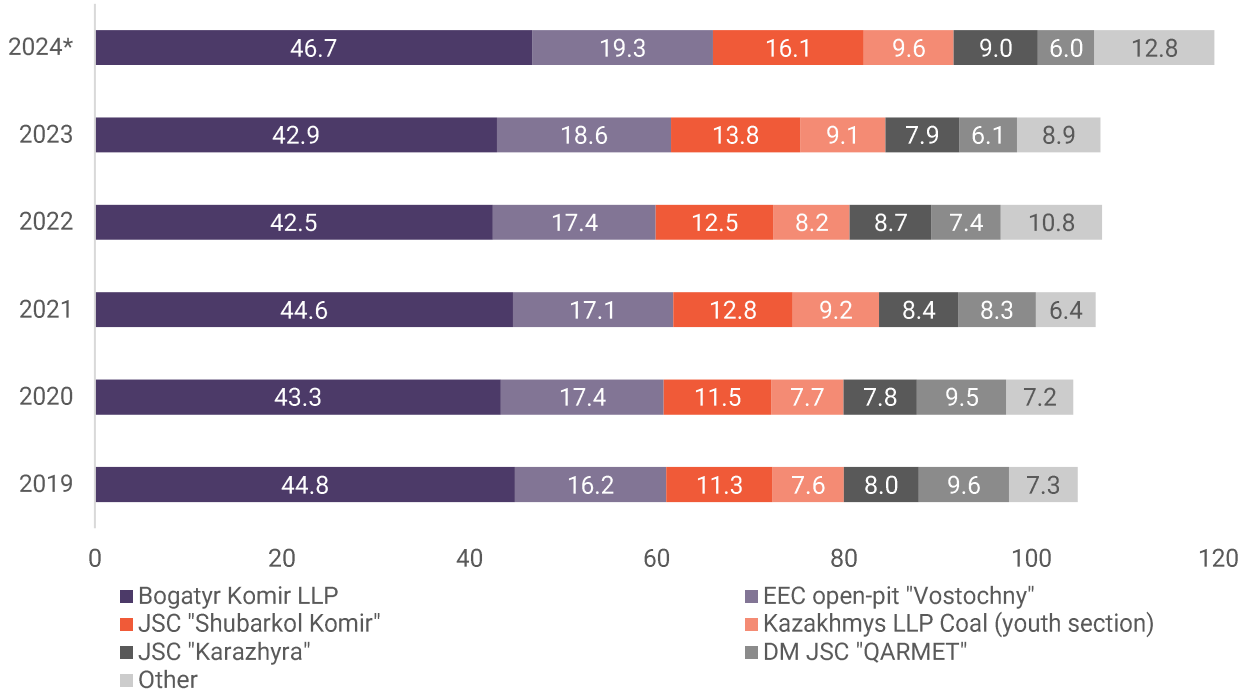
Graph 4: Coal Production Data (2000-2023), million TJ



Source: International Energy Agency (IEA)

***Note**: Trade Balance refers to coal exports minus imports.*

Graph 5: Coal Production by Companies (2019-2024*), million tonnes

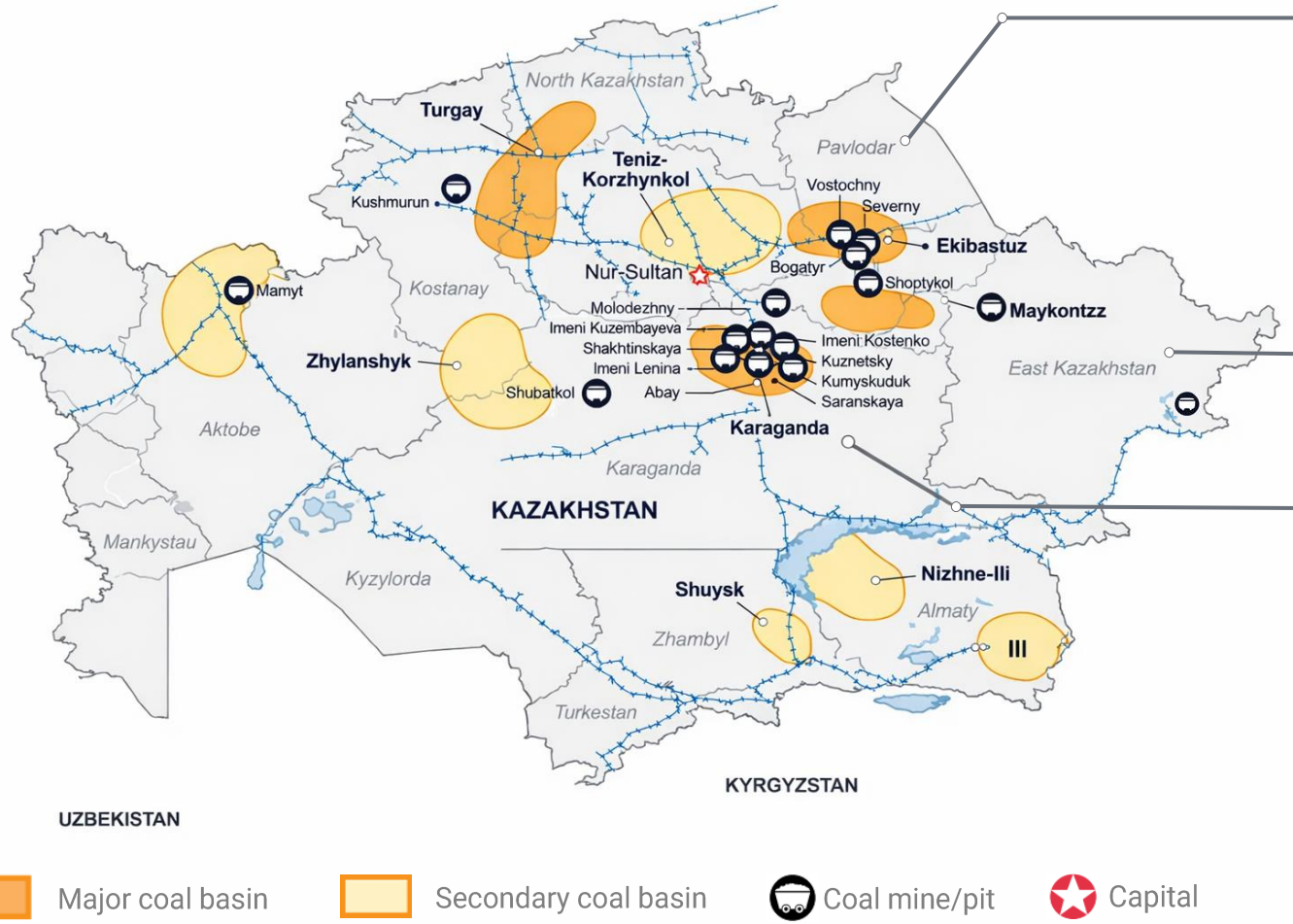


Source: QazStat

2024: plan for 2024*

Coal Sector Maps

Figure 1: Coal basins and key production sites in Kazakhstan (2023)



Source: IHS Markit (S&P Global), as cited in the KAZENERGY "The National Energy Report", 2023.
Note: *Approximate location and areas of coal basins.*

Main Coal Producers and their key assets

Povlodar Oblast

Bogatyr Komir LLP
- Bogatyr
- Severny

Maikuben-West LLP
- Shoptykol

Vostochny JSC Eurasian Energy Corporation
- Vostochny

East Kazakhstan Oblast

Karazhyra JSC
- Karazhyra

Karaganda Oblast

Shubarkol Komir JSC
- Centralny
- Zapadny

Kazakhmys Coal LLP
- Molodezhny
- Kyy-Chekinsky

Razez Kuzentsky LLP
- Kuzentsky

Sat Komir JSC
- Kumyskuduk

ArcelorMittal Temirtau JSC
- Abay
- Saranskaya
- Kazakhstanskaya
- Shakhitinskaya
- Imeni Kostenko
- Imeni Lenina
- Imeni Kuzumbayeva
- Tentekskaya

Oil Sector

Kazakhstan's oil sector remains the foundation of its economy, anchored by mega-projects such as **Tengiz**, **Kashagan**, and **Karachaganak**, which together account for about two-thirds of total output (Kazenergy, 2023). Oil provides nearly half of national export revenues, with roughly **80% of production exported,** mainly to the EU and China, and the remainder consumed domestically (World Bank, n.d.). Despite holding over **30 billion barrels of reserves**, high costs (USD 40-70 per barrel) and tax and transport burdens pushing break-even levels toward USD 90 have reduced competitiveness (The Times of Central Asia, 2024a).

Market and Cost Dynamics

- The oil and gas market was valued at **USD 9.5 billion in 2025**, projected to reach **USD 12.1 billion by 2030** (CAGR ≈ 4.9%) (Mordor Intelligence, 2025).
- **Upstream operations** dominate (≈ 68.5% market share), while **offshore projects** in the Caspian Sea comprise ≈ 85% of activity.
- **Operating costs:** mature onshore = USD 35-40 per barrel; offshore = USD 50-55 leaving profits highly exposed to price volatility.
- **Infrastructure strain:** aging midstream systems and limited refining capacity create logistical bottlenecks.

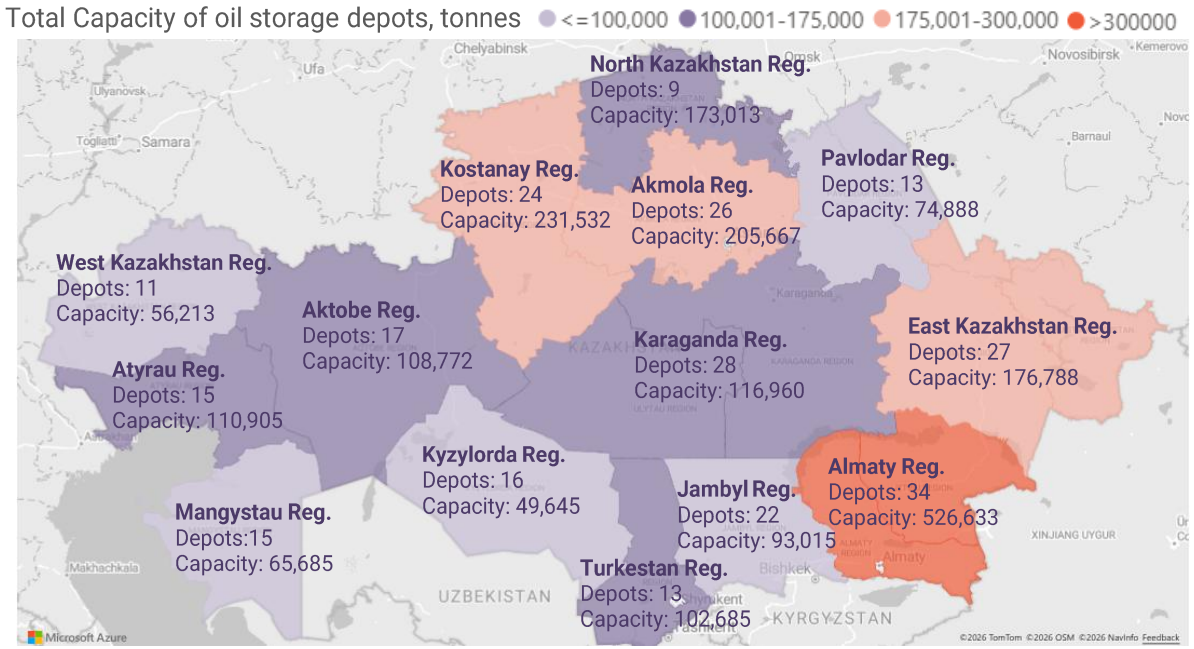
Key Investor Challenges

- **Distorted pricing:** under Production Sharing Agreements, major international operators export most output, while smaller firms must supply the domestic market at below-market prices, creating a "social burden" and dampening investment (Kazenergy, 2023).
- **Regulatory uncertainty:** frequent tax, local-content such as technology transfers and required local hires, and changes to cost-recovery procedures undermine predictability.
- **Dispute risk:** the 2023 Kashagan sulfur fine (≈ US$ 5 billion) exemplifies legal and compliance tensions (Rigzone, 2023).

Strategic Shifts

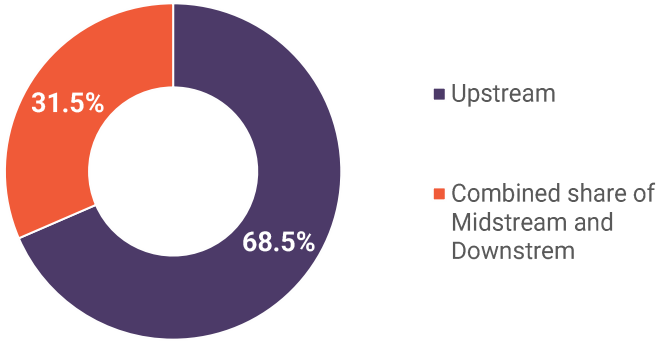
- The government plans to **triple refining and petrochemical capacity by 2030**, backed by over **USD 10 billion** in investments (Mordor Intelligence, 2025).
- Export diversification via the **"Middle Corridor"** is advancing, with **1.7 mln tonnes of crude** expected to move through the route in 2025 (Report.az, 2025).

Figure 2: Oil Storage Depots Capacity, Tonnes, and Number of Oil Depots in Kazakhstan (2021)



Source: Baker Tilly calculations based on open and closed source data, as cited in Forbes.kz.
Note: *Figure redrawn by the authors.*

Graph 6: Kazakhstan Oil And Gas Market: Market Share by Sector (2024), %

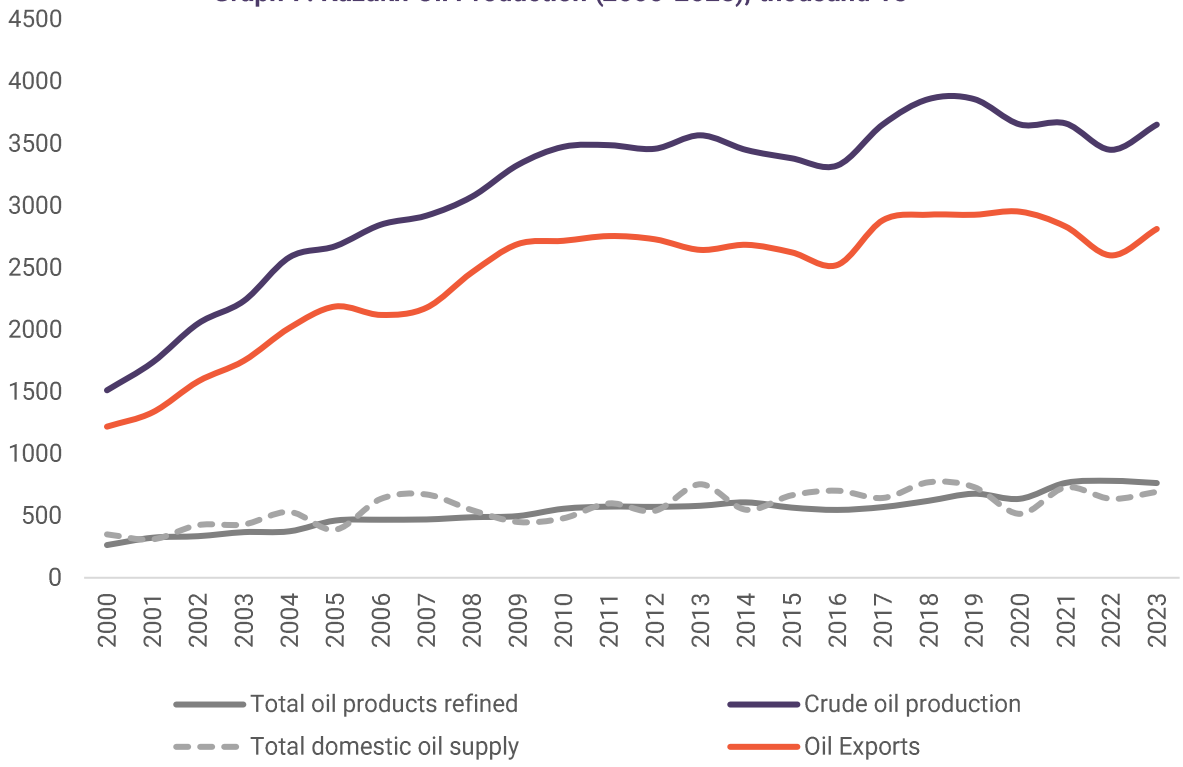


Source: Mordor Intelligence

Oil Sector Data

Kazakhstan's oil supply and consumption trends show a clear divide between strong production capacity and limited domestic processing. While crude oil output has partially stabilized since 2010, refining volumes have grown only modestly, revealing a continued dependence on exports and highlighting the underdevelopment of downstream capacity. The gradual rise in refined output since 2017 reflects some modernization, but domestic fuel demand still outpaces local supply, underscoring the need for investment in refining and storage infrastructure.

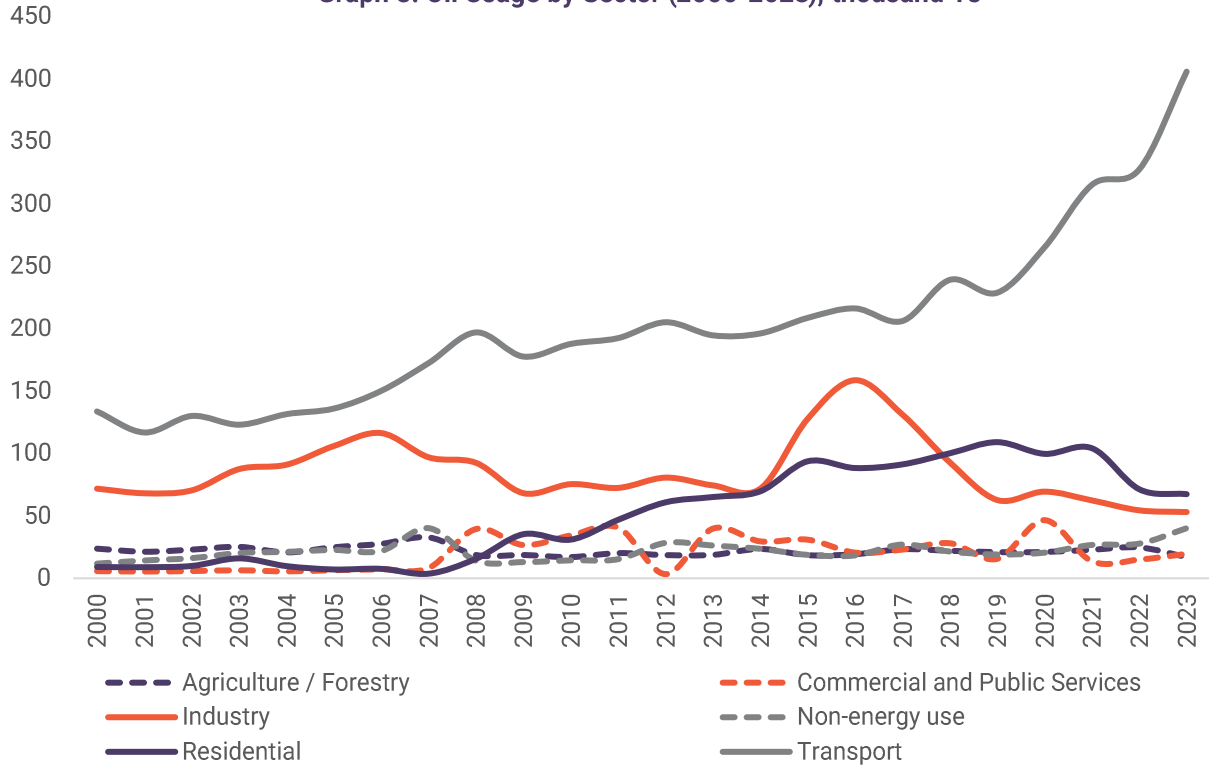
Graph 7: Kazakh Oil Production (2000-2023), thousand TJ



Source: International Energy Agency (IEA)

Oil use remains concentrated in transport and industry, with transport consumption now exceeding 400,000 TJ, nearly double 2010 levels. Industrial demand has fluctuated, driven by shifts in mining and metallurgy output, while residential and public service use has leveled off due to efficiency gains and fuel switching to gas and electricity. These patterns suggest that Kazakhstan's oil demand is still anchored in mobility and heavy industry, sectors that will need targeted reform and diversification to support long-term decarbonization goals.

Graph 8: Oil Usage by Sector (2000-2023), thousand TJ



Source: International Energy Agency (IEA)

Natural Gas Sector

Kazakhstan's natural gas sector is central to domestic energy security and the transition from coal. In 2025, gross gas production reached 68.2 bcm, up from 58.9 bcm in 2024, with over 85% of production coming from the Tengiz, Karachaganak, and Kashagan megaprojects (IEA, 2025). Of that gross output, marketable gas after reinjection stood at 34.7 bcm, while net production available for distribution fell to 21.4 bcm, which is down from 22.8 bcm in 2024 (ENERGY Insights & Analytics, 2026). Gas reinjection accounted for approximately 49% of gross production (IEA, 2025).

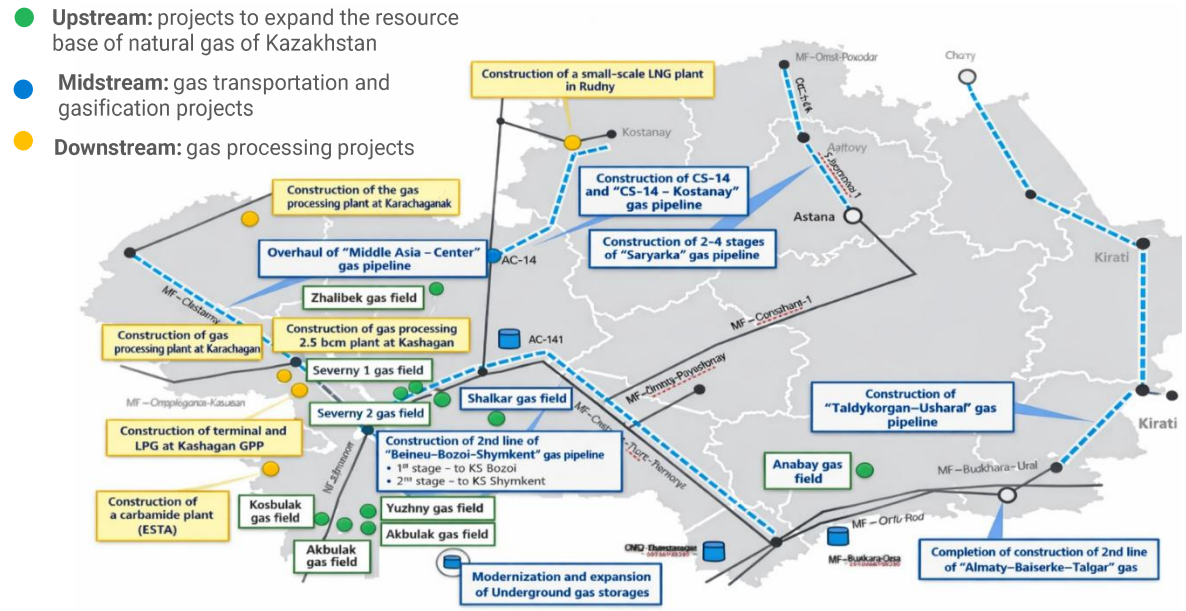
Domestic demand has continued to surge. Consumption of commercial gas increased 9% in 2024, reaching 21.2 bcm, with projections pointing to 32.4 bcm by 2028 (Ministry of Energy of Kazakhstan, 2025). In the first 11 months of 2025, domestic supply covered only 48% of total demand, while imports rose 45.1%, primarily from Russia (QazaqGreen, 2025). Kazakhstan holds reserves of approximately 3.8 trillion cubic meters (BP Statistical Review, 2024), yet without corresponding production growth, the demand trajectory is set to eliminate remaining export capacity (IEA, 2025).

- **Commercial allocation:** 79% is consumed domestically and 21% exported, with Russia (2.7 bcm) and China (1.7 bcm) the only export destinations in H1 2025 (Kazenergy, 2025).
- **Price constraints:** Wholesale prices remain well below cost, estimated at US$98 per thousand cubic metres for Almaty in 2025–2026, yet approved wholesale prices sit at roughly half that level. The Ministry of Energy warned that without price reform, a gas shortage could become critical after 2026 (Ministry of Energy of Kazakhstan, 2025).

Investment and Sectoral Developments

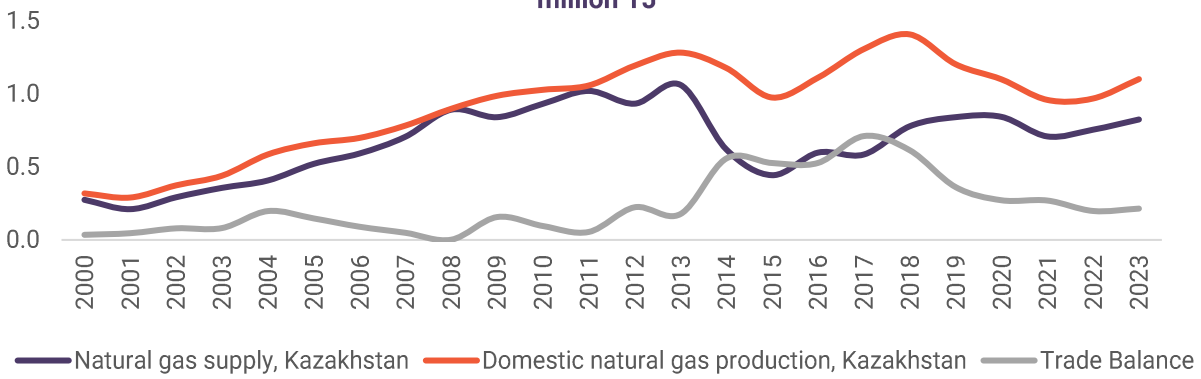
- **Project delays and state control:** Negotiations over a planned 4 bcm Karachaganak gas processing plant collapsed in 2025 after shareholders demanded Kazakhstan cover 100% of construction costs plus an additional $1 billion (Upstream, 2025).
- **New domestic projects:** In May 2025, the government unveiled a $15 billion investment plan for the oil and gas chemical sector, reflecting a broader push for energy sovereignty and reduced dependence on Russian infrastructure (Ministry of Energy of Kazakhstan, 2025). There is also a push to shift the economy from raw material exports to high-value industrial production utilizing gas.

Figure 3: QazaqGaz's planned development projects 2024-2028



Source: "QazaqGaz", as cited in the "Kazakhstan Energy Outlook" 2025, ENERGY.

Graph 9: Kazakh Natural Gas Sector Production and Trade (2000-2023), million TJ



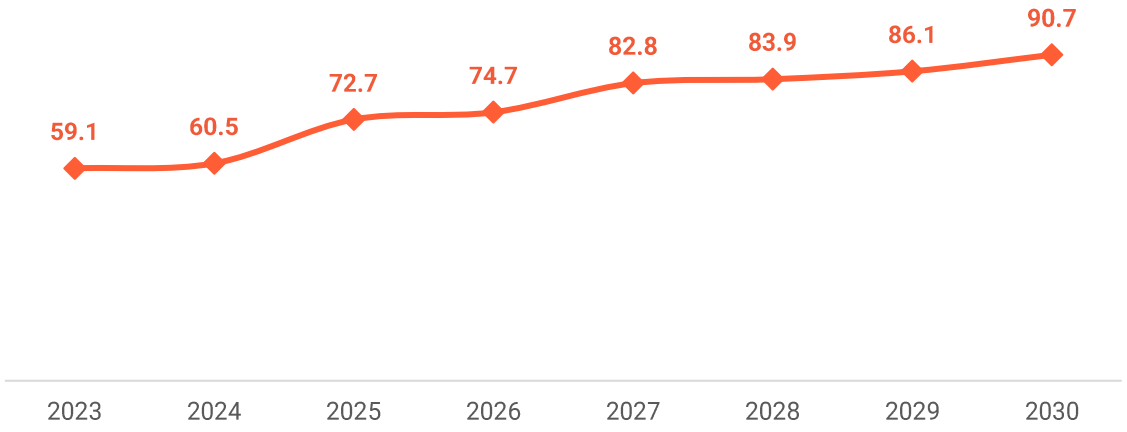
Source: International Energy Agency (IEA)

Gas Data

Kazakhstan's gas processing infrastructure displays significant imbalances in both capacity and utilization. Major facilities such **as Tengiz GPZ (13.0 BCM/y)** and **Zhanazhol GPZ (8.4 BCM/y)** operate as the sector's backbone, while smaller plants, including **KazGPZ** and **Severn Nurzhanov GPZ**, function well below their potential, with utilization rates as low as 10-16% (QazaqGaz, 2024).

This uneven performance reflects broader structural inefficiencies in gas collection and transmission networks, where logistical bottlenecks and inadequate interconnections limit throughput from smaller and mid-sized fields (IEA, 2023). As a result, Kazakhstan remains heavily dependent on a few large gas complexes, increasing vulnerability to operational disruptions and reducing flexibility in meeting domestic demand. According to national projections, total gas production is expected to rise from **59.1 BCM in 2023 to 90.7 BCM by 2030** (however much is reinjected and not extracted), driven by field expansions and gradual modernization of processing facilities (Kazenergy, 2024). Yet, without concurrent investment in midstream infrastructure and regional distribution capacity, this production growth may not fully translate into greater marketable gas supply (World Bank, 2024).

Graph 10: Projected Gas Production (2023-2030), BCM/Y



Source: Analytical Platform Exia, as cited in "Kazakhstan Energy Outlook", 2024, ENERGY

Table 1: Projected Gas Production (BCM/Y) and Utilization in 2021(%)

Gas Processing Plants	Max Capacity (BCM/Y)	Utilization in 2021 (%)
Tengiz GPZ	13.0	100%
Zhanazhol GPZ	8.4	62%
Bolashak GPZ	6.3	84%
Chinaresvskaya GTU	4.2	16%
KazGPZ	1.5	60%
Shagyrly GTU	1.3	73%
Amangeldy GPZ	0.7	49%
Akshabulak GTU	0.6	67%
Targabatay GPC	0.6	52%
Kozkhasay GPC	0.4	100%
Alibekmola GTU	0.4	100%
Borankol GTU GPZ	0.4	10%
Severny Nurzhanov GPZ	0.2	100%
Karakuduk GPZ	0.1	26%
Arystanovskoe GTU	0.1	44%

***Note**: Maximum capacity refers to the total volume of gas that the plant can process per year.*

Source: S&P Global, QazaqGaz, as cited in Kazenergy "The National Energy Report", 2023

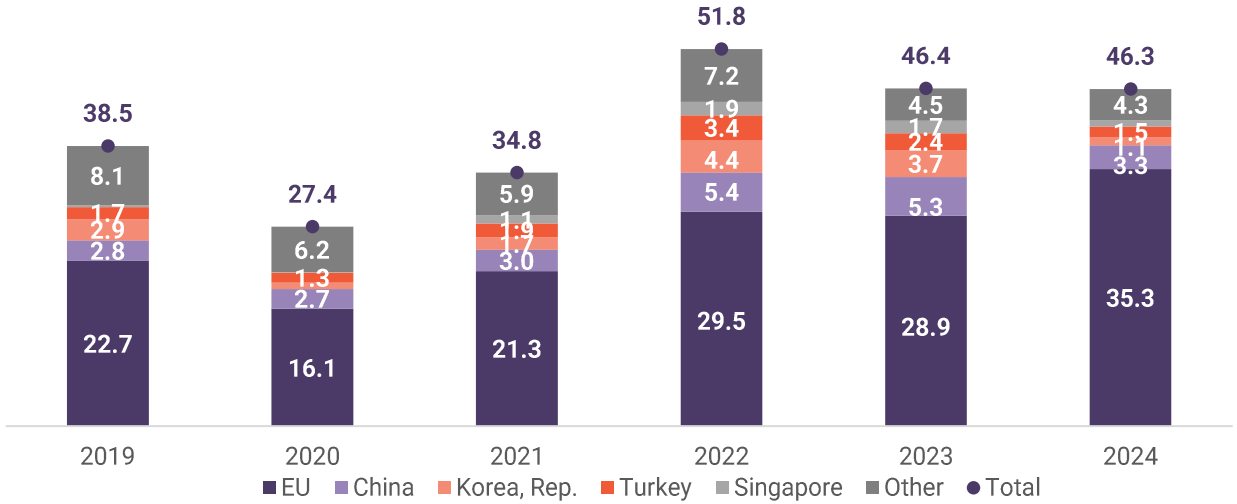
Pipeline and Energy Trade Development

Kazakhstan's oil and gas transportation network is vital to its role as a major energy exporter. The **Caspian Pipeline Consortium (CPC)** remains the cornerstone, moving up to **67 million tonnes annually** from the Tengiz and Kashagan fields to Russia's **Novorossiysk port** on the Black Sea (IEA, 2022). Other key routes include the **Kazakhstan-China Pipeline** and the **Atasu-Alashankou line**, deepening strategic energy ties with China (World Bank, 2023). For natural gas, the **Central Asia-China Gas Pipeline (CAGP)** dominates, carrying up to **60 bcm per year** of Turkmen, Uzbek, and Kazakh gas to China's Xinjiang region (UNDP, 2023).

Diversification and Geopolitical Risk

- **Russia dependence:** About two-thirds of Kazakhstan's oil exports transit via the CPC, which has faced **shutdowns and disruptions** linked to Russia's war in Ukraine (Energy Politics, 2023).
- **Diversification strategy:** Astana has expanded westward export routes through the **Baku-Tbilisi-Ceyhan (BTC) pipeline** and the **Trans-Caspian International Transport Route (TITR)**, targeting up to **20 million tonnes annually** via **Aktau and Kuryk** ports (Energy Politics, 2023).

Graph 11: Fuel Exports (2019-2024), billion USD



Source: UN Comtrade

- In February 2025, **QazaqGaz and PetroChina** agreed to expand Kazakh gas exports to China, marking a further shift away from Russian transit dependence (Caspian Energy Media, 2025).

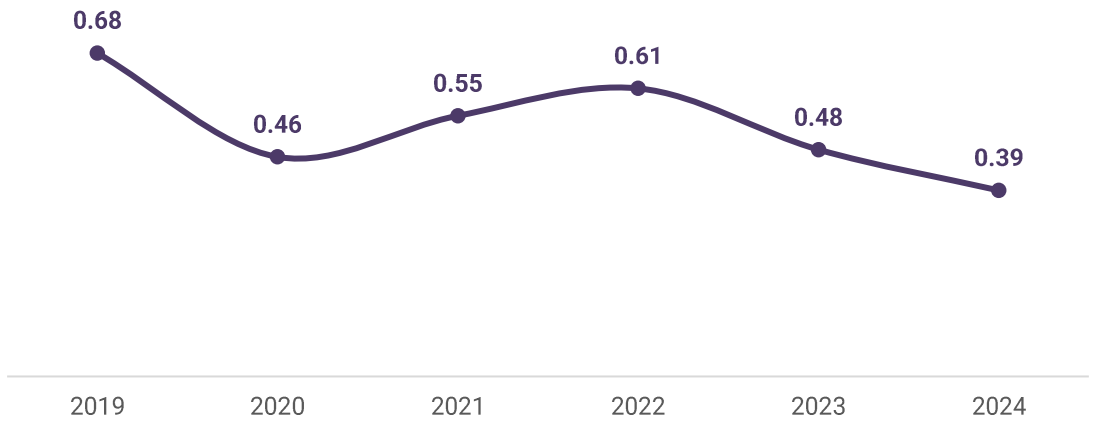
Port and Logistics Modernization

- **Aktau port upgrades:** As a key node in the TITR or "Middle Corridor," **Aktau** is being developed into a logistics hub linking **China-Central Asia-Caucasus-Europe** (Times of Central Asia, 2023).
- **Ongoing initiatives:** Port expansions financed by EBRD to double capacity, customs reforms, and digital cargo systems are underway.
- Kazakhstan plans a 2nd **Beineu-Bozoi-Shymkent** pipeline expand gas exports to China.

Role of Rail Infrastructure

- **Complementary mode:** Railways support coal exports and smaller oil deliveries, providing **flexibility** when pipelines face disruptions (UNDP, 2023).
- **Bottlenecks:** Wagon shortages and infrastructure delays increase energy costs and reduce export competitiveness (World Bank, 2023).

Graph 12: Fuel Exports to Russia (2019-2024), billion USD



Source: UN Comtrade

Caspian Sea Challenges and Opportunities

Figure 4: Major Caspian pipeline routes (2025)

Source: U.S. Energy Information Administration, „Regional Analysis Brief: Caspian Sea“ (2025)
***Note**: Figure redrawn by the authors.*

The legal and economic environment for Caspian Sea pipeline development remains highly uncertain, posing significant challenges for investors and regional energy strategy. The **2018 Convention on the Legal Status of the Caspian Sea** permits littoral states to construct subsea pipelines, but it does not define unified approval procedures, leaving Russia and Iran with de facto influence over trans-Caspian routes through environmental and jurisdictional controls (Norton Rose Fulbright, 2023; Albawaba, 2024).

Economic constraints amplify these challenges: deep-water engineering, seismic hazards, and strict environmental compliance make offshore pipelines expensive, while dependence on existing corridors exposes projects to geopolitical and operational disruption (Clingendael International Energy Programme, 2023; Energy Economics Institute, 2024). The proposed **Trans-Caspian Gas Pipeline** faces stalled progress due to high capital requirements and unresolved transit guarantees. Strategically, the high cost and risk profile of new pipelines effectively concentrate market power among established transit states, limiting Kazakhstan’s ability to unilaterally control export flows and realize full diversification benefits.

Governance and environmental factors add further complexity; Kazakhstan’s **Environmental Code (2021)** and overlapping bureaucratic oversight create administrative friction and elevate financial and reputational risk, while the Caspian’s ecological sensitivity amplifies scrutiny and potential liabilities (The Diplomat, 2025). Collectively, these interrelated legal, economic, and governance challenges shape a high-risk but strategically critical environment for Kazakhstan and other littoral states pursuing pipeline expansion and export route diversification.

Nuclear Sector

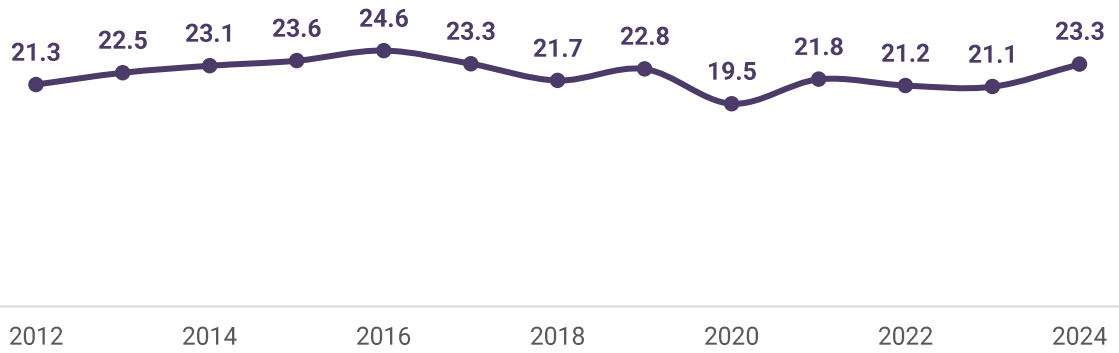
Kazakhstan holds approximately 14% of the world's uranium resources and has been the leading global producer since 2009, accounting for more than 40% of global output in 2024 (World Nuclear Association, 2024a). National production grew from **2,114 tU in 2001** to over **24,000 tU by 2016**, before dipping slightly during the COVID-19 pandemic and rebounding to **23,270 tU in 2024** (World Nuclear Association, 2024a). State-owned Kazatomprom manages most of the country's 13 uranium mines, often through joint ventures with international partners from Canada, China, France, Japan, and Russia (OECD-NEA & IAEA, 2022). The company is pursuing expansion into higher-value fuel production to support government targets of 5% nuclear electricity by 2035 and 2.0 GWe of installed nuclear capacity by 2050 (IAEA, 2023).

- Most uranium mining occurs in the **Chu-Sarysu and Syrdarya basins** using in-situ leaching (ISL), a cost-efficient and low-impact extraction method (World Nuclear Association, 2024a).
- Key operations include **Inkai, South Inkai, and Moinkum**; Tortkuduk, managed by Katco and Orano, is the world's largest ISL site (Cameco, 2023; Orano, 2023).
- The sector is supported by domestic **sulfuric acid plants** and a growing push to **localize the uranium supply chain**, reducing foreign dependence and increasing value capture from exports (OECD-NEA & IAEA, 2022).

Although Kazakhstan currently has no operating nuclear power plants, it maintains a legacy of nuclear technology through the **BN-350 fast breeder reactor** at Aktau (IAEA, 2023). Public opinion, historically shaped by Semipalatinsk nuclear testing, has shifted in favor of nuclear energy. A 2024 referendum indicated **70% support** for nuclear power, facilitating site selection in Almaty's Zhambyl district (World Nuclear Association, 2024b). In 2025, **Rosatom** was awarded the contract to build the first plant using Generation III+ VVER-1200 reactors, though financing challenges remain (Reuters, 2025). **China** has secured contracts for two additional plants, reflecting Kazakhstan's strategy to diversify partners and reduce dependence on a single supplier (World Nuclear Association, 2024b).

- **International Collaboration to Split Dependencies:** Joint ventures exist with **Russia (Rosatom, Uranium One), China (CGN, CNNC), Japan (Toshiba, Marubeni)**, and partnerships with **Canada's Cameco and France's Orano** (Cameco, 2023; Orano, 2023).
- Chinese firms have invested in mines like **Irkol and Semizbai** and partnered on a fuel fabrication plant, while France has supported fuel assembly production. In 2017, Kazatomprom launched a **Swiss-based trading subsidiary** to market uranium internationally (World Nuclear Association, 2024a).
- Following the Ukraine invasion, Kazatomprom began using the **Trans-Caspian route** to bypass Russian transit infrastructure (OECD-NEA & IAEA, 2022).
- Rail-sea links via **Port of Aktau** and **Port of Kuryk** enable uranium shipments to bypass Russia and expand access to European markets (OECD-NEA & IAEA, 2022).
- Transport follows International Atomic Energy Agency regulations with certified containers and strict protocols, ensuring safety despite added logistical steps (IAEA, 2023).

Graph 13: Uranium Produced Annually (2012-2024), thousand tonnes



Source: World Nuclear Association

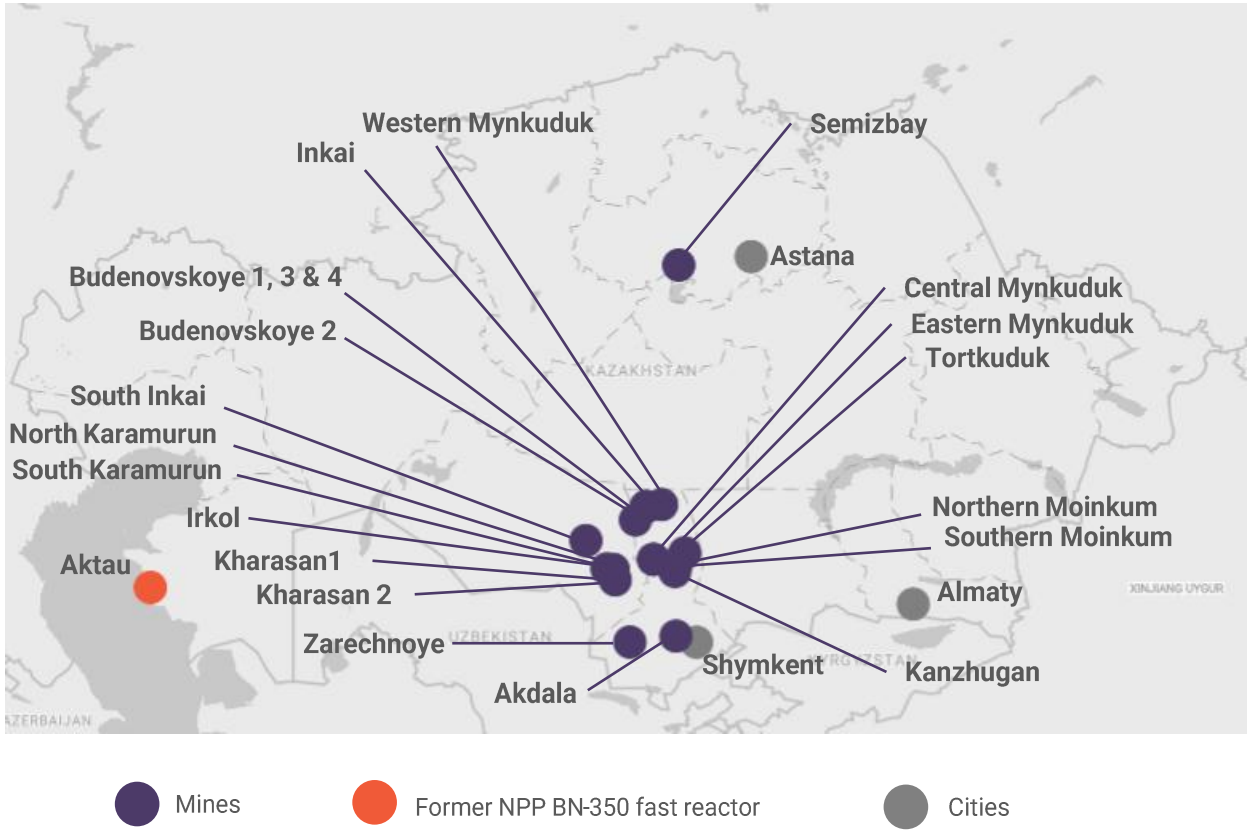
Location of Kazakh Uranium Mines

Kazakhstan's uranium deposits are strategically concentrated in its southern and central regions, reflecting a deliberate alignment between geological resources, transport infrastructure, and industrial capacity.

The Chu-Sarysu and Syrdarya basins, which together produce more than 80% of the country's uranium, are located near major industrial corridors and railway links connecting Shymkent, Kyzylorda, and the Caspian export terminals (OECD-NEA & IAEA, 2022). Their favorable hydrogeology supports the use of in-situ leaching (ISL), which reduces surface disturbance and operating costs. These basins' remoteness also minimizes land-use conflicts and environmental constraints, making them ideal for large-scale, low-cost extraction. Strategically, their position enables seamless integration with Kazakhstan's uranium conversion and transport systems, ensuring reliable export flows to global nuclear markets (World Nuclear Association, 2024a).

In contrast, the northern uranium provinces, including Akmola and Stepnogorsk, play a critical role in advancing Kazakhstan's midstream and value-added nuclear activities. These regions host the Ulba Metallurgical Plant in Oskemen, a major processing and fuel fabrication center that produces uranium dioxide and fuel pellets for European and Asian clients (IAEA, 2023). Their proximity to technical universities, research facilities, and manufacturing centers supports a more skilled, innovation-oriented workforce, reinforcing Kazakhstan's ambitions to move beyond raw uranium exports toward a vertically integrated nuclear industry (OECD-NEA & IAEA, 2022). This spatial balance between extraction zones in the south and processing hubs in the north strengthens the resilience and strategic autonomy of Kazakhstan's nuclear value chain, positioning the country as both a reliable supplier and an emerging technology partner in the global nuclear fuel market.

Figure 5: Uranium mines and former nuclear power plant in Kazakhstan (last updated 2026)



Source: World Nuclear Association (last updated 2026)

Uranium Mines and Foreign Investors

Table 2: Uranium Mines and Foreign Investors (2012-2022)

Province and Group	Mine	Foreign Investor and Share	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Chu-Sarysu, Eastern	Tortkuduk & northern Moinkum (Katco)	Orano 51%	3661	3558	4322	4007	4003	3519	3339	3252	2833	2840	2564
	Southern Moinkum & Kanzhugan (Taukent/GRK)	-	1075	1129	1174	873	781	616	609	1541	1230	1493	1273
Chu-Sarysu, Northern	Uvanas & Eastern Mynkuduk (Stepnoye-RU/GRK)	-	1234	1192	1154	1341	1222	974	866	0	0	0	0
	Central Mynkuduk (Ken Dala.kz)	-	1622	1800	1790	1770	1953	1898	1600	1694	1308	1579	1650
	Western Mynkuduk (Appak)	Sumitomo 25%, Kansai 10%	1003	998	870	880	1004	901	839	800	633	805	830
	Inkai 1, 2, 3 (Inkai)	Cameco 40%	1701	2047	1922	2418	2413	2202	2643	3209	2693	3449	3201
	Inkai 4 (South Inkai)		1870	2030	2002	2007	2058	2037	1617	1601	2260	2321	2225
	Akdala (Betpak Dala)	-	1095	1020	1007	1042	1000	900	835	800	2260	2321	2225
	Budyonovskoye 1, 3 & 4 (Akbastau)	Uranium One 50%	1203	1499	1594	1630	1778	1941	1561	1550	1363	1545	1545
	Budyonovskoye 2 (Karatau)		2135	2115	2084	2064	2108	2359	2081	2600	2460	2561	2560
Syrdarya, Western	North and South Karamurun (GRK)	-	1000	1000	941	956	1015	718	819	864	660	800	830
	Irkol (Semizbai-U)	CGN 49%, also CNEIC	750	750	700	781	700	678	560	960	753	962	940
	Kharasan 1 (Kyzylkum, now Khorosan-U)	Uranium One 30%, Energy Asia (Japanese + 40.05% Kazatomprom) 20%	583	752	858	1095	1354	1564	1554	1599	1455	1579	1580
	Kharasan 2 (Baiken-U)	Energy Asia (Japanese + 40.05% Kazatomprom) 47.5%	603	888	1135	1503	1838	1762	1666	1560	1181	1230	1315
Syrdarya, Southern	Zarechnoye (Zarechnoye)	-	942	931	876	800	817	802	781	778	648	655	741
Northern, Akmola region	Semizbay (Semizbai-U)	CGN 49%, also CNEIC	470	411	400	440	542	450	377	0	0	0	0
	RU-1 (Vostok, Zvezdnoye)	Uranium One 49.67% (bought from ARMZ in 2010), Krygyzstan 0.66%	370	331	298	0	0	0	0	0	0	0	0
Total (Tonnes)		-	**21,317**	**22,451**	**23,127**	**23,607**	**24,586**	**23,321**	**21,765**	**22,808**	**19,477**	**21,819**	**21,227**

Source: World Nuclear Association

Kazakhstan's Budding Green Energy

Kazakhstan's renewable energy sector has expanded rapidly over the past decade, growing from just 0.7% of electricity generation in 2015 to nearly 6% in 2023 (IEA, 2022; QazaqGreen, 2024). Policy reform has been a major driver of this transition. The 2009 **Law on Renewable Energy** established the first legal framework, while feed-in tariffs introduced in 2013 and the "Green Economy" strategy incentivized investment (PAGE, 2020).

- Renewable producers now benefit from guaranteed grid access and priority dispatch.
- Auction-based pricing through an independent online platform and subsidies covering up to 50% of project costs have further reduced financial barriers (UNDP, 2024).

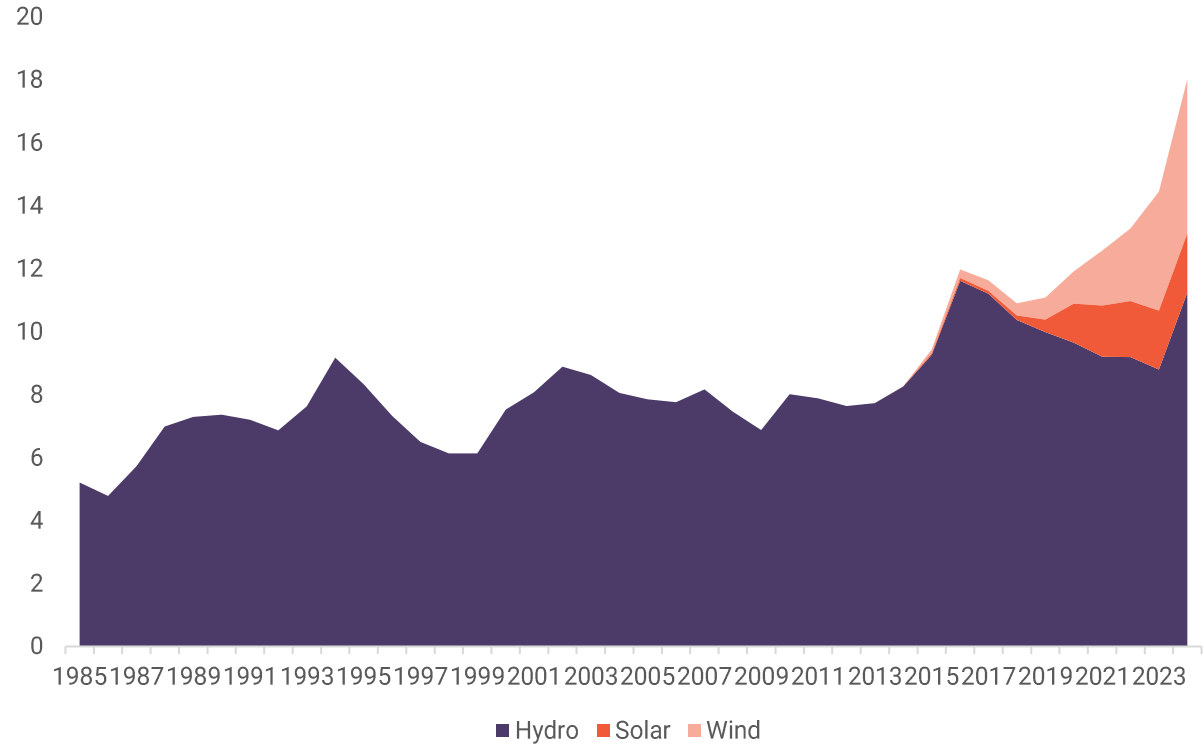
Vast steppes offer extensive wind resources, solar irradiance averages **1,300-1,800 kWh/m²** annually, and a legacy of Soviet-era hydropower provides additional capacity (IRENA, 2024). Geographic proximity to China and Europe has attracted foreign investment and technology transfer from multilateral development banks, aligning with Kazakhstan's strategy to diversify energy exports, lower greenhouse gas emissions, and become a regional low-carbon leader (World Bank, 2023; UNDP, 2024).

- By January 2024, installed renewable capacity reached **2,884 MW**, with wind (1,411 MW) and solar (1,196 MW) leading, and hydropower (275 MW) and biogas (1 MW) playing smaller roles (QazaqGreen, 2024).
- Renewables currently represent only **3.4% of total fuel resource use.** (World Bank, 2023).

Structural and operational challenges remain. Kazakhstan's grid is optimized for large, centralized coal plants, complicating integration of intermittent wind and solar without substantial storage or modernization (IEA, 2022). Project development faces delays from permitting complexity, land allocation issues, and overlapping institutional responsibilities (UNDP, 2024). Heavy reliance on imported turbines, panels, and inverters exposes the sector to high costs and currency fluctuations (IRENA, 2024).

Despite these challenges, Kazakhstan's renewable potential is significant. With proper investment in **transmission infrastructure, local component manufacturing, and cross-border power trading**, the country could become a net exporter of clean energy to southern Central Asian neighbors, the Caucasus, and Europe, supporting broader regional energy security. The key lies in aligning policy, finance, and technology to unlock this abundant resource base and position Kazakhstan as a Central Asian leader in renewables.

Graph 14: Renewable Energy Production (1985-2023) TWh



Source: Ember Energy Research CIC

Solar Power

Kazakhstan's solar energy sector has transitioned from a marginal source to a cornerstone of its renewable energy agenda. As of 2023, installed solar capacity stood at **1,696 MW**, supplying about **3.5% of national electricity generation**, compared with only 900 MW in 2019 and fewer than 100 MW in 2011 (Nakispekova, 2023). Key measures, including the **2009 Law on Renewable Energy**, the **2013 feed-in tariff**, and the *Green Economy* strategy, established the legal and financial framework for large-scale solar development (IEA, 2023). Major installations such as the **545 MW Altyn Dala Solar Power Station** demonstrate Kazakhstan's capacity to execute high-value projects and signal growing investor confidence (Kazakhstan Ministry of Energy, 2025).

- Foreign partnerships (**Masdar (UAE)**, **ACWA Power (Saudi Arabia)**, and **TotalEnergies (France),** have played a crucial role in technology transfer and financing (World Bank, 2024).

Despite this momentum, structural and regulatory barriers persist. Kazakhstan's grid remains optimized for coal plants, complicating integration of variable solar generation and leading to frequent curtailment (UNECE, 2025). Modernization of transmission lines and expansion of energy storage capacity are now critical for reliability. Market reforms introduced in 2023 including *single-buyer* and *real-time balancing* mechanisms seek to improve efficiency and market transparency but have also introduced **pricing uncertainty and payment-risk exposure** that concern investors (World Bank, 2024).

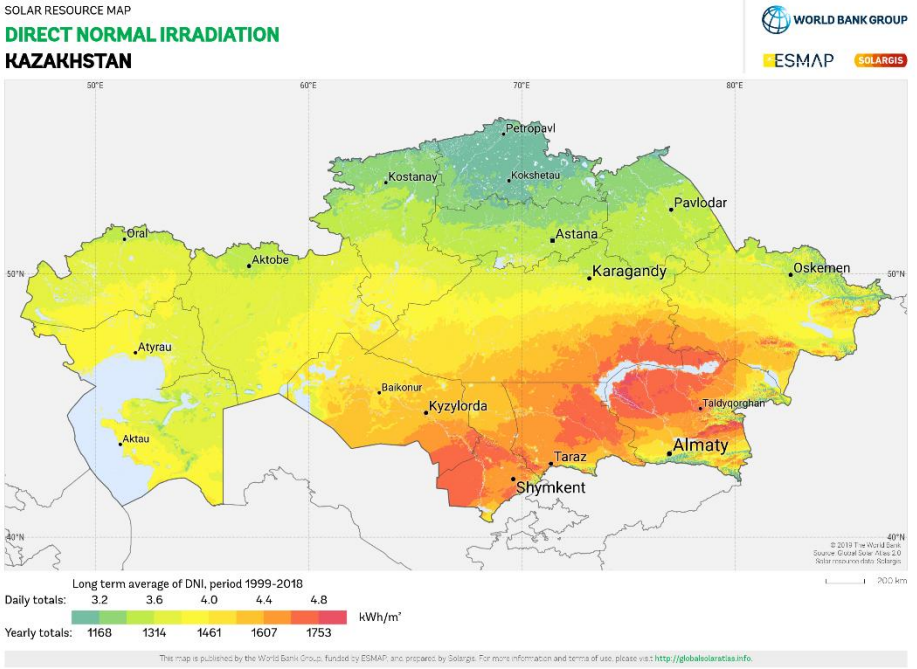
- This tension reflects a broader policy dilemma: balancing state control over pricing and dispatch with the private sector's need for long-term revenue stability.
- Without coordinated investment in grid flexibility, solar deployment risks becoming regionally concentrated rather than system-wide.

Financing remains the most significant bottleneck. While large-scale foreign investors have established a foothold, **smaller domestic developers face high capital costs** and lack access to stable feed-in tariffs or affordable loans (UNDP, 2025). The absence of a unified tariff mechanism and exposure to currency fluctuations add to project-level uncertainty. The government's carbon-neutrality target for 2060 underscores the need for coherent fiscal and regulatory support to attract broader participation.

- Policy continuity, concessional finance, and a stronger domestic supply chain, especially in panels, inverters, and storage systems, will be essential to lower costs and enhance self-reliance (IRENA, 2024).

With some of the **highest solar irradiance levels in Eurasia (1,300-1,800 kWh/m²)** and vast unused land, the country is well-placed to become a **net exporter of renewable electricity** (Ember, 2024). Enhanced interconnection through the *Trans-Caspian Energy Corridor* and Central Asian power grids could allow Kazakhstan to export clean power to Europe and neighboring states that face chronic energy shortages.

Figure 6: Direct Normal Irradiation Kazakhstan (2019)



Source: World Bank Group, Global Solar Atlas, Technical University of Denmark (DTU) (updated 2019, accessed 2026)

Solar Projects

Table 3: Solar Projects

Project Name	Capacity	Location	Developer	Timeline / Status	Notes
Akzhar Solar Project	185 MW	Zhambyl Region	Jinko Power (subsidiary)	Under development; expected completion in 2025	This project includes a 70 MW energy storage system, enhancing grid stability and enabling better integration of renewable energy. The location in Zhambyl Region is strategic for solar energy generation due to its high solar irradiance. (PVKnowhow)
Mannatech Kazakhstan Solar PV Project	20 MW	Zhualynsky District, Zhambyl Region	Universal Energy	Expected commissioning by 2026	The project was awarded through a government auction, with a competitive bid price of 14.95 tenge/kWh. This reflects a significant reduction in electricity costs, aligning with Kazakhstan's renewable energy goals. (QazaqGreen)
Zhangiztobe Solar Plant	30 MW	East Kazakhstan Region	Universal Energy	Completed in 2019	Generates approximately 38.9 GWh annually; reduces carbon emissions by 31,650 tonnes per year.
SES Saran Solar Plant	100 MW	Saran, Kazakhstan	SES Saran LLP	Completed in 2019	Annual production of approximately 140.116 GWh; reduces emissions by 93,500 tonnes per year.
Kapshagay Solar Plant	100 MW	Kapshagay, Almaty Region	Universal Energy, Development Bank of Kazakhstan	Completed in 2019	Annual production of approximately 140 GWh; cost ₸27.7 billion.
Nurgisa 100 MW Solar Park	100 MW	Qonayev, Almaty Region	Eneverse Kunkuat, a Kazakh-Chinese joint venture	Commissioned in August 2019	Built on 270 hectares; cost ₸27.7 billion; financed by Development Bank of Kazakhstan.

Source: Authors' compilation from official and industry sources.

Wind Power

Kazakhstan's expansive steppe offers exceptional potential for wind power, combining vast open terrain with high, consistent wind flows that few countries can match. The government has committed to installing **2.4 GW of wind capacity by 2030**, positioning wind as a cornerstone of the country's long-term decarbonization agenda.

- This target is backed by **favorable legislation**, including fixed-tariff mechanisms that provide predictable returns and mitigate investment risks for private developers.
- Administrative reforms have also **streamlined land and airspace permits**, overcoming key regulatory barriers that once slowed progress.

Installed wind capacity has expanded from minimal levels in the early 2010s to **1.44 GW in 2023**, underscoring the rapid institutional and financial maturation of the sector (IRENA, 2024, p. 14).

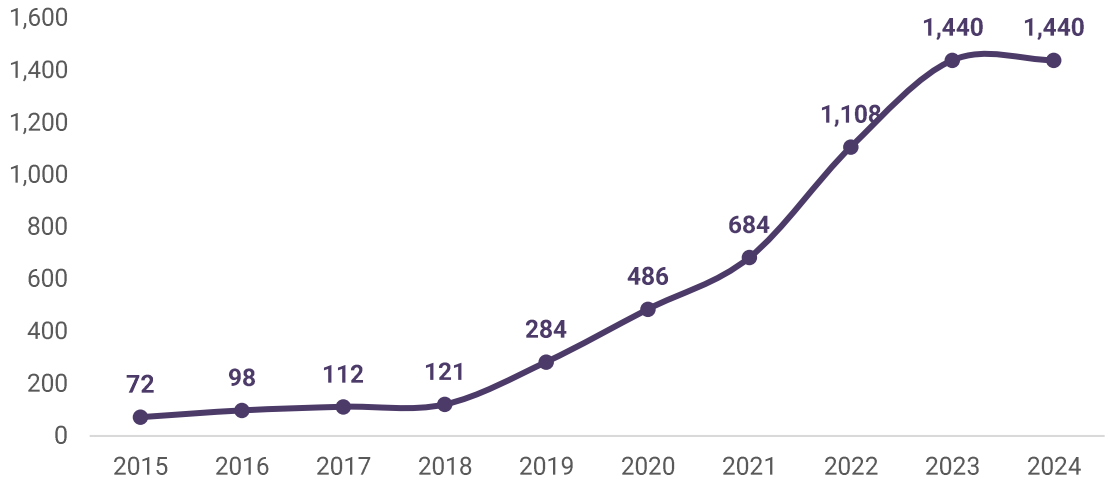
- Major projects such as **Zhualy (100 MW)** and **Ereymentau (50 MW)** have become anchors for regional power hubs (UNDP, 2024, para. 14).
- International developers, including **Goldwind** (China) and **Total Eren** (France), have introduced cutting-edge turbine designs and advanced construction techniques (PwC, 2024, p. 16).
- Since 2018, competitive auctions have secured **over 300 MW of new capacity**, with tenders increasingly favoring sites with existing grid infrastructure to reduce costs and enhance efficiency (EBRD, 2023, p. 3).

Wind sector growth in Kazakhstan is reinforced by **sovereign-backed offtake agreements**, providing stable long-term revenues and reducing investor risk (Mouraviev, 2021, p. 5; PAGE, 2020, p. 9).

Financing blends commercial loans with development bank and private equity capital, balancing fiscal discipline with growth objectives.

- The **EBRD's €200 million Renewables Framework** and **AIIB's turbine procurement program** continue to anchor large-scale projects (Darke et al., 2022).
- Efforts to **localize turbine manufacturing** and component assembly are strengthening domestic capacity and reducing import dependence (Qazaq Green, 2023, para. 4).

Graph 15: Wind Speed Capacity Development (2015-2024), MW



Source: The Wind Power

Yet substantial structural challenges remain.

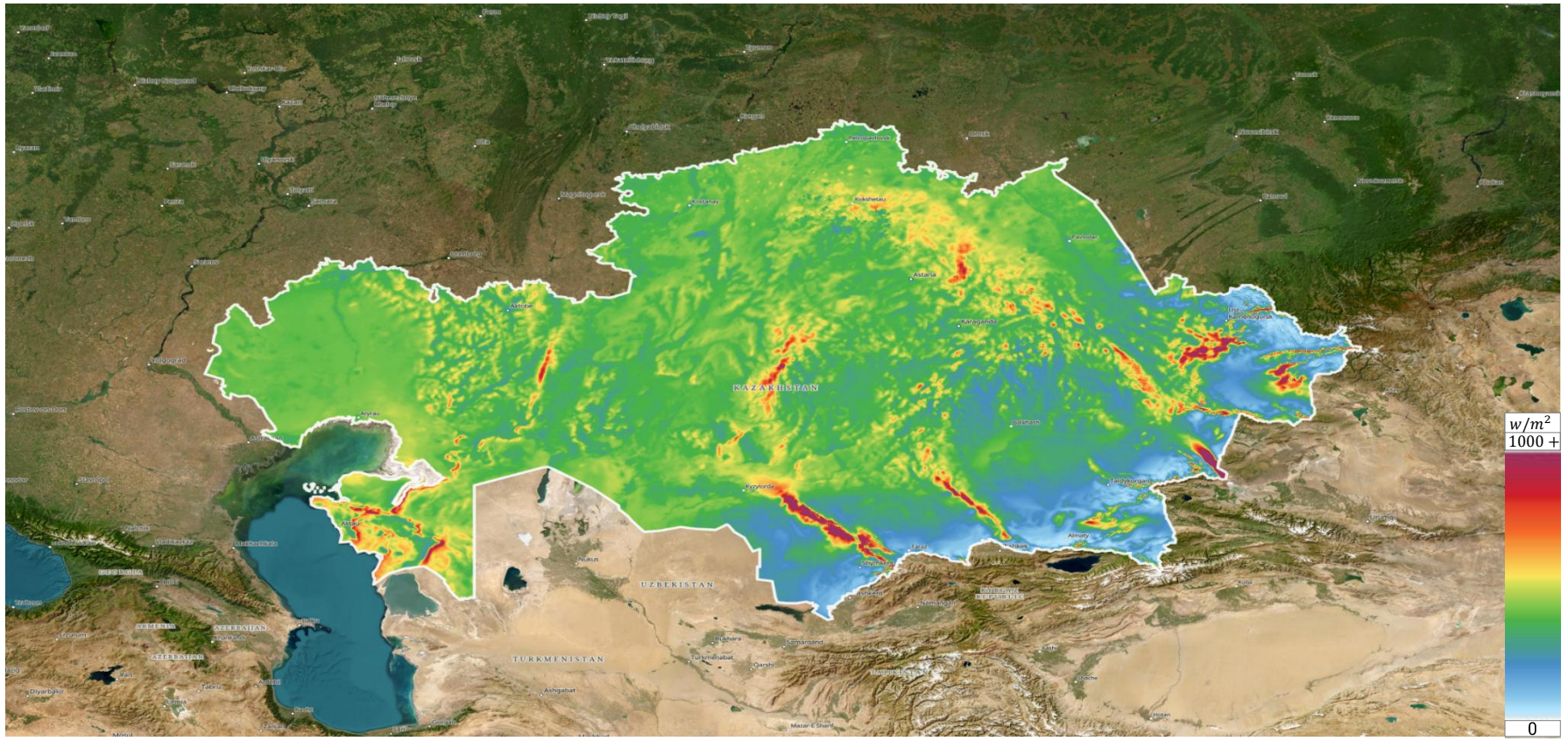
- Prime wind zones lie far from major demand centers, requiring **high-voltage grid expansion and modernization investments** to ensure efficient transmission (IEA, 2022, p. 37).
- The intermittency of wind generation also underscores the need for improved **forecasting, energy storage, and flexible backup capacity** (Zhunussova et al., 2020, p. 317).
- Grid operator **KEGOC** is reinforcing north-south transmission corridors to connect production hubs with load centers, improving system reliability (KEGOC, 2023, p. 6).
- Ongoing **wind-plus-storage pilot projects** (UNDP, 2024, p. 52) represent early experiments in balancing variable generation, and their success will be crucial in scaling a sustainable, flexible power system.

Mean Wind Power Density at 100m

Kazakhstan's **wind potential exceeds 920 TWh per year**, concentrated in the **Dzungarian Gates** near the Chinese border and the **Shelek Corridor** east of Almaty, where average wind speeds reach over **7 m/s** (World Bank, 2021, p. 12; UNDP, 2024, p. 47).

- These geographic advantages allow for large-scale development with minimal land-use conflicts due to the country's low population density.
- Seasonal wind cycles also produce stronger output during winter, offsetting this balance strengthens grid reliability while diversifying Kazakhstan's renewable mix, illustrating a **strategically coordinated approach** to leveraging natural resource advantages (Zabanova, 2024, para. 5).
- By aligning meteorological conditions with energy planning, Kazakhstan demonstrates an emerging capacity for **adaptive grid management**, a critical step toward a resilient clean energy system.

Figure 7: Wind Power Density



Source: World Bank Group, Global Solar Atlas, University of Denmark (DTU), accessed 2026

Wind Projects

Table 4: New or Planned Wind Projects

Project Name	Capacity	Location	Developer	Timeline / Status	Notes
Mirny Wind Farm	1,000 MW	Zhambyl Region	TotalEnergies	Construction begins 2025, first electricity 2028	Largest in Kazakhstan; requires 200 km of new transmission lines
Khromtau Wind Power Plant	150 MW	Aktobe Region	Eurasian Resources Group	Operational since Sep 2025	24 turbines, generates 500 million kWh/year, reduces 440,000 tonnes CO_2
Shokpar Wind Power Project	100 MW	Sarysu District, Zhambyl Region	China Power International Holding Ltd. & Visor International DMCC	Under development	Adjacent to Zhanatas Wind Power Plant; connects to same substation
Zhambyl Region Wind Project	1,000 MW (2×500 MW)	Sarysu & Talas Districts	Masdar (UAE)	Construction 2026, commissioning 2029	Part of broader renewable energy expansion; $1.4B investment
CPIH Kazakhstan Wind Portfolio	220 MW (5 plants)	Various locations	China Power International Holding Ltd.	Under development	Includes 42 km 220 kV lines and 220 kV substation expansion
Badamsha Wind Farms (1 & 2)	200 MW	Aktobe Region	ENI	Under development	First large-scale wind investment by ENI in Kazakhstan
Universal Energy Wind Project	100 MW	Kostanay Region	Universal Energy	Won auction Nov 2024	Adds to Universal Energy's growing Kazakhstan portfolio

Source: Authors' compilation from official and industry sources.

Hydroelectric Power

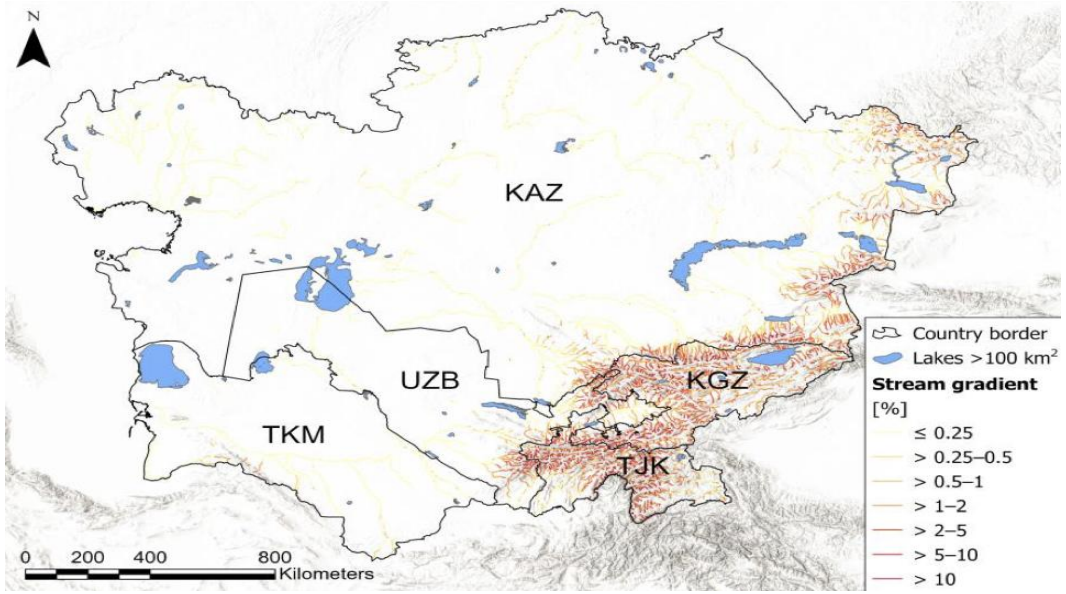
Hydropower remains a vital yet complex pillar of Kazakhstan's electricity system, accounting for **12-13% of installed capacity** and approximately **2.9 GW of operational power** (IRENA, 2024). It delivers low-cost, low-emission electricity while providing crucial co-benefits such as **irrigation support, flood mitigation, and industrial water supply**. Despite a **theoretical potential of 170 billion kWh annually**, only **27 billion kWh** is economically viable due to terrain, cost, and ecological constraints (Trade.gov, n.d.). This mismatch between potential and utilization highlights the structural inefficiencies in Kazakhstan's water-energy nexus and underscores the untapped opportunity for modernization.

- Large Soviet plants like **Bukhtarma** and **Shulbinsk** were built to power industrial centers rather than local communities, often at the expense of arable land and rural livelihoods (Trade.gov, n.d.).
- These facilities remain essential for grid stability but face **aging infrastructure, sedimentation, and limited operational flexibility**, which restrict integration with newer, variable renewable sources.

Hydropower capacity has grown modestly, up **8.5% in the past decade** to **2,903 MW by 2023** (IRENA, 2024). The sector's current focus is on **rehabilitating existing plants and expanding small to medium-scale projects**, which offer faster build times and lower environmental impacts that align with their decentralization goals.

- Major plants such as **Bukhtarma (675 MW)**, **Shulbinsk (702 MW)**, **Kapshagay (364 MW)**, and **Moinak (300 MW)** anchor the national grid but increasingly require **digital monitoring systems and turbine upgrades** to sustain output and efficiency (World Bank, 2021).
- Small hydropower (1-50 MW) projects are gaining traction, particularly in the **Almaty region**, where installed capacity totals **78 MW**, generating roughly **8 billion kWh annually** (Wikipedia, 2023).
- The government's plan to build five new small hydropower plants by 2030, totaling **74.3 MW**, reflects a pivot toward **distributed and climate-adaptive generation** (Astana Times, 2023; Inform.kz, 2023).
- These projects also advance **rural electrification and employment**, while diversifying regional economies that have long depended on coal and fossil industries.

Figure 8: Computed Slope of the Central Asian River Network



Source: Keyser et al. (2023), Scientific Data, Figure 4.
Note: *Only rivers with a mean annual flow >1 m3/s are represented in the map.*

The **Syr Darya** and **Ili** rivers link Kazakhstan with **Uzbekistan, Kyrgyzstan, and China**, making hydro policy inseparable from regional water diplomacy. When Kazakhstan retains water in the **Shardara Reservoir (5.2 billion m³)** for winter power generation, it limits irrigation flows for Uzbekistan; conversely, Kyrgyz winter releases can trigger flooding downstream. In the **Ili basin**, hydropower and irrigation expansion have sparked tensions with **China's Xinjiang region**, where reduced inflows threaten **Lake Balkhash**, a critical ecological and economic resource (Komakhia, 2025).

- Climate variability further destabilizes this balance, reducing glacial meltwater and increasing the unpredictability of river flows.
- Forecasts suggest **regional water demand could exceed supply by 15-20% by 2030**, intensifying trade-offs between **hydropower, agriculture, and ecosystem preservation** (Komakhia, 2025).

Hydroelectric Projects

Table 5: New or Planned Hydroelectric Projects

Project / Initiative	Capacity	Location / River(s)	Status / Timeline	Notes	Project / Initiative
East Kazakhstan small HPPs (5 new plants)	74.3 MW (combined)	East Kazakhstan Region: Katon-Karagay; Bukhtarma River (Altai district); Zaisan district; Markakol district	Planned; some plants by 2027-2030	Includes a 1.4 MW plant in Katon-Karagay (by 2027), a 50 MW facility on Bukhtarma River (by 2029), then smaller units (4.5 MW, 2.4 MW) in Zaisan and 16 MW in Markakol by ~2030. (The Astana Times)	**East Kazakhstan small HPPs (5 new plants)**
Kora River HPP-3	26 MW	Eskeldinsky District, Zhetysu Region	Recently commissioned (2025)	Part of broader regional push: attracted over 10 billion tenge in private investment; creates permanent jobs; contributes to energy security and grid stability. (renewables.az)	**Kora River HPP-3**
Baskan Cascade (HPP-2 & HPP-3)	Generates ~76.5 million kWh/year (exact MW not clearly stated in source)	Baskan River, Sarkand District, Zhetysu Region	Recently completed/in operation (HPP-2 since ~Oct 2024)	Built by Baskan Power LLP, with support of Development Bank of Kazakhstan. Part of ongoing cascade development in region; existing Upper-Baskan HPP-1 (since 2015). (kdb.kz)	**Baskan Cascade (HPP-2 & HPP-3)**
RES Auction Selected HPPs (KOREM Auction 2025)	~67.7 MW (combined of awarded projects)	Various sites under Unified Power System of Kazakhstan	Planned (projects selected in auction)	Companies: KGE Hydro (27.4 MW bid), KazHydroEnergo (~12.9 MW, etc.). Auction price around 41.2-41.23 KZT/kWh (excluding VAT). (qazaqgreen.com)	**RES Auction Selected HPPs (KOREM Auction 2025)**
Planned / Proposed Large & Small HPP Projects (Hydropower Development Plan 2020-2030)	Small HPPs up to 1,500 MW total; large HPPs up to ~1,300 MW	Various rivers: Tekes, Tentek, Charyn etc.	Some commissioning targeted by 2025-2026; modernization of existing plants through 2027-2030	Examples: small HPP on Tekes (~0.2 MW), Koktal HPP-1 (6 MW); Tentek River HPP (50 MW), Charyn cascade continuation etc. Also modernization of Bukhtarma HPP units, Shulbinskaya HPP Stage II, upgrade of existing plants like Ust-Kamenogorsk. (Mondaq)	**Planned / Proposed Large & Small HPP Projects (Hydropower Development Plan 2020-2030)**

Source: Authors' compilation from official and industry sources.

Employment and Education in The Energy Sector

Kazakhstan's energy sector remains a dominant employer, with fossil fuels continuing to provide the largest share of jobs. According to the Bureau of National Statistics, around **48,895 people** were employed in green jobs within medium-sized enterprises and **8,608 in small enterprises** in 2022 (Kazakhstan Bureau of National Statistics, 2023). Within the renewable energy sector specifically, 2,103 people were employed in 2025 (Kazakhstan Green Jobs and Skills Assessment, 2024, p. 19).

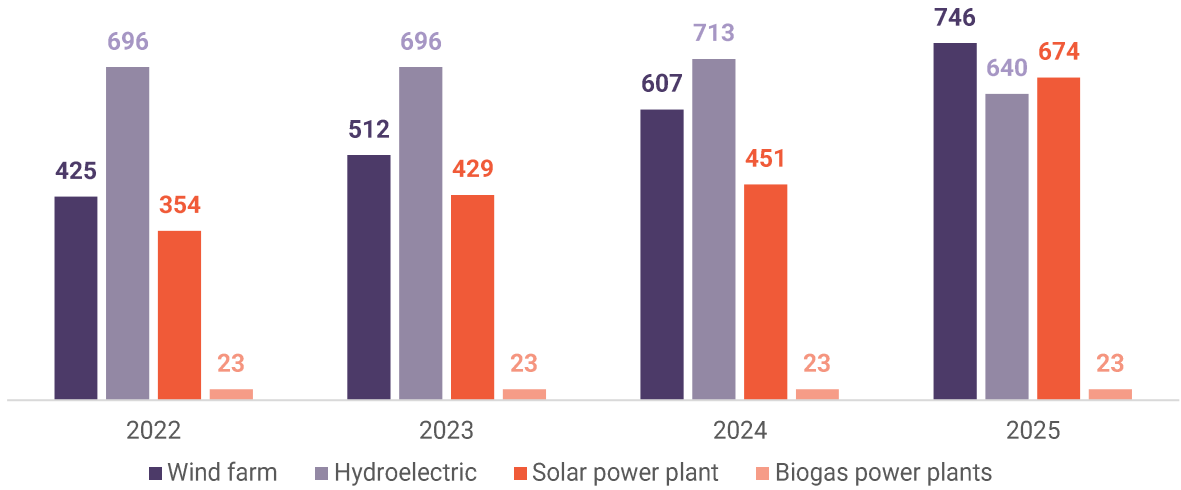
- **Employment distribution:** Hydropower remains the largest renewable employer, though its share is declining as solar and wind expand.
- **Gender composition:** Men accounted for roughly 1,402 positions compared to 258 held by women, Female participation rose from 235 in 2022 to a peak of 315 in 2024 (around a 34% increase), before slightly declining to 291 in 2025, indicating moderate but uneven progress toward inclusivity (Graph 17).

Kazakhstan hosts **61 universities and over 200 colleges** offering programs in electrical and thermal energy, many of which are adding modules on renewables, energy efficiency, and environmental management (QazaqGreen, 2025a). Institutions such as **Kazakh-German University (DKU)** have introduced targeted programs, while **Nazarbayev University** and **Kazakh National Agrarian Research University** are incorporating sustainability and green business practices into technical curricula (Kazakhstan Green Jobs and Skills Assessment, 2024, p. 34).

- **Training institutions:** The Qazaq Green Association, Green Academy, and International Green Technologies and Investment Projects Center (IGTIPC) lead national efforts in professional renewable energy training (Kazakhstan Green Jobs and Skills Assessment, 2024, p. 36).

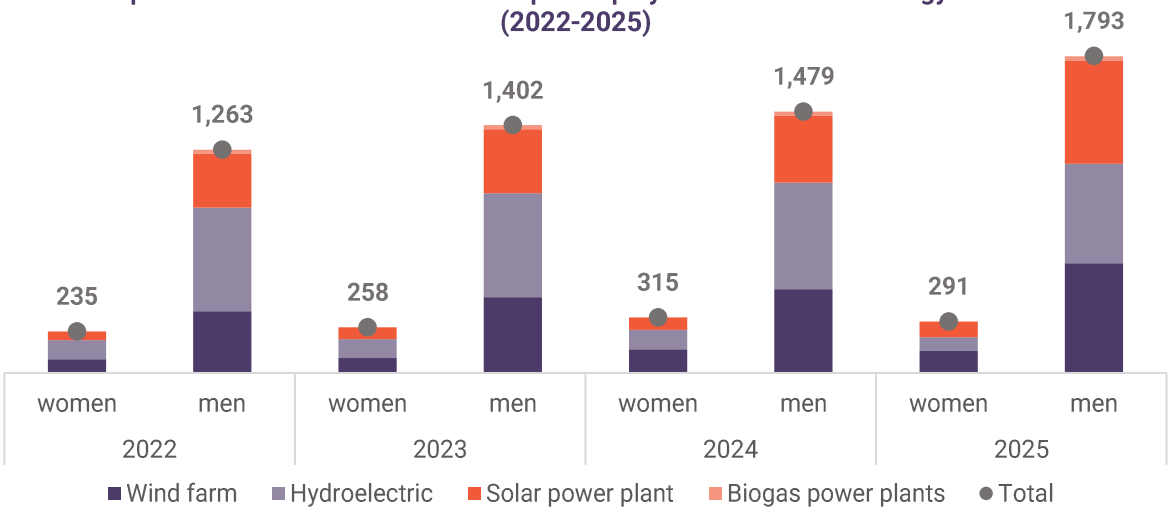
Social inclusion and workforce diversity are integral to Kazakhstan's green transition. Women currently represent **around 14% of the renewable energy workforce**, a modest but growing share compared to the fossil fuel sector (Astana Times, 2025a). International partners, including the **UNDP**, are promoting **gender-inclusive recruitment and leadership programs**, emphasizing that a balanced workforce enhances innovation and community support (UNDP, 2023).

Graph 16: Number of People Working in Renewable Energy Sectors (2022-2025)



Source: QazStat

Graph 17: Gender Distribution of People Employed at Renewable Energy Facilities (2022-2025)



Source: QazStat

Future Outlook

Kazakhstan's energy future will be shaped by how decisively it addresses coal dependency. Coal remains the backbone of power and heat generation, but also the country's most carbon-intensive fuel. A gradual yet firm phase-out is essential, not only for climate commitments but also for maintaining investor confidence. Failure to act risks stranded assets, declining export competitiveness, and lost opportunities in green finance. In particular, the EU's Carbon Border Adjustment Mechanism (CBAM) will penalize carbon-intensive exports, placing pressure on Kazakhstan's metals, chemicals, and construction materials. Although the near-term impacts are modest, by 2026 the economic risks will become much more pronounced.

At the same time, Kazakhstan's renewables push offers opportunities for both resilience and competitiveness. Wind and solar already account for nearly 6% of electricity generation, a dramatic increase from less than 1% in 2015. Yet the pace must accelerate to meet targets of 15% by 2030 and 50% by 2050. Policy clarity is key: inconsistent rules for auctions, small-scale generation, and direct contracts have slowed growth. Better incentives for households and enterprises to invest in distributed solar, plus reforms to facilitate bilateral "green power purchase agreements," could unleash untapped demand. International examples suggest these markets can rival state-led auctions in scale if properly supported.

Infrastructure modernization is another decisive factor. Kazakhstan's grid, built largely for centralized coal plants, struggles to accommodate intermittent renewables. Storage technologies, flexible gas capacity, and cross-border interconnections will be required to balance the system. Yet no significant storage projects have been implemented, and regulations remain absent. Introducing frameworks for batteries, pumped hydro, and demand-side flexibility would help stabilize the system as renewable penetration grows. Parallel reforms to raise tariffs, while cushioning vulnerable households through targeted support, would allow investments in modern grids and distribution networks.

Fossil fuel subsidies represent both a burden and an opportunity. Between 2010 and 2021, Kazakhstan spent on average 5.7% of GDP annually on direct and hidden subsidies, with coal receiving around $1.5 billion per year (IEA). Phasing out these subsidies by 2030 could free resources for renewable investment, grid upgrades, and social protection. While such reforms will raise household energy costs, targeted assistance is more efficient than blanket subsidies that currently benefit wealthier households the most. Redirecting subsidies toward retraining workers, supporting coal-dependent regions, and subsidizing clean heating alternatives could turn a fiscal liability into a driver of energy transition.

Looking forward, Kazakhstan's energy sector stands at a crossroads. On one path lies continued reliance on coal and fossil fuels, risking economic isolation, falling investment, and technological stagnation. On the other lies a difficult but achievable transition toward renewables, nuclear, and low-carbon innovation, supported by international partnerships and domestic reform. The country's vast solar and wind potential, strong uranium base, and strategic location near major markets offer clear advantages. But realizing them will require political will to reform tariffs, dismantle subsidies, and invest in modern infrastructure. If Kazakhstan acts decisively, it can secure its energy future while emerging as a regional leader in the global low-carbon transition.

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