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ELECTRICITY IN CENTRAL ASIA: STATUS QUO AND FUTURE OUTLOOK (2025–2030)

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Annotation: This article explores the current status and future outlook of electricity production and consumption in Central Asia, focusing on the period from 2025 to 2030. The region, rich in natural resources, has a growing demand for energy due to population growth, industrialization, and urbanization. The paper provides an analysis of the existing electricity infrastructure, including major power generation sources such as hydroelectric, thermal, and renewable energy. It also examines the challenges facing the electricity sector, including regional cooperation issues, outdated infrastructure, and the environmental impact of energy production. Furthermore, the article discusses potential future developments in the sector, such as the role of renewable energy, cross-border electricity trade, and modernization of the power grid. By projecting the trends and opportunities in the electricity sector, this paper aims to provide a comprehensive overview of the energy landscape in Central Asia for the next five years.
Keywords: Central Asia, electricity, energy infrastructure, renewable energy, power generation, hydroelectric power, thermal power, regional cooperation, electricity trade, energy future, environmental impact, energy policy, electricity demand.

Introduction. This brief report gives information about the current state of electricity including the key players, generation sources, infrastructure and JURU's position in this field as a technical advisory and engineering design company. Moreover, the report will outline the future developments which is consisted of grid modernization, international cooperation, and increased investments, alongside key risks such as climate vulnerability and political uncertainty.

Current status (as of 2025):

Key stakeholders & players of the market - state-owned and private (IPPs) in the region

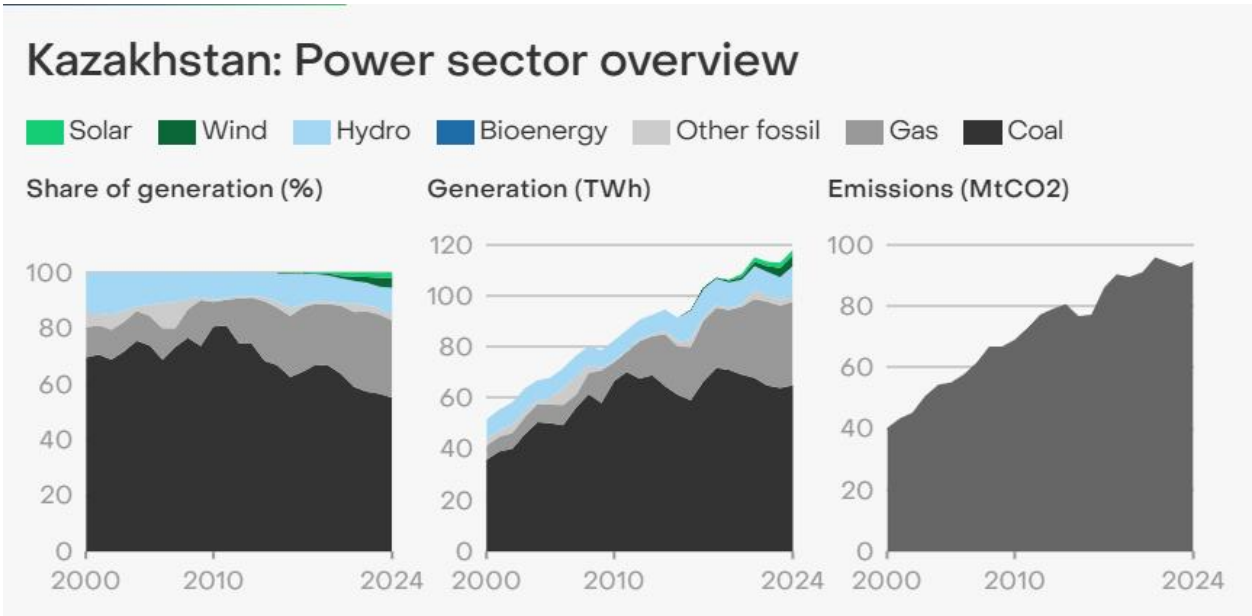
KEGOC (Kazakhstan Electricity Grid Operating Company) is Kazakhstan's state-owned national grid operator. It owns and operates the country's high-voltage transmission lines and manages electricity flow across the Unified Power System. KEGOC is 85% owned by the state fund Samruk-Kazyna. It plays a key role in Central Asia by enabling electricity exchange with neighboring countries and ensuring regional power system stability.

Moreover, another key state-owned player is Samruk-Energy, the largest energy holding in Kazakhstan, also fully owned by Samruk-Kazyna. It controls about 30% of national electricity generation and over 40% of coal production. Samruk-Energy operates across electricity generation, transmission, and renewables, and is actively developing green energy projects with international partners.

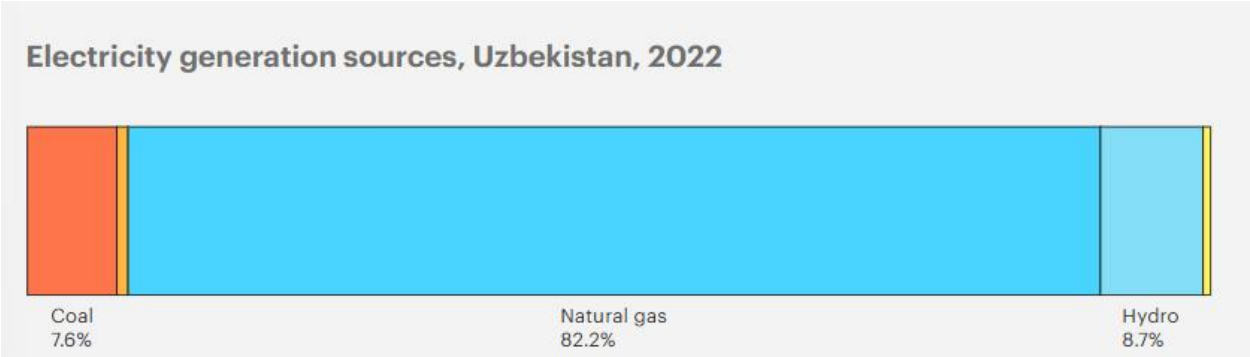
Formed after Uzbekenergo's restructuring, these state-owned companies handle most power generation (mainly gas) and national transmission. They are key to Uzbekistan's energy reforms, renewable energy goals (25% by 2030), and plans to become a regional electricity exporter.

The largest power producer in Kyrgyzstan, operating major hydropower plants like Toktogul. Hydropower provides over 90% of domestic electricity. The company is vital for balancing seasonal shortages and is a core participant in the CASA-1000 regional energy project.
A state-owned monopoly overseeing generation, transmission, and distribution. Nearly all electricity comes from hydropower. Barki Tojik is central to national energy supply, regional exports, and the construction of the massive Rogun Dam—set to be the tallest in the world.
Overview of electricity generation methods (hydropower, thermal, renewables, etc.)

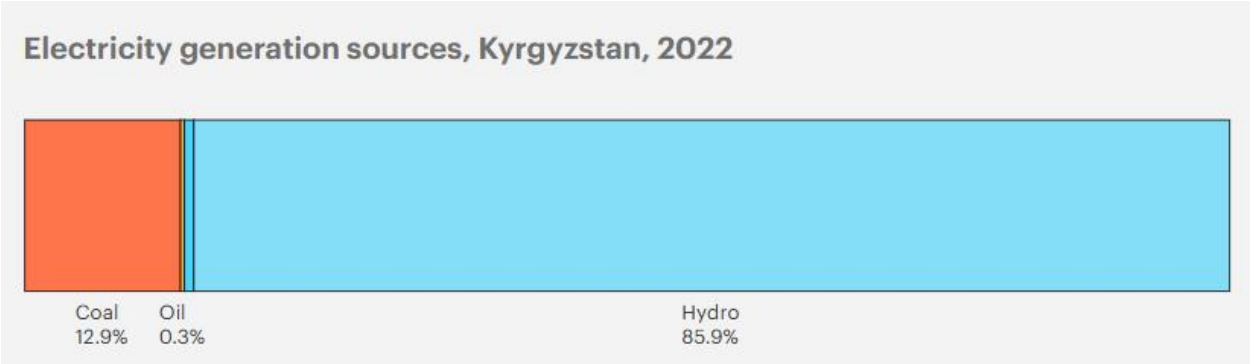
The main electricity generator and grid operator, using mostly gas-fired power plants. Oversees electricity exports to neighbors like Iran and Afghanistan. While Turkmenistan's power mix is gas-heavy, Türkmenenergo is investing in modern gas turbines and small-scale renewables.
According to the EMBER, Kazakhstan is more relied on fossil fuels which contributes its 85% of electricity in 2024. Hydro is considered as a main clean electricity source in Kazakhstan. Its share of wind and solar (5%) is a third of the global average (15%).



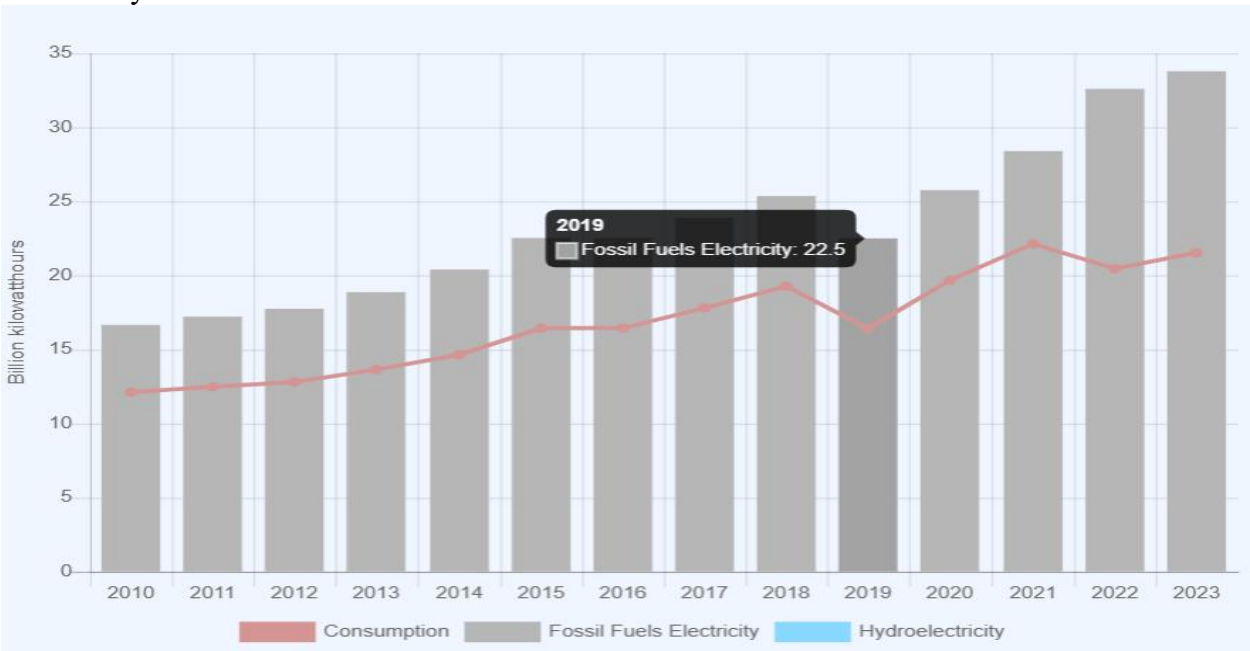
Electricity can be generated in two main ways: by harnessing the heat from burning fuels or nuclear reactions in the form of steam (thermal power) or by capturing the energy of natural forces such as the sun, wind or moving water. According to the finding from International Energy Agency (IEA), largest source of electricity generation in Uzbekistan is natural gas with 82%.



Fossil fuels, notably oil and coal, make up 72% of the country's total energy supply with the remaining 28% being composed of hydropower. Whilst fossil fuel consumption is primarily attributed to transport and heating, 85% of electricity is generated via hydropower.



Turkmenistan has virtually no renewable energy power plants and almost 100% of the country's electricity is generated by fossil fuel-fired plants, mainly gas, which are distributed throughout the country.



According to the World Bank, Tajikistan's power production is 92 percent hydropower, six percent hydrocarbon, and two percent from other sources. Tajikistan's hydropower potential is estimated at 527 billion kWh per year, which exceeds the existing electricity consumption of the countries of Central Asia by 300%

State of electricity transmission and distribution infrastructure

The electricity transmission and distribution (T&D) infrastructure in Central Asia is largely outdated, much of it built during the Soviet era and now operating beyond its intended lifespan. This aging infrastructure contributes to frequent power outages, high technical and commercial losses, and increasing maintenance costs. Losses in the system often exceed 18%, with distribution losses being especially high due to deteriorated lines, aging transformers, and outdated equipment.

Investment in T&D has lagged behind generation capacity development. Many countries in the region have prioritized expanding generation but underinvested in grid modernization. As a result, the integration of new and renewable energy sources—such as wind and solar—faces challenges due to weak grid flexibility and limited transmission capacity, particularly in remote regions where many of these projects are located.

Cross-border connectivity exists through the Central Asian Power System (CAPS), linking

Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. However, regional electricity trade remains underutilized due to infrastructure limitations and coordination issues. The 2022 regional blackout that affected multiple countries highlighted the urgent need for grid modernization and enhanced regional cooperation.
Country-specific conditions vary:

- **Uzbekistan** has a relatively extensive transmission network, but 66% of its transmission lines and over half of its transformers are more than 30 years old. Despite modernization efforts, significant investment is still required.
- **Kyrgyzstan** and **Tajikistan**, both heavily reliant on hydropower, face seasonal imbalances and rural reliability issues due to limited T&D capacity and difficult terrain.
- **Turkmenistan**'s grid is more isolated, with limited interconnection and export capacity.
- **Kazakhstan** has made more progress in upgrading its transmission network, including smart grid investments, but still contends with regional disparities.

Future outlook (2025–2030):

Master planning in generation, transmission, and distribution

Central Asia's electricity transmission and distribution (T&D) infrastructure is largely outdated, with many assets over 30 years old. This leads to high losses (up to 20%) and frequent outages, especially in rural areas. Investment in grid modernization has lagged behind power generation, limiting the integration of renewables and hindering reliable supply.
The regional grid, inherited from the Soviet-era Central Asian Power System (CAPS), remains partially functional. Disruptions—like the 2022 regional blackout—highlight the need for modernized and resilient interconnections.
While national planning dominates, efforts are underway to improve regional coordination. Projects supported by ADB, World Bank, and others aim to develop a regional master plan covering generation, transmission, and distribution. GIS-based models from the EU Joint Research Centre also propose optimal cross-border routes to link Central Asia with Europe, prioritizing areas rich in solar, wind, and hydro potential.
Central Asia is slowly shifting from fragmented, outdated systems to a more coordinated, modern, and trade-oriented power network.

Regional or international cooperation plans - electricity trade

Central Asian countries are developing cooperations inside and outside the borders of the region. One of them is CASA-1000 Project which facilitates electricity trade between Kyrgyzstan, Tajikistan, Afghanistan, and Pakistan. Enables export of surplus hydropower from Central Asia to South Asia during summer months.
Central Asia Power System is project links Kazakhstan, Kyrgyzstan, Uzbekistan, and Tajikistan. Facilitates real-time electricity balancing and trade. Efforts are ongoing to modernize and expand this system.
CAREC Energy Program promotes cross-border trade, harmonization of regulations, and joint infrastructure projects under the CAREC initiative.

Potential investments in pipeline and infrastructure development across the region

In an effort to shift to renewable sources, improve regional trade, and meet the climbing electricity demand, Central Asia is experiencing a rise in energy infrastructure investments. International investors such as Masdar, ACWA Power, IFC, and ADB are already helping Uzbekistan to plan the addition of over 10 GW of solar and wind capacities by 2030. Kazakhstan is also heavily investing in wind and solar power; the Zhanatas Wind Farm is one of many projects funded by the EBRD and ADB.

Construction of new high-voltage transmission lines to export surplus hydropower from Tajikistan and Kyrgyzstan to Pakistan is the CASA-1000 project. Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan CAPs cross-border transmission system is undergoing modernization and will become a Central Asia Power System (CAPs).
With the investment across the region in SCADA systems, smart meters, and real-time grid monitoring, digitalization is emerging as a focus area. Prioritizing the automation of the grid Kalas and Uzbekistan border the development of digital substations is occurring at a rapid pace.
Investment in the regional interconnectors to facilitate better electricity trade is also on the rise. Focused on leveraging their strategic position and renewable energy, the Central Asian countries aim to connect with China, South Asia, and possibly Europe.

Risks and challenges in ensuring energy security and sustainability in the region.

Interlinked challenges impact the energy security and sustainability of Central Asia. The electrical infrastructure within the region is antiquated, and as a result, there are numerous power outages and inefficient power transmission, particularly in rural and mountainous regions. Countries like Kyrgyzstan and Tajikistan, which depend heavily on hydropower, suffer from increased climate risks, including diminished water supply, season unpredictability, and considerable seasonal changes which are detrimental to the consistent generation of electricity.
For efficient long-term planning and cooperation on a regional scale, political and regulatory stability is key. Trust alongside the development of collaborative infrastructure contracts have suffered because of ongoing disputes regarding the cross-boundary use of water and electricity. On the other hand, a country such as Kazakhstan and Uzbekistan are still heavily dependent on fossil fuels, making them some of the highest emitters of CO_2 while simultaneously damaging the environment.
An already high cost of skilled labor, outdated digital frameworks, and a lack of funds makes the transition to renewable energy extremely difficult. The goals set out for sustainable energy development cannot be achieved without the modernization of power grids, digital systems like SCADA, and proper investing in human resources.
The electricity sector in Central Asia identifies several new opportunities to offer services to countries and utilities as local technical advisory and engineering design firms. As transmission and distribution systems progressively age, high losses and outages are common, and there is a compelling need for modernization planning, design, and testing. Utilities in the region are also accelerating their transition to renewable energy, particularly solar, wind, and small hydro energy resources that will also depend on feasibility studies, assessments of technologies, grid integration studies, and environmental planning—all a gap in engineering design firms' value propositions. There are regional interconnection proposals—CASA-1000 and others—that seek to provide electricity exchange routes into South Asia and Europe, and need complex system modeling, cross-border infrastructure design, and regulatory support—all opportunities for firms available as they are convincing local lessons learnt, have experience, modelling, infrastructure, and infrastructure to do this. Coupled with recent government decarbonization and energy diversification commitments, demand will grow for expert support from professionals in clean energy transition, energy storage, grid flexibility and battery usage optimization. It is also worth noting that rapid interest and investment in digital systems and smart grids, energy automation and digital monitoring tools is creating new opportunities for firms with design capabilities in digital system design and automation engineering to assist developing regions in improving overall performance, efficiency, safety, sustainability, resiliency, decarbonization and reliability as these systems evolve.
Firms can take advantage of these opportunities, but only if they proactively prepare for them. The first step is to develop interior firmness within the unique ways that depending on their bigger firm strategies could design capacity in renewable energy systems, digital power networks,

and environmental engineering through focused capacity development and specialized training. The capacity for firms to be competitive and carry out best-practice project delivery will depend both on the existing workforce and human resources of the firm, and acquisition of related software tools and capabilities such as software systems for grid simulation, geographic information systems, digital twins, automated design design tools, and workflows. Firms will also need to create new products and services that address the regulatory and operational challenges in Central Asia, such as: modular renewable system permits and approvals, digital systems and platforms for load forecasting, grid loss analysis, and planning for climate-resilient asset management.

Green energy and digitalization will be increasingly important throughout the region. For example; countries such as Uzbekistan and Kazakhstan now have renewable energy targets, provide private investment opportunities through public tenders, and create market incentives and major regulatory changes for private investment in this sector. Similarly, the digitalization of the energy sector is already beginning, with a large percentage of urban environments already having begun implementation towards the introduction of SCADA systems, smart meters, digital substations, etc., processes of renewable energy transition that would provide markets for firms that develop engineering design and planning capabilities and offer data-driven planning & technology delivery solutions.

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