Can Central Asia's Energy Transition Succeed Without Water Security?

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Key Messages

- A just energy transition in Central Asia is not only a shift toward lower-carbon generation. It must also deliver reliable and affordable electricity, strengthen resilience to climate and hydrological shocks, avoid transferring costs across borders and communities, and preserve water and ecosystem security.
- Water security is a system-level condition of the transition. Hydropower is directly exposed to hydrological variability; thermal and nuclear generation require water-sensitive planning; and water management itself consumes substantial electricity.
- The region's contrasting power systems create opportunities for complementarity, but interconnection alone is not enough. Solar and wind expansion must be matched by storage, flexible generation, stronger grids, balancing arrangements and coordinated regional market rules.
- Because rivers and electricity networks cross borders, nationally rational decisions can create regional costs. Cooperation should move from episodic water allocation toward joint scenarios, drought protocols and benefit-sharing linked to measurable services.

Central Asia is entering an energy transition while climate change is making its hydrology more variable and less predictable. Governments are expanding solar and wind power, hydropower, battery storage and electricity interconnections; Kazakhstan and Uzbekistan are also pursuing nuclear power. Yet water management, energy planning and climate adaptation are still commonly handled through separate sectoral processes. This creates a structural policy gap: infrastructure intended to improve energy security or decarbonisation can itself become vulnerable to drought, changing river flows, ecosystem degradation or transboundary tensions.

The transition is also taking place across very different national power systems. Kazakhstan remains strongly thermal and coal-based; Uzbekistan is still gas-based but diversifying rapidly; the Kyrgyz Republic and Tajikistan rely heavily on hydropower; and Turkmenistan remains predominantly gas-based. These differences create potential complementarity. Modelling by Agora Energiewende and the University of Central Asia finds that deeper integration among Kazakhstan, Uzbekistan and the Kyrgyz Republic could reduce annual system costs by about USD 3.5 billion, or 18 percent, by 2035 compared with current plans. The World Bank's REMIT programme seeks to operationalise this logic by raising annual regional electricity trade to at least 15,000 GWh, increasing transmission capacity to 16 GW and enabling up to 9 GW of clean energy.

"The launch of the Central Asian regional electricity market, underpinned by a strengthened grid, will advance energy security [and] support large-scale renewable integration." — Charles Cormier, World Bank Regional Infrastructure Director, 2026.

Country	Current profile	Expansion / capacity	Main transition challenge
Kazakhstan	Thermal/coal-heavy; 123.1 TWh generated in 2025. Renewables: 7% of generation; 3.5 GW installed.	2.4 GW conventional capacity planned in 2026; large wind/solar+BESS projects and nuclear development.	Replace ageing thermal assets while adding low-carbon capacity, storage and grid flexibility.
Uzbekistan	Gas-based but rapidly diversifying; 25.8 GW total capacity in early 2026, including 8.0 GW solar, wind and hydro	6.77 GW new capacity planned in 2026, including 2.8 GW solar, 470 MW wind and 884 MW storage; nuclear programme under development.	Meet fast demand growth while reducing gas exposure, losses and grid constraints.
Kyrgyz Republic	Hydro-dominated: 12.9 of 15.4 TWh domestic generation in 2025 came from large HPPs; 3.8 TWh imported.	Hydro rehabilitation; small hydro; solar/wind investment agreements; stronger interconnections.	Reduce winter shortages and import dependence while managing hydrological variability.
Tajikistan	Hydropower-dominated; 24.0 TWh generated in 2025.	Rogun: 3.78 GW and about 14.4 TWh/year at completion; transmission and export expansion.	Eliminate winter shortages while managing basin impacts and export-oriented hydro growth.
Turkmenistan	Predominantly gas-fired power system; utility-scale renewables remain at an early stage.	Initial solar-wind projects, thermal modernisation and grid/export connectivity.	Diversify gradually while retaining reliability in a gas-dominated system.

Sources: national energy ministries (2025–2026); World Bank Rogun HPP and REMIT; IEA country data. National accounting of “renewables” is not fully harmonised across countries, so figures are used to show system structure rather than direct cross-country equivalence. Regional integration therefore offers a way to use different resources and seasonal profiles more efficiently, but it is not a substitute for flexibility. Similar daytime solar peaks can occur across countries, while drought can reduce hydropower at the same time that heat raises electricity demand. A resilient regional system requires interconnection plus storage, flexible resources, demand response and coordinated operating rules.

Why This Issue Matters Now

Demand, climate stress and legacy infrastructure are moving in the same direction. The World Bank projects Central Asian electricity demand to triple by 2050 under business as usual. Uzbekistan illustrates the pressure: electricity generation rose to 86.7 TWh in 2025 and capacity reached 25.8 GW in early 2026, yet consumption is still rising. The country also remains highly energy-intensive: World Bank analysis has placed its energy use per unit of GDP at roughly 2.5 times the global average. This means the transition cannot be reduced to building new capacity; efficiency, grids and demand management are equally important.

Pressure on the existing gas-based model adds another driver of diversification. In the first half of 2026, Uzbek gas imports rose by 41.4 percent year-on-year to USD 971.7 million. At the same time, solar and wind generation reached 10.5 TWh in 2025, more than double the previous year, while total "green" generation including hydropower reached 16.8 TWh. These figures do not prove that variable renewables can replace firm capacity on their own, but they show why diversification is becoming an energy-security issue as well as a climate objective.

Water Stress Is Changing the Energy Planning Baseline

Climate change is altering not only average water availability but the timing, reliability and extremes of river flows. The World Bank reports that glacier surface area in Central Asia has declined by about 30 percent over the past 60 years. For Uzbekistan, it projects water availability to fall by 30–40 percent while irrigation demand rises by around 25 percent. A recent CMIP6-based study of the Amu Darya Basin adds an important nuance: total annual flow may not decline uniformly in the near term because accelerated glacier melt and rainfall can temporarily offset snowmelt losses, but seasonality, year-to-year variability and extremes are expected to change substantially. Energy planning should therefore be tested against hydrological volatility rather than historical averages alone.

Drought is inherently regional. CACCC/RES 2026 evidence presented by Iskandar Abdullaev indicates that around 30 percent of the region has a drought probability of 50 percent or more, with severe drought recurring every five to six years in some countries. The same work emphasises that shared rivers and reservoirs transmit national decisions across borders: in low-water years, unilateral releases, storage decisions or withdrawals can quickly affect electricity, irrigation, drinking water and ecosystems elsewhere in the basin.

The nexus also works in the opposite direction: water management itself is energy-intensive. World Bank project documentation notes that about 2.4 million hectares of irrigated land in Uzbekistan depend on pumping and that roughly 1,700 pumping stations consume around 7.2 TWh of electricity annually. This creates a direct efficiency dividend: modernising irrigation and pumping reduces both water losses and pressure on the power system.

Ecological flows must also be treated as a planning constraint rather than a residual allocation. Blue Peace Central Asia materials frame environmental flow as part of a Water–Energy–Food–Ecosystem nexus: the objective is not to maximise a single sector's withdrawals, but to preserve river functions and minimum ecological conditions while meeting human and energy needs**.**

The Water–Energy Link: Where Transition Risks Emerge

Hydropower: low-carbon power, seasonal trade-offs

Hydropower is central to the Kyrgyz and Tajik power systems and can provide firm generation, storage and balancing services. But reservoir operation has distributional consequences. Upstream systems may prefer to store water for winter electricity generation, while downstream agriculture values summer releases. Dinara Ziganshina's review of Central Asian water–energy mechanisms describes an existing service logic around reservoir regulation, electricity generation and reciprocal seasonal supplies, but identifies persistent weaknesses: deviations from planned schedules, weak forecasting, insufficient coordination, a seasonal rather than multi-year horizon and limited institutionalisation.

Expansion potential is also more constrained than headline resource estimates suggest. A 2026 Applied Energy study estimated Central Asia's theoretical hydropower potential at about 703 TWh/year, but only about 92.6 TWh/year remained after technical, geophysical and ecological constraints, including environmental-flow requirements, were applied. More than 80 percent of that remaining sustainable potential was concentrated in Tajikistan and the Kyrgyz Republic. This reinforces the need for ecosystem-aware, basin-level assessment rather than treating theoretical potential as developable capacity.

Solar, wind, storage and grids: diversification needs flexibility

Solar and wind can reduce exposure to hydrological shocks and fossil-fuel supply risks, but variability raises the value of storage, flexible generation, grids and balancing markets. Uzbekistan provides a useful real-world signal: in 2025, solar and wind generation rose rapidly to 10.5 TWh, while the country simultaneously expanded battery storage. In 2026, a further 884 MW of storage was scheduled for commissioning. Storage is therefore becoming part of the operating system, not a hypothetical future technology.

Regional modelling supports this direction. Agora Energiewende and the University of Central Asia estimate that deeper integration of Kazakhstan, Uzbekistan and the Kyrgyz Republic, combined with higher renewable deployment and stronger transmission, could lower annual system costs by about USD 3.5 billion by 2035. The World Bank's REMIT programme similarly treats renewable integration, transmission and market coordination as one package. The policy implication is not that trade

eliminates variability, but that flexibility and regional coordination lower the cost of managing it.

Nuclear energy: technology-neutral, water-aware assessment

Nuclear energy is among the most politically sensitive elements of the regional transition. Supporters emphasise firm low-carbon generation, diversification and reduced dependence on fossil fuels. Critics point to high upfront costs, long construction timelines, radioactive waste, safety and governance obligations, financing and supply-chain risks, and the opportunity cost of capital that could otherwise support grids, storage, renewables or efficiency.

Water considerations add another dimension but should not be used as a stand-alone argument either for or against nuclear power. Requirements depend on reactor design, cooling technology, siting and operating conditions. Kazakhstan and Uzbekistan should therefore apply the same climate-resilience tests to nuclear projects that should apply to hydropower and other major infrastructure: future water availability, extreme heat, competing municipal and agricultural demand, ecological flows, cooling options, lifecycle costs, spent-fuel and waste arrangements, safety, financing exposure and lower-water alternatives that can provide comparable system services.

The relevant policy question is therefore not whether nuclear power is inherently compatible or incompatible with a just transition, but under what technical, financial, environmental and governance conditions it can contribute without creating disproportionate long-term risks for water systems, public finances, communities or neighbouring states.

From Water Allocation to Benefit Sharing

Traditional negotiations often focus on how many cubic metres each country receives. Benefit-sharing asks a different question: what combination of reservoir operation, electricity production, flood protection, irrigation reliability, ecosystem services and trade creates the greatest joint benefit, and how should the gains and costs be distributed? Ines Dombrowsky's work shows that cooperation is economically attractive when joint participation increases total welfare or makes otherwise unviable infrastructure worthwhile. Compensation is therefore best framed as payment for measurable regulation or infrastructure services, not as purchase of ownership over water. (Dombrowsky, 2026).

International experience shows how this can work. The Manantali Dam on the Senegal River is jointly owned by Mali, Mauritania and Senegal, with hydropower, irrigation, navigation and storage benefits shared through treaty-based institutions. Its history also shows the limits of benefit-sharing if social and environmental effects are not adequately addressed. For Central Asia, Kambarata-1 is the more immediate test: joint investment by the Kyrgyz Republic, Kazakhstan and Uzbekistan can be

linked to agreed reservoir regimes, electricity purchases, drought reserves and measurable downstream services. The principle should be to divide benefits and responsibilities, not the river itself.

The Governance Gap

The region does not lack institutions or analysis. ICWC and basin organisations coordinate water allocation; CDC Energia coordinates power exchanges; CAWEP, Green Central Asia, Blue Peace and other programmes support data, modelling and dialogue. The gap is operational. OECD analysis identifies weak enforcement of interstate arrangements, limited economic incentives, insufficient coordination between water and energy authorities, inadequate multi-year river regulation and poor translation of modelling into planning and budgets.

World Bank and CACCC 2026 materials point in the same direction: insufficient regional coordination, weak cross-border data exchange, fragmented mobilisation of finance, implementation delays and the absence of strong institutions capable of carrying an agreed regional position from analysis into investment. Blue Peace regional analysis adds another problem: national assessments use different baselines, indicators and methods, making comparison and shared decisions harder even when data exist.

The economic cost of this fragmentation is material. At CACCC 2026, the World Bank estimated at least USD 4.5 billion in foregone benefits from insufficient water cooperation, while stronger electricity connectivity and trade could generate up to USD 15 billion in regional economic benefits by 2050. These estimates do not mean that all cooperation is automatically beneficial; they show the scale of value that can be lost when shared infrastructure is operated through disconnected sectoral and national decisions.

Central Asia does not face a choice between energy transition and water security. Water security is a system-level condition of the transition, while a more flexible and integrated power system can itself improve the region's ability to manage water risk. Climate change is altering the timing and reliability of hydrological resources; water infrastructure consumes large amounts of electricity; and renewable expansion increases the value of grids, storage and coordinated market rules. The policy challenge is therefore to design water, energy and climate adaptation as one interconnected regional system.

The region already has institutions, investment programmes and analytical tools that can support this shift. The next step is implementation: common evidence, pre-agreed drought rules, water-aware project appraisal, investment in system flexibility, and benefit-sharing arrangements that make cooperation economically and politically durable.

Policy Recommendations

1. Make water security a mandatory energy-planning criterion. Require major power projects and long-term generation plans to test climate-adjusted water availability, ecological flows, heat stress, drought scenarios and transboundary impacts.
2. Connect water and power institutions through shared scenarios. Create a standing technical process linking ICWC/basin organisations, CDC Energia and national ministries for joint drought, demand, reservoir and electricity-trade scenarios.
3. Adopt basin drought protocols before crises occur. Agree common indicators, thresholds, minimum ecological and operational flows, review procedures and rapid exchange of hydrological, meteorological, snow and glacier data.
4. Pilot benefit-sharing around major infrastructure. Use Kambarata-1 and other transboundary projects to test joint investment, electricity-purchase agreements and payments for defined storage or regulation services, with transparent benefit and impact assessment.
5. Invest in flexibility, not generation alone. Treat transmission, battery and pumped storage, flexible generation, demand response, efficiency and balancing markets as core energy-security investments. REMIT provides an existing platform for scaling this approach.
6. Use technology-neutral, water-aware appraisal for nuclear projects. Compare nuclear proposals with alternative portfolios on lifecycle cost, water and cooling needs, climate resilience, construction time, safety, waste, financing risk and comparable system services.
7. Align climate finance with integrated resilience. Prioritise portfolios that combine irrigation and pumping efficiency, resilient water infrastructure, ecosystem restoration, grid modernisation and storage. GGGI/PwC analysis presented at CACCC 2026 estimates Uzbekistan's annual climate-finance needs at roughly USD 15.7–34 billion, primarily in the power sector, underscoring the need for stronger project pipelines and blended finance.

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