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RENEWABLE ENERGY IN CENTRAL ASIA: ECONOMIC OPPORTUNITIES, EMPIRICAL EVIDENCE, AND POLICY PATHWAYS

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Abstract: Central Asia possesses one of the world's most underutilized renewable energy endowments: an estimated 5,470 GW of solar potential and 370 GW of wind capacity (OSCE, 2022). Despite a 26.6% expansion of installed renewable capacity to 17.3 GW in 2023 (IRENA, 2024), the region still generates most of its electricity from coal and gas. This paper argues that accelerating the green energy transition is not merely an environmental imperative but a measurable economic opportunity — attracting FDI, diversifying export revenues, creating employment, and reducing fossil fuel subsidies. Drawing on recent data from Kazakhstan and Uzbekistan, where investment commitments exceed USD 35 billion, the paper offers a comparative analysis, identifies structural barriers, and proposes five evidence-based policy recommendations.

Keywords: renewable energy; Central Asia; green transition; FDI; Uzbekistan; Kazakhstan; solar energy; energy policy

INTRODUCTION

Energy is the lifeblood of economic growth. For decades, Central Asian nations have funded their development on hydrocarbon revenues and subsidized fossil fuel grids — an arrangement that served short-term stability but accumulated long-term structural risks. Today, that model confronts three simultaneous pressures: aging infrastructure, growing domestic electricity demand, and a global investment community rapidly redirecting capital toward low-carbon assets.

The scale of the opportunity is extraordinary. The five Central Asian countries collectively possess solar irradiance conditions that rival the Sahara and steppe landscapes suited for utility-scale wind farms. According to the OSCE (2022), the region's combined solar PV potential exceeds 5,470 GW — roughly 270 times the region's current total installed power capacity of approximately 115 GW. Wind potential is estimated at nearly 370 GW. Yet as of 2023, total installed renewable capacity stood at only 17.3 GW (IRENA, 2024). The gap between potential and reality is not a natural resource problem: it is a policy, finance, and institutional problem. This paper examines the empirical evidence, draws lessons from early movers Kazakhstan and Uzbekistan, and proposes actionable policy pathways.

BACKGROUND AND LITERATURE REVIEW

The economic literature on renewable energy transitions consistently finds that such investment functions as a dual-dividend policy instrument: it simultaneously reduces carbon intensity and generates positive spillovers through job creation, technology transfer, and reduced fuel-import dependence (Apergis & Payne, 2014; Inglesi-Lotz, 2016). Cost dynamics have further altered the investment calculus: the levelised cost of solar electricity fell by over 89% globally between 2010 and 2023 (IRENA, 2024). The World Bank notes that renewables are already the most affordable energy source in many ECA countries and are expected to become more cost-competitive over the next decade (World Bank, 2025).

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Regarding FDI, investors in renewable energy require long-term, bankable Power Purchase Agreements (PPAs), transparent tariff-setting mechanisms, and credible dispute resolution. Countries providing this institutional framework attract disproportionately large capital flows relative to their market size (Blimpo & Cosgrove-Davies, 2019) — a pattern clearly observable in the Central Asian data reviewed below.

DATA AND METHODS

This paper employs a qualitative-comparative case study methodology combining secondary data analysis with policy review. Primary data sources are: IRENA (2024), OSCE (2022), IEA (2024), World Bank (2025), Uzbekistan Ministry of Energy (2025), and Verified Market Research (2025). Kazakhstan and Uzbekistan serve as the primary case studies given their advanced deployment and data availability. Where comparable data exist, Tajikistan, Kyrgyzstan, and Turkmenistan are included in the comparative table. All monetary figures are in nominal USD. The study does not claim causal identification; rather, it synthesizes available empirical evidence to characterize the regional transition and derive policy-relevant lessons.

RESULTS: COUNTRY-LEVEL EVIDENCE

Kazakhstan achieved the region's most impressive renewable expansion: an 83.4% increase in renewable capacity over five years, reaching 5.7 GW by 2023 (IRENA, 2024). Solar irradiance of 1,700–2,000 kWh/m²/year underpins viable photovoltaic investment, yet coal still accounts for approximately 70% of electricity generation (IEA, 2024). Government targets call for 15% non-fossil electricity by 2030 and 50% renewable by 2050. Amendments to Kazakhstan's Renewable Energy Sources Law in June 2024 streamlined net-metering and raised the capacity ceiling for small-scale renewables to 200 kW, signaling regulatory stability to investors.

Uzbekistan has emerged as the region's most dynamic reformer. By end-2025, the country had installed 28,570 MW of total electricity capacity, with 13 solar and 5 wind facilities producing 4.7 GW of clean power. These generated over 9.7 billion kWh, saving .8 billion m³ of natural gas annually and preventing 4.2 million tons of CO_2 emissions (Ministry of Energy, 2025). ACWA Power (Saudi Arabia) has committed a USD 15 billion investment portfolio including Central Asia's first green hydrogen plant. Total foreign investment in Uzbekistan's energy sector reached approximately USD 35 billion by 2025, and GDP surpassed USD 145 billion for the first time (Mirziyoyev, 2025).

2025 Milestone: Uzbekistan's renewable plants saved 2.8 billion m³ of natural gas — equivalent to approximately USD 560 million in avoided gas costs at current regional prices.

Tajikistan derives approximately 95% of its electricity from hydropower with an estimated potential of 527 TWh/year (OSCE, 2022); its planned Rogun Dam (3,600 MW) would make it a regional electricity exporter. Kyrgyzstan similarly relies on hydropower (~90%) but utilizes only 10% of its potential; both countries face drought-induced vulnerability. Turkmenistan — the world's fourth-largest gas exporter — has less than 0.1 GW of renewable capacity but recently signed agreements with Abu Dhabi's Masdar for a 100 MW solar facility.

Table 1. Renewable Energy Status by Country, Central Asia (2023–2025)

Country	RE Capacity	5-Yr Growth	Main Source	2030 Target
Kazakhstan	5.7 GW	+83.4%	Wind, Solar	15% non-fossil

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Country	RE Capacity	5-Yr Growth	Main Source	2030 Target
Uzbekistan	4.7 GW (new)	+rapid	Solar, Wind	25% RE share
Tajikistan	~6.2 GW	Stable	Hydropower (95%)	Rogun export
Kyrgyzstan	~3.9 GW	Slow	Hydropower (90%)	Expand utilization
Turkmenistan	<0.1 GW	Minimal	Gas dominant	100 MW solar

Source: IRENA (2024); OSCE (2022); IEA (2024); Ministry of Energy (2025).

DISCUSSION

Renewable energy has proven an exceptionally effective FDI magnet. Uzbekistan attracted USD 43.1 billion in total foreign investment in 2025 — nearly one-third of its GDP — with the energy sector as the central pillar. The renewable energy market was valued at USD 2.95 billion in 2023 and is projected to reach USD 8.47 billion by 2031, a CAGR of 14.1% (Verified Market Research, 2025). Individual solar and wind facilities create 150–200 direct jobs per project, while government industrial policy links deployment to domestic manufacturing of transformers and hydro units (Ministry of Energy, 2025).

Facilities brought online in Uzbekistan in 2025 are expected to reduce electricity production costs by approximately USD 90 million annually (Ministry of Energy, 2025). Beyond domestic savings, Uzbekistan, Azerbaijan, and Kazakhstan have established Green Corridor Union LLC to deliver certified green electricity to European markets. Uzbekistan targets 15 billion kWh/year in green electricity exports to Europe by 2030 — a revenue stream that did not exist five years ago (Ministry of Energy, 2025).

Despite the compelling economic case, the transition remains constrained by five structural barriers:

- Grid infrastructure deficit — Soviet-era grids are poorly suited for variable renewables; Uzbekistan alone needs USD 35 billion to modernize 69,000 km of power lines.
- Regulatory uncertainty — currency convertibility, profit repatriation, and land rights concerns historically deter private investors.
- Fossil fuel subsidy inertia — IMF estimates explicit and implicit subsidies represent several percentage points of GDP in some states.
- Financing gap — Uzbekistan's external debt exceeded USD 72 billion in 2025; smaller economies like Kyrgyzstan and Tajikistan face even tighter capital constraints.
- Water-energy-food nexus — hydropower disputes and cross-border water politics add geopolitical complexity to regional energy trade.

POLICY RECOMMENDATIONS

Recommendation 1: Establish a standardized regional green tariff framework with long-term PPA guarantees and transparent dispute resolution. Kazakhstan's 2024 RES Law amendments offer a replicable model.

Recommendation 2: Phase out fossil fuel subsidies with targeted social transfers. Fiscal resources equivalent to 3–5% of GDP could be redeployed as direct household cash transfers, correcting electricity price distortions.

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Recommendation 3: Prioritize grid modernization as public infrastructure investment, financed through multilateral development bank facilities. Grid integration is the binding constraint on renewable deployment.

Recommendation 4: Leverage green hydrogen as a second-wave industrial strategy. Kazakhstan and Kyrgyzstan should develop national green hydrogen roadmaps before global demand accelerates post-2030.

Recommendation 5: Institutionalize regional energy cooperation through binding intergovernmental agreements under the Central Asian Power System (CAPS) framework, building on the Green Corridor Union momentum.

CONCLUSION

Central Asia stands at a genuine economic inflection point. The region's solar and wind endowment, if mobilized, could power domestic industrialization, attract hundreds of billions in FDI, and generate new export revenues within a single generation. The empirical evidence from Kazakhstan and Uzbekistan — USD 43.1 billion in FDI, USD 145 billion GDP, USD 560 million in annual gas savings — demonstrates the transition is already yielding measurable dividends. Grid infrastructure, regulatory uncertainty, and subsidy inertia are real obstacles, but they are policy-solvable. The region that acts first and acts coherently will capture the largest share of a global green energy investment cycle that, by all projections, has decades yet to run.

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