Policy brief

Understanding the climate and net-zero transition risks and opportunities in Kyrgyzstan

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Key messages

Kyrgyzstan is already experiencing climate change impacts. Climate change projections for the 2050s indicate seasonal and annual shifts in both temperatures and precipitation, as well as increases in the frequency and intensity of extreme events that will affect the country's energy systems. Melting glaciers and snowpack could impact the generation capacity of large-scale hydropower in some river basins.

Hydropower remains the most cost-competitive source of energy and the focus of much of the investment, yet the country has significant untapped potential for solar and wind energy. While solar PV and wind are still cost-intensive compared to hydropower and fossil fuels, costs have been declining.

Increasing the share of wind and solar PV offers co-benefits in terms of job creation, reducing emissions, reducing climate risk by diversifying generation portfolios and improving the viability of the energy sector. Doing so will require tackling many policy challenges which impede the transformation of the energy sector.

Kyrgyzstan's future energy infrastructure must be designed with increasing demand, including that related to economic growth and diversification, climate change, and other threats like cyber-attacks in mind. The country should conduct full semi-quantitative to quantitative all-hazards risk assessments to identify risks over the decades that the infrastructure will operate, and to understand the costs and benefits of mitigation.

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Acronyms

HPP	hydropower plant
RCP	representative concentration pathway
R&D	research and development
RE	renewable energy
TPP	thermal power plant

1 Recommendations

This brief summarises Kyrgyzstan-specific findings and recommendations from the reports *Opportunities and co-benefits of transitioning to a net-zero economy in Kyrgyzstan, Tajikistan and Uzbekistan*, and *managing climate risks to protect net-zero energy goals*. Key recommendations as ways forward for transitioning to a net-zero economy and protecting infrastructure investments are highlighted below, and followed by the synopsis.

- Develop a comprehensive set of measures to support the development of non-conventional renewables – solar, wind and small-scale hydro – with medium-term (2030) and long-term (2050) goals, complementing the *National Energy Program* and the *Strategy for Fuel and Energy Sector Development* (2010–2025), and the *National Development Strategy* (2018–2040).
- Prioritise public and private investments in non-conventional renewable energy (RE) infrastructure by liberalising legal and regulatory frameworks to enable greater private sector participation.
- Ensure the integration of energy efficiency and RE generation goals by developing clear guidelines/strategy to achieve energy efficiency.
- Facilitate the implementation of a progressive tariff structure (for example, the medium-term tariff policy) across consumer groups (including residential consumers with less than 700 kWh consumption) to support the financial viability of the energy sector.
- Facilitate skills development to create a skilled workforce. Greater support of research and development in RE technologies and processes to ensure coherence with international standards is also needed.
- Continue strengthening and promoting regional cooperation and rejuvenation of the electricity export market. Coordinated efforts should be made to establish a dedicated regional cooperation mechanism for RE investments and trade.
- Energy infrastructure must be designed with climate change, increasing demand and other threats like cyber-attacks in mind. Full semi-quantitative to quantitative all-hazards risk assessments should be conducted to identify risks over the decades that the infrastructure will operate, and to understand the costs and benefits of mitigation.
- Energy sector all-hazards risk assessments require data: the network of automated weather, river gauges and glacier monitoring stations should continue to be strengthened, and Kyrgyz Hydromet should consider joining Coordinated Regional Downscaling Experiment (CORDEX) for high-resolution climate models.

2 Energy Sector

Kyrgyzstan is a landlocked mountainous country; glaciers and snowpack in the Tian Shan and Pamir mountains contribute to baseflows of the rivers that support hydropower and irrigation. Water resources and demand strongly influence energy generation.

Hydropower (HPP) dominates the energy mix in Kyrgyzstan at 92% of total installed generation capacity. Combined heat and power fossil-fuel thermal power plants (TPP) account for the remaining 8% of energy generation. However, if only non-conventional renewable energy sources like small HPP, solar and wind are considered, the installed renewable energy share falls to 1.1%.

Table 1 Installed generation capacity (MW)

Energy source	2017	2021
Coal TPP	862	862
HPP	3030	3034

Source: Ministry of Energy of the Kyrgyz Republic (2022)

Generation and transmission infrastructure are ageing in Kyrgyzstan – the average age of HPPs is 60 years. Several repair and upgrading projects of existing HPP, transmission and distribution systems throughout the country are underway. The country has plans to add two additional HPPs, three solar plants and one wind farm. Preliminary project screening has commenced.

As Kyrgyzstan is more reliant on HPP, it has greater generation capacity from late spring through to early autumn, when flows along the Naryn River Basin (the primary system along which HPPs have been built) are higher due to melting glaciers and snowpack. The country struggles to meet growing power demand, with recurring power deficits (electricity demand minus availability) reaching nearly 25% during the winter. Historically, Kyrgyzstan relied on neighbours, such as Uzbekistan, to offset seasonal shortages through regional transmission grids under the Central Asian Power System. However, interconnections have been reduced, and winter and early-spring power outages are frequent. The CASA 1000 project will restrengthen regional connectedness.

The Kyrgyz energy sector is in a poor financial state as the energy utilities are not able to cover their cost of service and incur regular revenue losses. The sector affects the country's fiscal position, with subsidies for electricity, heating, and hot water around 3% of GDP (World Bank, 2017; Yamano et al., 2019). Transmission and distribution losses are also high, with estimates of 17–20%; these have increased due to ageing infrastructure and shifting demand. Demand will increase due to economic diversification and expansion, population growth, and growing irrigation demand to offset hotter summers and decreasing summer precipitation in the eastern half of the country.

Kyrgyzstan has a series of laws governing the energy sector. The new *Law on Renewable Energy Sources* adopted in June 2022 provides an important framework for the development of RE and supersedes the old legislative framework (Ministry of Justice of the Kyrgyz Republic, 2022). Energy efficiency and security are among the key priorities for the energy sector as part of the *National Development Strategy 2018–2040* (National Council for Sustainable Development of the Kyrgyz Republic, 2018). The country will achieve energy sector objectives by utilising HPP potential, increasing the share of non-conventional renewables (solar, wind and storage HPPs) to 10% of the energy mix, and increasing level of gasification. The *Green Economy Programme 2019–2023* targets no less than 50 MW of RE production, including solar and wind, in areas where they may be more cost-competitive than transmission through the national network, while accounting for growth in energy consumption through 2040 (Ministry of Economy and Commerce of the Kyrgyz Republic, 2019a). As part of the Programme, the Kyrgyz government will finalise the concept for the *Development of the Fuel and Energy Complex until 2030* (Ministry of Economy and Commerce of the Kyrgyz Republic, 2019b).

3 Renewables potential

Levelised cost of electricity (LCOE) – the price at which the generated electricity should be sold for the system to break even at the end of its lifetime – continues to decrease for renewables globally, and RE is now competitive with conventional fossil-fuel electricity generation.

Hydropower is currently the cheapest energy in Kyrgyzstan, with a LCOE of $15/MWh in 2020 (below the global average LCOE for hydropower of $44/MWh) (FCDO 2015; IRENA, 2021; Ministry of Energy of the Kyrgyz Republic, n.d.). However, only an estimated 10% of the historical HPP potential has been harnessed (and less than 3% of that of small HPPs); future potential due to climate change impacts on glacial and snowpack melt, warmer temperatures and shifting river hydrology in specific catchments remains to be calculated.

The government continues to prioritise investments in HPP, although the country has significant untapped potential for solar and wind energy. Solar PV and wind are still cost-intensive compared to hydropower and fossil fuels, although costs have been declining. In 2015, estimated utility-scale solar LCOE was $378.8/MWh; by 2021 it had reduced to $171/MWh (FCDO 2015; IRENA, 2021; Ministry of Energy of the Kyrgyz Republic, 2022). This trend of declining costs is expected to continue, especially with increased uptake and implementation experience.

However, some key policy challenges are stalling the transition to a net-zero energy system. These include:

1. **Challenges to fostering a stable policy environment for long-term development planning.** The lack of stable policy environment associated with frequent political instability may contribute to short-term planning horizons among government ministries while impeding efforts to attract foreign direct investment and financing in priority sectors, including energy.
2. **Wind or solar power supply is not a priority.** While the government indicated some ambition to increase wind and solar power generation capacity, overall installed and planned wind and solar capacity remains insignificant, and well below the country's potential.
3. **Lack of investment and private sector participation.** Public investment in RE (other than large-scale hydropower) has been minimal. Lack of incentives and legislative complexities around renewables investment remain a big constraint for private sector participation.
4. **Kyrgyz energy sector operates at a loss.** Low tariffs, uncollected payments, and aged infrastructure all contribute to operating at a loss. Delaying reforms in this regard can undermine efforts to modernise Kyrgyz energy generation and transmission infrastructure.
5. **Lack of skilled workforce.** Limited personnel for non-hydro renewable energy projects, in the absence of clear targets for scaling up these RE sources and programmes to train local workforces, can increase project costs.

4 Climate risks to energy infrastructure

Infrastructure investments need to be resilient to a number of rapidly changing threats related to climate change, increasing demand and cyber-attacks. The expected lifetime of solar PV installations – the current type of planned solar – is 25 to 40 years; for wind farms, it is around 20 years (NREL, 2022). Infrastructure built now or before 2030 will have to contend with projected changes in the 2050s. Hydropower and thermal power plants have longer lifetimes and must be prepared to handle the climate of 2100.

High-resolution climate change projections for the 2050s indicate shifts in both temperatures and precipitation on a seasonal and annual basis, as well as in the frequency and intensity of extreme events. Mean annual maximum temperatures are projected to increase by 1.8°–2.2°C by the 2050s across most of Kyrgyzstan, under Representative Concentration Pathway (RCP) 2.6 and RCP4.5.[1] The country will experience warming days and nights in all seasons, with greater warming during the winter (January–March). The Lake Issyk-Kul region could experience warming of up to 3.8°C. Extreme heat waves and droughts could extend over a multi-country area, which would have cascading regional consequences for energy demand for irrigation pumping and transmission grid stability. The intensity and frequency of 24-hour extreme rainfall events is projected to increase. Warming temperatures and potential precipitation shifts will impact glaciers, snowpack and river discharges (see Opitz-Stapleton et al., 2022).

Climate risks to energy infrastructure result from the combination of vulnerability (e.g. specific operational requirements for water, sensitivities to temperature or demand loads during extreme heat), exposure (e.g. the location of the infrastructure in a hazard-prone area) and shifts in the frequency, intensity, duration and location of climate hazards. Climate risks have to be considered not only to individual infrastructure, but also for the energy system as a whole. Some climate risks to HPP, solar and wind projects in Kyrgyzstan are outlined in Table 2.

1 RCP2.6 is a lower-emission scenario that is in line with Paris Agreement goals of no more than 2°C. RCP4.5 is in line with the emission totals of current NDC pledges and would amount to mean global warming greater than 3°C.

Table 2 Climate risks to energy systems*

Hazard	Risks
Higher day and night temperatures accelerate glacier/snow melt and change river flow: increases of up to 1.6°–3.1°C in winter and 1.1°–5.0°C in summer over Pamir and Tian Shan	Direct risks: shifts in peak flow from late to early summer; sediment increases; potential flash floods due to rain-on-snow events in spring for low to mid-elevations Cascading risks: small HPP reservoirs lose storage to sedimentation and generation declines; shifting hydrology requires changing HPP operations; generation and transmission damaged by rockslide
Decreases in July–Sept precipitation of -10 to -40% over Tian Shan, including Lake Issyk-Kul	Direct risks: hydrological, agricultural and socioeconomic impacts; impacts may be magnified by concurrent heat wave; water availability and quality decline Cascading risks: energy demand for irrigation pumping increases; generation declines; load shedding; socioeconomic impacts
Extreme rainfall events: 1-in-80-year 24-hour precipitation events becoming 1-in-20-year events in parts of Jalal-Abad and Chuy	Direct risks: flooding, particularly in late winter and spring; increased sedimentation in rivers and reservoirs Cascading risks: normal operating levels on HPP reservoirs held lower for flood routing, reducing downstream water availability; storage maximum capacity of smaller reservoirs breached by excess runoff; infrastructure damage and network outages

*This is a summary. See full report, Opitz-Stapleton et al. (2022)

5 Co-benefits of transition

There are a number of benefits that arise from transitioning to a net-zero economy. The estimates used below for potential job creation and the economic value of potential benefits are from Jacobson et al. (2017) and IRENA statistics. More details are available in Panwar et al. (2022).

1. **Meeting future demand: S**caling up the use of renewable energy will help offset increases in energy demand as Kyrgyzstan's economy grows and diversifies, though greater energy efficiency will also be necessary. Using additional non-conventional renewable energy capacities will also diversify the current energy mix and support the move toward a more sustainable energy supply.
2. **Job creation:** Transitioning to a net-zero economy could stimulate economic output and create additional employment. The RE sector is expected to create 38 million jobs by 2030 and 43 million jobs by 2050 globally. The energy sector (generation, transmission, distribution) in Kyrgyzstan currently accounts for 5% of the total recorded jobs in the country. In a full (100% RE) transition scenario, RE could generate over 26,000 additional jobs by 2050 in Kyrgyzstan. This would add an average of nearly $1.2 billion to the Kyrgyz economy.
3. **Reducing energy sector costs:** Conventional energy production is costly; switching to RE could generate savings in the long term considering a declining trend in the cost of RE. Kyrgyzstan is projected to avoid up to $11.5 billion in carbon-based energy production costs per year by 2050 if it transitions to 100% RE.
4. **Investment opportunities:** A stable and reliable electricity supply, which is a prerequisite in attracting private investments, will help create a better business environment and improve investor confidence in Kyrgyzstan.
5. **Emissions reductions and commitments:** Increased use of RE sources can substantially reduce CO_2 emissions. Electrification and RE sources alone could deliver up to a 75% reduction in global energy-related emissions. By using HPP as a primary source of electricity, Kyrgyzstan has avoided 13.81 million tonnes of CO_2e in 2018.
6. **Health benefits:** Transition to 100% RE would avoid an estimated four thousand deaths per year by 2050 in Kyrgyzstan. The marginal co-benefits of avoided mortality is $50–380 per tonne of CO_2 (West et al., 2013; Vandyck et al., 2018).

Achieving these co-benefits and protecting energy investments will require additional steps on the part of the government, investors and energy companies, and cooperation with other countries on the regional grids. Some of these recommendations are outlined at the start of this brief. Full recommendations can be found in both reports.

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