Report

# Opportunities and co-benefits of transitioning to a net-zero economy in Kyrgyzstan, Tajikistan and Uzbekistan

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# Contents

# Acronyms

| | |
|---|---|
| ADB | Asian Development Bank |
| CHP | Combined heat and power plant |
| $CO_2$ | Carbon dioxide |
| $CO_2e$ | Carbon dioxide equivalent |
| CASA-1000 | Central Asia-South Asia power project |
| EBRD | European Bank for Reconstruction and Development |
| GBAO | Gorno-Badakhshan Autonomous Oblast of Tajikistan |
| GDP | Gross domestic product |
| GEF | Global Environment Facility |
| GHG | Greenhouse gas |
| HHP | Hydropower plant |
| IDA | International development assistance |
| IEA | International Energy Agency |
| IFC | International Finance Corporation |
| IFI | International finance institutions |
| IMF | International Monetary Fund |
| IRENA | International Renewable Energy Agency |
| LCOE | Levelised cost of electricity |
| LHPP | Large-scale hydropower plant |
| NDC | Nationally Determined Contribution |
| OECD | Organisation for Economic Cooperation and Development |
| PPP | Public private partnership |
| PV | Photovoltaic |
| R&D | Research and development |
| RE | Renewable energy |
| RES | Renewable energy sources |
| SDG | Sustainable Development Goal |
| SHPP | Small-scale hydropower plant |
| TPP | Thermal power plant |
| UNDP | United Nations Development Programme |
| UNESCAP | United Nations Economic and Social Commission for Asia and the Pacific |
| UNFCCC | United Nations Framework Convention on Climate Change |

# Executive summary

The recent report of the Intergovernmental Panel on Climate Change (IPCC, 2022) presents a troubling picture and warns of more severe impacts of climate change if we fail to cut our emissions by half by 2030. The three countries in the Central Asian region – Kyrgyzstan, Tajikistan and Uzbekistan – are emblematic of the risk. With the apparent increase in the physical risks linked to climate change in the region, the need to act has never been more urgent.

Despite being endowed with rich natural resources, the three countries have wrestled with energy security. The over-reliance of Kyrgyzstan and Tajikistan on hydropower makes them vulnerable to variations in precipitation and climate change. For Uzbekistan, an undiversified energy mix is a major concern, given its international commitments to reduce emissions. All three countries are experiencing the effects of climate change in the form of low water levels and climate-related hazards such as droughts. The progressive depletion of water and hydrocarbon reserves (and growing populations and expanding economies) makes it crucial for these countries to increase their share of non-conventional renewable energy (RE) sources (such as solar, wind and small hydropower) in the energy mix and to transition to such sources.

All three countries have huge untapped renewable energy potential. This report explores the opportunities and co-benefits of transitioning to a net-zero economy in the three Central Asian countries of Kyrgyzstan, Tajikistan and Uzbekistan, with a specific focus on the energy sector and non-conventional RE sources, particularly solar, small hydropower and wind power. To this end, the report builds on available studies, evidence and secondary data on the energy sector, including renewables. The study has benefited from several rounds of consultations with international and national experts and government officials in the respective countries.

Short-term investment to address energy crises must be accompanied by long-term investments in renewables. This report recognizes that such investments can not only improve energy security and provide a stream of revenues if exported, but can also help to diversify the economy and generate jobs in the three countries. With renewables becoming more cost-competitive in the energy landscape across the three countries, increasing their stake in the energy mix and gradually replacing carbon-intensive sources of energy presents an opportunity to exploit natural endowments and take strong and decisive steps towards a net-zero future.

The key opportunities and co-benefits of transitioning to a net-zero economy are summarised as follows.

## Opportunities in the energy sector – switching to a net-zero economy

1 **Harnessing the potential of renewables for energy security and diversification:** Theoretical RE potential is largely untapped across all three countries and could be harnessed to ensure a long-term, uninterrupted supply of energy at affordable prices.

Among the major non-conventional RE sources, the potential for solar and wind energy is high in the region. The potential of stand-alone off-grid solutions such as solar photovoltaic (PV) can be utilised to help reduce supply pressure on national energy infrastructure, as well as to improve energy access, particularly in rural areas, across all three countries. The prospect of the declining cost of energy generation through RE sources presents an opportunity for cost-competitive energy generation compared with fossil fuels.

2 **RE investment and financing opportunities:** Transition to a net-zero and sustainable energy system presents opportunities for investors to diversify risks, generate cash yields with low volatility and improve portfolio resiliency. It could also make both public and private markets accessible to investors in Kyrgyzstan, Tajikistan and Uzbekistan. Public investments in infrastructure that uses non-conventional RE have been minimal, but recent commitments to improve the energy mix could provide the impetus to increase funding for RE projects across the three countries. Since the energy sector is state controlled in all three countries, governments must play a pivotal role in planning, financing and regulating RE infrastructure investments and development. However, investments by national governments will require support from the private sector and international partners.

3 **Opportunities for energy trade with RE capacities:** Energy trade has been a key driver in shaping Central Asia's energy landscape, but it is currently dominated by non-renewables. Ensuring an increased RE share in the energy mix in each of the three countries could significantly increase their energy generation capacities and help them to meet internal demand and even produce surplus energy to be traded with neighbouring countries. Generating additional energy capacity using renewable energy sources to generate electricity, as well as electricity trade, would help to ensure the profitability of investments in the energy sector, which in turn could free up more capital in the development of energy technologies using renewable energy sources.

4 **Integrating energy efficiency and RE:** There are many opportunities to improve both demand and supply efficiency for the three countries by exploiting the synergies between energy efficiency and RE sources. Improving energy efficiency can reduce energy demand and thus reduce capital costs for energy projects, while increasing the use of renewable energy can lead to decarbonisation of the electricity sector. Therefore, RE and energy efficiency can be integrated to mitigate system-wide economic and environmental costs.

## Co-benefits of pursuing net-zero, resilient energy production

1 Transitioning to a net-zero energy system could help to avoid the substantial economic cost of carbon-based energy production (including subsidies) for the three countries. Due to greater uptake and the declining cost of renewables, reduced fiscal pressure could help the governments to reallocate resources to other economic activities, promoting pathways to sustainable growth and stimulating progress towards achieving the Sustainable Development Goals (SDGs). In addition, the RE sector – which currently accounts for a very low proportion of total energy sector jobs in the three countries – has the potential to generate employment in the construction and operation of renewable energy systems.

2 Increased use of RE sources can substantially reduce carbon dioxide ($CO_2$) emissions. The transition to a net-zero energy system would help the three countries to meet

targets for Nationally Determined Contributions (NDCs) to reduce greenhouse gas (GHG) emissions.

3 Conventional energy sources, including fossil fuels and large-scale hydropower, have serious repercussions for environmental sustainability. Non-conventional RE sources, particularly small hydropower, solar and wind energy, can help to avoid and mitigate such impacts by producing more sustainable energy, leading to an improved ecosystem, better air quality and fewer adverse impacts on human health and well-being.

4 New and upcoming RE infrastructure development is expected to incorporate climate and disaster risk and resilience considerations. This would make it easier for countries to capitalise on the co-benefits of such an energy transition, where the resulting energy infrastructure is able to cope with challenges, including climate risks, and continue to provide uninterrupted energy supplies.

## Challenges and recommendations

In recent years, governments in the three countries have introduced multiple energy sector plans and measures, aimed not only at reforming and revitalising the energy sector, but also at promoting RE development. Despite these efforts, several policy challenges remain in the energy sector and need to be addressed to ensure the countries' transition to a net-zero economy. These challenges include an aged and worn energy infrastructure, poor financial viability of the energy sector, lack of a skilled workforce and technical know-how to operationalise non-conventional RE technologies, and the absence of a targeted policy and operational measures to broaden the adoption of such resources. Given these challenges, and building on the opportunities created by a net-zero transition, governments in the three countries are expected to continue and upscale their efforts to:

### I. Capitalise on RE potential and support its development

- upscaling efforts to develop non-conventional RE capacities
- developing a dedicated policy and operational framework for non-conventional RE sources with medium-term (2030) and long-term (2050) targets – aligned with national development plans and targets
- putting an existing or separate government entity in charge of assessing and mapping the regional (within country) techno-economic potential of such sources
- facilitating an in-depth regional assessment of the cost of electricity generation through such sources, to assess their cost-competitiveness compared with existing fossil fuels and hydropower-based technologies.

### II. Prioritise RE infrastructure development and its integration in the energy system

- prioritising investments (public and private) in non-conventional RE infrastructure development, complemented by timely completion of ongoing energy projects
- liberalising legal and regulatory frameworks to enable greater private sector participation in the energy sector and RE development
- removing existing restrictions on energy infrastructure and grid connection for the integration of generating capacities using non-traditional RE; energy systems need to be more flexible to accommodate renewable energy technologies.

### III. Reform and implement progressive tariff structure for revitalisation of energy sector

- implementing a progressive tariff structure to support the financial viability of the energy sector.

### IV. Maximise energy efficiency through non-conventional RE sources

- developing an integrated policy/strategy to achieve energy efficiency through RE
- mapping energy efficiency potential through non-conventional RE across sectors.

### V. Promote skills development and support research and development (R&D) on RE technologies

- investing in the development of a high-quality and skilled workforce suitable for construction and operations-related human resource requirements of the RE sector
- developing standards and certifications for technologies and components in the RE sector in line with international standards and practices
- promoting R&D on the most important aspects of such energy technologies to improve their efficiency and widen their adoption.

### VI. Foster regional cooperation

- making consistent and coordinated efforts to resume regional cooperation, through the Central Asia United Power System or by establishing a similar mechanism and an electricity export market.

# 1 Introduction

This report explores the opportunities and co-benefits of transitioning to a net-zero economy[1] in the three Central Asian countries of Kyrgyzstan, Tajikistan and Uzbekistan, with a specific focus on the energy sector and non-conventional renewable energy sources,[2] particularly small hydropower, solar and wind energy. To this end, the report builds on available studies, evidence and secondary data on the energy sector, including on renewables in the three countries. The study has also benefited from several rounds of consultations with international and national experts and government officials in the respective countries.

To avoid the catastrophic effects of climate change, greenhouse gas emissions must be reduced in line with the target of a 1.5°C increase in global mean temperature above pre-industrial levels. The recent report of the Intergovernmental Panel on Climate Change (IPCC, 2022) presents a troubling picture and warns of more severe impacts of climate change if we fail to cut our emissions by half by 2030. The three countries in the Central Asian region – Kyrgyzstan, Tajikistan and Uzbekistan – are emblematic of the risk. Given the apparent increase in the physical risks posed by climate change in the region, the need to act has never been more urgent (see Opitz-Stapleton et al., 2022).

The energy sector alone is responsible for nearly 60% of global GHG emissions (Ritchie et al., 2020). The sector accounts for nearly 55% of GHG emissions in Kyrgyzstan and Tajikistan, and nearly 80% in Uzbekistan (World Bank, 2021a). Achieving more ambitious climate goals and meeting NDCs will therefore require changes in the energy sector for the three Central Asian countries, specifically in terms of upscaling the use of non-conventional RE sources. Despite the devastating economic impacts of the COVID-19 pandemic, global investments in renewable technologies such as solar and wind power have grown at their fastest pace in the last two decades (IEA, 2021). This is a clear indication that the world is now witnessing the emergence of a new energy economy fuelled by innovative technologies and sustainable energy sources to address climate change.

Transitioning to a net-zero economy is critical for the three Central Asian countries, in order to ensure national and regional energy security. Despite being endowed with rich natural resources, the three countries have faced difficulties with national energy security. Following the end of the Soviet era, which functioned as a centrally governed regime, the

[1] The term 'net-zero' is used for the purpose of this report as it aligns with the Paris Agreement on Climate Change and NDC commitments of signatories to the agreement. As a concept, 'net-zero' refers to net-zero GHG emissions that are achieved where the amount of GHG produced is no more than the amount taken out, i.e. cancelling out the emissions. The concept of net-zero emission is very similar to carbon-neutrality; however it has much wider scope as it covers all GHGs rather than just $CO_2$.

[2] Non-conventional or modern RE sources, such as solar, wind and small hydropower, are considered to have very low GHG emissions (IRENA, n.d.). They are also commonly termed as 'zero-carbon' sources of energy.

independent countries found it difficult to balance seasonal energy exchanges, failing to maintain the Soviet-era practice of "exchanging the upstream nations' hydropower in summer for electricity or fuels supplied by the downstream nations in winter" (Boute, 2019). Energy deficits have been largely addressed by increasing the use of natural gas in Uzbekistan, and of coal and other fossil fuels in Kyrgyzstan and Tajikistan – all energy sources with significant GHG emissions. More closed-in politics and border disputes between Kyrgyzstan and Uzbekistan, and Tajikistan and Uzbekistan, have exacerbated the situation (Shadrina, 2019; Sabyrbekov and Ukueva, 2019).

In addition, the over-reliance of Kyrgyzstan and Tajikistan on hydropower[3] makes them vulnerable to variations in precipitation and to climate change. For Uzbekistan, an undiversified energy mix is a major concern, given its international commitments to reduce emissions. All three countries are experiencing the effects of climate change in the form of low water availability, caused by drought in Central Asia in 2021 (IMF, 2022). The depletion of water and hydrocarbon reserves (and growing populations and expanding economies) makes it crucial for these countries to increase their share of RE sources in the energy mix and to transition to clean and sustainable energy.

Kyrgyzstan, Tajikistan and Uzbekistan have huge untapped RE potential. While the governments of each country have started to explore opportunities to increase RE production, and in some cases have RE projects already under way, overall the RE potential is largely under-exploited. With renewables becoming more and more cost-competitive in the energy landscape, increasing their stake in the energy mix and gradually replacing the carbon-intensive sources of energy presents an opportunity to exploit natural endowments and take strong and decisive steps towards a net-zero future.

While structural changes implemented in a short period of time may lead to transition risks, the long-term benefits of renewables could be substantial. This approach will not only allow countries to meet their climate commitments, but could also enable them to reap the co-benefits of the transition. For instance, a reliable source of energy such as solar power, coupled with adequate and indefinite access, could lower costs, attract investments and boost economic growth. Renewable energy can therefore improve energy security and provide a stream of revenues if it can be exported, helping to diversify the economy and generate jobs for Kyrgyzstan, Tajikistan and Uzbekistan. These and other opportunities and co-benefits of transitioning to a net-zero economy will be further discussed in this report.

The report is structured as follows: it begins with an overview of the key features of the economy and the energy sector of the three case study countries (Kyrgyzstan, Tajikistan and Uzbekistan). This is followed by a discussion on the opportunities of developing renewable energy sources and the co-benefits of such endeavours. Finally, the report examines the challenges and limitations of pursuing these opportunities.

[3] Hydropower is considered a conventional renewable energy source. However, large-scale hydropower plants can have adverse environmental impacts (such as water stress, displacement, biodiversity loss) across the life cycle of a project.

# 2 Economy and energy sector trends

This section examines the economic profiles and energy sectors of Kyrgyzstan, Tajikistan and Uzbekistan, as a basis for assessing the opportunities of transitioning towards a net-zero economy.

## 2.1 **Economy**

### 2.1.1 Economic profiles

Kyrgyzstan, Tajikistan and Uzbekistan are in various stages of economic development. The World Bank has classified Kyrgyzstan and Uzbekistan as lower-middle-income economies, while Tajikistan is considered low-income. While Tajikistan has shifted to a service economy in terms of output, in terms of employment, it is still largely agrarian, with most employment being in the low-productivity agriculture sectors. In contrast, both Kyrgyzstan and Uzbekistan have seen structural shifts in their economies, from agriculture to services. Despite this, the industrial share of output has remained relatively flat in Kyrgyzstan and the manufacturing sector has largely been limited to low technology and low value-added production (ADB, 2016; Anderson, Ginting and Taniguchi, 2020; IFC, 2021). Uzbekistan's economy is more diversified, with an industry sector that is focused on energy, metals, heavy chemicals, and light industry production, such as food processing and textiles (OECD, 2019). Table 1 presents a snapshot of major socio-economic indicators in the three countries.

Despite rapid economic and population growth over the past few years, the rate of urbanisation has remained slow across the three countries. A relatively high proportion of the Kyrgyz and Tajik populations lives below their respective national poverty thresholds – 20.1% and 26.3% respectively. At 11%, the poverty ratio in Uzbekistan is comparatively lower than that of Kyrgyzstan and Tajikistan.

All three economies are exposed to fluctuations in commodity prices. For example, Tajikistan's economy is sensitive to the prices of its main exports – cotton and aluminium – while Kyrgyzstan is heavily reliant on gold export receipts, with gold accounting for 56% of exports in 2019. Similarly, Uzbekistan's economy depends on primary exports and commodity prices. After gaining independence, cotton was the dominant export commodity of Uzbekistan, but this has since shifted, as gold and natural gas have become key exports. This dependence on commodity exports makes all three countries vulnerable to price fluctuations.

**Table 1 Socio-economic indicators**

| | Kyrgyzstan | Tajikistan | Uzbekistan |
|---|---|---|---|
| Nominal GDP ($ billion) 2020 | 7.8 | 7.9 | 59.9 |
| Nominal GDP ($ $billion) 2021 | 8.2 | 8.1 | 65.5 |
| GDP per capita ($) (2020) | 1,173.6 | 859.1 | 1,750.7 |
| Real GDP growth (% year-on-year) | | | |
| 2018 | 3.5 | 7.3 | 5.4 |
| 2019 | 4.6 | 7.5 | 5.7 |
| 2020 | -8.6 | 4.5 | 1.7 |
| 2021 | 2.1 | 5 | 6.1 |
| Remittances (as % of GDP) (2020) | 31.32% | 26.68% | 11.65% |
| Share of agriculture (+forestry & fishing) in GDP - (2020) | 14% | 23.80% | 25.10% |
| Share of industry in GDP (2020) | 29.50% | 32.80% | 31.60% |
| Share of services in GDP (2020) | 49.60% | 35.30% | 36% |
| Share of emplt in agriculture (2019) | 19.32% | 44.72% | 25.71% |
| Share of emplt in industry (2019) | 25.36% | 15.79% | 23.02% |
| Share of emplt in services (2019) | 55.33% | 39.49% | 51.27% |
| Population in 2020 (million) | 6.5 | 9.5 | 34.2 |
| Rural population in 2020 (million) | 4.1 | 6.9 | 16.9 |
| Urban population in 2020 (million) | 2.4 | 2.6 | 17.2 |
| Urbanisation rate (1990–2020) (Average Annual Growth Rate) | 1.26% | 1.47% | 2.42% |
| Poverty incidence (2019) | 20.10% | 26.30% | 11.00% |
| World Bank – Doing business (2020) | 80/190 | 106/190 | 69/190 |
| Human Development Index rank (2018) | 120/189 | 126/189 | 107/189 |
| Major export products | Gold, other precious metals and stones, energy (oil and gas), cotton, minerals | Agricultural products, fuels and mining products, manufactures | Gold, petroleum gas, cotton |
| Key trading partners | Exports: UK, Kazakhstan, Russia, Uzbekistan, Turkey.<br>Imports: China, Russia, Kazakhstan, Turkey, European Union, Uzbekistan (2020) | Exports: Russia, European Union, Uzbekistan, Switzerland, UK.<br>Imports: Uzbekistan, Russia, Ukraine, Kazakhstan, European Union (2020) | Exports: Russia, China, Kazakhstan, Turkey, Kyrgyzstan.<br>Imports: China, Russia, European Union, Kazakhstan (2020) |

Sources: World Bank (2021), IMF (2021a; 2021b; 2019), WTO (2022)

For example, during the 2008–2009 recession, Tajikistan's economy experienced a decline as trade deteriorated due to the sharp fall in aluminium and cotton prices.

Kyrgyzstan, Tajikistan and Uzbekistan are all dependent on remittances to varying degrees. In 2020, remittances accounted for 31% of Kyrgyz gross domestic product (GDP), with many emigrants working in Russia, Germany, Ukraine, Uzbekistan and Tajikistan. Inflows of remittances support domestic demand and the service industry (wholesale retail and trade) (IFC, 2021). Tajikistan is also dependent on the inflow of remittances, which fuels private consumption, but with limited spillovers to private investments on account of a poor business environment and weak financial intermediation (ADB, 2016). The country's productive capacity remains constrained by this lack of investment, which could make growth unsustainable. With both countries dependent on remittances, shocks from key remittance countries such as Russia can lead to volatility

and a decline in remittances (Poghosyan and Blancher, 2020). Uzbekistan also relies on remittances, but to a lesser extent (11.7% of 2020 GDP).

All three countries have planned and undertaken multiple economic reforms in recent years. Uzbekistan has been undergoing an economic transformation since 2017, when it began to shift towards greater economic liberalisation, with a more transparent and market-based economy. Reforms have been aimed at reducing macroeconomic distortions and state participation in the economy, and the liberalisation of key sectors. Notable reforms include the liberalisation of the exchange rate, which removed the black market premium and made the country more attractive to investors. Similarly, Tajikistan is introducing a new industrialisation policy, which defines strategic goals for "accelerated industrialisation of the country".

### 2.1.2 Pandemic impact and economic outlook[4]

The global COVID-19 pandemic had significant impact across the three Central Asian countries. In Kyrgyzstan, GDP declined by 8.2% in 2020 as exports, gold production, industry and tourism contracted (World Bank, 2022a). At the same time, inflation rose to 9.7% on higher food prices and pressure from the exchange rate as the Kyrgyzstani *som* depreciated 19% against the US dollar. Meanwhile, public debt increased by 17% to 68% of GDP and the fiscal deficit widened to 3.3% of GDP from 0.1% in 2019. This limits the fiscal space of the government to finance its needs. The economy posted annual growth of 2.1% in 2021. Inflation remained elevated in 2021 due to higher food and fuel prices. The slow roll-out of vaccines, new COVID-19 variants, lower gold prices, reduced remittances, and economic ramifications of the Russia–Ukraine conflict remain the major risks to the country's economic outlook.

Tajikistan's economy experienced a relatively lesser impact of the COVID-19 pandemic in 2020. The economy rebounded in 2021 to year-on-year growth of 5%, albeit still lower than the pre-pandemic growth levels of 7.5% (World Bank, 2022b). The recovery was supported by commodity exports and an uptick in domestic demand. The resumption of air travel meant that migrants could travel overseas and bolster remittances. Inflation, which slowed to 8% in 2021, is expected to rise to 15% in 2022, largely due to geopolitical uncertainty. In 2021, the end of an expansionary fiscal policy and improvements in economic activity led to higher revenues and budget consolidation. The country's economic outlook also hinges on COVID-19 vaccinations, the economic implications of the Russia–Ukraine conflict and the resilience of the global economy. Structural issues still have an impact on the outlook.

Uzbekistan experienced relatively slow growth in early 2020 due to the COVID-19 pandemic. However, support from the government and containment measures helped the economy to rebound in the second half of the year and the country managed to grow 1.6% in 2020 (World Bank, 2022c). The year 2021 saw growth exceed 6% on the back of a low growth base in 2020, but how the country performs going forward will be determined by the COVID-19 vaccine roll-out, commodity prices, domestic economic recovery and economic fallout from the Russia–Ukraine conflict. The country will also need to continue its structural reforms – reducing the role of the state and developing the private sector – to achieve sustainable long-term growth.

[4] Based on data from the World Bank, Asian Development Bank (ADB) and International Monetary Fund (IMF's) Economic Outlooks for respective countries.

### 2.1.3 Economic ramifications of the Russia–Ukraine conflict

Kyrgyzstan, Tajikistan and Uzbekistan are exposed to the economic impacts of the Russia–Ukraine conflict. Economic sanctions on Russia have prevented goods and services, particularly from Europe, from reaching Central Asia and the region has practically lost access to its export markets particularly in Europe. Furthermore, over the next year or so, remittances are expected to fall by 33%, 22% and 21% in Kyrgyzstan, Tajikistan and Uzbekistan, respectively, due to the sanctions (World Bank, 2022d). The three countries are therefore bracing for an immediate and profound impact in the form of high inflation, unemployment and budgetary shortfall, largely as a result of pressure on the Russian *ruble*, restrictions on banking transactions for foreigners and the potential collapse of the labour market in Russia.

The economic impact of this conflict in the three countries could prove to be particularly severe given that they are still recovering from the COVID-19 pandemic. The collateral damage of the sanctions on Russia could therefore be more destabilising for the region than previously estimated.

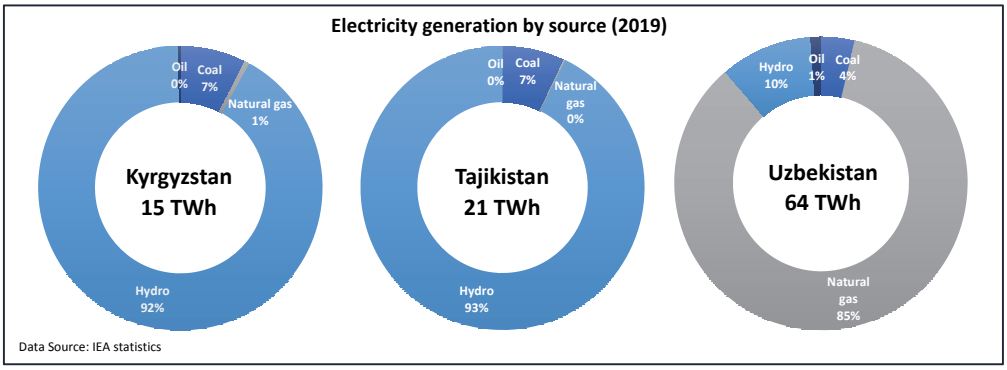
## 2.2 Energy sector

Access to electricity and energy security can constrain economic growth, and the three Central Asian economies under examination all suffer from unreliable electricity supply, as well as from energy systems that are not financially viable. The following sections explore these issues in greater detail, as a precursor to identifying where opportunities may lie.

### 2.2.1 Energy mix and demand

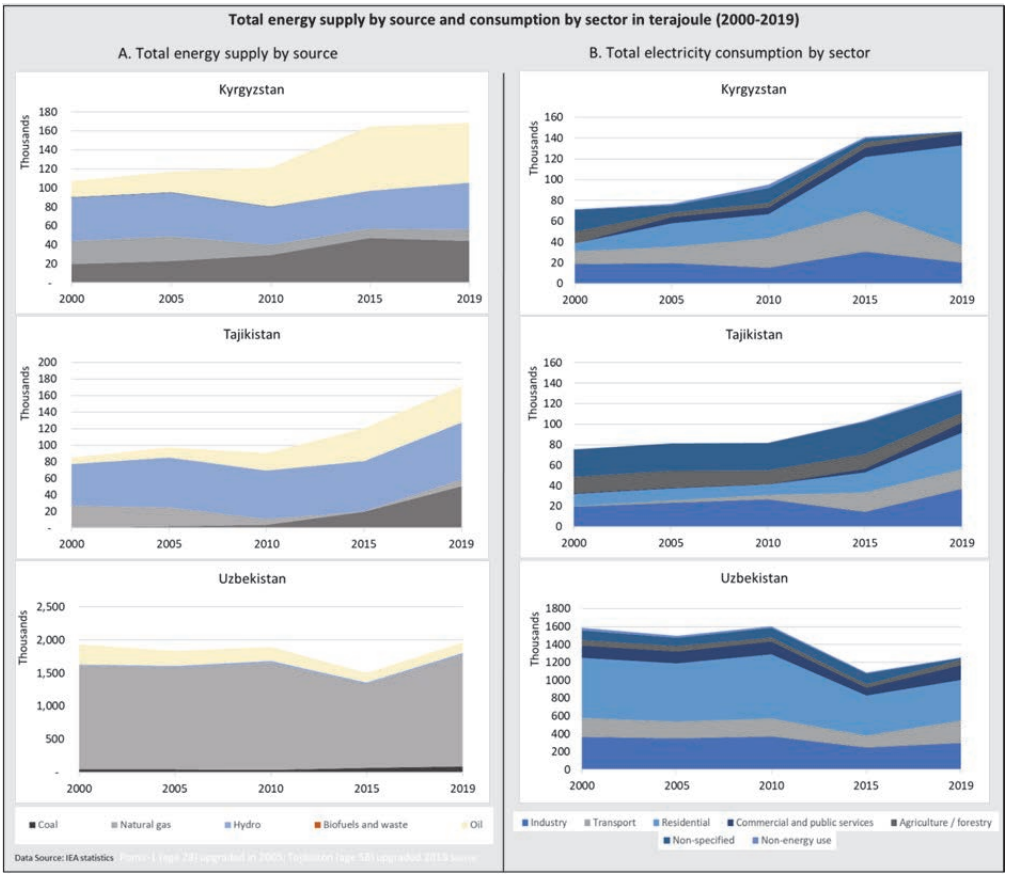
All three countries are richly endowed with energy resources. Hydropower dominates the energy mix of Kyrgyzstan and Tajikistan, while fossil fuels such as natural gas and coal are the predominant energy sources in Uzbekistan (see Figure 1). In Kyrgyzstan, total electricity generation in 2019 was about 15 TWh, of which 92% came from hydropower plants and the remaining 8% from fossil fuels. Similarly, in Tajikistan, 93% of the total electricity of 21 TWh was generated through hydropower. Conversely, 85% of the total electricity (64 TWh) in Uzbekistan was generated through fossil fuels, predominantly using natural gas. The current structure of the energy balance in each of the three countries is concentrated on using one primary source of energy and is non-diversified.

**Figure 1 Electricity generation by source in 2019**




Data source: IEA Statistics (IEA, n.d.)

**Figure 2 Total energy supply by source and consumption of electricity by sector (2000–2019)**

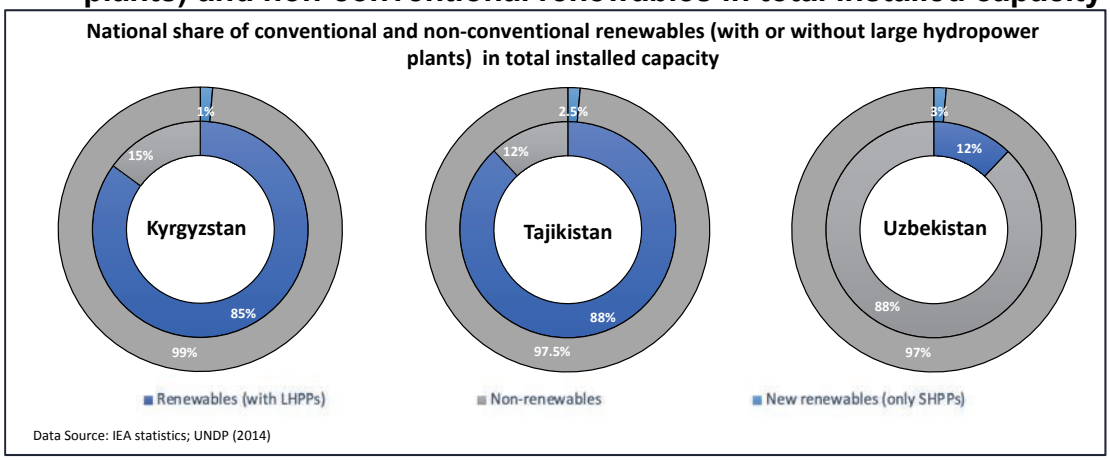



Data source: IEA statistics (IEA, n.d.)

In Kyrgyzstan, hydropower dominates the country's energy supply, while residential consumption tops the chart in terms of sectoral consumption of energy (see Figure 2). The country is reliant on imports to meet energy demands, as domestic production covers about half of annual energy consumption. A similar scenario can be observed in Tajikistan, with hydropower a dominant source of energy supply, and the majority of the electricity consumed by the residential and industrial sectors. In Uzbekistan, the energy supply is mainly sourced from fossil fuels, which are generally sufficient to cover the country's annual energy demand.

Non-conventional renewables such as solar, small hydropower and wind constitute a smaller proportion of the total energy mix in Kyrgyzstan, Tajikistan and Uzbekistan. As shown in Figure 3, conventional large-scale hydropower plants (LHPPs) account for more than 90% of electricity generation from RE in Kyrgyzstan and Tajikistan. However, if non-conventional RE sources such as small-scale hydropower plants (SHPPs), solar and wind are considered (excluding LHPPs), the installed renewable energy capacity falls to 1.1% for Kyrgyzstan and 2.54% for Tajikistan. The share of renewables in Uzbekistan, excluding LHPPs, declines to 2.5% of the total installed energy capacities.

**Figure 3 National share of conventional (with and without large Hydropower plants) and non-conventional renewables in total installed capacity**




Data source: IEA statistics; UNDP (2014)

## 2.2.2 Energy sector: policy and governance

**Kyrgyzstan**

The Ministry of Energy of the Kyrgyz Republic has broad oversight over energy policy. The Ministry is tasked with improving energy security and increasing the efficiency of the fuel and energy complex, creating favourable conditions for its development and uninterrupted power supply for consumers. It manages industry policy, but also has regulatory, supervisory and coordinating functions. The Department for Regulation of the Fuel and Energy Complex under the Ministry sets tariffs for electricity, heat and natural gas and implements antimonopoly regulation. The Ministry of Energy plays a crucial role in increasing the share of renewable energy sources (RES) in the energy mix, as it creates conditions and incentives for the use of RES and the introduction of renewable energy technologies, as well as providing incentives for energy efficiency and energy conservation (Ministry of Energy of the Kyrgyz Republic, n.d.).

Until recently, the Renewable Energy Law (2008) provided the main legislative framework for the development of RE, outlining incentives to stimulate RE production and use (Parliament of the Kyrgyz Republic, 2019). In June 2022, the Government of the Kyrgyz Republic adopted a new Law on Renewable Energy Sources (2022), which superseded the old legislative framework. The new law provides an important framework for the future development of RES, including tax and customs legislation. Other important provisions include a requirement to provide unhindered access to power networks for electricity producers using RES, as well as stipulating additional compensation for the purchase of electricity from RES by introducing medium-tariff policy for consumers (Ministry of Justice of the Kyrgyz Republic, 2022).

The National Development Strategy 2018–2040 (Strategy 2040) defines long-term development priorities (National Council for Sustainable Development of the Kyrgyz Republic, 2018). Priorities for energy sector include greater energy efficiency, utilising hydropower potential and 'gasification' of the country to improve energy security. The strategy sets out to increase the share of non-conventional RE (such as solar, wind and SHPPs) to at least 10% of the energy mix. Improving cost recovery through transfer to 'economically justified tariffs' is also a priority, to stimulate new investment in the energy sector, including through public private partnerships (PPPs). The medium-term strategy for 2022–2026 echoes Strategy 2040 in prioritising the construction and recovery of large and

small hydropower plants (HPPs), and the development of solar and wind renewable sources, but also of coal consumption for heating (Government of the Kyrgyz Republic, 2021).

The long- and medium-term energy sector priorities are supported by a series of economic and sectoral plans. The Green Economy Programme 2019–2023 emphasises the need for a shift towards energy efficiency and saving, and renewable energy production (Ministry of Economy and Commerce of the Kyrgyz Republic, 2019a). Modest targets of no less than 50 MW of RE, including solar and wind, are set for areas where they may be more cost-competitive than transmission through national networks. This also accounts for growth in energy consumption through 2040. Importantly, concept for the Development of the Fuel and Energy Complex until 2030 will be finalised during the duration of the Programme (Government of the Kyrgyz Republic, 2019b).

A previously published National Energy Program and the Strategy for Fuel and Energy Sector Development (2010–2025) are the other key policies for the country's energy development. The expansion of renewables – predominantly hydropower – is prioritised; the strategy aims to add 100 small HPPs, with a capacity of 180 MW (IEA, 2020).

**Tajikistan**

The Ministry of Energy and Water Resources manages the energy sector and water policy in Tajikistan. It develops a strategy for the energy sector, including proposals for economic, investment and tariff policies, and attracts foreign investment to the sector. The Ministry is responsible for the licensing and approval of investment plans. It develops regulations for energy supply from RE sources and oversees a cadastre of these sources across the republic (UNDP, Government of Tajikistan and Association of Power Engineers, 2011). The Antimonopoly Service also plays a critical role in regulating the energy sector by managing anti-competitive behaviour and developing a tariff methodology and tariff-level proposals. The President has authority over the final tariffs for end-users (ADB, 2017).

Tajikistan has a series of laws that govern the energy sector. The Energy Law (2000) provides a legislative framework for the development of the sector and its transition towards market competition. The Renewable Energy Law (2010) regulates and defines RE sources, and their integration in the energy system. It prioritises RE projects in remote areas with low population densities, poor grid connection and power supply shortages. This law stipulates a guaranteed purchase price for electricity from RE sources, with tariffs determined based on generation costs. The Law on Energy Saving and Energy Efficiency (2013) requires that the Fund for the Development of Renewable Energy Sources, Energy Saving and Energy Efficiency be established to support energy efficiency and conservation policy.

Tajik energy and economic development priorities are defined in the National Development Strategy of the Republic of Tajikistan 2030 (Government of the Republic of Tajikistan, 2016). Energy security and efficient electricity use are among its four strategic priorities. Specifically, the strategy envisages electricity sector development based on the '10/10/10/10 concept': "(a) increased design capacity of the electric power system to 10 GW; (b) annual electricity export to neighbouring countries reached 10 billion kilowatt hours; (c) ensured diversification of capacity of the country's electric power system by at least 10% through increasing the capacity of other energy sources, including coal, oil, gas and renewable energy sources; (d) electricity losses in the country are reduced to 10%."

The Power Sector Development Master Plan, published in 2017 with support from the ADB, is the main strategic document guiding the development of the energy sector. The Master Plan did not consider wind or solar power as priority supply options, with a caveat that these may become more attractive as technology improves and costs decline. Nevertheless, it included 50 MW of solar PV capacity (ADB, 2017).

The Government of Tajikistan has sought to increase the country's renewable energy capacity since the mid-2000s. In 2007, it approved a Special Programme for Renewable Energy Sources Use in Tajikistan (2007–2015), to develop and deploy RE sources such as small rivers, solar, wind and biomass energy, and capitalise on their potential to increase energy supply and raise living standards (UNDP, Government of Tajikistan and Association of Power Engineers, 2011). In 2013, the government published the Sustainable Energy for All framework through to 2030, which aimed to increase the share of non-conventional RE to 10% of total electricity production (IEA, 2021). More recently, the Programme for the Development of Renewable Energy Sources and Construction of Small Hydropower Plants for 2016–2020 targeted the construction of 64 SHPPs, with total installed capacity of between 5,000 and 10,000 kW (Ministry of Energy and Water Resources of the Republic of Tajikistan, n.d.). The President of Tajikistan tasked the Government of Tajikistan with developing and adopting the Green Economy Strategy by the end of 2022 (Embassy of the Republic of Tajikistan, 2021).

**Uzbekistan**

The Ministry of Energy, established in 2019, regulates the energy sector, develops PPPs, improves tariff policies, and has overall responsibility for the development and implementation of energy plans, programmes and policies. It regulates and supervises the production, transmission, distribution and consumption of energy resources, which include electricity and the functioning of energy sectors, and the implementation of production-sharing agreements. The Ministry is also involved in the development of energy-related PPPs and has a role in improving tariff policy to foster a competitive business environment. The Ministry of Energy is the main body authorised to implement Uzbekistan's unified state policy for RES. The Law on the Rational Use of Energy (amended 2020) stipulates the role of the Ministry of Energy as the main pillar for implementing Uzbekistan's energy policy, which includes renewables. The Ministry of Energy has a 10-year plan to promote energy security in Uzbekistan. To promote RE development, it has also established the National Research Institute of Renewable Energy Sources.

Some of the key targets for RE include:

- reducing specific GHG emissions per unit by 35% of the 2010 level by 2030
- doubling the energy efficiency indicators and reducing the carbon intensity of GDP
- further developing renewable energy sources and raising their share of total electricity generation to more than 25% by 2030.

Uzbekistan has adopted multiple policies aimed at stimulating RE use and ensuring energy security. These include the development of a Concept Note for ensuring electricity supply in 2020–2030 (Ministry of Energy, Republic of Uzbekistan 2020), which defines medium- and long-term objectives for the development of the power sector. The Strategy of Action for the Five Priority Development Areas of Uzbekistan in 2017–2021 (2017) includes an expansion of the use of RES. Similarly, priorities articulated in the Strategy for the Transition of the Republic of Uzbekistan to the Green Economy for the period 2019–

2030 (2019) include (i) further developing renewables by raising their share in the power mix to over 25% by 2030; (ii) modernising the infrastructure; and (iii) applying clean and environmentally-friendly safe technologies.

More recent legislation specific to the development of RE sources includes the Law on the Use of Renewable Energy Sources (2019), which outlines opportunities and incentives for renewable energy installations. Similarly, the Law on Public–Private Partnerships (2019) was introduced to stimulate private sector participation in public sector infrastructure projects, with multiple PPP projects currently under way. In addition to the broad set of laws adopted since 2017, the Government of Uzbekistan has launched large-scale renewable projects, including the development of new renewable sources (solar, wind and nuclear) in order to meet its 2030 target of reducing GHG emissions (see Section 2.2.5 for details).

The New Uzbekistan Development Strategy (2022–2026) plans to increase the energy efficiency of the economy by 20% and to reduce harmful gas emissions by 20% by 2026 through the introduction of green technologies. The Development Strategy also aims to add additional generation capacities from renewable sources (including 4 GW solar and 4 GW wind) by 2026. In line with this, the Government of Uzbekistan has set a target of 25% of electricity generation to come from renewable energy by 2031. To this end, the government has recently adopted a regulation to enable the integration of renewable energy generation into the country's single electricity system. Several new RE projects are currently under way, with the participation of Total Eren (France), Masdar (United Arab Emirates), and ACWA Power (Saudi Arabia). Major lenders in the energy sector include the European Bank for Reconstruction and Development (EBRD) and the ADB.

### 2.2.3 Energy security

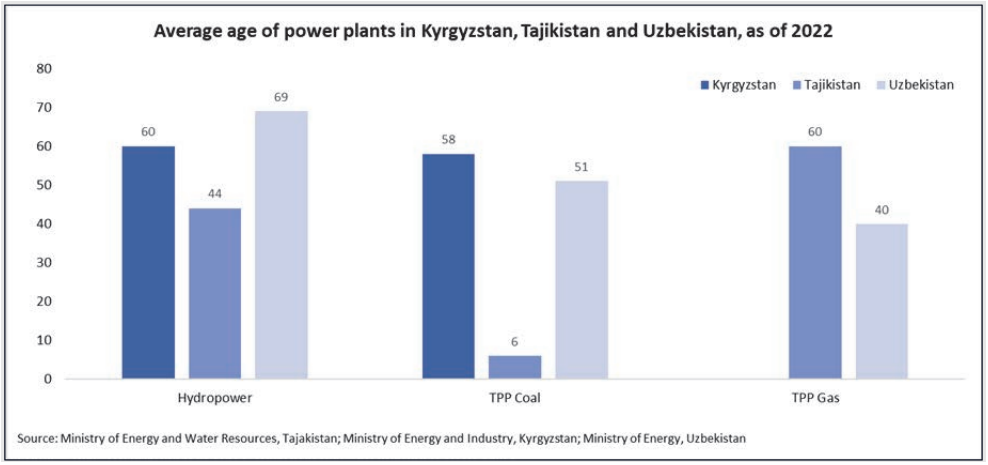
Energy insecurity, implying a lack of sustainable energy supply, is a recurring problem in Central Asia. This is reflected in government policies across the three countries, which put energy security at the top of the agenda for the energy sector. As discussed, all three case study countries have plentiful domestically available energy resources – Kyrgyzstan and Tajikistan are rich in hydro resources, capable of supplying domestic demand, as well as of exporting to other countries (Jalilov et al., 2018); Uzbekistan is hydrocarbon-rich, heavily dependent on non-renewable resources. Yet Kyrgyzstan and Tajikistan face severe electricity shortages during winter. The two countries struggle to match their growing power demands, with power deficits (electricity demand minus availability) reaching nearly 25% for Kyrgyzstan and 24% for Tajikistan in the winter months.

The energy supply and demand imbalance in Central Asia stems from the systems and infrastructure inherited from the Soviet Union and the geopolitical tensions between the now independent states, which have impacted energy supply. Historically, countries like Kyrgyzstan and Tajikistan relied on neighbours such as Uzbekistan to meet their seasonal energy shortages, particularly during winter. This is no longer the case and Kyrgyzstan and Tajikistan generally face energy shortages in winter (Boute, 2019).

Outdated energy infrastructure in all three countries also leads to disruptions and system losses (World Bank, 2017a; Radovanović et. al., 2021). As shown in Figure 4, the three countries have an aged and worn infrastructure. As of 2022, the average age of hydropower infrastructure was 60, 44 and 69 years in Kyrgyzstan, Tajikistan and Uzbekistan, respectively. A similar scenario can be observed for coal- and gas-fuelled power plants. Most generation and distribution systems are operating beyond the 50 years

of average useful life (Anderson et al., 2020). Outdated infrastructure across the three countries often leads to a risk of network failures, long-term supply disruptions, energy losses and resource depletion.

**Figure 4** **Average age of power plants in Kyrgyzstan, Tajikistan and Uzbekistan, as of 2022**

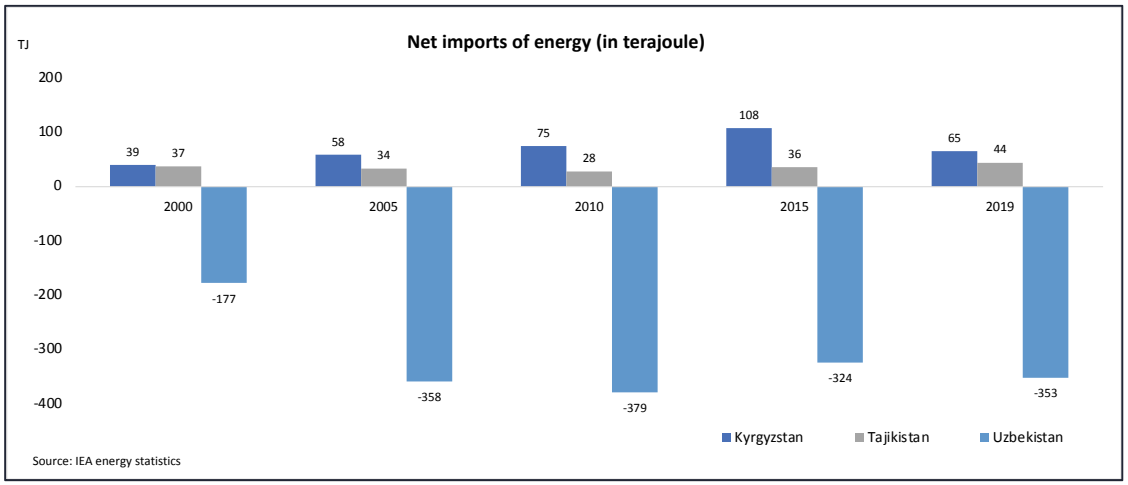



Data source: Ministry of Energy and Industry, Kyrgyzstan; Ministry of Energy and Water Resources, Tajikistan; Ministry of Energy, Uzbekistan

The over-reliance of Kyrgyzstan and Tajikistan on hydropower makes the electricity supply in these countries vulnerable to seasonal effects and fluctuations in the water supply and a range of climate risks (as highlighted in Opitz-Stapleton et al., 2022). Kyrgyzstan and Tajikistan are net importers of energy, while Uzbekistan is a net exporter (see Figure 5). This includes imports of oil products and natural gas. Uzbekistan, on the other hand, is a net energy exporter. It is a leading producer of natural gas, with its main export markets being China, Russia, Kazakhstan and other Central Asian countries. However, Uzbekistan also imports additional crude oil (nearly 30% of input in 2018) for refineries to satisfy domestic market demands (IEA, 2020a).

All three countries have plans to develop their energy infrastructure to satisfy internal demand and address energy security needs. Annex A summarises the planned energy infrastructure across the three countries, including both renewable and non-renewable energy infrastructure. While Uzbekistan seems to place a significant focus on diversifying its energy mix by introducing RE sources, the plans for building new energy capacities in Kyrgyzstan and Tajikistan are still concentrated on hydropower plants.

**Figure 5 Net imports of energy**



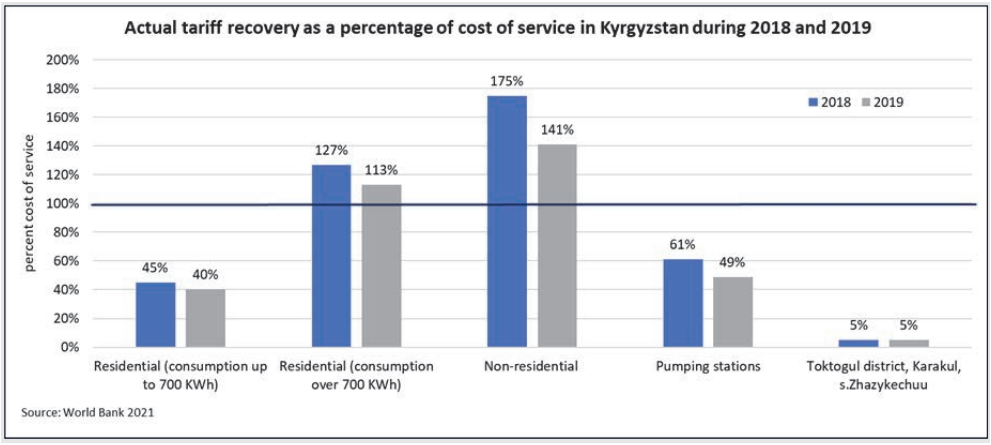

Data source: IEA energy statistics

## 2.2.4 Financial viability of the energy sector

Energy sector utilities are largely state-owned across the three countries and suffer from poor financial health. The widening deficit between cost and revenue is partly due to low tariffs in all three countries. Energy tariffs in Kyrgyzstan ($0.01/KWh), Tajikistan ($0.02/KWh) and Uzbekistan ($0.02/KWh) are among the lowest in the world. This has led to high demand due to cheap electricity costs, as well as low supply, given fewer investments in the sector. With demand likely to outpace supply as these countries develop, this would translate into smaller power exports and costly imports (World Bank, 2017b).

The energy sector in Kyrgyzstan is in a poor financial state, as the energy utilities are not able to cover their cost of service and incur regular revenue losses (see Figure 6). Residential tariffs (for consumption below 700 kWh), which constitute nearly 52% of total consumption, covered only 40% of cost of service in 2019, down from 45% in 2018. By 2017, cumulative debts of the energy sector had reached Kyrgyzstani *som* (KGS) 103.3 billion ($.1.27 billion as of August 19 2022), or close to 20% of GDP, and has remained steady at 18% since 2015 (World Bank, 2021a). The sector also affects the fiscal position, with subsidies for electricity, heating and hot water hovering at around 3% of GDP (World Bank, 2017b; Yamano et al., 2019). Noting the likely rise in electricity consumption, Kyrgyzstan's 'medium-term strategy' (2022–2026) highlights raising tariffs as critical to modernising the energy sector. The Medium-Term Tariff Policy however does not foresee raising tariffs to cost-recovery levels until 2022, with some consumer groups exempt from rises. Tariffs were previously raised between 2014 and 2017 after policy reforms were depoliticised.

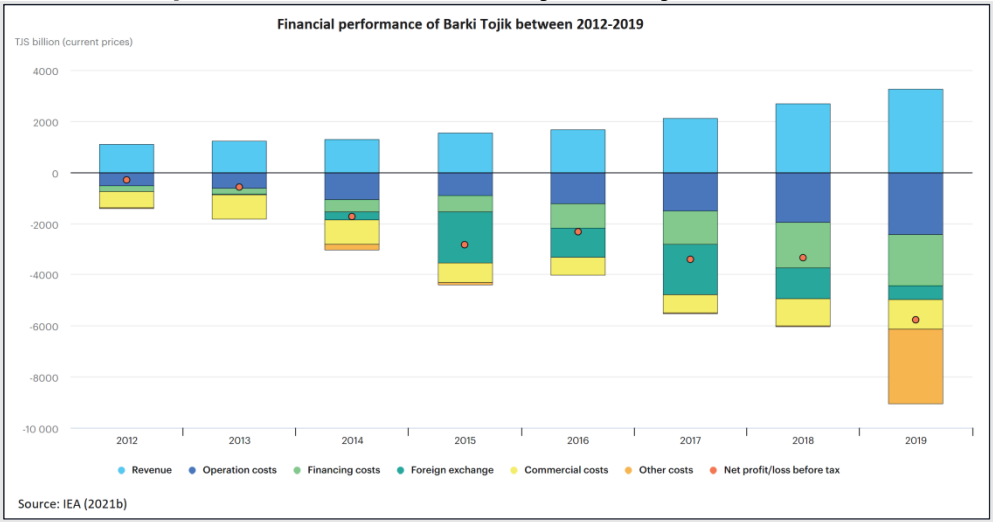
**Figure 6 Actual tariff recovery as a percentage of cost of service in Kyrgyzstan during 2018 and 2019**




Source: World Bank (2021)

In Tajikistan, the state-owned utility Barki Tojik, responsible for nearly 80% of the country's energy supply, struggles to recover the cost of production (see Figure 7). In the past, Barki Tojik provided electricity at tariffs below cost recovery and the quasi-fiscal deficit of the electricity sector ballooned to 8% of GDP in 2008 (ADB, 2016). This trend has continued, and Barki Tojik has been operating at a loss. In addition to low tariffs, uncollected payments, theft and outdated infrastructure have contributed to losses. Notably, the government has taken steps to ease the utility's financial woes. It has increased average end-user tariffs by 22% and plans to work on a tariff restructuring scheme to improve cost recovery (IEA, 2021c).

**Figure 7 Financial performance of Barki Tojik of Tajikistan between 2012 and 2019**




Data source: IEA (2021b)

In Uzbekistan, Uzbekenergo, the state-owned utility firm, was not financially viable and was unbundled into separate companies. It sustained a cash deficit due to high technical and commercial losses in the sector, low collection rates, debt problems that were exacerbated by foreign exchange risk after the currency was devalued in 2017, and below-cost recovery tariffs (World Bank, 2021b). To improve efficiency, and prepare for eventual

privatisation, the vertically integrated electric utility company was divided into separate production, transmission and distribution companies in 2018 (IMF, 2021b).

The Uzbek government has taken steps to enhance cost recovery in the energy sector, establishing the Interdepartmental Tariff Commission in 2018 to determine tariffs. Due to increasing demand for fuel and energy resources, the government is deliberating on plans to liberalise prices for electricity and gas, as well as to introduce social norms for the consumption of energy resources. Prices for fuel and energy resources are expected to be based on the inflation rate for next few years and from 2026, prices will be based on market conditions.

# 3 Opportunities in the energy sector – switching to a net-zero economy

This section discusses the opportunities associated with transitioning to a net-zero economy that could create multiple co-benefits for the wider economy, both at national and regional levels.

## 3.1 Harnessing the potential of renewables for energy security and diversification

### 3.1.1 The untapped RE potential

As discussed in the previous section, all three countries have plentiful domestically available energy resources. Yet each of them faces severe electricity shortages during winter, particularly Kyrgyzstan and Tajikistan. Developing new capacities will help countries to meet internal demand and improve energy security by diversifying the energy mix and sustainable energy supply. Using additional non-conventional RE capacities can also support their climate change goals. This report mainly focuses on non-conventional RE sources such as solar, wind and small-scale hydropower, based on the specific country contexts. However, there are alternative RE sources such as bioenergy, geothermal energy and hydrogen power, which have relatively low technical potential across these countries. Such sources are presented in Box 1.

**Box 1 Alternative non-conventional RE energy sources in Kyrgyzstan, Tajikistan and Uzbekistan**

**Geothermal (hydrothermal) energy:** Geothermal energy is produced with the heat generated within the Earth. If the transfer of heat from the Earth to its surface involves water, then it is labelled as hydrothermal energy (a subset of geothermal). In comparison with other RE sources, geothermal energy potential and capacities are relatively low across the three countries. In Kyrgyzstan, there are more than 30 geothermal resources. Yet with the threshold temperatures remaining well below 60$^{o}$C (commonly considered as a minimum temperature for heat generation capacities in thermal waters), only a few of these could be used for heat and hot water supply (mostly in the Issyk-Kul region). Tajikistan, although relatively rich in geothermal resources, also faces challenges in exploiting such resources. Eight of the sources produce a yield of 20.25 l/s and the rest of the sources can only be used for hot or warm water supply (Ilolov et al., 2022). Like Kyrgyzstan and Tajikistan, the use of thermal waters is still in the very early stages in Uzbekistan. The country has a gross potential of 244,000 tonnes of coal equivalent for

hydrothermal, with an average thermal temperature of 45.5°C (IEA, 2020a). The technical potential for hydrothermal energy has not been determined.

**Bioenergy:** Bioenergy is derived from recently living organic substances. In its traditional form it includes combustion of wood, charcoal and animal waste. Modern bioenergy also includes liquid biofuels and bio-refineries. All three countries have some potential to use bioenergy. The technical potential for bioenergy is lowest in Kyrgyzstan (200 MW), followed by Tajikistan with 300 MW, with Uzbekistan having the highest potential of 800 MW. There is no credible data available on the installed capacities of bioenergy across the three countries. High costs, low conversion efficiency (related to other fuel types), lack of supply chain, and risks of intensification of agriculture are some of the common barriers to the development and wider uptake of bioenergy across the three countries (IEA, 2020a).

**Green hydrogen from renewables:** Hydrogen is an energy carrier that can be used to store renewable energy. Hydrogen produced from renewables is known as 'green hydrogen'. Most commonly, renewable electricity is used to split water into oxygen and hydrogen using electrolysers. For a hydrogen-based energy transition, development and/or upscaling of renewable electricity generation is a prerequisite and synergies between the two can exploited. Falling costs and greater urgency to reduce GHG emissions could provide an impetus for scaling up green hydrogen globally (IRENA, 2021a). At present, the prospects of green hydrogen generation are in the very early stages in all three countries.

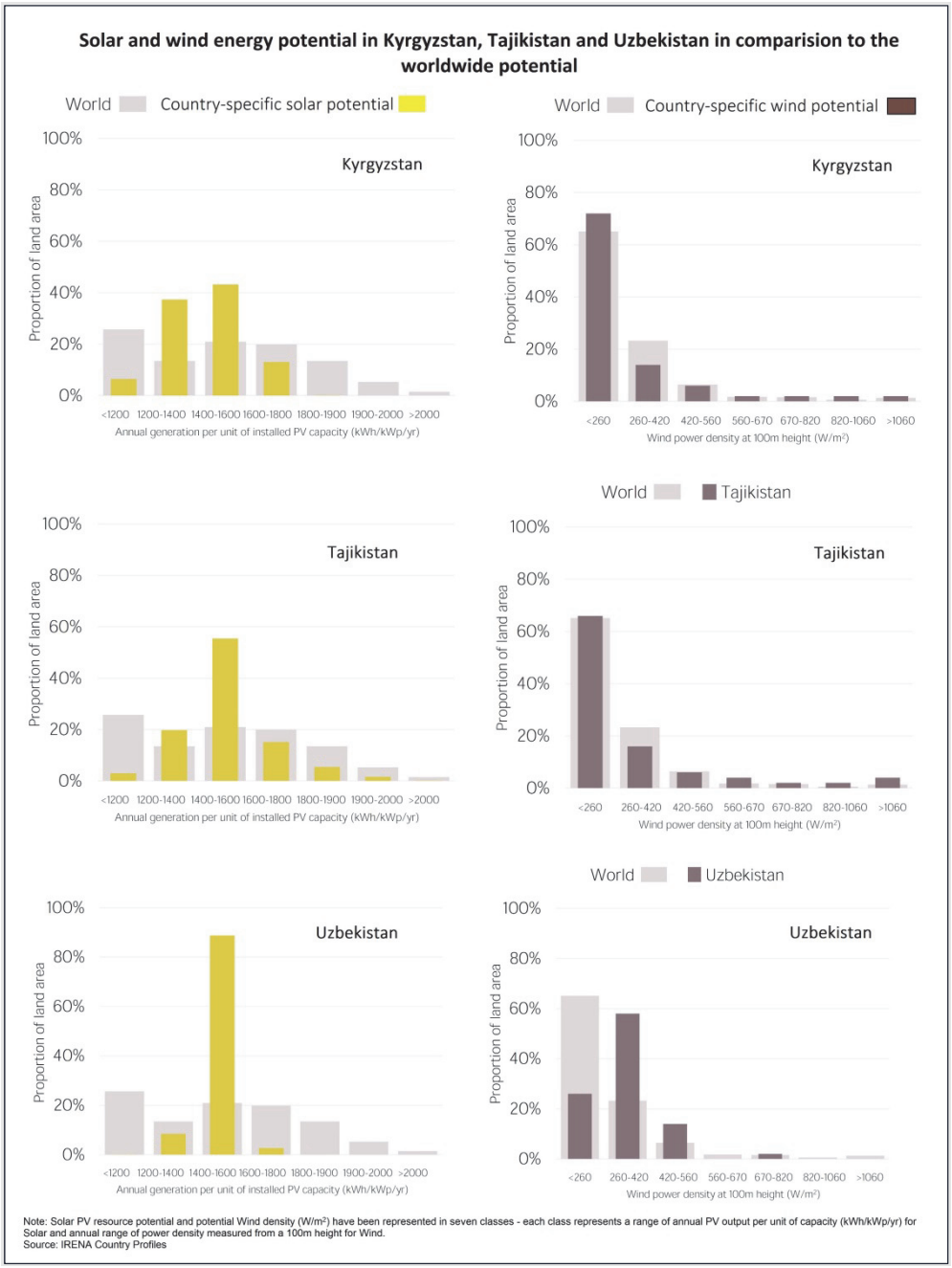
**Table 2 Technical potential and installed capacities for RE sources in Kyrgyzstan, Tajikistan and Uzbekistan as of 2019**

| Country | Small hydropower | | Solar PV | | Wind | |
|---|---|---|---|---|---|---|
| | Technical potential | Installed capacity | Technical potential | Installed capacity | Technical potential | Installed capacity |
| Kyrgyzstan | 1,800 | 46 | 267,000 | not significant | 1,500 | not significant |
| Tajikistan | 23,000 | 132 | 195,000 | not significant | 2,000 | not significant |
| Uzbekistan | 1,800 | 71 | 593,000 | 3.51 | 1,600 | 0.75 |

Source: Authors' compilation from UNDP (2014); IRENA (n.d.); Laldjebaev et al. (2021)

RE potential is largely untapped across all three countries, with significant gaps between technical potential and actual installed capacity (see Table 2). This potential could be harnessed to ensure a long-term, uninterrupted supply of energy at affordable prices. Kyrgyzstan has 45.6 MW of small-scale HPP installed, representing just 1.1% of its total hydropower capacity and less than 3% of the potential (IRENA, n.d.; UNDP, 2014). The country's hydro resources are currently exploited at less than 10% of their potential. The installed capacity for solar and wind power plants remains insignificant (Baybagyshov and Degembaeva, 2019). A similar scenario can be observed in the case of Tajikistan, where just 2.54% of the total generation capacity comes from RE, despite having the highest technical potential for electricity generation from small-scale HPPs. Only about 6% of the hydro reserves have currently been harnessed (World Energy Council, 2016). Tajikistan also has significant untapped potential for solar, wind and biomass energy. Uzbekistan has the highest potential for solar energy among the three Central Asian countries, which is currently underutilised.

**Figure 8 RE (solar and wind) potential in Kyrgyzstan, Tajikistan and Uzbekistan vis-à-vis the world**




Note: Solar PV resource potential and potential wind density ($W/m^2$) have been represented in seven classes – each class represents a range of annual PV output per unit of capacity (kWh/kWp/yr) for solar and annual range of power density measured from a 100 m height for wind.

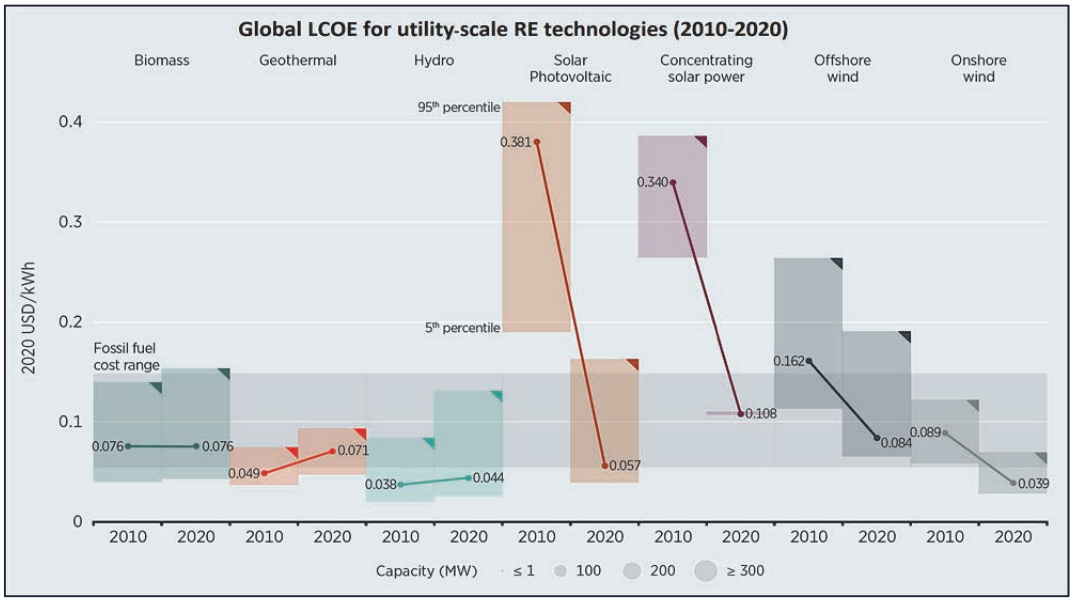
Source: IRENA (n.d.)

Among the major non-conventional RE sources, the potential for solar and wind energy is highest. As demonstrated in Figure 8, the three countries have an above average proportion of land area with good potential for solar and wind generation (IRENA, n.d.). This comparison further underscores the probable benefits that the three countries could realise by tapping the potential of such sources. These could include reduced geopolitical risks (such as supply risks and import dependency), lower electricity costs and complete access to clean energy.

### 3.1.2 Prospects of cost-competitive energy production

The cost of energy production through RE technologies continues to decline globally (see Figure 9) (IRENA, 2021; IEA, 2020b). Energy costs are measured by calculating the levelised cost of electricity (LCOE), which is a common measure for comparing the cost and price competitiveness of different generating technologies. LCOEs for renewables are declining below the costs of conventional electricity generation using fossil fuels, largely driven by technological improvements, competitive supply chains, economies of scale and learning from implementation (IRENA, 2021; IEA, 2020b). The levelised cost of electricity for renewables, particularly for solar PV and onshore wind, is competitive with fossil fuel generation in most countries, but it is also influenced by national and locational factors, resulting in variations in costs (IEA, 2020b).

**Figure 9 Global LCOE between 2010 and 2020 from utility-scale RE technologies, compared with LCOE for fossil fuels**

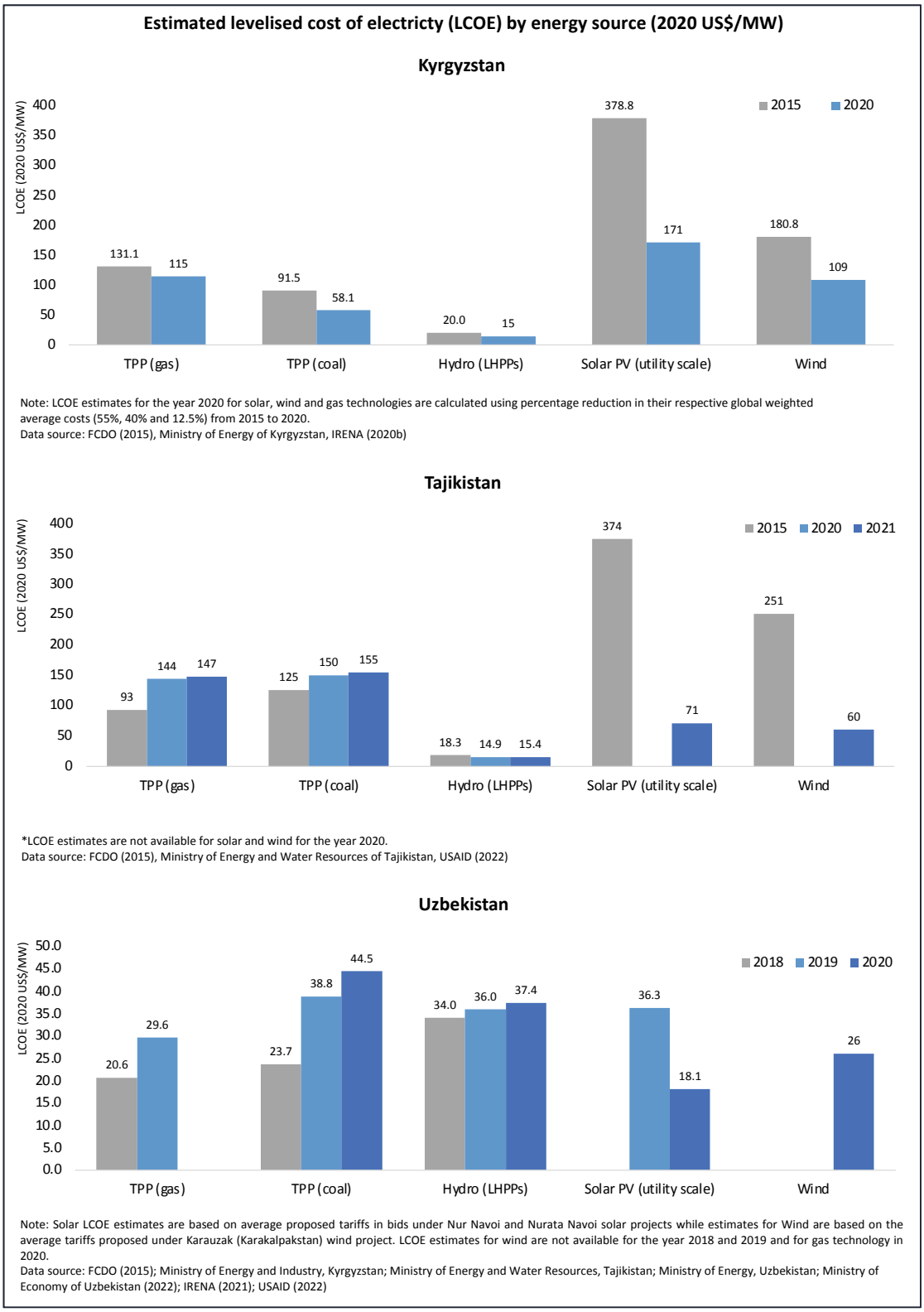



Source: IRENA (2021)

In common with the global LCOE, the estimated cost of electricity through renewables has been declining in the three case study countries (see Figure 10). The estimated LCOE[5] for renewables such as solar PV and wind energy is closing in on the cost of fossil fuels, such as coal and natural gas. In contrast, the cost of fossil fuel-based technologies like coal and natural gas has gradually increased, or has remained largely the same in all three countries.

[5] It should be noted that these figures represent an indicative LCOE for different technologies and do not necessarily represent actual estimates.

**Figure 10 Estimated LCOE for Kyrgyzstan, Tajikistan and Uzbekistan for different energy generation technologies**




Source: FCDO (2015); Ministry of Energy and Industry, Kyrgyzstan; Ministry of Energy and Water Resources, Tajikistan; Ministry of Energy, Uzbekistan; Ministry of Economy of Uzbekistan; IRENA (2021); USAID (2022)

Hydropower remains the cheapest energy source in Kyrgyzstan and Tajikistan, with an LCOE of $15 and $15.4/MWh in 2020 respectively, well below the global average LCOE

for hydropower of $44/MWh. Hydropower LCOE for Uzbekistan is much closer to the global average, at $37/MWh. However, as discussed earlier, traditional hydropower (LHPPs) is contentious due to its potentially adverse impacts on water resources and ecosystems, and population displacement issues. Furthermore, aged hydro infrastructure in both countries increases generation, transmission and distribution losses and adversely affects energy efficiency (World Bank, 2017a). Small-scale hydropower has the potential to address most of these limitations. The LCOE for SHPPs, which is typically higher than that of the LHPPs, is also declining globally, making it an attractive alternative to traditional hydropower (IEA, 2020b). As illustrated previously, all three countries have significant untapped potential for small-scale hydro energy.

For solar PV and wind energy, Uzbekistan has an estimated LCOE of about $18/MWh, significantly lower than the global average of $57/MWh in 2020. In fact, both solar and wind technologies are estimated to have become a cheaper source than the natural gas TPPs, a primary electricity source in Uzbekistan. Solar PV and wind are still cost-intensive energy options in Kyrgyzstan and Tajikistan. However, as is evident from Figure 10, the cost of solar and wind energy has been declining in all three countries over the years.

Based on the global experience, the declining trend in the costs of non-conventional RE sources is expected to continue (IRENA, 2021). Solar module prices dropped by 93% globally between 2010 and 2020, leading to an 85% reduction in installed costs (including installation and supporting maintenance costs). Similarly, the installed cost for onshore wind fell by 31% during the same period. With the growing interest and experience of working with power and wind technologies in the three countries, RES – particularly solar and wind – are expected to be cost-competitive with fossil fuel and hydropower in the near future. This will open up new avenues for investment in RE by incentivising investors and encouraging the public sector to allocate resources to RE across the three countries.

### 3.1.3 Improving energy access and supply with off-grid RE sources

Power generation through off-grid systems has been common practice for years. Distributed RE systems, including off-grid systems (as well as mini-grids and micro-grids), have the potential to provide electricity to households and small enterprises, irrespective of a centralised grid connection. Nearly 150 million people across Asian and African regions have already accessed household electricity through off-grid solutions (REN21, 2022). Off-grid solar PV systems also offer significant cost advantages over other systems, such as stand-alone diesel generator sets (Okoye and Oranekwu-Okoye, 2018; Balalola et al., 2022).

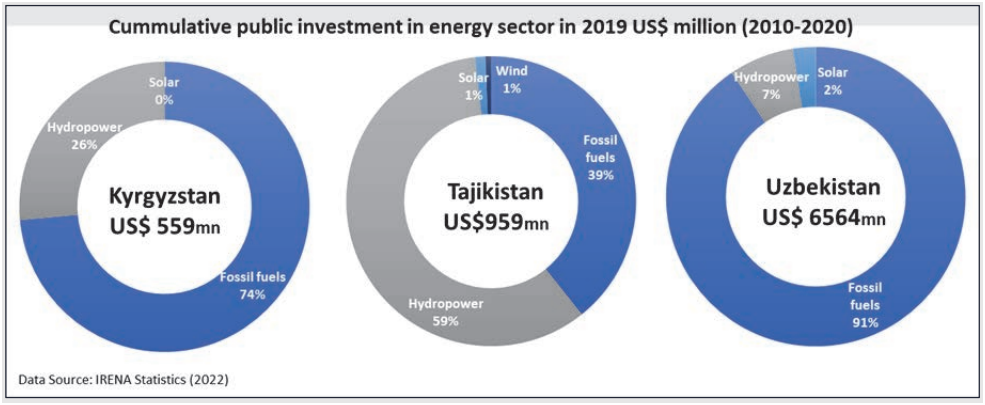
Although all three countries have achieved near universal access to electricity, power outages persist, especially in rural areas (UNESCAP, 2021). The potential of stand-alone off-grid solutions such as solar PV can be harnessed to help reduce supply pressure on national energy infrastructure, while improving energy access, particularly in rural areas. To this end, the Government of Uzbekistan has already approved the installation of 150,000 rooftop solar PV units, which are expected to cover 2%–2.5% of households by 2025.

## 3.2 RE investment and financing opportunities

The transition to a net-zero and sustainable energy system presents opportunities for investors to diversify risks, generate cash yields with low volatility, and improve portfolio resilience. The shift could make both public and private markets accessible to investors in Kyrgyzstan, Tajikistan and Uzbekistan. However, although declining costs of renewable technologies have reduced the capital

requirements, a lack of incentives and legislative complexities around renewables in all three countries remains a major constraint for investors contemplating participation in energy markets (OECD, 2015; Svobodova et al., 2020).

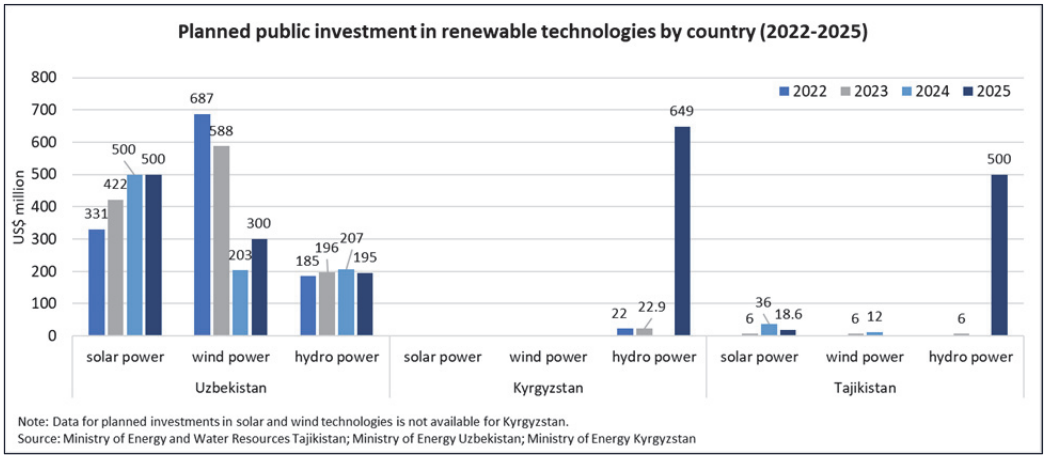
**Figure 11 Cumulative public investments in energy sector in Kyrgyzstan, Tajikistan and Uzbekistan during 2010–2020 (in 2019, million $)**




Source: IRENA statistics (2022)

Public investments in renewable energy infrastructure have been minimal in the three countries (see Figure 11). Recent commitments to improve the energy mix could provide the impetus to increase funding for RE projects. However, doing so requires significantly scaling up public investments from existing levels, as shown in Figure 12. Uzbekistan has relatively ambitious investment plans for renewables such as solar and wind, while Kyrgyzstan and Tajikistan appear to continue prioritising investments in hydropower plants.

**Figure 12 Planned public investments in renewable technologies between 2022 and 2025 in Kyrgyzstan, Tajikistan and Uzbekistan**

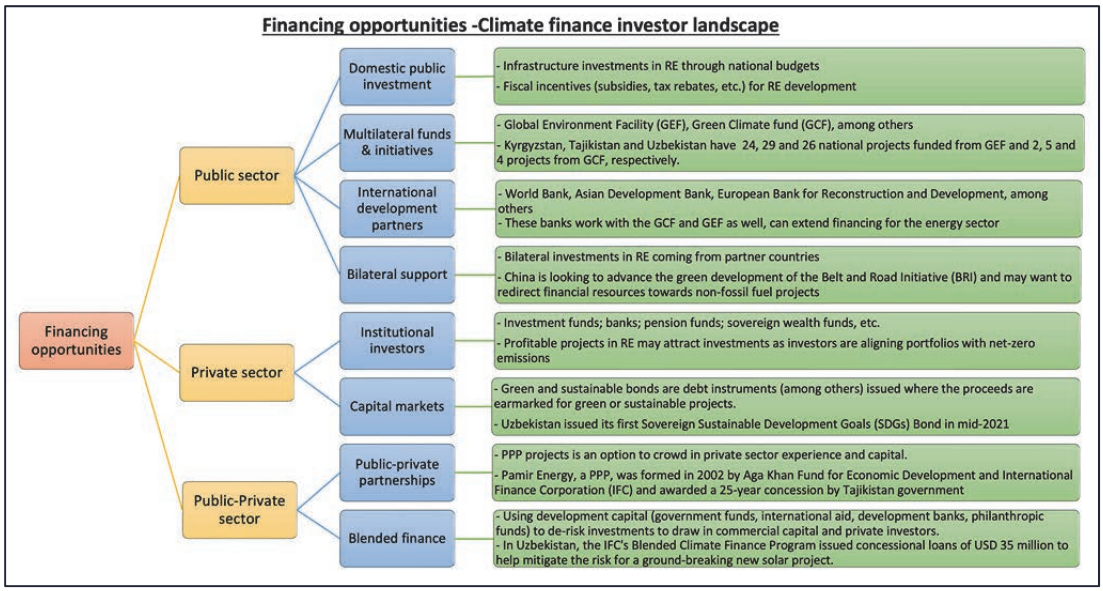



Source: Ministry of Energy and Water Resources Tajikistan; Ministry of Energy Uzbekistan; Ministry of Energy Kyrgyzstan

Increased fiscal stress owing mainly to elevated public sector debt due to the pandemic could constrain some of the planned public investment. Investments from the national governments will therefore require support from other sources. Figure 13 provides an overview of the types of public and private financing options available to Kyrgyzstan, Tajikistan and Uzbekistan.

To aid the development of RE, countries in Central Asia can apply for funding from multilateral funds such as the Global Environment Facility (GEF), a financing mechanism of the United Nations Framework Convention on Climate Change (UNFCCC), and the Green Climate Fund – another large global climate fund. Both work through grants and loans and aim to help countries to shift towards low-emission and climate-resilient development. The three case study countries have benefited from these funds, but only on a very small scale. For example, the GEF Trust Fund has in part financed 24, 29 and 26 national projects in Kyrgyzstan, Tajikistan and Uzbekistan, respectively.

**Figure 13 RE financing options available in Kyrgyzstan, Tajikistan and Uzbekistan**




Source: Authors' own compilation

Projects financed through multilateral funds are often supported by international development partners (or multilateral development banks) such as the World Bank, ADB and EBRD. For example, Uzbekistan received $690 million in 2021 from the EBRD, with funds going to projects in renewable energy (solar plants) and green lending, among others (EBRD, 2022). Bilateral financing to invest in the renewable energy sector in the three countries also remains a practical option. For example, China is looking to advance the green development of the Belt and Road Initiative and may want to redirect financial resources towards non-fossil fuel projects (Vakulchuk et al., 2019).

As mentioned earlier, institutional investors are increasingly becoming aware of the impacts of climate change and how it may affect their investments. Some 86% of global investment for renewables between 2013 and 2018 has come from private sources (IRENA and CPI, 2020). With that in mind, profitable projects in renewable energy may attract investments, particularly from institutional investors. Financial instruments such as green bonds also create new avenues of financing opportunities for the three countries. For instance, Uzbekistan successfully issued its first Sovereign Sustainable Development Goals Bond in mid-2021 (UNDP, 2021).

Public–private partnerships, which are an arrangement to crowd in private investments to support the public sector, could be a viable option for the three countries. Tajikistan, for example, saw some early success with PPPs in the energy sector with the formation of Pamir Energy. This was formed in 2002 by the Aga Khan Fund for Economic Development

and the International Finance Corporation (IFC) and was awarded a 25-year concession by the Government of Tajikistan to supply power to the Gorno-Badakhshan Autonomous Oblast of Tajikistan (GBAO) (Parpiev, 2020).

Finally, an innovative approach to financing in the form of blended finance could create opportunities for different investors to come together for the development of RE in the three countries. Blended finance uses development capital (government funds, international aid, development banks, philanthropic funds) to de-risk investments, so as to draw in commercial capital and private investors. For example, the Blended Climate Finance Program of the IFC and Canada-IFC issued concessional loans of $17.5 million each to help mitigate the risk for a groundbreaking new solar project in Uzbekistan. The 100-megawatt solar photovoltaic power plant is expected to supply "270 GWh per year of renewable electricity to the grid, preventing the release of greenhouse-gas emissions of 156,000 metric tons per year on average, and mobilizing nearly $110 million private capital financing." (IFC, 2020).

Since the energy sector is state controlled in all three case study countries, governments must play a pivotal role in planning, financing and regulating RE infrastructure investments and development. To appreciate and capitalise on the available financing opportunities created by a prospective move towards energy transition, governments in the three countries must encourage renewables as their primary choice of energy. To do this more effectively, policymakers in each of the countries will have to consider three things: incentives, investment conditions, and information.

**Incentives:** Government financial incentives such as tax credits/breaks, grants and loan programmes can be used to stimulate investments in (non-LHPP) renewables, mainly solar, small hydropower and wind. In general, these incentives need to improve the risk–return profile of renewable investments to entice private investors. Finance literature has established the relationship between investment risks and returns, where higher perceived risks need higher returns. To make RE projects more attractive, policy instruments can (1) increase returns; (2) reduce risks; or (3) be a combination of both (Polzin et al., 2019). This is particularly relevant as fossil-fuel-based assets and related investments face transition risks and potentially lower returns, with low carbon pricing and stricter climate mitigation policy and standards (air pollution).

**Investment conditions:** Institutional investors, mainly concerned with the risk-adjusted financial performance of assets, will consider factors such as sovereign risk, the investment climate, and the state of policies and institutions before investing (OECD, 2015). Greater market liberalisation, such as appropriate tariffs and removal of inefficient indirect subsidies, can help to improve the investment climate.

**Information (asymmetry):** Compared with more traditional energy investments, those in renewables are still comparatively new and carry a high perceived risk. The private sector will need more information and greater transparency to conduct due diligence and better understand the investment case for renewables in the three countries.

## 3.3 Opportunities for energy trade with RE capacities

Energy trade has been a key driver in shaping Central Asia's energy landscape, boosted by regional cooperation to expand trading opportunities and modernise energy infrastructure. Inter-regional energy trade has been ongoing for many years, accounting for nearly $7.6 billion in 2019 (UNESCAP, 2021). However, the energy trade is currently dominated by non-renewables.

As discussed in Section 3.1.2, energy production through hydropower is already cost-effective in Kyrgyzstan and Tajikistan, and is well below the regional and global average cost of electricity. During non-peak load times (mostly in summer), Kyrgyzstan exports energy mainly to Kazakhstan at an average price of nearly $0.02/KWh and to Uzbekistan at an average price of nearly $0.022/KWh (Ministry of Energy and Industry Kyrgyzstan, n.d.). Export prices have fluctuated in the past few years and dropped to $0.01/KWh as of 2018. The cheaper export prices for Kyrgyzstan give it a distinct advantage in energy trade with neighbours. However, due to seasonal shortages to meet internal demand, it has been unable to fully capitalise on this cost advantage.

Afghanistan has been a major energy export destination for Tajikistan for several years. Between 2017 and 2021, Tajikistan exported an average of 1.2 billion KWh of electricity annually to Afghanistan, accounting for more than 90% of the country's total energy exports. Like Kyrgyzstan, Tajikistan has been unable to optimise the cost-advantage of its hydro resources. The country also experiences seasonal electricity deficits of approximately 2.4 TWh. In addition, Tajikistan has only managed to develop about 4% of its total hydropower potential of 527 TWh. Scaling up the development of renewables in Tajikistan is estimated to have the potential to generate 10 TWh of exportable surplus in the country by 2030 (IEA, 2021b).

In common with Tajikistan, Uzbekistan exports energy mainly to Afghanistan – an average of 2.2 billion KWh annually between 2017 and 2021 – as well as to other countries in the region, such as Kyrgyzstan, Kazakhstan and Tajikistan that are connected to its energy systems. However, Uzbekistan's energy export is predominantly fossil fuel-based.

An increased share of RE in the energy mix across the three countries can significantly increase energy generation capacities and help to meet internal demand, and even produce surplus energy which can be traded with neighbouring countries. Complementary energy capacities in the form of renewables and energy trade would bring cost-effectiveness that could in turn free up more capital to divert to RE capacity development. This will help countries to move towards transition more swiftly.

A resumption of regional cooperation, largely halted after Turkmenistan (in 2003) and Tajikistan (in 2009) exited the Central Asia United Power System, is likely to be instrumental in creating energy trade opportunities. Recent developments in efforts to revitalise regional cooperation have been encouraging. For example, in 2019, during the Second Central Asian Conference on Energy Reforms, the Central Asian countries signed a joint declaration for regional cooperation in energy sector reforms and the creation of a common electricity market. Similarly, the integration plan known as the Central Asia-South Asia power project (CASA-1000) is expected to connect Kyrgyzstan and Tajikistan with Afghanistan and Pakistan to export electricity by 2023.

## 3.4 Integrating energy efficiency and RE

There are many opportunities to improve both demand and supply efficiency for the three case study countries by exploiting the synergies between energy efficiency and RE sources. The energy sector in all three countries suffers from lack of investment, and is characterised by outdated infrastructure, with low capacity utilisation and significant system losses spread across generation, transmission and distribution (see Section 2.2.3). All three countries are trying to capitalise on their energy saving potential through specific legislation. Kyrgyzstan has an estimated energy saving potential of a minimum of 15% in buildings, while modernisation of the energy systems could yield 25% savings (IEA,

2020a). In Tajikistan, the Ministry of Energy and Industry estimated a 30% reduction potential in current power consumption. The recently adopted Presidential Decree No. 4779 (10 July 2020) on enhancing energy efficiency in Uzbekistan aims to save 3.3 TWh of electricity between 2020 and 2022 (Decree of President of the Republic of Uzbekistan, 2020).

Integrating renewables and energy efficiency could have a mutually advantageous impact on policy development to tackle climate change. A dual-pronged approach is likely to be instrumental in achieving the desired reduction in $CO_2$ emissions, given estimates that a combined portfolio of renewables and energy efficiency technologies could reduce emissions by one-third to one-half by 2050 (IRENA, 2017).

As the share of renewables increases, less energy would be required to fulfil the same level of energy demands. Therefore, RE and energy efficiency can be integrated to mitigate system-wide economic and environmental costs. For instance, renewable energy allows for a decentralised power supply and provides an off-grid and on-site connection to efficient buildings, reducing end-user demand, grid congestion and transmission losses and transport costs. This potential could be particularly valuable for providing electricity in rural and remote areas in the three case study countries (IRENA, 2017).

# 4 Co-benefits of pursuing net-zero, resilient energy production

In this section, we discuss some of the co-benefits of transitioning towards a net-zero energy system. These include a surge in employment, more sustainable growth, benefits to human health, and alleviating potential transitions risks.

## 4.1 Job creation and sustainable economic growth

The world is projected to lose up to 18% of global economic output by 2050 in a business-as-usual scenario of action on climate change (SwissRe, 2021). It is estimated that the damage could be reduced to 4% if the commitments under the Paris Agreement were to be fulfilled. Increasing investment in non-conventional RE sources can help to expand economic output and create employment.

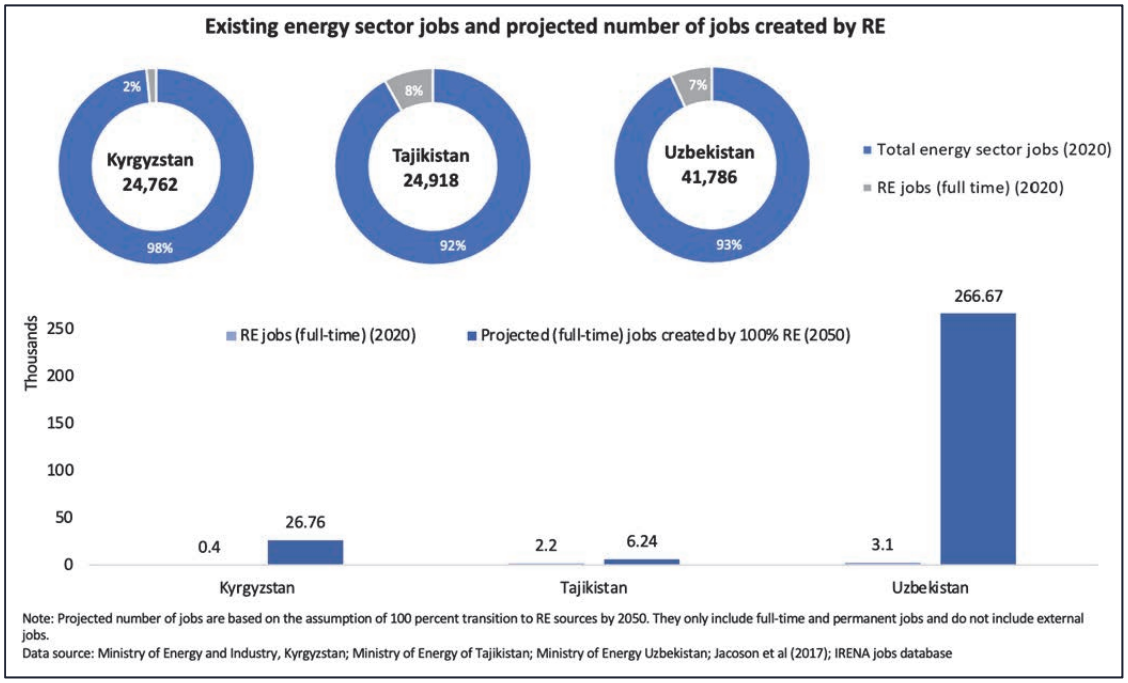
Transitioning to a net-zero energy system could help to avoid the substantial economic cost of carbon-based energy production for the three countries in question. The declining costs of renewables and a parallel increase in RE generation can reduce fiscal pressure and help governments to reallocate resources to other economic activities and promote growth. In a 2050 full-scale (100% RE) energy transition scenario, Kyrgyzstan is projected to avoid costs of carbon-based energy production of up to $11.5 billion every year, while Tajikistan and Uzbekistan could avoid up to $5 billion and $181 billion each year, respectively (Jacobson et. al., 2017). The avoided cost would be added to each country's GDP, resulting in a higher growth scenario relative to business-as-usual. Furthermore, having a stable and reliable electricity supply can create a better business environment and improve investor confidence (Rehermann and Shi, 2016; Hashemi, 2021).

The RE sector is expected to create 38 million jobs by 2030 and 43 million jobs by 2050 on a global scale. A study of the top 38 renewable energy consuming countries found that RE consumption had a positive impact on growth for 23 countries in the sample, where RE was a significant driver of growth, generating additional jobs (Bhattacharya et al., 2016). Approximately 12 million new direct and indirect jobs were created in the RE sector globally during 2020, with numbers increasing continuously over the past decade (IRENA, 2021b). Solar PV, wind and hydropower were among the largest employers, accounting for 33%, 10.5 % and 18% of the total RE jobs created. Furthermore, on a global scale, RE employs greater numbers of women compared with the fossil fuel segment of the energy sector – 32% compared with 22%.

The energy sector currently accounts for nearly 5%, 1.2% and less than 1% of the total recorded jobs in Kyrgyzstan, Tajikistan and Uzbekistan, respectively. As shown in Figure 14, at present the RE sector accounts for a very low proportion of total energy sector jobs across the three countries. However, it has the potential to generate significant employment opportunities. Based on projections by Jacobson et al. (2017), RE could generate more than 26,000 full-time direct jobs for Kyrgyzstan and more than 6,000 such

jobs for Tajikistan by 2050, assuming a full-scale (100%) transition to RE sources. For Uzbekistan, the projected number of additional jobs that could be created by 2050 is more than 266,000. Since these projections do not include indirect and part-time jobs, the actual number could be even higher in a full-scale transition scenario. The projected number of additional jobs is expected to add an average of nearly $1.2 billion, $0.3 billion and $15 billion per year to the economy in Kyrgyzstan, Tajikistan and Uzbekistan respectively.

**Figure 14 Existing energy sector jobs with RE share and projected number of jobs created by RE by 2050**




Source: Ministry of Energy and Industry, Kyrgyzstan; Ministry of Energy of Tajikistan; Ministry of Energy Uzbekistan; Jacobson et al (2017); IRENA (n.d.)

Greater uptake of RE generation is expected to stimulate progress towards achieving the Sustainable Development Goals. Currently, all three countries are behind in their expected progress towards Target 7.2.1 (Renewable energy share) under SDG 7 (Affordable and clean energy) (UNESCAP, 2022). SDG 7 is strongly correlated to SDG 1 (No poverty), SDG 2 (Zero hunger), SDG 4 (Quality education), SDG 6 (Clean water and sanitation), SDG 13 (Climate action) and SDG 17 (Partnerships) (UNESCAP, 2021). Multiple socio-economic co-benefits associated with a net-zero transition strengthen the case for governments to promote such a transition.

## 4.2 Reduced emissions and fulfilment of climate goals

Shifting to a net-zero energy system will help Kyrgyzstan, Tajikistan and Uzbekistan to meet their Nationally Determined Contribution targets (see Table 3). All three countries have recently submitted their updated NDCs, pledging to substantially reduce emissions and increase the share of renewables in the energy mix. Considering Kyrgyzstan and Tajikistan's overwhelming reliance on hydropower, developing other renewable sources would help with the adaptation goals of diversifying energy sources and strengthening reliability. For Uzbekistan, energy transition should be a priority, given its greater dependence on fossil fuels.

Increased use of RES can help to substantially reduce $CO_2$ emissions. Electrification and RE alone could deliver a reduction of up to 75% in global energy-related emissions (IRENA, 2017). RE combined with energy efficiency technologies, and complemented by substantial electrification, could reduce global energy-related emissions by 90%. By using hydropower as a primary source of electricity, Kyrgyzstan avoided an estimated 13.81 million tonnes of carbon dioxide equivalent ($CO_2e$) in 2018 (IRENA, n.d.). Similarly, Tajikistan avoided an estimated 8.64 million tonnes of $CO_2e$ in the same year. By contrast, Uzbekistan is estimated to have avoided 2.9 million tonnes of $CO_2e$ in 2018 due to its dependence on fossil fuels.

**Table 3 Climate mitigation targets for Kyrgyzstan, Tajikistan and Uzbekistan as submitted through respective NDCs**

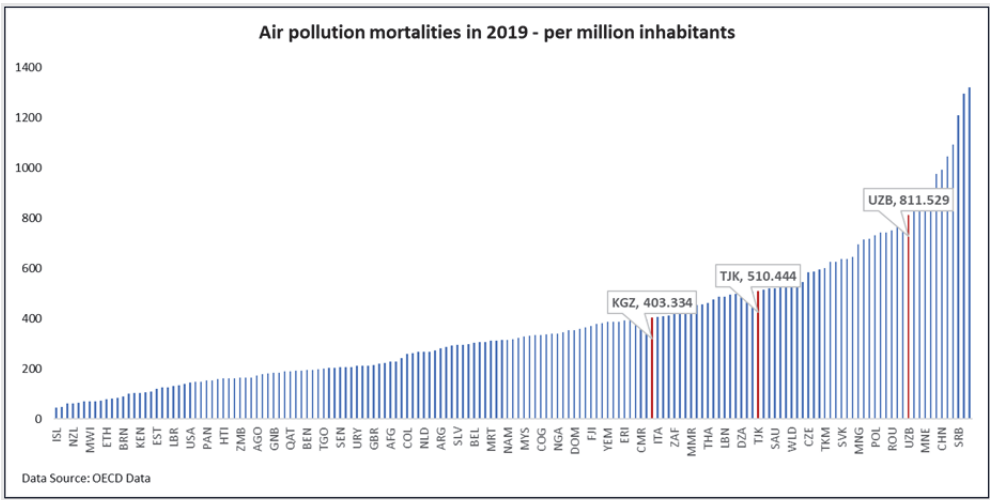
| | Kyrgyzstan | Tajikistan | Uzbekistan |
|---|---|---|---|
| Conditional target | Reduction of GHG by 36.61% by 2025.<br><br>Reduction of GHG by 43.62% by 2030. | Subject to significant international funding and technology transfers, the target is not to exceed 50%–60% GHG emissions as of 1990 by 2030. | Reduce specific greenhouse gas emissions per unit of GDP by 35% by 2030 from the 2010 level. |
| Unconditional target | Reduction of GHG by 16.63% by 2025.<br><br>Reduction of GHG by 15.97% by 2030. | Target is not to exceed 60%–70% of greenhouse gas emissions as of 1990 (the reference year) by 2030. | No information |
| Targets related to energy sector | By 2030, it plans to reduce CO2e by 1,899,783 (000s of tons) from internal resources and by 4 111,827 (000s of tons), with international support. | Conditional: limit of 17.76 to 21.32 $MtCO_2$ to be emitted in 2030. Unconditional: limit of 21.32 to 24.87 $MtCO_2e$ to be emitted in 2030. | Increase RE share to 25% of total power generated by 2030. |

Source: UNFCCC NDC submissions 2021

## 4.3 Environmental and health benefits – improved ecological system, air quality and human health

Electricity production across all three countries relies on conventional sources of energy dominated by hydropower in Kyrgyzstan and Tajikistan and fossil fuels in Uzbekistan. Such sources have negative repercussions on quality of life and environmental sustainability. Although hydropower is considered a renewable energy source, it can have an adverse environmental impact (such as water stress, displacement and biodiversity loss) across the life cycle of a project. Furthermore, given the transboundary implications of hydropower plants, their construction often creates trade-offs and tension between upstream and downstream countries (UNESCAP, 2021). Non-conventional RE sources – particularly small hydropower, solar and wind – can help to avoid and mitigate such impacts by producing cleaner and more sustainable energy.

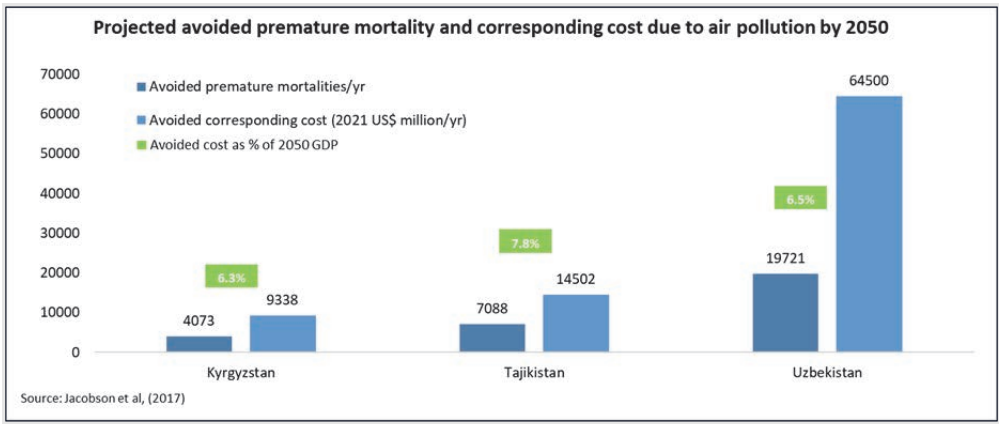
**Figure 15 Air pollution mortalities per million inhabitants in 2019**




Source: OECD data

The by-products of electricity generation include harmful air pollutants, which can lead to health issues, including higher mortality rates. Substituting the combustion process – which is associated with air pollutant emissions – with the use of cleaner wind, solar and hydroelectric systems to generate electricity, can help to cut air pollutant emissions (EEA, 2019). Kyrgyzstan, Tajikistan and Uzbekistan have relatively high mortality rates due to air pollution, with particularly high rates in Uzbekistan (see Figure 16). GHG mitigation can reduce premature deaths, and the marginal co-benefits of avoided premature mortality of around $50–$380 per tonne of CO2 are projected to exceed marginal abatement costs in 2030 and 2050 globally. (West et al., 2013; Vandyck et al., 2018).

**Figure 16 Projected avoided premature mortality and corresponding cost due to air pollution by 2050**




Source: Jacobson et al. (2017)

Similarly, as shown in Figure 16, transition to a net-zero energy system by 2050, with 100% RE sources, could avoid more than 4,000 premature deaths per year in Kyrgyzstan and more than 7,000 and 19,000 deaths per year in Tajikistan and Uzbekistan, respectively. The estimated economic value of such avoided deaths could range from 6% to 8% of projected 2050 GDP across the three countries.

## 4.4 Increased resilience of the energy infrastructure

As highlighted in Section 2.2.3, old and poorly maintained energy infrastructure across the three countries causes widespread system losses. Further, the existing energy infrastructure is exposed to a number of rapidly changing threats related to climate change, environmental degradation and cyber-attacks (see Opitz-Stapleton et. al., 2022). As interest in and commitment to increasing RES grows, governments in all three countries are expected to lead and encourage long-term investments in such energy sources. Any new and upcoming RE infrastructure development should integrate best practices on climate and disaster risk and resilience. This would help to ensure the realisation of the co-benefits of such a transition, including the delivery of an uninterrupted energy supply.

# 5 Country-specific policy challenges/limitations and ways forward

In this section we reflect on country-specific policy challenges that could hinder transition to a net-zero economy, as well as challenges highlighted in earlier sections of the report. Suggestions follow of ways to integrate and promote renewable energy generation in the future, in each of the three case study countries.

## 5.1 **Policy challenges**

### 5.1.1 Kyrgyzstan

Kyrgyzstan has demonstrated interest in diversifying its energy mix with non-conventional RE – most recently by adopting a new law on RES, to help improve energy security, which is a significant issue for the country and the focus of much of its energy policies. Nevertheless, progress to date has been limited and well below the country's potential. Key policy challenges for promoting non-conventional RE and planning and investment in the broader energy sector persist, as follows:

1 Since independence in 1991, Kyrgyzstan has experienced frequent political instability – the country has seen three anti-government coups, six presidents and a succession of often short-lived, governments. Frequent government changes and shifting priorities pose challenges for the business environment and strategic planning. Political and policy uncertainty may deter foreign investment, including in the energy sector.

2 Long-term strategic planning is challenging, with development programmes regarded as 'wish lists' by some Kyrgyz experts, with little prioritisation of sectors and costings (Borodyna, Calabrese and Nadin, 2022). This poses challenges to fostering a stable policy environment for investment and may contribute to short-term planning horizons among government ministries, impeding efforts to attract foreign direct investment and financing in priority sectors. Furthermore, the absence of a clear policy hierarchy, accompanying budgets, monitoring and evaluation criteria and relationships between policies may all undermine the ability to achieve long-term development priorities.

3 Diversifying the energy mix towards non-conventional RE may prove challenging, given the country's reliance on large scale HPPs for future energy security. As demonstrated in Opitz-Stapleton et. al. (2022), these are vulnerable to a range of climate and geopolitical risks. Nonetheless, diverting government resources towards attracting and implementing non-conventional RE investment may prove challenging in the absence of clear policy signals and political commitment to energy diversification.

4 Raising energy tariffs to cost-recovery levels is critical to modernising the Kyrgyz energy sector, particularly for reinvestment in its ageing generation and transmission

infrastructure. The Government of Kyrgyzstan took positive steps towards energy sector reform when the sector was depoliticised in 2014 and tariffs were raised between 2014 and 2017, when large-scale consumers and non-residential users bore the brunt of price increases. The government may experience challenges and pressure from different consumer groups if and when it attempts to raise tariffs for residential consumers and other groups previously excluded from rises. Although electricity accounts for a relatively small amount of household spending – between 2.3% and 2.6%, a survey cited in the Green Economy Programme found that 65% of respondents thought that energy tariffs should be lowered. In the absence of further efforts to raise awareness of energy reforms, public perceptions may weigh on decision-making, slowing the pace of tariff reforms and delaying modernisation of the energy sector.

5 Sourcing skilled personnel to implement renewable energy projects locally may prove challenging in the absence of policies to build capacity and policy certainty on RE ambitions. As highlighted in Section 4.1, RE could generate more than 26,000 full-time jobs in Kyrgyzstan, as well as indirect and part-time opportunities along the value chain (Jacobson et. al., 2017). However, with few current non-hydro RE projects in the country and inadequate capacity-building programmes, sourcing skilled personnel locally may prove difficult, increasing project costs and deterring investment.

6 While the operating environment for companies in the Kyrgyz extractives sector is uniquely challenging due to its politicised nature, some concerns about job localisation, environmental impacts and land ownership can reverberate in the energy sector. For example, concerns about alleged land ownership resulted in the cancellation of a Chinese agricultural investment project shortly after it was announced. Poor enforcement of existing legislation, lack of skilled labour and conflict prevention strategies all contribute to strained relations between investors and local communities. Similar challenges may emerge for investors in RE who operate locally, and the government should consider having strategies in place to maximise opportunities/minimise the risks associated with RE for both local communities and investors prior to the commencement of projects.

### 5.1.2 Tajikistan

Tajikistan has shown interest in diversifying its energy mix and stimulating the uptake of non-conventional RE, publishing several plans and strategies to that effect. With several solar and wind projects planned in the coming years, these efforts appear to be yielding positive results. Nonetheless, the overall ambition for non-conventional RE is below the country's potential, and a number of policy challenges remain:

1 The Master Plan that guides development of the Kyrgyz energy sector did not consider wind or solar power as priority supply sources, with a caveat that these may become more attractive as technology improves and costs decline. As shown in Section 3.1.2, the LCOE for solar and wind projects is estimated to have declined, but these changes are not reflected in existing policies for the country's energy sector.

2 Since the mid-2000s the Government of Tajikistan has published a series of programmes to develop the country's renewable energy capacity. The strategies set various targets for developing SHPPs, solar, wind and biomass energy. Nonetheless, RE from sources other than large-scale HPPs still accounts for less than 3% of the country's energy mix. It is unclear which framework for RE development – particularly for smaller-scale hydro HPPs – is currently guiding the government's approach to the

sector. Existing policies and frameworks for RE do not reflect the continued fall in LCOE of solar and wind projects, and hence their enhanced cost-competitiveness.

3 The Tajik energy sector operates at a loss, fuelled by low tariffs, uncollected energy bills and outdated infrastructure. The government took steps to improve cost recovery by raising tariffs and is working on a tariff restructuring scheme. However, recent unrest associated with price hikes in neighbouring Kazakhstan in January 2022, along with the potential macroeconomic impacts in Tajikistan of the Russian invasion of Ukraine, may limit interest in raising tariffs in the foreseeable future. Delaying reforms will undermine efforts to modernise Tajik energy generation and transmission infrastructure, impeding the country's push for energy security.

4 RE could create more than 6,000 full-time jobs in Tajikistan, together with part-time roles and other opportunities along the value chain (Jacobson et. al., 2017). In common with the other case study countries, Tajikistan may struggle to provide a skilled workforce for non-hydro RE projects in the absence of clear targets for scaling up the sector and programmes to train local personnel. This may both increase the costs of projects and limit positive spillovers of the industry within the country.

### 5.1.3 Uzbekistan

Uzbekistan regularly experiences acute power shortages, particularly in the winter months, causing blackouts. The frequent power outages have contributed to growing frustrations among the population. Over the past years, the country has made progress in moving towards a green economy and reducing its carbon footprint. The transition strategy towards a green economy by 2030 has already begun to be operationalised, including the formation of the New Uzbekistan Development Strategy 2022–2026. The development and use of RE sources has been included in Uzbekistan's NDC, with specific plans for the construction of large solar photovoltaic and biogas plants, as well as an increase in wind energy production.

Despite these developments, the following key challenges remain in the energy sector, in efforts to transition to a net-zero economy:

1 Despite offering low electricity prices due to the low domestic cost of natural gas (relative to global prices), the cost of producing electricity from RE sources in Uzbekistan remains high. There are currently no specific financial mechanisms, such as tariffs and taxes, to encourage the use of RE sources. Introducing a green tariff, as has currently been done by more than 65 countries, could serve as an economic mechanism to promote RE and investment in RE technologies (IEA, 2021a). The Ministry of Economic Development proposed to raise prices for electricity and gas from 1 July 2022, as well as to introduce social norms for the consumption of energy resources. However, the prices remained unchanged for population but were increased for legal entities. New prices were proposed to come into force in April 2023 to improve operational efficiency and energy saving among enterprises (Gazeta Uz, 2022).

2 Uzbekistan has made advances in attracting foreign investment in alternative energy; however, most energy sector projects are still related to upstream oil and gas, with too little investment in RE sources (in line with the government's energy goals). As discussed earlier, Uzbekistan's current investments in electricity generation continue to focus mainly on fossil fuel-fired power plants, with around 60% of planned power generation projects involving natural gas-fired electric power plants. Investors could perceive this as a lack of interest in transitioning to a net-zero economy, posing

potential challenges for long-term renewable energy sources. Nonetheless, interest in the RE sector appears to have grown in recent years. The Law on Public–Private Partnership is an example of efforts to stimulate private sector participation in public sector infrastructure projects, including in the energy sector. However, challenges remain in relation to the regulatory framework in Uzbekistan, particularly given the excessive complexity of certain legislation and policies, which have hindered the development of an enabling business environment (IEA, 2022).

3 Uzbekistan currently lacks personnel with the skills and knowledge to install, operate and repair RE technologies (IEA, 2022). The shortage of a qualified local workforce could limit project choice, as well as increase the cost of operations and maintenance. This could become a barrier and lead to decisions regarding the transition to a net-zero economy being forestalled or blocked. There is an opportunity to invest in personnel with relevant profiles, with the potential to develop their skillsets in this field.

4 The general public in this country has low levels of awareness of RE, and the current share of alternative energy is less than 2% of Uzbekistan's overall energy consumption (IEA, 2021a; REN21, 2022). Local opposition prevents the construction of new grid connections, largely due to lack of understanding of renewable technologies and their benefits (IEA, 2022). Raising awareness among the public could both increase renewable energy uptake and incentivise the government to accelerate its transition programme and meet targets on time or even ahead of schedule.

5 Outdated energy infrastructure remains a challenge, as outdated equipment slows and disrupts the implementation of large-scale reforms in the energy sector (Shadrina, 2019; IEA, 2020a). In Uzbekistan, infrastructure problems include faulty equipment operations, as well as power and gas lines that have surpassed their service life. The outdated infrastructure leads to network failures, energy losses and supply disruptions. To reduce GHG emissions and fulfil its obligations under the Paris Agreement, Uzbekistan will need to attract funds to modernise infrastructure and improve the country's energy efficiency.

6 Sociopolitical challenges could hinder energy sector reforms in Uzbekistan. For example, in November 2021, it was announced that the country would increase tariffs for electricity and natural gas from 1 January 2022. However, following unrest in neighbouring Kazakhstan in January 2022, stemming from protests over an increase in liquefied petroleum gas prices, Uzbekistan decided to postpone the tariff increases. Price surges remain politically sensitive and the economic impacts of the Russia–Ukraine war may also weigh on any future decision to raise energy tariffs.

## 5.2 Ways forward

Given the challenges outlined and the current state of the energy sector in the three countries, the following recommendations are suggested. These build on the opportunities provided by a net-zero transition highlighted in Section 3.

1 **Capitalise on RE potential and support its development:** Non-conventional RE potential is largely untapped across the three countries. As discussed earlier, governments in the three countries have taken a series of steps to promote RE. However, a comprehensive set of measures is required to support the development of non-conventional RE. These may include developing a dedicated policy and operational framework for non-conventional RE sources, particularly solar and wind energy, with medium-term (2030) and long-term (2050) goals. The policy should align with existing energy sector plans and development programmes. This should be

complemented by appointing an existing or separate government entity to be in charge of assessing and mapping the regional (within country) techno-economic potential of such sources. Furthermore, an in-depth regional assessment of the cost of electricity generation through such sources is recommended in the three countries, to assess their cost-competitiveness with existing fossil fuels and hydropower-based technologies. Such measures would also contribute to providing transparent information on RE development, which could help to boost investor confidence.

2 **Prioritise infrastructure development for non-conventional RE and its integration in the energy system:** For a greater uptake of non-conventional RE sources in the three countries, governments should show their commitment by supporting the development of RE infrastructure. This should be complemented by on-time completion of ongoing energy generation projects. Existing infrastructural and grid connection constraints could hinder the integration of renewables in the energy system. Clearer rules and standard operating procedures should be formulated for RE project installation and grid construction. In addition, power systems should be made sufficiently flexible to adjust to power supply fluctuations that may occur due to non-conventional RE sources such as solar and wind.

   Governments in the three countries should build on the momentum created by a series of economic and energy sector reforms introduced in recent years. As discussed earlier, governments should play a pivotal role in diverting energy sector investments to RE in all three countries. As discussed in Section 3.3, the legal and regulatory frameworks to support private sector participation in the energy sector should be liberalised, with adequate incentives to encourage private investments in RE.

3 **Reform and implement progressive tariff structure to revitalise the energy sector:** The energy sector across the three case study countries has been facing financial viability issues. Low electricity tariffs are one of the major reasons for the unprofitable energy sector in all three cases. A financially viable energy sector is likely to provide greater opportunities for RE development. All three countries are aware of this issue and have developed plans for restructuring tariffs (such as a multi-year mid-term tariff policy in Kyrgyzstan). However, such tariff restructuring plans have not yet been implemented across different types of users.

4 **Maximise energy efficiency through non-conventional RE sources:** Energy inefficiency is common and an ongoing issue in all three countries. As shown in Section 3.5, a combined portfolio of energy efficiency and RE energy generation plans could be mutually advantageous in addressing policy challenges posed by climate change. It is recommended that all three countries adopt an integrated policy/strategy on energy efficiency and RE generation. This integration should be part of their existing national plans and measures to promote efficiency and should be supported by developing clear monitoring indicators for energy efficiency. The development of new and resilient RE infrastructure with energy efficient technologies should complement efforts to reduce energy intensity in these countries.

5 **Promote skill development and support R&D on RE technologies:** To promote growth in the RE sector, governments of the three countries should invest in the development of a high-quality and skilled workforce, suitable for the sector's construction and operations requirements. A skilled workforce is essential to ensure a smooth and cost-effective transition to a net-zero economy. In addition, the development of standards and certification for technologies and components in the RE sector should align with international standards and practices. Given that non-

conventional RE technologies are still evolving, it is recommended to promote R&D activities in the most critical aspects of such technologies, to improve their efficiency and deployment.

6 **Foster regional cooperation:** Consistent and coordinated efforts should be made by the governments of the three countries (along with other countries in the region) to resume regional cooperation, through the Central Asia United Power System, or by establishing a similar mechanism and an electricity export market. It is recommended to build on recent developments to revitalise regional cooperation through, for example, the Central Asian Conference on Energy Reforms and the Central Asia-South Asia power project.

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# Appendix 1 Annex A

**Table A1: Planned energy infrastructure in Kyrgyzstan**

| No. | Planned energy projects/investor | Project type | Funding, $m | Project cost, $m | Loan (Y/N) | Grant $m | Region | Energy project capacity MW | Construction started (Y/N - if Y, list year of start) | Construction finish |
|---|---|---|---|---|---|---|---|---|---|---|
| **1** | CASA-1000 | High voltage transmission lines | 178.25 | 233* | Y | 6.75 | Osh, Jalal-Abad, Batken | | 2021 | 2024 |
| | World Bank | | 38.25 | | Y | | | | | |
| | European Investment Bank | | 90 | | Y | | | | | |
| | Islamic Development Bank | | 50 | | Y | | | | | |
| **2** | Kambar-Ata 2 2nd aggregate | Hydropower plant | 110 | 138 | Y | | Jalal-Abad | 120 | 2023 | 2026 |
| | Kyrgyz Government | | 28 | | | | | | | |
| | Eurasian Development Bank | | 110 | | | | | | | |
| **3** | Kambar-Ata 2 Action Plan for Safe Operation | Hydropower plant | 58.2 | 58.2 | | | Jalal-Abad | | 2024 | |
| | Eurasian Development Bank | | 50.7 | | Y | | | | | |
| | Kyrgyz Government | | 7.5 | | | | | | | |
| **4** | Toktogul HPP Reconstruction 1st phase | Hydropower plant | 49.6 | 49.6 | Y | | Jalal-Abad | | 2019 | 2019 |
| | Asian Development Bank | | 49.6 | | Y | | | | | |
| **5** | Toktogul HPP Reconstruction 2nd phase | Hydropower plant | 168.8 | 168.8 | Y | | Jalal-Abad | | 2021 | 2025 |
| | Asian Development Bank | | 68.8 | | Y | | | | | |
| | Eurasian Development Bank | | 100 | | Y | | | | | |
| **6** | Toktogul HPP Reconstruction 3rd phase | Hydropower plant | 57.6 | | Y | | Jalal-Abad | 240 | 2021 | 2025 |
| | Asian Development Bank | | 57.6 | | Y | | | | | |
| **7** | At-Bashy HPP Reconstruction | Hydropower plant | 22.2 | 22.2 | Y | | Naryn | 44 | 2019 | 2022 |
| | Swiss Confederation | | 22.2 | 22.2 | Y | | | | | |
| **8** | Uch-Kurgan HPP Reconstruction | Hydropower plant | 60 | 100 | Y | 40 | Jalal-Abad | 36 | 2020 | 2026 |
| | Asian Development Bank | | 60 | | Y | 40 | | | | |
| **9** | Improvement of electricity supply Arka district, Batken | High voltage transmission line | 16.25 | 16.25 | Y | | Batken | 51 km | 2018 | 2022 |

| No. | Planned energy projects/investor | Project type | Funding, $m | Project cost, $m | Loan (Y/N) | Grant $m | Region | Energy project capacity MW | Construction started (Y/N - if Y, list year of start) | Construction finish |
|---|---|---|---|---|---|---|---|---|---|---|
| | Substation Razakov construction | | | | | | Batken | 110/35/10kV | | |
| | Islamic Development Bank | | 16.25 | 16.25 | Y | | | | | |
| **10** | Osh electro rehabilitation (euro) | Distribution company | €4 m | €5 m | Y | €1 m | Osh | | 2021 | 2023 |
| | European Bank for Reconstruction and Development | | €4 m | | Y | | | | | |
| | Smart electric metric systems | | | | | | | 82,000 pcs. | | |
| | Self-supporting insulated wire | | | | | | | 719 km | | |
| **11** | Vostok electro rehabilitation (euro) | Distribution company | €6 m | €6 m | Y | €2 m | Issyk-Kul, Naryn | | 2021 | 2023 |
| | European Bank for Reconstruction and Development | | €4 m | | Y | | | | 2021 | |
| | Smart electric metric systems | | | | | | | 82,000 pcs. | | |
| | Self-supporting insulated wire | | | | | | | 719 km | | |
| **12** | Heat supply improvement project | Heat energy distribution | 36.5 | 36.5 | Y | | Bishkek | | 2021 | 2023 |
| | International Development Assistance (IDA) | | 31 | | Y | | | | | |
| | Russian-Kyrgyz Development Fund | | 5.6 | | Y | | | | | |
| | New individual heat points, equipment | | €635 840.82 | | Y | | | | 2021 | |
| | Heat metering units | | 572 €754.48 | | Y | | | | 2021 | |
| **13** | Bala-Saruu HPP construction | Hydropower plant | 22.9 | n/a | Y | | Talas | 25 | 2021 | 2023 |
| | Russian-Kyrgyz Development Fund | | 22.9 | | Y | | | | | |
| **14** | Karakul HPP | Hydropower plant | | n/a | | | Jalal-Abad | 18 | | |
| | Chakan GES | | | | | | | | | |
| **15** | Solar power plant | Solar power plant | | n/a | | | Chuy | 125 | 2022 | |
| | LWF COMPANY LLC | | | | | | | | | |
| **16** | Solar power plant | Solar power plant | | n/a | | | Issyk-Kul | 300 | 2022 | |
| | Bishkek Solar LLC | | | | | | | | | |
| **17** | Solar power plant | Solar power plant | | n/a | | | Issyk-Kul | 500 | 2022 | |
| | China Huaneng Group Co., Ltd | | | | | | | | | |
| **18** | Wind Power Plant | Wind power plant | | | | | Isyyk-Kul | 10 | 2021 | |
| | «METRUM KG» | | | | | | | | | |

## Table A2: Planned energy infrastructure in Uzbekistan

| Investor | Project name | Project type | Region | Capacity MW | Financing | Stage & deadline | Year of planned operation start | Construction started |
|---|---|---|---|---|---|---|---|---|
| **ADB** | Tamshush project | Hydropower | | 10.3 | Loan | | 2021 (commissioning) | |
| **ADB** | Chappasuy project | Hydropower | | 7.5 | Loan | | 2021 (commissioning) | |
| **ADB** | Rabat project | Hydropower | | 6.2 | Loan | | 2021 (commissioning) | |
| **French AFD** | Part of "Project Factory" Initiative | Hydropower | | | Loan | | | 2020 |
| **French AFD** | Part of "Project Factory" Initiative | Hydropower | | | Loan | | | 2020 |
| **Saudi Arabia** | Nukus Wind project | Wind | | 100 | Loan | | 2024 | |
| **Saudi Arabia** | Syrdarya Power Plant (CCGT) - replacing the ageing thermal power faciilty in the area | LNG-fired thermal | | 1500 | Hybrid | | 2024 (expected commissioning) | Jan-21 |
| **ADB** | Surkhandarya Plant | Solar | | 200 | Hybrid | | 2022 | |
| | Kashkadarya Solar PV Park | Solar | | 400 | | | 2025 (commercial operation) | 2023 (due to start) |
| **ADB; Japan Bank for International Cooperation; Uzbek capital resources** | Talimarjan Power Project | TPP - gas | | 800 | Loan | | | 2019 |
| **ADB** | Guzar Solar | Solar | Kashkadarya | 300 MW | | RfP - Jun-22 | | |
| | Ferghana | Solar | Ferghana | 100 MW | | RfQ - Mar-23 | | |
| | Ferghana | Solar | Ferghana | 100 MW | | RfQ - Sep-22 | | |
| **IFC** | Solar 3 | Solar | Bukhara, Namangan, Khorezm | 500 MW | | RfP - Jun-22 | | |
| **EBRD** | Beruny, Karauzak | Wind | Karakalpakstan | 200 MW | | RfQ- Jun-22 | | |
| | Karakalpakstan | Wind | Karakalpakstan | 700 MW | | RfQ - Mar-23 | | |

## Table A3: Planned energy infrastructure in Tajikistan

| Investor | Project name | Project type | Funding, $m | Project cost, $m | Loan (Y/N) | Region | Energy project capacity MW | Year planned operation start | Construction started |
|---|---|---|---|---|---|---|---|---|---|
| **ADB** | Renewable energy production program, | Solar & wind | 2.6 | 4.5 | No | Sugd, Gafurov | 50 | 2024 | No |
| **ADB** | Project construction of a solar power plant | Solar | – | – | No | Khatlon, Shartuz | 10 | 2024 | No |
| **World Bank** | Energy source diversification project, construction of a solar power plant | Solar | 36 | 36 | No | Sugd, Gafurov | 200 | 2024 | No |
| **World Bank** | Rural electrification | Solar wind & hydropower | 18 | 18 | No | Sugd<br>GBAO, Murgab and G Mascha | 9.929 | 2024 | No |
| **South Korea** | Project construction of a solar power plant | Solar | 13.5 | 13.5 | No | Sugd<br>GBAO, Gafurov | 10 | 2024 | No |
| **USAID** | Construction of solar power plant 'Murgab' 2nd stage | Solar | 0.6 | 0.6 | No | GBAO, Murgab | 0.2 | 2020 | Yes |
| **EU, KFW, USAID, WB, SECO** | Construction of a small HPP 'Sebzor' | Hydro | 56 | 56 | No | VMKB: Located on the Shokhdara River in Roshtqala region, some 20 km southeast from the regional centre, the plant can be easily connected to Pamir Energy's main grid. | 11 | end of 2023–early 2024 | No, preparatory works for design are ongoing |
| **EU, GIZ** | Project "Economic and social development of mountainous regions" | Hydro | 0.4 | 0.4 | No | GBAO, GBAO-wide | 0.47 | 2024 | No |
| **IFIs are not identified** | Shurob | CHP | – | – | – | Khatlon, Shurab | 150 | 2024? | No |
| **IFIs are not identified** | Fon-Yagnob | CHP | – | – | – | Sugd, Ayni | 700 | 2024? | No |
| **Budget, World Bank, Eurobonds** | Rogun | HPP | | 500 | | DRS, Rogun | 2,400 | 2025 | No |
| **IFIs are not identified** | Nurek | HPP | – | – | – | Khatlon, Nurek | 100 | 2033 | No |
| **IFIs are not identified** | Sanobod | HPP | – | – | – | Khatlon, Sanobod | 125 | 2033 | No |
| **IFIs are not identified** | Shurob | CHP | – | – | – | Khatlon, Shurab | 350 | 2035 | No |

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