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INVESTMENT IN THE WATER AND ENERGY COMPLEX OF CENTRAL ASIA

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The report contains an analysis of the current situation, international cooperation, challenges, and investment activity in the water and energy complex of Central Asia 30 years after the five republics (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan) gained their independence. The authors have also compiled a database of ongoing and future investment projects related to the CA water and energy complex by analysing investment strategies of the key players, and the relevant state programmes. The report presents a preliminary assessment of capital investment needs of the water and energy segments until 2030.

Keywords: investment, power industry, water resources, Central Asia, multilateral development banks, infrastructure.

JEL: F21, F33, F36, L94, L95.

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ACRONYMS AND ABBREVIATIONS

ADB – Asian Development Bank

AIIB – Asian Infrastructure Investment Bank

CA – Central Asia

CAEWDP – Central Asia Energy-Water Development Programme

CAPS – Central Asia Power System

CAREC – Central Asia Regional Economic Cooperation

CASA-1000 – Central Asia – South Asia Power Project

CASAREM – Central Asia/South Asia Regional Electricity Market

CA UDO – Unified Dispatch Office of Central Asia

CAWEP – Central Asia Water and Energy Programme

CCGT – combined cycle gas turbines

CDO – central dispatch office

CEIC – Census and Economic Information Centre

CHP – combined heat and power plant

CIS – Commonwealth of Independent States

COVID-19 – COronaVIrus Disease 2019

EAEU, Union – Eurasian Economic Union

EBRD – European Bank for Reconstruction and Development

EDB, Bank – Eurasian Development Bank

EEC – Eurasian Economic Commission

EFSD – Eurasian Fund for Stabilisation and Development

EIA – Energy Information Administration

EIB – European Investment Bank

EU – European Union

FDI – foreign direct investment

GDP – gross domestic product

GTPP – gas turbine power plant

GW – gigawatt

HPP – hydro power plant

IFI – international financial institution

IMF – International Monetary Fund

IWMCC RIC – Water Management Research and Information Centre under the Central Asia Interstate Water Management Coordination Commission

kW – kilowatt

MDB – multilateral development bank

MW – megawatt

N/A – data not available

NPP – nuclear power plant

OECD – Organisation for Economic Cooperation and Development

pp – percentage point

PRC – People's Republic of China

PSP – pumped-storage plant

PTL – power transmission line

PVPS – photovoltaic power system

RES – renewable energy sources

SPECA – Special Programme for the Economies of Central Asia (UN)

SPP – solar power plant

SS – substation

TPP – thermal power plant

TW – terawatt

UDC – unified dispatch centre

UES – unified energy system

UN – United Nations Organisation

UNCTAD – United Nations Conference on Trade and Development

UNDP – United Nations Development Programme

USA – United States of America

USAID – United States Agency for International Development

USD – United States dollar

USSR – Union of Soviet Socialist Republics

WB – World Bank

WPP – wind power plant

% y/y – year-on-year growth rate

SUMMARY

The existing level of cooperation among the countries of Central Asia (CA) in the water and energy complex, as well as the technical and economic solutions currently in place, are leading to significant economic losses.

- The annual economic damage and unrealised economic benefits are estimated at up to USD 4.5 billion (adelphi and CAREC, 2017), which corresponds to 1.5% of the region's GDP. Losses in agriculture are estimated at 0.6% of CA GDP, and in the energy complex at 0.9% of CA GDP.
- Preliminary EDB estimates show that over the next five years, removal of water and energy complex inefficiencies may result in an increase of CA GDP by 7% (or by USD 22 billion). In five years, economic growth rates in CA countries will additionally increase by 1.5 pp (relative to the inertial development scenario).
- According to World Bank estimates, over the longer term (until 2050), the difference between the costs of the inertial scenario and the benefits of the scenario assuming the strengthening of CA water and energy complex cooperation may reach 20% of GDP.

The CA countries face a number of challenges:

Energy Sector:

- High wear and tear on power grid equipment and generating capacities (the share of facilities aged 30 years or more ranges from 44% to 75%);
- High electricity losses (7–20% of total generation in some countries);
- Lack of balance between generation and consumption of electricity in CA (loss of export potential of 11 billion kWh);
- Diminished reliability of power supply in Uzbekistan and in the south of Kazakhstan as a result of shortage of manoeuvrable capacity reserve and failure to use HPPs in the neighbouring countries;
- Non-rational use of hydropower, including seasonal shortages and sterile spills due to the failure to align generation and consumption peaks (according to PJSC RusHydro, annual unsatisfied demand in Kyrgyzstan and Tajikistan is estimated at 1.5–3 TWh and 4.0–4.5 TWh, respectively);
- Differences in the legal mechanisms and regulatory/tariff tools used by various countries.

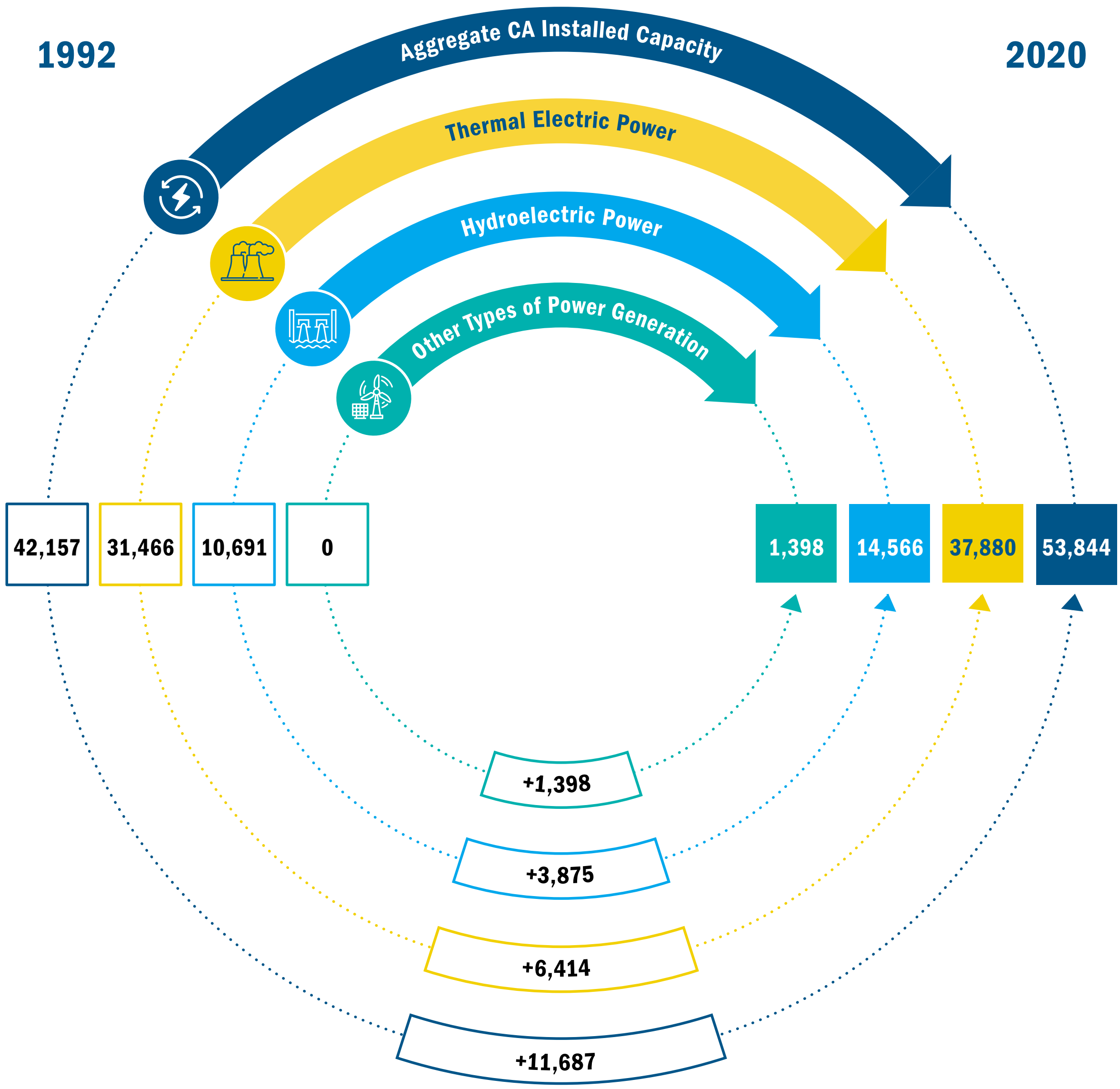
Water Complex:

- Reduction of water supply in the countries of the Aral Sea basin to 1,400 m^3 per person per year (critical threshold: 1,700 m^3), and widening of the deficit of water resources in the lower reaches of water basins as a result of shrinkage of glaciers and decline of meltwater reserves;
- High share of irrigated lands becoming salinized and waterlogged (about 50%) as a result of deterioration of water management facilities (pumping stations, principal canals, the irrigation network, and the collector and drainage network);
- Deviations from designed operating regimes of reservoirs and HPPs;
- Loss of long-term storage capacity of reservoirs, and increasingly critical shortage of irrigation water even during wet years;
- Absence of efficient interstate water regulation required to meet irrigation water needs, which vary from season to season throughout the year;
- Conflict of interests between the countries situated in the upper and lower reaches of transboundary river basins with respect to water resources utilization regimes, etc.

The drastic weakening of cooperation in the Central Asia water and energy complex in the 2000s coincided with a period of rapid increase of the load borne by the energy sector. Net electricity consumption increased by 71.1% – from the post-Soviet minimum of 108.1 TWh in 1999 to 184.9 TWh in 2020 – due to the rapid expansion of energy-intensive industries (the average annual growth rate during the period was 6.7%, excluding Turkmenistan) and high population growth (by 33.5% from 54.3 million to 72.4 million). Parallel to a considerable decrease of average annual energy cross-flows, CA countries intensified construction of new and modernization of existing generating capacities, enabling satisfaction of the growing demand by domestic generation. In fact, over the last two decades, CA countries achieved **self-sufficiency of their energy systems.**

The CA energy sector evolved in the context of state programmes in the region. Subject to the ownership structure and the nature of investment projects in the water and energy complex, the state plays the key role in the development of the complex. The role of the state and state-owned companies is manifested at various levels, including conceptual frameworks for the development of the complex, determination of pricing policies, identification of funding sources, implementation of projects, etc. In 2020, the leaders in capital investment were Kazakhstan (USD 2.783 billion, or 1.6% of GDP) and Uzbekistan (USD 1.377 billion, or 2.4% of GDP). In Tajikistan and Kyrgyzstan, capital investment in the water and energy complex was USD 507 million (6.3% of GDP) and USD 89 million (1.2% of GDP), respectively. In Tajikistan, budget constraints did not prevent implementation of an active state investment policy, with foreign borrowings as the chief source of funding. Weak investment performance of the water and energy complex in the Kyrgyz Republic can be explained by the limited public revenues and low electricity rates, which do not cover the costs of generation.

Figure A. Changes in CA Installed Capacity, MW



Source: based on data provided by EIA and Fitch Solutions (2020 estimate).

Inasmuch as the water and energy complex of most CA countries has weak investment appeal for private capital and foreign investors, multilateral development banks (MDBs) act as an important source of financial resources required to implement state initiatives. At this time, there are 104 ongoing MDB-financed projects, with a total value of USD 10.2 billion. The EBRD tops the list of funding providers with a portfolio of USD 3.3 billion, or 32.7% of total MDB financing in CA. It is followed by the WB (USD 3.0 billion, or 29.6%) and the ADB (USD 2.6 billion, or 26.2%). The combined EDB, EFSD, EIB, and AIIB portfolio stands at USD 1.2 billion (11.5%). The MDBs have continued to finance the CA water and energy complex despite the global drive to minimise the effects of the COVID-19 pandemic. In 2020, the MDBs approved financing of 24 CA water and energy projects for a total of USD 1.8 billion.

Figure B. Participation of MDBs in the Financing of Investment Projects in the CA Water and Energy Complex

Share in Total CA Financing, %		Amount of Financing, USD billions
32.7	European Bank for Reconstruction and Development	3.318
29.6	The World Bank IBRD • IDA	3.005
26.2	ADB Asian Development Bank	2.659
6.7	Eurasian Development Bank / EFSD Eurasian Fund for Stabilization and Development	0.677
3.8	European Investment Bank	0.389
1.1	AIIB Asian Infrastructure Investment Bank	0.107
100	**Total:**	**10.155**

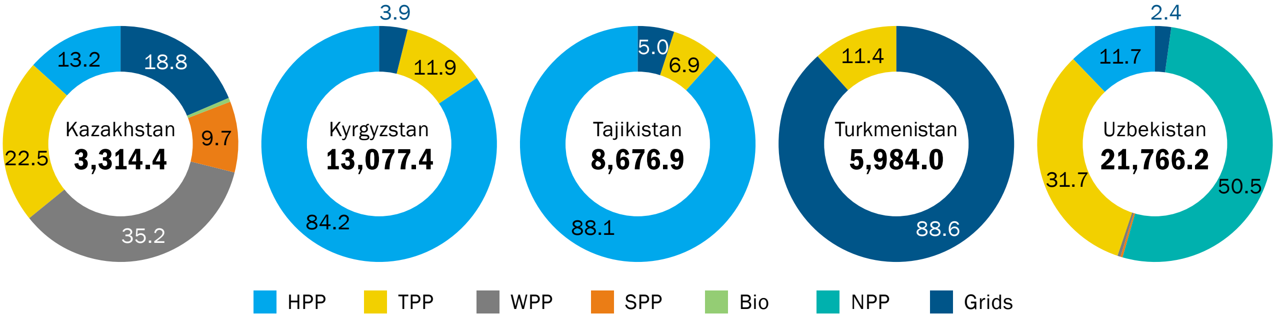
Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

It is anticipated that the average CA GDP growth rate over the long term will remain relatively high because of considerable demographic growth (according to UN forecasts, the median CA population will increase from the current 74.4 million to 90.0 million in 2050), and development of manufacturing, services, and agriculture. Those processes will boost electricity consumption in the region and, accordingly, increase the loads experienced by the existing generating capacity and the grid infrastructure, which are already degraded by significant wear and tear. On the other hand, because of the geographic isolation of the area, the land-locked status of its transboundary river basins, and increasing changes in climate, the growth of water consumption is becoming the chief driver of interstate water use and, accordingly, of interstate relations in the region.

The infrastructure of the CA water and energy complex has substantial investment needs of at least USD 90 billion in 2021–2030 (about USD 9 billion per year, which is much more than would be indicated by the current regional trend). Annual investment needs of the CA water and energy complex stand at 1% of GDP for Kazakhstan, 5.7% of GDP for Kyrgyzstan, 7.4% of GDP for Tajikistan, 3.5% of GDP for Uzbekistan, and 1.7% of GDP for Turkmenistan (Branchoux et al., 2018).

Total identified investment proposals in the energy segment of the CA water and energy complex are currently estimated at **USD 52.8 billion**, with the generation segment and the power grid accounting for USD 45.4 billion (86.0%) and USD 7.4 billion (14.0%), respectively. The main purpose of the relevant projects is to ensure energy supply efficiency, and to do that, it will be necessary to diversify energy sources, build up generating capacities that are traditional for each country, expand into new electricity markets, and reinforce internal power industry ties.

Figure C. Value and Structure of Identified CA Energy Investment Projects, %, as of 1 April 2021



Source: calculated by the authors on the basis of publicly available data.

It is expected that despite the growth of electricity consumption in the region, completion of investment projects scheduled for the next decade will avoid electricity shortages. Electricity surplus in the region will increase from 37.2 TWh in 2020 to 45.6 TWh in 2030 (EDB calculations based on data published by Fitch Solutions, 2020, 2021a, 2021b, 2021c, 2021d) which, in turn, will encourage electricity exports and raise the issue of where such surplus electricity should be sold.

The structure of the investment portfolio comprising ongoing CA water and energy projects is not optimal. In all CA countries, most identified investment projects pursue national interests without proper regard for regional interests, which is a consequence of the uncoordinated evolution of the water and energy complex. Accordingly, development of cooperation in the CA water and energy complex will improve the balance of water and energy resources in the region, and streamline the volume and structure of the investment portfolio. In particular, efficient use of regional hydropower resources will reduce the region's need for new generating capacity.

The challenges faced by the energy segment of the CA water and energy complex are numerous, and each country is trying to find its own solution to counter those challenges. The main problems in that area will come from the growing shortage of water resources. The use of water in CA has been growing rapidly, especially since 1960, due to demographic factors and the development of manufacturing and agriculture, particularly irrigation. The CA countries in the Aral Sea basin are distinctive in that their social and economic development proceeds in the context of **depletion of water resources**. In other words, the volume of resources used exceeds the volume available, and that trend will be determining the nature of interstate relations among the countries of the region. While the natural river runoff in the Aral Sea basin is 116.0 km^3/year, total water intake reached maximum values back in the 1980s–1990s at 120.69–116.27 km^3/year. The elevated demand for water is supported by recycled water.

In 2020, the countries of the Aral Sea basin continued to suffer from water shortages. According to the international classification of availability of water resources, they fall under the "stress" category (1,405 m^3 per person per year; threshold: 1,700 m^3 per person per year). Under the moderate development scenario for CA, this trend will persist over the long-term perspective. If CA countries fail to engage in meaningful regional economic cooperation (including water and energy integration), by 2050 they may move closer to the "scarcity" category (1,296 m^3 per person per year; threshold: 1,000 m^3 per person per year). The water situation will continue to deteriorate due to demographic factors (including persistently high population growth and urbanisation rates in the region) and the possible increase of the area of irrigated lands.

Achievement of the sustainable social and economic development goals facing CA is largely linked to the state of its water resources. Reaching a consensus on interstate water distribution in transboundary river basins is the key task that requires political will and an integrated solution embracing social, economic, and environmental changes as well as the political situation in the countries adjacent to the region. Tasks related to the alignment of positions on joint use of transboundary water resources cannot be regarded separately from country-specific economic development models and regional economic cooperation frameworks. The strengthening of trade and economic ties among the countries of the region and their close cooperation, with water policy becoming an effective economic integration factor, will help deal with the issues associated with the joint use of transboundary water resources.

Figure D. Use of Water and Land Resources in the Aral Sea Basin

	1980	1990	2000	2020	2030	2050
Population (millions)	26.8	33.6	41.5	74.4	81.6	90.0
Irrigated Lands: Total (thousand hectares)	6,920	7,600	7,990	8,040	8,100	8,200
per capita (hectares per person)	0.26	0.23	0.19	0.11	0.1	0.09
Water Intake: Total (km³ per year), including	120.69	116.27	105.0	104.6	107.5	106.3
Irrigation (km³ per year)	106.79	106.4	94.66	94.1	87.5	78.72
Irrigation per hectare (m³ per year)	15,430	14,000	11,850	11,704	10,800	9,600
per capita (m³ per person per year)	4,500	3,460	2,530	1,405	1,317	1,296

Note: Total water intake projections incorporate data on reuse of discharge, collector and drainage water, prospective rate of urbanisation in the countries of the region, and climate change.
Source: IWMCC RIC, authors' calculations.

Water infrastructure facilities are the most important long-term investment targets in any country, as capital investment in such facilities determines the quality of life of the population and the state of the economy for the next 20–30 years. That is why it is clearly necessary to design an efficient capital investment utilization mechanism, and to take into account the real risks to which infrastructure projects are exposed due to corruption and inefficient decision-making. To mitigate risks at all stages of implementation of such projects, it is important to ensure availability of accurate and updated information, rigorous planning, and clearly defined and audited business processes. Because construction of hydropower and water management facilities is very expensive, and it takes a very long time to go through the preparation and construction periods, loan and credit financing requires government bodies and financial institutions to thoroughly analyse and forecast the financial, economic, and environmental implications of each project. That is why it would make sense for the EDB, as well as for the ADB and the World Bank (the only MDBs involved in the funding of water projects), to pay more attention to analytical assessment and pre-investment substantiation of hydropower and water management projects, keeping in mind that they are directly linked to sustainable development.

1. CURRENT STATE OF THE WATER AND ENERGY COMPLEX OF CENTRAL ASIA

1.1. Natural and Geographic Description of Central Asia and the Current State of Its Water Resources

Nestled in the very centre of Eurasia, this region has the world's seventh-largest land area (more than 4 million km^2) and borders on Russia in the north-west, on Iran and Afghanistan in the south, and on Russia and China in the east. CA represents a vast endorheic area of the land-locked Aral Sea and Caspian Sea basin, covering subtropical latitudes and the southern fringe of the temperate latitudes. Because of its geographic position inside the belt of intracontinental deserts, remoteness from seas and oceans, and orographic structure, the region has a continental climate with typical hydrographic patterns and river regimes.

In orographic terms, Central Asia is divided into two parts: the western part, which accounts for 70% of its territory and is dominated by lowlands (the Turan Depression); and the eastern part, which is occupied by mountain ranges. Based on its physical and geographical properties, the territory of Central Asia can be divided into four large sea and lake basins: the Aral Sea basin; the Lake Balkhash basin; the north-eastern part of the Caspian Sea basin, the Ural and the Emba (Zhem) rivers; and the Kara Sea basin. The Irtysh river basin and the Lake Balkhash basin contain the bulk of water resources of the south-eastern and eastern parts of Kazakhstan – a strategic source of water for its central and northern regions. The Irtysh, as well as its tributaries the Ishim and the Tobol, are the key water sources. The average volume of surface water of the region that includes Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan is 196 km^3 per year (Volynov et al., 1980).

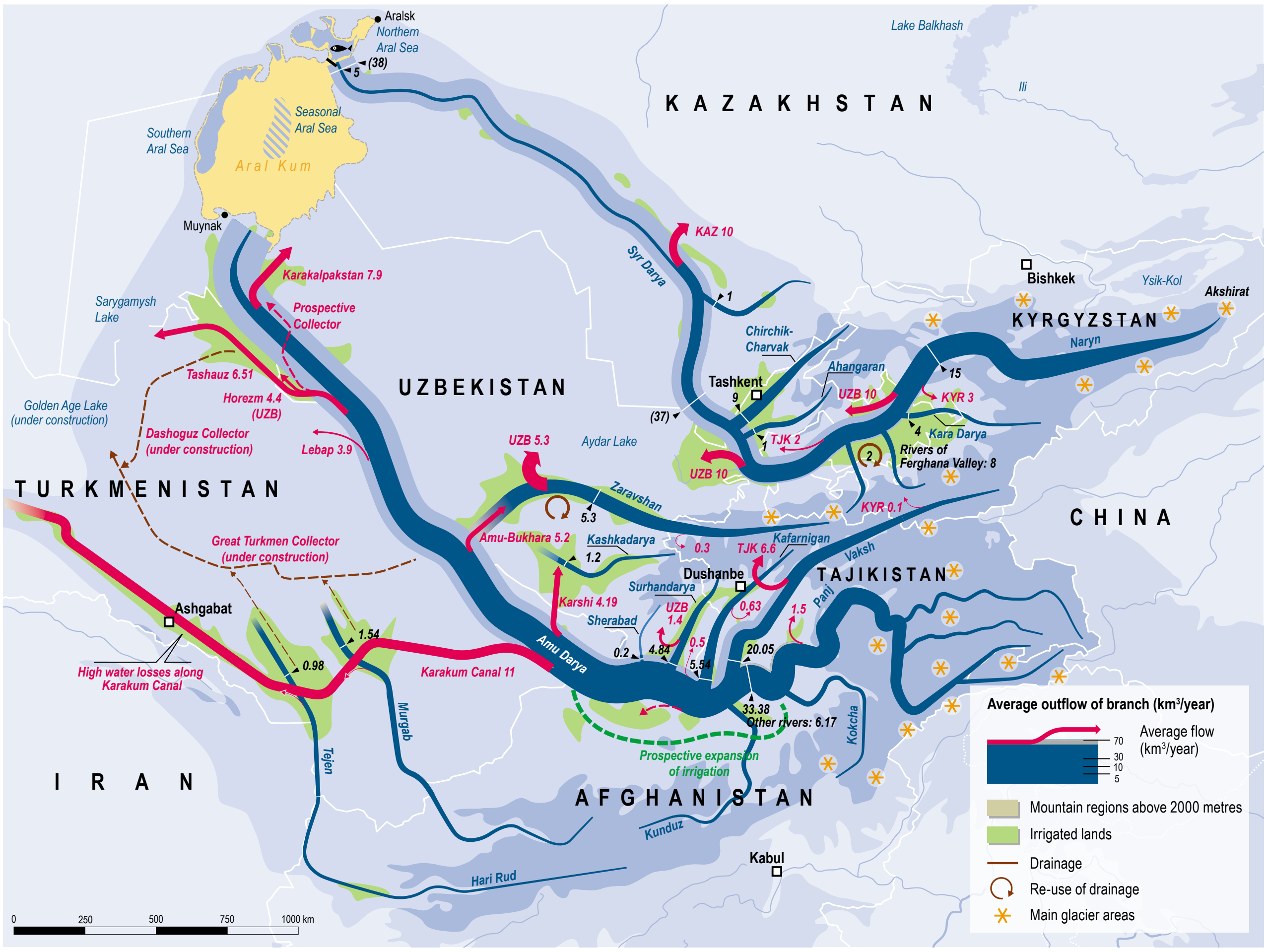
The Aral Sea basin (with boundaries almost the same as those of Central Asia) covers the entire territory of Tajikistan and Uzbekistan, a large part of Turkmenistan, four regions of Kyrgyzstan, the southern part of Kazakhstan, and the northern parts of Afghanistan and Iran. The water resources of the Aral Sea basin mostly belong to the basins of the Syr Darya and the Amu Darya rivers. Independent basins (endorheic, but gravitating towards the Amu Darya) are formed by the Kashka Darya, the Zeravshan, the Murghab, and the Tejen (the Hari), which lost their connection to the main river a long time ago. Disposable water resources of the Aral Sea consist of renewable surface and subterranean waters of natural origin, and return waters of anthropogenic origin.

Table 1. Aggregate Natural River Runoff in the Aral Sea Basin (average annual runoff, km³ per year)

Countries	River Basins		Aral Sea Basin	
	Syr Darya	Amu Darya	km³	%
Kazakhstan	2.516	-	2.516	2.2
Kyrgyzstan	27.542	1.654	29.196	25.2
Tajikistan	1.005	58.732	59.737	51.5
Turkmenistan	-	1.405	1.405	1.2
Uzbekistan	5.562	6.791	12.353	10.6
Afghanistan and Iran	-	10.814	10.814	9.3
Total	**36.625**	**79.396**	**116.021**	**100**

Source: IWMCC RIC.

Figure 1. Water Resources of Central Asia*



* Reproduced with the permission of the copyright holder.

Source: UNEP, GRID-Arendal and Zoï Environment Network (2011).

All large rivers of the Syr Darya basin (the Naryn, the Kara Darya, the Chirchiq, and the Syr Darya itself) are snow- and glacier-fed. Depending on water content as it changes from year to year, surface runoff fluctuates within a broad range. The highest mean annual flow rate in these rivers is observed in June. Dry years alternate with wet years, with dry years usually occurring two or three times in a row, and wet years occurring one at a time.

More than 80 reservoirs with a useful storage capacity of 10 million cubic metres each have been built in the Aral Sea basin (see Annex 2). The total storage capacity of the reservoirs is 64.5 km^3 (useful storage capacity: 46.5 km^3), including 20.2 km^3 in the Amu Darya basin and 26.3 km^3 in the Syr Darya basin. These reservoirs have a high degree of control of the runoff of these rivers – 0.94 for the Syr Darya (natural runoff is almost fully controlled), and 0.78 for the Amu Darya (that is, control reserves remain available). It is expected that river runoff control reserves will have been fully exhausted by 2030.

Mountainous areas are concentrated in the south-eastern part of CA, and act as a "water tower" feeding the rivers that flow towards northern and western arid and semiarid regions. Inasmuch as those territories in Tajikistan and Kyrgyzstan are the place of origin of the main water resources of Central Asia, while Kazakhstan, Turkmenistan, and Uzbekistan lie in the lowlands, control and management of water resources is a very sensitive regional issue.

Kazakhstan, Uzbekistan, and Turkmenistan are characterised by high transboundary water dependence. For example, Kazakhstan's disposable water resources are 100.5 km^3 per year, with 56.5 km^3 of internal resources and 44 km^3 of external resources coming from the adjacent countries. Accordingly, Kazakhstan's transboundary water dependence ratio is as high as 0.44. In Uzbekistan, that ratio stands at 0.68: out of total disposable water resources of 50.6 km^3 per year, 34.1 km^3 per year are external resources. Turkmenistan has the highest transboundary water dependence ratio of 0.95. Out of total disposable water resources of 24.8 km^3 per year, 23.4 km^3 per year come from abroad (Yasinskiy, Mironenkov, Sarsembekov, 2010).

The large hydraulic engineering facilities built during the USSR era – HPP reservoirs, powerful canals, and pump stations – were mostly used to provide irrigation water to cotton plantations in Uzbekistan, Tajikistan, Kyrgyzstan, Kazakhstan, and Turkmenistan. Generation of hydropower in upstream countries was a secondary task (adelphi and CAREC, 2017). The fast expansion of irrigated lands and development of other types of water use, including hydroelectric engineering, changed the natural hydrological regime of the region, and created serious social and environmental problems, including the drying up of the Aral Sea, destruction of its ecosystem, desertification of huge adjacent areas, deterioration of water quality and the health of the local population, local climate change, etc.

1.2. Current State and Structure of the Energy Complex of Central Asia

The energy complex is a core sector of CA national economies. With their considerable energy resources and advanced energy complexes, the countries of the region are well positioned for economic integration. These factors, while shaping the region's development strategy for the energy complex, call for coordination of energy policies in domestic and external energy markets (Vinokurov, 2008).

Energy resources are unevenly distributed across Central Asia, and each country makes use of its natural advantages (Vinokurov, 2018). In countries with significant oil, gas, and coal resources

(Kazakhstan, Turkmenistan, and Uzbekistan), most electricity is produced by thermal power plants. In Kyrgyzstan and Tajikistan – mountainous countries with a high hydropower potential – hydro power plants account for a considerable part of total electricity generation (more than 90%). Central Asia has large uranium reserves, making Kazakhstan and Uzbekistan the world's leading producers. However, the region has no active NPPs. Uzbekistan is building the region's first NPP, which is expected to go live in 2028.

Table 2. Resource Potential of the Power Industry of the Central Asian Countries

	Kazakhstan		Kyrgyzstan		Tajikistan		Turkmenistan		Uzbekistan		CA	
	2000	2020	2000	2020	2000	2020	2000	2020	2000	2020	2000	2020
Coal, billion tonnes*	34.1	34.1	1.34	1.27	0.67	1.0	N/A	N/A	2	2	38.11	38.37
Oil, million tonnes*	2,760	2,760	11.5	1.2	5.4	10	75	75	350	350	3,261.9	3,205.2
Gas, billion m^3*	1,841	1,841	6.54	6.2	9.2	10	2,860	2,860	2,000	2,000	6,716.74	671.2
Uranium, thousand tonnes**	601	601	N/A	N/A	N/A	N/A	N/A	N/A	83.7	83.7	684.7	684.7
Hydropower, billion kWh/year***	27	27	52	99	317	317	2	2	15	15	413	460
NRES****, including compact HPPs, billion kWh/year	66	66	N/A	N/A	18.4	18.4	N/A	N/A	N/A	N/A	84.4	84.4

* Data for coal, oil, and natural gas represent total explored recoverable reserves;
** WEC (World Energy Council) assessment of explored uranium reserves with production costs of up to USD 130 per kilogram;
*** Economically viable hydropower potential. Uzbekistan – technical hydropower potential;
**** NRES – non-renewable energy sources.

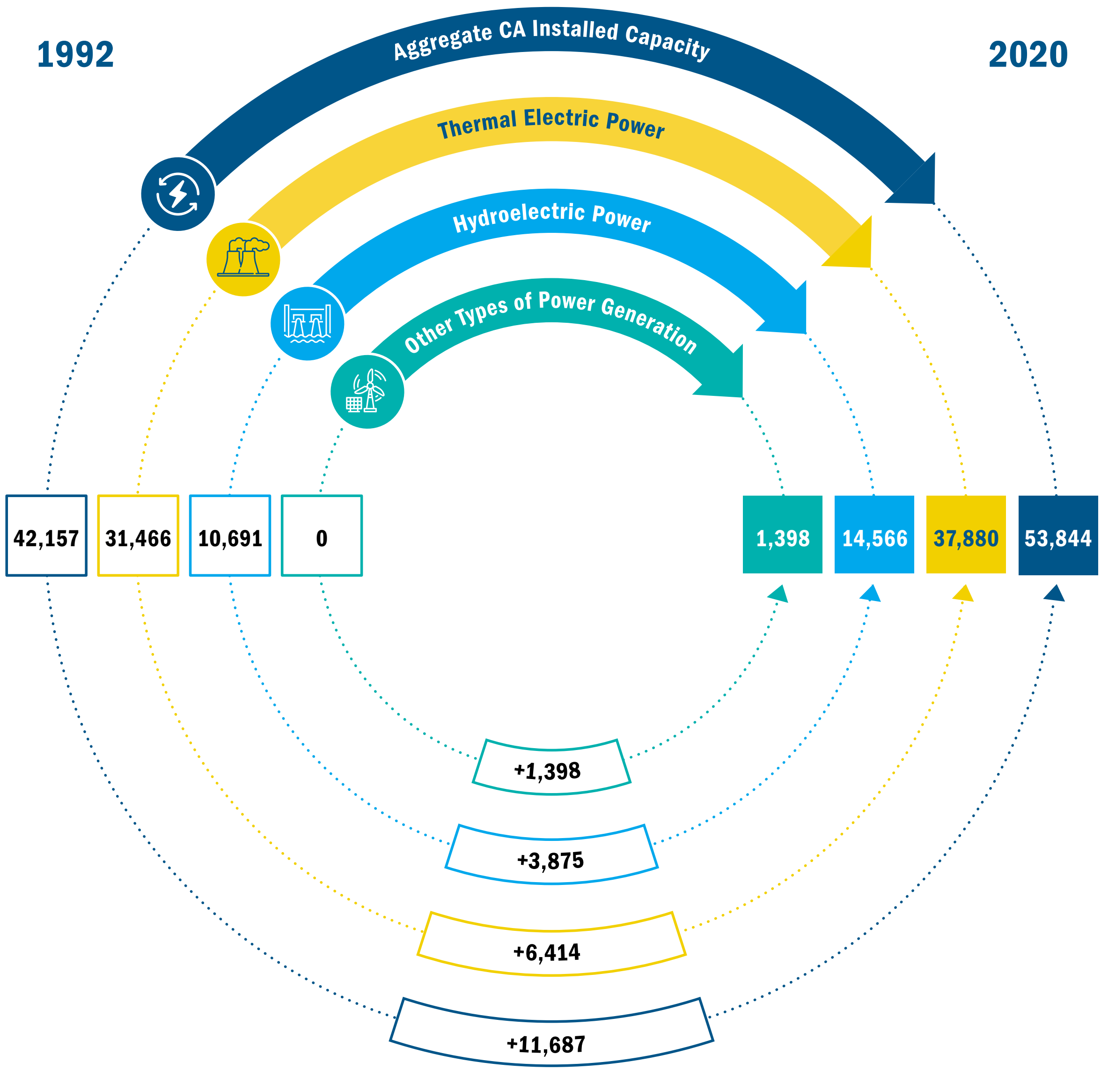
Source: based on data provided by the UN and national agencies.

CA's power generation potential substantially strengthened as economic development gained momentum. As a result, by the end of 2020 total generating capacity increased by 27.7% (or by 11.7 GW) relative to 1992, reaching 53.8 GW (0.7% of total global capacity – which is still less than one half of the 1.5% recorded in 1992).

Kazakhstan, Tajikistan, and Uzbekistan became the region's leaders in the rate of increase of generating capacity. Due to vigorous investment activity in the energy sector, capacity in these three countries increased in 1992–2020 by 4.5 GW, 3.3 GW, and 2.3 GW, respectively. In Turkmenistan, the capacity increase was 1.3 GW. **Kyrgyzstan posted the least capacity increase** during the post-Soviet period (1992–2020), with merely 0.3 MW.

Despite a decline in its share of total installed capacity and electricity output in the region, Kazakhstan maintained its leadership, and at the end of 2020 accounted for 43.5% of total CA capacity and 46.1% of total CA electricity generation (estimates by Fitch, 2021a). The country is actively stepping up investments in modernisation of the electric power segment, including development of RES. Kazakhstan became the only CA country which successfully launched the process of raising investment capital to finance the new "green" segments of the power industry (solar and wind generation).

Figure 2. Changes in CA Installed Capacity, MW



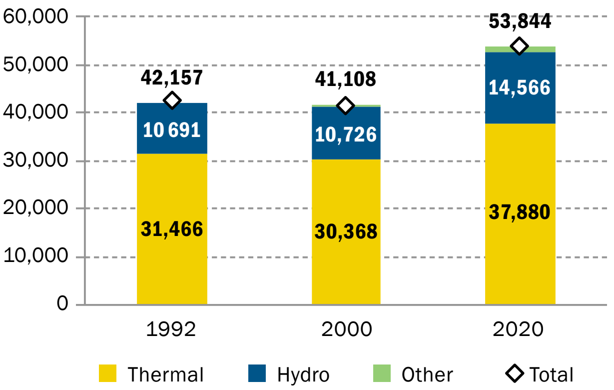
Source: based on data provided by EIA and Fitch Solutions (2020 estimate).

The bulk of Central Asia's installed capacity (70.4%) is represented by thermal power plants using fossil fuels (coal, gas, fuel oil, etc.) as the primary source of energy. At the end of 2020, their aggregate capacity stood at 37.8 GW, a 20.4% increase relative to 1992.

More than 50% of thermal power generating capacity of Central Asia is concentrated in Kazakhstan. In 2020, its total potential was estimated at 19.5 GW (Samruk-Energo, 2021). Kazakhstan has substantial coal reserves, and most of its electricity is generated by coal-fired power plants. They are usually situated in the vicinity of coal fields and large industrial centres concentrated in the north of the country. The total capacity of steam turbine TPPs is 17.4 GW. Steam turbine power plants generate about 2 GW. A few plants operate on fuel oil (less than 1.0% of total generation). In total, thermal power plants account for 19.5 GW, or 84.5% of Kazakhstan's total generating capacity. The main producer is JSC Samruk-Energo, which generates almost one third of all electricity produced in the country (2009: 30.2 TWh out of 106 TWh, or 28.5%), and controls the main thermal power plants. The second- and third-largest producers in Kazakhstan are the Eurasian Resources Group (ERG) with 18.5 TWh (18.3%), and LLP Kazakhmys Energy with 7.4 TWh (7%).

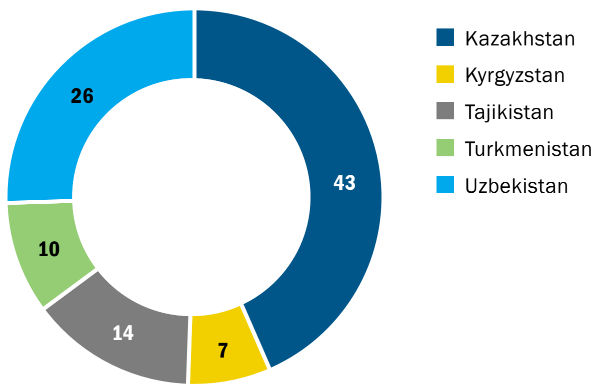
Uzbekistan and Turkmenistan have considerable gas reserves. Accordingly, energy sector development there is driven primarily by gas-fired power plants. In 2020, total installed capacity of thermal power plants was 11.8 GW in Uzbekistan and 5.2 GW in Turkmenistan (estimates by Fitch 2021c, 2021d), accounting for 89% and 99% of total generation, respectively. In Uzbekistan, the structure of primary energy resources used to generate electric power at TPPs is dominated by gas (86.6%), followed by coal (10.8%), fuel oil (2.4%), and underground coal-derived gas (0.2%) (Executive Committee of the CIS Electricity Council, 2020). The main producer is JSC TES, comprising 14 enterprises. Turkmenistan has been actively building gas-fired power plants, including high-tech combined-cycle plants. The main producer is the Turkmenenergo State Electricity Corporation, comprising 12 state-owned power plants.

Figure 3. CA Installed Capacity, MW



Source: based on data provided by EIA and Fitch Solutions (2020 estimate).

Figure 4. CA Installed Capacity Structure, 2020, %



Source: based on data provided by EIA and Fitch Solutions (2020 estimate).

In Kyrgyzstan and Tajikistan, thermal power plants are used less extensively due to those countries' geographical features and considerable hydropower potential. In 2020, the share of TPPs in total generating capacity was 19.2% (0.7 GW) in Kyrgyzstan, and 8.4% (0.7 GW) in Tajikistan (estimates by Fitch 2021b, 2021d). Amid mounting power shortages, both countries took steps to diversify their sources of electricity supply by expanding their TPP networks. Kyrgyzstan modernised the Bishkek CHP, with total installed capacity increasing to 812 MW after two new power units had been put in operation, with a combined capacity of 300 MW. Tajikistan's sizeable coal reserves enabled a TPP capacity boost. For example, Phase 2 of Dushanbe CHP-2 was commissioned in 2018. Together with Dushanbe CHP-1, it will facilitate the control of water reserves in the Nurek Reservoir during the autumn/winter.

At the end of 2020, hydro power plants generated 15.8 GW, with a 29.3% share in total Central Asia generating capacity. Most HPPs are concentrated in Tajikistan (44.7% of the region's HPPs) and Kyrgyzstan (19.6%). In those two countries, HPPs account for 92.7% and 91.8% of total generation, respectively. In 1992–2020, both countries increased their HPP generating capacities. In Tajikistan, total capacity was up by 74.1% from 4 GW to 7 GW. Some of the largest projects completed during that period were the Sangtuda-1 HPP, the Sangtuda-2 HPP, and two Rogun HPP power units. Kyrgyzstan was active during the first 10 post-independence years, but after that total HPP capacity changed little, if at all, until 2020. The only large completed project was the new 120 MW power unit at the Kambarata-2 HPP in 2010. Two modernisation projects are under way at the Toktogul HPP and the Uch-Kurgan HPP.

Central Asia as a whole has a large RES development and generation potential. In addition to hydropower, it appears expedient to promote development of solar and wind power. The solar generation potential is rated high (Solargis, 2019). It exceeds the average values in European and Asian continental territories, but is lower than in tropical and subtropical deserts further south. The wind generation potential is rated as moderate (DTU, 2019), with higher values along mountain ranges in the south of Kazakhstan, and in the open steppe to the east of the Caspian Sea.

So far, alternative sources of energy in CA have been used only in Kazakhstan: the total installed capacity of solar power plants (SPPs) and wind power plants (WPPs) increased from 2 MW in 2012 to 1,398 MW in 2020.

Table 3. Installed RES Capacity (Excluding Compact HPPs) in Kazakhstan, 2020

Power Plants	Installed Capacity			Disposable Capacity		
	2019	2020	Δ, MW	2019	2020	Δ, MW
Total	**880.06**	**1,398**	**517.94**	**513.5**	**954.3**	**440.8**
SPPs	597	885.3	288.30	364	641.6	277.60
WPPs	282	511.6	229.60	149	311.6	162.60
Biogas Units	1.06	1.1	0.04	0.5	1.1	0.60

Source: based on JSC Samruk-Energo data.

Increased utilisation of RES in Kazakhstan and involvement of investors in that process are facilitated by state support. For example, while in 2014–2017 RES power rates were fixed, the new terms introduced in 2018 (when the rate was set in a competitive bidding procedure, and subsequently adjusted for exchange rate and CPI changes) are designed to encourage private investment in the RES sector.

Uneven geographical distribution of various types of fuel and energy resources across the countries of the region can be construed as both an opportunity and a necessity to strengthen regional cooperation on a market basis. However, there are many obstacles to the use of energy resources in CA which require new region-specific approaches to dealing with the above issues.

1.3. Key Operating Principles of the Central Asia Power System (CAPS)

During Soviet times, the water and energy complex of Central Asia was created and developed in an integrated manner as a critical component of the Central Asian economic district of the

Soviet Union. Accordingly, plans were developed and implemented to ensure efficient management of Central Asian water and fuel/energy resources; those plans provided a special mechanism to offset costs and allocate benefits among the countries of the region (World Bank, 2010). Thus, most of the electricity generated by the Naryn HPP Cascade (in the Syr Darya basin) and the Vakhsh HPP Cascade (in the Amu Darya basin) during the summer irrigation releases was handed over to the neighbouring republics, while in exchange Kyrgyzstan and Tajikistan received electricity, natural gas, coal, and fuel oil for thermal power plants in autumn and winter from the Soviet Union's reserve of material and technical resources (Vinokurov, 2008).

The mutual exchange mechanism used in the USSR was based on a set of arrangements ensuring integrated utilisation and protection of water resources of the Syr Darya River. It imposed water intake limits on each republic for both the vegetation period (from April to September) and the non-vegetation period (from October to March), and defined the prospects for further development of hydropower generation in the basin of the river, including the construction of the Kambarata-1 HPP, the Kambarata-2 HPP, and the Upper Naryn HPP Cascade. The construction of the Kambarata-1 HPP (which needed to be higher than the Toktogul HPP) was planned to secure a guaranteed water supply to meet agricultural needs, regardless of water content during any particular year. The Rogun HPP, with an over-year storage reservoir, was designed for the same purpose.

The Central Asia Power System (CAPS) was created in the 1970s to streamline the utilisation of water and energy resources and increase reliability of the power supply and irrigation water supply. Its operating footprint was approximately 2 million km^2, and covered the entirety of Uzbekistan, Tajikistan, Kyrgyzstan, and Turkmenistan, and five adjacent regions of Southern Kazakhstan. Its network consisted of 83 power plants of different types (TPPs – 70%, HPPs – 30%) owned by the power systems of the region's countries, and joined by 220 kV and 500 kV power transmission lines. The CAPS was managed by the Unified Dispatch Office of Central Asia (CA UDO) in Tashkent.

Long-term planning of CAPS regimes took into consideration the structure of the generating capacities of each power system, and sought to minimise fuel consumption and power losses in the system's networks. Power system regimes and CAPS HPP reservoir regimes were aligned by the CA UDO, as well as by BWMO Syr Darya and BWMO Amu Darya. CA UDO went live in April 1960, and was responsible for operational and technical management of the CAPS. In this way, a unique integrated power system was created in Central Asia that ensured both reliable electricity supply and season-adjusted long-term control of river runoff for irrigation purposes, taking into consideration the dry periods in the Syr Darya and Amu Darya basins. Notably, even though the CAPS was isolated from the USSR UES, the CA UDO reported to the USSR UES CDO, and was financed by the Ministry of Power Industry and Electrification of the USSR.

After the dissolution of the USSR, centralised funding of CAPS operations from the USSR budget stopped, and its operating regime was disrupted. Because of the shortage of domestic energy resources, countries that relied heavily on hydropower generation began to release more water from their reservoirs during the winter to cover seasonal electricity demand peaks, thereby breaching the operating rules of HPPs and their designed water and energy regimes. The CAPS functionality decline was accompanied by a spike in the number of power system incidents eroding power supply reliability. To avoid further deterioration of the sustainability of power systems, the CA countries got together in Ashgabat in November 1991 to sign the *Agreement on Parallel Operation of Power Systems*, and to establish a jointly financed Unified Dispatch Office of Central Asian Power Systems (CA UDO).

In 1994, the CA UDO changed its name to Unified Dispatch Centre – UDC Energy. The CAPS Council, consisting of the heads of power systems of the countries of the region, became the governance body charged with the management and coordination of parallel operation of the CAPS component systems.

Despite efforts to maintain the integrity of CAPS, in June 2003 Turkmenistan withdrew from the joint operation, which severely impaired the operating conditions in the western part of the system, and reduced the reliability of power supply to end consumers. In October 2004, CAPS member countries entered into an *Agreement on Coordination of Relations in the Central Asian Electric Power Industry*, and established the Electric Power Coordination Council of Central Asia (CA EPCC) as an advisory body. In September 2006, the CA EPCC established the "Coordination and Dispatch Centre – CDC Energy". The key functions of that non-governmental non-commercial organisation were to maintain parallel operation and coordinate operation and dispatch activities of Central Asian power systems. The CDC Energy reports to the CA EPCC, which acts as its supreme governing body.

In October 2009, Uzbekistan unilaterally disconnected the interstate power transmission line between Uzbekistan and Tajikistan, whereupon the latter's power system ceased to operate in the parallel mode. As a result, the CAPS lost up to 1 GW of control capacity, while Tajikistan was forced to make up for winter power shortages by reservoir drawdowns, resorting to sterile spills during the summer because of its inability to supply surplus electricity to other countries. In certain years, sterile spills bypassing HPP turbines were as large as 5 km^3.

Intense utilisation of water resources in the region and breach of reservoir operating regimes (rules) caused serious complications in the Syr Darya basin during both winter and summer. After the Toktogul Reservoir had switched to the power generation regime, the entire water management situation in the Syr Darya basin changed. The downstream Kayrakkum and Shardara reservoirs were overrun by increased releases from the Toktogul Reservoir during the inter-vegetation period, and annual sterile spills to the Arnasay Depression were used to prevent the flooding of the lower reaches of the Syr Darya.

In an attempt to resolve their differences, Kazakhstan, Kyrgyzstan, and Uzbekistan began to execute, starting from 1995, annual inter-governmental agreements on the use of water and energy resources in the Syr Darya basin. The agreements fixed the volume of vegetation releases from the Toktogul Reservoir to meet the irrigation needs of the basin, and determined the scope of compensatory supplies of energy resources (natural gas, electricity, fuel oil, coal) from Uzbekistan and Kazakhstan to Kyrgyzstan during the autumn/winter in exchange for the transfer of surplus electricity generated by hydro power plants using the additional releases during the summer. For example, in 1998 the governments of Kazakhstan, Kyrgyzstan, and Uzbekistan signed an agreement on the use of water and energy resources of the Syr Darya basin. The document established the following scheme for the water/energy exchange: Kyrgyzstan guaranteed summer releases from the Toktogul Reservoir, while Kazakhstan and Uzbekistan guaranteed acceptance of surplus electricity during the summer and supply of fuel and energy resources during the winter. In addition, the agreement envisaged the creation of an international water and energy consortium.

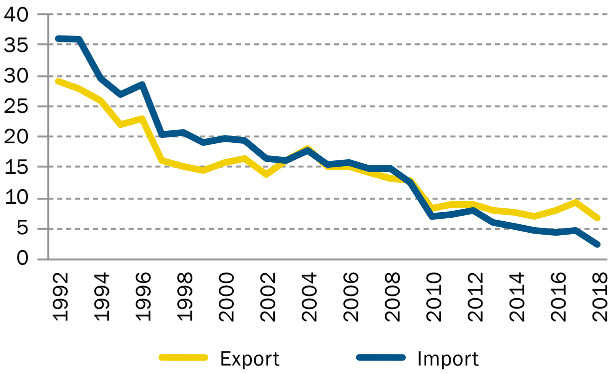
Later (from 2003 and on) the parties switched to bilateral "energy in exchange for water" agreements (Kazakhstan–Kyrgyzstan, Uzbekistan–Kyrgyzstan) depending on the current water management situation. Still, during the dry years consumers occasionally failed to receive the agreed amount of water. The creation in CA of an international water and energy consortium has been under discussion since 1998. In 2004, the countries of the region approved (but later failed to implement) a conceptual framework for the establishment of such a consortium. The water and energy cooperation framework has also been under consideration by the EurAsEC since 2004, but in the end it was not approved either, as the parties were unable to align their positions on certain key issues.

1.4. Economic Costs of the Loss of CAPS Functionality

Dissolution of the CAPS contributed to reduced cooperation in the water and energy segment, and gave rise to multiple problems in the energy sectors of virtually all countries of the region. In 2018, the average annual energy cross-flows among the CA countries were about 18% of the 1992 level. The average volume of interstate exchange of electricity among these countries decreased from 35.9% to 2.4% of net electricity generation in the region for receipts (imports), and from 29.1% to 6.7% for transfers (exports).

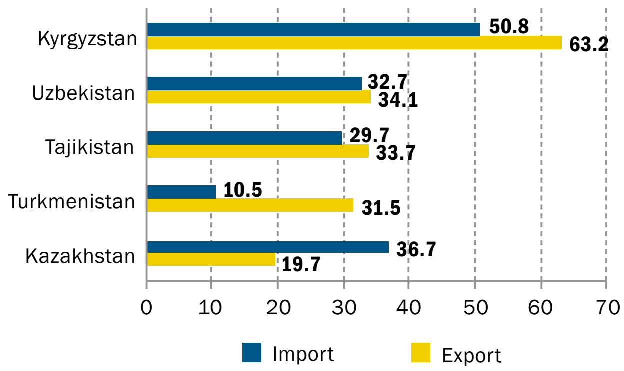
Taking into consideration the growing load borne by the electric energy complex of a rapidly developing region, these developments jeopardised power supply security, particularly in the countries heavily relying on hydropower generation (Kyrgyzstan and Tajikistan). In 1992, these two countries imported 50.8% and 29.7% of net generation, respectively (see Figure 5). Export volumes were even higher: 63.2% and 33.7%, respectively. In that context, and taking into consideration the generally "energy-excessive" nature of the power systems of these countries, the dissolution of the CAPS strongly aggravated the problem of electricity shortages during the winter and electricity surplus during the summer. During peak periods, these countries are now forced to resort to power outages as a demand management tool, and have to import electricity.

Figure 5. Export and Import of Electricity in CA, % of net generation



Source: based on EIA data.

Figure 6. Export and Import of Electricity in CA in 1992, % of net generation



Source: based on EIA data.

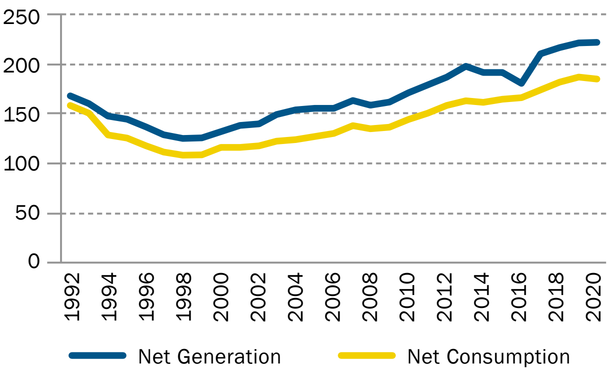
In the countries located in the lower reaches of water basins (Kazakhstan and Uzbekistan), the problems created by power supply shortages during peak periods have been exacerbated by the shortage of water for the agricultural sector. Because of a disproportionate allocation of generating capacity in Kazakhstan (production breakdown by zones shows that 76.8% of electricity in 2020 was generated in the Northern Zone) (Samruk-Energo, 2021), southern regions regularly face power shortages. Uzbekistan, with its limited hydropower potential, is facing the peak loads issue. One of the key advantages of hydro power plants is that they can be used as a manoeuvrable capacity reserve, because their generators can be easily switched on/off depending on demand. That enables efficient frequency control[1] and coverage of increasing peak loads.

Occasionally there are disruptions of agreed cross-flows between the Kazakhstan UES and the CAPS. The shortage of capacity and energy in the Uzbekistan power system during the autumn/winter peaks overloads the Kazakhstan North–South section, triggers automatic Kazakhstan North–South splits, and results in unscheduled diversions of cross-flows between the power systems of Russia and Kazakhstan. All these negative factors lead to severe accidents in CA national power systems, loss of long-term storage capacity of reservoirs, and increasingly critical shortage of irrigation water even during wet years.

After a protracted slump during the period of economic transformation and reduction of electricity consumption in 1992–1999, CAPS loads have been growing almost continuously since 1999. Economic recovery and acceleration in the region were accompanied by a net growth of electricity consumption in 1999–2020 by 71.1% (or 76.8 TWh) to 184.9 TWh. At the same time, the growth of production and consumption was accompanied by massive losses and inefficient utilisation of energy resources. For example, in countries producing hydropower, annual losses caused by sterile spills are estimated at 1–3.6% of total consumption.

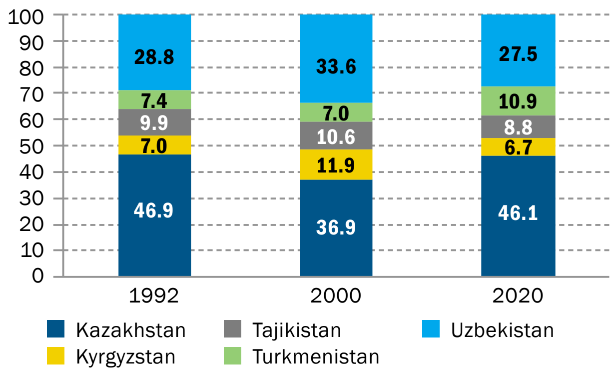
Economic damage and unrealised economic benefits in CA are estimated at up to USD 4.5 billion (adelphi and CAREC, 2017), which corresponds to 1.5% of the regional GDP. Losses in agriculture are estimated at 0.6% of CA GDP, and in the energy complex at 0.9% of CA GDP. According to World Bank estimates (World Bank, 2016), over the longer term, until 2050, the difference between the inertial scenario costs and the CA water and energy complex cooperation scenario benefits may reach 20% of GDP. Preliminary EDB estimates show that by 2025 removal of water and energy complex inefficiencies may result in a CA GDP increase of 7% (or USD 22 billion). In five years, economic growth rates in CA countries will additionally increase by 1.5 pp relative to the inertial development scenario.

Figure 7. Electricity Generation and Consumption in CA, billions of kWh



Source: based on EIA data.

Figure 8. Structure of Electricity Generation in CA, %



Source: based on EIA data.

[1] Frequency control in a power system is the process whereby alternating current frequency is maintained within an agreed range. Frequency is one of the most important electricity quality metrics, and a critical power system operating parameter. Frequency is determined by the balance of generated and consumed active power. When the power balance is compromised, frequency changes. If frequency in a power system goes down, it is necessary to increase active power generation by the plant to restore the normal frequency level.

The Central Asia energy security problem, already urgent in the case of Kyrgyzstan and Tajikistan, was aggravated even further as net electricity consumption was restored to Soviet-era levels in Kazakhstan (since 2012) and Uzbekistan (since 2014). For a long time, disposable capacity in those countries had been adequate for the diminished consumption needs. Growing electricity consumption combined with low energy efficiency spurred renewed interest in cooperation on water and energy issues.

Kyrgyzstan and Tajikistan are actively promoting projects for the construction of large hydropower facilities along the beds of transboundary rivers and creation of mechanisms enabling integrated management of regional hydropower infrastructure, insisting on possible compensation of costs incurred during the operation of international hydropower facilities.

CA lacks a consistent inter-governmental policy for development of regional cooperation in the water and energy complex; however, there have been some positive changes. In 2017, Uzbekistan, one of the largest consumers of water provided by the region's transboundary rivers, has softened its position regarding the construction of the Rogun HPP in Tajikistan and the Kambarata-2 HPP in Kyrgyzstan; took practical steps to restore parallel operation with Tajikistan's power system; and initiated restoration of the CAPS. It is expected that participation of Tajikistan and Turkmenistan in the CAPS will reduce electricity shortage risks during the dry years forecasted for the region.

Kazakhstan has traditionally taken a moderate position on preservation of the common power system with Kyrgyzstan for mutual electric power supplies, but Kazakhstan does not support the construction of large hydropower facilities along the Syr Darya River without prior approval of all countries within its basin.

1.5. Central Asia Grid Architecture: Mutual Dependence and High Losses

Following the independence of the CA republics and the subsequent breakup of the CAPS, the volume of transit and mutual exchange of electricity decreased significantly; however, a new distribution network reconfiguration process was launched concurrently to capture new opportunities. For example, after its withdrawal from the CAPS, Turkmenistan synchronised its grid operations with Iran. Uzbekistan and Tajikistan are cooperating with Afghanistan's North East Power System (NEPS) and are supplying electricity, but their power system operations are not synchronised because of stability issues (Shamsiev, 2019).

The development of the internal electricity grid in all CA countries aimed at the formation of their own unified energy systems in order to improve national energy security. Thus, large projects for the construction of high-voltage lines were implemented in Kazakhstan in order to expand the transmission capacity of electricity from the surplus north region to the south and east of Kazakhstan. In Kyrgyzstan, a project was implemented to build the Datka–Kemin high-voltage line, connecting the north and south of the country.

Most CAPS facilities, including distribution networks, were built in 1950–1970. Distribution networks have also been affected by wear and tear, and their equipment has become obsolescent, which has had a serious impact on the quality of power supply. In all the countries, electricity losses, including those occurring during transmission, are estimated at 7–20% of total generation (Kochnakyan et al., 2013; World Bank, 2013, 2017).

The region's geography, with high mountain ranges in the south-west, vast deserts in the south, and semiarid steppes in the west, has affected the distribution of settlements and, consequently, the power system configuration. The architecture of regional grids (see Figure 9) follows distribution of the population, and has the shape of an open circle wrapped around centrally positioned deserts, steppes, and the Aral Sea. The northern and eastern segments of the regional grid display the most sophistication and continuity, and have multiple parallel branches and transitions to the adjacent territories. In the southern segment, comprising Turkmenistan and Uzbekistan, the regional grids assume a single-flow configuration. In the eastern segment, the system lacks integrity because of a gap between Kazakhstan's and Turkmenistan's grids.

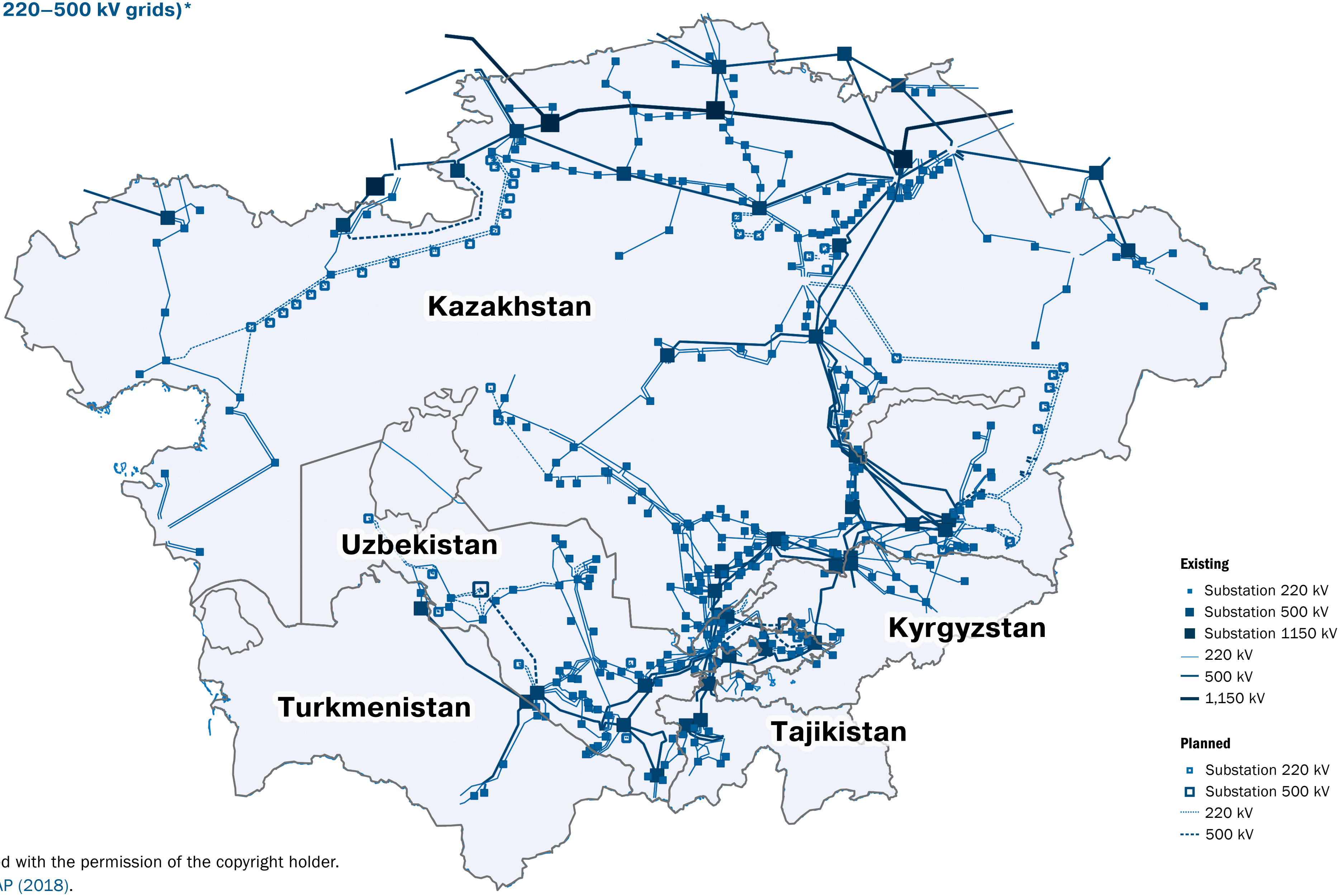
The backbone of the regional grid system is the 500 kV trunk line which originates in the Russian Federation, and runs north to south across all the Central Asian republics, all the way to Turkmenistan. Lines of 220 kV run parallel to the trunk line, connecting it to the adjacent territories. The grid system forms loops in areas with higher density of the population, such as Northern and Southern Kazakhstan, the south-east of Uzbekistan, and parts of Tajikistan. The system has many dead-end branches in southern and western territories (Turkmenistan and Western Kazakhstan), and in the valleys of Tajikistan and Kyrgyzstan. The central part of Kazakhstan around the Aral Sea has the lowest grid density (EDB, 2012).

In remote areas, the grid system is not homogeneous. Because of terrain configuration in certain border areas, some grid segments of a country may be not connected. In such cases, connections are completed through the neighbouring countries. That is part of the USSR heritage, in which internal borders had little meaning, and all the countries of Central Asia were parts of the same state. For example, the western part of Kazakhstan's power system is not directly connected to the remaining (and larger) part of the country. In the north, grid connections pass through the Russian Federation. Some grid segments in Kyrgyzstan, Tajikistan, and Turkmenistan are connected through Uzbekistan. Turkmenistan, which lies at the end of the trunk line, is the least integrated in the common grid system. Uzbekistan, on the other hand, is the core of the entire region, and is connected to all of the other four countries.

The vast spaces that characterize the regional grid configuration inflate the cost of construction and maintenance of power lines in the region. Nevertheless, Kazakhstan plans to connect its western network to the main network in the east, and to reinforce the grid system by building additional high-voltage power lines.

Due to the original power system scheme, the five Central Asian countries remain strongly linked to each other. Notably, supply of electricity to certain grid segments of a country may be completely dependent on a neighbouring republic. Inasmuch as the CAPS was designed as the southern extension of the Russian power system, it remains closely linked to Russia through a network of power transmission lines joining settlements in the north of Kazakhstan with settlements in the south of Russia. In the southern and eastern segments of the regional grid system of Central Asia, lines between neighbouring countries are used largely for mutual exchanges. At this time, there is no connection to China.

Figure 9. Central Asia Power System (the main 220–500 kV grids)*



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Source: ESCAP (2018).

1.6. Key Challenges Faced by the Water and Energy Complex of Central Asia

Despite the efforts by CA states and international financial institutions to improve the operation of the water and energy complex, and despite some success in development of the energy potential, **the countries of the region face a number of challenges that need to be resolved.**

Energy Sector:

- High wear and tear on power grid equipment and generating capacities (the share of facilities aged 30 years or more ranges from 44% to 75%) (ADB, 2012);
- High electricity losses (7–20% of total generation in some countries);
- Lack of balance between generation and consumption of electricity in CA (loss of export potential of 11 billion kWh);
- Diminished reliability of power supply in Uzbekistan and in the south of Kazakhstan as a result of shortage of manoeuvrable capacity reserve and failure to use HPPs in the neighbouring countries;
- Non-rational use of hydropower, including seasonal shortages and sterile spills, due to failure to align generation and consumption peaks (according to PJSC RusHydro, annual unsatisfied demand in Kyrgyzstan and Tajikistan is estimated at 1.5–3 TWh and 4.0–4.5 TWh, respectively);
- Differences in the legal mechanisms and regulatory/tariff tools used by various countries.

Water Complex:

- Reduction of water supply in the countries of the Aral Sea basin from 8,400 m^3 per person per year to 1,400 m^3 per person per year (critical threshold: 1,700 m^3), and widening of the deficit of water resources in the lower reaches of the water basins;
- High share of irrigated lands becoming salinized and waterlogged (about 50%) as a result of deterioration of water management facilities (pumping stations, principal canals, the irrigation network, and the collector and drainage network);
- Deviations from designed operating regimes of reservoirs and HPPs;
- Loss of long-term storage capacity of reservoirs, and increasingly critical shortage of irrigation water even during wet years;

- Absence of interstate water regulation required to meet irrigation water needs, which vary from season to season;
- Conflict of interests between the countries situated in the upper and lower reaches of transboundary river basins with respect to water resources utilisation, etc.

CA needs to further increase its electricity output (by building new capacity and modernizing existing capacity), to streamline power consumption, ensure efficient transport of newly generated electricity to consumers, and to expand into new markets (by building new power transmission lines). In the context of climate change, the volume of water originating from glaciers may decrease, and the rate of satisfaction of water needs of CA economies may change (Yasinskiy, Mironenkov, Sarsembekov, 2012).

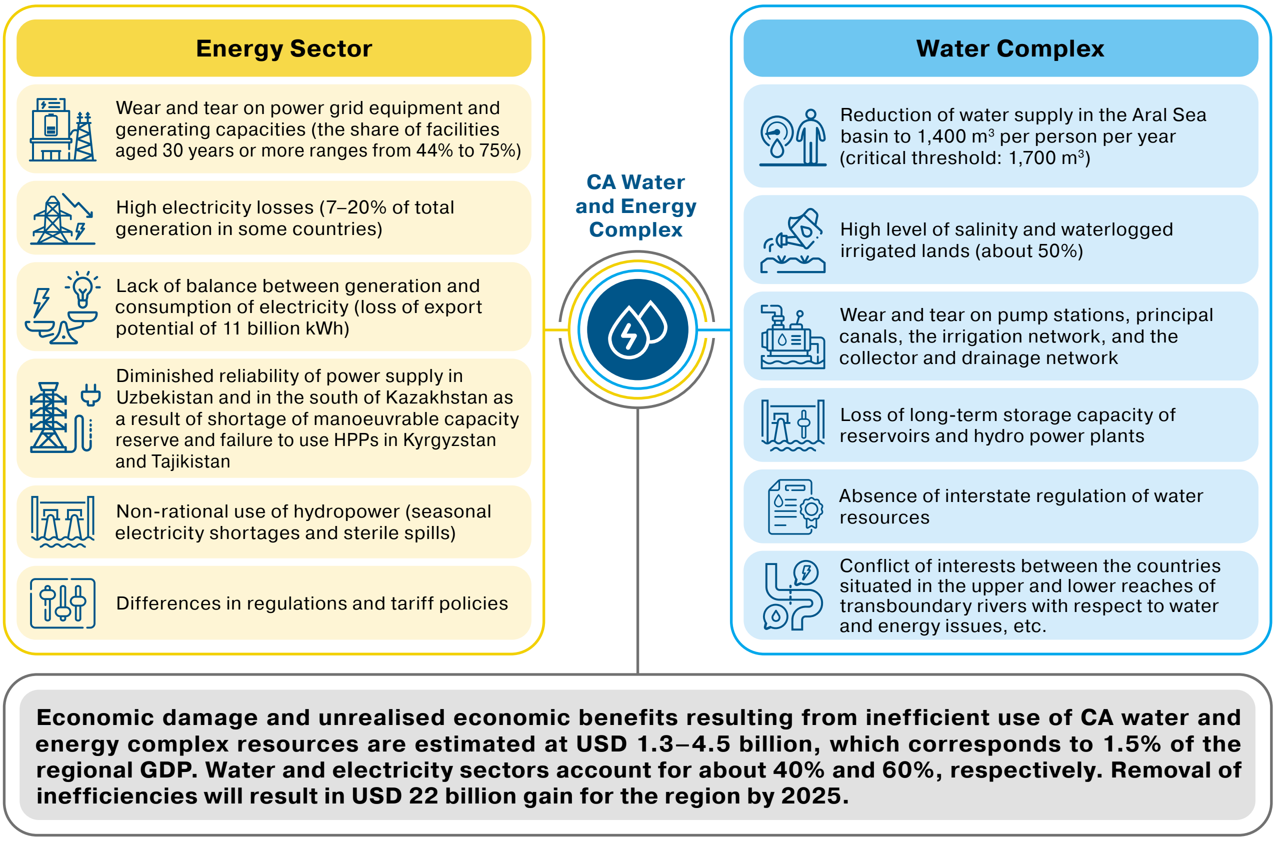
All the countries intend to resolve these issues by making full use of their advantages and actively increasing their potential (primarily as regards each country's conventional generating capacity) over the medium and long term. The significance of "green" energy in the region has increased due to such factors as climate change and environmental pollution: virtually all countries have designed policy measures and laws to promote renewable energy sources (Eshchanov et al., 2019).

The infrastructure of the water and energy complex of Central Asia has substantial investment needs of at least USD 90 billion in 2021–2030 (about USD 9 billion per year). This estimate is based on the findings of a study (Branchoux et al., 2018) used by international agencies (ESCAP, 2020). According to the study, annual investment needs of the CA water and energy complex stand at 1% of GDP for Kazakhstan, 5.7% of GDP for Kyrgyzstan, 7.4% of GDP for Tajikistan, 3.5% of GDP for Uzbekistan, and 1.7% of GDP for Turkmenistan.

From the methodological point of view, the estimates incorporate the funding required to eliminate the overhang of unsatisfied infrastructure-related needs, meet the growing demand for new infrastructure facilities, properly maintain the existing infrastructure facilities, and reduce their vulnerability to climate change-related risks. Projected CA water and energy complex investment needs until 2030 are based on a 1990–2015 panel data covering 71 developing countries. Those projected needs can be regarded as minimal, as they cover the needs related to only two types of economic activity: power supply and water supply. CA water supply needs related to irrigation and agricultural production are excluded from the calculation.

Alternative ADB estimates (ADB, 2017) for the period from 2016 to 2030 indicate that total Central Asia and Caucasus energy investment needs are USD 256 billion under the baseline scenario, or USD 316 billion including climate change-related investments.

Figure 10. Key Challenges Faced by the CA Water and Energy Complex, and Costs Related to Inefficient Use of Resources



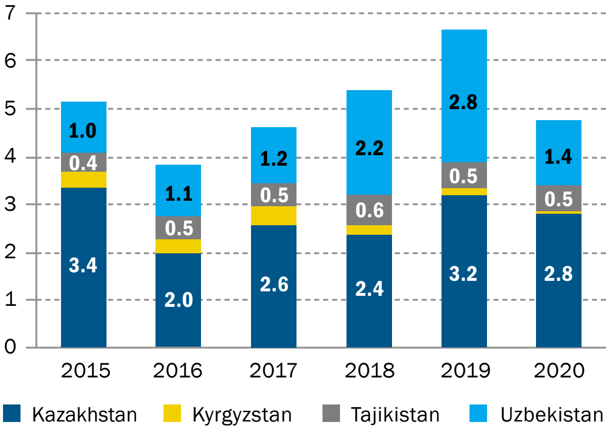
Source: developed by the authors.

2. LEADING ROLE OF MULTILATERAL DEVELOPMENT BANKS IN FINANCING DEVELOPMENT OF THE WATER AND ENERGY COMPLEX OF CENTRAL ASIA

2.1. Key Investment Trends in the Water and Energy Complex of Central Asia

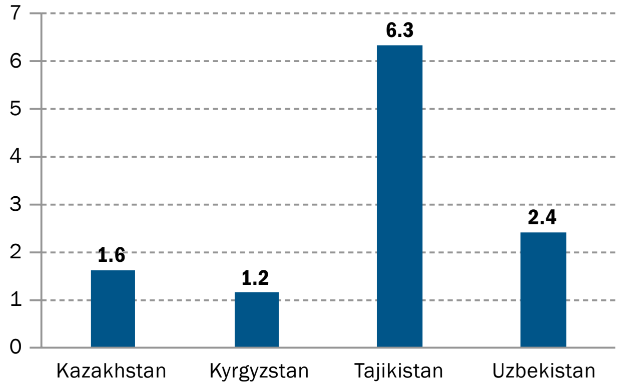
Analysis of the current state of the water and energy complex of Central Asia shows that investment activity increases as economic development accelerates and the issue of energy supply in the region aggravates. As a result, by the end of 2020 total generating capacity had increased by 27.7% (or by 11.7 GW) relative to 1992, reaching 53.8 GW (0.7% of total global capacity).

Figure 11. Changes in Capital Investment in CA Water and Energy Complex in 2015–2020, USD billions



Source: based on data provided by statistical agencies and CEIC.

Figure 12. Share of Capital Investment in CA Water and Energy Complex in 2020, % of GDP



Source: based on data provided by statistical agencies and CEIC.

Accelerated development of the CA energy sector can be attributed to the implementation of state programmes of the region's countries. Subject to the ownership structure and the nature of water and energy complex investment projects, the state plays the key role in the development of the complex. The role of the state and state-owned companies is manifested at various levels, including development of conceptual frameworks for long-term development of the water and energy complex, determination of pricing policies, identification of funding sources, implementation of various projects, etc.

Capital investment in the CA water and energy complex[2] grew at a high rate in 2016–2019,[3] reaching about USD 6.7 billion by the end of 2019 for four countries – Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan.[4] In 2020, as CA countries posted lower revenues and expenditures and modified their priorities because of the COVID-19 pandemic, a considerable drop in capital investment in the water and energy complex (minus 28.6% y/y down to USD 4.8 billion) was recorded in all countries of the region. Capital investment in CA water and energy complex was concentrated primarily in the Electricity Supply segment, which by the end of 2020 had received about USD 3.4 billion, while capital investment in the Water Supply segment stood at USD 1.4 billion.

The largest providers of capital investment in the CA water and energy complex are Kazakhstan (USD 2.783 billion, or 1.6% of GDP) and Uzbekistan (USD 1.377 billion, or 2.4% of GDP). These two countries have large and actively evolving economies. They have significant financial resources and, accordingly, are actively engaged in investment projects in many sectors of the economy, including the water and energy complex. They are taking proactive steps to expand and attract investment in the complex. Higher visibility of the Water Supply segment in Kazakhstan (36.6% of total investment in the sector) relative to Uzbekistan (26.2%) represents an important difference between the two countries. Despite the considerable amount of investment in the water and energy complex in nominal terms, their share in total investment (2020: 9.3% in Kazakhstan and 16.3% in Uzbekistan) and in the GDP (2020: 1.6% in Kazakhstan and 2.4% in Uzbekistan) remains limited.

In Tajikistan and Kyrgyzstan, capital investment in the water and energy complex by the end of 2020 amounted to USD 507 million (6.3% of GDP) and USD 89 million (1.2% of GDP), respectively. In Tajikistan, budget constraints have not prevented the government from pursuing a proactive investment policy in the sector for a long time. Funds to finance the largest investment projects in the water and energy complex are provided by the state. Capital investment in the water and energy complex accounted for about 45% of total capital investment in the economy, emphasizing the high priority assigned to the sector in the country's industrial policy. In the Kyrgyz Republic, the rate of development of the water and energy complex has been the slowest in CA during the post-Soviet period, including because of weak investment activity in the sector. Inferior investment performance of the water and energy complex in the Kyrgyz Republic can be explained by the limited public revenues and the low electricity rates, which do not cover generation costs.

At the end of 2020, foreign direct investment (FDI) in the financing of investment projects in the CA water and energy complex was insignificant. The low appeal to foreign investors can be explained by the dominant position in the sector of the state, which regulates power rates subject to social policy requirements. CA water and energy complex investment projects are long-term projects that have modest profit margins constrained by the strategic and social importance of the sector;

[2] Statistics provided in this report on capital investment and foreign direct investment in the water and energy complex represent the total of indicators describing two types of economic activity: (1) "supply of electricity, gas, steam, hot water, and conditioned air", and (2) "water supply; collection, treatment, and removal of waste, liquidation of contaminations".

[3] Statistics on investment in the CA water and energy complex were compiled on the basis of 2015–2020 data from various official sources because of the need to compare various CA countries. Construction of longer time series will require additional work.

[4] Statistics on the volume of investment in fixed assets and sectoral structure of attracted foreign direct investment are not available at this time for Turkmenistan, so Turkmenistan has been excluded from our analysis in this section. All aggregated regional data include only four countries: Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan.

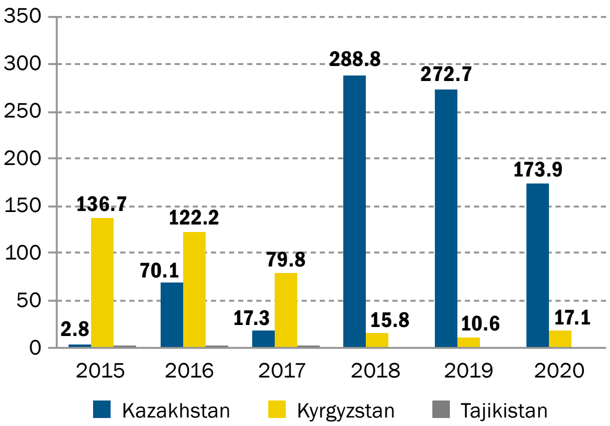
besides, such projects depend on availability of state support, and need a predictable institutional environment. Most foreign sources of capital investment in CA water and energy complex are loans and grants.

In Kazakhstan, attraction of FDI in the water and energy complex is limited and volatile. Over the last 10 years, investments in the water and energy complex did not exceed 1.4% of total attracted FDI. By the same token, the share of FDI in total capital investment in the water and energy complex did not exceed 12.2% (2018). In nominal terms, FDI in Kazakhstan's water and energy complex during the period under review ranged from USD 2.8 million (2015) to USD 338 million (2013). In 2020, total inward FDI in Kazakhstan's water and energy complex amounted to USD 173.9 million.

In Kyrgyzstan, active attraction of FDI in the water and energy complex was observed in 2015–2017. During that period, it ranged from 9% to 15% of total attracted investment, and accounted for about 40% of total capital investment in the water and energy complex. In nominal terms, maximum FDI in the Kyrgyz Republic's water and energy complex was recorded in 2015 at USD 136.7 million. Most of the time, however, its share and volume were limited. In 2019, the share of FDI attracted in the country's water and energy complex was merely 1% of total capital investment (USD 10.6 million). In 2020, total inward FDI in the Kyrgyz Republic water and energy complex was USD 17.1 million.

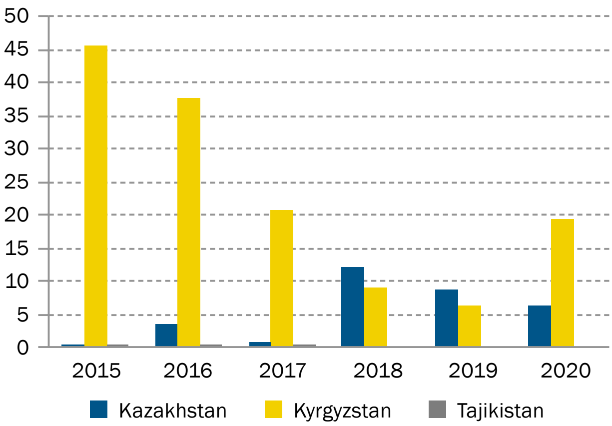
Tajikistan reports virtually no FDI in the water and energy complex. According to the statistics published by the National Bank of the Republic of Tajikistan, over the last 10 years inward FDI in the water and energy sector was reported only in 2015–2017. The volume of inward FDI was extremely limited, with a maximum of USD 353,800 in 2015. No foreign capital investment in Tajikistan's water and energy complex was registered in 2020.

Figure 13. Changes in FDI in CA Water and Energy Complex Capital Assets in 2015–2020, USD millions



Source: based on data provided by statistical agencies, central banks, and CEIC.

Figure 14. Share of FDI in CA Water and Energy Complex Capital Assets in 2020, %



Source: based on data provided by statistical agencies, central banks, and CEIC.

The maximum foreign investment in the water and energy complex of Uzbekistan was in 2018–2019, when it exceeded USD 2 billion, and its share ranged from 16% to 20% of total foreign investment. In 2020 it decreased, and by the end of the year was merely 9.6%. Available statistical data are not sufficient for a meaningful analysis of the sectoral structure of foreign direct investment attracted to Uzbekistan.

The low investment appeal of the CA water and energy complex to foreign investors is attributable to the weakness of the CA institutional environment, elevated economic, political, and industry-specific risks, the presence of strategic political interests and regional differences in most water and energy projects, and the operation of a number of economic factors (for example, low electric power tariffs in virtually all CA countries, reflecting the sector's social importance) unique to the CA water and energy complex, which make it impossible to secure adequate profitability. Accordingly, water and energy projects in CA are often politicised and burdened with state security issues, which occasionally overrule economic feasibility considerations (Laruelle et al., 2016). Investors also often have to deal with the unsatisfactory financial position of the key state-owned water and energy complex players, which are responsible for the development and implementation of the relevant projects. Governments often support strategically important water and energy complex companies despite their financial difficulties and high debt.

World Bank indicators which reflect the state of the institutional environment in many countries of the world reveal that CA is weak in most areas (Kaufmann et al., 2010). In the CA water and energy complex, implementation of complex projects with long maturities and often modest returns can become even more difficult for a number of reasons, including insufficient accountability of government bodies, possible corruption, substandard regulations, inferior legal compliance and continuity of decisions, etc.

2.2. Involvement of MDBs in the Development of the Water and Energy Complex of Central Asia

Inasmuch as the CA water and energy complex has weak investment appeal, and the profitability of related projects is too low from the viewpoint of private capital and foreign investors, multilateral development banks act as an important source of financial resources required to implement state-initiated projects for the development of the complex. At this time, there are 104 ongoing projects with a total value of USD 10.2 billion (EDB database). The EBRD tops the list of funding providers, with a portfolio of USD 3.3 billion, or 32.7% of total MDB financing in CA. This is followed by the World Bank (USD 3.0 billion, or 29.6%) and the ADB (USD 2.6 billion, or 26.2%). The combined EDB, EFSD, EIB, and AIIB portfolio stands at USD 1.2 billion (11.5%). The MDBs have continued to finance the CA water and energy complex despite the global drive to minimise the effects of the COVID-19 pandemic. In 2020, the MDBs approved financing of 24 CA water and energy projects for a total of USD 1.8 billion.

Figure 15. Participation of the MDBs in the Financing of Investment Projects in the CA Water and Energy Complex

Share in Total CA Financing, %		Amount of Financing, USD billions
32.7	European Bank for Reconstruction and Development	3.318
29.6	The World Bank IBRD • IDA	3.005
26.2	ADB Asian Development Bank	2.659
6.7	Eurasian Development Bank / EFSD Eurasian Fund for Stabilization and Development	0.677
3.8	European Investment Bank	0.389
1.1	AIIB Asian Infrastructure Investment Bank	0.107
100	**Total:**	**10.155**

Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

In their energy sector operations, the multilateral development banks rely on global initiatives, notably Sustainable Energy for All (SEforALL), the 2030 Agenda for Sustainable Development, and the Paris Climate Agreement (see Box 1). The purposes of such global initiatives are reflected in the operating principles and priorities of many MDBs. For example, the key MDB priorities in the power industry are: development and improvement of national energy infrastructure; improvement of access to energy; transition to a less carbon-intensive energy structure (see Table 5). According to AIIB estimates, investment in energy projects with zero carbon emissions ranged from 20% to 41% of total sovereign loans and grants extended by the MDBs in Asia (AIIB, 2018).

MDBs play the leading role in the development of the water and energy complex because they offer grant-based or soft-termed financing to offset extended cycles and high costs. Such financing is special because it is impossible to raise arm's-length financing fully covering all project needs on reasonable terms and at an acceptable level of risk. Accordingly, wind and solar energy projects, as well as costly geothermal energy projects in Asia, are often financed with grants and soft loans. Such grants were provided by the Global Environment Facility, the Clean Technology Fund, and the International Development Association. Financing of water and energy projects is contingent upon completion of a rigorous pre-project analysis and availability of technical assistance throughout the entire project lifecycle. One of the advantages of MDBs relative to the other players is their ability to provide risk coverage, facilitate expansion of project membership, raise additional public and private funding to finance infrastructural projects, etc. (Wurf, 2017).

Table 4. Participation of the MDBs in Financing Investment Projects in the CA Water and Energy Complex

	Share in Total CA Financing, %	Amount of Financing, USD billions	Number of Projects	Average Loan Amount, USD millions
EBRD	32.7	3.318	42	79.0
WB	29.6	3.005	23	130.7
ADB	26.2	2.659	20	133.0
EDB & EFSD	6.7	0.677	10*	52.1**
EIB	3.8	0.389	7	55.5
AIIB	1.1	0.107	2	53.4
Total	**100**	**10.155**	**104**	**94.9****

* Total number of projects should be increased by three EFSD projects currently under way in the Kyrgyz Republic (co-financed by the ADB), which would make the total number of EDB and EFSD projects 13.

** Including three EFSD projects currently under way in the Kyrgyz Republic (co-financed by the ADB).

Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Box 1. Global Power Industry Initiatives

Sustainable Energy for All (SEforALL): this initiative was launched by then-UN Secretary-General Ban Ki-moon in September 2011, and sets three goals to be achieved by 2030: ensure universal access to modern energy sources; double the share of renewable energy in the global energy mix; double the global rate of improvement in energy efficiency. The initiative was launched following Resolution 65/151 of the UN General Assembly on 20 December 2010, when 2012 was declared the International Year of Sustainable Energy for All.

The 2030 Agenda for Sustainable Development is a set of 17 goals adopted by all UN member states in 2015. The document also contains a 15-year plan to achieve those goals. Goal 7 is to ensure access to affordable, reliable, sustainable, and modern energy for all by 2030.

The Paris Agreement governs measures to reduce the content of carbon dioxide in the atmosphere. The purpose of the agreement (according to Article 2) is to improve implementation of the United Nations Framework Convention on Climate Change and, in particular, to hold the increase in the global average temperature to “well below” 2 ˚C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5 ˚C.

The EBRD, financing leader acting within the framework of the Energy Sector Strategy for 2019–2023, is taking an active part in the development of the water and energy complex in all CA countries. The share of ongoing EBRD water and energy projects is 20.3% of its total portfolio in Kazakhstan, 4% in Kyrgyzstan, 10% in Tajikistan, and 17% in Uzbekistan. The EBRD places special emphasis on private sector projects. EBRD financing was approved for more than 80% of all private energy projects in CA. Kazakhstan accounts for the bulk of EBRD operations, with 13% of the bank’s total energy portfolio.

Since 2009 the ADB has been providing significant support to CA countries by financing energy projects on an ongoing basis. Projects with a total value of USD 4.8 billion, or 26% of the bank's total CA portfolio, have received cumulative financing in the form of credits, grants, and technical assistance programmes. ADB support has been focused on enhancing access to clean and modern energy, scaling up the deployment of renewable energy, strengthening electricity transmission and distribution systems to integrate more renewable energy, improving demand-side energy efficiency in buildings, transport, and industries, and promoting reforms in the power sector, governance, and regional integration. Grants are provided on a preferential basis by the Asian Development Fund.

Table 5. MDB Energy Priorities and Documents

MDB	Programme	Time-frame	Priorities
ADB	Adopted in 2009	No timeline	• Promotion of energy efficiency and renewable energy sources • Maximum access to energy for all • Promotion of energy sector reforms, build-up of energy potential, and better governance
AIIB	Energy Sector Strategy: Sustainable Power for Asia	2018 to the present	• Improvement of access to energy • Enhancement of energy efficiency • Reduction of emissions in the course of energy production • Strengthening of regional cooperation
WB	Energy Sector Management Assistance Programme (ESMAP) and Global Gas Flaring Reduction Partnership (GGFR)	No timeline	• Improvement of operational and financial indicators of the energy sector • Enhancement of governance in the energy sector
EBRD	Energy Sector Strategy	2019–2023	• Decarbonisation and electrification • Well-functioning energy markets • Energy-efficient and inclusive economy • Cleaner value chains in oil and gas industry

Source: MDB web sites.

The World Bank is implementing several CA water and energy complex development programmes, and taking an active part in financing regional initiatives (see Section 2.3). Over the last five years alone, the World Bank allocated USD 6.2 billion to finance energy access programmes, with the CA power industry receiving about 15.6% of that amount. The World Bank is the absolute leader in financing CA irrigation and water management projects. Out of USD 1.5 billion of CA funding approved by MDBs, 97.5% comes from the WB. The World Bank's Uzbekistan country programme is the second largest in Europe and Central Asia. As of 1 October 2020, 23 ongoing projects in the country were supported with the financial involvement of the bank for a total of USD 4.44 billion (the IBRD and the IDA are members of the World Bank Group).

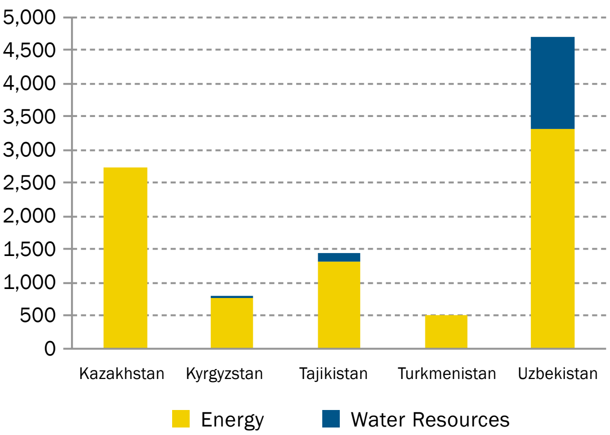
The ADB and the WB are actively involved in providing technical assistance to government bodies seeking to formulate public policies for the CA water and energy complex. That assistance ensures support in preparation of a number of important projects in Central Asia, including projects for the improvement of electricity distribution, RES utilisation, and energy efficiency in the Kyrgyz Republic, and an energy sector development programme in the Republic of Tajikistan. In addition, the technical assistance programme offers high-level integrated examination (audit) and definition of components for an energy sector development project in Kazakhstan. These MDBs participate in the financing of water management, water supply, and irrigation projects. According to the information available at this time, other MDBs are not financing projects in that segment of the CA water and energy complex.

The AIIB focuses on projects dealing with renewable energy sources, energy efficiency, restoration and modernisation of existing power plants and transmission and distribution networks. The AIIB, the EFSD, and the WB are co-financing restoration of the Nurek HPP in Tajikistan.

The EDB and the EFSD are actively financing CA energy projects. The EDB has focused its efforts on financing energy projects on market terms in Kazakhstan, where it works primarily with private companies. The EFSD is operating in Kyrgyzstan and Tajikistan – countries which require the most funding to finance large-scale infrastructural projects while suffering from budget constraints. Energy projects account for more than half of the EFSD investment portfolio. Bridging system-wide infrastructural gaps in the key sectors of Kyrgyzstan and Tajikistan by providing sovereign investment credits is an important task for the EFSD.

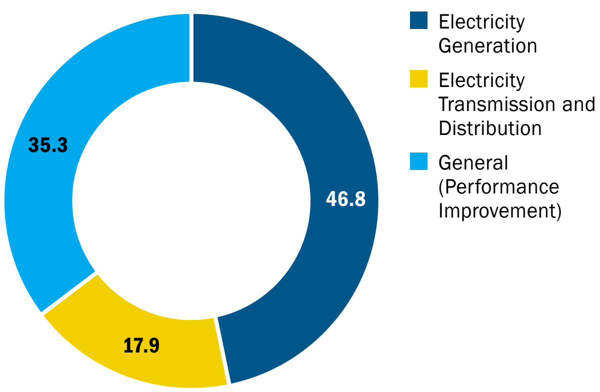
In the structure of MDB investment in the CA water and energy complex, energy projects take precedence over water management and water supply projects (see Figure 16). MDBs are currently implementing 92 projects in the energy sector for a total of USD 8.6 billion. Among energy projects, electricity generation projects account for 46.8%, or USD 4.2 billion, followed by energy efficiency projects (35.3%, or USD 3.1 billion). The share of investment in electricity transmission and distribution is 17.9%, or USD 1.6 billion (see Figure 16). Most water projects in CA are non-commercial, and financed primarily with budget funds. Accordingly, MDBs use grants and preferential interest rates to finance such projects.

Figure 16. Breakdown of CA Water and Energy Projects, USD millions



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Figure 17. Main CA Energy Project Types, %



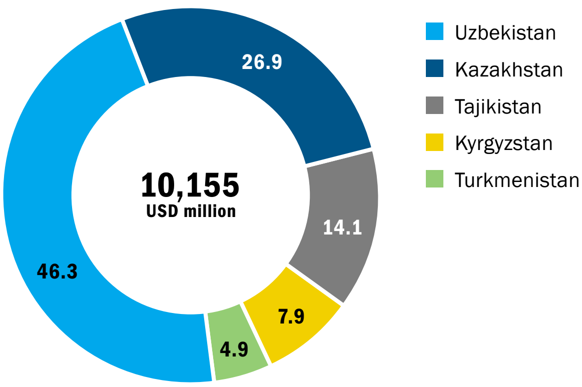
Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Water resources management is one of the key areas of regional cooperation in Central Asia which remains underfinanced. Out of 104 ongoing MDB-financed projects, there are only 12 water management, water supply, and irrigation projects. Approved financing in that area is USD 1.5 billion (15.1% of total funding allocated to all MDB-financed projects in the CA water and energy complex). Uzbekistan accounts for more than 90% of that amount. Commercial investors view water management projects as less attractive than energy projects. Of the MDBs featured in this report, only the ADB and the WB are involved in water supply projects.

Uzbekistan is the leader in raising MDB financing. Its cooperation with MDBs gained strong momentum after the government announced it would be pursuing a policy of political and economic openness. Since 2017, 20 of 26 identified active investment projects have been completed. Kazakhstan with a total funding of USD 2.7 billion (26.9%) holds the second position, followed by Tajikistan and Kyrgyzstan. Turkmenistan has attracted the least MDB funding for its water and energy projects, and mostly relies on its own financial resources.

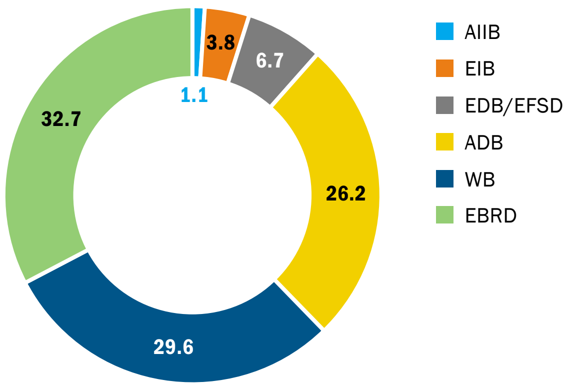
Uzbekistan has 26 ongoing projects for a total of USD 4.7 billion, or 46.3% of total funding allocated by multilateral banks to finance development projects in Central Asia (see Figure 18). MDBs significantly increased their financial, technical, and analytical support since 2017 in a bid to assist the country's government in implementation of a comprehensive market reform programme. Prior to 2017, there had been only eight projects. The average amount of MDB loans to finance water and energy projects is USD 180.7 million, which is significantly higher than in the other countries of the region. Most projects are aimed at development of the energy sector. Some water supply and water delivery projects are also under way. On the regional level, more than 90% of all CA water projects are implemented in Uzbekistan.

Figure 18. Share of CA Countries in Total MDB Financing, %



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Figure 19. Share of MDBs in Total Financing, %

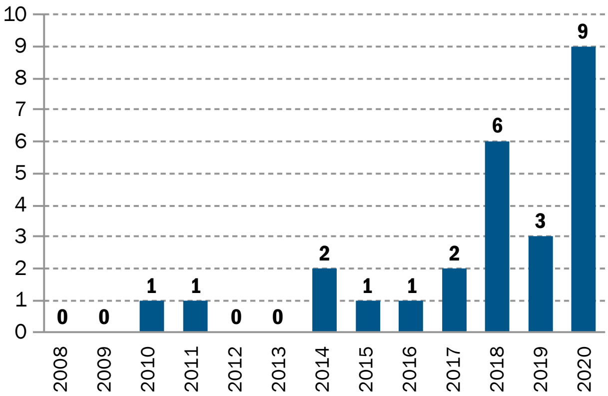


Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

The World Bank is the leading MDB involved in the financing of water and energy projects in Uzbekistan, with more than half of the total MDB water and energy investment portfolio in the country (50.8%) (see Figure 21). It is followed by the ADB and the EBRD, with 27.9% and 17.6%, respectively. Eurasian financial institutions are not involved in water and energy complex financing at this time.

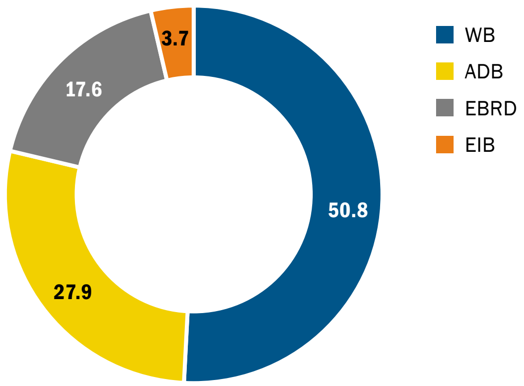
The private sector currently has no presence in Uzbekistan's water and energy complex. The Samarkand solar power plant project financed by the EBRD is one of the first two private energy projects in Uzbekistan. Its successful completion will set an example for wider private sector participation.

Figure 20. Number of New Energy Projects in Uzbekistan



Source: calculated by the authors on the basis of publicly available MDB data as of 1 April 2021.

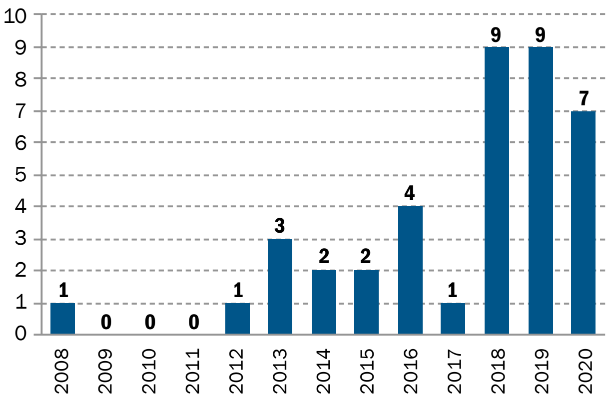
Figure 21. MDB Involvement in Energy Projects in Uzbekistan, %



Source: calculated by the authors on the basis of publicly available MDB data as of 1 April 2021.

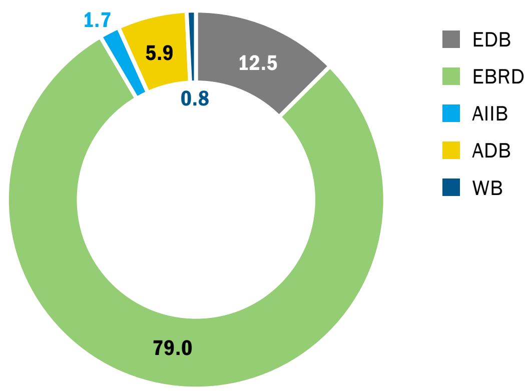
Kazakhstan has the largest number of active water and energy projects – 39 projects for a total of USD 2.7 billion, or 26.9% of total funding by multilateral development banks to Central Asia. In 32 projects, the loans were extended to private entities, while seven projects have sovereign financing. The peak number – nine projects – was recorded in 2018 and 2019 (see Figure 22). During that period, Kazakhstan started to actively increase new RES capacity. Most approved projects were related to the construction of new WPPs and SPPs. Active involvement of MDBs in RES development in 2018–2020 made it possible to finance 25 out of 39 active RES projects in Kazakhstan.

Figure 22. Number of New Energy Projects in Kazakhstan



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Figure 23. Role of MDBs in Financing the Water and Energy Complex in Kazakhstan, %



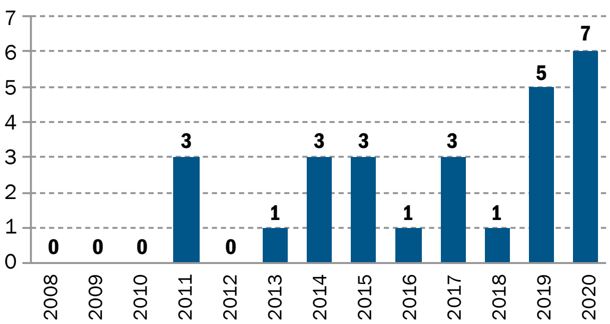
Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

The EBRD provides the most MDB financing in Kazakhstan (see Figure 23). It accounts for 79% of the entire MDB water and energy portfolio in the country. The EDB comes in second with 12.5%. Only one World Bank project was financed with a grant. The average loan amount was USD 70 million. All projects were from the energy segment. No MDB-financed water management projects have been identified so far.

Tajikistan has 26 ongoing water and energy projects for a total of USD 1.4 billion, or 14.1% of all MDB financing in CA. All loans were extended to the state. Grants were the main type of financing. In 2020, there was a significant increase in the number of newly approved projects (see Figure 24). In Tajikistan, total financing is distributed among MDBs more evenly than in the other CA countries. The World Bank accounts for more than one third of the country's project portfolio (38.7%), while the ADB and the EBRD account for 23.1% and 22%, respectively.

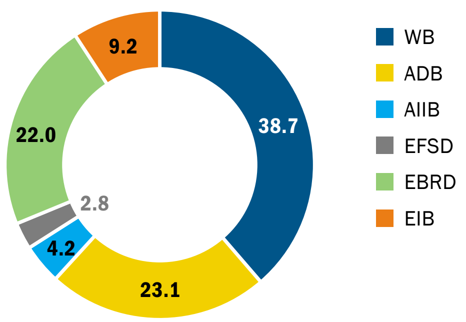
In 2020, six new energy projects were approved in Tajikistan for a total of USD 366.5 million. Most of those were energy efficiency projects.

Figure 24. Number of New Energy Projects in Tajikistan



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Figure 25. MDB Involvement in Energy Projects in Tajikistan, %

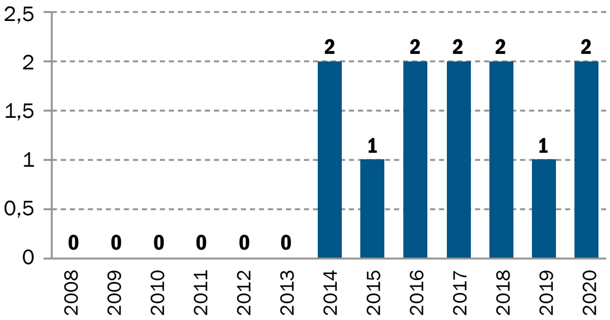


Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Kyrgyzstan has 12 ongoing water and energy projects for a total of USD 797.8 million, or 7.9% of total funding allocated by multilateral development banks to Central Asia. New water and energy projects have been evenly distributed by years, starting in 2014. All loans were extended to the state. Subject to Kyrgyzstan's higher investment risks and funding costs, mixed project financing has often been used, with a high share of grants and co-financing arrangements (3 out of 12 projects). In all three of those projects, the ADB and the EFSD are the principal co-investors. The aim of the projects is to modernise the country's largest HPPs.

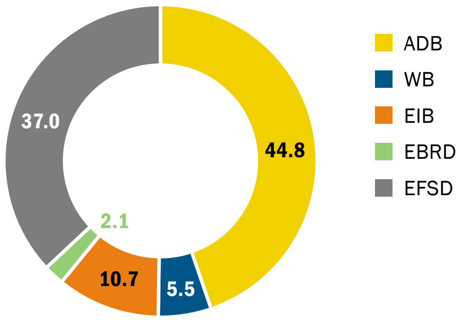
The ADB accounts for almost half of total MDB financing of Kyrgyzstan's water and energy complex (44.8%) (see Figure 27); the bank is actively participating in the financing of CAREC activities, and is involved in a number of water projects. The EFSD comes second with 37%. The Fund co-financed the commissioning of the second hydropower unit of the Kambarata-2 HPP. The average amount of MDB loans was USD 66.5 million. Most projects (10 out of 12) were from the energy segment, with two projects in the water management segment. Unlike in Kazakhstan, in Kyrgyzstan the EBRD is implementing a limited number of small projects (USD 5 million – USD 7 million) for the modernisation of regional distribution companies in the energy sector.

Figure 26. Number of Water and Energy Projects in Kyrgyzstan



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Figure 27. Role of MDBs in Water and Energy Complex Financing in Kyrgyzstan, %



Source: calculated by the authors on the basis of public MDB data as of 1 April 2021.

Only one active project was identified in Turkmenistan (USD 500 million, or 4.9% of total MDB financing in CA). The ADB has been involved in the project since 2018, within the framework of a local CAREC initiative designed to enhance the country's electricity grid. The loan was extended to the state.

The number and value of ongoing CA energy projects are much higher than the number and value of completed projects. Forty-two energy projects for a total of USD 2.3 billion have been successfully completed in CA. Uzbekistan was the largest borrower, and the ADB the largest lender – accounting for almost half of total financing in both cases. The average value of completed projects is 1.96 times less than the average value of ongoing projects.

2.3. International Initiatives in the Water and Energy Complex of Central Asia

Due to the disparity of irrigation and hydropower interests of CA countries, cooperation in the water and energy complex is developing within the framework of regional initiatives of international development institutions. In each work area, those institutions not only finance projects, but also provide the countries with the required knowledge, build systems, identify approaches to the development of individual sectors, and implement advanced technological solutions and governance methods.

The best known regional initiative of that type is CAREC (Central Asia Regional Economic Cooperation). CAREC was established in 1997 by the Asian Development Bank. The purpose of the programme is to promote economic development of the countries of the region and reduce poverty. Partners of the programme among the IFIs are the Asian Development Bank (acting as the CAREC Secretariat), the World Bank, the EBRD, the IFM, the Islamic Development Bank, and the UNDP. CAREC activities are designed to ensure further expansion of regional energy cooperation. CAREC has 11 member countries: Azerbaijan, Afghanistan, Georgia, Kazakhstan, Kyrgyzstan, Mongolia, Pakistan, China, Tajikistan, Turkmenistan, and Uzbekistan.

The policy document of the programme is "CAREC Energy Strategy 2030". The joint declaration on development and implementation of a common energy strategy until 2030 was signed by the ministers of energy of the CAREC member countries in Tashkent on 20 September 2019. "CAREC Energy Strategy 2030" was approved at the 18th CAREC Ministerial Conference, which was held in Tashkent on 14 November 2019.

Total investment in 208 CAREC projects from 2001 to September 2020 amounted to USD 39.2 billion. More than USD 14.6 billion was provided by the ADB, more than 15.8 billion by the other development partners, and more than USD 8.7 billion by CAREC member country governments. The bulk of that capital (about 76%, or more than USD 29.9 billion) was invested in transport projects, **22%, or more than USD 8.7 billion, in energy projects**, and 2%, or USD 0.61 billion, in trade projects. By September 2020, total investment in CAREC-related technical assistance projects reached almost USD 538.4 million.

Box 2. Pillars of "CAREC Energy Strategy 2030"

Pillar 1. Better energy security through regional interconnections.

Pillar 2. Scaled-up investments through market-oriented reforms.

Pillar 3. Enhancing sustainability by greening the regional energy system.

To support the three strategic pillars, the CAREC energy programme will prioritise three crosscutting themes:

Theme 1. Building knowledge and forming partnerships.

Theme 2. Attracting private-sector investments across the energy value chain.

Theme 3. Empowering women in the energy sector.

Source: CAREC (2019).

In terms of ideology, aims and objectives, contents, implementation mechanism, and membership, CAREC is close to SPECA (The United Nations Special Programme for the Economies of Central Asia (UN, 2004)). The main objectives of SPECA are to establish closer economic ties between Europe and the CA countries, and to intensify attraction to the region of investment provided by international financial institutions. Five priority projects in transport, energy, environmental protection, and development of small and medium businesses were approved in Tashkent in 1998. SPECA has failed to gain sufficient momentum in the region, and its participants are not showing due interest in its projects.

The World Bank is the leading institution of the Central Asia Water and Energy Programme (CAWEP), a partnership formed by the World Bank, the European Union, Switzerland (via SECO), and the United Kingdom (via the Department for International Development of the United Kingdom, DFID) to create conditions conducive to the improvement of water and energy security at the regional level and in beneficiary countries. The programme has three components: energy security, water and energy links, and water security. Since its launch in 2009, it has been working in three target areas: data and diagnostics; institutions, potential and dialog; and investment support.

In 2019, total financing under CAWEP was increased to USD 8.76 million. Twenty-seven grants were approved in 2019, and five of them were issued before the end of the year. Total disbursements in 2019 amounted to USD 1.3 million (15% of the total programme budget). The current financing structure is as follows: water security 41%, energy security 22%, water and energy links 29%, programme management and communications 8%. By the end of 2019, total disbursements exceeded USD 2 million (23% of the total programme budget).

Yet another World Bank instrument is CAEWDP (Central Asia Energy–Water Development Programme), an initiative designed to provide technical assistance in energy and water management to Kazakhstan, Kyrgyzstan, Tajikistan, and Uzbekistan, and to promote the involvement of Turkmenistan and Afghanistan in regional projects.

The World Bank is also supporting the Central Asia South Asia Electricity Transmission and Trade Project (CASA-1000). The project (see Section 2.4) was supported by the World Bank, the Islamic Development Bank, the United States Agency for International Development (USAID), the US State Department, the Department for International Development of the United Kingdom (DFID), and the Australian Agency for International Development (AusAID).

Other initiatives for promotion of cooperation in the CA water and energy complex include: Transboundary Water Management in Central Asia (GIZ Programme commissioned by the German Federal Foreign Office); Transboundary Water Management Adaptation in the Amu Darya Basin to Climate Change Uncertainties (USAID); Central Asia Energy Regulatory Partnership within the framework of the Energy Regulatory Partnership Programme (ERPP) (USAID); the "USAID Power Central Asia" Regional Energy Programme (USAID and Ministries of Energy of CA countries),[5] etc.

All the international initiatives are designed to:

- Improve the environment;
- Promote integrated water management technologies;
- Implement and develop green energy through exchange of best practices and technologies;
- Provide technical assistance in energy, water supply, and efficient management of water and land resources;
- Improve land reclamation, irrigation and drainage systems, etc.

All these power industry programmes promoted by the ADB, the World Bank, and the USAID are similar in that they generally seek to support the CASA-1000 project and create electricity transmission infrastructure and commercial and institutional mechanisms that can be used to expand regional and transboundary electricity trade among the countries of Central and South Asia.

2.4. Assessment of CASA-1000 Prospects and Role in the CA Water and Energy Complex

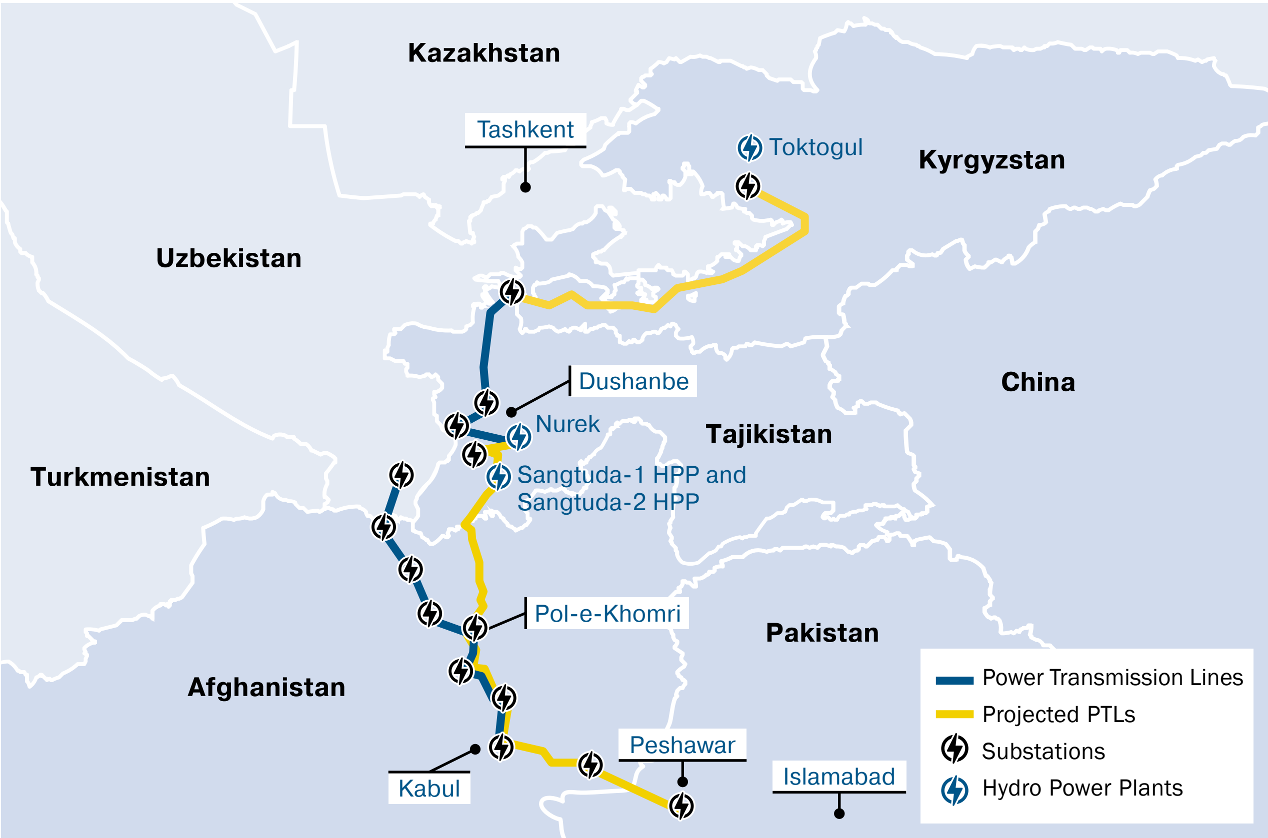
In 2006, the Central Asia/South Asia Regional Electricity Market (CASAREM) programme was developed with assistance from the Asian Development Bank and other international donors to promote development of the sub-regional electricity trade market. One of the programme's components

[5] On 28 May 2021, the USAID launched a new five-year regional energy programme in Tajikistan with a USD 39 million budget: USAID Power Central Asia. The programme will help five Central Asian countries – Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan – to meet their national energy priorities, unlock the economic benefits of transboundary energy trade, and improve their energy security through more extensive regional integration.

was CASA-100 (Central Asia/South Asia Electricity Transmission and Trade Project), for the export to South Asia of about 1,300 MW of electricity generated during the summer by hydro power plants in Tajikistan and Kyrgyzstan. The plan was to export most of the electricity (1,000 MW) to Pakistan, with the balance (300 MW) going to Afghanistan.

It is anticipated that the CASA-1000 project and other CASAREM projects will galvanise the regional electricity market, particularly during the summer, when there is surplus generation. For the time being, the existing power transmission lines can be used to transmit limited amounts of electricity only to the north – to Kazakhstan and Russia. At later stages, most electricity for the project will be generated by the Kambarata-1 HPP and the Rogun HPP. Kyrgyzstan and Tajikistan intend to sell most of the electricity generated under the project to South Asia (Yasinskiy, Mironenkov, Sarsembekov, 2015).

Figure 28. CASA-1000 Power Transmission



Source: EDB based on CASA-1000 data.

The purpose of the CASA-1000 project is to build an international high-voltage power transmission line (PTL) connecting Kyrgyzstan, Tajikistan, Afghanistan, and Pakistan. During the summer, the two Central Asian countries generate surplus electricity (even using only the existing generating capacity), while the two South Asian countries experience a significant shortage of electricity (peak loads created by air conditioning). The project envisages construction of:

- A 500 kV Datka–Khujand PTL connecting the power grids of Kyrgyzstan and Tajikistan (477 km);

- A 500 kV Khujand–Rogun–Sangtuda PTL connecting the exit from Kyrgyzstan and the north of Tajikistan with the central areas of Tajikistan (350 km);
- A 500 kV Sangtuda–Kunduz–Pol-e-Khomri–Kabul–Peshawar HVDC PTL from Tajikistan to Pakistan through Afghanistan (750 km);
- Electric substations in Datka, Khujand, Sangtuda, Kabul, and Peshawar.

Under the CASAREM programme the 500 kV South–North Overhead Power Line (OPL) (Tajikistan) has already been built and commissioned; construction of the 220 kV Tajikistan–Afghanistan OPL is still under way. The ongoing regional project for construction of an inter-grid 220 kV Sangtuda–Pol-e-Khomri OPL (Tajikistan–Afghanistan) envisages construction of the Tajik section of the line from the Sangtuda-1 HPP to the state border (118 km), and of the Afghan section (156 km). Construction of the Tajik section has been completed; work on the Afghan section is still under way. Kyrgyzstan has begun the construction of the 500 kV OPL from Datka substation to the Tadjik border. The project should be completed in 2022–2023.

At project launch, total costs, including unforeseen construction costs, were estimated at USD 953 million. That amount covered the reinforcement of internal transmission lines to be used by the CASA-1000 project, and initial environmental and social costs. It was expected that each party would allocate funding for the facilities located in its territory and involved in the project. The country breakdown of the costs was as follows: Afghanistan USD 309 million; Kyrgyzstan USD 196 million; Pakistan USD 197 million; and Tajikistan USD 251 million.

Over time, the total cost of the CASA-1000 project increased to USD 1.17 billion. On 27 March 2014, the Board of Directors of the World Bank Group (which had assumed coordination functions after the ADB's withdrawal from the project) approved funding in the amount of USD 526.5 million in the form of grants and loans for the CASA-1000 project. Out of total funding to be provided by the World Bank, Afghanistan will receive a USD 316.5 million grant, Pakistan a USD 120 million loan, Kyrgyzstan a USD 45 million grant and loan, and Tajikistan a USD 45 million grant.

The remaining funding to finance CASA-1000 (USD 643.5 million) will be provided by the other development partners, including the Islamic Development Bank and the USAID. In addition to investment in the infrastructural part of the project, the World Bank Group, acting through the Multi-Donor Trust Fund and the Afghanistan Reconstruction Fund, will provide financial support for community programmes in the participating countries by creating a multilateral trust fund.

For the CASA-1000 project (SNC–Lavalin International, 2011), the future expansion of the region's electricity exports is a key. However, the export potential, in particular of Kyrgyzstan and Tajikistan, is closely related to the issues of water resources availability and, consequently, to the HPP operating regimes which are, in turn, linked to the irrigation needs of downstream countries. When the Syr Darya and the Amu Darya experience low water periods (which may last three to four years), no surplus electricity is expected to be generated by the existing hydro power plants during the summer.

For example, low water in Kyrgyzstan at the beginning of the 2021 vegetation period led to an almost complete drawdown of the Toktogul Reservoir. Kyrgyzstan intends to compensate for the resultant shortage by importing electricity from Uzbekistan and Kazakhstan. The possibility of electricity imports to cover Kyrgyzstan's needs was discussed by the heads of state of those countries in March and April 2021. The current tense situation involving water and energy supply in the region was caused not only by low water, but also by inadequate regulation of interstate water use issues and of the CAPS operating mode in that context.

Beside the matter of sufficiency of water resources, which may restrict stable generation of electricity in CA to be exported to South Asia under the CASA-1000 project, **there are certain doubts as to whether the potential importers (Afghanistan and Pakistan) will have enough effective demand.** With low power rates in CA, electricity exports from CA to third countries may be economically viable only if higher rates are used.

Table 6. Average Power Rates for Domestic Consumption and Export to CASA-1000 Countries, in USD

	2014	2015	2016	2017	2018	2019	2020
Average National Rates							
Kyrgyzstan (cents per 1 kWh)	1.720	2.010	1.920	1.980	1.980	1.950	1.950*
Tajikistan (cents per 1 kWh)	2.330	2.030	1.650	1.860	1.980	2.250	2.317*
For reference: Volume of export from Tajikistan to Afghanistan (USD millions)	*38.8*	*44.7*	*51.2*	*50.9*	*38.2*	*2.4*	*38.6*

* estimate.

Sources: CIS Electricity Council, Trademap, national agencies.

One of the most important geopolitical features of Central Asia is the transboundary nature of its main river basins. When developing hydropower generation and irrigation plans, it is necessary to consider the salient features of those basins and their water resources, transboundary water use, population growth, mounting water shortages, and deteriorating environmental situation. Delivery of electricity outside of the region must be synchronised with the interstate water use regime. Otherwise electricity exports to external markets, i.e., beyond the boundaries of a closed water basin (region) with limited water resources, may impair interstate relations and compromise energy, water, food, and environmental security of CA countries.

3. DEVELOPMENT TRENDS AND INVESTMENT PROJECTS IN THE WATER AND ENERGY COMPLEX OF CENTRAL ASIA

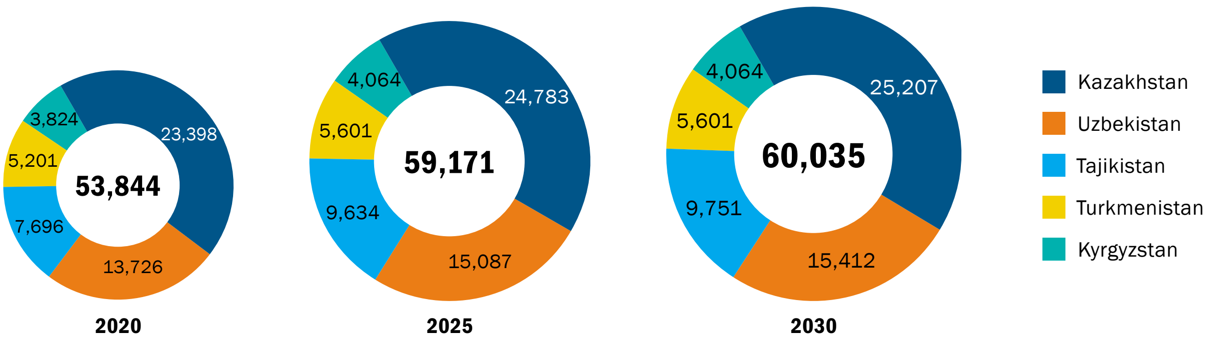
3.1. Prospects and Areas of Development of the Energy Sector of Central Asia

It is anticipated that the average CA GDP growth rate in 2020–2030 will remain relatively high because of considerable demographic growth (the median CA population will increase from today's 74.4 million to 90.0 million in 2050) and development of manufacturing, services, and agriculture. These processes will boost electricity consumption in the region and, accordingly, the loads experienced by the existing generating capacity and grid infrastructure.

Fitch Solutions estimates the anticipated increase of electricity consumption in CA in 2020–2030 at 13.6% (25.1 TWh). The main contribution to total consumption will be made by Uzbekistan (growth by 10.4 TWh, or 21%) and Kazakhstan (growth by 8.1 TWh, or 8.7%). A significant consumption increase is also expected in Tajikistan (growth by 3.9 TWh, or 27.1%).

The active policy of expanding generating capacity pursued by most CA countries (increase by 12.4%, or by 6.6 GW to 60 GW in 2030) will make it possible to meet the growing regional demand. The main contributors will be Uzbekistan (increase by 2.1 GW) through implementation of large-scale TPP and HPP construction projects (NPP projects are currently not included in projections), Tajikistan (increase by 2.1 GW) due to completion of large-scale HPP construction and upgrade projects, and Kazakhstan (increase by 1.8 GW) thanks to equipment upgrades at major CHPs and proactive RES encouragement policies. As new capacity is put in operation in response to escalating energy loads in CA, **anticipated growth of electricity output may amount to 15.1%**, with a capacity increase from 222.1 TWh to 255.6 TWh.

Figure 29. Projected CA Installed Capacity, 2021–2030, MW



Source: compiled by the authors using data provided by Fitch Solutions.

Despite the growth of electricity consumption in the region, completion of investment projects scheduled for the next decade will, generally speaking, help avoid electricity shortages. According to Fitch Solutions (Fitch Solutions, 2020, 2021a, 2021b, 2021c, 2021d), electricity surplus in the region will increase from 37.2 TWh in 2020 to 45.6 TWh in 2030 which, in turn, will encourage electricity exports and raise the issue of where such electricity surplus should be sold.

Subject to the ownership structure, the state will retain the key role in the development of the water and energy complex and financing of investment projects in all CA countries. CA water and energy complex development prospects are currently described in state policy papers and programmes which have been updated in virtually all CA countries.

Box 3. Key Official Documents on CA Water and Energy Complex Development

Kazakhstan: *Conceptual Framework for the Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030*, and *Strategic Plan for the Development of the Republic of Kazakhstan until 2025*. Kazakhstan's *Conceptual Framework for the Transition to a Green Economy* and *Kazakhstan 2050 Strategy* set targets for the share of alternative and renewable energy sources in the country's energy mix. In addition, the 59th Step of the National Plan *100 Concrete Steps to Implement Five Institutional Reforms* sets the task to attract strategic investors into the energy conservation sphere through the internationally recognised mechanism of performance contracts.

Kyrgyzstan: *Strategy for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2025.* The *Conceptual Framework for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2040* is currently under discussion.

Tajikistan: Energy sector development tasks are formulated in the *Tajikistan Development Strategy until 2030* and the *Investment Programme for the Restoration of the Production Base and Implementation of New Technologies.*

Turkmenistan: Currently the key document is the *Programme for the Social and Economic Development of Turkmenistan for 2019–2025.*

Uzbekistan: *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030* and *Conceptual Framework for the Development of the Water Sector in the Republic of Uzbekistan for 2020–2030.*

The following major areas of development of the CA water and energy complex will require significant investment:

- **Development of new generating capacity**, including hydro power plants (only 10% is being used out of the total potential capacity of 430–510 TWh), high-tech CCGT plants, solar and wind power plants, nuclear power plants, etc. In particular, construction of CA's first 200 MW pumped-storage plant (the Hojikent PSP) in Bostanliq District, Tashkent Region;

- **Development of the power grid** through construction and modernisation of transmission and distribution systems (including smart grids);

- **Development of the water complex**, including steps to reduce electricity consumption by pumping stations, deployment of digital water-metering technologies, automation of governance processes, modernisation of the irrigation system, etc.

Possible new CA water and energy complex development areas include:

- **Digitisation of power systems** to regulate loads as the contribution of RES increases and new energy storage types are introduced;

- **Application of new green technologies**, which represent a symbiosis of conventional ecological approaches to environmental protection and new clean technologies (CleanTech/GreenTech) and digital technologies (artificial intelligence, big data, etc.).

Figure 30. Key Areas of Development of the CA Water and Energy Complex

Source: developed by the authors.

3.2. Energy Development Strategy and Investment Projects in Kazakhstan

In Kazakhstan, in line with the updated *Conceptual Framework for the Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030*, approved by Decree of the Government of the Republic of Kazakhstan dated 28 June 2014, No. 724, the main purpose of **development of the oil, gas, coal, nuclear, and power industries is to create an integrated complex.** The baseline scenario contains an option for balanced development of conventional and alternative energy sources.

The optimal target structure of installed generating capacity by 2030 is defined as follows: coal 55%, gas 25%, RES, including hydropower 20%. There is a plan to actively implement digital energy management technologies. The *Strategic Plan for the Development of the Republic of Kazakhstan until 2025* sets the task of reducing the energy intensity of the GDP to less than 25% by 2025 (relative to 2008). The existing system of state support for the development of the RES sector was codified in 2009.

According to the *Conceptual Framework for the Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030* (approved by Decree of the Government of the Republic of Kazakhstan, dated 28 June 2014, No. 724), the **average annual rate of increase of electricity generation in 2021–2025 will be 3.0%.** Electricity consumption will be growing at 1.9% per year, and electricity output will increase from 106 billion kWh in 2020 to 120.9 billion kWh in 2025. Total installed capacity will increase to 27,000 MW in 2025.

The state support of investment projects typically takes the form of state preferences. Matters related to the state support of investment projects are within the purview of the Ministry of Foreign Affairs of Kazakhstan. The purpose of state support of investment projects is to create a favourable investment climate for the development of the economy, to encourage investment in the creation of new production facilities and expansion and upgrade of existing production facilities, and staff training. The use of auctions to select RES projects (see Table 8) and the flexible terms applied to RES investment projects have enabled involvement of foreign investors in the construction of RES facilities.

In the structure of high-potential energy projects in Kazakhstan, projects associated with the development of alternative energy sources (including small scale HPPs) dominate in terms of both the number and total financing of projects (see Table 7). At this time, the total value of high-potential projects designed to increase generating capacity in the country is USD 2,689.8 million, with alternative energy sources accounting for USD 1,508.4 million, or 56.1% of that amount, including USD 1,168 million (43.4%) for wind generation, USD 323.1 million (12.0%) for solar generation, and USD 17.4 million (0.6%) for biogeneration. HPP construction projects (USD 436.3 million, or 16.2%) can also be classified as “clean” energy sources; their development is critical for Kazakhstan’s power industry, as large HPPs can be used as manoeuvrable capacity reserve. Conventional energy sources, including thermal generation, account for USD 745.1 million (27.7%). Potential projects may also include grid development projects implemented by JSC KEGOC under its *Investment Programme for 2021–2025* (total value of identified projects: at least USD 624.6 million).

Table 7. Select Potential Investment Projects in Kazakhstan (as of 1 April 2021)

Project Name	Amount, USD millions	Timeframe	
Construction and operation of a solar power plant (200 MW)	241.4	2024	2025
Construction of an 80 MW combined-cycle gas turbine unit with an option to upgrade to 250 MW	237.2	2021	2025
Modernisation of the Almaty-2 CHP: gasification	232.6	2021	2025
Construction of the Turgusun-3 HPP	218.1	2024	2024
Shelek WPP (Phase 3)	179.1	2023	2025
Construction of a 50 MW wind park in the city of Kulsary	110.7	2021	2025
Construction of a 50 MW combined-cycle gas turbine unit with a 60 Gcal/h waste heat boiler in the city of Turkestan (PPP)	106.0	2020	2024
Construction of a wind power plant in the city of Nur-Sultan	100.0	2020	2022
Construction of a waste heat power plant	95.3	2021	2024
Badamsha-2 WPP	76.7	2020	2022
Construction of a 100 MW wind power plant	73.3	2021	2021
Construction and operation of the Dossor WPP	54.2	2020	2021
Modernisation of the Nur-Sultan-1 CHP and the Nur-Sultan-2 CHP: partial gasification	50.7	2021	2025
Construction of a wind power plant	45.1	2020	2021
Construction of the Turgusun HPP on the Turgusun River	31.1	2019	2021
HPP-2 on the Chazha River	30.2	2019	2021
Construction of the Turgusun-2 HPP	29.6	2022	2023
Dzungarian Gate WPP (Phase 3)	27.9	2024	2025
Birlik SPP	26.3	2024	2025
Upgrade of a gas engine power plant to 40 MW	23.3	2020	2022
Dzungarian Gate WPP (Phase 2)	22.1	2024	2025
Kora-3 HPP on the Kora River	20.9	2021	2023
Construction of 4.8 MWh power plants using biogas and 4.8 MWh power plants using solar energy	17.4	2022	2024
Upper Baskan-2 HPP	9.3	2020	2021
Construction of a solar power plant	8.8	2019	2020
Upper Baskan-3 HPP	7.9	2020	2021
Dzungarian Gate WPP (Phase 1)	5.8	2024	2025
Birlik HPP	5.8	2024	2025
Construction of a 4.95 MW wind power plant near the village of Zhangiz Tobe	5.2	2020	2021
Construction of a solar power plant	2.8	2019	2021
Construction of a wind power plant	2.4	2020	2021

Source: project proposals compiled by the authors on the basis of publicly available information.

Table 8. List of Auctioned RES Projects (as of 1 April 2021)

Project Name	Timeframe*	
Construction of a 20 MW SPP in Aral District, near the city of Aralsk	2020	2022
Construction of a 20 MW SPP, city of Kentau, Iassy Rural District	2020	2022
Construction of a 50 MW WPP, Alakol District	2020	2022
Construction of a 10 MW WPP, Taiynsha District	2020	2022
Construction of a 4.95 MW WPP, city of Ereymentau	2020	2022
Construction of a 10 MW SPP, Keles District	2020	2022
Construction of a 10 MW SPP, Keles District	2020	2022
Construction of a 1 MW HPP, Zharma District	2020	2025
Construction of a 2 MW HPP, Tole Bi District, near Upper Aksu Rural District	2020	2025
Construction of a 2 MW HPP, Tole Bi District, near Koksayek Rural District (Project 1)	2020	2025
Construction of a 3 MW HPP near the city of Esik	2020	2025
Construction of a 4,5 MW HPP, Koksu District, near Labasin Rural District	2020	2025
Construction of a 2 MW HPP, Tole Bi District, near Koksayek Rural District (Project 2)	2020	2025
Construction of a 1.5 MW HPP, Kazygurt District, near Kokpak Rural District	2020	2025
Construction of a 2 MW HPP, City of Kentau, near the village of Yntaly (Maydantal), Maydantal Rural District	2020	2025
Construction of a 5 MW HPP, Sarkand District, near the village of Kargaly	2020	2025
Construction of a 50 MW SPP, Otyrar District, near the village of Shauildir	2020	2022
Construction of a 39 MW WPP, Aiytrau District	2019	2022
Construction of a 7 MW WPP, Astrakhan District	2019	2022
Construction of a 4.99 MW WPP near the city of Ereymentau	2019	2022
Construction of a 10 MW WPP near the village of Novoishimskoe, Gabit Musirepov District	2019	2022
Construction of a 4 MW BioPP, Kazybek Biy District	2019	2023
Construction of a 2.4 MW BioPP near Karaoy Rural District, Ile District	2019	2023
Construction of a 4 MW BioPP near the village of Karaoy, Ile District, Almaty Region	2019	2023
Construction of a 2.5 MW HPP	2019	2025
Construction of a 4.5 MW HPP, Raiymbek District	2019	2025

* estimate based on approved rules used during the auction.

Source: project proposals compiled by the authors on the basis of publicly available information.

3.3. Energy Development Strategy and Investment Projects in Kyrgyzstan

In Kyrgyzstan, comprehensive work is being done in line with the current National Strategy to modernise existing equipment and build new energy facilities. The *Strategy for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2025,* created to ensure efficient operation of the fuel and energy complex and continuous development of the energy sector, was approved by Decree of the Government of the Kyrgyz Republic, dated 13 February 2008, No. 47. Kyrgyzstan also became the first Central Asian country to adopt a *Framework Law on Renewable Energy Sources*, which contains general principles governing regulation of the RES.

The *Conceptual Framework for the Development of the Fuel and Energy Complex of the Kyrgyz Republic until 2040* is currently under discussion. The document envisages creation of an installed capacity reserve to enable the power system to deal with loads exceeding crisis threshold values; that will require stage-by-stage implementation of a series of projects for the construction of high-potential HPPs, TPPs, and RES power units. Taking into consideration the heavy wear and tear on the existing equipment, there is a plan to restore and refurbish existing facilities. The Conceptual Framework considers the possibility of doubling electricity output to 34.6 TWh by 2040.

Virtually all promising energy projects in Kyrgyzstan are associated with hydropower potential and expansion of HPPs. For example, the Kyrgyz Republic is currently looking at nine large-scale generation development projects (eight HPPs and one TPP) and 63 small-scale HPP projects, for a total of USD 12,568.9 million. The high value of the projects is related to the large size of the proposed HPPs. Only one large-scale project is recommended that involves construction of a new thermal generation facility (the Karakeche TPP, USD 1,557 million). The list of potential projects may include grid expansion projects implemented by PLC National Power Grid of Kyrgyzstan for a total of USD 255.5 million, and the project for the construction of the 500 kV Datka–Khujand PTL within the framework of the CASA-1000 regional initiative for a total of USD 233 million.

Table 9. Potential Investment Projects to Develop Generating Capacity in the Kyrgyz Republic (as of 1 April 2021)

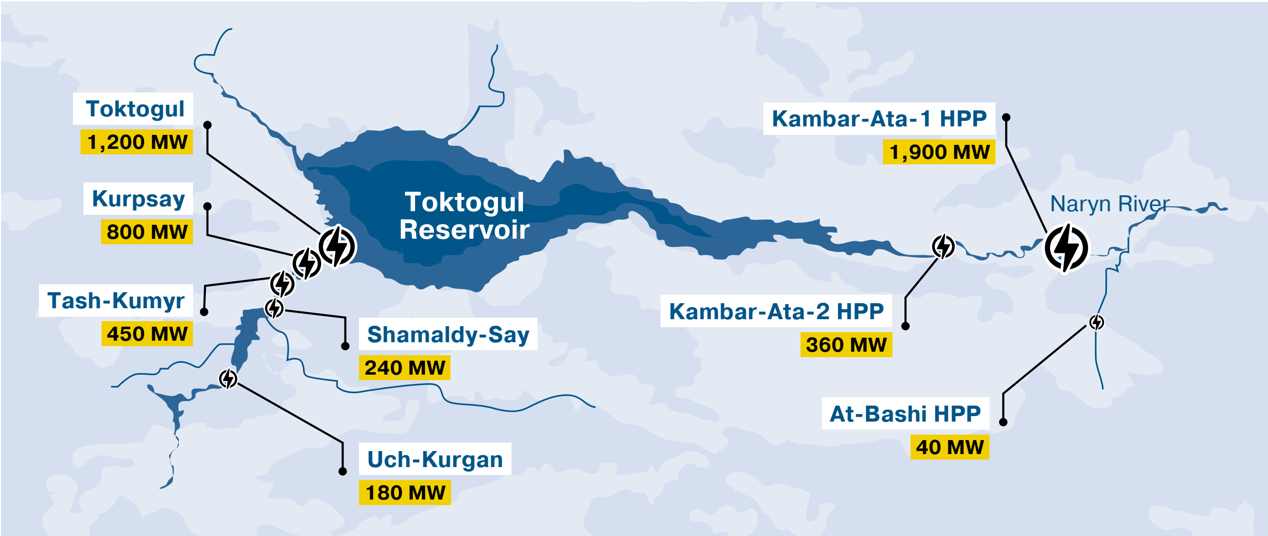
Project Name	Amount, USD millions
Kazarman HPP Cascade (1,160 MW)	3,610.0
Suusamyr–Kökömeren HPP Cascade (1,305 MW)	3,340.0
Kambarata-1 HPP (1,860 MW)	2,916.0
Karakeche TPP (1,200 MW, five years)	1,557.0
Construction of the Upper Naryn HPP Cascade – construction of four HPPs with a total capacity of 240 MW: – Ak-Bulun HPP – Naryn-1 HPP – Naryn-2 HPP – Naryn-3 HPP	727.0
Compact HPPs–UNDP – 63 units, including:	*314.0*
Construction of the Orto Tokoy HPP – 20 MW	*25.0*
Construction of the Oy-Alma HPP – 7.7 MW	*18.0*
Construction of the Sokuluk HPP – 1.5 MW	*3.3*
Construction of the Turtkul HPP – 3 MW (Batken Region)	*2.6*
Reconstruction of the Uch-Kurgan HPP	80.0
Reconstruction of the At-Bashi HPP	24.9
HPP Cascade on the At-Bashi River (6 units, 237.2 MW)	
HPP Cascade on the Ala-Buga River (4 units, 414 MW)	

Source: project proposals compiled by the authors on the basis of publicly available information.

The largest promising project in Kyrgyzstan and CA is construction of the Kambarata-1 HPP (1.9 GW, USD 2.9 billion), which will be strategically important for the entire water and energy complex of the region. It is expected that, in addition to improving Kyrgyzstan's energy security, the project will enable a transition to the balanced water management regime in the Naryn–Syr Darya Basin. The

Kambarata-1 HPP dam – the third-highest in the CIS after the Rogun HPP (construction under way) and the Nurek HPP in Tajikistan – will be built on the Naryn River 14 kilometres above the existing Kambarata-2 HPP (see Figure 31).

Figure 31. HPP Cascade on the Naryn River*



* The project for the construction of the Kambarata-1 HPP is currently at the design stage.
Source: EDB.

The Kambarata-1 HPP is part of a hydropower complex designed by the Central Asian Branch of the Gidroproekt Institute (Tashkent) in the early 1980s. The feasibility study for the project was completed in 1982, and design documentation was approved in 1988. The complex consists of three hydro power plants: (1) the Kambarata-1 HPP (1,900 MW), a counter-regulator controlling water releases by the upstream HPP; (2) the Kambarata-2 HPP (360 MW); and (3) the Kambarata-3 HPP (170 MW), a diversion power plant operating on water diverted from the riverbed via special discharge outlets.

The regional advantage of the Kambarata-1 HPP is that it (together with the already operating Toktogul HPP and the Kambarata-2 HPP) will enable more efficient control of the reservoir operating regime. The Kambarata-1 HPP project will have a positive impact on the ability to control water resources in CA during both dry and wet years. HPP reservoirs will make it possible to better meet the irrigation needs of the neighbouring countries, which is fully consistent with the national interests of Uzbekistan and Kazakhstan.

In 2017, Shavkat Mirziyoyev, President of Uzbekistan, affirmed that Uzbekistan was interested in construction of the Kambarata-1 HPP. JSC Uzbekhydroenergo and the National Energy Holding Company of the Kyrgyz Republic signed a memorandum of cooperation. In March 2021, Sadyr Japarov, President of Kyrgyzstan, and Shavkat Mirziyoyev, President of Uzbekistan, reached an agreement on joint implementation of the project for construction of the Kambarata-1 HPP. The parties resolved to establish a Joint Coordination Committee to develop an integrated action plan ("roadmap") for joint construction of the Kambarata-1 HPP. By June 2021, the Committee was to prepare and present proposals regarding the cooperation format, financing sources, control procedures, and terms of Uzbekistan's involvement in the project.

3.4. Energy Development Strategy and Investment Projects in Tajikistan

Energy sector development is one of the most important components of the *Tajikistan Development Strategy until 2030* and the *Investment Programme for the Restoration of the Production Base and Implementation of New Technologies*. Both administrative and technical activities are under way in the sector, including transformation of the power system governance structure, with a breakdown by types of operations; increase of generation potential through construction of new generation facilities and modernisation of existing ones; expansion of transport infrastructure for the power system; and improvement of energy efficiency through the use of modern automated energy dispatch and metering systems. Implementation of the RES programme has been completed, and numerous compact HPPs have been put in operation. The *Law on the Use of Renewable Energy Sources* regulates RES activities.

In line with the *Tajikistan Development Strategy until 2030*, a series of hydropower reforms will be implemented to ensure deployment of market mechanisms that will eventually create a competitive environment. That key stage will make it possible to complete the construction of the Rogun HPP and ensure the country's energy security. A balanced market will be created to support electricity supplies to the Central Asian region, and mutually beneficial cooperation in that area will be renewed.

Development of Tajikistan's energy sector will rely on the 10/10/10/10 concept:

1) Design capacity of the power system will be increased to 10 GW;

2) Annual export of electricity to the neighbouring countries will reach 10 billion kWh;

3) At least 10% of the country's power system will be diversified by increasing the share of alternative energy sources, including coal, oil, gas, and renewable energy sources;

4) Electricity losses in the country will be reduced to 10%.

To ensure reliable supply of energy to the Tajikistan economy, implementation of a generation diversification programme is under way on the basis of development of small scale hydropower and the coal industry, and construction of combined heat and power plants (CHPs). Construction and reconstruction of power plants, CHPs, power transmission lines and substations, as well as energy sector reforms have made it possible to considerably improve energy supply to the population, ensure stable operation of the energy infrastructure, and export electricity to the neighbouring countries during the summer. The following facilities were built and put into operation: the Sangtuda-1 HPP, the Sangtuda-2 HPP, the Dushanbe CHP (Phase 1), as well as the South–North, Lolazor–Khatlon, and Khujand–Ayni power transmission lines.

Tajikistan has significant RES reserves. More than 285 compact HPPs with capacities of up to 4,300 kW have been registered in the country. Of these, 16 compact HPPs were built and are operated by OJSHC Barqi Tojik, and are owned by the state. The Pamir Energy company manages 11 compact and mini HPPs with a total installed capacity of 44.16 MW. In 2020, they produced 11.2 million kWh of electricity, or less than 0.1% of total output for the period. About 100 compact HPPs of those described above are not in operation. The main reason is that most of them were built without a proper hydrological stream review and survey work. Some are inactive because of the shortage of water: in summer it is used for irrigation, and in winter there is no sufficient runoff. Tajikistan's experience demonstrates that large-scale construction of compact HPPs is economically unviable and inefficient. They can be built in small, hard-to-reach settlements or tourist destinations that are far from the principal power transmission lines.

As in Kyrgyzstan, virtually all projects in the structure of high-potential energy projects in Tajikistan are associated with hydropower potential and the expansion of HPPs. For example, at this time Tajikistan is looking at about 10 large projects to develop generating capacity (nine HPPs and one TPP) for a total of USD 8,243.0 million. Only one large-scale project is recommended that involves construction of a new thermal generation facility (the Fon Yaghnob coal-fired TPP, USD 600 million, or 7.3% of the total). The remaining USD 7,643 million (92.7%) will be used to expand the hydropower potential. The Rogun HPP project has been restored to the list of HPP projects. It is financed primarily with state funds, and at this time the Government of Tajikistan is trying to raise another USD 340 million tranche.

Tajikistan has the world's eighth-largest hydropower potential. Only 4–5% of that potential has been harnessed to date. New projects are designed to eliminate the imbalance created by surplus generation during the summer and shortage of electricity during the winter.

Table 10. Scheduled Investment Projects for the Development of Generating Capacity in Tajikistan (as of 1 April 2021)

Project Name	USD millions
Construction of the Khostav HPP (1,200 MW)	2,039.0
Construction of the Shurab HPP (850 MW)	1,500.0
Construction of the Shtien HPP (160 MW)	1,500.0
Construction of the Anderob HPP (650 MW)	1,300.0
Construction of the coal-fired Fon Yaghnob TPP (600 MW)	600.0
Rogun HPP (3,600 MW)	340.0
Construction of the Yavan HPP (140 MW)	282.0
HPP on the Fan Darya River (135 MW)	270.0
Construction of the Ayni HPP on the Zeravshan River (160 MW)	220.0
Modernisation of the Nurek HPP (Phase 2)	192.0

Source: project proposals compiled by the authors on the basis of publicly available information.

The list of investment projects may also include grid expansion and modernisation projects, including those designed to reduce losses, deploy an automated control and metering system, encourage trans-regional electricity trade, etc. The total value of such projects reaches USD 433.9 million (excluding construction of Tajikistan's section of CASA-1000, which is classified as a completed project).

3.5. Energy Development Strategy and Investment Projects in Turkmenistan

The Government of Turkmenistan prefers modern mixed-type gas turbine plants, which were built under the *Conceptual Framework for the Development of the Energy Sector of Turkmenistan in 2013–2020,* approved by the Head of State. The *Programme for the Social and Economic Development of Turkmenistan for 2019–2025* envisages construction of seven more large energy-producing facilities. The Government has demonstrated that it understands the importance of adaptation to climate change and development of alternative energy sources. That is confirmed by official documents and initiatives, such as the *National Climate Change Strategy*, which pays a lot of attention to adaptation measures, particularly in the water and agriculture sectors.

However, Turkmenistan remains the only country in Central Asia which does not publish information on expansion of its RES capacity, let alone on regulations and tax benefits that apply to renewable energy sources. In 2020, Turkmenistan began to work on its *National Strategy of Development of Renewable Energy Sources.*

Table 11. Ongoing Investment Projects for the Development of Generating Capacity in Turkmenistan (as of 1 April 2021)

Project Name	USD millions
Modernisation of eight generating units at the Mary HPP and two generating units at the Turkmenbashi HPP with a capacity increase to 645 MW	684
Construction of the 432 MW Zerger CCGT plant in Çärjew Etraby [District]	N/A
Construction of two power plants in the Ahal Welayat [Region]: the Gurtly Power Plant (508.4 MW) and the Ahal-2 Power Plant (254.2 MW)	N/A
Commissioning of a gas turbine unit (126 MW) at the Turkmenbashi Refinery	N/A
Turkmenistan–Afghanistan–Pakistan (TAP) power transmission line (500 km)	5,300
Construction of the 500 kV Ashgabat–Balkanabat–Turkmenbashi OPL	N/A
Construction of the 400 kV Mary–Sarakhs (Iran) and Balkanabat–Gonbad (Iran) OPLs	N/A
Construction of the 500 kV Mary HPP–Atamurat–Andkhoy (Afghanistan) OPL and the 220 kV Pelvert–Atamurat OPL	N/A

Source: project proposals compiled by the authors on the basis of publicly available information.

As regards expansion of the national grid, there is a plan to join the country's power nodes by 500 kV overhead power transmission lines into a single system, which will create a ring of such nodes. In addition, a **transboundary 500 kV PTL is to be built to enable fulfilment of plans to export electricity to Iran and Turkey (transit through Iran).** In February 2020, Turkmenistan launched a project for the construction (as part of Turkmenistan's section of the Turkmenistan–Afghanistan–Pakistan HV PTL) of a transmission line from the Mary HPP to the Afghan city of Herat, which, in addition to supplying power to all infrastructural facilities along the line, will enable transit electricity exports via Afghanistan to Pakistan and other South Asian countries (CentralAsia.news, 2021).

3.6. Energy Development Strategy and Investment Projects in Uzbekistan

Uzbekistan implemented a series of large-scale reforms in the energy sector in line with Decree of the President of the Republic of Uzbekistan dated 27 March 2019, No. PP-4249, *On the Strategy of Further Development and Reform of the Electric Power Industry of the Republic of Uzbekistan.*

A number of documents were approved to **support energy conservation technologies, develop renewable energy sources, attract foreign direct investment** to the power industry, and expand the use of alternative fuels and energy sources. The *Law on the Use of Renewable Energy Sources*, providing tax benefits to companies using RES to generate electricity, was approved in May 2019. Implementation of a **"roadmap"** is under way to **improve energy efficiency** and save fuel and energy resources at large, energy-intensive enterprises in 2020–2022.

Pursuant to the *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030*, thermal power plants continue to dominate generation of electricity in the country. It is expected that generation will be developing on the basis of energy-efficient technologies. In 2020–2030, special attention will be paid to expansion of the use of RES, particularly solar energy, to generate electricity. There are plans to build new wind and solar power plants with a total capacity of 3 GW and 5 GW, respectively. In total, Uzbekistan plans to double its generating capacity by 2030.

Construction of new high-tech combined cycle gas turbine plants and modernisation of existing capacity. The *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030* envisages construction of six new TPPs with a total capacity of 3,800 MW, and reconstruction of six existing TPPs to increase their total capacity by 4,100 MW. A series of demand management power plants will be built to cover peak loads; they will have a total capacity of about 1,200 MW, and operate on low-capacity gas turbines (50–100 MW) and gas reciprocating engines. There is also a project for the modernisation of Power Units 1–5 at the Novo-Angren TPP to boost its capacity by 330 MW.

Development of solar and wind generation. The *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030* envisages development of 100–500 MW photovoltaic power systems (PVPSs), primarily in the central and southern areas (Jizzakh, Samarkand, Bukhara, Qashqadaryo, and Surxondaryo regions). A number of 50–200 MW solar PVPSs will also be built in the remaining regions. The main wind generation development area is creation of large wind parks with a capacity of 100–500 MW each, with most such parks concentrated in the north-west of the country.

The first tender for a wind generation project will be conducted with the support of the EBRD under a cooperation agreement whose ultimate goal is to build wind power plants with an aggregate capacity of 1 GW. The site for construction of the wind power plant and auxiliary infrastructure facilities was selected in the Qarao'zak District of the Republic of Karakalpakstan. The project is a part of a large-scale RES utilisation strategy pursued by the Government of Uzbekistan. Economically efficient and environmentally friendly wind power plants with an aggregate capacity of up to 3 GW will be deployed over the next 10 years to meet the growing demand for electricity in the country.

The Conceptual Framework also lists the following major areas of development of the energy sector.

Development of hydro generation. The *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030* envisages 62 projects, including construction of 35 new HPPs with a total capacity of 1,537 MW, and modernisation of 27 existing HPPs to increase their total capacity by 186 MW. Explored hydropower resources amount to 27.5 billion kWh per year, and only about 30% of that potential is actually being used. The assessment was conducted 30 years ago, and today it is necessary to review and update the list of new areas in river basins suitable for hydropower generation.

Development of nuclear power. A USD 11 billion project for the construction of an NPP in Jizzakh Region of Uzbekistan is currently under review. SC Rosatom is engaged in the project in line with the relevant inter-governmental agreement between Russia and Uzbekistan. The project envisages construction by 2030 of two generating units using VVER-1200 water-cooled and water-moderated reactors with a capacity of 1.2 GW each.

Table 12. Potential Investment Projects for the Development of Generating Capacity in Uzbekistan (as of 1 April 2021)

Project Name	USD millions	Timeframe	
NPP (2 x 1,200 MW)	11,000.0	2021	2030
Construction of a gas-fired CHP (1,500 MW)	1,800.0	2021	N/A
Modernisation of the Navoiy TPP (Phase 2). Construction of a 600+ MW CCGT unit	1,454.0	N/A	N/A
Construction of a coal/gas-fired power plant in Tashkent Region	1,200.0	N/A	N/A
Completion of the construction of the Turakurgan TPP	1,100.0	N/A	N/A
Expansion of the Talimarjan TPP, including construction of new combined-cycle gas turbine units with a total capacity of at least 900 MW	1,004.6	2019	2024
Pskem HPP on the Pskem River (400 MW)	862.4	2019	2024
Construction of the Navoiy WPP (500 MW)	600.0	2020	2024
Construction of the Mullalak HPP (140 MW)	350.0	2020	2025
Hojikent Pumped-Storage Plant (PSP, 200 MW)	320.0	2024	2027
Stage-by-stage modernisation of generating units at the Syr Darya TPP	216.5	2018	2021
Upper Pskem HPP (200 MW)	200.0	2023	2028
Akbulak HPP (60.0 MW)	160.0	2024	2027
Construction of the Lower Chatkal HPP on the Chatkal River (76 MW)	151.7	2020	2024
Construction of two gas turbine units (GTUs) with a capacity of 27 MW each at the Tashkent CHP	114.2	2019	2023
Construction of 100 MW a solar photovoltaic plant in Navoiy Region (pilot project) on public-private partnership terms	100.0	2020	2021
Construction of a 100 MW solar photovoltaic plant in Nurobod District, Samarkand Region	100.0	2020	2021
Modernisation of the Tupalang HPP	84.5	2019	2022
Zarchob Compact HPP Cascade on the Tupalang River (75.6 MW)	80.4	2017	2021
Modernisation of UE Farkhad HPP	72.4	2017	2021
Kamchik Compact HPP on the Ohangaron River (26.5 MW)	27.2	2017	2020
Construction of the Rabat HPP on the Aksu River (6 MW)	25.3	N/A	N/A
Construction of the Chappasuy HPP on the Aksu River (8 MW)	25.0	N/A	N/A
Construction of the Tamshush HPP on the Akdarya-Aksu River (10 MW)	25.0	N/A	N/A
Construction of a compact HPP near the Sardoba Reservoir	24.1	2020	2022
Kamolot HPP, Chirchiq-Bozsuy Cascade (8.2 MW)	22.6	2017	2021
Construction of the Bagishamal-2 Compact HPP on the Dargom Canal (6.45 MW)	21.7	2020	2022
Modernisation of UE Samarkand HPP Cascade (HPP-2B)	21.7	2019	2021
Construction of a compact HPP at Surveyor Station 102+00 on the Dargom Canal (6.4 MW)	21.0	2020	2022
Modernisation of UE Chirchiq HPP Cascade (HPP-10)	18.6	2019	2021
Construction of a compact HPP at Surveyor Station 135+50 on the Dargom Canal (7.4 MW)	15.7	2019	2021
Construction of the Shaudar Compact HPP on the Dargom Canal (7.2 MW)	14.9	2019	2021
Modernisation of UE Tashkent HPP Cascade (HPP-1)	12.4	2019	2021

Source: project proposals compiled by the authors on the basis of publicly available information.

Uzbekistan became the first country in the region to try hydrogen generation. Remote territories can be supplied with electricity generated by standalone hydrogen power plants. Decree of the President of the Republic of Uzbekistan, dated 9 April 2021, No. PP-5063, *On Measures to Develop Renewable and Hydrogen Generation in the Republic of Uzbekistan,* was signed to facilitate deployment of the new technology. To create the infrastructure required to promote renewable energy sources, it is necessary to perform a huge amount of research and development work. For that purpose, the National Renewable Energy Sources Research Institute is to be established under the Ministry of Energy. The institute will host a hydrogen generation research centre and a laboratory for the testing and certification of renewable and hydrogen generation technologies.

Electricity transmission networks. Subject to the increasing wear and tear on electricity networks and the need to integrate new sources of generation, including RES, Uzbekistan's specialised agencies are working on a transmission network development plan. The *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030* envisages that to improve reliability of power supply, all nodes of the common power system will be joined into a single 500 kV network. A *Plan for the Development of Transmission Networks until 2030* will be developed with the participation of the World Bank. Distribution network construction, modernisation, and reconstruction works will be financed by JSC National Power Grid of Uzbekistan's own and borrowed funds.

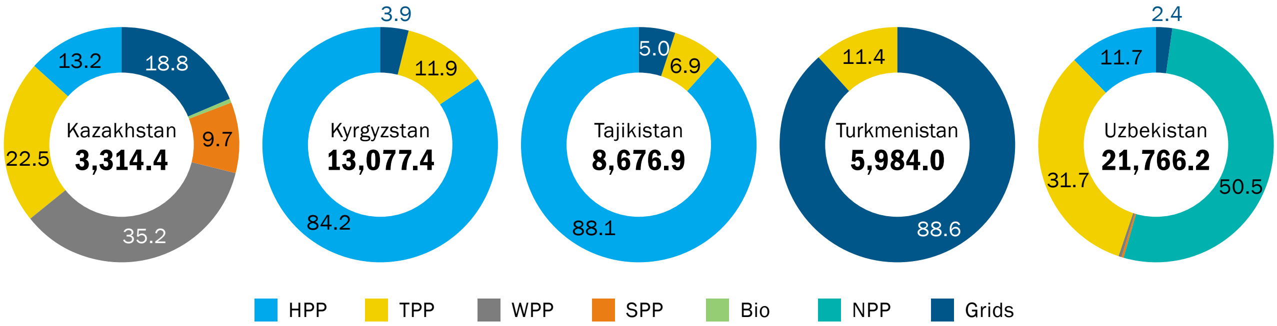
Electricity distribution networks. To ensure proper implementation of the *Conceptual Framework for the Supply of Electric Power in the Republic of Uzbekistan in 2020–2030*, the Government of Uzbekistan is to develop a state programme for construction of new and modernisation of existing 35–110 kV power networks. The work to modernise and reconstruct low-voltage distribution networks will continue in 2021–2025, and an appropriate state programme is to be adopted in 2022–2025. The work related to construction of new and modernisation/reconstruction of existing power transmission lines and substations will be financed with long-term IFI loans and JSC Regional Power Grids' own funds. With the development of new types of generation and emergence of a competitive market, Uzbekistan will face the need to create smart grids capable not only of transmitting energy to consumers, but also of taking back any surplus energy.

The total value of Uzbekistan's energy projects under review is USD 21,766.2 million. The largest of those projects is the USD 11 billion NPP construction project (50.5% of the total). Conventional energy sources which retain high priority status account for USD 9,445.9 million (43.4%), including USD 6,889.3 million (31.7%) for thermal generation, and USD 2,556.6 million (11.7%) for hydro generation. At this time, the role of alternative energy sources remains limited. The list of projects under review currently includes only two SPP construction projects for a total of USD 200 million (0.9%), and one WPP construction project (Navoiy WPP, 500 MW) for USD 600 million (2.8%). Despite the fact that RES have been incorporated in strategic development documents, solar and wind power plants are still regarded as experimental. According to publicly available information, the value of grid development projects implemented by JSC National Power Grids of Uzbekistan within the framework of its investment programme is currently estimated at USD 520.3 million.

3.7. Total Value of Investment Projects in the Energy Sector of Central Asia

The total value of identified CA energy investment projects is currently estimated at USD 52.8 billion, with the generation segment and the power grid accounting for USD 45.4 billion (86.0%) and USD 7.4 billion (14.0%), respectively. The estimates are based on publicly available information, and largely reflect plans announced by the government for the long term or, in some cases, investment plans of certain major players, as well as projects that are part of international regional initiatives. The information on investment projects planned by Kazakhstan and Turkmenistan is probably incomplete and may need to be adjusted.

Figure 32. Value and Structure of Identified CA Energy Investment Projects, %, as of 1 April 2021



Source: calculated by the authors on the basis of publicly available data.

Uzbekistan is the leader in announced projects (USD 21.8 billion, or 41.2% of the total). This is largely explained by the fact that the country has announced a USD 11 billion NPP construction project, but it also holds the top position in thermal generation, and is actively working on its HPP network.

Kyrgyzstan (USD 13.1 billion, or 24.8%) and Tajikistan (USD 8.7 billion, or 16.4%) come in second and third, respectively. For a long time, those two countries have been trying to build up their hydropower potential, diversify generation by promoting thermal generation, find new electricity sales markets, and reduce electricity losses by modernizing their power grids. They have similar investment proposal structures in terms of their preferred investment targets. Many of the announced major projects were developed during Soviet times for the construction of new HPPs. As a rule, such projects require massive investments, and their implementation may be subject to additional technical examination and political endorsement at the regional level.

Turkmenistan, despite the extreme scarcity of available information on its energy investment plans, **comes in fourth with USD 5.9 billion (11.3%),** mostly thanks to the large-scale project for construction of the 500-km Turkmenistan–Afghanistan–Pakistan power transmission line. Several other transmission line construction projects were identified, but no information regarding their value is available. Policy papers mention several TPPs, but no investment value figures are provided. As new information is obtained, substantial changes may need to be made to the regional structure model in favour of Turkmenistan.

Kazakhstan (USD 3.3 billion, or 6.3%) takes the last position in terms of identified investment opportunities, despite the large size of its water and energy complex relative to the other countries. This may be explained by the complexity of the data collection process due to the presence of a larger number of private players, as opposed to the other countries where the state plays the dominant role in the development of the sector, and creates more comprehensive open investment project databases to simplify investors' searches. The information on investment proposals that we have managed to obtain from open sources, including government publications, shows that development of RES in Kazakhstan is high on the list of priorities. SPP and WPP construction projects account for a large share of the total value of investment proposals in Kazakhstan: 35.2% (USD 1.2 billion) and 9.7% (USD 323.1 million), respectively. As noted above, Kazakhstan is the only CA country which managed to successfully start the build-up of alternative energy sources on a commercial basis, with active private capital involvement.

3.8. Investment Needs of the Water Complex of Central Asia

The use of water resources in CA, especially after 1960, is characterised by high growth rates due to demographic factors and the development of manufacturing and agriculture, particularly irrigation. The CA countries in the Aral Sea basin are distinct in that their social and economic development proceeds amid gradual **depletion of water resources**. In other words, the volume of used resources exceeds the volume of disposable resources – and that factor will be determining the nature of interstate relations among the countries of the region. While the natural river runoff in the Aral Sea basin is 116.021 km^3/year,[6] total water intake reached maximum values in the 1980s–1990s at 120.69–116.27 km^3/year. The elevated demand for water resources in irrigation is supported by reused water.

In 2020, CA countries continued to suffer from water shortages due to limited availability of water resources (1,405 m^3 per person per year; threshold: 1,700 m^3 per person per year), and according to the current international classification they fall under the "stressed" category. Under the moderate development scenario for CA, this trend will persist over the long term. If CA countries fail to engage in meaningful regional economic cooperation (including water and energy integration), by 2050 there may emerge a scenario whereby they may move closer to the "scarcity" category (1,296 m^3 per person per year; threshold: 1,000 m^3 per person per year). The water situation will continue to deteriorate due to demographic factors (including continuing high population growth and urbanisation rates) and the possible increase of the area of irrigated lands.

Table 13. Classification of Countries by Sufficiency of Water Resources

Indicator (m^3 per person per year)	Water Sufficiency Category
> 1,700	No Stress
1,000–1,700	Stress
500–1,000	Scarcity
< 500	Absolute Scarcity

Source: Falkenmark and Widstrand (1992).

According to current estimates, by 2030–2050 CA countries may exhaust the stock of available irrigated lands because of general scarcity of lands that can be used for irrigated farming. Long-term expansion of the area of irrigated lands will be restrained. Because of geographic factors and intensive development of agriculture during the Soviet era, Uzbekistan, CA's largest agricultural producer, as well as the mountainous Kyrgyzstan and Tajikistan, have already approached the ceiling of availability of irrigated lands and disposable water resources used for irrigation. Kazakhstan, on the other hand, with its substantial stock of available land, has a significant potential for expansion of territories used for agricultural production. That potential, however, is restrained by the scarcity of water and low productivity of unused lands. As a result, land conversion to agricultural needs in CA will eventually require more sophisticated technologies and, accordingly, become more expensive.

[6] The average volume of renewable water resources in CA is 116.021 km^3, and over a long period it may vary depending on the dryness of each particular year and the operation of natural and climatic factors. Projections are based on the average volume of water resources in the region. The use of water resources also changes from year to year, and the rate of consumption depends, besides the dryness of the year, on demand, i.e., on water needs of various sectors of the economy.

It is also safe to assume that the natural river runoff in the Aral Sea basin will be decreasing over the next several decades because of climate change. The observed climate change is having a severe impact on the Tian Shan and Pamir glaciers. The average ice loss by the Tian Shan glaciers is 5.4 billion tonnes per year since 1960, adding up to a total loss of 3,000 km^3. The shrinking of glaciers changes seasonal distribution of the natural river runoff in the Aral Sea basin, increasing the drive for a major revision of regional water use practices in favour of stronger regional cooperation. This gives rise to the need to pursue a coordinated regional water management policy to balance used and disposable water resources, subject to demographics, climate change, development of agriculture, etc.

Despite the depletion of water and irrigation resources in CA, all countries intend to further increase the use of water resources for irrigation and hydropower generation purposes, as evidenced by their national strategies and programmes. Each country of the region has a long-term programme to improve the reclamation status of irrigated lands, but almost all such programmes are implemented only in part because of the lack of funding and investment capital. The same is true for municipal water supply and sanitary infrastructure, where lack of investment prevents any significant improvement of the quality of potable water supplied to the population. Investment in these critical sectors is still characterised by low growth rates and weak inflow of international private capital.

Figure 33. Use of Water and Land Resources in the Aral Sea Basin

	1980	1990	2000	2020	2030	2050
Population (millions)	26.8	33.6	41.5	74.4	81.6	90.0
Irrigated Lands: Total (thousand hectares)	6,920	7,600	7,990	8,040	8,100	8,200
per capita (hectares per person)	0.26	0.23	0.19	0.11	0.1	0.09
Water Intake: Total (km^3 per year), including	120.69	116.27	105.0	104.6	107.5	106.3
Irrigation (km^3 per year)	106.79	106.4	94.66	94.1	87.5	78.72
Irrigation per hectare (m^3 per year)	15,430	14,000	11,850	11,704	10,800	9,600
per capita (m^3 per person per year)	4,500	3,460	2,530	1,405	1,317	1,296

Note: Total water intake projections incorporate data on reuse of discharge, collector and drainage water, prospective rate of urbanisation in the countries of the region, and climate change.
Source: IWMCC RIC, authors' calculations.

The water sector, with its extremely close links to the other sectors of the economy, must be assigned a priority status in Central Asia national development strategies and programmes. Water infrastructure facilities – both in municipal water supply and in irrigation – have used up their service lives and require upgrade and modernisation. The poor state of repair of the irrigation infrastructure leads to substantial loss of water, causing waterlogging and salinization of irrigated lands whose agricultural use then has to be discontinued.

Table 14. Planned and Projected Investment in CA Water Sector

	2021–2025, USD millions		2026–2030*, USD millions	
	Annual Average	Entire Period	Annual Average	Entire Period
Kazakhstan	530.0	2,140.0	535.0	2,140.0
Kyrgyzstan	70.0	350.0	75.0	375.0
Tajikistan	45.0	225.0	50.0	250.0
Turkmenistan	90.0	450.0	95.0	475.0
Uzbekistan	250.0	1,250.0	205.0	1,025.0
Total	**990.0**	**4,415.0**	**960.0**	**4,265.0**

Note: * projected values.
Source: authors' calculations based on publicly available data.

The authors estimate that the planned and projected water sector investment needs of CA countries in 2021–2030 will amount to about USD 8.7 billion, or up to USD 990 million per year. The bulk of water sector investments will go to the two countries situated in the lower reaches of the transboundary rivers of the Aral Sea basin – Kazakhstan (49.3%) and Uzbekistan (26.2%). They are faced with more severe water availability challenges. Ongoing projects are frequently implemented within the framework of state programmes and funded with budget allocations.

The planned and projected (indirect assessment) investment needs were measured on the basis of our analysis of national strategies and state programmes for the development of the water sector (if any) and the agricultural complex (see Box 4), and of the existing financial planning trend for irrigation. As a result, the proposed estimates reflect, to a large extent, the water sector investment planning practices already adopted in the region. Assessment of plans to expand irrigated lands and, accordingly, of the cost of construction of new irrigation facilities was an important factor that substantially affected our projections.

Kazakhstan has approved a draft *State Programme for the Management of Water Resources of Kazakhstan for 2020–2030.* The purpose of the draft programme is to guarantee availability of water resources required for sustainable development of the country, and to preserve and restore water management facilities to a state of repair enabling their comfortable use by the population and the economy. The draft programme covers 10 key areas: international cooperation, regulatory update, institutional reform, modernisation and reconstruction of water management facilities, review of international best practices on establishment of water markets, digitisation of the water sector, implementation of the Smart Water project, environmentally sound use of water resources, training of skilled water-sector specialists, and implementation of critical national water projects. According to the information provided by the Ministry of Ecology, Geology and Natural Resources of the Republic of Kazakhstan, the total cost of implementation of the programme over the next 10 years will be KZT 2.3 trillion (about USD 5.3 billion, or USD 530 million per year).

Box 4. Key Official Documents on CA Water Complex Development

- State Programme for the Management of Water Resources of Kazakhstan for 2020–2030
- Kazakhstan 2050 Strategy: New Political Course of the Established State
- Conceptual Framework for the Transition of the Republic of Kazakhstan to a 'Green' Economy
- State Programme for the Development of the Agricultural Complex of the Republic of Kazakhstan for 2017–2021
- State Programme for the Development of Irrigation in the Kyrgyz Republic for 2017–2026
- Programme for the Reform of the Water Sector of the Republic of Tajikistan for 2016–2025
- State Programme for the Development of New Irrigated Lands and Reclamation of Lands Withdrawn from Agricultural Use in the Republic of Tajikistan for 2012–2020
- National Development Strategy of the Republic of Tajikistan until 2030
- Conceptual Framework for the Development of the Water Sector in the Republic of Uzbekistan in 2020–2030
- State Programme for the Irrigation and Reclamation of Irrigated Lands for 2017–2019 (Republic of Uzbekistan)
- Programme for the Social and Economic Development of Turkmenistan for 2019–2025

Kyrgyzstan's 2017–2026 programme envisages construction of irrigation infrastructure to ensure availability of new irrigated lands to farmers, taking into consideration projected population growth. The purpose of the programme is to improve the social and economic situation and to ensure continuous development of the country's regions, and to deal with food security and poverty reduction issues. Total programme funding is estimated at approximately USD 700 million, or about USD 70 million per year. The programme envisages construction of 46 water management facilities (projects), which is expected to result in introduction of new irrigated lands, improvement of water availability, transition from pump irrigation to gravity irrigation, improvement of land reclamation status, etc.

Uzbekistan's state programme envisages construction and reconstruction of irrigation system canals, hydraulic and water management structures, reclamation facilities, etc. The purpose of the programme is to introduce drip irrigation and other water conservation technologies. State programmes are used as the framework for six large-scale investment projects with a total value of USD 1.395 billion, financed by MDBs:

- Restoration of the principal irrigation canal in Toshsoq, Xorazm Region (USD 145.5 million);

- Improvement of water management practices in Southern Karakalpakstan (USD 376.7 million);
- Restoration of Amu-Bukhara irrigation networks (USD 406.3 million);
- Restoration of Qarshi Cascade pumping stations (USD 115.9 million);
- Improvement of water management practices in the Fergana Valley (Phase 2) (USD 228.2 million);
- Improvement of water management practices in Surxondaryo Region (USD 122.7 million).

In addition, there is a plan to upgrade 229 of Uzbekistan's pumping stations for a total of about USD 818.9 million. The total investment in the country's water sector over the next 10 years is expected to be USD 2.3 billion (from USD 205 million to USD 250 million per year).

Work continues under the **Programme for the Reform of the Water Sector of the Republic of Tajikistan for 2016–2025** to ensure transition to the integrated water management model. The programme provides for 35 activities worth about USD 158 million in the following areas: improvement of existing laws and regulations (18 activities), institutional development (six activities), restoration of infrastructure (five activities), and development of water sector reform support tools (six activities). Taking into consideration the above activities and activities envisaged by other strategic programmes related to the development of agriculture and the water sector, the total to be invested in the water sector in Tajikistan in 2021–2030 may be as high as USD 475 million (from USD 225 million to USD 250 million per year).

Turkmenistan and the UN are implementing a joint project to improve sustainable water sector management (USD 78 million until 2022). The main purpose of the project is to ensure sufficient and environmentally sustainable water supply in order to maintain and improve social conditions and sources of livelihood of the population of Turkmenistan. The project covers four tasks: (1) to introduce new irrigated farming technologies to ensure efficient use of energy, conservation of water resources, and sustainable management of land resources (SMLR); (2) to attract investment in new and expanded efficient water management infrastructure; (3) to provide local and region-specific planning and training programmes for comprehensive management of water resources (CMWR) and SMLR for the *dayhan* (farmers) and water sector managers; and (4) to develop political reform to support CMWR and promote its implementation. The total of investment in Turkmenistan's water sector in 2021–2030 may be as high as USD 925 billion (from USD 90 million to USD 95 million per year).

In the future, it would be expedient to consider the possibility of introduction in CA countries of environmentally sound runoff intake standards for surface bodies of water in order **to reduce the anthropogenic load borne by such bodies.** It is also important to set and monitor compliance with environmentally sound reservoir water levels, and to provide all stakeholders with prompt access to all relevant hydrological information.

It would be desirable to set pollutant release/discharge standards on the basis of available best practices in reduction/prevention of pollution. That approach could be used in combination with existing methods based on assessment of pollution impact on the ecological status of bodies of water, and on expert environmental evaluation of projects for the construction of new and reconstruction of existing facilities whose release/discharge practices may have significant impact on the state of bodies of water.

It will be necessary **to increase investment in construction and modernisation of purification and treatment facilities, deployment by enterprises of new water conservation technologies**, purification and disposal by enterprises of sewer sludge, expansion of sewage systems in small settlements, and creation of objective monitoring systems. It appears expedient **to switch to modern high-tech methods to collect and process information on the state and use of water resources.** For example, new remote sensing technologies make it possible to conduct a preliminary assessment of the current state of water resources and measure the efficiency of water use.

Joint management of bodies of water and joint use of water resources of transboundary rivers is one of the most complex problems in Central Asia. Its resolution must be regarded as a key area for integration of the countries of the region, alongside food, energy, and environmental security, development of transport infrastructure, expansion of mutual investment, and other areas of economic cooperation. No decision pertaining to regional water issues can be considered apart from national strategies for water use, food supply, and energy; on the other hand, it must be consistent with the interests of the basin as a whole.

Achievement of the sustainable social and economic development goals facing CA is largely linked to the state of its water resources. Thus, reaching a consensus on interstate water distribution in transboundary river basins is the key task that requires an integrated solution embracing both social, economic and environmental changes and the political situation in the countries adjacent to the region. These natural and geopolitical factors objectively substantiate the need to promote regional integration and joint management of local river basins in accordance with international law.

Certain regional institutions could be instrumental in dealing with these issues, such as the International Fund for Saving the Aral Sea (IFAS) and its affiliates: the Interstate Sustainable Development Commission, the Interstate Water Coordination Commission, and the Electric Power Coordination Council of Central Asia and its “Energy” Coordination and Dispatch Centre. Those structures must work together under the auspices of the IFAS, which has the political competence and sufficient authority to regulate water and energy relations and pursue regional infrastructure and investment policies.

Water and energy infrastructure is the most important long-term investment target in any country, as capital investment in such facilities determines the population’s quality of life and the state of the economy for years to come. CA energy and water infrastructure facilities – both in municipal water supply and in irrigation – have used up their service lives and require upgrade and modernisation. Besides, in line with the logic of regional integration in the sector, it would be reasonable to discontinue the operation of isolated national power systems and to create an interconnected transboundary infrastructure (Vinokurov and Libman, 2012). That is why it is clearly necessary to design an efficient mechanism to coordinate, attract, and use investment provided by MDBs – sources of financial resources for state water and energy initiatives.

One also needs to take into account the real risks to which infrastructure projects are exposed due to inefficient decision-making and corruption. To mitigate risks at all stages of such projects, it is important to ensure availability of accurate and updated information, rigorous planning, and clearly defined and audited business processes. Because construction of hydropower and water management facilities is very expensive, and it takes a very long time to go through the preparation and construction periods, loan and credit financing requires government bodies and financial institutions to thoroughly analyse and forecast the financial, economic, and environmental implications of each project.

Over the long term, CA will attract large-scale investment in the development of its water and energy complex. International experience shows that **efficiency of utilisation of investment capital largely depends on the availability of sufficiently highly skilled specialists.** Long-term plans to attract investment in cutting-edge technologies to facilitate development of the CA energy complex can be realised only if CA countries engage, on a non-stop basis, in basic and advanced training of skilled personnel. Unfortunately, that component of investment and innovation policy has so far been relegated to the background. Staffing issues remain poorly addressed in all the water and energy complex strategies and programmes. Lack of specialists is felt at all stages from design to construction and operation of energy facilities.

A shortage of various energy specialists is building up in all countries of the region from year to year. According to expert estimates, the shortage of skilled designers has already exceeded the critical threshold and stands at 50% or more; similarly, there is a 70% deficit of project managers, a 50% deficit of installers, etc. In the next 5–10 years this may grow into one of the most serious problems hindering utilisation of investment capital and, consequently, the further development of the water and energy complex.

4. CONCLUSION

The central topic of the report is **analysis of the investment pool in the water and energy complex of Central Asia** – its key components, players, financing terms, etc. Our main conclusions are as follows:

- **In 2020, the largest providers of capital investment in the water and energy complex were Kazakhstan (USD 2.783 billion, or 1.6% of GDP) and Uzbekistan (USD 1.377 billion, or 2.4% of GDP).** In Tajikistan and Kyrgyzstan, capital investments in the water and energy complex were USD 507 million (6.3% of GDP) and USD 89 million (1.2% of GDP), respectively.

- Due to increased investment activity in the energy segment of the water and energy complex over the last several years, **the aggregate generating capacity in CA increased** from 42.2 GW in 1992 to 53.8 GW in 2020.

- Inasmuch as the CA water and energy complex has weak investment appeal, and profitability of related projects is too low from the viewpoint of private capital and foreign investors, MDBs act as **an important source of the financial resources required to implement state-initiated development projects in this complex**. At this time, there are 104 ongoing MDB-financed projects with a total value of USD 10.2 billion.

- **The EBRD tops the list of funding providers with a portfolio of USD 3.3 billion, or 32.7% of total MDB financing in CA.** It is followed by the WB (USD 3.0 billion, or 29.6%) and the ADB (USD 2.6 billion, or 26.2%). The combined EDB, EFSD, EIB, and AIIB portfolio stands at USD 1.2 billion (11.5%).

- In the structure of MDB investment in the CA water and energy complex, **energy projects take precedence over water management and water supply projects**. MDBs are involved in only 12 water projects with a total value of USD 1.5 billion (15.1% of total MDB investment in the CA water and energy complex).

- **The infrastructure of the water and energy complex of Central Asia has substantial investment needs of at least USD 90 billion** in 2021–2030 (about USD 9 billion per year, which is much more than would be indicated by the current regional trend). **Water sector infrastructure accounts for USD 8.7 billion of that amount.**

- Total identified **investment proposals in the energy segment** of the CA water and energy complex are currently estimated at **USD 52.8 billion**, with the generation segment and the power grid accounting for USD 45.4 billion (86.0%) and USD 7.4 billion (14.0%), respectively. It is expected that **despite the growth of electricity consumption in the region**, completion of investment projects scheduled for the next decade will help **avoid electricity shortages**.

- **The structure of the investment projects portfolio actually implemented in the CA water and energy complex is not optimal.** In all CA countries, almost all projects are aimed at meeting the needs of national economies and do not necessarily take into account regional interests, which is a result of uncoordinated development of the complex.

In conclusion, we would like to draw readers' attention to a number of very important issues that, in our view, need to inform future CA water and energy complex research and investment planning. **First and foremost, it is necessary to constantly remember the exceptional importance of the water use regime.** It is no great exaggeration to say that in the water and energy complex of Central Asia, "water" is more important than "energy". However, analysis of current investment trends shows that this key principle of has been disregarded for more than 30 years.

All large rivers in Central Asia are transboundary and have an interstate status. The river runoff in the basins of transboundary rivers is almost entirely formed in the upper reaches and used downstream. These natural and geopolitical factors objectively substantiate **the need to promote regional integration and joint management of local river basins** in accordance with international law. The lack of clear arrangements among CA countries on joint use of water of these rivers significantly diminishes the regional economic integration potential, including trade, transport, and labour markets, thereby inflating costs and hindering achievement of sustainable development objectives.

The CA countries in the Aral Sea basin are distinctive in that for a long time their **social and economic development has proceeded amid gradual depletion of water resources**, and this trend will be determining the vector of interstate relations among the countries of the region. In that context, the challenges facing the energy segment of the CA water and energy complex and its main problems will be related to the growing shortage of water resources, insufficient cooperation, and lack of investment capital for energy and water infrastructure development projects.

The water shortage in the region is largely attributable to weak organization of water use in agriculture and manufacturing, the poor state of repair of water management facilities, and insufficient funding allocated to finance their maintenance and development. Critical scarcity of water resources, their uneven distribution among the countries of the region, and mounting environmental problems call for coordination of efforts and economic integration on the basis of shared interests.

Previously used CA water and energy complex regulation principles were quite effective for a planned and centralised economy, but today they need **to be adapted to new political and economic realities and new technological opportunities.** CA needs new approaches to the regional electricity market and settlement of water issues – approaches that will be consistent with the interests of all countries of the region. These should ensure that the region's electricity and water needs are satisfied using the most economical and environmentally sound methods, contributing to the convergence of pricing methods and power rates, and deploying modern technological and digital solutions.

ANNEXES

1. The Main Transboundary Rivers of Central Asia

The **Amu Darya** is the largest river of Central Asia: its length from the head of the Panj is 2,540 km, and its basin area is 309,000 km^2. After the confluence of the Panj and the Vakhsh, the river is called the Amu Darya. The Amu Darya's runoff is formed mostly in Tajikistan. Then the river flows along the border between Afghanistan and Uzbekistan, traverses Turkmenistan, returns to Uzbekistan, and discharges into the Aral Sea. In the middle reaches, two large right tributaries (the Kofarnihon and the Surxondaryo) and one left tributary (the Kunduz) discharge into the Amu Darya. It has no other tributaries downstream from that point to the Aral Sea. The river is fed mostly by melted snow and glacier water, with maximum flow observed in summer, and minimum flow in January and February. The Amu Darya is one of the muddiest rivers in the world.

The **Syr Darya** is the second largest and the longest river in Central Asia. Its length from the head of the Naryn is 3,019 km, and its basin area is 219,000 km^2. The head of the Syr Darya is situated in the Central (Inner) Tian Shan. From the point of confluence of the Naryn and the Kara Darya, the river is called the Syr Darya. It is a glacier- and snow-fed river, with snow being the dominant source. The water regime is characterised by spring and summer flooding, which starts in April. The maximum runoff is in June. The Syr Darya's runoff is formed mostly in Kazakhstan. Then the Syr Darya traverses Uzbekistan and Tajikistan, and discharges into the Aral Sea in Kazakhstan.

The **Naryn** is the main component of the Syr Darya. Like its tributaries, it rises in the Tian Shan mountains, and emerges at the point of confluence of the Larger Naryn and the Smaller Naryn. When leaving the mountains to flow into the Fergana Valley, the Naryn has a runoff 3.5 times greater than that of the Kara Darya.

The **Kara Darya** is formed by the confluence of the Tar and the Kara-Kulja rivers, which, in turn, rise on the slopes of the Fergana Range and the Alay Range. Most of the Syr Darya's tributaries are concentrated in the Fergana Valley, where they flow down from the Chatkal Range, the Qurama Range, and the Turkestan Range. The largest of these tributaries are: right tributaries – the Padsha-Ata (the Namangasay), the Kasansay, and the Gava; left tributaries – the Isfayram, the Sokh, and the Isfara. Due to intensive water withdrawal for irrigation purposes, most of those tributaries do not discharge to the Syr Darya. As the Syr Darya emerges from the Fergana Valley, it takes in several right tributaries (the Ohangaron, the Chirchiq, and the Keles), with the last right tributary (the Arys) flowing into the Syr Darya below Shardara.

The **Chirchiq** is formed by the confluence of the Chatkal and the Pskem, feeding from the West Tian Shan and partially from Kazakhstan. The length of the Chirchiq is 161 km, its average long-term flow rate as it emerges from the mountains is 224 m^3/sec, and its average annual runoff is 7.15 km^3. The Chirchiq's catchment area is situated between the Talas Alatau Range and the Chatkal Range. Below the point of confluence of the Chatkal and the Pskem, the Chirchiq flows through a 29-km-long canyon at the bottom of an ancient valley. The Charvak Reservoir and the Charvak HPP are built at that segment of the river. The Chirchiq takes in only two relatively large tributaries: the Ugam from the right, and the Aksakata from the left. The other tributaries are “*says*” (small rivers drying up in the summer).

The **Ohangaron** is considerably smaller than the Chirchiq. Its catchment area is situated between the Chatkal Range and the Qurama Range. In the lower reaches, it is replenished with water from the Chirchiq through the Karasu Canal (left). The Ohangaron feeds on snow melt, and is characterised by early spring flooding. The river’s regime is regulated by the Tashkent Reservoir.

The **Chu** has a length of 1,067 km, and its basin area is 62,500 km^2. It rises in the Tian Shan in Kyrgyzstan, and disappears in the Ashikol Depression in Kazakhstan.

The **Talas** has a length of 661 km, and its basin area is 52,700 km^2. It rises in Kyrgyzstan and disappears in the sands of the Muyunkum Desert in Kazakhstan.

2. Water Reservoirs of Central Asia

No.	Name		Reservoir Parameters**					In Service, year
	Rivers	Reservoirs	NWL, m	V_1, million m³	V_2, million m³	F, km²	L, km	
Amu Darya Basin								
1	Amu Darya	Tuyamuyun Reservoir	130.0	7,300	5,270	790		1979
2	Jachsu	Selbur Reservoir	583.0	25.4	16.9	2.6	2.8	1964
3	Jachsu	Muminabad Reservoir	1,221.5	30.1	29.2	2.8	1.45	1959
4	Vakhsh	Nurek Reservoir	910.0	10,500	4,500	98.0	70.0	1972
5	Vakhsh	Principal HPP Reservoir	485.0	21.6	10.6	7.5	15.0	1962
6	Surxondaryo	South Surkhan Reservoir	415.0	641	610	64.6	20.0	1964
7	Surxondaryo	Degres Reservoir	536.0	12.8	12.2	2.3	3.5	1958
8	Surxondaryo	Uch-Kyzyl Reservoir	321.5	160	80	10.0	5.5	1960
9	Qashqadaryo	Chim-Kurgan Reservoir	488.2	440	418	45.1	15.0	1964
10	Qashqadaryo	Kamashin Reservoir	495.3	25.0	23.8	3.4	3.0	1946
11	Qashqadaryo	Pachkamar Reservoir	676.0	243	243	12.4	5.5	1967
12	Qashqadaryo	Hissaraq Reservoir	1,118.0	170	155	4.1	3.5	1985
13	Amu Darya	Talimarjan Reservoir	400.5	1,530	1,400	77.4	14.0	1977
14	Zeravshan	Katta-Kurgan Reservoir	511.0	845	834	84.5	17.0	1952/1968*
15	Zeravshan	Kuyumazar Reservoir	237.5	306	246	16.3	5.3	1957/1966*
16	Zeravshan	Tudakul Reservoir	222.0	875	855	225	18.5	1983
17	Zeravshan	Shorkul Reservoir	220.0	165	17.0			1983
18	Vakhsh	Sangtuda-1 Reservoir		258	120			2008
19	Tejen	Dostluk Reservoir		1,250	1,000			2005
Syr Darya Basin								
20	Naryn	Toktogul Reservoir	905.0	19,500	14,000	284	65.0	1974
21	Naryn	Kurupsay Reservoir	(500)	354	350	11.7	40.0	1982
22	Naryn	Tashkumyr Reservoir	(500)	144	133	7.8	18.8	1988
23	Naryn	Uch-Kurgan Reservoir	539.0	54.0	37.6	3.7	16.0	1961
24	Kara Darya	Andijan Reservoir	900	1,750	1 600	60.0	14.4	1970
25	Mailuusuu	Baza-Kurgan Reservoir	720.5	22.5	20.0	2.7	2.4	1962
26	Akbura	Papan Reservoir	1,282.0	260	240	7.1	8.5	1981
27	Aravan	Nayman Reservoir	1,201.6	39.5	38.0	3.2	8.0	1966
28	Kuvasay	Karkidon Reservoir	626.0	218	213	9.5	5.0	1964
29	Kasansay	Urta-Tokay Reservoir	1,128.0	160	160	7.6	5.0	1954/1956*
30	Isfara	Turtkul Reservoir	1,147.0	90.0	75.0	6.6	5.0	1970
31	Kattasay	Kattasay Reservoir	1,175.0	55.0	33.6	2.9	1.9	1966
32	Ohangaron	Ohangaron Reservoir	1,100.0	399	319	8.1	7.9	1974
33	Ohangaron	Tuyabuguz Reservoir	394.0	204	195	20.7	10.0	1966
34	Syr Darya	Kayrakkum Reservoir	346.6	3,510	2,230	510	55.0	1959
35	Syr Darya	Shardara Reservoir	252.0	5,200	4,230	783	80.0	1967
36	Chirchiq	Charvak Reservoir	890.0	1,990	1,690	40.3	22.0	1978
37	Chirchiq	Hojikent Reservoir	741.0	30.0		2.5		1977

No.	Name		Reservoir Parameters**					In Service, year
	Rivers	Reservoirs	NWL, m	V_1, million m³	V_2, million m³	F, km²	L, km	
38	Chirchiq	Gazalkent Reservoir	681.0	20.0		1.7		1980
39	Sangzor	Jizzakh Reservoir	371.4	73.5	73.3	12.5	3.0	1962
40	Bugun	Bugun Reservoir	438.0	370	363	63.5	14.7	1962
41	Badam	Badam Reservoir	672.0	61.5	5.9	4.8		1965
42	Syr Darya	Koksaray Reservoir	204.0	4,160	3,000	467.5	44.7	2008
43	Syr Darya	Sardoba Reservoir	305.0	973	922	68.0	28.0	2017
44	Chartaksay	Chartak Reservoir	701.6	30.0	21.1	4.92	4.0	1989
45	Rezaksay	Rezaksay Reservoir		300				2008
46	Syr Darya	Aydarkul (Reservoir Lake)	247	44,300		5,568	160	1969
Chu and Talas Basins								
47	Chu	Orto Tokoy (Kasansay) Reservoir	1762	470	450	25.0		1957
48	Chu	Tashutkul Reservoir	514.0	620	550	77.7		1980
49	Sokuluk	Sokuluk Reservoir	657.0	19.2	10.8	1.3	3.6	1968
50	Ala-Archa	Ala-Archa Reservoir	689.0	51.2	48.2	5.5	3.5	1983
51	Talas	Kirov (Kara-Burin) Reservoir	866.5	550	544	26.5	14.0	1976
52	Karabalta	Karabalta Reservoir	617.6	4.3	3.3	1.5	2.4	1964
Turkmenistan Rivers and Karakum Canal Zone								
53	Murghab	Tashkeprin Reservoir	321.31	18.5	18.5	39.9	25.0	1940
54	Murghab	Sary-Yazy Reservoir	321.30	653	78.5	26.0		1960
55	Murghab	Kolkhozbent Reservoir	297.0	30.0	30.0	20.4	32.5	1910
56	Murghab	Iolotan Reservoir	286.2	24.0	24.0	10.6	25.0	1910
57	Murghab	Hindukush Middle Reservoir	278.4	15.0	14.3	5.5	8.8	1896
58	Murghab	Hindukush Lower Reservoir	276.51	16.0		6.1	7.8	1896
59	Tejen	Khor-Khor Reservoir	302.10	18.0	18.0	3.4	3.0	1959
60	Tejen	Tejen I Reservoir	232.64	30.5		20.7	11.2	1952
61	Tejen	Tejen II Reservoir	221.0	132		42.0	15.0	1960
62	Karakum Canal	Khauz-Khan Reservoir	212.4	875	850	10.6	5.0	1962
63	Karakum Canal	Western Reservoir	192.5	48.5	41.0	3.3		1964
64	Karakum Canal	Eastern Reservoir	195.0	6.2		33.0	10.8	1980
65	Karakum Canal	Kopet Dag Reservoir	143.0	218.0	194	6.3		1973
66	Atrek	Mamedkul Reservoir	100.0	16.4		7.0		1980
67	Atrek	Dekhili Reservoir	95.0	11.0				1980

* numerator – year when the reservoir was put in operation; denominator – year when the dam was upgraded.

** reservoir parameters: NWL – normal water level; V_1, million m³ – gross storage capacity; V_2, million m³ – effective storage capacity; F, km² – area; and L, km – length.

Source: Sarsembekov et al. (2004).

3. Ongoing Central Asia Energy and Water Projects Financed by Multilateral Development Banks (MDBs)

Kazakhstan

Project	Form	Borrower	MDB	Value, USD millions	Co-Financing, USD millions	Period
			Energy			
Zhanatas HPP (capacity: 100 MW)	Credit	Private	AIIB	46.7	No	2019
Baikonur Solar Power Plant Project	Credit	Private	ADB	11.5	No	2019
Energy Restructuring and Transformation Project (Samruk-Energo)	Credit	Private	ADB	80	No	2018
Akmola Distribution Network Modernisation and Expansion Project	Credit	Sovereign	ADB	40	No	2013
Total Eren Access M-KAT Solar Energy Project	Credit	Private	ADB	30.5	No	2018
Improvement of energy efficiency (CAREC)	Grant	Sovereign	WB	21.8	Government – 1.3	2013–2021
Financing of JSC Samruk-Energy investment programme	Credit	Private	EDB	52.0	No	2018–2025
Financing of public-private partnership projects and partial refinancing of JSC Batys Transit bond-secured loan	Credit	Private	EDB	43.4	No	2019–2025
Construction of solar power plants in the Republic of Kazakhstan (installed capacity: up to 90 MW)	Credit	Private	EDB	66.5	No	2019–2031
Construction of a solar power plant in Akmola Region, Republic of Kazakhstan (installed capacity: 100 MW)	Credit	Private	EDB	56.8	No	2019–2031
Construction of a wind power plant near the City of Ereymentau (capacity: 50 MW)	Credit	Private	EDB	55.6	No	2019–2034
Participation in the bond-secured loan to JSC Kazakhstan Electricity Grids Operating Company	Credit	Private	EDB	20.8	No	2020–2035
Construction of a solar power plant in Turkistan Region, Republic of Kazakhstan (installed capacity: 50 MW)	Credit	Private	EDB	37.9	No	2020–2034
Construction of a solar power plant in Kyzylorda Region, Republic of Kazakhstan (installed capacity: 10 MW)	Credit	Private	EDB	8.9	No	2020–2034

Project	Form	Borrower	MDB	Value, USD millions	Co-Financing, USD millions	Period
Modernisation of KEGOC, Phase 2 (CAREC)	Credit	Sovereign	EBRD	187.4	Other funds – 187.4	2008
Risen Solar	Credit	Private	EBRD	22	No	2018
KazRef II – wind power plant	Credit	Private	EBRD	25.28	No	2020
Karaganda. Solar power plant. Phase II	Credit	Private	EBRD	30	No	2020
VISP – Samruk	Credit	Private	EBRD	55	No	2020
Kaztransgaz	Credit	Private	EBRD	290	No	2020
RES	Credit	Private	EBRD	360	No	2019
KazRef (energy)	Credit	Private	EBRD	12	No	2019
KazRef – networks modernisation	Credit	Private	EBRD	30	No	2019
Chulakkurgan – solar power plant	Credit	Private	EBRD	32	No	2018
SES Saran	Credit	Private	EBRD	52.7	No	2018
KAZREF – M-KAT solar power plant	Credit	Private	EBRD	60	No	2018
KAZREF – Nomad solar power plant	Credit	Private	EBRD	28	No	2018
Privatisation and transformation of Mangystau Distribution Grid Company	Credit	Private	EBRD	42	No	2018
Renewable energy financing mechanism	Credit	Private	EBRD	240	No	2016
Burnoye – solar power plant	Credit	Private	EBRD	84	No	2015
Burnoye-2 – solar power plant	Credit	Private	EBRD	50	No	2017
Kulan – solar power plant	Credit	Private	EBRD	24	No	2016
Modernisation of gas infrastructure	Credit	Sovereign	EBRD	58	No	2016
Samruk-Energy credit	Credit	Sovereign	EBRD	180	No	2016
Atyrau-Energy Project	Credit	Private	EBRD	5.9	No	2015
Kyzylorda Distribution Grid Company	Credit	Sovereign	EBRD	22	No	2014
Ereymentau wind power plant	Credit	Private	EBRD	65	No	2014
CAEPCO Modernisation Project	Credit	Private	EBRD	130	No	2013
Shardara HPP Modernisation Project	Credit	Sovereign	EBRD	73	No	2012
Other (mostly RES) projects						
Total MDB Financing				**2,730.7**		

Kyrgyzstan

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Energy						
Modernisation of the Uch-Kurgan HPP (CAREC)	Grant Credit	Sovereign	ADB/ EFSD	100	Government – 15 EFSD – 45	2019–2025
Toktogul – restoration. Phase 3 (CAREC)	Credit Grant	Sovereign	ADB/ EFSD	110	Government – 25 EFSD – 40	2016–2024
Toktogul – restoration. Phase 2 (CAREC)	Grant Credit	Sovereign	ADB/ EFSD	110	Government – 41.68 EFSD – 100	2014–2024
Additional financing of the Heat Supply Improvement Project	Credit	Sovereign	WB	2.66	No	2020
Heat Supply Improvement Project (CAREC)	Credit	Sovereign	WB	41	No	2017–2023
Restoration of Oshelektro (CAREC)	Credit	Sovereign	EBRD	7	No	2015
Restoration of Vostokelektro	Credit	Sovereign	EBRD	5	No	2017
Modernisation of Jalalabadelektro	Credit	Sovereign	EBRD	5	No	2018
Energy links between Tajikistan and Kyrgyzstan	Credit	Sovereign	EIB	85	No	2014
Commissioning of the second hydropower unit of the Kambarata-2 HPP	Credit	Sovereign	EFSD	110	No	2016
Total MDB Financing (Energy)				*575.66*	*185*	
Water						
Water conduit from the water intake facility “Plotina” [Dam] to the water treatment station “Ozgur”, City of Osh. Chlorine neutralisation unit	Grant	Sovereign	ADB	0.5	No	2020
Project for the management of Issyk Kul Region waste waters	Grant, credit	Sovereign	ADB	36.52	No	2018
Total MDB Financing (Water)				*37.02*		
Total MDB Financing				**797.68**		

Tajikistan

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Energy						
Nurek – restoration. Phase 1	Grant	Sovereign	AIIB	60	No	2017–2023
Project for the restoration of the 240 MW Golovnaya HPP (CAREC)	Grant	Sovereign	ADB	136	Government – 34	2013–2022
Project for the reconnection to the Central Asia Power System (CAREC)	Grant	Sovereign	ADB	35	Government – 5	2018–2022
Wholesale Metering and Transmission Reinforcement Project	Grant	Sovereign	ADB	54	No	2014
Development of the energy sector	Credit Grant	Sovereign	ADB	105	No	2020
Rural Electrification Project (CAREC)	Grant	Sovereign	WB	31.7	No	2019–2025
Nurek – restoration. Phase 1 (CAREC)	Grant Credit	Sovereign	WB	226	No	2017–2023
Financial rehabilitation of the power industry		Sovereign	WB	134	No	2020
Project development support: Rural Electrification, Sebzor HPP, and Khorog–Kozidekh PTL		Sovereign	WB	0,5	No	2020
Nurek. Phase 2		Sovereign	WB	50	No	2020
Reduction of energy costs (Dushanbe)	Credit	Sovereign	EBRD	25	No	2020
Tajikistan's energy efficiency	Credit	Sovereign	EBRD	52	No	2020
Reduction of energy losses (Khatlon)	Credit	Sovereign	EBRD	25	No	2019
Improvement of climate change sustainability of the Kayrakkum HPP	Credit	Sovereign	EBRD	38	No	2016
Transregional electricity trade	Credit	Sovereign	EBRD	110	No	2015
Kayrakkum HPP Modernisation Project	Credit	Sovereign	EBRD	50	No	2014
Sogdiana – Energy Losses Reduction Project	Credit	Sovereign	EBRD	14.15	No	2011
Improvement of climate change sustainability of the Kayrakkum HPP	Credit	Sovereign	EIB	36	Government – 15	2019
Energy links between Tajikistan and Kyrgyzstan	Credit	Sovereign	EIB	85	No	2014
Crescent Clean Energy Fund Turkey	Credit	Sovereign	EIB	1.5	No	2011
Energy sector restoration	Credit	Sovereign	EIB	9	No	2011
Nurek – restoration. Phase 1	Grant	Sovereign	EFSD	40	No	2017–2023
Total MDB Financing (Energy)				*1,317.85*		

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Water						
Dushanbe Water Supply and Removal Project	Grant	Sovereign	WB	30	No	2019
Rural Water Supply and Sewage Project	Grant	Sovereign	WB	58	No	2019
Second Dushanbe Water Supply Project – additional financing	Grant	Sovereign	WB	10	No	2015
Tajikistan PAMP II – additional financing	Grant	Sovereign	WB	12	No	2015
Total MDB Financing (Water)				*110*		
Total MDB Financing				**1,427.85**		

Turkmenistan

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Energy						
National Grid Reinforcement Project (CAREC)	Credit	Sovereign	ADB	500	Government – 175	2018–2024
Total MDB Financing				**500**		

Uzbekistan

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Energy						
Forward Electricity Metering Project	Credit	Sovereign	ADB	150	No	2011
Takhiatash SDPP Performance Improvement Project	Credit	Sovereign	ADB	300	No	2014
North-Western Region TPL Project	Credit	Sovereign	ADB	150	No	2015
Energy Sector Performance Improvement	Credit	Sovereign	ADB	450	FRIR – 177	2017
Sustainable Hydropower	Credit	Sovereign	ADB	60	No	2019
Energy Sector Reform	Credit	Sovereign	ADB	200	No	2020

Project	Form	Borrower	Donor	Value, USD millions	Co-Financing, USD millions	Period
Energy Efficiency Fund for Industrial Enterprises (CAREC)	Credit	Sovereign	WB	324	No	2010–2023
Transmission Substations Modernisation (CAREC)	Credit	Sovereign	WB	150	Government – 46	2016–2022
Central Heat Supply Performance Improvement Project (CAREC)	Credit	Sovereign	WB	324.2	No	2018–2024
Energy Efficiency Fund for Industrial Enterprises. Phase 3 (CAREC)	Credit	Sovereign	WB	200	No	2018–2023
Project of an independent solar power generating company in Navoiy		Sovereign	WB	5	No	2020
Syr Darya Energy Project	Credit	Private	EBRD	200	No	2020
Samarkand solar power plant	Credit	Private	EBRD	52	No	2020
Nur Navoiy	Credit	Private	EBRD	60	No	2020
VISP: Electricity Support Facility	Credit	Sovereign	EBRD	98	No	2020
Navoiy Transmission Line Modernisation	Credit	Sovereign	EBRD	96.1	No	2019
Talimarjan, Energy Project	Credit	Sovereign	EBRD	240	N/A	2018
Uzbekenergo Muruntau Substation	Credit	Sovereign	EBRD	82,5	No	2018
Solar power plant, Samarkand	Credit	Sovereign	EIB	52	No	2020
Heat Supply	Credit	Sovereign	EIB	120	No	2019
Total MDB Financing (Energy)				*3,313.8*		
Water						
Additional financing – Horticulture Development Project	Credit	Sovereign	WB	500	No	2018
Water Resources of Southern Karakalpakstan. MGMT Improvement	Credit	Sovereign	WB	260.79	No	2014
Water Supply and Institutional Support Project	Credit	Sovereign	WB	239	No	2020
Rural Infrastructure Development Project	Credit	Sovereign	WB	100	No	2020
Central Heat Supply Performance Improvement Project	Credit	Sovereign	WB	140	No	2018
Fergana Valley Water Resources Management. Phase II	Credit	Sovereign	WB	144.9	No	2017
Total MDB Financing (Water)				*1,384.69*		
Total MDB Financing				**4,698.49**		

4. Central Asia Water and Energy Projects with Participation of Russian Companies

Project	Country	Participation of Russian Companies	Value	Comments
Solar power plant in Akmola Region (100 MW)	Kazakhstan	LLP KB Enterprises (Hevel Kazakhstan) (own funds and EDB financing)	USD 98.5 million	Completed in 2020
Solar power plant in Turkistan Region (50 MW)	Kazakhstan	LLP KZT Solar (Hevel Kazakhstan) (own funds and EDB financing)	USD 47.6 million	Ongoing
Sarybulak SPP (4.95 MW), Kapchagay SPP (3 MW), Kushata SPP (10 MW) and Shoktas SPP (50 MW), SPPs in Kentau and Shymkent (aggregate capacity: 70 MW)	Kazakhstan	Hevel Kazakhstan		Construction rights awarded in 2018–2019 following a RES Projects Auction
Sangtuda-1 HPP (capacity: 670 MW)	Tajikistan	Inter-RAO and SC Rosatom – investors. PJSC Power Machines – supplier of core hydraulic power and energy equipment	USD 482 million	Completed
Rogun HPP (capacity: 3,600 MW)	Tajikistan	PJSC RusHydro – designer (JSC Gidroproekt). PJSC Power Machines is prepared to supply hydropower unit if project financing becomes available	USD 3.9 billion	Partially completed
Kayrakkum HPP	Tajikistan	PLC Nord Hydro (2016) – design documentation for the modernisation of two hydropower units of the plant (with PLC Tyazhmash involvement)	USD 200 million	Design works (engineering survey)
NPP Project	Uzbekistan	SC Rosatom – general contractor	USD 11 billion	Design works (engineering survey)
Pskem HPP	Uzbekistan	PJSC RusHydro provides construction assistance to JSC Uzbekgidroenergo	USD 800 million	Financing by Eximbank and Uzbekistan Government
Modernisation of the Tupalang HPP, construction of the Lower Chatkal HPP, modernisation of the UE Farkhad HPP	Uzbekistan	Vneshekonombank (VEB.RF) – creditor. With the participation of PJSC Power Machines	Total cost – USD 297.5 million	VEB.RF credit facility – EUR 146.5 million
Modernisation of HPP cascades: Chirchik HPP, Kadyrya HPP, Urta-Chirchik HPP, and Tashkent HPP	Uzbekistan	Vneshekonombank (VEB.RF) – creditor	Total cost – EUR 78.4 million	New projects under review

Project	Country	Participation of Russian Companies	Value	Comments
Construction of a compact HPP near the Sardoba Reservoir (capacity: 10.7 MW)	Uzbekistan	Direct external credits from Roseximbank with the participation of PJSC Power Machines	EUR 21.3 million	Construction in 2020–2022:
Turnkey modernisation of generating units at the Syr Darya TPP	Uzbekistan	Vneshekonombank (VEB.RF) – creditor. With the participation of PJSC Power Machines	USD 177.1 million	VEB.RF – USD 129.0 million
Construction of a wind power plant in Qarao'zak District, Republic of Karakalpakstan (capacity: 100 MW)	Uzbekistan	JSC NovaWind (umbrella company for all wind generation assets of SC Rosatom) – tender participant		Ministry of Energy of Uzbekistan announced the tender in April 2020

Note: This Annex is based on publicly available data.

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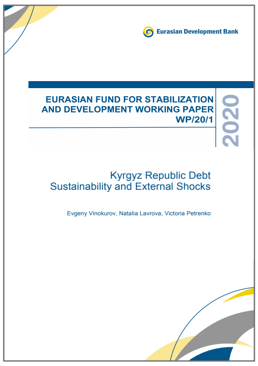

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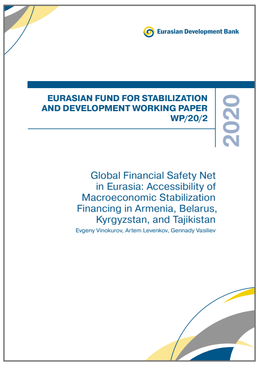

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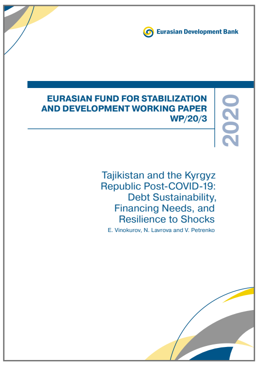

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