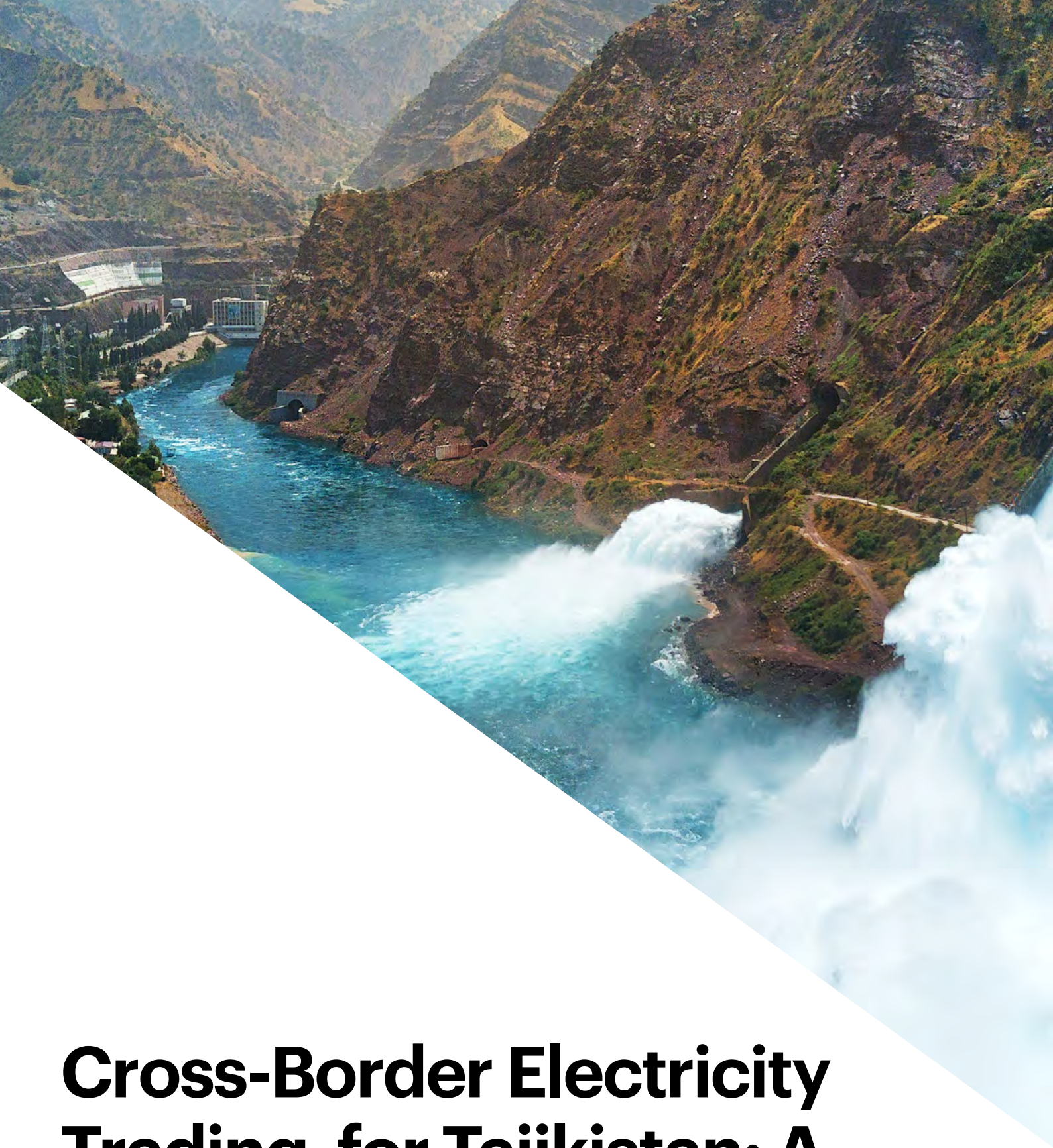




Cross-Border Electricity Trading for Tajikistan: A Roadmap



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Executive Summary

Increasing electricity exports to at least 10 terawatt-hours (TWh) annually by 2030 is a goal set out in Tajikistan's National Development Strategy. Electricity exports can bring much needed revenue to the state-owned utility to finance further development of the country's water resources. Tajikistan has close to 527 TWh of hydropower potential, with only about 23 TWh developed thus far. A lack of cross-border electricity trading opportunities is a major factor that prevents it from maximising the revenue potential from surplus water flow during the summer and limits options for imports during periods of shortages during the winter.

Tajikistan has several neighbouring countries with which it could establish cross-border electricity trading. Based on factors such as transmission system requirements and potential revenue, developing further trade with Central Asia and Pakistan appear to be suitable options to achieve its export goals in the current decade.

Tajikistan has existing transmission infrastructure with its Central Asian neighbours that is in the process of being reactivated; increasing its utilisation would be a low-risk option. Developing a regional electricity market that allows for flexible trading opportunities or to sell balancing services would expand the income streams for Tajikistan relative to previous and current agreements which generally are fixed long-term contracts. Similarly, for trading with Pakistan via the planned Central Asia-South Asia (CASA-1000) transmission line, introducing flexible trading in addition to the current long-term power purchase agreement could increase its utilisation and maximise welfare for the parties. Given Tajikistan's financial challenges, it would be more strategic for it to optimise the use of what it has available first and maximise revenue there before venturing to establish new trading relationships from new transmission infrastructure that rely on large capital investment that could take years to complete and generate income streams.

Other countries in the region could be considered for cross-border electricity trading, but those would be much more difficult to establish in the 2030 target period. Political factors and/or security risks associated with trading or infrastructure construction are factors beyond Tajikistan's control and thus could delay efforts to achieve the export goal by 2030.

Ongoing reform efforts are underway in Tajikistan's power sector which should help improve governance of the state-owned utility and improve its financial viability. This will be a key measure for it to effectively participate in any effort to build a regional electricity market.

There are several regional market models that Tajikistan, along with its neighbours, could adopt to optimise the use of common infrastructure and resources. Depending on their respective political and economic objectives, they could select a model that is suitable for the medium term without precluding new trading partners or a more integrated market arrangement in the future.

In order to reinforce its unique hydropower advantages, Tajikistan could refurbish and upgrade its facilities to improve technical flexibility. This would strengthen its options to provide flexibility services as its neighbours ramp up the share of variable renewables in their power generation mix.

Tajikistan could unlock several cross-border electricity trading opportunities with the existing and planned infrastructure within the next decade by investing in its institutions and encouraging neighbouring countries to do the same. By developing a modern power sector, Tajikistan could deliver financial benefits to its citizens and environmental benefits to the wider region through the expanded use of its hydropower resources.

Overview

Purpose

The International Energy Agency (IEA) completed this report, Cross-Border Electricity Trading for Tajikistan, as part of the EU4Energy programme¹, a five-year initiative funded by the European Union. The programme aims to support the development of evidence-based energy policy design and data capabilities within the countries of the Eastern Partnership and Central Asia.

The central purpose of this report is to guide policy making at all levels to facilitate effective cross-border integration of electricity markets to the benefit of Tajikistan as well as the region. This report can serve as a roadmap to support the Tajikistan's National Development Strategy for 2030, which includes goals to export at least 10 TWh of its hydropower generation and to undertake reforms to improve the performance and sustainability of its power sector.

Cross-border electricity trading can bring many benefits in terms of optimising resource allocation among the countries involved. The availability of generation technologies, geography, socio-economic factors, and political agreements will determine the potential for cross-border electricity trading that countries could develop and subsequently the benefits that could be achieved. Therefore, the focus of this roadmap is to assess the feasibility and extent of electricity trade with Tajikistan's neighbours and to lay out policy requirements for implementation. As the focus here is Tajikistan, the recommendations are based on the Tajik context.

Structure

First, this report considers the context of Tajikistan's power sector, its challenges and opportunities for cross-border electricity trade. It then provides an overview of its institutional framework and the policy landscape.

Next is an assessment of electricity trade opportunities with its neighbours by taking into consideration their development plans to determine the feasibility and extent of potential trade.

The roadmap outlines the policies, technologies and management practices needed to fully develop and optimise its power system and natural resources through electricity trading. The focus is on:

- Ensuring favourable conditions to enable multilateral electricity trade.
- Adopting multilateral market models to expand electricity trade.

¹ Tajikistan is one of the focus countries of the EU4Energy programme, which is carried out by the IEA and the European Union along with the Energy Community Secretariat and the Energy Charter Secretariat. The other EU4Energy focus countries are Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Turkmenistan, Ukraine and Uzbekistan. The programme is designed to support the goals and aspirations of the 11 focus countries to implement sustainable energy policies and foster co-operative energy sector development at the regional level. As part of this programme, the IEA conducts in-depth reviews of each focus country.

- Strengthening Tajikistan's role as a flexibility provider for the region.

The report provides recommendations for Tajikistan for electricity trade options with its neighbours for the next ten years. The recommended actions are intended to take place between 2021 and 2030 to help achieve the goals stated in the National Strategy for Development for 2030.

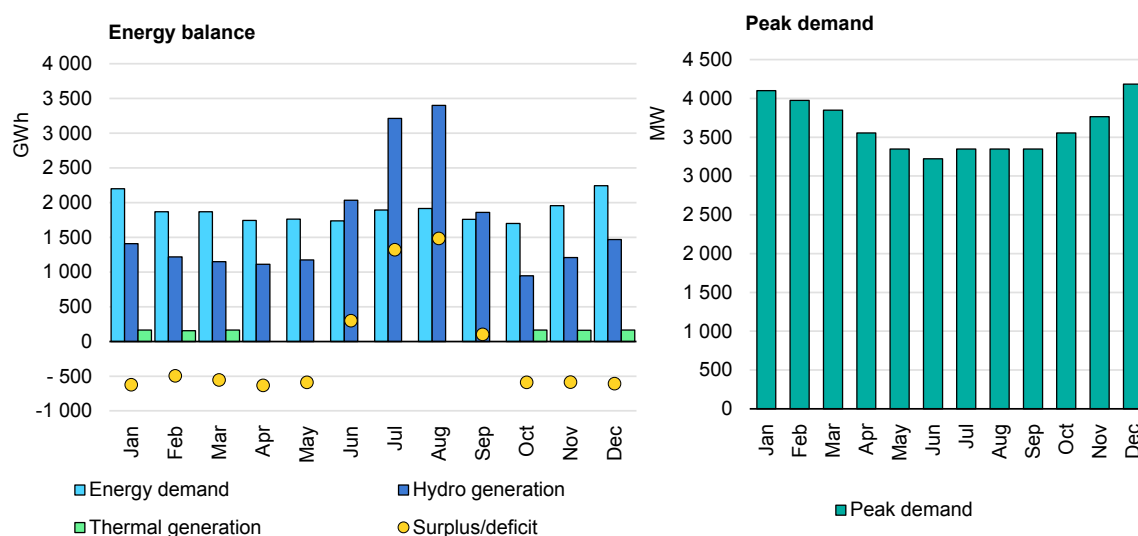
Background

Power system profile

Tajikistan's electricity sector is almost solely based on hydropower and is characterised by seasonal surpluses and shortages, and a state-owned electric utility with financial viability issues. The power sector is undergoing several institutional reforms to alleviate these challenges including restructuring the vertically integrated utility, implementing energy efficiency laws and measures, and updating its regulatory and tariff regimes.

Tajikistan's electricity needs are largely supplied by hydroelectric power thanks to its abundant water resources, namely the rivers Amu Darya and Syr Darya with a total length of 28 500 km, as well as several glaciers with a total volume of 845 km³ (MEWR, 2021a). It has relatively little thermal generation. In 2019, 93% of its generation was from hydro and 7% was from coal-fired capacity. Tajikistan has limited sources for heating other than electricity which accentuates winter peak demand and deficits (Figure 1).

Figure 1 Monthly energy balance (left) and peak demand (right) in the Tajik power system, 2015



Source: Corporate Solutions, ADB, and MEWR (2017). Power Sector Development Master Plan Vol 1.

Installed generation capacity in Tajikistan today is 5 810 megawatts (MW), of which 3000 MW comes from the Nurek hydro facility, about 1900 MW from various run-of-river hydro plants, and just under 600 MW from combined heat and power (CHP) plants (Table 1). Barki Tojik, the state-owned utility, owns and operates majority the electricity system except for the Gorno-Badakhshan Autonomous Region which is served by Pamir Energy through a concession agreement, and power plants Sangtuda-1 and Sangtuda-2. Several power plants and transmission lines were built during the Soviet era and are overdue for rehabilitation. Network losses are estimated to be 28% (EBRD, 2020).

Table 1 Generation capacity in Tajikistan, 2020

	Type	Units	Installed capacity (MW)	Available capacity (MW)	Average annual output (GWh)	Operator
Nurek	Reservoir	9	3 000	2 400	13 465	BT
Baypaza	Run-of-River	4	600	450	2 732	BT
Vaksh Cascade	Run-of-River		285	214	1 298	BT
<i>Golovnaya</i>		6				
<i>Perepadnaya</i>		3				
<i>Central</i>		2				
Varzob Cascade	Run-of-River		27	7	52	BT
<i>Varzob-1</i>		2				
<i>Varzob-2</i>		2				
<i>Varzob-3</i>		2				
Kayrakkum	Run-of-River	6	126	120	864	BT
Sangtuda-1	Run-of-River	4	670	670	2 184	UES
Sangtuda-2	Run-of-River	2	220	220	1 000	Sangob
Rogun (1/6)*	Reservoir	2	240	240	1 600	BT
Dushanbe-1 CHP	Thermal	1	198	42	32	BT
Dushanbe-2 CHP	Thermal	4	400	400	1 001	BT
Yavan CHP (mothballed)	Thermal	1	0	0	0	BT
Pamir Energy (combined)			44		179	Pamir
TOTAL			5 810		24 407	

*The two units of Rogun have been installed out of the planned six in total, but only one unit is operating since 2019 (CABAR, 2019).

Notes: GWh = gigawatt-hour; BT = Barki Tojik; UES = Unified Energy Systems; CHP = combined heat and power. The Yavan CHP plant has not operated for the last decade due to lack of fuel supply and hot water customers (Corporate Solutions, ADB and MEWR, 2017).

Sources: Sangtudinskaya HPP-1 (2021), Production Dynamics; MEWR (2017a), Energy Production and Use; MEWR (2017b), Electric Power System; communications with EU4Energy country expert for Tajikistan.

Historically, Tajikistan relied on imports from its Central Asian neighbours to make up for seasonal electricity shortages. But it was disconnected from the Central Asian Power System (CAPS) in 2009 effectively isolating the country and exacerbating the winter shortfall. However, in 2018 Tajikistan reconnected and initiated bilateral electricity trade with Uzbekistan in which it exported 1.5 terawatt-hours (TWh) at USD 20 per megawatt-hour (MWh). The price and quantities are expected to be renegotiated every season.

Electricity shortages in the winter are critical for Tajikistan. Load shedding has been a regular practice. The most recent was in December 2020 in response to a drop in water levels at the Nurek hydropower facility (Eurasianet, 2021). Further development of its thermal and hydro resources has been a priority. The first two generating units of the six planned at the much delayed Rogun hydro development were installed by 2019, but only one operated in 2020. Full development at Rogun is expected to provide 3 600 MW of capacity by the end of 2030 (Corporate Solutions, ADB and MEWR, 2017).

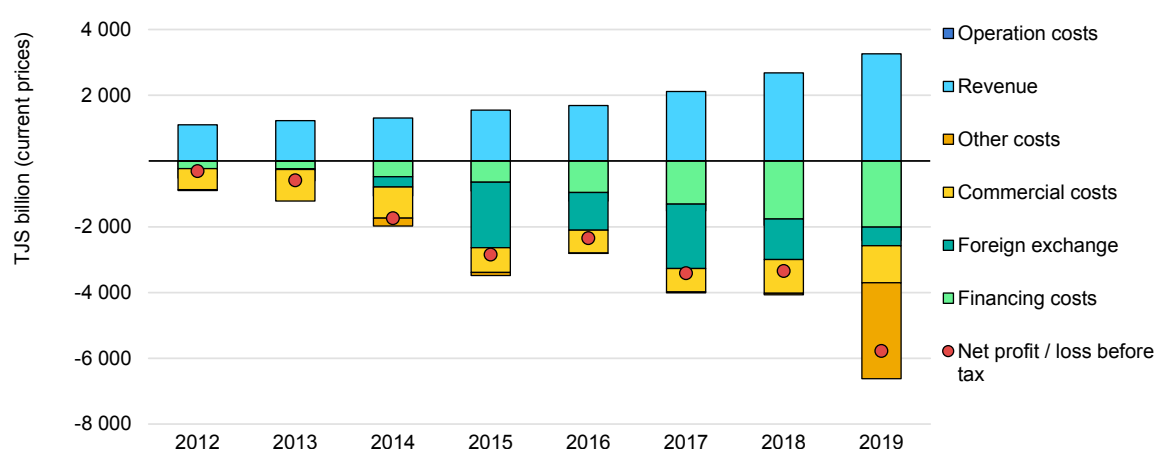
Financial woes of the state-owned utility hinder development of new generating capacity

Tajikistan's GDP increased 73% in the 2010-2018 period and total energy consumption rose 48%. Even with the boost in economic activity, Tajik households remain among the

poorest in the region in terms of average income and this influences measures to keep the government-regulated residential electricity tariffs low.

A high rate of uncollected payments for electricity use due to illegal connections, power theft and outdated metering infrastructure contribute to the worsening financial health of Barki Tojik (BT) (Figure 2). The state-owned utility has been operating with losses in recent years. In 2019, BT experienced losses before tax at USD 506 million (about Tajikistani Somoni 5.8 trillion²) and had an equity value of USD 793 million and debt of USD 1.66 billion. Such financial conditions make it difficult to raise capital to invest in new generation capacity and to sustain payments to private operators. In 2019, for example, BT owed USD 114 million to the Sangtuda-1 hydro plant, one of the first hydropower joint-ventures in Tajikistan (Sputnik Tajikistan, 2019).

Figure 2 Financial performance of Barki Tojik, 2012 to 2019



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Notes: TJS = Tajikistani Somoni. Other costs include inventory, disposal of property, plant and equipment, and revaluation of fixed assets.

Source: OHSC Barki Tojik (2020), Audit reports.

The residential sector accounts for about 47% of electricity demand. Industry accounts for about 31%, primarily from the aluminium production company, Tajik Aluminium Company (TALCO). Agriculture accounts for about 16% (MEWR, 2017a). Aluminium and agriculture are strategically important as significant contributors to GDP and to exports. Currently, TALCO pays industrial tariffs of USD 6 per megawatt-hour (MWh) in the summer and USD 10/MWh during the winter whereas residential tariffs are USD 20/MWh.

The government has taken steps recently to address the financial viability issues of BT. It increased average end-user electricity tariff by 22% and is developing a methodology for future tariff increases in order to achieve cost recovery. In addition, some USD 450 million, equivalent to about 35% of Barki Tojik's long-term debt, has been restructured to help with liquidity issues (ESMAP, 2020).

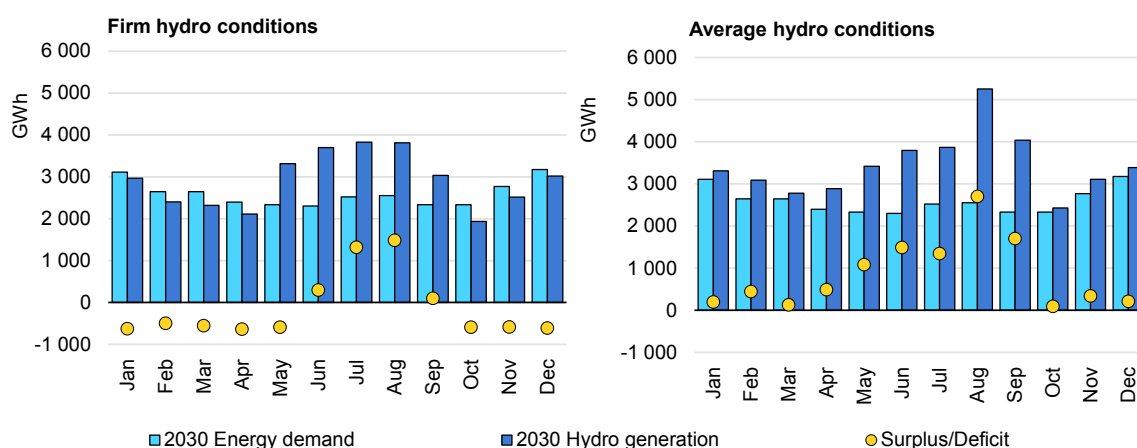
² 1 USD = 11.40 Tajikistani Somoni, 2021.

Cross-border electricity trading optimises resource use and energy security

Limited cross-border electricity trading opportunities hinder Tajikistan from optimising the advantages of its hydro resources. This affects its ability to pay liabilities and raise capital to further develop its power generation fleet (ADB, 2016). Its hydropower potential is around 527 TWh, of which only 23 TWh is developed. If Tajikistan tapped most of its hydropower potential, it is estimated that by 2030 it could generate an average exportable surplus of 10 TWh and a firm exportable surplus of 5.6 TWh (excluding its thermal generation capacity) (Figure 3).

As private participation in electricity generation is currently limited, developing its hydropower resources would require significant investment from Barki Tojik. Improving the utility's financial conditions is essential to raise capital. Obtaining additional income through electricity exports could help. In 2019, BT exported 3.2 TWh and imported 0.3 TWh of electricity.

Figure 3 Projected surplus and deficit electricity supply based on firm and average hydropower output, 2030



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Notes: Firm hydro conditions are the amount of electricity that can be generated with water levels at historic lows. Average hydro conditions represent hydropower output with typical weather conditions. Average hydro supply includes generation from existing hydropower facilities at Nurek, Baypaza, Vaksh, Vairzob and Karakkum, plus planned hydro capacity at Rogun, Fondarya, Sanobad, Ayni, Yavan, Nurek 2 and Shurob. Existing and planned thermal power plants are not included in this figure.

Source: IEA Analysis of Corporate Solutions, ADB and MEWR (2017). Power Sector Development Master Plan Vol 1.

While exports are the prime motivation of Tajikistan to pursue cross-border electricity trade in order to gain revenue, the option to import electricity in times of shortage should be open. Imports could also delay or avoid the need to build new thermal generation capacity. This is an important consideration as several lending institutions such as Asian Infrastructure and Investment Bank (AIIB), European Bank for Reconstruction and Development (EBRD) and European Investment Bank (EIB) are restricting funding for coal-fired power projects and coal mining (IEEFA, 2021). In Tajikistan's power sector plan, coal is the main fuel choice in several of its scenarios to address increasing electricity demand, especially in winter.

In the long term, climate change could pose risks in terms of melting glaciers and increasing droughts. Given Tajikistan's reliance on hydro, it exposes the power system to

risks arising from potential water unavailability. Apart from higher evapotranspiration affecting agricultural water demand, recent studies show that Tajik glaciers could lose 15-20% of their original volume over the next 50 years. This is estimated to lead to an initial increase in water flow in key hydropower rivers such as the Vaksh - a tributary river to the Amu Darya, but with a long-term decrease due to the depletion of glacial reserves (Tajik NIIGIM, 2020).

Diversifying electricity sources and trading partners through cross-border trading could help Tajikistan manage the risks related to water supply and hydropower output. Given the country's goal for energy independence, opting for short-term flexible contracting allows it to undertake strategic trades without being tied to long-term agreements.

Policy landscape

Tajikistan's primary energy legislation is the Law on Energy (2000) that grants the government the authority to develop the energy sector including investment and concessions, pricing and tariff structures, and to control the use of fuels and renewable energy resources. Other relevant energy legislation includes the Law on Renewable Energy Resources (2010) and the Law on Energy Saving (2013).

The electricity sector is largely owned and operated by Barki Tojik, a vertically integrated state-owned utility responsible for generation, transmission, distribution and retailing. Several restructuring efforts were conducted to help improve the power system's operation. The transmission, distribution and retail have been financially unbundled based on Decree No. 431 "On an individual plan for the restructuring of Barki Tojik" (2011). Based on Resolution No. 234 (2018) efforts were undertaken to establish separate legal entities for the transmission network operator and the distribution network operator for the country, except for the Gorno-Badakhshan Autonomous Oblast (GBAO). The heads of these entities were appointed in 2020, and in 2021 the operating entities were legally registered with the official names OJSC "Shabaqahoi intiqoli barq" (transmission) and OJSC "Shabaqahoi taqsimoti barq" (distribution). OJSC Barki Tojik remains responsible for electricity generation and for export and import. In the GBAO autonomous region, the Pamir Energy Company, a public-private partnership established in 2002, owns and operates the generation, transmission and distribution system.

Energy prices and electricity tariffs are administratively set by the Antimonopoly Committee of the Ministry of Economic Development and Trade on an *ad hoc* basis. In the past, tariffs have not been reflective of the cost of service. Hence, in 2017, a new tariff methodology was established that aimed to increase electricity tariffs incrementally to achieve cost recovery by 2025 by establishing a required income for the generation, transmission and distribution assets. Excluded are the Sangtuda 1 and 2 hydropower plants, and Pamir Energy in the GBAO autonomous region which have separate investment agreements (Republic of Tajikistan, 2017). Tariff increases were implemented in 2018 and 2019, the next incremental increase was postponed in 2020 due to the COVID-19 crisis.

The power sector is considered a strategic industry for Tajikistan. In 2016, it launched the National Development Strategy 2030 which includes a goal to become energy independent. The strategy's primary aims are summarised as "10-10-10-10-500", which is shorthand for:

- Increasing installed capacity by 10 GW.
- Reducing technical grid losses by 10%.

- Increasing electricity exports to 10 TWh per year.
- Diversifying generation sources by increasing non-hydro generation capacity to at least 10% of the total share.
- Achieving energy savings of 500 GWh from energy efficiency measures.

In order to achieve these goals several laws related to investment were streamlined. Investment in the power sector is governed by laws on: Privatisation of State Property (1997, updated 2017); Production Sharing Agreements (2008); Credit Histories (2009); Concessions (2011); Public-Private Partnerships (2012); and Investment Agreements (2016). Some of the mechanisms under these laws involve:

- Income tax exemptions based on amount invested
- Tax and customs benefits for relevant machinery and equipment for energy production
- Legal status for the investor, such as right to transfer profits abroad
- Capital protection, with legal frameworks, partnership and investment agreements.

Developments that facilitate private sector participation in the power sector are relatively recent. The Pamir Energy Company was the first public-private partnership, which is a concession agreement to serve the GBAO autonomous region. The hydropower plant Sangtuda-1 was commissioned in 2009 and is operated by the Russian company, Unified Energy Systems. Sangtuda-2 was commissioned in 2011 and is operated by Iranian company, Sangob. Both Sangtuda hydro projects were executed under a build-own-operate-transfer arrangement.

Key institutions and stakeholders

National stakeholders

The **Ministry of Energy and Water Resources** is responsible for the management of the country's water and energy resources. Its mandate is to harmonise water and energy policy through planning the development of water and energy resources, management and regulation, capacity building and exercising state control over the rational use and protection of water resources. It facilitates investment and concession agreements in the energy sector, is responsible for co-ordinating activities of the ministries and agencies involved in water resources, and acts as the authority and leading body in the national dialogue on policy related to integrated use of water resources.

The **Ministry of Economic Development and Trade** is in charge of developing short-term, medium-term and long-term strategies for socio-economic development in conjunction with state programmes for internal and external investments. Through its Antimonopoly Committee, it is the regulator for the tariffs of BT. It is also responsible for sectoral and regional development programmes, as well as developing principles and mechanisms for economic reform.

The **Ministry of Finance** allocates budgets for state-owned companies and also handles debts and financing from multilateral institutions.

The **Agency on Statistics, Tajikistan (TajStat)** is the central statistical office tasked with collecting and disseminating key data on demographics, prices and enterprise surveys.

The **Open Joint Stock Holding Company (OHSC) Barki Tojik (BT)** is the state-owned electric utility responsible for generation, transmission, distribution and retail sales. It has been legally unbundled into three separate companies, with ongoing separation of responsibilities. It is responsible for supplying Tajikistan's electricity needs, except for the GBAO autonomous region. BT manages electricity imports and exports.

Pamir Energy is a company established as a public-private partnership. It was formed in 2002 to meet the energy needs of the residents of the Gorno-Badakhshan Autonomous Region, a mountainous territory bordering the People's Republic of China (hereafter, "China") to the east.

International Stakeholders

The **Central Asia-South Asia (CASA)-1000 Intergovernmental Council** was established by the governments of Tajikistan, Kyrgyzstan, Afghanistan and Pakistan to make decisions about the transmission system project implementation and operation, common policies and rules, and use of established technical, safety and environmental standards. The council also selects the operator of the CASA-1000 transmission system.

The **Interstate Commission for Water Coordination of Central Asia (ICWCCA)** is an interstate body that includes Tajikistan, Kyrgyzstan, Kazakhstan, Turkmenistan and Uzbekistan. It is the only interstate body established and authorised by the heads of the respective Central Asian countries to make binding decisions on current and emerging issues related to interstate water allocation and use. It is responsible for determining regional water policy, establishing water limits and schedules for reservoir operating regimes.

The **Coordination Electrical Power Council of Central Asia (CPC)** is a deliberative body to co-ordinate the operation of power grids in Central Asia. Its current members are the grid operators in Kazakhstan, Uzbekistan, Kyrgyzstan and Tajikistan. Turkmenistan was a member until 2003 when it disconnected from the Central Asian Power System to fully operate in parallel with Iran. The body agrees on operating concepts, decisions and rules to ensure cost-effectiveness and reliability for Central Asian energy systems, and approves methodologies, rules, instructions and regulations governing the interaction of the various power systems.

The **Central Dispatch Centre Energiya (CDC)** is an operating and dispatch institution under the CPC responsible for calculating transfers between the countries of Central Asia in the former Central Asian Power System. Located in Uzbekistan, it received investments from the five Central Asian countries. The withdrawal of Turkmenistan and Tajikistan reduced the co-ordinating activities.

In Tajikistan's neighbouring countries, the various national ministries for energy, economy and trade as well as the entities involved with generation, transmission and distribution of electricity as trading partners are relevant stakeholders in establishing efficient cross-border electricity trading.

Opportunities for electricity trade

In this section we consider Tajikistan's opportunities for electricity trade with neighbouring countries. The main features assessed are demand patterns, prevailing cost of generation and infrastructure requirements.

- Demand patterns are favourable if they are complementary to Tajikistan's seasonal profile of summer surpluses and winter shortages.
- A high prevailing cost of generation in a neighbouring country increases the favourability for exports, whereas a low prevailing cost of generation provides opportunity for imports. The estimated average marginal cost of generating electricity in Tajikistan is USD 6/MWh (RTE and ADB, 2020).
- Infrastructure requirements such as new transmission interconnections can significantly prolong the commencement of trading, given the financial challenges of the country.

The potential degree of integration that could be feasible between Tajikistan and its different neighbours in the next ten years is assessed. Ultimately of course, these are choices to be made by the relevant stakeholders and their perception of trade opportunities and risks relative to their respective resources.

Figure 4 shows a hierarchy of power system integration models. These vary from ones that are very limited, e.g. the simplest model being unidirectional power trading, to ones that can be considered complete. The fully integrated model is represented by the PJM system in the United States, which organises markets, supports transmission planning and manages generator dispatch across a wide geographic area that includes multiple jurisdictions. Different models require varying levels of cross-border collaboration and resource sharing, from low levels in bilateral trade models to high levels in more unified models.³

Figure 4 Degrees of cross-border power system integration: From limited to complete

Nascent	Bilateral, unidirectional power trade	• Thailand imports from Lao PDR
Nascent	Bilateral, bidirectional power trade	• Malaysia-Singapore (non-financial) • California (United States) - Baja California (Mexico)
Secondary	Multilateral, multidirectional trade among differentiated markets	• Central American Electrical Interconnection System (SIEPAC) • Southern African Power Pool (SAPP)
Primary	Multilateral, multidirectional trade among harmonised markets	• European Union Internal Energy Market
Primary	Unified market operations	• PJM (Northeastern United States)

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Source: Adapted from IEA (2019a). Establishing Multilateral Power Trade in ASEAN.

³ Under unified models, resources are optimised across jurisdictional (e.g. national) borders, which means a high level of integration and a lack of local markets that are distinct from the regional market.

Higher degrees of integration generally allow for more optimal use of common resources such as transmission grids, thereby shortening the payback periods and maximising the economic outcome for the participants.

- Nascent trading arrangements such as bilateral trading arrangements are between two countries. In this model, often each trade is negotiated separately, and hence the volume of trade and the margins need to be sufficient to cover high transaction costs and to justify any required grid investment. Where transmission infrastructure exists, a market arrangement can be developed relatively quickly as it does not require high degrees of harmonisation.
- Secondary trading is a model in which domestic electricity markets are cleared first using respective domestic generation with any surplus or deficit traded and balanced with the trading partners. It requires a higher degree of system harmonisation and political agreement among participants although it does not require the same domestic market structures. Examples of a secondary market are the Southern Africa Power Pool and the Central American Electrical Interconnection System.
- Primary trading is a model in which a multilateral market is the main platform for trade. Primary trading arrangements require participants to restructure and harmonise domestic frameworks, such that all generators and consumers have equal status across boundaries. Examples of primary arrangements are PJM in the United States and the European Union Internal Energy Market. This arrangement requires high levels of co-ordination and political agreement among the various jurisdictions.

Multilateral trades can coexist alongside other differentiated (market or non-market) arrangements such as long-term power purchase agreements (PPAs) or non-financial power exchanges, wherein the participants are not restricted from such choices. A common feature among these models is third-party access to the domestic grid, so that any generator can directly supply a demand in another jurisdiction for a defined trading period. The assessment of a likely degree of integration depends on the common economic and political interest among the countries.

Multilateral trade in the near term in Central Asia

Historically Tajikistan was connected to the other Central Asian⁴ countries as part of the Central Asian Power System (CAPS) which was built during the Soviet era (Figure 5). The system was slowly abandoned in the 2000s as Turkmenistan disconnected in 2003 for more favourable trading arrangements with Iran, and in 2009 when Kazakhstan and Uzbekistan withdrew, and Tajikistan was cut-off due to transit disputes and disagreements on system usage. There have been several initiatives to resolve these disputes. Tajikistan reconnected to CAPS in 2018 and started electricity trade with Uzbekistan. Initiatives stemming from the Central Asia Regional Economic Cooperation (CAREC) programme by the Asian Development Bank (ADB) and the Central Asia Regional Electricity Market (CAREM) by the US Agency for International Development aim to re-establish co-operation by addressing common concerns such as energy security, water rights, and financial viability and technical capacity of the electric utilities.

⁴ Central Asia here includes the five countries of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan.

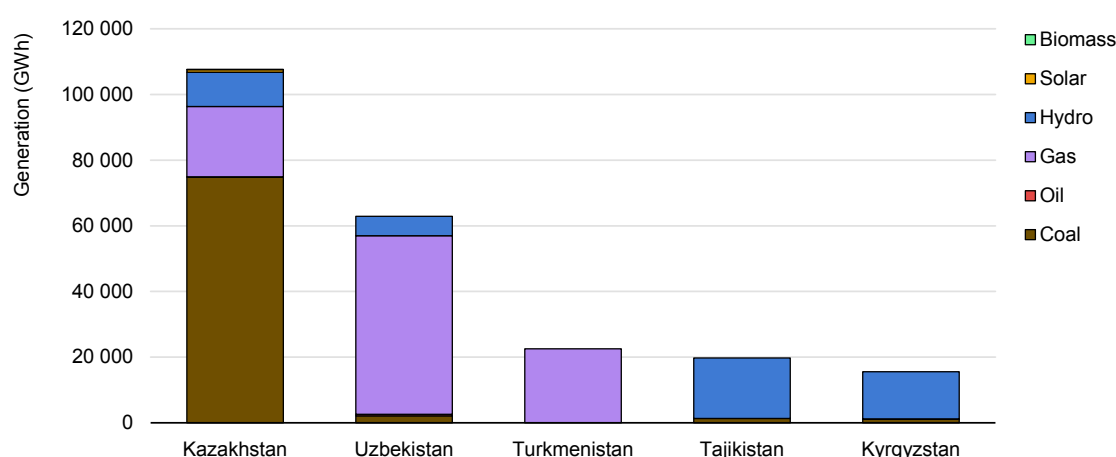
Figure 5 Central Asian power system, 2015

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This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Source: USAID (2015), Central Asia Electric Grid.

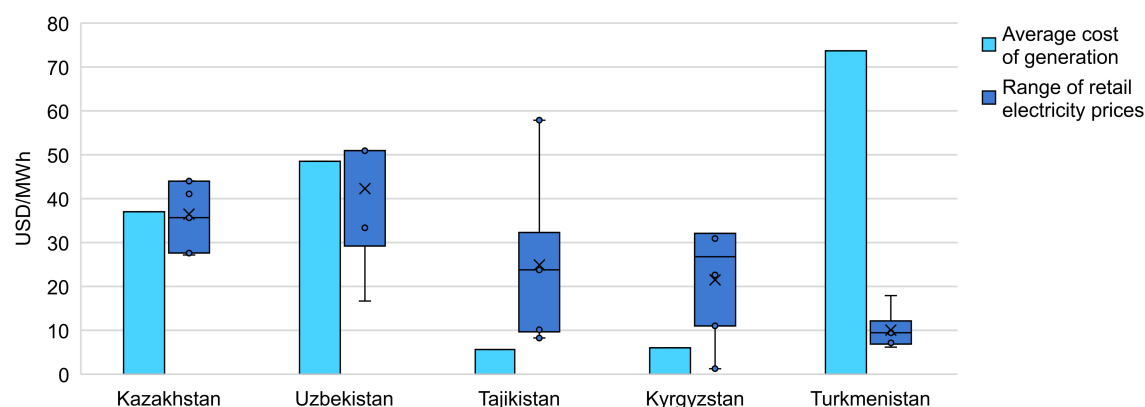
There is a high level of complementarity of resources for the power sector among the Central Asian countries. During the summer, Tajik and Kyrgyz surpluses from hydropower could be exported to the rest of the region, while during the winter thermal power from coal and gas could be exported from Kazakhstan, Uzbekistan and Turkmenistan (Figure 6). Winter peak electricity demand in the gas-producing countries is not as significant as in Tajikistan because those countries have systems and appliances to use gas for heating.

Figure 6 Electricity generation by fuel in Central Asia, 2018

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Source: IEA (2021), World Energy Statistics and Balances (database).

The average cost of generation in Kazakhstan, Uzbekistan and Turkmenistan is generally higher than the average cost of hydropower in Tajikistan (Figure 7). Prevailing retail electricity subsidies are still common, but there is a clear opportunity for Tajikistan to trade electricity especially as the region adopts more market-oriented and cost-recovery approaches. Given that the transmission infrastructure is in place, the cost of reconnection would be lower than new construction and the region could focus on grid reinforcement to improve system security.

Figure 7 Average cost of generation and range of retail electricity prices in Central Asian countries, 2020

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Source: ADB. (2020). Regional Cooperation on Renewable Energy Integration to the Grid; Bureau of National Statistics Agency of the Republic of Kazakhstan (2020a), Prices in Industry in the Republic Kazakhstan 2015-2019; Bureau of National Statistics Agency of the Republic of Kazakhstan (2020b), Prices at the Consumer Market in the Republic of Kazakhstan; State Agency for Fuel and Energy Regulation of the Kyrgyz Republic (2020), Approval of the Medium-term Tariff Policy of the Kyrgyz Republic for the Electric and Thermal Energy for 2020-2022; Ministry of Energy of the Republic of Uzbekistan (2019), Electricity Tariffs; Barki Tojik (2019), Tariffs for electricity and heating; ATHA (2017), New Prices on Gas and Electricity.

In addition, if the Central Asian countries move to increase the share of variable renewables in their generation mix, then developing a more integrated market would

expand the trade opportunities for Tajikistan and Kyrgyzstan to provide ancillary services. Kazakhstan, Uzbekistan and Turkmenistan have high potential for solar PV and wind energy (Table 2). Maximising the potential of these renewable resources could serve as an additional driver to deepen integration of the regional electricity market.

Table 2 Technical potential for installed renewable energy capacity in Central Asia

Country	Small hydro (GW)	Wind (GW)	Solar PV (GW)
Kazakhstan	4.8	354	3760
Kyrgyzstan	1.8	1.5	267
Tajikistan	23	2	195
Turkmenistan	1.3	10	655
Uzbekistan	1.8	1.6	593

Source: UNDP (2014), Renewable Energy Snapshots.

A recent study assessed the benefits of regional power system co-operation in Central Asia (RTE and ADB, 2020). It highlighted that, based on their abundant hydropower resources, Tajikistan and Kyrgyzstan could provide important secondary regulation. In particular, Tajikistan could increase the volume of activated frequency restoration reserve (FRR) from 4 TWh in a situation without regional co-operation to 17.6 TWh with full cross-border procurement of FRR by 2030. This could provide a significant income stream for Tajikistan in addition to its existing seasonal bilateral exports. The existing and scheduled developments to the grid were assessed to be sufficient for this level of FRR trade. While there would be an increase in generation costs for Tajikistan from the large amounts of FRR mobilised, the study found that as long as those higher costs are reflected in the price of the service, participation in this trade would be a net benefit for the country.

A number of entities are in place that could support stronger market integration. Established in 1993 in Uzbekistan with investments from the five countries, the Central Dispatch Centre Energiya (CDC) (originally as the Unified Dispatch Office) is a key enabling institution to optimise the resources and power systems in Central Asia. The CDC is responsible for calculating transfers between the countries. If a power pool model were to be pursued, the CDC potentially could boost its capacity to serve as the market operator.

In terms of operations, there is the Coordination Electrical Power Council of Central Asia (CPC), which is the governing body of the CDC. The members of the CPC are the power system operators KEGOC (Kazakhstan), UzbekEnergo (Uzbekistan), Kyrgyzstan NPG (Kyrgyzstan) and Barki Tojik (Tajikistan). Turkmenistan has not been involved in CPC or CDC since it disconnected from the CAPS in 2003 to operate synchronously with Iran.

The CPC and CDC increase the institutional readiness of re-establishing a Central Asian Power System, capable of designing and operating a regional multi-directional market-based system that could support optimal resource allocation and utilisation. The stakeholders could aim for a multilateral, multi-directional trade among their differentiated markets similar to the model of the Southern African Power Pool (SAPP). The SAPP operates as a multilateral platform to trade electricity surplus close to real-time alongside other arrangements, which preserves the domestic price-setting approach of the participants as well as to remain rather independent from neighbouring countries for electricity security. For Central Asia, when confidence in the regional market is established and variable renewables increase in the generation mixes, the depth of integration can strengthen. In these conditions, Tajikistan's hydro resources would be a significant contributor to balance electricity systems for the region.

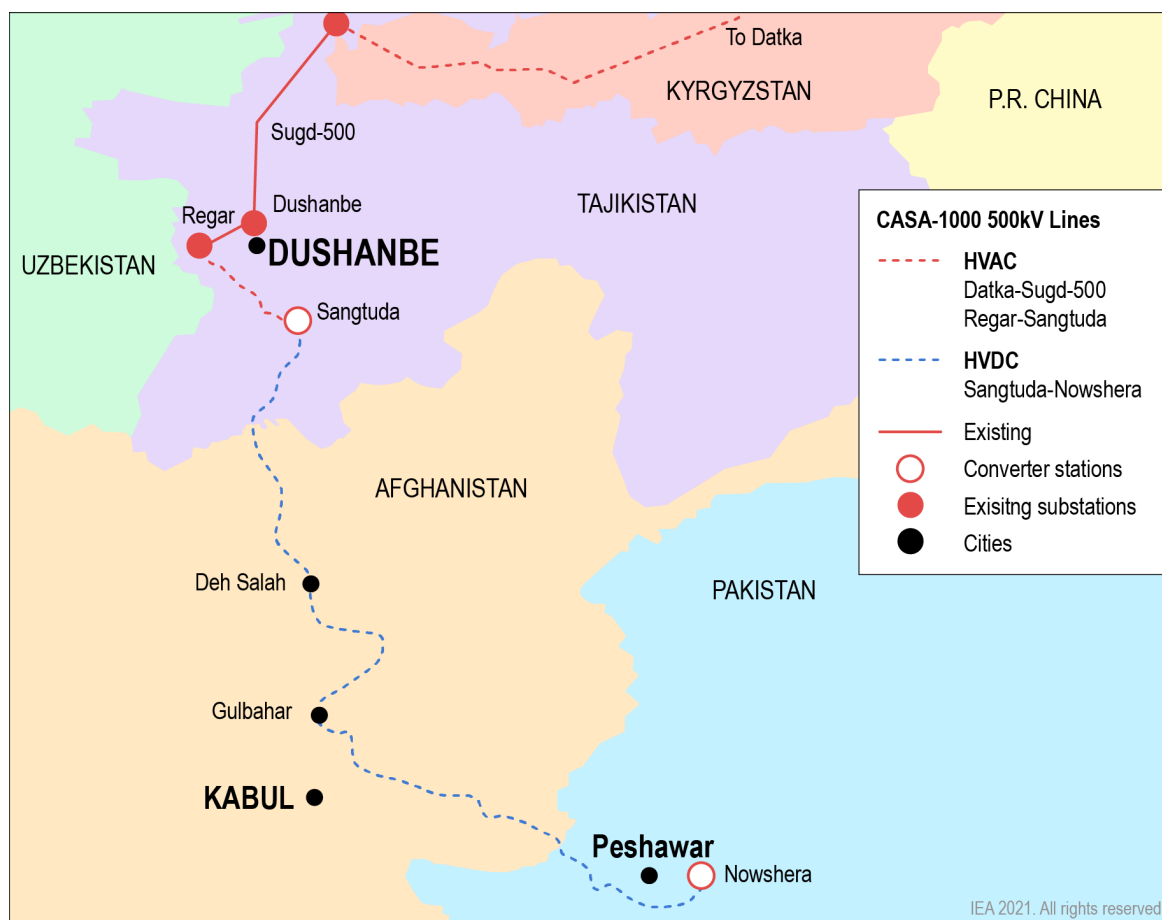
Flexible trading in the near term and increased exports in the long term with Pakistan

Tajikistan's abundant hydro resources during the summer represent an excellent opportunity to export electricity to Pakistan, its southern neighbour, where shortages are common in the summer due to high cooling demand. In fact, there are planned electricity trade initiatives as part of the new electricity transmission system, called CASA-1000, to connect Tajikistan and Kyrgyzstan, both with abundant hydropower resources, with nearby Pakistan, which suffer from chronic electricity shortages (Figure 8). It includes 500 kilovolt (kV) alternating current (AC) lines in Tajikistan and Kyrgyzstan and a 1 300 MW capacity high voltage direct current (HVDC) line to Pakistan, passing through Afghanistan. Currently, there is a power purchase agreement in place, through a 15-year bilateral contract between Tajikistan and Pakistan (Government of Pakistan, 2015). The terms include:

- Term: estimated start of operation in 2023 and a term of 15 years.
- Tariff and delivery type: firm energy for May to October at USD 94/MWh, with an option to offer excess at USD 64/MWh.
- Transit costs through Afghanistan: USD 12.5/MWh.
- Minimum supply requirements: 1 299 GWh in year 1 to 1 071 GWh in year 15.

Feasibility studies show that Tajik electricity export can be increased further to 2.7 TWh in a co-ordinated operation with Kyrgyzstan (SNC Lavalin, 2011). Short-term flexible trading could pave the way for higher utilisation of the CASA-1000 transmission line. Tajikistan, Kyrgyzstan and Pakistan, the three main countries involved with electricity trading via the CASA-1000 transmission network could consider flexible trading in the near term. Trade contracts for flexibility could be in addition to the 15-year term PPAs. Short-term arrangements for flexibility services could allow Tajikistan to adjust the price and quantity offering depending on its volume of surplus. Short-term arrangements could also allow Tajikistan to export electricity in the winter if domestic demand is served and there is sufficient demand in Pakistan. Moreover, short-term arrangements could provide opportunities in the winter for Pakistan to export surplus electricity to the upstream countries in a reverse flow.

There are no current arrangements for importing. A barrier is the high cost of electricity in Pakistan at around USD 77/MWh (CPPA, 2019). However, if short-term trading is established, it could open possibilities as it would not require Tajikistan to commit resources long term while retaining the option of importing electricity in the winter when domestic thermal plants or cheaper Central Asian imports are unavailable.

Figure 8 Map of CASA-1000 transmission plan

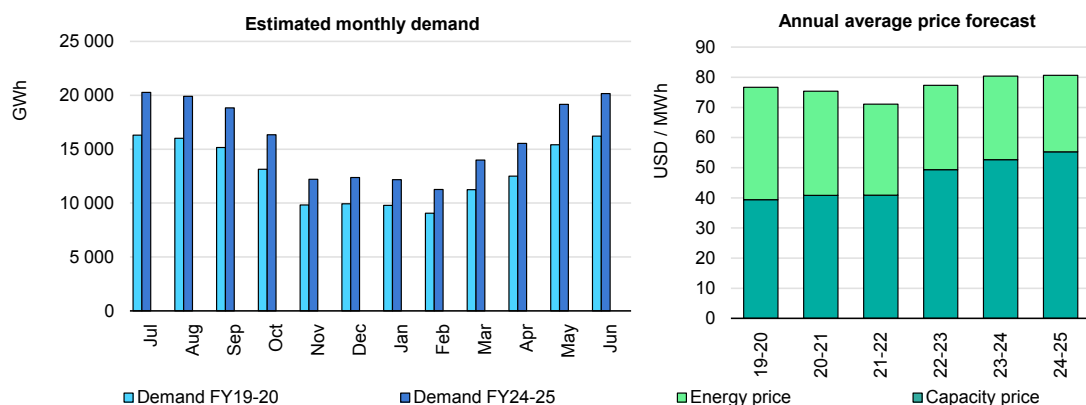
This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Note: Previous plans of CASA-1000 included a converter substation to set aside 300 MW of capacity for Afghanistan with the remaining 1000 MW allocated for Pakistan. The current plan will allocate the whole 1300MW to Pakistan, where Afghanistan would benefit from transit payments.

Source: Adapted from CASA-1000 (2018). About CASA-1000.

Increasing exports to Pakistan in addition to the CASA-1000 network could be possible in the long term with new transmission lines. Electricity demand in the summer in Pakistan is projected to increase by about 22 TWh and annual demand by more than 37 TWh in the period to fiscal year (FY) 2024-2025 (Figure 9). The average electricity price in Pakistan is expected to remain high at 80 USD/MWh which offers a high margin with the cost of operation in Tajikistan.

Figure 9 Monthly electricity demand in FY 2019-2020 and estimated for FY 2024-2025 (left), and annual average price in Pakistan (right)

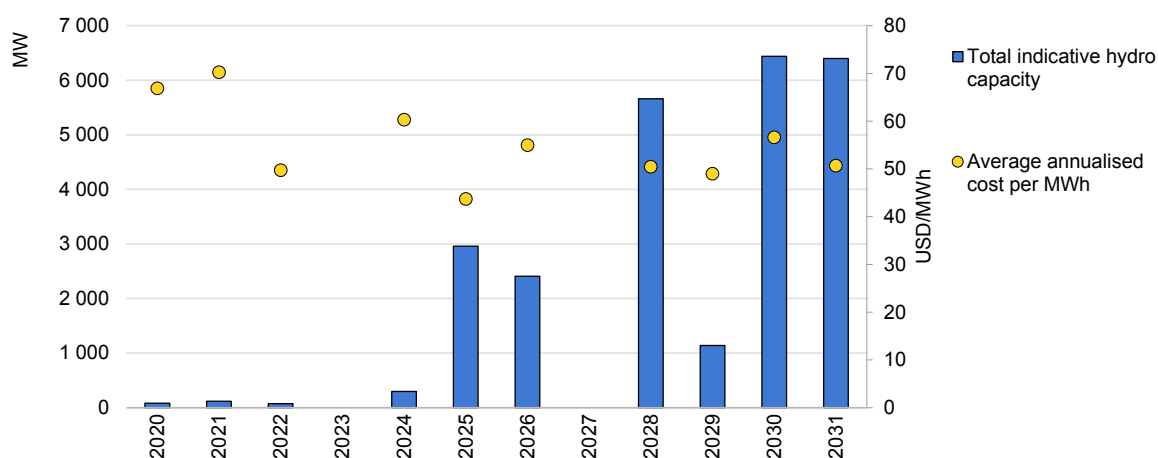


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Source: CPPA (2019), Power Purchase Price Forecast FY 2019-20.

Pakistan is planning to build new hydropower plants equivalent to about 2 GW per year in the period to 2031 to meet peak demand in summer (Figure 10). It is conceivable that these summer demand peaks could be met by imports of surplus power from Tajikistan.

Figure 10 Pakistan indicative projects in indicative capacity expansion plan and average annualised cost per MWh, 2020 - 2031



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Note: Capacity from committed projects, as well as capacity expected from the CASA-1000 imports are not shown on this figure.

Source: NTDC (2019). Indicative Generation Capacity Expansion Plan 2018-40.

Indicative hydropower projects from 2025 and beyond are expected to have high volumes and economies of scale which would lower the average cost per MWh. Hence, if exports were to increase beyond the capacity of the CASA-1000 network (1 300 MW), new transmission infrastructure would need to keep costs and risks to a minimum in order for the cost to remain competitive with domestic hydro generation in Pakistan. Shared investment among the Central Asian countries could help distribute the risks and benefits of new transmission projects.

Tajikistan is geographically situated at a central point between Central Asia and South Asia, an advantage to facilitate integration of the two markets. If common principles in grid operation, wheeling charge methodologies and dispute resolution mechanisms applied in Central Asia were to be adopted for the CASA network, then the two markets could be more easily integrated over time. A broader market would provide Tajikistan with more opportunities to expand its exports and to benefit from transit fees.

Moreover, if additional transmission capacity with Pakistan is to be built, then a co-ordinated approach among the Central Asian countries could facilitate a quicker deployment of capital and a wider distribution of risks. Tajikistan should weigh the risks and benefits of pursuing a simple bilateral-unidirectional export to Pakistan compared to a highly optimised line with multilateral participation.

Increase exports in the long term to Afghanistan

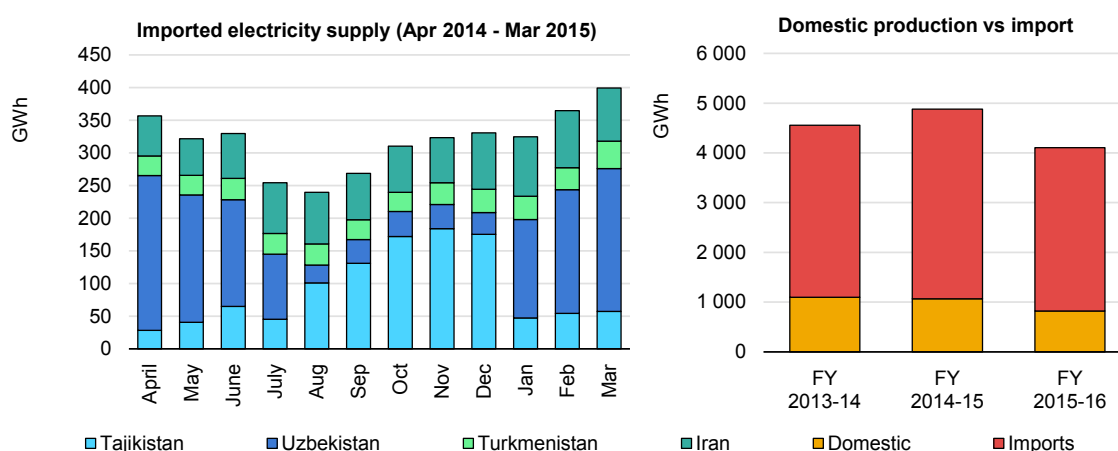
With little domestic generation capacity, Afghanistan is reliant on year-round electricity imports. Tajikistan exports electricity surplus in the summer to Afghanistan and occasionally in the winter depending on its domestic supply conditions (Table 3).

Table 3 Trade arrangements and transmission infrastructure: Tajikistan and Afghanistan

Term	Type	Transmission voltage and capacity	Tariff and delivery type
2003 (renewed 2014)	Unidirectional from Tajikistan to Afghanistan	110 kV with estimated 50 MW capacity	Non-firm energy at 20 USD/MWh
2010 - 2030	Unidirectional from Tajikistan to Afghanistan	220 kV with 300 MW capacity	- Firm energy for April to October, set at 500 GWh in 2010, adjusted to 651 GWh by 2014 - Non-firm energy for winter - All set at 35 USD/MWh increasing by 2% annually unless otherwise agreed

Sources: Corporate Solutions, ADB and MEWR (2017). TA 0213 (TAJ) Power Sector Development Master Plan. Fichtner and ADB (2014). TA 8475 (AFG) Addendum to the Afghanistan Power Sector Master Plan.

Figure 11 Electricity imports in Afghanistan, FY 2014-2015 (left) and domestic production versus imports, FY 2013-2017 (right)



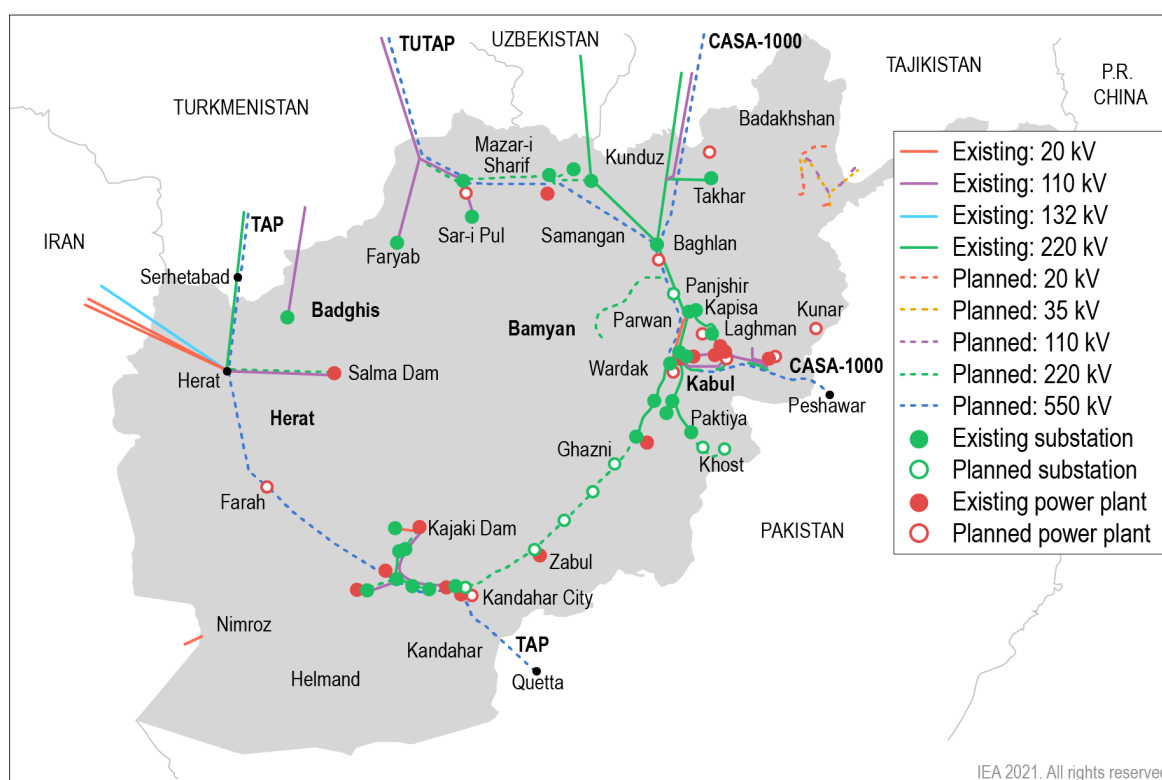
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Source: Aminjonov, F. (2016). Afghanistan's Energy Security: Tracing Central Asian Countries' Contribution.

The outlook is for electricity demand in Afghanistan to increase to about 16 TWh by 2032 with increasing electrification and gradual recovery of the economy (Fichtner and ADB, 2013). It is important to underline that the main driver of electricity imports is the lack of domestic generation rather than seasonal shortage as the case in Pakistan. In fact, peak demand in Afghanistan is in the winter, similar to Tajikistan (Figure 11). Hence, the attractiveness of exporting Tajik electricity surplus in summer depends on its price competitiveness relative to other exporters.

The cost of domestic electricity generation in Afghanistan is high. This suggests sufficient margin for electricity exports from Tajikistan even with competition from other exporters. Nonetheless, increasing Tajik electricity exports to Afghanistan would not be as straightforward relative to exports to Pakistan.

Figure 12 Existing and planned transmission infrastructure in Afghanistan, 2018



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This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Note: TAP = Turkmenistan-Afghanistan-Pakistan transmission line.

Source: Adapted from US SIGAR (2018). Afghanistan's Energy Grid: Planned and Existing Infrastructure as of September 2018.

Afghanistan has no central transmission grid; several regional grids operate with no interconnection. Various donor plans look to connect the grids such as the Turkmenistan-Uzbekistan-Tajikistan-Afghanistan-Pakistan (TUTAP) project that aims to integrate grids in Central Asia with South Asia (Figure 12), and a 500-kV line between Baghlan and Kabul to connect the northern and southern regions of Afghanistan to facilitate larger import options (ADB, 2020).

There are issues of synchronisation which need to be tackled prior to connecting the domestic grids. Turkmenistan, Tajikistan and Uzbekistan have not operated synchronously in the past. As part of reconnection to the CAPS, Tajikistan is in the process of operating in parallel with Uzbekistan and with the rest of Central Asia by 2022 (ADB, 2018). Turkmenistan is still operating in parallel with Iran. Hence, investment in back-to-back converters or changes in cross-border operations would be needed prior to grid integration.

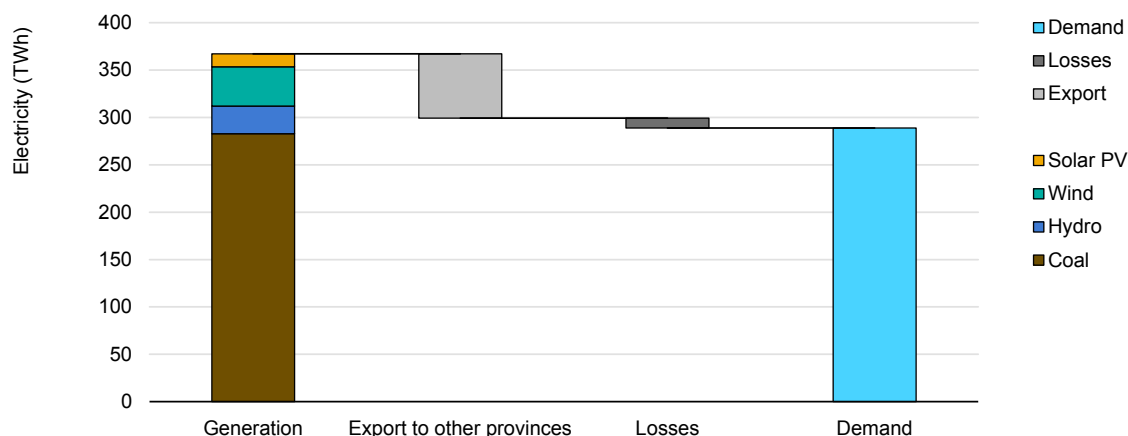
Afghanistan has expressed interest in joining the CAPS in the future (ADB, 2020). Tajikistan could further expand electricity trade with Afghanistan in the context of a regional electricity market with additional transmission capacity and resolution of synchronicity issues.

Electricity trade and transit in the long term with China

Tajikistan's east borders China's Xinjiang Uyghur Autonomous Region. The Xinjiang province is one of the most energy resource-rich regions in China, both in terms of fossil fuels and renewable resources. Xinjiang province ranks first in China in coal, oil and natural gas reserves, second for wind and solar potential, and fourth for hydroelectric potential (Duan et al., 2016).

Xinjiang province has a high level of industrial activity yet relatively low electricity consumption (290 GWh in 2019) compared with the more developed and urban eastern provinces such as Guangdong (670 GWh), Jiangsu (626 GWh) and Shandong (453 GWh) (NBSC, 2020). Hence, a significant portion of the electricity produced in Xinjiang is exported to other provinces (Figure 13).

Figure 13 Power generation, export and electricity demand in Xinjiang province, 2019



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Source: Xinjiang Bureau of Statistics (2020), Xinjiang Statistical Yearbook 2020.

Data on the cost of generation in Xinjiang province are not available. So the retail price serves as a point of comparison to consider the competitiveness of Tajik hydropower. In resource-rich Xinjiang province the electricity price is lower than in other provinces in China. The benchmark price for coal-fired power in Xinjiang is about USD 38.5/MWh while in a high demand area such as Shanghai it is around USD 64/MWh and in Guangdong about USD 70/MWh. While prices for hydropower in Xinjiang province are bilaterally negotiated and are not publicly available, a survey of hydro tariffs across China range from about USD 40/MWh in Sichuan to about USD 67/MWh in Guangdong (Zhihui Photovoltaic, 2020).

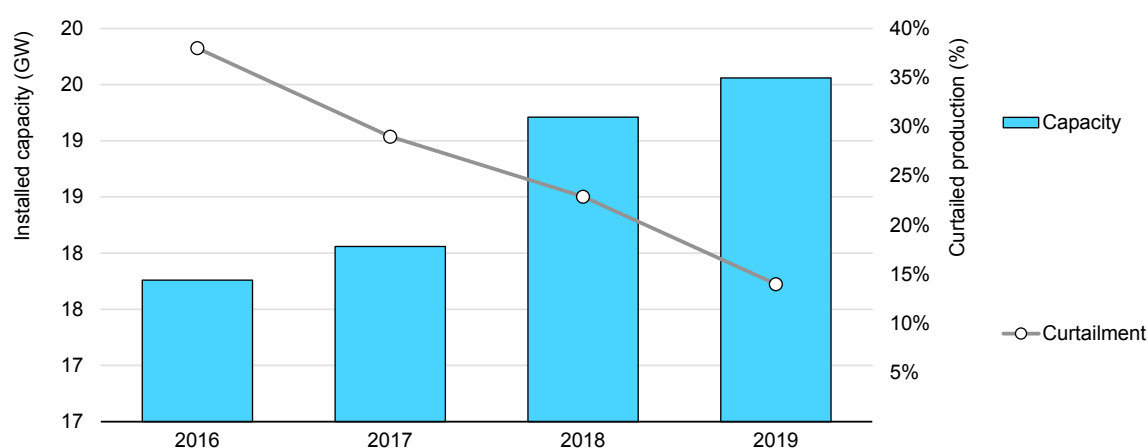
The seasonal availability of the Tajik electricity surplus would be a major factor. Xinjiang experiences peak load during the summer months with winter months of November and December reaching above 90% of the annual peak load. Hence, there could be a preference for generation technology with higher availability even during the winter season. The installed hydro capacity in Xinjiang province is 2.55 GW and has an average capacity factor of 20-30% during winter, while the economically exploitable hydro resources in the province are around 16 GW (Hai et al., 2018).

In contrast to economic dispatch, the current practice in China is that all generators are dispatched for an equal amount of hours irrespective of their marginal cost. This implies that electricity imports from Tajikistan would not have a cost-competitive advantage. China's power sector is undergoing reforms towards more market-oriented measures, though it is doing so in a stepwise manner. For example, a modification in early 2020 was to allocate 10% of coal-fired power generation to be priced in the market while 90% remains pegged to administratively set benchmark prices. This suggests that prevailing power prices in Xinjiang are likely to remain low, so Tajik summer surplus electricity exports are unlikely to be attractive on a cost basis. Other provinces in China do import electricity to a limited degree; the northeast region imports from the Russian Federation (hereafter, "Russia") and the Democratic People's Republic of Korea, and Yunnan province imports from Myanmar (EPPEI, 2018).

An alternative driver for an interconnection between Tajikistan and China could be as a transit country for electricity trade with higher demand regions such as Uzbekistan or to balance high levels of variable wind power installations energy in the region.

Massive construction of wind power capacity has taken place in Xinjiang in recent years. The expansion has spawned significant levels of wind power curtailment, especially between July and October (Luo et al., 2018). The number of curtailment hours is being progressively reduced (Figure 14). In time, both Tajikistan and China may find value in using Tajik hydro capabilities to manage the variability of electricity supply by providing balancing services.

Figure 14 Wind power and curtailment in Xinjiang, 2016 - 2019



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Sources: NEA (2020), Grid-connected Operation of Wind Power in 2019; NEA (2019), Grid-connected Operation of Wind Power in 2018; NEA (2018), Grid-connected Operation of Wind Power in 2017; NEA (2017), Grid-connected Operation of Wind Power in 2016.

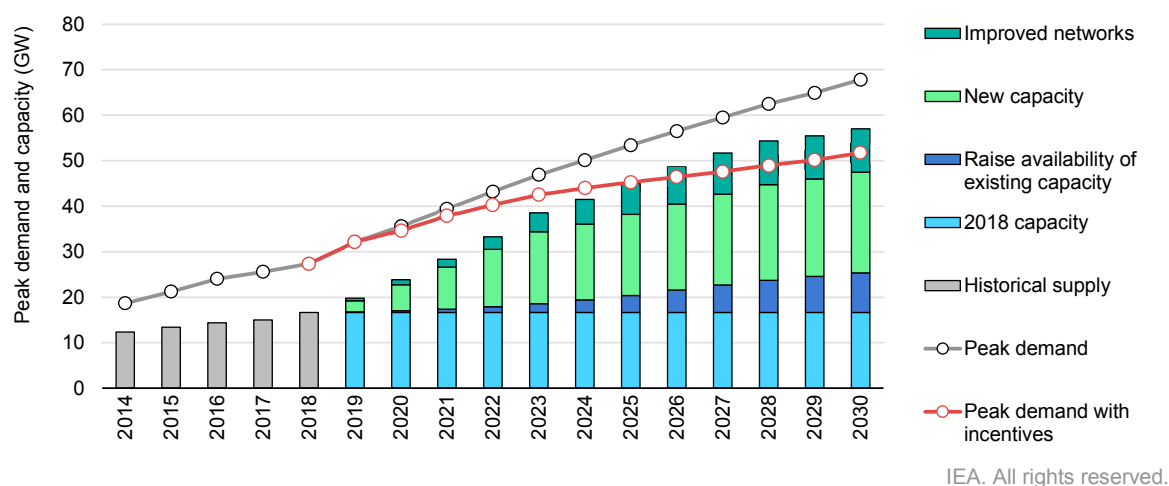
Any potential for electricity trade for balancing services or as transit for Tajikistan with China would only likely to be feasible in the long term. Transmission infrastructure investment would be required. China has plans to develop HVDC and ultra-high voltage

direct current (UHVDC) transmission networks to connect its north-western regions with eastern China, as well as with Central Asia, as part of the Global Energy Interconnection Initiative (GEIDCO, 2016). It has recently constructed a 1 100 kV UHVDC line from Changji, in Xinjiang province to Guquan, in Anhui province to the east capable of delivering 66 TWh (State Grid Corporation of China, 2019). Building a transmission network to connect Central Asia and China requires plans and political agreement among the participating countries involved. Currently, there are no official announcements suggesting such co-operation.

Electricity exports in the long term to Iraq and Iran

Given Tajikistan's proximity to the Middle East, the opportunity to export surplus electricity to address shortages is considered in this analysis. Iraq, like Afghanistan, has electricity shortages due to insufficient domestic power generation (Figure 15). Peak demand in Iraq occurs during summer. This suggests a possible match for the electricity surplus in the summer from Tajik hydropower.

Figure 15 Peak demand and generation capacity in Iraq, 2014 - 2030



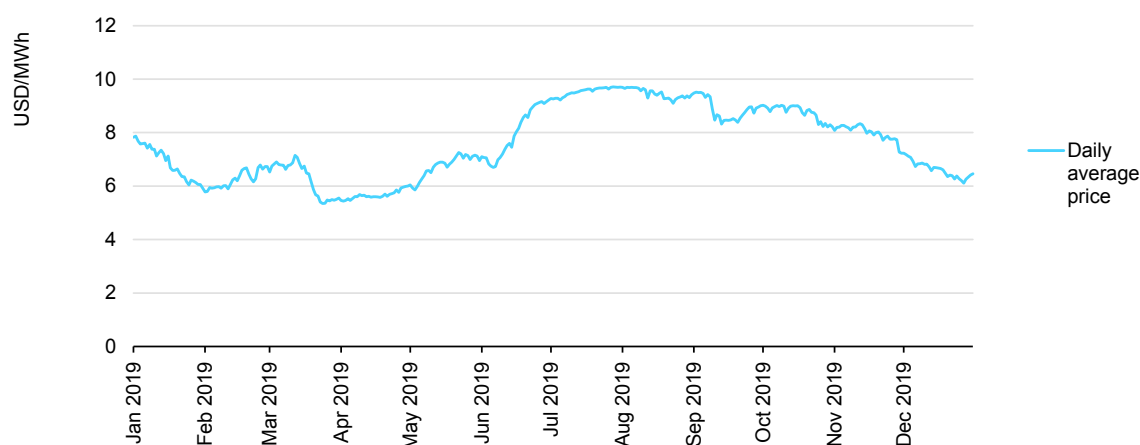
Source: IEA (2019b), Iraq's Energy Sector: A Roadmap to a Brighter Future.

To sell electricity to Iraq, Tajikistan would have to wheel power through Uzbekistan and Turkmenistan via a 500 kV transmission line and through Iran. Challenges are associated with each step.

- Electricity transit through Uzbekistan and Turkmenistan would be necessary before delivering to Iran and eventually Iraq. This suggests that it is more sensible for Tajikistan to establish a Central Asian regional market prior to any expanded transit ambitions.
- Turkmenistan has been exporting electricity to Iran and Turkey via Iran through a 220 kV line since 2003. Due to increasing demand, Turkmenistan is planning to build a 400 kV line to increase transmission capacity (Business Turkmenistan, 2021). Tajikistan would have to negotiate with Turkmenistan for transmission access for lines that now are heavily used by Turkmenistan.
- Finally, Iran's peak demand takes place during summer when its transmission lines are highly used, so using its national grid solely for wheeling could be prohibitive.

Tajik direct electricity exports to Iran faces challenges. Iran has cheap and abundant fossil fuel resources for electricity generation. Tajikistan would need to have a significantly attractive price offer after taking into account the cost of transit through Uzbekistan and Turkmenistan, or through Afghanistan if a new transmission line were to be built. In Iran's wholesale electricity market, the highest price observed during the peak summer demand is below USD 10/MWh, which is above the Tajik average generating cost for hydropower but perhaps an insufficient margin when the cost of transmission is included (Figure 17). The margins that would be obtained from Iran are lower than those observed in Central Asia, and there would also be the added costs of wheeling over existing or new transmission lines.

Figure 16 Daily average wholesale electricity prices in Iran, 2019



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Source: IREMA (2019). Average Daily Market Data.

Iran aims to become a regional electricity hub and to increase exports to Afghanistan, Pakistan and Iraq (Official Gazette of Iran, 2017). In 2011, it proposed the creation of a regional electricity market to include Central Asia, Iraq, Turkey, Azerbaijan, Afghanistan and Pakistan under the Economic Cooperation Organization. In such a scheme, Iran could import electricity from Tajikistan, but likely with the purpose of increasing its own exports to Iraq, Turkey or Pakistan where it could gain a trade advantage due to its proximity and existing transmission infrastructure. Progress has developed slowly but plans to develop a roadmap are still ongoing (ECO, 2021).

Currently, sanctions on Iran limit options for electricity trade. The possibilities of a larger regional integration of electricity trading could be revisited if these conditions change.

Electricity exports in the long term to India

The CASA-1000 transmission project includes 500 kilovolt (kV) AC lines in Tajikistan and Kyrgyzstan and a 1 300 MW capacity HVDC line to Pakistan, passing through Afghanistan. This will open a pathway to a possible connection to India. This is considered in this analysis since India, like Pakistan, sees peak demand in the summer season when Tajikistan's hydropower surplus is generally available for export.

India currently has electricity trading relationships with Nepal, Bangladesh and Bhutan. India imports electricity produced by hydropower in Bhutan. There might be appetite in India to import electricity from Tajikistan as well. India and the other South Asian countries

are investigating increased electricity trading among themselves as well as with countries in the Association of Southeast Asian Nations (ASEAN) like Myanmar and Thailand.

Although unlikely in the near term, there are two avenues for Tajikistan to export electricity to India. One is to build a direct transmission line to India through Pakistan or China. Another is to wheel via grids in Afghanistan and Pakistan to India.

- The direct line option would involve building transmission lines either through disputed territories or the surrounding mountainous ranges. Either of these routes are infeasible in the short or medium term given the difficulties in getting agreements related to sensitive territories. In addition, the construction costs of building transmission in mountainous regions are unlikely to support the business case of the export lines.
- The option of wheeling through Afghanistan and Pakistan would also be infeasible given that these countries encounter high demand during summer. Therefore it is reasonable to assume that Afghanistan and Pakistan would rather use their national grids to satisfy domestic demand rather than for wheeling. Moreover, currently there are no transmission interconnections between Pakistan and India. In 2014, there was a proposal for Pakistan to import 500 MW of electricity from India through the construction of a 1200 MW transmission line, but this did not materialise.

Tajikistan's opportunities to export electricity to India could be revisited in time based on political and economic conditions. There are two reference points:

- In 2000, the United States Agency for International Development launched the South Asia Regional Initiative for Energy (SARI/EI) which involves eight countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. Development of electricity trade has been most successful in the east, where Bangladesh, Bhutan, India and Nepal account for the majority of cross-border electricity trade in the region. In terms of the likelihood of electricity trade between Pakistan and India, it is considered to be relatively low given the lack of transmission connections as well as political matters.
- The Turkmenistan-Afghanistan-Pakistan-India (TAPI) natural gas pipeline will facilitate the export of Turkmen gas to the other countries and is expected to be completed in 2022. This will be one of the first examples of energy infrastructure co-operation between Pakistan and India.

It is suggested to monitor updates from the SARI/EI initiative to see if progress is made in the western part of the South Asian region. Likewise, if the operation of the TAPI pipeline proves successful, then it would highlight the value of energy co-operation among the countries and could pave the way for constructing electricity transmission infrastructure.

Recommended trading options

Several options for Tajikistan's cross-border electricity trading are explored in this report. The analysis indicates that resource availability and variations in seasonal electricity demand profiles in relation to its neighbours provide opportunities for Tajikistan to export electricity. Cross-border trade could improve the viability of its electricity sector by augmenting its income stream through exports and to reduce shortages in the winter with selected electricity imports.

Tajikistan could immediately expand electricity trading opportunities with its Central Asian neighbours in the near term based on existing transmission assets. Because the Central Asian transmission system has been connected previously, enabling institutions for cross-border integration exist. Tajikistan can export to the regional market during the summer season when electricity from hydro production is abundant, thereby lowering the region's collective generation reserves requirement. In addition, the regional market can be an

immediate source of supply for Tajikistan to cope with winter shortages when needed. Expanding beyond long-term bilateral contracts to include short-term flexible multilateral contracts would allow Tajikistan to maximise the value of its hydropower surplus for both its own and the region's benefit, while not precluding Tajikistan from establishing additional trading relationships with other countries in the future.

Several multilateral institutions have initiatives to rebuild the Central Asian regional electricity market. If the region succeeds to establish multilateral electricity trading that is broader than long-term bilateral contracts, then it would be the first Asian region to accomplish a higher level of integration. As such, Central Asia would be a pathfinder and could provide valuable experience to other regions that are working to establish regional electricity markets.

Pakistan represents an opportunity for Tajikistan to increase its exports. The CASA-1000 transmission line is under construction and is expected to be completed by 2023. The Tajik summer export opportunity is a good match with regular supply deficits in the summer in Pakistan, plus trade volumes could increase in the future if there are attractive margins. Facilitating short-term flexible contracts would support a more optimal use of the existing transmission line and could foster integration of the CASA countries (Tajikistan, Kyrgyzstan, Afghanistan and Pakistan) with a wider Central Asian regional market. Integrating the markets could pave the way for other countries to use the CASA-1000 transmission line in the future and provide additional transit income for Tajikistan. It may also serve as catalyst for investment in additional transmission interconnections in the region.

For Afghanistan, its high annual shortfalls in meeting electricity demand will likely last until it installs sufficient domestic generation capacity. In the meanwhile, it is well placed to receive imports of Tajik surplus electricity. However, grid integration and synchronisation issues must be resolved first and Tajikistan will have to ensure that the electricity export prices remain competitive.

China is also an option for future cross-border integration with Tajikistan. However, given that Xinjiang province is rich in renewable and fossil fuel energy resources, it is unlikely to be a viable export market for Tajikistan. It could be possible for China and Tajikistan to make arrangements for ancillary services but it is unlikely to be a firm part of Tajikistan's 2030 goal of exporting 10 TWh. China could be a long-term option for cross-border integration, though it would require government-level political agreements and significant investment in transmission networks in China and with its Central Asian neighbours.

India is an unlikely candidate for electricity trade with Tajikistan by 2030. This reflects the multiple challenges to build transmission capacity between India and Pakistan.

Iraq and Iran also are unlikely candidates for electricity trade with Tajikistan by 2030. This is due to the wheeling requirements to deliver electricity through transiting countries, which are likely to eliminate any cost advantages that Tajikistan's hydropower may have.

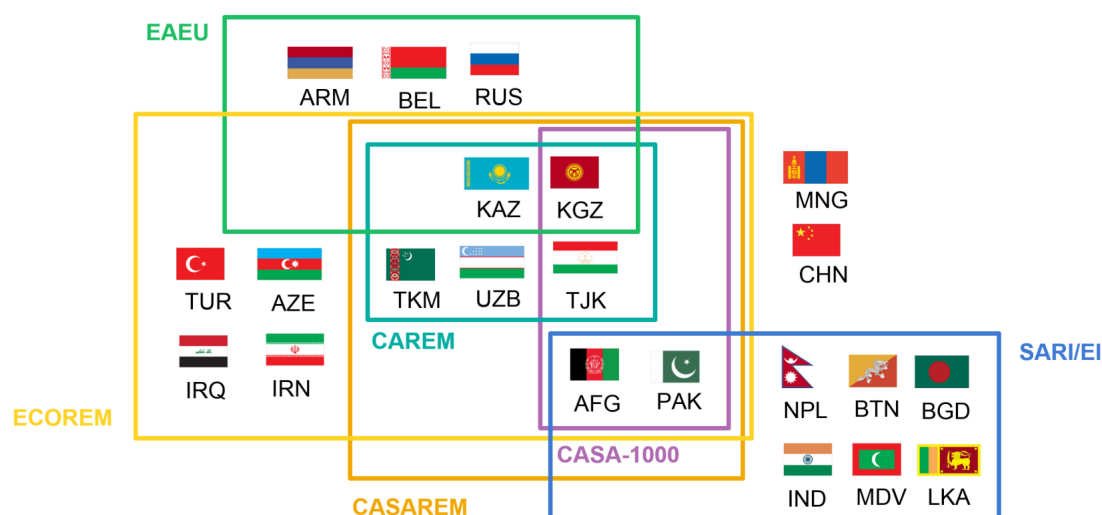
A roadmap for cross-border electricity trading for Tajikistan

Cross-border electricity trading can bring a number of benefits to Tajikistan and its neighbouring countries. It has implications for economics, energy security and the integration of variable renewables.

- In economic terms, interconnecting power systems allows the parties to enhance economies of scale by expanding the customer base and maximising a broader portfolio of power system assets. In the case of Tajikistan, it provides a bigger market to which it can sell its hydropower surpluses.
- In energy security terms, interconnecting power systems offers a more diverse energy supply and reduces the impact of disruptions. Supplying electricity to meet peak demand can be more flexible by combining generation units to address varying demand patterns or outages with system resources.
- In terms of the integration of increasing shares of variable renewables, interconnecting power systems provides more flexibility sources for balancing, thereby facilitating their integration at higher levels.

Recognising these opportunities, several initiatives aim to progress regional electricity market integration (Figure 17). Tajikistan has several options to directly or indirectly trade electricity with other countries as these markets develop.

Figure 17 Regional electricity market initiatives in the region central, south, and west Asian, and Eurasian regions



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Note: EAEU = Eurasian Economic Union; SARI/EI = South Asia Regional Initiative for Energy Integration; ECOREM = Economic Cooperation Organization Regional Electricity Market; CAREM = Central Asia Regional Electricity Market; CASA = Central Asia-South Asia; CASAREM = Central Asia-South Asia Regional Energy Markets. AFG=Afghanistan; ARM = Armenia; AZE=Azerbaijan; BEL=Belgium; BGD=Bangladesh; BTN=Bhutan; CHN=China; KAZ=Kazakhstan; KGZ=Kyrgyzstan; IND=India; IRN=Iran; IRQ=Iraq; LKA=Sri Lanka; MDV=Maldives; MNG=Mongolia; NPL=Nepal; PAK=Pakistan; RUS=Russia; TKM=Turkmenistan; TJK=Tajikistan; TUR=Turkey; UZB=Uzbekistan

Source: IEA analysis based on International Energy Charter (2020), Promoting integration of power markets in the ECO Region.

It is important to note that the benefits of cross-border electricity trade are rarely distributed equally among countries. They can be hard to estimate beforehand, thereby making agreements on shared investment such as transmission system assets more difficult (IEA, 2019c).

Another issue is increased exposure to risk beyond a country's sole control. For example, a major disruption in another country could affect an interconnected system (IEA, 2019c). Or, failure to deliver on capacity investments or to meet operational requirements in one country may compromise others on the system.

Co-ordination at the regional level for the development and operation of generation and transmission assets for the integrated system is critical. Avoiding under or over investment is a key element to avoid poor performance and ensure investor confidence.

Minimising these risks requires that the design of the electricity market, system operations and governance structures are robust and effective.

For Tajikistan, given its economy and the financial and physical condition of its power sector, regional electricity market opportunities would be attractive. Multilateral trade would allow the use of Tajik's excess seasonal hydropower for economic gain in the near term. As the region installs more and more variable renewables in the generation mix, Tajikistan can offer valuable flexibility services to an integrated regional market.

Based on these considerations, for Tajikistan to strengthen and expand electricity trade, the IEA recommends a roadmap focused on three key points:

- Ensure favourable conditions to enable multilateral electricity trade.
- Adopt multilateral market models to expand electricity trade.
- Strengthen Tajikistan's role as a flexibility provider for the region.

For each of these points, the following sections offer examples of international best practice and suggested policies in the Tajik context.

Ensure favourable conditions to enable multilateral electricity trade

Most electricity trading arrangements in Tajikistan today are long-term bilateral contracts with limited options for variations in volumes or price. While Tajikistan can continue this trading model, a multilateral market framework can unlock more opportunities for its hydropower resources, gain revenue and improve the efficiency of resource use for the region.

A regional multilateral electricity market requires a higher level of political agreement among the participants compared with bilateral contracts. Political will is required to implement necessary reforms associated with harmonisation and market functioning.

Tajikistan should increase its institutional readiness for more integrated electricity markets. Effective cross-border trade depends on a reliable power sector at the domestic level. Sustainability of operations, transparency and effective regulation are important to reinforce the functioning of the Tajiki power sector, which can boost confidence among

trading partners in more integrated markets. To strengthen its readiness for increased electricity trading, Tajikistan should embrace these principles:

- Financial viability of utilities signals their operational sustainability as market entities – a critical characteristic to ensure confidence with trading partners that rely on electricity supply. Good management and governance contribute to operational and financial discipline, and economic viability. By working with relevant stakeholders which are affected by their operations, well-governed power system entities help to ensure beneficial and enduring business relations with trading partners.
- Transparent and timely data and information underpin effective market functioning.
- Effective regulation enforces market discipline for utilities and can contribute to their financial viability.

In addition to these principles, Tajikistan would profit in appropriately preparing power sector systems and operations for expanded trading opportunities. Capacity building in areas such as financial modelling and optimal dispatch in a regional market would be advantageous. Investment in hardware and software needed for multilateral and flexibility trading would increase Tajikistan's readiness for opportunities in an integrated market.

Conditions to support multilateral trade: case studies

Institutional arrangements for integration of regional electricity markets

Case studies were analysed by Oseni and Pollitt (2014) to determine the important factors that promote trade in established regional electricity markets. The relevant points for Tajikistan are: to ensure a cost-effective and reliable domestic power sector, and to facilitate additional transmission capacity.

Sufficient generation capacity is essential to participation in a multilateral market. Established in 2000, the West African Power Pool (WAPP) has had almost no electricity trade for more than a decade. Inadequate installed capacity and poor infrastructure among the member countries were found to be major barriers. Interconnection studies and significant investments were made by international development institutions to help encourage trade, but concerns remained on the reliability of the domestic power sectors. In contrast, the South African Power Pool (SAPP) with ample installed generation capacity among its member countries was able to begin trading in its regional market, albeit mostly through bilateral trading.

In addition to sufficient generation capacity among the market participants, adequate transmission capacity is essential. The case studies showed that insufficiency in this regard hampered spot market transactions in the SAPP and the Central American Electrical Interconnection System (SIEPAC) which prolonged a dominance of bilateral trading. In contrast, the case studies highlighted significant transmission capacity underlying the Pennsylvania-New Jersey-Maryland Interconnection (PJM) and NordPool regional power markets. Agreements on cross-border transmission investment can be a challenge reflecting difficulties to determine cost sharing among the parties. In the cases of SIEPAC, WAPP and SAPP, cross-border transmission planning has been supported by feasibility assessments co-ordinated by international development agencies.

Ensuring a reliable domestic power sector capable of attracting sufficient investment can help Tajikistan prepare for expanded regional trade. Though cross-border transmission investment is challenging, having a capable regulatory authority co-operating with regulators in the participating countries can facilitate cost-sharing agreements.

Power sector reform: lessons learned from emerging economies

A World Bank multiyear study, *Rethinking Power Sector Reform in the Developing World*, tracks outcomes of power sector reforms from the 1990s in several emerging economies (Foster and Rana, 2020). It covers key issues related to governance, regulation, cost recovery, power markets and political economy. Its findings highlight that: cost recovery is difficult to achieve; the private sector has contributed to generation expansion but less so for distribution; and well-run public institutions can be made to function as efficiently as private ones.

Regulatory authorities were found to be widespread, although their level of independence in many countries is debatable. The case studies showed that the regulators perform the function of providing technical advice for the ultimate political decision makers. Some success in effective regulation of private companies was found, though less so for state-owned utilities that lack commercial incentives.

The case studies show that under recovery of cost is common and that even in countries showing progress towards cost recovery, backsliding often happens especially in emergency situations. Removing electricity subsidies is often difficult and citizens displeasure could derail the overall reform process. Targeted subsidies for the poor help to avoid universal under pricing of electricity. Several institutions such as the International Monetary Fund (IMF) and Energy Sector Management Assistance Program (ESMAP) provide case studies to appropriately strategise subsidy reform processes.

As Tajikistan undergoes further reforms in order to improve its governance and cost-recovery goals, it will be beneficial to learn from the case studies and adapt its pace and direction to ensure success.

Key policies to enable multilateral and flexible trading frameworks for Tajikistan

Principal actions

- Improve financial viability and governance in the power sector with continuing reforms and their effective implementation. Ensure appropriate co-ordination with relevant stakeholders, such as regional co-operation on water resources for hydropower.
- Increase transparency by developing open access for supply, demand and transmission, and other relevant data. The scope, frequency and resolution of additional data shared with trading partners would be determined based on the agreed market model.
- Strengthen regulatory authorities through training and capacity building. Ensure their independence and legislate reporting requirements that aid in their decision making.

Specific policies for consideration

Progress power sector reforms

- Progress the restructuring of Barki Tojik, the state-owned electric utility.
- Advance cost-recovery efforts through tariff reform with an appropriate strategy to handle current subsidies.

Increase data transparency

- Enable open access for key operational data such as demand and supply conditions, and planned or emergency works on power plants and transmission lines that could affect the functioning of an integrated market.
- Provide access to information relevant to forecasts such as water levels, planned works, generation expansion plans and financial statements.

Strengthen regulators

- Support training and technical capacity building for regulatory authorities in key areas such as cross-border interconnections and the functioning of various market models. This can boost the regulatory authority's capacity to review plans for power sector investments, assess public benefits and equity of cost-sharing arrangements.
- Consider establishing institutional frameworks to ensure the independence of a national regulatory authority. This might include elements such as: creation of a body that is independent from a government ministry; assured working budget allocation; and restrictions on pre- and post- employment of staff to reduce conflict of interest risks (OECD, 2016).
- Consider providing the regulatory authority the ability to compel relevant data reporting from utilities on a regular basis.

Adopt multilateral market models to expand electricity trade

Multilateral electricity markets would provide several options for Tajikistan to increase revenue. In addition to the current practice of seasonal surplus electricity sales through bilateral arrangements, daily or weekly surpluses could be sold in day-ahead or week-ahead markets. The balancing capabilities of reservoir hydro power plants could also be sold in balancing markets.

Establishing a specific trading model would need to take due account of the readiness of countries in terms of their power sector structure and market including third-party participation, as well as experience in cross-border electricity trading.

In the Central Asia region, only Kazakhstan has significant experience in power sector market-oriented operation with private sector participants (Table 4). Hence, a secondary trading model like the Southern African Power Pool could provide the countries in Central Asia time to pursue national reforms while realising the benefits of increased trade.

In the South Asia region, only Pakistan has significant experience with third-party participation. Tajikistan and Kyrgyzstan in association with Pakistan could develop a secondary trading model which could be a feasible near-term model to optimise the CASA-1000 transmission project.

Table 4 Power sector structure in the Central and South Asian countries

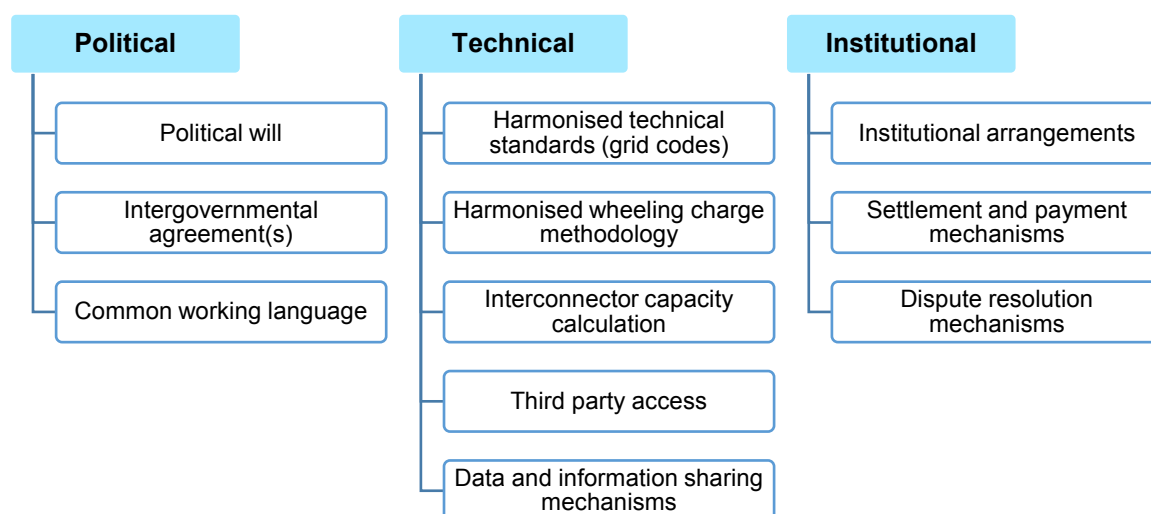
Country	Structure	Domestic Market	Third-party participation
Tajikistan	Legally unbundled, with Barki Tojik as the holding company for all activities	Monopoly	Limited
Kazakhstan	Full legal and functional unbundling	Wholesale and retail markets.	Yes. Currently about 45 privately owned enterprises
Kyrgyzstan	Legally unbundled	Monopoly	Limited
Turkmenistan	Vertically integrated	Monopoly	None
Uzbekistan	Legally unbundled	Energo Sotish as single buyer and seller	Limited
Afghanistan	Vertically integrated (fragmented)	Monopoly	Limited
Pakistan	Functionally unbundled with private sector participation	Central Power Purchasing Authority as single buyer and seller	Yes. Currently several independent power producers

Sources: IEA (2020), Kyrgyzstan Energy Profile; IEA (2019d), Kazakhstan Energy Profile; IEA (2019e), Uzbekistan Energy Profile; MEWR (2021b), Reform of the Electricity Sector in Tajikistan; ADB (2020), Regional Cooperation on Renewable Energy Integration to the Grid.

It is important to note that Afghanistan would not have electricity supplied via the CASA-1000 line and would only benefit from transit payments. Its existing AC transmission connections are with Central Asia. In the long term, when the grids in Afghanistan are connected and additional transmission lines connect it with Pakistan, the Central Asia and South Asia regions could be connected. Stepwise inclusion of new participants is possible when cross-border arrangements have clear procedures and rules.

Moving towards a more primary trading model such as the EU Internal Electricity Market would require the eventual harmonisation of national market structures of the participating countries. Given their varying structure and pace in restructuring, this may be considered as an option for the long term. Certain countries could choose to remain in a secondary trading arrangement while a sub-group could explore a primary trading arrangement in the future. Power pools can start with a small number of countries and grow over time as it offers more chance of steady and deep progress, as observed in the growth of PJM in the United States and Nord Pool in the European Union, rather than prolonged initial development periods (Oseni and Pollitt, 2014).

Regardless of the model chosen, there are minimum political, technical and economic requirements that the countries would need to adopt to establish effective multilateral power trading (Figure 18). These minimum requirements are discussed in the key policies section.

Figure 18 Minimum requirements to establish multilateral power trading

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Source: IEA (2019a). Establishing Multilateral Power Trade in ASEAN.

Establishing political agreement and executing the necessary institutional changes are vital steps. The Central Asia region exhibits substantial interest to pursue expanded cross-border electricity integration and trade. A number of multilateral donors are supporting various initiatives. Tajikistan and its neighbours endorsed a roadmap to promote cross-border electricity connections as a means to pursue sustainable development.

Roadmap to promote cross-border electricity connectivity

The UN Economic and Social Commission for Asia and the Pacific (UNESCAP) member states endorsed a roadmap to promote cross-border electricity connectivity to support sustainable development. It aims to provide a framework for co-operation in the 2020-2035 period. The roadmap includes the following strategies:

- Build trust and political consensus for cross-border electricity trade.
- Develop a regional cross-border electricity grid master plan.
- Develop and implement intergovernmental agreements on energy co-operation and interconnection.
- Co-ordinate, harmonise and institutionalise policy and regulatory frameworks.
- Create competitive markets for cross-border electricity and enhance multilateral trade.
- Co-ordinate cross-border transmission planning and system operations.
- Mobilise investment in cross-border grid and generation infrastructure.
- Build capacity and share information, data, lessons learned and best practice.
- Ensure the coherence of energy connectivity initiatives and the UN Sustainable Development Goals.
- Develop a regional cross-border electricity grid master plan.

Tajikistan and its neighbours across Asia are members of the UNESCAP. It can serve as a common reference point to foster cross-border electricity trading and integration to contribute to the region's economic development through optimal use of resources.

Source: UNESCAP (2021). Regional Roadmap on Power System Connectivity: Promoting cross-border electricity connectivity for sustainable development.

Examples of multilateral electricity trading models to expand trading

This section highlights the key characteristics of primary electricity trading models, such as in the European Union, and secondary trading models such as in Southern Africa and Central America. The case studies summarise the rationale for the choice of the models and how they have developed over the years. These examples can help guide Tajikistan and its neighbours as they proceed to develop a regional electricity market.

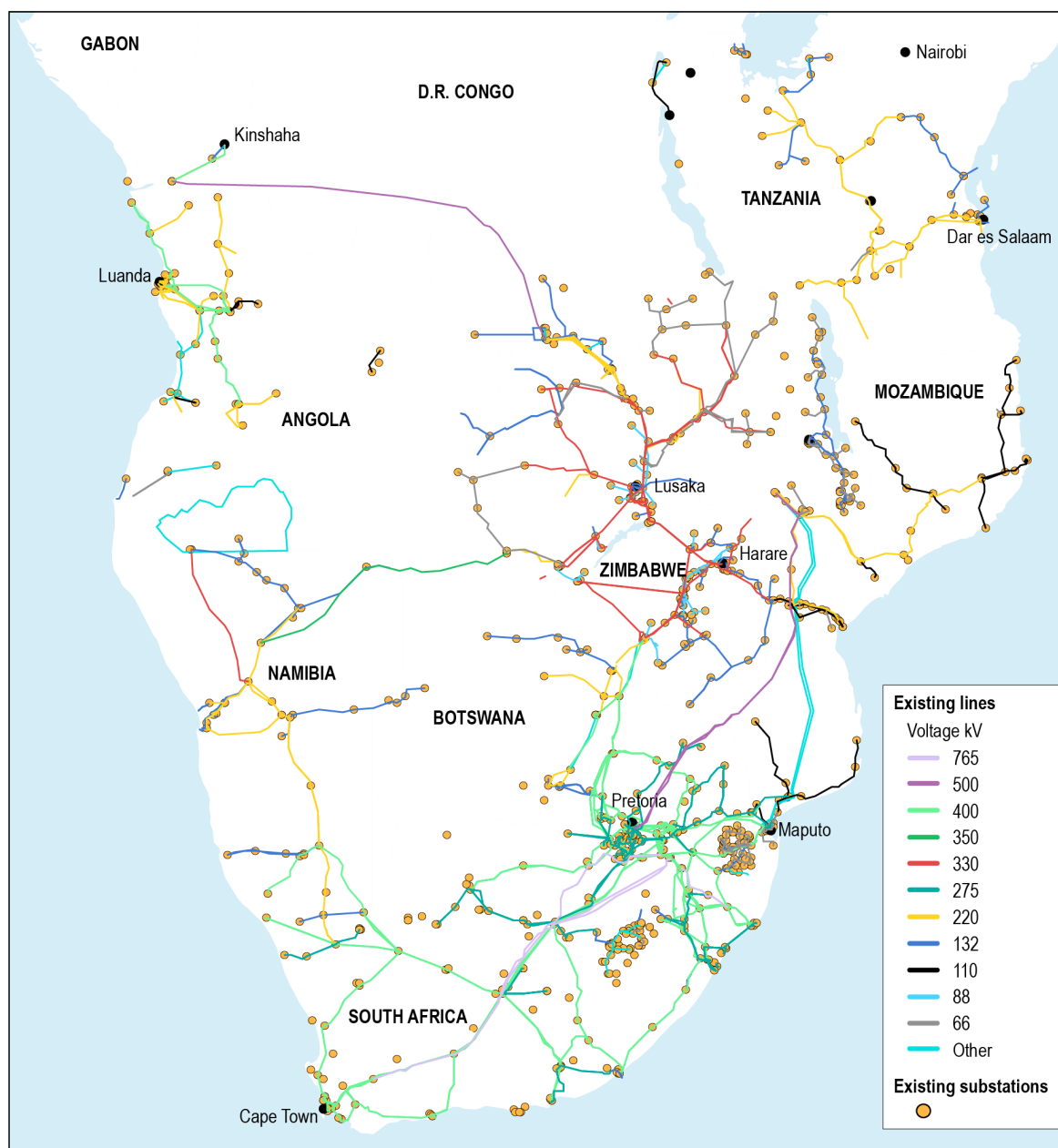
Southern African Power Pool Model

The Southern African Power Pool (SAPP) was created in August 1995 when member governments of the Southern African Development Community (SADC) signed an intergovernmental memorandum of understanding. The SAPP has twelve member countries represented by their respective electric power utilities. The SAPP co-ordinates the planning and operation of the electric power system among member utilities. Its primary aim is to provide reliable and economical electricity supply to consumers in each member country consistent with reasonable use of natural resources and minimal negative impact on the environment. For fiscal year 2018-2019, 2 TWh of electricity were traded in the competitive market, accounting for 32% of total trading while 68% were bilateral trades.

The regional power pool (Figure 19) was established even though the electricity markets at the national level had not necessarily been restructured. National utility companies act as buyers and sellers of electricity. Independent power producers (IPPs) are allowed to trade directly. In 2001, the short-term energy market was established and in 2004, SAPP started the development of a competitive electricity market for the SADC region. A day-ahead market was instituted in 2009 and in 2015 the trading platform was upgraded with forward physical markets and an intra-day market.

An important feature of the SAPP is that only excess generation is traded; hence its classification as a secondary market arrangement. Member utilities first ensure that they can cover domestic demand before offering generation capacity to the regional market. Electricity can also be traded through the pool on an emergency basis to meet unexpected shortfalls.

The Regional Electricity Regulators Association of Southern Africa (RERA) was created in 2002 and consists of the national regulators of the member countries. RERA functions only as a co-operative body to facilitate harmonised electricity sector policy, legislation and regulation and does not wield authority in regulatory matters.

Figure 19 Southern African Power Pool

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This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

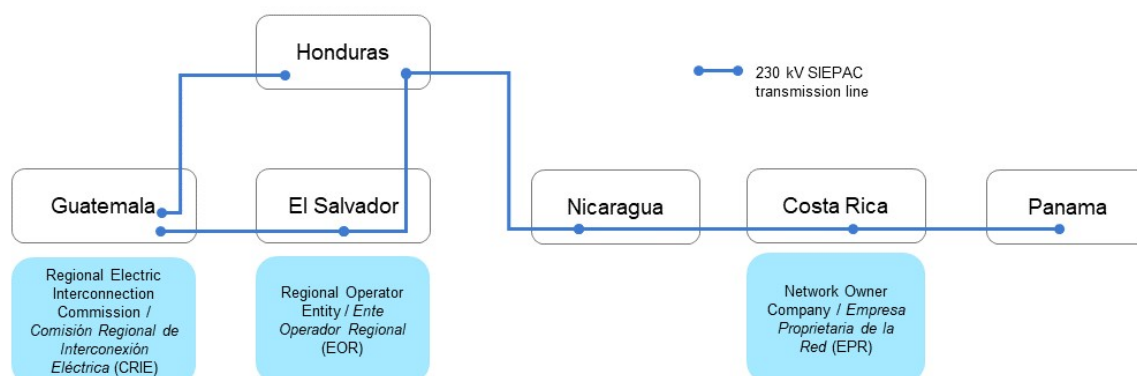
Source: SAPP (2021), SAPP SADC Grid Map.

Central American Electrical Interconnection System (SIEPAC) Model

Another secondary market model is the Central American Electrical Interconnection System (SIEPAC) which is an interconnection of the power grids of six countries (Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama). The SIEPAC is a dedicated 230 kV transmission line (Figure 20). It is referred to as the “seventh market”, since it functions on top of the six national markets. The regional institutions are located in various member countries: the regulator, Comisión Regional de Interconexión

Eléctrica (CRIE), in Guatemala; the market operator, Ente Operador Regional (EOR), in El Salvador; and the transmission owner, Empresa Proprietaria de la Red (EPR), in Costa Rica.

Figure 20 SIEPAC transmission line and regional market institutions



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Source: IEA adapted from EOR (2021), Regional Electric System.

The SIEPAC market is a supplemental market rather than an integration of the six national markets. It was designed in this fashion to avoid issues with free riders and undesirable price formation.

- The free rider issue can arise in a regional market where a member fails to contribute their fair portion to the costs of a shared resource such as adequate generation capacity. It is a type of market failure in which those that benefit do not pay or under pay for use of the resource.
- The undesirable price formation issue can arise when a member with relatively low generation costs is connected with others that have higher generation costs. Resource sharing will lead to an average equilibrium price that could be significantly higher than for the country accustomed to low prices in the absence of international trade. As the costs of generation and the level of electricity subsidies vary in the region of Tajikistan's likely markets, avoiding a poor price outcome can make trading more appealing.

While these concerns can be addressed with effective regulation and market design, the SIEPAC approaches them by a pre-dispatch modelling of national markets before bidding into the market. Market participants that have not been dispatched in their national markets can bid into the SIEPAC market. In this way the individual countries can utilise their own least expensive resources and any excess or deficit can be covered in the SIEPAC market without increasing prices for consumers in the countries that are fully covered by domestic generation, typically the countries with low cost generation. In this model, high cost generation is replaced by surplus power from lower cost markets.

Trading in the SIEPAC market is mainly short term, but there is progress in setting up firm one-year ahead trades. Long-term investments with cash flow, coupled with available long-term transmission rights could enable larger scale investments that the national markets would not normally support due to their small sizes and projected low demand growth rates.

EU Internal Electricity Market

The European Union Electricity Market is a primary trading model. It has evolved with different levels of restructuring at member state levels since the 1990s as part of the European Council's objective of achieving increased market integration to improve security of supply, reduce costs and improve economic competitiveness. Four EU directives (1996, 2003, 2009 and 2019) instituted major changes to achieve common market structures, expand competition and increase interconnections (European Parliament, 2020).

In order to increase the participation of the member states, a number of choices were offered to achieve specific goals. For example, the 1996 directive to increase competition in electricity generation provided that member states could set up a wholesale market where all generation utilities could freely enter or to establish competitive procurement through a single buyer. Third-party access to grids could either be through negotiations with an integrated utility or by regulation (Pollitt, 2019).

Given the difficulties associated with assigning costs in new cross-border transmission developments, the European Union established a “project of common interest” status where prospective project developers can take advantage of accelerated permitting, financial incentives and access to loans. In order to obtain this status, a prospective transmission project developer must first submit a cost-benefit analysis following an agreed methodology from the European Network of Transmission System Operators for Electricity (ENTSO-E) and the Agency for the Co-operation of Energy Regulators (ACER). In addition, a cross-border cost allocation agreement process has been established where ACER can step in and mediate disagreements about cost allocation among countries to progress a project (Meeus, 2020). These measures have been used successfully to expand cross-border transmission capacity in the European Union.

For Tajikistan and its neighbours, the process of negotiating a regional market arrangement could involve setting different pathways to reach common objectives to increase the level of participation. In addition, establishing measures to allocate costs for cross-border grid developments and to have mediation procedures could help boost investment and improve integration of a regional market.

Key policies for expanding multilateral trade

Principal actions

- Start with the basics of obtaining political agreement, understanding common goals and ambitions, and common working languages.
- Define technical standards such as harmonisation of grid codes, wheeling charge methodologies, interconnector capacity calculation methodology, third-party access, data and information sharing requirements.
- Define institutional arrangements including settlement and payment mechanism and dispute resolution measures.
- Provide enabling environments to increase trade frequency and integration by establishing regional co-operation among national regulatory authorities.

Specific policies for consideration

Obtain political agreement

- Obtain political agreement through appropriate avenues. For example, for the CASA-1000 countries (Tajikistan, Kyrgyzstan, Afghanistan and Pakistan), the system and market operation could be decided in CASA-1000 Intergovernmental Council. Matters relating to the Central Asian regional market could be discussed in the Coordination Electrical Power Council of Central Asia (grid operators in Kazakhstan, Uzbekistan, Kyrgyzstan and Tajikistan).

Determine appropriate market models and common working languages

- Determine appropriate market models for Central Asia and the CASA-1000 transmission project based on an assessment the advantages and disadvantages in relation to the participating countries.
- Develop common working languages. Central Asia uses Russian as a *lingua franca* while South Asia uses English. It may be useful to use both as Afghanistan and Pakistan may elect to integrate with Central Asia in the long term.

Harmonise grid codes for Central Asia and CASA-1000

- Develop harmonised grid codes in areas such as connection policies for customers and generators, requirements based on grid connection mode (synchronous versus converter-based) and HVDC connections.
- Establish operational policies in areas such as security, planning and scheduling, load frequency control and reserves, emergency response and restoration measures.
- Set market policies in areas such as capacity allocation and congestion management, balancing, forward capacity allocation, metering and operator training.

Given that the connection with Pakistan is through an HVDC line, the degree of harmonisation would be less compared to AC connections. Nonetheless, harmonisation would be important to ensure smooth system operation and to avoid trade distortions.

Establish co-operation among transmission system operators

- Establish a co-operative body of transmission system operators to co-ordinate the development of regional networks, identify projects of common interest and share information. The Central Asia Transmission Cooperation Association (CATCA) initiated by the Central Asia Regional Economic Cooperation (CAREC) programme, which includes both electricity and gas networks, could be a suitable platform.
- Consider reinforcing the role of the Coordination Electrical Power Council of Central Asia to facilitate and sustain a co-operative body of transmission system operators.
- As an independent operator operates the CASA-1000 line, it can serve as the main operator for the four countries. Co-operation of the national transmission system operators in relation to the CASA-1000 operator would need to be formalised.

Harmonise wheeling methodologies

- Harmonise wheeling charge methodologies such that the cost of trading is transparent to the parties involved. Key parameters would involve: amount of wheeling capacity,

time duration of transmission, entry and exit points, metering of actual flows, agreed balancing procedures and mechanisms for handling losses, and cross-border taxation.

- Ensure that the complexity of the methodology is appropriate for the trades involved and that the wheeling charge is cost-reflective.
- Agree on collection management: market participants could pay directly to transmission owner in a decentralised manner. As trades increase frequency and actual power flows cross multiple borders, then a centralised institution could collect and distribute these charges. This could be achieved through the revival of the functions of CDC Energiya.

Note that as the regional market becomes more integrated, wheeling may become obsolete. In a primary trading model, transmission system operators could be compensated instead with congestion rent or income from the sale of long-term transmission rights. These rules would depend on the market model selected.

Harmonise interconnector capacity calculation methodologies

- Harmonise the technical methodologies to assign net transfer capacity limitations for each cross-border line. Take into consideration how to handle deviations between expected and actual power flows.
- As cross-border trading expands, the region can consider more complex calculations of interconnector capacities such as flow-based or model-based capacity determination to maximise use of the transmission systems.

Establish frameworks for third-party access to domestic grids

- Provide basic provisions for third-party participants in national grids such as transmission licences, connection and use agreements, and generation licences with export and import capabilities.
- Outline rights and obligations of national utilities: rights to access regional transmission networks; obligations to operate in a secure and reliable manner; to grant grid access to approved producers and consumers; and to allow power transfer through national networks.
- Outline rights and obligations of transmission system operators: rights to interconnect and transmit power; obligations to allow market participants to connect and use transmission networks; to ensure that the operation of transmission assets is in line with the grid code. (Note that if an additional transmission line were to be constructed to connect with Pakistan, an external owner and operator providing merchant transmission could be considered.)
- Outline rights and obligations of independent power producers.
 - In restructured markets, rights and obligations such as connections to the grid, and to participate as long as the rules and requirements of the grid code are upheld.
 - In vertically integrated monopolies, rights and obligations such as wheeling as long as the rules and requirements of the grid code are upheld.

Countries participating in an integrated electricity trading arrangement will need to agree on how to structure third-party participation. In the example of the Southern African Power Pool, IPPs have rights to sell power to a variety of pool players including national integrated utilities, and transmission system operators are obligated to provide access to wheel power to its destination.

Share data and information

- Develop a central institution that can collect critical system information such as operations, cross-border power flows and traded values.
- Share forecasts of demand growth, daily and seasonal peak and power system plans to guide optimal decision making for investment. Provide information on current and potential market participants. This informs the market to facilitate development of the least-cost options to ensure adequate reserves.

The level of shared data should be specified in the cross-border agreements. More integrated and high frequency trading set-ups tend to involve more data in order to improve decision making.

Dispute resolution mechanisms

- Develop mechanisms for settlement of deviations in trade volumes, failures and for delays in trade or payment.
- Develop mechanisms to settle disputes that may arise in the development of cross-border arrangements and market frameworks.

Establish regional co-operation of regulators

- Establish a regional co-operation body of national regulatory authorities. Its objectives would be to facilitate the harmonisation of regulatory matters relevant for integrated electricity markets.

Strengthen Tajikistan's role as a flexibility provider for the region

Tajikistan is surrounded by countries with high potential for wind and solar. Kazakhstan and Uzbekistan have high ambitions for their development. Integrating variable renewables can be facilitated with regional initiatives. Tajikistan can provide high value, fast-acting regulation reserves to support the integration of variable generation sources.

The higher the ambition of the Central Asian regional market to integrate variable renewables, the greater the appetite will be for hydropower for flexibility. This may lead to additional incentives to develop Tajikistan and Kyrgyzstan's hydro reserves. With higher variable renewables, the flexibility needs of the system may involve balancing services in minutes and hours. This may add operational requirements to the existing hydro fleet for which it may not have been originally designed.

In addition, in proposing connections to regions with significant shares of wind power like in Xinjiang province, Tajikistan could position a clear offering that takes advantage of its hydro resources as a flexibility provider. If transmission lines are built, then it would have to involve Pamir Energy, the operator in the Gorno-Badakhshan Autonomous Oblast (GBAO) directly bordering Xinjiang province, as a stakeholder.

Key policies to strengthen Tajikistan's role as a flexibility provider for the region

Principal actions

Enhance capacity to optimise hydro operation in different markets

- As different markets are created in Central Asia and South Asia, Tajikistan could consider developing its capacity to optimise its hydro operation for the different markets or trading arrangements that may develop, e.g. long-term bilateral arrangements, day-ahead markets and ancillary services.

Undertake refurbishments to adapt to increasing flexibility needs

- Given the advantages of Tajik hydropower capacity, refurbishing or upgrading its hydro plants and facilities to increase flexibility could unlock more opportunities as the rest of the region increases the share of variable renewables generation.

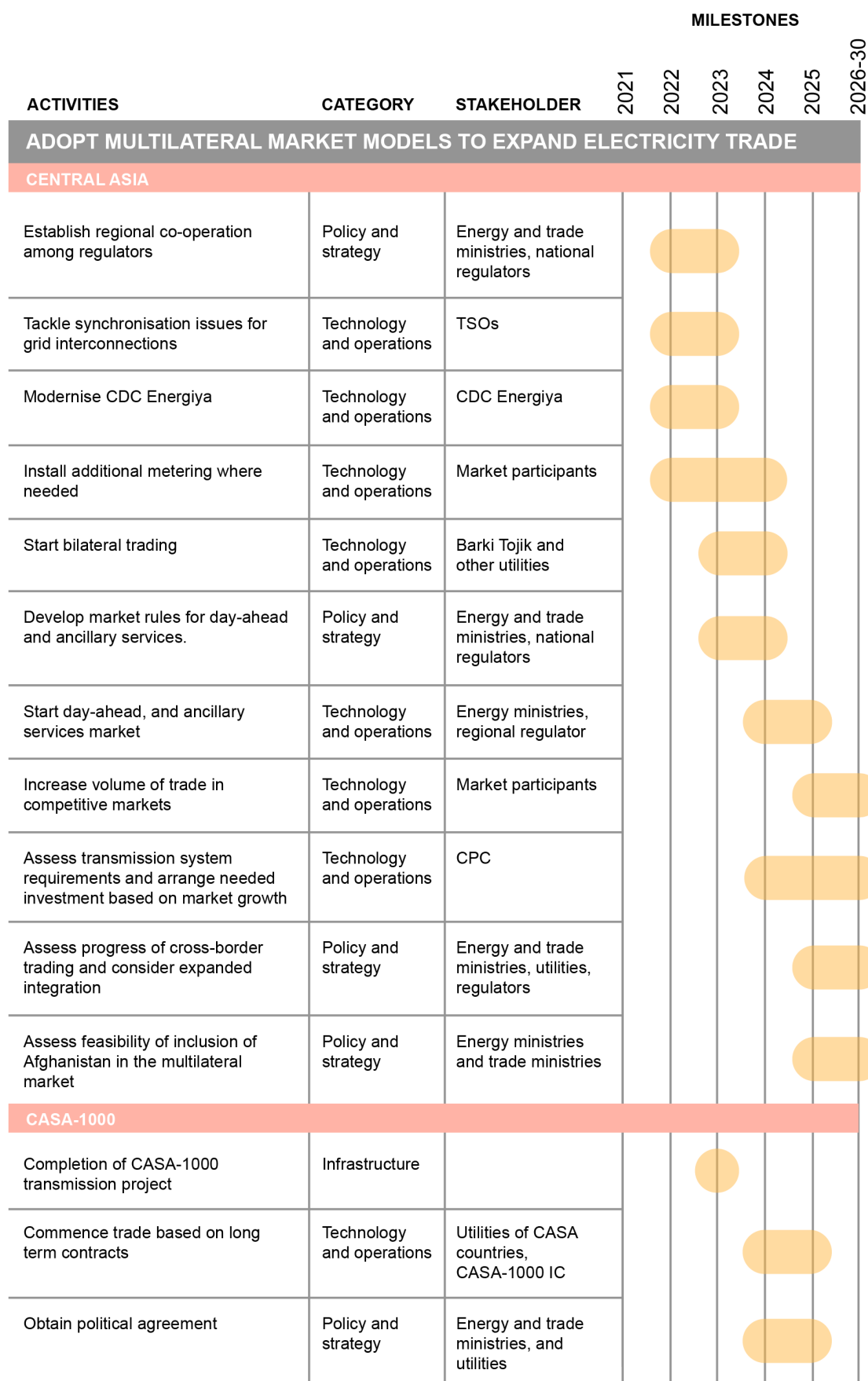
Initiate dialogue on additional transmission lines and upgrade existing lines where needed

- Initiate dialogue on exploring additional transmission lines which may serve as “seasonal reserve” (summer surplus with Pakistan), or spinning and regulating reserve (Central Asia).
- Initiate dialogue with extended partners such as China, India, and Iran to explore interest in regional market.

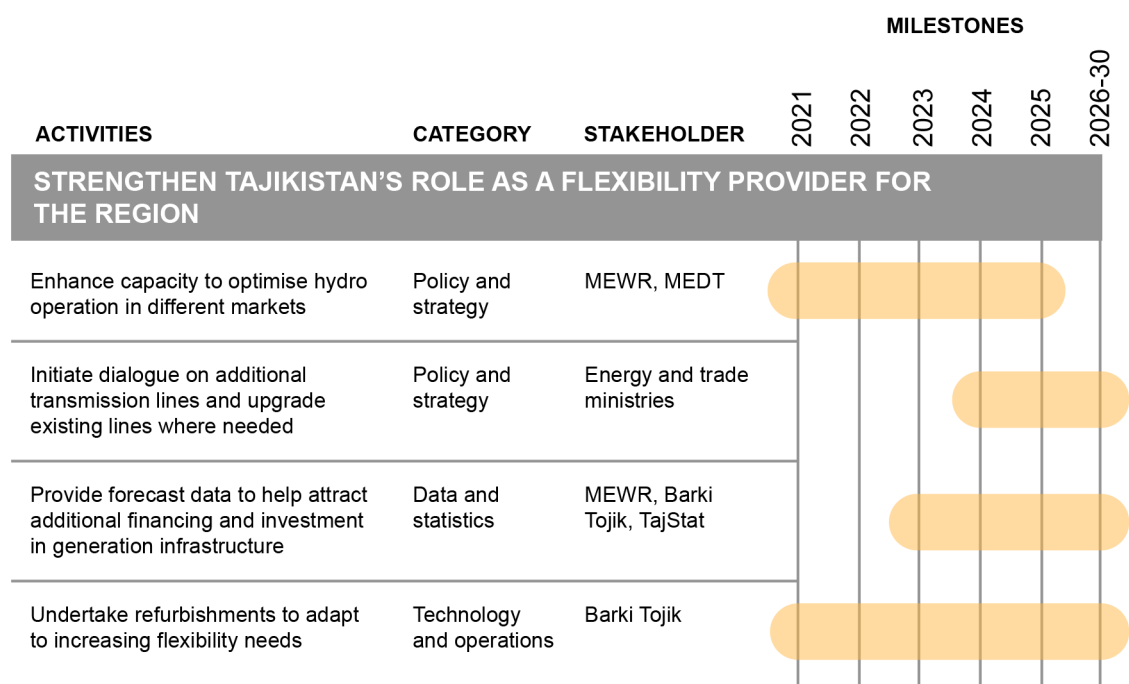
Vision for 2030

Tajikistan's aim to export 10 TWh of electricity in 2030 requires a power system capable of maximising value from its hydro resources within the existing transmission infrastructure and leveraging its advantages moving forward with expanded cross-border electricity trading. To achieve its goal, Tajikistan will need to take several important steps as suggested by this roadmap. The timeline below indicates milestones. They assume that sufficient resources are available to develop the regional market. Discussions with internal stakeholders and trading partners as well as sufficiency of resources may call for timeline adjustments.

			MILESTONES						
ACTIVITIES	CATEGORY	STAKEHOLDER	2021	2022	2023	2024	2025	2026-30	
ENSURING FAVOURABLE CONDITIONS TO ENABLE MULTILATERAL ELECTRICITY TRADE									
Progress power sector reforms	Policy and strategy	MEWR, Barki Tojik							
Increase data transparency	Policy and strategy	MEWR, Barki Tojik, MEDT							
Strengthen regulators	Policy and strategy	MEWR, MEDT							
Formalise agreements on regular data-sharing with utilities and other relevant agencies	Data and statistics	MEWR, Barki Tojik, TajStat							
Enhance capacity for optimal dispatch in a regional market	Technology and operations	Barki Tojik							
Update hardware and software where needed, e.g. metering for hourly trading.	Technology and operations	Barki Tojik							
ADOPT MULTILATERAL MARKET MODELS TO EXPAND ELECTRICITY TRADE									
CENTRAL ASIA									
Obtain political agreement	Policy and strategy	Energy and trade ministries, and utilities							
Determine an appropriate market model. Select common working languages	Policy and strategy	Energy and trade ministries, and utilities							
Harmonise grid codes	Policy and strategy	Energy and trade ministries, and utilities							
Establish cooperation of transmission system operators	Policy and strategy	CPC							
Harmonise wheeling methodologies	Policy and strategy	CPC							
Harmonise interconnection capacity calculation	Policy and strategy	CPC							
Establish frameworks for third-party access to domestic grids	Policy and strategy	Energy and trade ministries							
Share data and information	Policy and strategy	Energy ministries and utilities							
Establish dispute resolution mechanisms	Policy and strategy	CDC Energiya, CPC, national and regional regulator							



			MILESTONES					
ACTIVITIES	CATEGORY	STAKEHOLDER	2021	2022	2023	2024	2025	2026-30
ADOPT MULTILATERAL MARKET MODELS TO EXPAND ELECTRICITY TRADE								
CASA-1000								
Determine an appropriate market model. Select common working languages	Policy and strategy	Energy and trade ministries, and utilities						
Harmonise grid codes	Policy and strategy	Energy ministries, and utilities						
Establish cooperation of transmission system operators	Policy and strategy	CPC, CASA-1000 IC						
Harmonise wheeling methodologies	Policy and strategy	CPC, CASA-1000 IC						
Harmonise interconnection capacity calculation	Policy and strategy	CPC, CASA-1000 IC						
Establish frameworks for third-party access to domestic grids	Policy and strategy	Energy and trade ministries						
Share data and information	Policy and strategy	Energy ministries and utilities						
Establish dispute resolution mechanisms	Policy and strategy	Energy ministries and utilities						
Establish regional co-operation among regulators	Policy and strategy	Energy and trade ministries, national regulators						
Tackle synchronisation issues for grid interconnections	Technology and operations	TSOs						
Install additional metering where needed	Technology and operations	Market participants						
Start of more flexible multilateral market	Technology and operations	Barki Tojik and other utilities						
Increase volume of trade in competitive markets	Technology and operations	Market participants						
Assess transmission system requirements and options for expansion	Policy and strategy	Barki Tojik, MEWR						
Assess the feasibility of integrating markets in Central Asia and participants in CASA-1000 transmission system	Policy and strategy	Energy and trade ministries, utilities, regulators						



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Notes: Stakeholders in the table include: MEWR = Ministry of Energy and Water Resources; Barki Tojik = state-owned electric utility; MEDT = Ministry of Economic Development and Trade; CPC = Coordination Electrical Power Council of Central Asia; CDC Energiya = Central Dispatch Centre Energiya; TSOs = transmission system operators; CASA-1000 IC = CASA-1000 Intergovernmental Council; Taj Stat = Agency of Statistics.

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