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## Renewable energy in Central Asian economies: Role in reducing regional energy insecurity

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**ADB Working Paper Series**

**RENEWABLE ENERGY IN CENTRAL  
ASIAN ECONOMIES: ROLE IN REDUCING  
REGIONAL ENERGY INSECURITY**

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**Abstract**

Ideally, to reduce energy insecurity, a nation needs to deploy a range of renewable energy (RE) sources. For Central Asian economies, renewable sources appear to be a rational choice; yet, the deployment of renewables is limited and varies substantially by country. Conventional statistics for RE in Central Asia confirm the expected: hydrocarbon-poor countries (Kyrgyz Republic and Tajikistan) rely on RE to a greater extent than fuel-rich economies (Kazakhstan, Turkmenistan, and Uzbekistan). However, this picture changes drastically once a stricter definition of RE—without the contribution of large-scale hydro power plants (LSHPPs)—is incorporated. Such treatment is appropriate due to several considerations, including sustainability, as the LSHPPs are infamous for their adverse environmental impacts; and security, as the water-energy nexus leaves national energy policymaking susceptible to sometimes arduous regional consensus. The latter aspect is especially relevant in the Central Asian setting. Thus, with the strict definition of RE applied, fossil fuel-rich Central Asian countries lead in the RE segment, whereas hydrocarbon-poor economies have almost no RE facilities in place. This paper seeks to explore such possibilities in Central Asia. Section one reviews the evolution of the energy security concept. Section two examines the regional context for energy cooperation. Section three analyses the economic and energy profiles of Central Asian economies. Section four investigates nations' RE policies and explores the RE potential in each economy. In section five, the common regional and specific national barriers for RE development are discussed in detail. Section five also contains our recommendations about ways to ensure energy security through regional energy cooperation, and characterizes the essential components of comprehensive national policies to enable a fuller utilization of the RE potential existing in Central Asia. Finally, section six presents our conclusions.

**Keywords:** Central Asia, energy resources, international cooperation, government policy for renewable energy

**JEL Classification:** O13, P28, P33, Q28

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# 1. INTRODUCTION

The International Energy Agency (IEA) defines energy security as “the uninterrupted availability of energy sources at an affordable price” and distinguishes between long-term energy security that focuses on “timely investments to supply energy in line with economic developments and environmental needs” and short-term energy security which concerns “the ability of the energy system to react promptly to sudden changes in the supply-demand balance.”<sup>1</sup>

Originally, energy security was perceived in an immediate connection to national security as a whole, and was therefore approached through the theory underlying international relations, security studies, and geopolitics (Grigas 2017; Yergin 1992). Moreover, in the aftermath of the 1973 oil crisis, energy security was long equated to security of supply (Ang, Choong, and Ng 2015; Månsson, Johansson, and Nilsson 2014; Winzer 2012; Yergin 2006, 2011). Treating energy security in that way, major importers made security one of the principal goals of their national energy policies, addressing the matter through an array of means at the international (under the aegis of the specially established IEA) and national levels (via strategic stockpiling; sundry backing for national companies’ overseas projects, enabling domestically-oriented exports; enhancement of investment in domestic energy systems and supply chains; and so forth). These contributed to the inception and evolution of the 4As concept of energy security, comprising availability, accessibility, affordability, and acceptability of energy (Ang, Choong, and Ng 2015; Cherp and Jewell 2011; Kisel et al. 2016).

By the turn of the twenty-first century, the notion of security of energy demand had somewhat consolidated (Dickel 2009; Johansson 2013a; Yenikeyeff 2006). National, regional, and global energy markets began to undergo a dramatic transformation, a result of continuous investment in energy saving and energy efficiency, enhancement of technical and technological progress in production (revolutionary advancements of non-conventional energy and renewable technologies), transmission, distribution and storage of energy, spatial and structural optimization of energy infrastructure, incorporation of information and communications technologies (ICT) in the distributed energy systems, harmonization of regulatory frameworks, and many other shifts. Accustomed to trading in a sellers’ market, major energy producers and exporters initially did not recognize the complexity of the ongoing modifications and remained averse to structural and geographic diversification of their exports, investment in energy value chains, and ignored institutional transformations in the consumer markets. Expectedly, the exporting nations started more frequently to encounter the consequences of institutional inconsistencies. To illustrate, research into energy relations between the Russian Federation and the European Union (EU) confirms that the conflicts between the two originate in their institutional incompatibility: while the EU seeks to solve its energy supply insecurity through the liberalization and harmonization of energy markets, the Russian Federation pursues long-term energy demand security, operating upon the principles of state capitalism and resource nationalism (Buchan and Keay 2015; Dickel 2009; Kuzemko et al. 2012; Kuzemko 2014; Stern and Yafimava 2017; Yafimava 2013; Yenikeyeff 2006). Addressing these sorts of inquiry, a strand of studies inspired by institutional theory treats energy security as a public good, thus placing it within the realm of public policy at national, supranational, international, and global levels (Energy Charter Secretariat 2015; Goldthau 2017; Goldthau and Witte 2010).

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<sup>1</sup> For the definition, see <https://www.iea.org/topics/energysecurity/> (accessed 10 February 2018).

Contemporary energy security research additionally embraces the concept of sustainability (Saavedra, Fontes, and Freires 2018; Stockholm Environment Institute 2011), which advocates the need for an interdisciplinary approach and nexus-thinking for the interlinkages existing among energy, water, food, and climate change (Al-Saidi and Elagib 2017; Biggs et al. 2015; Endoa et al. 2017; Goldthau 2017; Goldthau, Keating, and Kuzemko 2018; Kuzemko 2013; Raszewski 2018). As is demonstrated further, Central Asia is one of the most convincing cases justifying the nexus approach.

The diffusion of renewable energy (RE) technology brought about the conceptualization of RE security. Initially, greater reliance on RE was analogous to ensuring energy security. While security of RE (SRE) shares the features of a general case of conventional energy,<sup>2</sup> it involves a number of distinct aspects. That is, SRE implies a dependence on variable flows rather than exhaustible stock; necessitates solutions for the scattered character of RE sources' location, the interrelated nature of renewable resources (hydro resources – food, biomass – food, solar power – land) (Taghizadeh-Hesary, Rasoulnezhad, and Yoshino 2019), irregularity in their availability (for example, solar and tidal energy), or dependence on other materials (e.g., rare-earth metals needed for the manufacturing of solar panels); and, most seriously, encompasses considerations of technically and technologically diverse modes for RE electricity generation (Johansson 2013b), among other things. Moreover, SRE relies critically on ICT in every segment of the value chain, from generation, transmission, distribution, and process technologies to energy market services; therefore, cybersecurity arises as a critical category. Furthermore, RE is often perceived as a domestic source, which automatically helps reduce import dependence and enhance self-sufficiency, though the contemporary regional energy markets are increasingly integrated logistically and commercially (through the mechanisms of international trading). This has long been the case for the European power markets, and to some extent for the trade in hydro power electricity in Central Asia. In other words, RE does not necessarily imply lower dependency on external supplies (Francés, G. E., J. M. Marín-Quemada, and E. S. M. González, 2011).

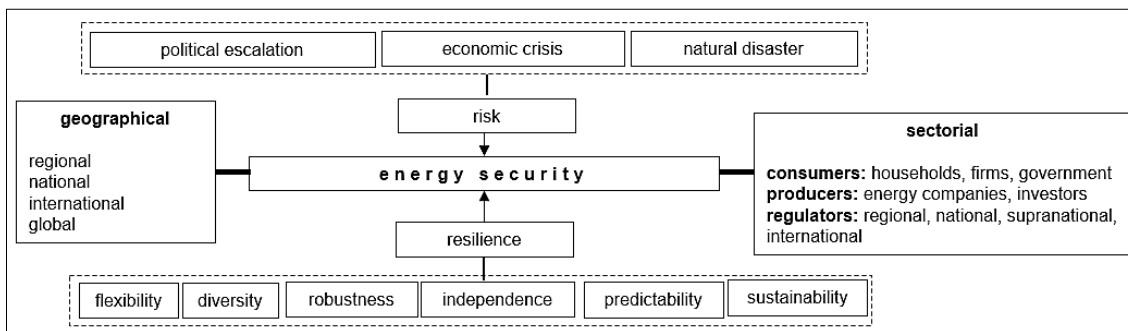
Finally, the advancements in energy security studies include inquiries into improved metrics of energy security with the incorporation of parameters of technical resilience, operational resilience, technical vulnerability, energy efficiency, cost efficiency, societal effects, economic dependency (including the case of export), environmental impacts, political affectability, and others (Ang, Choong, and Ng 2015; Bhattacharya et al. 2016; Kisel et al. 2016; Radovanović, Filipović, and Pavlović 2017).

This study proceeds upon adopting the definition of energy security as “low vulnerability of vital energy systems and sustained provision of modern energy services” (Cherp and Jewell 2014: 415). The vulnerability of an energy system is determined by the interaction between the parameters of risk and resilience (Figure 1).

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<sup>2</sup> This is, to an extent, a figurative assumption, as security of natural gas, oil, and coal would have many specific aspects in each respective case. However, in a comparative case such as fossil energy vs. renewable energy, such generalization is permissible as fossil energy and renewable energy will have common features within their respective categories.

**Figure 1: Energy Security: Conceptual Framework**



Source: Author, based on Al-Saidi and Elagib (2017); Biggs et al. (2015); Cherp and Jewell (2014); Endoa et al. (2017).

Energy insecurity in Central Asia has a multi-faceted nature influenced by national, regional, and international factors. Strictly speaking, all the Central Asian nations have plentiful domestically available energy resources. Some—Turkmenistan, Kazakhstan, and, to a lesser extent, Uzbekistan—are rich in hydrocarbon resources; others—the Kyrgyz Republic and Tajikistan—have hydro resources capable of generating a significant amount of electric power, sufficient even for export (Jalilov, Amer, and Ward 2018). Yet the Kyrgyz Republic and Tajikistan are experiencing severe shortages of electricity in winter. To a great extent, this is due to a lack of intraregional cooperation (Sokolov 2017). After Turkmenistan exited the Soviet-era built Central Asia United Power System (CAPS) in 2003, and Uzbekistan followed suit in 2009, the Soviet-style practice of exchanging the upstream nations’ hydro power in summer for electricity or fuels supplied by the downstream nations in winter was abandoned (Tomberg 2012). In the subsequent years, intraregional cooperation continued to shrink further owing to Uzbekistan’s indifference about cooperation with the neighbors, and Turkmenistan’s self-chosen isolationism. The Kyrgyz Republic, and especially Tajikistan, were left alone to face the disastrous seasonal shortages of electricity, and it was mainly funding by international financial institutions that helped the two nations build some critically needed electricity-generating capacities and somehow overcome the acute energy deficits. Since 2017, however, Uzbekistan has become interested in improving regional cooperation and has engaged in initiating multi-format dialogues (Morozov 2018) and settling the border disputes with Tajikistan and, especially, the Kyrgyz Republic (Larin 2017). Such dynamics create a vital environment for the enhancement of regional energy cooperation in Central Asia.

The rest of the paper is devoted to examining the potential role of RE in solving energy insecurity in Central Asia. In doing so, the paper first analyses the principal components of energy insecurity originating in the interlinkages among the Central Asian nations along the water-energy nexus and within the regional electrical grid. Analysis of the national energy profiles of Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan focuses on the role of RE in the respective countries. The study identifies specific national and common regional barriers for RE development in Central Asia. The paper argues that, faced with energy insecurity, Central Asian economies need to enhance regional and international cooperation in harnessing the tremendous existing potential for RE development. However, this should be parallel with the implementation of effective national RE policies by respective Central Asian governments.



## 2. PUTTING ENERGY INSECURITY INTO REGIONAL CONTEXT

### 2.1 International Dimensions

Energy security in Central Asia is inseparable from its geopolitical context (Shadrina 2010). The geostrategic significance of Eurasia, to which Central Asia belongs, was emphasized by Mackinder and Spykman.<sup>3</sup> After the demise of the Soviet Union, studies on Eurasia's geopolitical and geoeconomic role saw a resurgence, influenced by Brzezinski (1997, p. 124), who characterized the Eurasian Balkans—wherein he included Central Asia—as “infinitely ... important as a potential economic prize: an enormous concentration of natural gas and oil reserves is located in the region, in addition to important minerals, including gold.” Such a perception of Central Asia reflects the logic prevalent in the early post-Soviet period scholarly debate, named the New Great Game<sup>4</sup> (Edwards 2003; Pomfret 1995). Over time, however, this approach, denying the independent roles of the Central Asian nations and portraying them as satellite states governed by non-regional powers, has become increasingly inaccurate.

Despite the Russian Federation having certain security and economic influence over Central Asia, it initially prioritized a Greater Europe concept. After 2014, the Russian Federation found itself at a juncture that dictated formulation of a novel idea suiting the pronouncedly changed geoeconomic context. Accordingly, a Greater Eurasia<sup>5</sup> paradigm was developed to enhance interconnections with the emerging economies in Asia and Central Asia in particular (Maçães 2018; Shadrina 2018). Throughout the post-Soviet period, the People's Republic of China has been methodically mastering trade and investment channels to substitute the Russian Federation in Central Asia. Seeking natural resources just as much as additional external drivers for its sustained economic growth, the PRC has been perhaps the most energetic and creative actor, seriously contesting traditional external players' positions in Central Asia.<sup>6</sup> Having confirmed their interest in the PRC's Belt and Road Initiative (BRI), the Central Asian nations have nonetheless grown increasingly cautious of an upsurge in the inflow of Chinese workers to Central Asia (Laruelle 2018), as well as uncontrolled financial dependency on the PRC.<sup>7</sup> Following the 9/11 terror attacks, a non-regional power, the United States, attempted to augment its military presence in Central Asia. However, as some regional economies (Kazakhstan and Turkmenistan) grew stronger, they chose an independent stance, while others (the Kyrgyz Republic) eventually opted to resume closer economic

<sup>3</sup> This paragraph is written based on Shadrina (2010: 6–7). The spatial-functional structure of the world with a significant role designated to Central Asia was initially presented by British geographer and geopolitician Halford J. Mackinder in his 1904 speech “The Geographical Pivot of History” at the Royal Geographical Society. Later, an American political scientist Nicholas Spykman also emphasized the importance of Eurasia. Early post-Soviet studies of Eurasia were largely influenced by an American geostrategist and former National Security Advisor Zbigniew Brzezinski, author of *The Grand Chessboard* (1997).

<sup>4</sup> For a brief description of the Great Game, see, for instance, Pomfret (1995: 21–25).

<sup>5</sup> Clauses 51, 78–80, 82–84, and 87–90 of “Ob utverjdenii Kontseptsii vneshnei politiki Rossiiskoi Federatsii”, Ukaz Prezidenta Rossiskoi Federatsii, № 640, 30 November 2016. <http://static.kremlin.ru/media/acts/files/0001201612010045.pdf> (accessed 17 April 2018); Luzyanin, S. 2018. Bol'shaya Evraziya: Obchie zadachi dlya Kitaya i Rossii. *Mejdnarodnyy Diskussionnyy Klub Valdai*. 16 April 2018. <http://ru.valdaiclub.com/a/highlights/bolshaya-evraziya-zadachi/> (accessed 17 April 2018).

<sup>6</sup> See Soyuz, da ne tot: Kitai "perekupaet" kandidatov v EAES. *CA-portal*. 6 February 2018. <http://www.ca-portal.ru/article:40669> (accessed 6 February 2018).

<sup>7</sup> Kitaiskii posol v rezkoj forme napomnil Kyrgyzstanu o neobhodimosti platit' po dolgam. *StanRadar* 21 March 2018. <http://stanradar.com/news/full/28903-kitajskij-posol-v-rezkoj-forme-napomnil-kyrgyzstanu-o-neobhodimosti-platit-po-dolgam.html> (accessed 22 March 2018).

connections with the Russian Federation.<sup>8</sup> Most recently, the United States modified its policy toward Central Asia, trying to enhance economic and other ties with the region via a newly invented C5+1 format.<sup>9</sup> The EU has a rather noticeable profile as an economic partner to the Central Asian nations. However, Turkey, with its multi-dimensional agenda underpinned by its pan-Turkic aspirations, and Iran, attempting to diversify its economic links away from the nations practicing or threatening to resume sanctions, are progressively contributing to the palette of powers and interests intertwined in Central Asia (Laruelle and Peyrouse 2013). In one way or another, energy—be that resources, commodities, technologies, or infrastructure—constitutes an important agenda for all the regional and non-regional players in Central Asia.

## 2.2 Regional Setting

There has been a significant conflict of interests between the water-rich Kyrgyz Republic and Tajikistan and fossil fuels-endowed Turkmenistan, Uzbekistan, and Kazakhstan.<sup>10</sup> The Kyrgyz Republic and Tajikistan's respective Naryn and Amu Darya rivers boast gigantic hydro power potential for generating electricity.

Dependency on transboundary water ranges from critical to high (Turkmenistan 94%, Uzbekistan 77%, Kazakhstan 42%), and this has been a key factor impeding hydro power development in the upstream countries, especially as the upstream countries started to seek to monetization of their hydro power potential through the exports.

By the end of the Soviet era, the Central Asia United Power System (CAPS) connected more than 80 power plants with a total generating capacity of 25,000 MW.<sup>11</sup> More than half of the total CAPS electricity was generated in Uzbekistan; Tajikistan and the Kyrgyz Republic added about 15% each; the rest was split almost equally between Turkmenistan and Kazakhstan. The CAPS was part of the energy-water sharing mechanism, which helped supply electricity across the region and prevent seasonal power interruptions. In the post-Soviet period, energy-rich Central Asian economies adopted more self-oriented positions, disregarding the benefits of regional cooperation. Water-energy tensions were exacerbated by the border disputes between Uzbekistan and the Kyrgyz Republic and Uzbekistan and Tajikistan. Eventually, Turkmenistan withdrew from the CAPS in 2003; the electricity-for-fuels seasonal schemes between Tajikistan and Uzbekistan stopped in 2009; and Tajikistan departed from the CAPS in 2009. By 2008, the intra-regional trade in electricity had shrunk to 4 GWh (from 25 GWh in 1990), allowing Turkmenistan to expand electricity export to Iran, whereas

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<sup>8</sup> The Manas Air Base installed near Bishkek in 2001 was closed in 2014. In 2015, the Kyrgyz Republic acceded to the Eurasian Economic Union (EAEU).

<sup>9</sup> Uzbekistan and Turkmenistan are parties of the Non-Alignment Movement, which explains their attitude toward any kind of military alliance, including those supported by EAEU member-states. Yet, in 2015 a C5+1 was created at a first meeting of foreign ministers in Samarkand as a format for dialogue and a platform for joint efforts to address common challenges faced by the US and Central Asian states. It focuses on three sectors: security (terrorist threats), economy (enhancement of intra-regional trade, and trade and investment links with the US), and environmental challenges. At the second meeting in Washington in August 2016, five projects—counter-terrorism, Central Asia business competitiveness, transport corridor development, power in the future to advance low-carbon energy solutions, and national and regional adaptation planning to identify environment risks and prioritize actions—were concretized and allotted \$15 mn funding through the USAID.

<sup>10</sup> *Gidroenergeticheskie problemy v Tsentral'noi Azii: vzglyad iz Kazakhstana*. 12 April 2016. <http://stanradar.com/news/full/20425-gidroenergeticheskie-problemy-v-tsentralnoj-azii-vzglyad-iz-kazahstana.html> (accessed 2 March 2018).

<sup>11</sup> *Elektroenergetika Kyrgyzskoi Respubliki*. <http://energo-cis.ru/wyswyg/file/Kyrgyziya.pdf> (accessed 3 February 2018).

Uzbekistan and Tajikistan started transmitting power to Afghanistan.<sup>12</sup> Presently, the CAPS links southern Kazakhstan, Uzbekistan, and the Kyrgyz Republic.

Because of its geographical position, Uzbekistan holds the key to energy cooperation in Central Asia: a more open and region-oriented policy in Uzbekistan since 2017 has improved the prospects of such cooperation.<sup>13</sup> Uzbekistan has endorsed the transit of Turkmen electricity to the Kyrgyz Republic and southern Kazakhstan, with a possibility also open for winter deliveries to Tajikistan. Reopening of the CAPS, recovery of the capacity market, and connection to the grid in eastern Afghanistan promise to promote regional cooperation.<sup>14</sup>

### 3. CENTRAL ASIAN ECONOMIES

Energy profiles of Central Asian economies are dissimilar (Asian Development Bank 2014). Kazakhstan and Turkmenistan are significant producers and exporters of hydrocarbon resources; Uzbekistan is self-sufficient in oil and natural gas; and the Kyrgyz Republic and Tajikistan have only one indigenous resource suitable for electricity generation—water (Table 1). Distribution of energy resources in Central Asia suggests a case for solid regional cooperation, but this has been problematic.

**Table 1: Reserves of Energy Resources in Central Asian Countries**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Coal (bt)	31.3	0.9	3.6	–	3.3
Natural gas (tcm)	2.4	0.006	0.006	7.5	1.8
Oil (bb)	30	0.04	0.01	0.6	0.594
Hydro (MW)	20,000	26,000	40,000	–	1,700

Note: bt = billion tons, tcm = trillion cubic meters, bb = billion barrels, MW = megawatts.

Source: Author, based on The World Factbook. Central Intelligence Agency. Retrieved from <https://www.cia.gov/library/publications/the-world-factbook/>.

Kazakhstan possesses large oil reserves. Consequently, the energy sector largely determines Kazakhstani foreign trade and investment. The EU has become one of Kazakhstan's key partners,<sup>15</sup> but the country pursues diversification of export routes. Also, Kazakhstan is interested in augmenting its RE segment. Overall, the incorporation of national energy potential into various international initiatives—the Central Asia Regional Economic Cooperation (CAREC) program, the Eurasian Economic Union (EAEU), and the PRC-led BRI—has been increasingly important to Kazakhstan. Turkmenistan has splendid natural gas reserves. Following the commencement of the gas pipeline in 2009, the Chinese market has become the key

<sup>12</sup> For more detail, see [https://energycharter.org/fileadmin/DocumentsMedia/Events/12RECA\\_Almaty\\_2016\\_S2\\_VTsyssin.pdf](https://energycharter.org/fileadmin/DocumentsMedia/Events/12RECA_Almaty_2016_S2_VTsyssin.pdf) (accessed 26 March 2018).

<sup>13</sup> The President of Uzbekistan, Shavkat Mirziyoyev, concluded the year with a historic first address to the Parliament. <http://voicesoncentralasia.org/a-year-of-economic-reforms-with-president-mirziyoyev/> (accessed 27 March 2018).

<sup>14</sup> For more detail, see <https://energycharter.org/what-we-do/events/12th-meeting-on-regional-energy-cooperation-in-central-and-south-asia/> and [https://energycharter.org/fileadmin/DocumentsMedia/Events/12RECA\\_Almaty\\_2016\\_S2\\_KShamsiev.pdf](https://energycharter.org/fileadmin/DocumentsMedia/Events/12RECA_Almaty_2016_S2_KShamsiev.pdf) (accessed 26 March 2018).

<sup>15</sup> For a review of EU–Central Asia relations, see <http://voicesoncentralasia.org/three-reasons-why-the-eu-matters-to-central-asia/> (accessed 2 February 2018).

destination for Turkmen export (Chichkin 2017). A party to CAREC and a recipient of significant Chinese investment in the gas sector, Turkmenistan is barely engaged in intraregional cooperation. Like Kazakhstan, Turkmenistan is actively pursuing new options for export diversification. While Kazakhstan considers the possibilities for greater oil and gas exports to the PRC, Turkmenistan is eager to reach the European gas markets via the Trans-Caspian, TANAP, TAP, and White Stream gas pipelines.<sup>16</sup> Possessing no fossil fuels of significance, the Kyrgyz Republic and Tajikistan rely heavily on import thereof and depend profoundly on hydro power for electricity generation. Yet, the two, as explained, are vulnerable to border and water disputes with the neighbors, most seriously with Uzbekistan. Uzbekistan has sufficient energy resources and, owing to its geographical location, plays a key role in regional cooperation.

Speaking of economic development (Table 2), Kazakhstan and Turkmenistan appear to lead in the region. With the demography factored in and the parameters of growth considered more closely (Table 3), the Uzbekistani economy seems to be comparatively more robust.

**Table 2: Central Asian Economies' Profiles**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Population 2017 (millions)	18.04	6.2	8.92	5.76	32.39
Population growth 1992–2017 (annual average, %)	0.35	1.26	1.93	1.61	1.68
GDP growth 1992–2017 (annual average, %)	3.45	1.87	2.08	4.99	4.73
GDP per capita growth 1992–2017 (annual average %)	3.05	0.57	0.12	3.34	3.00
GDP per capita, PPP (constant 2011 international \$) 2017	24,079	3,393	2,910	16,389	6,253

PPP = purchasing power parity.

Notes: The latest available data for Turkmenistan is from 2014.

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

With all the Central Asian economies performing poorly at the outset of the post-Soviet period, the Kyrgyz Republic, additionally affected by two revolutions, and Tajikistan, most profoundly hit by the civil war and insurgencies, experienced the most dramatic economic declines (Table 3). Tajikistan is likely to remain the weakest economy in the region with the highest (and projected to remain so) population growth. Increasingly, the economic achievements of an acclaimed early democracy of Central Asia—the Kyrgyz Republic—are disappointing.

<sup>16</sup> Gas genatsvales: Georgia Promotes Turkmen Gas in Europe. *EurAsia Daily*. 31 January 2018. <https://eadaily.com/en/news/2018/01/31/gas-genatsvales-georgia-promotes-turkmen-gas-in-europe> (accessed 26 March 2018).

**Table 3: Summary of Central Asian Economies' Growth Statistics 1992–2017**

	GDP Growth, %				GDP P.C. Growth, %				GDP P.C., PPP Constant 2011 Int. \$			
	Mean	SD	Max	Min	Mean	SD	Max	Min	Mean	SD	Max	Min
Kazakhstan	3.45	6.64	13.5	-12.60	3.05	6.16	13.69	-11.32	15,640.3	5843	24,078.2	8,282.9
Kyrgyz Republic	1.87	7.71	10.92	-20.1	0.57	7.34	8.74	-20.06	2,500.7	511.8	3,393.5	1,696.4
Tajikistan	2.05	11.04	10.93	-29.0	0.11	10.72	8.77	-30.3	1,830.7	570.9	2,910.2	1,047.1
Turkmenistan	5.00	8.80	16.50	-17.3	3.34	8.93	15.12	-19.4	8,312.6	3,907.6	16,389.0	4,202.5
Uzbekistan	4.73	4.91	9.92	-11.2	3.00	4.96	8.37	-13.26	3,534.2	1,300.6	6,253.1	2,237.0

Note: SD = standard deviation; Max = maximum; Min = minimum.

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

All hydrocarbon-rich economies rely on their domestic resources and, unlike water-rich nations, are energy self-sufficient (Table 4). Uzbekistan, closely followed by Turkmenistan, is the most energy intensive economy. Tajikistan, followed by the Kyrgyz Republic, appears to have the highest efficiency of energy use—i.e., it generates greater GDP value per unit of energy use.

**Table 4: Energy: Economy Metrics**

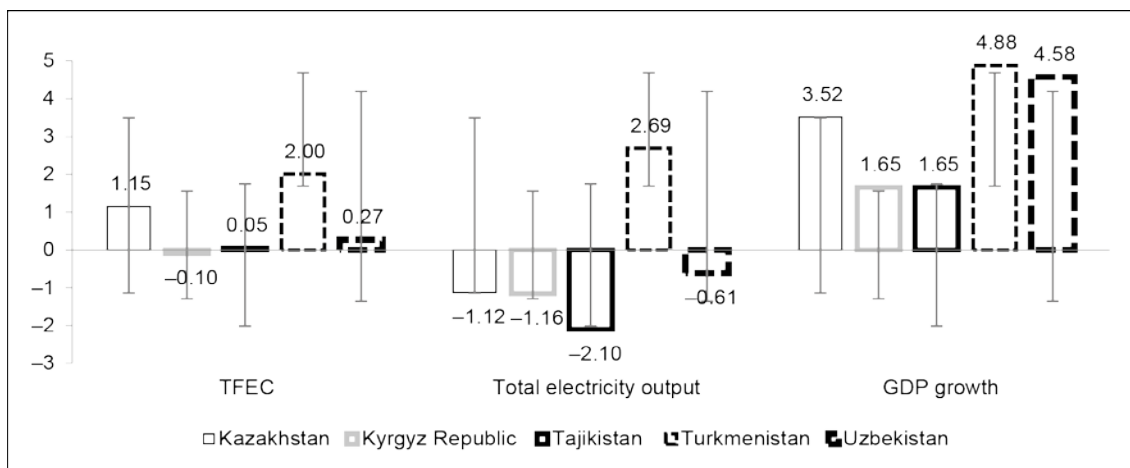
	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Fossil fuel energy consumption, avg. 1992–2014, % of total	98.21	70.02	41.36	N/A	98.52
Energy use, kg of oil equiv. per capita, avg. 1992–2014	3,585.68	590.79	369.26	3,753.86	1,881.34
Energy use, kg of oil equiv. per \$1,000 GDP (constant 2011 PPP), avg. 1992–2014	264.65	251.74	233.18	548.34	660.57
Energy intensity level of primary energy, MJ/\$2011 PPP GDP, avg. 1992–2015	10.54	10.49	9.57	22.58	26.56
GDP per unit of energy use, constant 2011 PPP \$ per kg of oil equiv., avg. 1992–2014	4.04	4.18	4.89	1.91	1.73
GDP per unit of energy use, PPP \$ per kg of oil equiv., avg. 1992–2014	3.56	3.67	4.40	1.67	1.54
Adjusted savings: energy depletion, avg. 1993–2016, % of GNI	8.96	0.15	0.04	22.76	10.64
Energy imports, net, avg. 1992–2014, % of energy use	-93.56	52.13	37.75	-189.05	-13.49

GNI = gross national income.

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

In terms of average growth rate throughout the transition period, the economy of Turkmenistan has been growing most rapidly, but this expansion has been accompanied by an even higher surge in electricity intensity (Figure 2). Assessing the trends in GDP dynamics, total electricity output (TEO), and total final energy consumption (TFEC), Uzbekistan appears to secure its GDP growth at the expense of a modest increase in TFEC and a decline in TEO.

**Figure 2: Central Asian Economies' Growth: Energy, Average Growth 1992–2015 (%)**

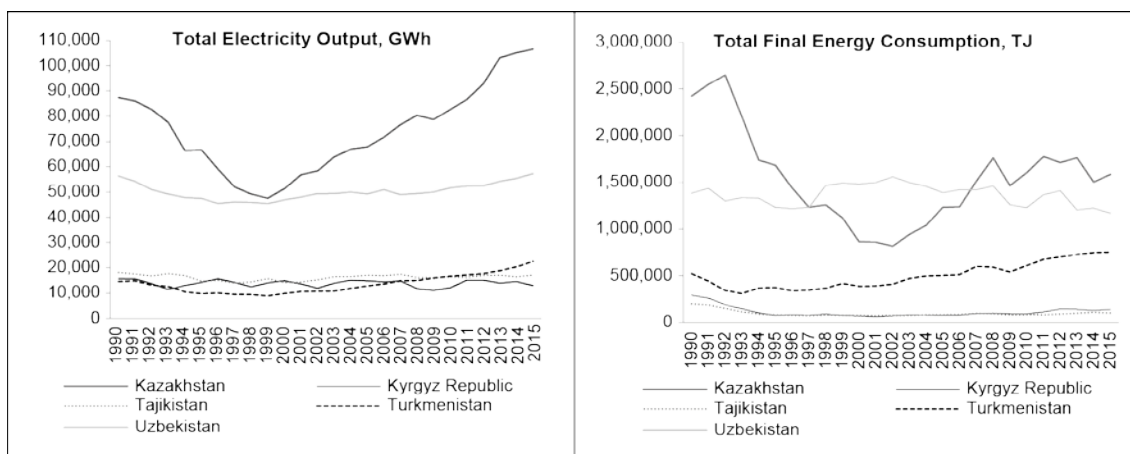


Note: Vertical lines display standard deviation of a parameter.

Source: Computed based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Since the early 1990s, the Central Asian economies have exhibited dissimilar shifts in patterns of TEO and TFEC (Figure 3). Kazakhstan experienced the deepest decline in electricity generation, which recovered to the 1990 level only in 2010. In 2015, Kazakhstan’s generation was around 20% above the 1990 level. The Kyrgyz Republic and Tajikistan’s electricity outputs have fluctuated, and in 2015 were still slightly under the 1990 levels. Turkmenistan exceeded its 1990 level in 2007, and by 2015 had increased electricity output by 40% compared with its 1990 level. Uzbekistan’s lowest electricity output was in 1999 (a decline of nearly 20% from 1990); in 2015, it recovered to the 1990 level. Based on World Bank data, Kazakhstan’s TFEC in 2015 was around 65% of its 1990 level. In 2015, the Kyrgyz Republic and Tajikistan saw their TFECs at half the 1990 levels; Turkmenistan had increased its TFEC by about 44% compared to its 1990 level. Unlike other Central Asian economies, Uzbekistan did not see significant fluctuations in TFEC during the 1990–2015 period.

**Figure 3: Central Asian Economies' Total Electricity Output and Total Final Energy Consumption, 1990–2015**



Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Different in terms of their energy resources endowment and economic performance, the Central Asian economies share similar features in the realm of energy security (Table 5). As Table 5 shows, some Central Asian economies (Uzbekistan and Turkmenistan) display low diversity of energy sources combined with a high reliance on a principal source (gas for Uzbekistan and Turkmenistan, hydro for Tajikistan, oil for the Kyrgyz Republic, and coal for Kazakhstan). This is combined with the aforementioned significant degree of interdependency for water-energy affairs, as well as largely dysfunctional institutions for regional cooperation (Shustov 2019).

**Table 5: Total Primary Energy Supply (TPES) by Source, 2016**  
(%)

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Coal	<b>43.25</b>	23.53	20.15	0	4.11
Oil	20.21	<b>44.54</b>	32.05	23.35	6.34
Gas	35.14	6.21	0.10	<b>76.61</b>	<b>86.85</b>
Hydro	1.22	25.70	<b>47.70</b>	0	2.70
Biofuels and waste	0.13	0.03	0	0.04	0.01
Geothermal, solar, etc.	0.04	0	0	0	0

Source: Author, based on data from World Energy Balances 2018. (2018). International Energy Agency.

The following section examines the extent of RE deployment in Central Asian.

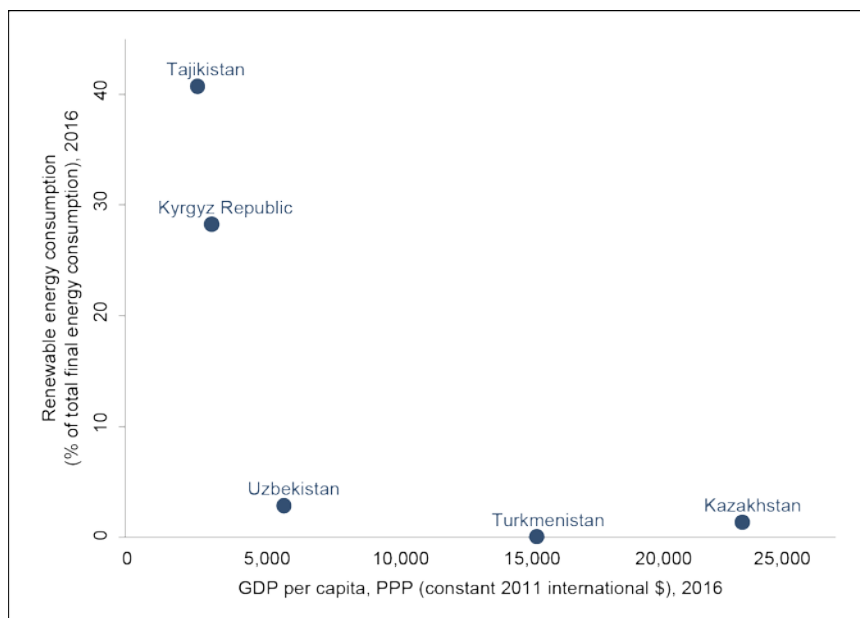
## 4. RENEWABLE ENERGY IN CENTRAL ASIA

### 4.1 Role in Electricity Generation

Non-fossil fuels play an insignificant role in three Central Asian economies (Figure 4, Table 6), but occupy a somewhat noticeable position in energy consumption in Tajikistan and the Kyrgyz Republic, which is rather typical for low-income economies.<sup>17</sup>

Kazakhstan, Turkmenistan, and Uzbekistan generate a major environmental footprint in Central Asia, which is expected, given the size of their economy. Exceptionally high energy-related methane emissions in Turkmenistan can be explained by the structure of the national economy, which is less diversified and dominated by the energy sector.

<sup>17</sup> A developing nation has a higher share of renewable resources in energy balance, which normally declines with income growth until it reaches a turning point after which the share of renewables begins to rise again. The phenomenon is explained by the fact that initially dominant comparatively inexpensive hydro power becomes less adequate to satisfy the electricity needs of a rapidly growing economy. Various forms of renewable energy—solar, wind, and others—require a certain level of technical and technological expertise, financial means, and institutional capabilities, which are more likely to be readily available or easier to augment in an advanced economy.

**Figure 4: Renewable Energy Consumption vs Income in Central Asia**

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

**Table 6: Non-Fossil Fuels and Environmental Footprint in Central Asia**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
<b>Non-Fossil Fuels</b>					
Alternative energy, avg. 1992–2014, % of total energy use	0.94	20.53	49.13	0.00	1.19
Renewable energy consumption, avg. 1992–2015, % of TFEC	1.71	26.74	57.10	0.06	1.84
Combustible renewables and waste, avg. 1992–2014, % of total energy	0.10	0.13	0.00	0.04	0.01
<b>Energy – Environment</b>					
Energy-related methane emissions, avg. 1992–2008, % of total	57.04	7.45	13.36	75.53	59.70
Nitrous oxide emissions in energy sector, avg. 1992–2008, 1,000 metric tons of CO <sub>2</sub> equiv.	1,029.43	22.58	15.62	63.31	413.38
Methane emissions in energy sector, avg. 1992–2008, 1,000 metric tons of CO <sub>2</sub> equiv.	28,493	285	489	17,281	22,905
CO <sub>2</sub> intensity, avg. 1992–2014, kg per kg of oil equiv. energy use	3.34	2.20	1.19	2.57	2.43

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Table 7 and Figure 5 display significant metrics in respect of harnessing the RE potential in the Kyrgyz Republic and Tajikistan; however, which is entirely due to the LSHPs' contribution to electricity generation, as emphasized earlier.



**Table 7: RE in Central Asian Economies, 2015\***

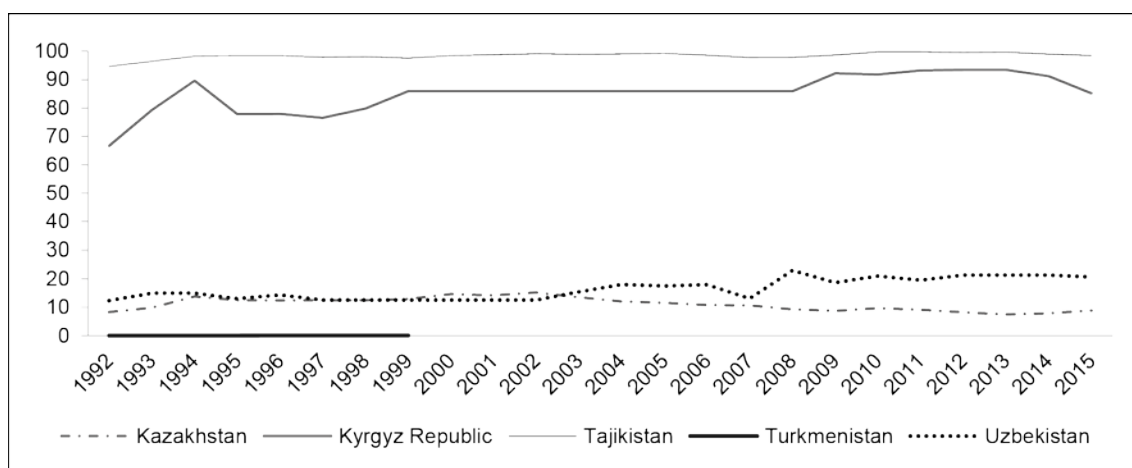
	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Total final energy consumption, TFEC	1,586,535	139,850	98,814	753,233	1,169,202
Renewable energy consumption, TJ	24,725	32,595	44,130	308	34,727
Renewable energy share of TFEC, %	1.56	23.31	44.66	0.04	2.97
Total electricity output, GWh	106,468	13,030	17,162	22,534	57,280
Renewable electricity output, GWh	9,448	11,100.00	16,900	0	11,830
Renewable electricity share of total electricity output, %	8.87	85.19	98.47	0	20.65

Note: \* The latest available data are for 2015.

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Speaking of trends in RE<sup>18</sup> employment, the share of renewable sources in electricity output in Kazakhstan peaked at 15% in 2002 and then steadily declined to remain at around 8%. In contrast, Uzbekistan increased its employment of renewables by 10% from the 1990 level. In the Kyrgyz Republic and Tajikistan, reliance on renewable sources for electricity generation increased by 28% and 10%, respectively. What kind of RE sources have been added?

**Figure 5: Renewable Electricity Output, % of Total Electricity Output**



Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

<sup>18</sup> The study perceives renewable energy in its traditional definition, which includes large scale hydro power. LSHPPs have a generation capacity of over 100 MW, medium-scale HPPs have a capacity of 10–100 MW, and small-scale HPPs can produce less than 10 MW. Strictly speaking, the renewable nature of LSHPPs is increasingly questioned for their significant negative ecological and social impacts.

Until 2013, new RE installations in Central Asian economies were almost exclusively in the LSHP segment. The newly-added hydro power capacities are incomparably more significant than those for solar, wind, and biogas (Table 8).

**Table 8: RE for Electricity Generation in Central Asian Economies, Installed Capacity (%) 2017**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Hydro power	94.1	100	100	N/A	99.8
Onshore wind	3.9	–	–	N/A	–
Solar photovoltaic	2	–	–	N/A	0.2
Biogas	–	–	–	N/A	–

Source: Compiled based on International Renewable Energy Agency (IRENA) data. Retrieved from <http://resourceirena.irena.org/gateway/dashboard/?topic=4&subTopic=19>.

In the following, we analyze in more detail the deployment of RE in respective economies, examine the main provisions of the national RE policies, and assess Central Asian countries' RE potential.

## 4.2 RE Development in Central Asia

### 4.2.1 Kazakhstan

Among the Central Asian economies, Kazakhstan appears to be the most capable of RE deployment in terms of both diversity of sources and scale of generation (Table 9). In 2018, Kazakhstan had 60 RE projects operating and projected another 50 projects of total capacity 2,353 MW to be implemented by 2020 (Konyrova 2019). Nonetheless, LSHPs contributed to nearly 92% of electricity generation in the non-fossil fuels segment. The main hydro power resources of Kazakhstan are located in the eastern and south-eastern regions, where the majority of Kazakhstan's 24 hydro power plants are.<sup>19</sup>

In respect of the 'new' RE segment, Kazakhstan has between 2,200 and 3,000 hours of sunlight per year, which yields 1,200–1,700 kW/m<sup>2</sup> annually.<sup>20</sup> Such a characteristic makes concentrated solar thermal and solar photovoltaic power generation technically and economically feasible. Kazakhstan has recently been actively adding solar power capacities. In 2019, in cooperation with the European Bank for Reconstruction and Development (EBRD) and European companies, Kazakhstan commissioned the largest solar power station in Central Asia, of 100 MW capacity. Major physical obstacles to extensive solar energy deployment in Kazakhstan are frequent and powerful blizzards and storms. Also, Kazakhstan possesses an extraordinary wind power potential (Karatayev and Clarke 2016; Karataev et al. 2016). Geographically, the Dzungarian

<sup>19</sup> The Irtysh river hosts the largest HPPs: Bukhtarma (675 MW), Ust-Kamenogorsk (332 MW), and Shulbinsk (702 MW). Other large-scale HPPs are Kapchagay HPP (364 MW) on the Ili river, Moinak HPP (300 MW) on the Charyn river, and Shardara (100 MW) on the Syrdarya river. By 2020, Kazakhstan plans to commission Kerbulak (50 MW), Bulak (68 MW), and a number of smaller HPPs with a total installed capacity of 56 MW. See Kazakhstan Electricity Grid Operating Company KEGOC. <http://www.kegoc.kz/en/company/national-power-system> (accessed 2 May 2018).

<sup>20</sup> Here, and for other renewable sources in Kazakhstan, data as of 2016 are from V Kazakhstanne rastoyot dolya vozobnovlyayemyh istochnikov energii v sector energetiki, 3 April 2017. <http://mk-kz.kz/articles/2017/04/03/v-kazakhstanne-rastet-dolya-vozobnovlyayemykh-istochnikov-energii.html> (accessed 20 March 2018).

Gates, Mangystau Region, the Karatau Peak, and the Chu-Ili Mountains are the best fitted for wind farm installations.<sup>21</sup> Presently, Kazakhstan has 14 wind farms, with a total installed capacity of 180 MW (Yerementau in Akmola oblast and Kordai in Zhambyl oblast, among others), which materialize only a tiny fraction of the existing potential. Other underutilized RE potential is agricultural residual: about 10% of it is being used (Pala 2009) and the only large-scale facility, Vostok Biogas, operates in Kostanai region.

**Table 9: Deployment of RE in Kazakhstan**

Parameter	2018	2017	2016	2015	2014
<b>Installed capacity, MW, including:</b>	<b>531</b>	<b>342.3</b>	<b>295.7</b>	<b>251.5</b>	<b>177.52</b>
Wind	121.5	112.4	98.16	71.76	52.81
Small-scale HPP	200.3	170.8	139.9	122.3	119.27
Solar	209	58.8	57.3	57.07	5.04
Biofuels	0.35	0.35	0.35	0.35	0
<b>Output, mn kWh, including:</b>	<b>1,352</b>	<b>1,102</b>	<b>927.9</b>	<b>703</b>	<b>578.17</b>
Wind	401.9	339	262	131.8	0
Small-scale HPP	807.4	649.1	577.2	424.1	17.4
Solar	142.3	114.3	86.8	46.96	558.15
Biofuels	1.3	0.06	1.86	0.48	2.62
<b>RE electricity in total output (%)<sup>a</sup></b>	<b>1.27</b>	<b>1.08</b>	<b>0.98</b>	<b>3.16</b>	<b>0.62</b>
<b>RE electricity output growth, y-o-y (%)<sup>*</sup></b>	<b>19.00</b>	<b>15.80</b>	<b>24.10</b>	<b>21.59</b>	<b>8.90</b>

<sup>a</sup> The large-scale HPPs contribute about 90% to electricity generation in the non-fossil fuels segment. See Kazakhstan Electricity Grid Operating Company KEGOC. <http://www.kegoc.kz/en/company/national-power-system> (accessed 29 March 2019).

Note: <sup>\*</sup>According to the Ministry of Energy.

Source: Composed from annual reports by Kazakhstan's Ministry of Energy.

Considering the market environment for RE development, Kazakhstan has privatized most of its power sector, except for high voltage transmission. Around 97% of power plants are privately owned. The state-owned electricity companies are system operator KEGOC (a 100% state-owned transmission and dispatch company assigned an exclusive right as a renewable energy buyer),<sup>22</sup> electric power and electric capacity market operator JSC Kazakhstan Wholesale Electric Power Market (KOREM), and Samruk-Energo.<sup>23</sup> The latter two are managed by the National Wealth Fund Samruk-Kazyna. The large power stations, with 39% of the total generating capacity, are managed by Samruk-Energo. There are 20 regional distributing companies and more than 100 transmission companies. More than 160 retail supply companies (some are state-owned) purchase electricity from generating companies or at the centralized auctions and sell it to retailers and final consumers (Aldayarov, Dobozi, and Nikolakakis 2017). The government does not regulate prices for electricity. Wholesale electricity prices are determined by the market, which is administered by the market operator KOREM. Consumers can choose their provider of electric power. In 2019, Kazakhstan will be integrated into the EAEU's Common Electric Power Market (Shadrina 2018).

<sup>21</sup> IRENA Case Study 2013: Wind Atlas Kazakhstan. [http://globalatlas.irena.org/UserFiles/CaseStudies/IRENA\\_Case\\_Kazakhstan.pdf](http://globalatlas.irena.org/UserFiles/CaseStudies/IRENA_Case_Kazakhstan.pdf) (accessed 2 February 2018).

<sup>22</sup> See <http://www.kegoc.kz/report2014/eng/rynok-energo.php> (accessed 2 May 2018).

<sup>23</sup> See <https://www.samruk-energy.kz/ru/company/samruk-energo-today/production-indicator> (accessed 2 May 2018).

In 2013, Kazakhstan adopted the National Concept for Transition to a Green Economy up to 2050 (Concept 2050),<sup>24</sup> outlining an ambitious plan to increase the share of alternative energy (including nuclear) in electric power generation to 3% by 2020, 30% by 2030, and 50% by 2050.<sup>25</sup> According to Concept 2050, by 2020 Kazakhstan will have 106 electricity generating units with a total capacity of over 3,000 MW operating on renewable sources.<sup>26</sup>

Development of RE is encouraged by the Law on Supporting the Use of Renewable Energy Sources (2013), which sets the feed-in-tariff (FIT) for 15 years (2013–2028) for electricity generated at biomass, solar, and wind farms, as well as at geothermal and HPPs of up to 35 MW. The investment stimuli include subsidies equivalent to up to 30% of the costs related to land acquisition, construction, and equipment purchases.

Recent policy shifts towards the enhancement of RE in Kazakhstan include energy saving programs to reduce energy intensity by 25% by 2020, 30% by 2030, and 50% by 2050 against the levels of 2008;<sup>27</sup> facilitation of modernization of existing power generation, power grids, and oil refining installations; endorsement of a 15–25% reduction in greenhouse gas emissions by 2030 (against the 1990 level); and adoption of policies to support the development and inclusion of available RE sources in the energy mix, among others.

Favored by the Kazakhstani government, foreign investment and technical expertise are indispensable for RE development. ABB, KB Enterprises, Solarnet Investment GmbH, United Green, and Nomad Solar (a Kazakhstani company co-owned by Total Eren SA of France and Access Infra Central Asia Ltd. of the UAE) are among the businesses implementing RE projects in Kazakhstan. However, the decisive role in RE development in Kazakhstan belongs to the international financial institutions, most of all to the EBRD (who additionally assisted in setting the legal framework for RE), but also to the Asian Development Bank (ADB), Eurasian Development Bank (EDB), and Green Climate Fund. Samruk-Kazyna Invest (an investment arm of Kazakhstan's sovereign wealth fund) and Samruk Energy (Kazakhstan's national energy company) are co-financing RE projects. Overall, RE is a way to for domestic energy companies to diversify their portfolio, while for the government, enhancement of RE is a way to attract FDI, thereby demonstrating 'normality' in terms of the openness, flexibility, and modernity of the Kazakhstani state-driven economy. A special Green Economy Council has been created within the Ministry of Energy to foster the development of RE in Kazakhstan.

#### 4.2.2 Kyrgyz Republic

As has been discussed, a lack of regional cooperation over the water-energy agenda affects the Kyrgyz Republic. The economy struggles to match its growing power demand with the existing supply capacities: the power deficit, according to some estimates, reaches 25% in winter (Smirnov 2018). A less prosperous economy, the Kyrgyz Republic lacks its own financial and technical qualifications to renovate obsolete or construct new

<sup>24</sup> Official documents on RE development can be found at [https://asiapacificenergy.org/#main/lang/en/time/\[1990,2019\]/geo/\[ \]/search](https://asiapacificenergy.org/#main/lang/en/time/[1990,2019]/geo/[ ]/search) (accessed 31 March 2019).

<sup>25</sup> Available at <https://www.kazakhembus.com/content/renewables> (accessed 1 May 2018).

<sup>26</sup> Kazakhstan planiruet dovesti dolyu vozobnovlyaemyh istochnikov energii do 10%. <https://ria.ru/economy/20160914/1476935187.html>, (accessed 1 May 2018).

<sup>27</sup> Here, we would like to point out the inconsistency of targets within one document (the Concept, English version). While on page 7 the energy intensity reduction targets are set vis-à-vis the 2008 level, page 24 sets reduction target for the year 2030 at 35% and mentions 2010 as a base year for both 2030 and 2050.

generating facilities. Currently, electricity generation in the Kyrgyz Republic relies entirely on hydro resources, which are enormous and exploited at less than 10% of their potential. The 'new' RE in the Kyrgyz Republic remains undeveloped; the small-scale hydro power stations contribute only 1.1% to electricity generation.<sup>28</sup> The LSHPs of the Kyrgyz Republic are Toktogul (1,200 MW), Kurpsai (800 MW), Tash-Kumyr (450 MW), Shamaldy-Sai (240 MW), Uch-Kurgan (180 MW), and Kamar-Ata-2 (120 MW) on the Naryn river.<sup>29</sup> One of the peculiar features of the Kyrgyz hydro power sector is the advanced age of its major generating capacities, most of which were built in the 1960s and 1970s, including the largest Toktogul HPP, whereas the majority of small-scale HPPs were constructed in the 1940–1960s.<sup>30</sup> New capacities are projected in the LSHP segment: Kamar-Ata-1 (1,860 MW) by 2020; Verkhne-Narynsky cascade of HPPs (237.7 MW) by 2025; and, by 2025–2030, Kazarman cascade HPPs (1,050 MW) and Susamyr-Kokemerens cascade HPPs (1,305 MW).

In 2016, the Kyrgyz Republic endorsed the Concept for Energy Sector Development to 2030, which advances the provisions of the earlier National Energy Program for 2008–2010 and the Strategy for the Fuel-Energy Complex Development till 2025.<sup>31</sup> On 13 August 2018, the Kyrgyz Republic introduced the National Development Strategy to 2040,<sup>32</sup> which announced the expectation of the role of renewable sources in the energy mix to grow up to 50%, and the parameters of energy intensity and efficiency to improve on a par with OECD countries' practices. Adopted the same day, the Strategy for Sustainable Development to 2040<sup>33</sup> emphasized the need to address the problem of energy security through the development of infrastructure<sup>34</sup> and approved 16 projects with a total investment requirement of \$8.3 billion.<sup>35</sup>

The first document initiating RE policy in the Kyrgyz Republic was the Law on Renewable Energy Sources.<sup>36</sup> In 2008, the law introduced FIT, which is designed to ensure the reimbursement of investment costs for up to eight years.<sup>37</sup> However, the law is not fully functioning, because the essential bylaws explaining the calculation of tariffs and other aspects have not been adopted. Other development laws important for RE are on energy and on electrical power. They envisage the restructuring of the state-owned OAO

<sup>28</sup> Retrieved from <http://regulator.tek.gov.kg/ru/content/statisticheskie-dannye-harakterizuyushchie-sovremennoe-polozhenie-energосистемы-kyrgyzstana> (accessed 27 April 2018).

<sup>29</sup> Retrieved from <http://regulator.tek.gov.kg/ru/content/statisticheskie-dannye-harakterizuyushchie-sovremennoe-polozhenie-energосистемы-kyrgyzstana> (accessed 27 April 2018).

<sup>30</sup> Data retrieved from Ministry of Energy and Industry of the Republic of Kyrgyzstan. [energo.gov.kg](http://energo.gov.kg), [OAO Elektricheskie Stantsii energo-es.kg](http://oao.elektricheskie.stantsii.energo-es.kg), [Natsional'naya Energeticheskaya Set' Kyrgyzstana nesk.kg](http://natsionalnaya.energeticheskaya.set.kyrgyzstana.nesk.kg), [OAO Chakan GES chakang.es.kg](http://oao.chakan.ges.chakang.es.kg), accessed 27 April 2018.

<sup>31</sup> Minekonomiki predlozhit' utverdit' kontseptsiyu razvitiya energetiki KR do 2030 goda, [http://www.teploseti.kg/content/articles\\_view/816](http://www.teploseti.kg/content/articles_view/816) (accessed 2 August 2018).

<sup>32</sup> Strategiya 2040: Natsional'naya Strategiya Razvitiya Respubliki na 2018-2040 gody. [http://www.president.kg/ru/sobytiya/novosti/6015\\_proekt\\_nacionalnoy\\_strategii\\_razvitiya\\_kirgizskoy\\_respubliki\\_na\\_2018\\_2040\\_godi](http://www.president.kg/ru/sobytiya/novosti/6015_proekt_nacionalnoy_strategii_razvitiya_kirgizskoy_respubliki_na_2018_2040_godi) (accessed 2 August 2018).

<sup>33</sup> See <https://mir24.tv/news/16317856/ot-energetiki-do-ipoteki-kyrgyzstan-prinyal-strategiyu-razvitiya-816> (accessed 2 August 2018).

<sup>34</sup> Strategiya Ustoichivogo Razvitiya Kyrgyzskoi Respubliki na 2018-2040 gody. *Taza Koom Zhany Door*. [http://www.president.kg/ru/sobytiya/novosti/5624\\_na\\_obshestvennoe\\_obsugdenie\\_vinositsya\\_proekt\\_strategii\\_ustoychivogo\\_razvitiya\\_kirgizskoy\\_respubliki\\_na\\_2018\\_2040\\_gg\\_taza\\_koom\\_ghai\\_door](http://www.president.kg/ru/sobytiya/novosti/5624_na_obshestvennoe_obsugdenie_vinositsya_proekt_strategii_ustoychivogo_razvitiya_kirgizskoy_respubliki_na_2018_2040_gg_taza_koom_ghai_door) (accessed 2 August 2018).

<sup>35</sup> See <https://m.ru.sputnik.kg/economy/20180813/1040605122/strategiya-razvitiya-kyrgyzstan-summa.html> (accessed 17 August 2018).

<sup>36</sup> Official documents on RE development can be found at [https://asiapacificenergy.org/#main/lang/en/time/\[1990,2014\]/geo/\[ \]/search](https://asiapacificenergy.org/#main/lang/en/time/[1990,2014]/geo/[ ]/search) (accessed 31 March 2019).

<sup>37</sup> *Elektroenergetika Kyrgyzskoi Respubliki*. <http://energo-cis.ru/wyswyg/file/Kyrgyziya.pdf> (accessed 5 March 2018).

Elektricheskie Stantsii (OJSC Electric Stations), which produces 98% of electricity, and OAO NES Kyrgyzstana (OJSC National Energy Network Kyrgyzstan), which is a national system operator dominant in the transmission segment. Legally, the electricity market is unbundled, but the system operators retain distribution and supply services. Electricity generating plants of under 30 MW capacity can be privately owned.

The National Energy Program of the Kyrgyz Republic recognizes the importance of environmental protection and the need for a specific renewable policy, such as a new tariff policy, but no explicit targets have been set. The Law on Renewable Energy Sources exempts imported and exported equipment and materials for the use of RE power plants from customs duties, and transmission companies are obliged to purchase electricity from renewable facilities. Overall, heavily subsidized electricity tariffs in the low-income Kyrgyz economy make private investment in RE unattractive. The Kyrgyz Republic seems not to be pressured by the climate change agenda. This is so for an obvious reason: due to the Kyrgyz Republic's modest economic performance, its CO<sub>2</sub> emissions in 2017 were only 47.18% of the 1990 level.<sup>38</sup>

### 4.2.3 Tajikistan

RE in Tajikistan is represented entirely by hydro power. Responding to a severe energy crisis following the disruption in regional cooperation, international organizations and aid donors helped finance several mini and small power plants with a total capacity of 47 MW which were commissioned in 2009–2011.

Overall, the terrain and climate of Tajikistan are highly favorable for the development of hydro power. By hydro resources, the country is ranked top in Central Asia and eighth in the world.<sup>39</sup> Only about 6% of hydro stock has been harnessed.<sup>40</sup> The installed hydro capacity amounts to about 5,500 MW. The chief HPP is Nurek (3,015 MW), built in 1972. The fourth and the latest unit at the Sangtuda-1 plant on the river Vakhsh came into operation in 2009; together, the four units have a capacity of 670 MW. Commissioned in 2011, Sangtuda-2 has a capacity of 220 MW. Other large HPPs on the Vakhsh river include Baipara (600 MW) and Golovnaya (240 MW). If the projected Rogun (3,600 MW) and Shurbob (863 MW) HPPs are constructed, over 9,200 MW will be generated on the Vakhsh river alone. The Farkhad (126 MW) and Kaykakkum (126 MW) HPPs are built on the Syr Darya river. An enormous hydro potential also exists on the Pyanj river (the principal tributary of the Amu-Darya): 14 HPPs with an aggregate capacity of 18,720 MW are projected there.<sup>41</sup> One severe problem is obsolete generating capacities. To maintain the existing capacity, approximately 60% of Tajikistan's HPPs need to be rehabilitated by 2020 and nearly 80% by 2030.

Tajikistan is found to have considerable potential for solar and biomass energy, which is currently not utilized.

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<sup>38</sup> Retrieved from <https://countryeconomy.com/energy-and-environment/co2-emissions/kyrgyzstan> (accessed 30 March 2019).

<sup>39</sup> World Energy Resources Hydropower. World Energy Council. 2016: 12. [https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources\\_Hydropower\\_2016.pdf](https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Hydropower_2016.pdf) (accessed 30 March 2018).

<sup>40</sup> World Energy Resources Hydropower. World Energy Council. 2016: 12. [https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources\\_Hydropower\\_2016.pdf](https://www.worldenergy.org/wp-content/uploads/2017/03/WEResources_Hydropower_2016.pdf) (accessed 30 March 2018).

<sup>41</sup> *Elektroenergetika Respubliki Tajikistan*. <http://energo-cis.ru/wyswyg/file/Tadjikistan.pdf> (accessed 3 March 2018).

Tajikistan has recently been advancing its efforts in energy efficiency and energy saving rather than in the enhancement of RE.<sup>42</sup> Nevertheless, there have been a number of legislative steps for RE development. Specifically, Tajikistan adopted the Long-term Program for Building Small Hydro Power Plants for 200–2020 (envisioning the construction of 189 small HPPs of 103.6 MW total capacity), the Targeted Program for the Widespread Use of Renewable Energy Sources (2007), and the Law on the Use of Renewable Energy Sources (2010).

The regulations envision FIT (based on the project's costs, but guaranteed up to 15 years) for electricity produced at wind, solar, geothermal, biomass, and hydro power (up to 30 MW) plants, provided the plant operators receive approval from the government's antimonopoly service.<sup>43</sup> Most electricity generation capacity is owned by the state-owned electricity company Bargi Tajik; only one private company, OJSC Pamir Energy, operates in Gorno-Badakhshan Autonomous Region. Both companies are monopolists concentrating on the spectrum of services, although there has been a proposal for Bargi Tajik to be restructured.

Tajikistan pursues a traditional concept of RE, considering, for instance, that the addition of super-scale HPP Rogun<sup>44</sup> is a step toward larger RE employment. Such an approach is misleading, because it does not offer sustainable solutions to the existing energy problems; nor does it help overcome the complexity of the water-energy regional context. The development of RE necessitates liberalization of the electricity market in combination with tariff policy reforms. This is a difficult decision to make, because structural reforms in one sector require adequate changes in other spheres. Finally, tariff reforms are an unpopular policy choice because they would make people in this low-income economy vulnerable.

Finally, comprehension of the sustainability component of RE seems to be missing in Tajikistan, perhaps due to the fact that as a result of major economic decline over the post-Soviet transition, the country's CO<sub>2</sub> emissions in 2017 were 46.46% of their level in 1990.

#### 4.2.4 Turkmenistan

Because of very scant information on the topic at hand, Turkmenistan represents the most difficult case to examine. Based on the available data, Turkmenistan has no established RE segment. Turkmenistan has one HPP, built in 1913, on the Murgab river Gindukush (1.2 MW).<sup>45</sup> The largest power plant, Mary (1,685 MW), completed in 1973, and all the other facilities are thermal power plants. The average age of the majority of facilities is around 50–60 years.<sup>46</sup> The newly commenced as well as renovated power stations with gas and steam turbines Ashghabat, Dashoguz, Mary, Ahal, Abaza, Balkanabad, Lebap, Derveze, and Watan do not solve the problem of depreciation of generating capacities (Power Sector Development in Turkmenistan 2018). One of the

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<sup>42</sup> See analysis in "Tadjikistan: uglublennyi obzor energoeffektivnosti". Sekretariat Energeticheskoi Khartii, 2013. [https://energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Tajikistan\\_2013\\_ru.pdf](https://energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Tajikistan_2013_ru.pdf) (accessed 2 April 2018).

<sup>43</sup> *Renewable Energy Snapshot: Tajikistan*. UNDP. <http://www.undp.org/content/dam/rbec/docs/Tajikistan.pdf> (accessed 2 March 2018).

<sup>44</sup> The first unit of the 3,600 MW Rogun HPP was commissioned in November 2018. The second unit is expected in 2019, while all six 600 MW units are scheduled to be completed in 2024.

<sup>45</sup> *Elektroenergetika Turkmenistana*. <http://energo-cis.ru/wyswyg/file/Turkmenistan.pdf> (accessed 2 March 2018).

<sup>46</sup> Assessed based on [http://www.cawater-info.net/bk/dam-safety/pdf/hps\\_tm\\_r.pdf](http://www.cawater-info.net/bk/dam-safety/pdf/hps_tm_r.pdf) (accessed 2 April 2018).

most significant gas exporters, Turkmenistan is expected to have the financial means for maintenance and development of the national energy sector, but the national priority seems to be energy saving (which to some extent suits the logic of an exporter, as consuming less domestically frees additional volumes for export).

Turkmenistan has a tremendous potential for solar power, especially in Kuli, Gasan, and Ashgabat regions, where annual sunshine duration ranges anywhere from 2,768 to 3,150 hours. The Karakum Desert, which covers about 80% of the country's land mass, has the largest potential for solar farming due to the vacancy (availability) of land as well as the sand's high content of silicon, a chemical element necessary for manufacturing solar panels. Also, the Caspian Sea coast in the west of the country is known for its strong wind currents that are sufficient for sustainable wind farming.

The electricity market is controlled by the vertically integrated state-owned Turkmenenergo, which solely owns and operates the grid, generating and distributing the electricity to the final consumers. Turkmenistan has been known for having the world's lowest energy tariffs, but the worsening public finances forced the government eventually to introduce unpopular tariff reforms. Such a move may seem justified considering Turkmenistan's income statistics; however, the reliability of the latter can be questioned. In addition, there is a serious income inequality.

There is no legislation on RE specifically. However, the government has been setting out its climate change policy. The National Strategy on Climate Change (2012) outlines the long-term vision for promoting RE and low emissions. Also, the government created a National Climate Change Fund to finance climate change mitigation and adaptation projects, including renewable generation.<sup>47</sup> Recently, a new State Program of Energy Saving for 2018–2024 was adopted.<sup>48</sup>

#### 4.2.5 Uzbekistan

Hydro power contributes slightly over 20% to electricity production in Uzbekistan, but it dominates in the renewable segment. Like in other Central Asian countries, LSHPPs generate the principal share of electricity. The key HPPs in Uzbekistan are Charvak (620 MW), Khodjikit (165 MW), Tuyamuyun (150 MW), Andijan (140 MW), Farkhad (126 MW), and Gazalkent (120 MW).<sup>49</sup> Endorsed in 2017, the Program on Hydro Power Development for 2017–2021 envisages financing the construction of 42 new HPPs and the modernization of 32 HPPs.<sup>50</sup>

Elements of the RE policy in Uzbekistan can be traced back to the 1990s. The 1997 Law on Rational Energy Utilization introduced a project-specific FIT allowing sufficient return on the capital invested, the future operation costs, and other technical costs for RE facilities. To attract foreign investment, exemptions from profit tax, property tax, and unified tax payments for newly established small and medium renewable businesses were enacted. RE producers are also exempted from payments to Uzbekistan's road fund. Those tax privileges are granted for three years for foreign investment of between \$300,000 and \$3 million, or for five to seven years for investment up to and exceeding

<sup>47</sup> Renewable Energy Snapshot: Turkmenistan. UNDP. <http://www.undp.org/content/dam/rbec/docs/Turkmenistan.pdf> (accessed 2 March 2018).

<sup>48</sup> Turkmenistan Plans to Build Solar Power Stations and Wind Farms. 26 April 2018. [orient.tm/en/2018/02/26/5120.html](http://orient.tm/en/2018/02/26/5120.html) (accessed 2 March 2018).

<sup>49</sup> Retrieved from *Eletroenergetika Respubliki Uzbekistan*. <http://energo-cis.ru/wyswyg/file/Uzbekistan.pdf>, and *Ispol'zovanie gidroenergeticheskogo potentsiala gosudarstv – uchastnikov SNG: Problemy i perspektivy* (informatsionno-analiticheskii material). Moskva: Ispolnitel'nyi Komitet Sodruzhestva Nezavissimyh Gosudarstv. 2016. <http://www.e-cis.info/index.php?id=296> (accessed 2 May 2018).

<sup>50</sup> Retrieved from <https://www.gazeta.uz/ru/2017/05/05/hydroenergy/> (accessed 2 March 2018).



\$10 million. To the effectuated projects, the government guarantees legislation stability for ten years. For all the above incentives to apply, the share of foreign capital should exceed 33%.

Tasks for RE development were more specifically outlined in the Roadmap on the Development of Solar Energy in the Republic of Uzbekistan during 2014–2031 (2014) and the Program on Energy Intensity Reduction and Implementation of Energy Saving Technologies in the Sectors of Economy and Social Sphere during 2015–2019 (2015). The Roadmap stipulated that by 2030, 6% of Uzbekistan's energy mix will be provided by solar energy.<sup>51</sup> Like other spheres of national economy, Uzbekistan's RE segment has seen dramatic shifts since 2017. In Uzbekistan's Strategy on Five Priority Directions for Development in 2017–2021, the development of RE is named as one of the most important dimensions. It is projected that the share of RE in electricity generation will reach 20% by 2025.<sup>52</sup> In 2017, a new Program of Measures for Further Development of Renewable Energy and Improvement of Energy Efficiency in the Sectors of Economy and Social Sphere for 2017–2021 was adopted.

Also, to spur the development of RE, the government started considering stimuli for households: property and land tax exemptions for up to three years for those who invest in RE installation in their residences are being discussed.<sup>53</sup>

The structure of the electricity market is reminiscent of that in other Central Asian economies. The state-owned electricity company UzbekEnergo generates 97.5% of the country's electricity. The remaining share is the capacity of a small HPP, which is 84% operated by state-owned Uzsuvenergo, the remainder being owned by small blockstation enterprises.<sup>54</sup>

## 5. IMPEDIMENTS TO REDIFFUSION IN CENTRAL ASIA: POLICY IMPLICATIONS

### 5.1 Domestic Barriers

If the Central Asian economies' RE choices were defined entirely by their nature-allotted potential (Table 10), Kazakhstan would most of all deploy solar photovoltaic and wind energy (the potential of wind energy alone exceeds tenfold Kazakhstan's projected electricity needs by 2030); the Kyrgyz Republic would develop solar and small HPPs; Tajikistan would be interested in fully utilizing the potential of solar energy and small HPPs; Turkmenistan's best choice would lie with solar and wind energy; while Uzbekistan would benefit from exploiting energy from the sun, small HPPs, and biomass. If rationality-driven, the fossil fuel-poor economies would be the most active in deploying RE. In practice, so, too, are the fossil fuel-rich economies (the exception being Turkmenistan, which we consider a separate case).

<sup>51</sup> Retrieved from <http://www.uza.uz/ru/business/alternativnaya-energetika-dostizheniya-i-perspektivy-01-08-2017> (accessed 3 March 2019).

<sup>52</sup> Vsemirny Bank podderjivaet razvitie vozobnovlyaemyh istochnikov energii v Uzbekistane. 5 December 2017. <https://www.uzdaily.uz/articles-id-35230.htm> (accessed 3 March 2019).

<sup>53</sup> Retrieved from <https://ru.sputniknews-uz.com/economy/20170912/6287082/Alternativnaya-energiya-analogi.html> (accessed 3 February 2019).

<sup>54</sup> Renewable Energy Snapshot: Uzbekistan. UNDP. <http://www.undp.org/content/dam/rbec/docs/Uzbekistan.pdf> (accessed 2 March 2019).

**Table 10: Technical Potential for Installed Renewable Electricity Capacity (MW)**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Small Hydro	4,800	1,800	23,000	1,300	1,800
Wind	354,000	1,500	2,000	10,000	1,600
Solar PV	3,760,000	267,000	195,000	655,000	593,000
Biomass	300	200	300	not significant	800

Source: Compiled based on UNDP Renewable Energy Snapshot for respective Central Asian countries. Retrieved from [https://www.eurasia.undp.org/content/rbec/en/home/library/environment\\_energy/renewable-energy-snapshots.html](https://www.eurasia.undp.org/content/rbec/en/home/library/environment_energy/renewable-energy-snapshots.html).

Why is the available RE potential barely utilized in Central Asia, and even less so in the Kyrgyz Republic, Tajikistan, and Turkmenistan? To explain the situation, we distill the principal features of the relevant economies (Table 11). Turkmenistan and Uzbekistan, very closely followed by Kazakhstan, have the largest value stock of hydrocarbons (coal, crude oil, and natural gas) and are dependent on energy rents. The low-income fossil-poor Tajikistan and Kyrgyz Republic are remittance-dependent economies. As the state plays a significant role in all Central Asian economies, public–private partnerships and private investment in the energy sector as a whole are nearly non-existent. Our principal argument is that fossil-rich economies escape challenging their hydrocarbon sector with an authentic energy transition, because this sector secures the stability of their idiosyncratic political and economic institutions. The prime interest of the governments in fuel-rich economies is to open up a niche in which national private–public partnerships will cooperate with foreign businesses, from which they will learn and share high economic risks. This logic equally applies to Turkmenistan, the difference being that its preference to maintain its economic and political institutions (the most rigid in the region) does not permit even a niche opening. In turn, the fossil-poor economies incorporate RE development into their developmental programs, which are traditionally implemented with the substantial technical and financial backing of numerous international organizations and donors. We elaborate on our argument in the following.

**Table 11: Rents and Remittances in Central Asian Economies**

	Kazakhstan	Kyrgyz Republic	Tajikistan	Turkmenistan	Uzbekistan
Adjusted savings: energy depletion, avg. 1993–2016, % of GNI	8.96	0.15	0.04	22.76	10.64
Total natural resources rents, % of GDP, avg. 1992–2016	18.17	4.34	0.95	41.56	19.35
Mineral rents, % of GDP, avg. 1992–2016	2.56	3.77	0.72	0	3.98
Natural gas rents, % of GDP, avg. 1992–2016	0.90	0.05	0.06	27.98	12.60
Oil rents, % of GDP, avg. 1992–2016	13.40	0.39	0.11	13.58	2.66
Personal remittances, received, % of GDP avg. 1992–2014*	0.17	13.78	33.27	0.12	8.06
Public–private partnerships' investment in energy, 1992–2017	Insignificant by value, 1990s	None	Insignificant, 2000s	None	None
Investment in energy with private participation, 1992–2017	Insignificant, 1990s	None	Insignificant, 2000s	None	None

Note: \*Depends on data availability: Kazakhstan 1995–2014, Kyrgyz Republic 1993–2014, Tajikistan 2002–2014, Turkmenistan 2004–2014, Uzbekistan 2004–2013.

Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Overall, the Central Asian countries are neither seriously concerned about sustainability nor genuinely enhancing energy transition. Instead, they pursue RE development as a means of energy addition, according to the definition by York and Bell (2019). All the Central Asian economies submitted their Intended Nationally Determined Contribution (INDC) toward achievement of the global goal of the UN Framework Convention on Climate Change (UNFCCC)<sup>55</sup> in 2015 (Uzbekistan did so in 2017), because this is literally costless to them. As a result of deep and prolonged economic malaise that followed the collapse of the integrated Soviet economy, they all still have emissions growth 'reserve' when setting their INDC against 1990 (Kazakhstan and Tajikistan) and even against 2010 (the Kyrgyz Republic, Turkmenistan, and Uzbekistan). Why then has RE become an element of energy policies, albeit for the fossil-rich nations more than for the fossil-poor? We assume that for the rent-dependent state-dominated economic systems (Kazakhstan and Uzbekistan), this is the way to demonstrate their 'normality' and at the same time secure the desired foreign investment and technology. Belonging to the same group, Turkmenistan does not articulate RE policy, as the highly centralized economy with idiosyncratic institutions rejects the commonly perceived ideas and values of RE. For the Kyrgyz Republic and Tajikistan, hydrocarbon-poor and stricken by an energy deficit, the development of RE is one of the most viable ways to address the problem through the channels of international aid and other non-commercial financing. The Kyrgyz Republic's INDC clearly specifies that while implementing climate change policy the country plans that more than half of the necessary effort will be funneled in through international financial support.<sup>56</sup> Turkmenistan voices a similar hope, albeit less explicitly.

Regarding RE policy (IRENA 2014), having incorporated our earlier findings into the available rankings, we can draw some comparative lines across Central Asia (Table 12). The Kyrgyz Republic (placed 32nd) and Turkmenistan especially (8th) have poor metrics for national RE policies. Placed in the range between 33rd and 66th, the rest of the group are assessed as having established some essential elements of RE policy. All countries except for Turkmenistan are evaluated as having in place the necessary RE legislation; our analysis demonstrates that Kazakhstan has comparatively more comprehensive RE legislation. A latecomer, Uzbekistan has been very proactive in formulating and promoting the national RE policy in the past couple of years. The example of Uzbekistan, which is trying in earnest to fill the regulatory vacuum, suggests that energy markets cannot be enhanced without comprehensive institutional transformations across a range of sectors. The Kyrgyz Republic, Tajikistan, and Turkmenistan have been favoring energy saving over the promotion of renewables. Among the five, Kazakhstan can also be credited with some achievements in liberalizing the national electricity market. Other national electricity systems are characterized as being under the exclusive control of respective state-owned enterprises. Such a market structure dwarfs the development of renewables. The prohibition of private investment and the restriction on foreign capital reproduce an energy system that is economically inefficient and technically and technologically obsolete.

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<sup>55</sup> Available at <https://www4.unfccc.int/sites/submissions/indc/Submission%20Pages/submissions.aspx> (accessed 30 March 2019).

<sup>56</sup> The Kyrgyz Republic Intended Nationally Determined Contribution. [https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Kyrgyzstan/1/Kyrgyzstan%20INDC%20\\_ENG\\_%20final.pdf](https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/Kyrgyzstan/1/Kyrgyzstan%20INDC%20_ENG_%20final.pdf) (accessed 30 March 2019).

**Table 12: RE Policy Scores 2017**

Indicators	Kyrgyz				
	Kazakhstan	Republic	Tajikistan	Turkmenistan	Uzbekistan
Legal framework for RE	100	100	100	0	100
Planning for RE expansion	40	5	35	3	49
Incentives and regulatory support for RE	35	19	38	0	38
Attributes of financial and regulatory incentives	33	33	17	8	0
Network connection and use	48	30	32	27	26
Counterparty risk	64	38	30	17	6
Carbon pricing and monitoring	100	0	0	0	50
Overall score 2017 (2010)	60 (44)	32 (22)	36 (29)	8 (3)	38 (9)

Source: Based on Renewable Indicators for Sustainable Energy, World Bank (<http://rise.worldbank.org/>).

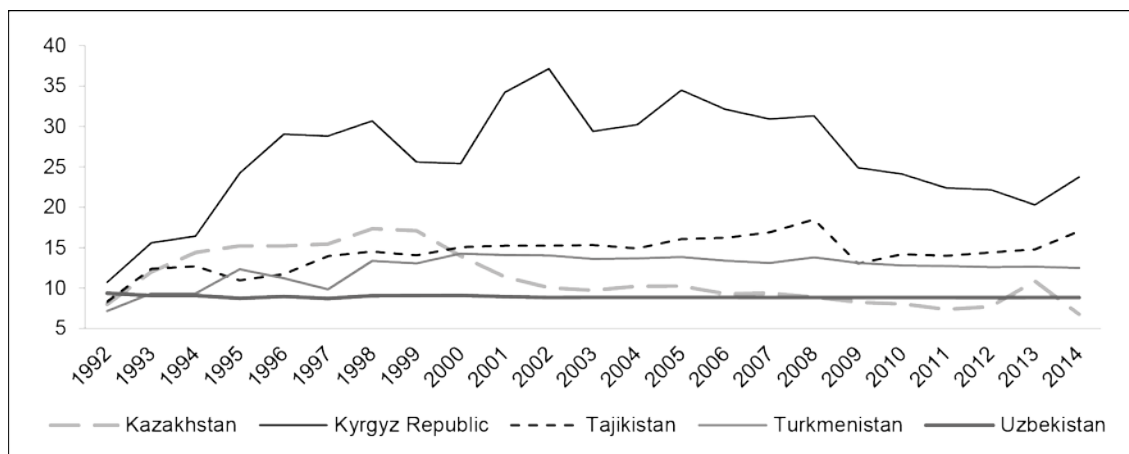
Governments in the developing economies often justify their interference in the energy sector, arguing that they fulfil a task of social protection of the population which has a relatively, or even absolutely, low income. Even in the wealthier nations, as Andreas et al. (2017) argue, initiation of the RE transition can slow down economic growth; the changes across a wide range of regulatory institutions in a broad spectrum of sectors are too drastic. All Central Asian nations are renowned for practicing the subsidization of energy. IRENA assessed that in 2012 energy subsidies, measured as a percentage of GDP, were highest in the Kyrgyz Republic (26.4%), followed by Uzbekistan (26.3%), Turkmenistan (23%), Kazakhstan (11%), and Tajikistan (7.1%).<sup>57</sup> A result of this is nearly certain cost and price non-competitiveness of renewables compared with the cost and price of electricity generated from conventional sources. In Kazakhstan in 2017, for instance, the cost of alternative energy was three- or fourfold higher than that of traditional energy. The average cost of one kWh generated at a coal-fired facility was 7–8 tenge (\$0.02), while a kWh generated at a wind farm cost 22 tenge (\$0.07), and even more at a solar photovoltaic—34 tenge (\$0.1).<sup>58</sup> Such a comparison illustrates the disincentives to invest in costly RE projects in Central Asian economies despite the global trend of a decline in the levelized cost of electricity (LCOE) (IRENA 2018abc; Sovacool 2008).

Energy additions in Central Asia are becoming essential, because as hydro assets generating power are ageing, the economies experience frequent outages, high losses in electricity transmission (Figure 6), low quality services, and growing energy poverty, to name a few issues. However, in addition to the intra-regional water-energy controversies discussed, an expansion of LSHPPs' capacities is susceptible to the impacts of climate change, such as the projected post-2030 water stock reduction.

<sup>57</sup> Retrieved from <https://www.irena.org/-/media/Files/IRENA/Agency/Events/2017/Apr/26/1-Session-I-Status-and-Priorities-for-Renewable-Energy-Development-Gurbuz-Gonul.pdf?la=en&hash=A785E05B7E28E5E1ADB7F80F95FAD5D4A9ABF108> (accessed 3 February 2018).

<sup>58</sup> Sluhi o razvitii VIE v Kazakhstane neskol'ko preuvelicheny. 16 October 2017. <https://ism.kz/sluhi-o-razvitii-vie-v-kazahstane-neskol-ko-preuvelicheny-eksperty> (accessed 3 February 2018).

**Figure 6: Electric Power Transmission and Distribution Losses 1992–2014, % of Output**



Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Operating by the World Bank's parameter of the number of power outages of firms in a typical month in 2013, Tajikistan, with 6.1 blackouts, seems to have the most serious problems. Uzbekistan, with 5.7 outages, is also in a difficult situation. While Kazakhstan's outages are expectedly low (0.5 occasions), the Kyrgyz Republic's parameter of 0.9 is surprisingly good.<sup>59</sup> This may well be because we rely on data of outages for firms, meaning that rural areas are excluded from the observation. Reference to the World Bank's database SE4ALL on access to electricity in the rural areas in 2014 returns a result that 99.7% of the rural population in the Kyrgyz Republic and 99.3% in Tajikistan have access to electricity, while the other Central Asian economies have this parameter at 100%. This seems to be overly optimistic. Other sources assess that about 10% of the population living in remote mountainous areas cut off from the grids by large fast-flowing rivers have no access to electricity.<sup>60</sup> In total, an estimated 2 million households in Central Asian countries live in energy poverty, mostly in the Kyrgyz Republic and Tajikistan,<sup>61</sup> but also in Uzbekistan (Chen 2014). For many rural and remote areas across Central Asia, off-grid power generation from renewable sources, including solar thermal energy, seems to be among the most feasible options.

Among other aspects critically important for the development of RE in Central Asia is limited access to affordable bank loans. The lending interest rates in the Kyrgyz Republic and Tajikistan, for example, are close to 20%. Other limitations include the insufficiency (if not non-existence) of local green financing, high initial investment costs (RE projects have a lower rate of return) because new RE technologies tend to be expensive (Taghizadeh-Hesary and Yoshino 2019), and a higher risk for RE projects compared to fossil fuel projects (Yoshino, Taghizadeh-Hesary, and Nakahigashi, 2019). In addition,

<sup>59</sup> Compiled based on data retrieved from <http://databank.worldbank.org/data/reports.aspx?source=2&series=IC.ELC.OUTG&country=> (accessed 3 February 2018).

<sup>60</sup> Tajikistan: Uglublennyi obzor energoeffektivnosti". Sekretariat Energeticheskoi Khartii. 2013. [https://energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Tajikistan\\_2013\\_ru.pdf](https://energycharter.org/fileadmin/DocumentsMedia/IDEER/IDEER-Tajikistan_2013_ru.pdf) (accessed 2 April 2018).

<sup>61</sup> Retrieved from <https://www.irena.org/-/media/Files/IRENA/Agency/Events/2017/Apr/26/1-Session-I-Status-and-Priorities-for-Renewable-Energy-Development-Gurbuz-Gonul.pdf?la=en&hash=A785E05B7E28E5E1ADB7F80F95FAD5D4A9ABF108> (accessed 2 April 2018).

the poor investment climate discourages potential investors (UNEP and Bloomberg New Energy Finance 2017).

Also, a lack of information about concrete technically sound and commercially feasible RE projects, especially for Turkmenistan, the Kyrgyz Republic, and Tajikistan, does not facilitate the advance of private initiatives in this area. In this regard, a front-runner in the sector, Kazakhstan, seems to have utilized the opportunities of EXPO 2017 for the promotion of its national projects, as well advancing the idea of renewables for the entire region by launching the Astana Communiqué on Accelerating the Uptake of Renewables in Central Asia. Kazakhstan hosts the Central Asia Renewable Summits in 2019 and 2020. Uzbekistan is following suit: having held the International Environmental Forum Strengthening Cooperation for Environment and Sustainable Development in 2018, it also plans to make the Central Asia Climate Change Conference an annual event.

Comprehensive reforms in the national electricity markets toward de-monopolization and de-regulation are necessary for RE development. However, rent-seeking behavior and the predominance of vested interests in energy-rich economies secure against such transformations (Moe and Midford 2014). Even disregarding the aspect of fossil fuels endowment, the Central Asian economies, with their below-standard metrics for quality of governance and semi-market or quasi-state economic institutions, lack the vigor of entrepreneurship and innovation-driven environment (Auty and de Soysa 2006; Shadrina 2017, 2018). The latter, as the advanced economies leading the process of renewable development demonstrate, is critically important (Rafindadi and Ozturk 2017).

Some readily available rankings, such as the Ease of Doing Business Ranking (EDBR), are informative for the assessment of the quality of institutional environment. Out of 190 countries ranked, Kazakhstan leads the group of Central Asian economies (36th position, improved). Uzbekistan has moved up (74th position, significantly improved). The Kyrgyz Republic has demonstrated the least progress (ranked 77th). Tajikistan keeps a rather low profile (123rd). Related to the theme at hand, the metrics of ease of access to electricity show a significant difference across the group, from relatively good to outstandingly bad (Table 13). Uzbekistan has made exceptional progress in streamlining procedures (Figure 7), which allowed the country to overtake Kazakhstan in terms of proximity to the best performers.

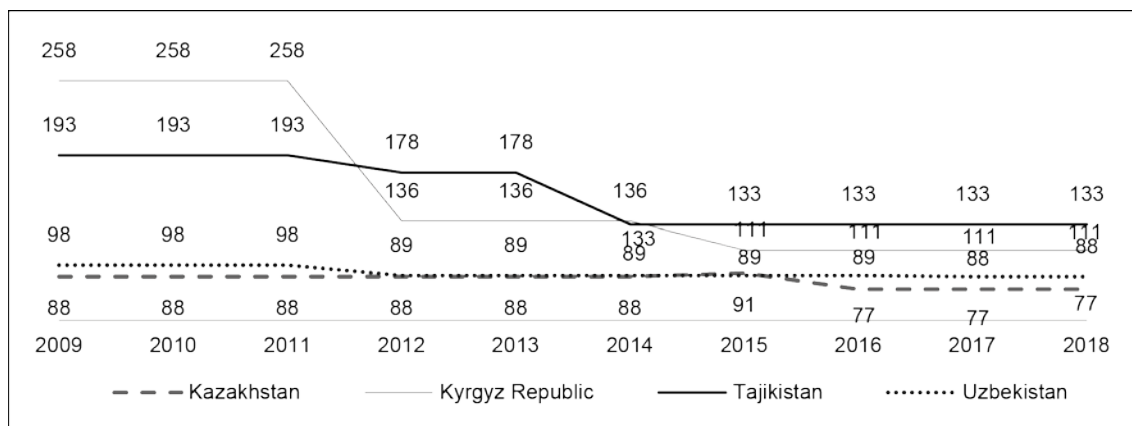
**Table 13: Ease of Access to Electricity**

Parameter	Kazakhstan	Kyrgyz Republic	Tajikistan	Uzbekistan
Getting electricity, rank	70	164	171	27
Distance to frontier score for getting electricity, 0–100	76.77	44.19	35	85.5
Procedures, number	7	7	9	4
Time, days	77	125	133	88
Cost, % of income per capita	47.4	814.4	811.5	833.1
Reliability of supply index and transparency of tariffs index, 0–8	8	0	0	8

Source: Doing Business 2018. Reforming to Create Jobs. World Bank Group, 2018, pp. 170, 172, 198, 203, <http://www.doingbusiness.org/~media/WBG/DoingBusiness/Documents/Annual-Reports/English/DB2018-Full-Report.pdf> (accessed 20 May 2019).

A reference to the metric of cost of getting access to electricity calls into question the objectivity of the earlier data for 100% access to electricity. It is rather improbable that the entire population in low-/middle-income economies could afford access, whose cost exceeds income per capita more than eightfold (Table 13).

**Figure 7: Time Required to Get Electricity, in Days**



Source: Author, based on The World Bank. DataBank. World Development Indicators. Retrieved from <https://databank.worldbank.org/source/world-development-indicators>.

Thus, having acknowledged in the preceding sections the differences across the countries in their attitudes to RE, we admit that many factors that impede RE development in Central Asia are shared. Yet, prioritizing the expansion of ‘new’ RE (besides the LSHPPs), Kazakhstan and Uzbekistan demonstrate steady progress in improving their RE policies.

## 5.2 Intraregional and International Barriers

In this section, we discuss possible dimensions for intraregional and international cooperation (Wee et al. 2012; Wu 2012), the realization of which will reduce energy insecurity in Central Asia.

The disintegration of CAPS in 2009 caused an acute energy crisis in Tajikistan. From 2012, Tajikistan did not receive gas from Uzbekistan. The energy situation in Tajikistan demonstrates the failure of the resource-sharing mechanism in Central Asia and proves that disintegration of intraregional energy cooperation exacerbates energy insecurity. Having the lowest GDP per capita among the Central Asian economies, Tajikistan is assessed as losing \$90 to \$225 million annually from the idle discharge of water in summer; disconnection from the cross-boundary grid costs Tajikistan lost export opportunities of 5 GWh in a single summer (Aminjonov 2016; Laldjebaev et al. 2018). Hydro power export is one feasible option for Tajikistan to be included in regional and international cooperation. Current exports of 1.3 billion kWh and 0.1 billion kWh to Afghanistan and the Kyrgyz Republic, respectively, are equal to 8% of Tajikistan’s total electricity generation. Provided the government-favored \$3 billion–\$5 billion Rogun HPP is constructed, Tajikistan may generate about 33.5 billion kWh and export about 10 billion kWh annually.

Nowadays, the Central Asian nations are voicing their support for resumption of the CAPS.<sup>62</sup> Full deployment of the CAPS and its connection to the grids in northern Kazakhstan and Afghanistan could ease the problems with large-scale electricity trading. Examination of other possibilities of the Common Electricity Market of the EAEU<sup>63</sup> and the Energy Club of the Shanghai Cooperation Organization could open additional avenues for cooperation, even to non-members of these arrangements. While it appears that Central Asian countries have an institutional coherence in that the state plays a prominent role in the economy, launching cross-border trade still requires the harmonization of regulations and standards. Specifically, the prospect of the Common Electricity Market of the EAEU needs to be taken into consideration.

The Central Asian electricity markets can be linked via the centralized trading platforms, especially given that Kazakhstani JSC KOREM is already functioning. Coordination in electricity planning is among the important initiatives. The establishment of a cross-border market requires an inventory of RE sources and the deployment of renewables in those areas with the highest potential. Green et al. (2016) estimate that this may help lessen intermittency and reduce fuel, operating, and transmission costs by 15%. Also, the improved capacity coordination of the cross-border trade can help reduce costs by 5%. Some successful practices of international wholesale electricity markets, such as those already functioning—the Nord Pool and North American Electricity Grid—as well as the projected SAARC Market for Electricity, can be analyzed for their applicability in Central Asia.<sup>64</sup>

The development of an adequate water-energy sharing mechanism is one of the most urgent tasks for intra-regional energy cooperation in Central Asia (Babow and Meisen 2012; Putz 2016; World Bank 2019). Without addressing this problem in a regional format, Tajikistan and the Kyrgyz Republic will remain unable to utilize their hydro power potential. The telling stories are those of the Rogun and Kambar-Ata-1 HPPs. The downstream nations have long been disregarding appeals from Tajikistan and the Kyrgyz Republic for these major HPPs to be built. Uzbekistan has been particularly hostile to these LSHPPs. Tajikistan's reasoning that without the Rogun HPP added, the country risks losing its critically important Nurek HPP because of silting was not attended (Aminjonov 2015). By the same token, the Kyrgyz Republic has struggled to progress with its Kambar-Ata-1 HPP. The Kyrgyz Republic needed external financing, but the search for potential investors turned out to be tough. In 2012, contracts on the construction of two cascades—the Kambar-Ata-1 and Verkhne-Narynsky—were signed with a Russian company. However, after the estimated costs almost doubled, the Russian contractor decided to terminate its participation in 2015. In 2016, the Kyrgyz Republic attempted to acquire foreign investment by signing an agreement with a Czech company, Liglass Trading, but the project reached an impasse again, this time due to the investor's bankruptcy in 2017.<sup>65</sup> After Uzbekistan revealed its interest in participating in the projects (de facto endorsing them in principle),<sup>66</sup> their prospects improved

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<sup>62</sup> See <http://documents.worldbank.org/curated/en/866191467998204221/pdf/101742-BRI-CAPS-PB-Box393265B-PUBLIC.pdf> (accessed 3 March 2018).

<sup>63</sup> Since the EAEU launch in 2015, cross-border electricity trade has grown by 24% to 7.61 bn kWh per annum. However, currently unutilized capacity exceeds 282.8 GW.

<sup>64</sup> The experience of the Nord Pool seems to be especially worthy of analysis. See Nord Pool. <https://www.nordpoolgroup.com/> (accessed 3 March 2018).

<sup>65</sup> 7 vazhnyh proektov, kotorye nikak ne mogut realizovat' v Tsentral'noi Azii. *CA-portal*. 5 February 2018. <http://www.ca-portal.ru/article:40646> (accessed 6 February 2018).

<sup>66</sup> <https://ru.sputnik-tj.com/asia/20171113/1023867265/uzbekistan-pristupil-proektirovaniyu-odnoy-ikrupneyshih-ges-centralnaya-aziya.html> (accessed 6 February 2018).



dramatically; yet, the scale of these hydro power projects necessitates regional and international cooperation.

The engagement of several Central Asian economies in international energy projects proves that coordination is essential. The CASA-1000 and TUTAP are projected and implemented by a large group of diverse stakeholders. The CASA-1000 envisages construction of an electricity transmission system to link the Kyrgyz Republic and Tajikistan with Afghanistan and Pakistan.<sup>67</sup> Owing to the CASA-1000, the Kyrgyz Republic and Tajikistan stand to activate a part of their export potential. Similarly, parties to the TUTAP, Turkmenistan, Uzbekistan, and Tajikistan will gain from international energy cooperation.

An array of actors is engaged in international cooperation targeted at solving energy insecurity in Central Asia. Among those are the EU (INOGATE, Investment Facility for Central Asia and Sustainable Energy Program for Central Asia),<sup>68</sup> the World Bank (Central Asia Energy Water Development Program), the ADB (Central Asia Regional Economic Cooperation Program), the EBRD (RE projects in Central Asia, especially in Kazakhstan), the Eurasian Development Bank (RE projects in Central Asia, especially in Kazakhstan), and many others.

## 6. CONCLUSION

The study has demonstrated that RE according to its traditional definition (with large-scale hydro power, 'old' RE) is important to energy-rich and critically important to energy-poor Central Asian economies. However, non-hydro ('new') RE plays a very modest role in fossil fuel-rich economies and is non-existent in fossil fuel-poor countries. A logical question to ask here is whether there is a need for RE development in Central Asia? Certainly, as the Central Asian economies face a deficit of power, as well as the problem of aging and becoming increasingly inefficient and unreliable energy-generating facilities, they stand to benefit from adding new capacities from RE sources. Is there an RE potential in Central Asia? Undoubtedly, Central Asian countries have enormous potential for all kinds of RE sources. What, then, are the essential elements which, by activating, Central Asian countries can improve their energy security? To begin, it seems that there is the question of the overall design of the RE policy. To explain, we demonstrated that there are principal differences in RE policies' modes in fossil fuel-rich versus fossil-poor economies in Central Asia. Energy-rich countries are increasingly active in enhancing 'new' RE. Seeing 'new' RE as a niche for learning-by-doing, these countries are gradually putting in place the standard principles and practices, such as electricity market deregulation and adoption of specific RE legislation, to name but two. Needing the 'new' RE much more, the energy-poor countries are, first of all, not financially equipped to promote it. They are also inconsistent in formulating and implementing their national RE policies and appear to be unfolding the RE agenda as an element of their broader developmental efforts. Their RE targets are often a mere demonstration that they fulfil the standard requirements (such as the National Sustainable Development Strategy) and are qualified the international grants and external financing of their development.

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<sup>67</sup> For an overview, see <http://www.casa-1000.org/> (accessed 6 February 2018).

<sup>68</sup> For details, see [http://www.eeas.europa.eu/archives/docs/central\\_asia/docs/factsheet\\_energy\\_en.pdf](http://www.eeas.europa.eu/archives/docs/central_asia/docs/factsheet_energy_en.pdf) (accessed 2 March 2018).

Effectively, the Central Asian nations have a choice between approaches that see the solution to energy insecurity through the enhanced marketization of energy and improving energy efficiency; those that prioritize the developmental aspects of energy security, such as solving the problem of power inequality and energy poverty; and those that combine these two approaches, with either marketization or the development agenda prioritized. The marketization-oriented approach is more suitable for economies with a relatively developed energy sector and with the necessary market institutions in place (such as the rule of law, competition, private ownership, capital market, among the key factors). This approach assumes that the government is capable of formulating and implementing the RE policy, although financial, technical, and other kinds of support may need to come from outside to supplement the national assets. The development-oriented approach assumes that the national government needs greater external support and expertise to overcome the major institutional and structural inefficiencies in the national economy, meanwhile addressing the most essential developmental needs in the energy sector through the enhancement of small-scale HPP, solar, wind, and other renewables.

Finally, Central Asia sets a clear case for the need for regional (and international) cooperation for the sake of ensuring individual countries' energy security. Such cooperation involves explicit technical, financial, and other forms of coordinated activity directed toward rehabilitation of existing and construction of new intra- and inter-regional energy-generating facilities and infrastructure. Equally important is the harmonization of standards for the 'new' RE policies and the diffusion of best practices for the 'new' RE policymaking and policy implementation among Central Asian economies.

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