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Energy Transition in Central Asia: a Short Review

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ABSTRACT

The five countries of Central Asia, Kazakhstan, Kyrgyzstan, Uzbek- istan, Tajikistan and Turkmenistan, have each adopted climate tar- gets to achieve the climate goals agreed in Paris by 2050.

In this paper, the starting positions of all five countries are pre- sented and the respective obstacles on the path to climate neu- trality are identified. The starting positions in the countries with large oil, gas or coal reserves (Kazakhstan, Uzbekistan and Turk- menistan) differ from the countries where the basis of energy sup- ply are large hydroelectric plants (Kyrgyzstan and Tajikistan).

One problem in all countries is the poorly developed power grid, which is partly outdated and not designed for high throughput rates. Existing power plants are mainly located in metropolitan regions and rural areas are partly undersupplied. If wind and so- lar power plants are built on a large scale in uninhabited areas, the lack of transmission lines is a major problem.

Another problem is that energy prices are sometimes heavily sub- sidised, which can make it difficult for the population to accept necessary investments in the renewable energy sector. Especially in economically weak sections of the population, resistance to market-based energy prices is likely to be particularly strong. In the long term, information and increased education of large parts of the population can significantly improve the acceptance of the en- ergy transition from carbon-based energy to solar, wind and small hydro power.

The use of renewable energy is still in its infancy in all countries and must develop quickly if the ambitious climate goals are to be achieved. To this end, the training of local experts is particularly important. To this end, centres should be established at selected locations where local experts can be trained and further educated in various fields, from conception and planning to construction, maintenance and operation.

KEYWORDS

Renewable Energy, Central Asia, Energy Transition, Renewable Energy Policy, Legal Situation, Social Acceptance, Investment Climate, Poverty, Green Energy, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan

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1. Introduction

Renewable energy is energy that is generated from natural processes that are continuously replenished. The main sources for renewable energy in dry countries are sunlight, geothermal heat and wind. If there are mountains that collect rainwater, the streams of water provide kinetic energy that also may be used. In Central Asia all of these sources are plentiful, but they are not distributed evenly. Different countries dispose of different sources of renewable energy.

This article concerns the countries in Central Asia (figure 1), namely Kazakhstan, Kyrgyzstan, Tajikistan,Turkmenistan and Uzbekistan. We want to examine the current status of these five countries, in particular, what resources and potential exist and what the legal situation is.

Figure 1. Central Asia "Map of Central Asia", 2022

All five countries ratified the Paris Agreement, and we want to trace how the transition in energy has developed so far. We will describe their climate goals and check their respective climate targets.

Furthermore, we will investigate the implementation of energy transition from fossil-based energies to renewable energy sources. The countries have different natural resources to exploit, but the exploitation differs and may also be improved. We will weigh the different approaches to the necessary transitions.

The inevitable transformation of the energy sector has major implications for individuals and society as a whole. Therefore it is crucial to look after the impact. There will be no success if the people cannot be convinced about the necessity of the transformation.

Finally, a short outlook of a possible development and next steps deduced from the development will be given.

2. Current status

In the region under consideration, Kazakhstan is by far the largest country, but the most densely populated country is Uzbekistan. In Kyrgyzstan and Tajikistan, the major part of the inhabitants lives in rural areas (roughly two thirds and three quarters respectively). As far as the national economy is concerned, Kazakhstan is the strongest of the five, while Turkmenistan and Uzbekistan come on the second and the third rank. Table I shows the key socio-economic indicators as of 2018.

Table I. Key socio-economic indicators as of 2018 in Mehta et al., 2021

Country	Surface Area in km^2	Population in million	Share of Rural Population	GDP in billion US$	GNI per capita in US$
Kazakhstan	2,724,902	18.2	43	170.0	7,970
Kyrgyzstan	199,950	6.3	43	8.0	1,130
Tajikistan	141,380	9.1	73	7.5	990
Turkmenistan	488,100	5.8	43	40.8	6,380
Uzbekistan	447,400	33.0	50	50.5	2,000

To summarise, Kazakhstan is in the pole position as far as socio-economic indicators like GDP[1] and GNI[2] are concerned. But Turkmenistan and Uzbekistan, although smaller in size, are close followers, while Kyrgyzstan and Tajikistan run behind.

2.1 Future of Fossils

In Central Asia, fossil resources are plentiful. After the countries of Central Asia had become independent from the former Soviet Union, they have been using more or less the energy system they inherited from the former USSR. The improvement of the energy system is little; and in many parts it is deteriorating. Also investments in alternatives to coal, gas or crude oil is negligible. So the situation over the last decades has not changed significantly. Table II shows the usage of fossil resources in each country as part of the total energy consumption.

One must also take into account that the total energy consumption – after a small decline immediately after independence – is rising steadily since the turn of the century.

Kazakhstan has by far the largest resources of coal, and is therefore depending heavily on coal. Besides Kazakhstan, Turkmenistan and Uzbekistan have plenty of natural gas. Kazakhstan and Turkmenistan have many supplies of crude oil. Kyrgyzstan and Tajikistan, located in the high mountains, have many hydro-power stations.

[1]Gross Domestic Product
[2]Gross National Income

Table II. Fossil Resources according to Energy Transitions Commission (ETC), 2017

Country	Coal in billion tons	Natural Gas in billion m^3	Crude Oil in billion barrels	Hydro-Power in GW
Kazakhstan	31.3	2,400	30	20
Kyrgyzstan	0.9	6	0.04	26
Tajikistan	3.6	6	0.01	40
Turkmenistan	-	7,500	0.6	-
Uzbekistan	3.3	1,800	0.6	1.7

Today the countries of Central Asia cover their energy needs mainly from the natural resources they have: Kazakhstan is burning coal to generate electrical energy and heat. Kyrgyzstan and Tajikistan are using their large hydro-power stations and thereby controlling the flow of water upstream of the large rivers that irrigate the fields downstream in Uzbekistan and Turkmenistan. This nexus of energy and water leads to another heap of dispute between the countries of Central Asia. Turkmenistan and Uzbekistan are burning crude oil as source of energy. By 2016 the use of renewable energies like wind energy, solar energy or bio-fuels and waste were still negligible. The use of coal even increased during these years at the expense of natural gas. Figure 2 shows the development of use of natural resources between 2000 and 2018.

In a decarbonising world, the demand for fossil resources will be decreasing. Nevertheless, the decrease will not affect all forms of fossil resources in the same manner. According to Energy Transitions Commission (ETC), 2017, in January 2017 ca. 85 % of all energy used worldwide was fossil. The trajectory for a 2 °- outcome requires a worldwide drop of fossil energy to 60 % by 2040. Energy Transitions Commission (ETC), 2017 estimates the main uses of fossil fuels as follows :

- Coal will be used for metallurgy: drop by 67 % to 23 % of current use.
- Crude oil will be used for transport and producing chemicals: drop by 33 % to 67 % of current use.
- Natural gas will be used for transport and industry: no drop expected.

These changes will also put pressure on national economies depending on the export of fossil energies. Even if the 2°-trajectory will not be met, a significant reduction in the use of fossil energy can be expected, and relying on exporting coal or crude oil will threaten the economy.

2.2 Resources and Potentials

In Central Asia sources of renewable energies are abundant. Due to reliable sunshine and a steady wind in the plains of the North and snowy mountains in the South, the different types of renewable energy are not distributed evenly among the countries. Table III shows the availability of natural resources in each country.

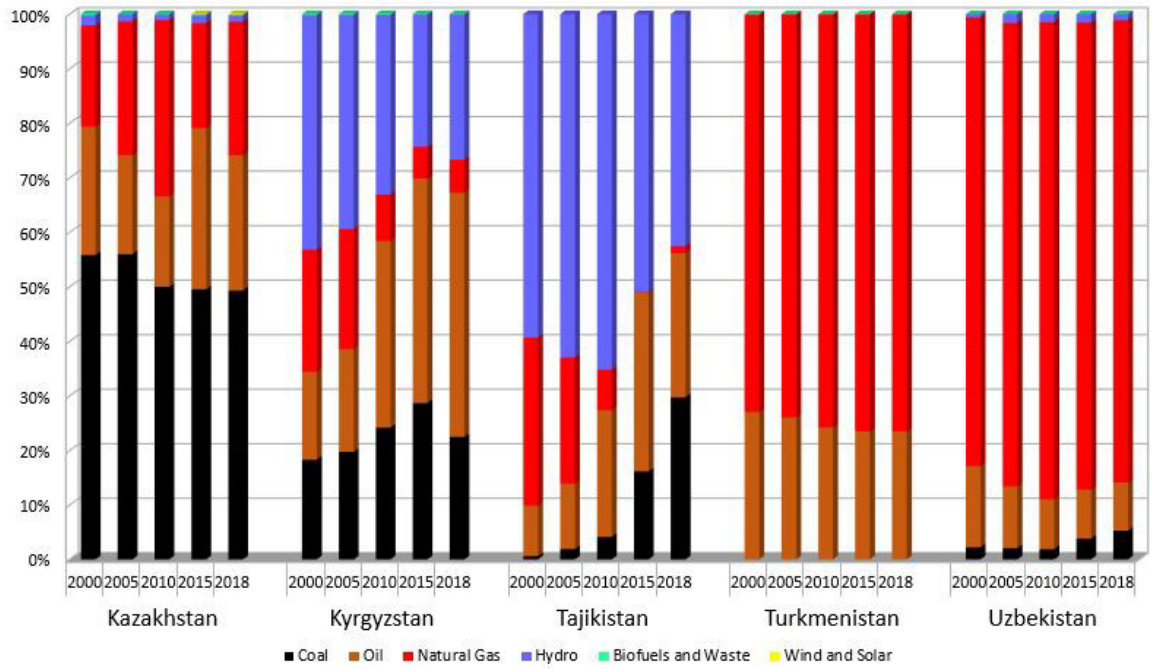

Figure 2. Total Energy Supply between 2000 and 2018, compiled from IEA, 2020

We will count only small scale hydro-power stations as sources of renewable energy. When we talk about the necessary energy transition in Central Asia and the steps to be taken, we cannot and will not emphasise on building large hydro-power stations like the existing ones because of the large damage building new large hydro-power stations does to nature. We will not replace one severe damage to the environment with another.

Comparing the potentials of renewable power with the consumption, we see that Central Asia can easily satisfy its need of energy with its renewable sources.

Table III. Renewable Power Potentials in MW according to Shadrina, 2020

Country	Small Scale Hydro	Solar PV	Wind	Geothermal	Bio Mass
Kazakhstan	4,800	3,760,000	354,000	6,200,000	300
Kyrgyzstan	900	267,000	1,500	19,500	200
Tajikistan	30,000	195,000	2,000	5,100	300
Turkmenistan	1,300	655,000	10,000	-	-
Uzbekistan	1,180	593,000	1,600	230	800

2.3 Legal Situation

The biggest obstacles for a transition are (a) legal situation and (b) economic condition. Connected with both of them is the democratic situation because reliability and stability of the political system is an urgent need for foreign investors to finance the transition. As seen before in table I, the overall economical situation counted in GDP units shows that without foreign investment the energy transition cannot be managed. Even Kazakhstan, the largest economy in this region, is overloaded with this challenge.

Table IV shows the democracy index on a scale from 0 to 10 and the human development index on a scale from 0 and 1 in the year 2020:

Table IV. Democratic Development according to Economist Intelligence Unit, 2020 and United Nation's Development Programme, 2020

Country	Democracy Index, 0.0 to 10.0	Human Development Index, 0.0 to 1.0	Form of Government
Kazakhstan	3.14	0.825	presidential republic
Kyrgyzstan	4.21	0.697	presidential system representative in a democratic republic
Tajikistan	1.94	0.668	presidential republic
Turkmenistan	1.72	0.715	presidential republic
Uzbekistan	2.12	0.720	presidential constitutional republic

It should be noted that in the states of Central Asia the regulatory framework is mostly rather declarative character. In most countries, energy conservation laws do not contain mechanisms of direct action, weakly connected with other legislative acts regulating various issues of energy, ecology, etc. Norms in energy legislation is often not harmonised with each other, there are gaps and outstanding issues. However, almost all countries are actively studying international experience and work on its adaptation to national conditions. In particular, Кузьмич, В.В., 2013 notes a tendency to harmonise the legislation in the field of energy efficiency with EU legislation

Kazakhstan According to the law of the Republic of Kazakhstan "On supporting the use of renewable energy sources", issued by the Ministry of Justice of the Republic of Kazakhstan, 2009, state regulation in the field of supporting the use of renewable energy sources is carried out to create favourable conditions for the production of electrical or thermal energy. Using renewable energy sources to reduce the energy intensity of the economy and the impact of the sector of electrical and thermal energy production on the environment is favoured, as well as to increase the share of using renewable sources energy in the production of electrical or heat energy.

In paragraph 1 of Art. 1 of the "Renewable Energy Sources Law", issued by the Ministry of Justice of the Republic of Kazakhstan, 2009, gives a definition of renewable energy sources; they include:

- Continuously renewable due to naturally occurring natural processes: solar radiation energy, wind energy, hydrodynamic water energy for installations with a capacity of up to thirty-five megawatts;
- Geothermal energy: heat of soil, groundwater, rivers, reservoirs;
- Anthropogenic sources of primary energy resources: biomass, bio-gas and other fuels from organic waste used for the production of electrical or thermal energy.

State regulation in the field of supporting the use of renewable energy sources for the production of electrical or thermal energy includes:

- Approval and implementation of the plan for the location of facilities for the use of renewable energy sources, taking into account the target indicators for the development of the renewable energy sector;
- Setting fixed tariffs and ceiling auction prices;
- Providing targeted assistance;
- Creation of education and training facilities for local experts and the implementation of scientific research in the field of the use of renewable energy sources;
- Technical regulation;
- Adoption of regulatory legal acts in the field of the use of renewable energy sources.

The main directions of state regulation in the field of support for the use of renewable energy sources are:

- Creation of favourable conditions for the construction and operation of facilities for the use of renewable energy sources;
- Stimulation of the production of electrical or thermal energy using renewable energy sources;
- Provision of investment preferences to legal entities engaged in the design, construction and operation of facilities for the use of renewable energy sources in accordance with the Entrepreneurial Code of the Republic of Kazakhstan;
- Creation of favourable conditions for the effective integration of facilities for the use of renewable energy sources into a single electric power, thermal system and the market of electric and thermal energy;
- Assistance in fulfilling the international obligations of the Republic of Kazakhstan to reduce greenhouse gas emissions.

In 2013, Kazakhstan adopted the "Concept on the transition of the Republic of Kazakhstan to green economy" until 2050, as written by the President of the Republic of Kazakhstan, 2013, which provides principles of *green economy* (figure 3) as a direction of future development. One of the goals of this concept is to increase the share of renewable energy sources within the total volume of electricity production from just over 1 % up to 3 % by 2020, up to 30 % by 2030 and up to 50 % by 2050.

Changes made in above mentioned law, adopted in 2013, provided various elements and had a significant impact on stimulating primary investments:

- Allocation of a plot of land for construction of structures with using renewable energy;
- Introduction of fixed tariffs;
- Purchase of the entire volume of energy generated from renewable energy sources for a fixed tariff guaranteed for 15 years;

- Exemption from fees for the transportation of electricity for producers of renewable energy sources;
- Installation of a clearing house, that is responsible for centralised procurement and the sale of electricity produced from renewable energy sources;
- Financial settlement of imbalances due to supplies in electricity network from renewable energy sources by the clearing house.

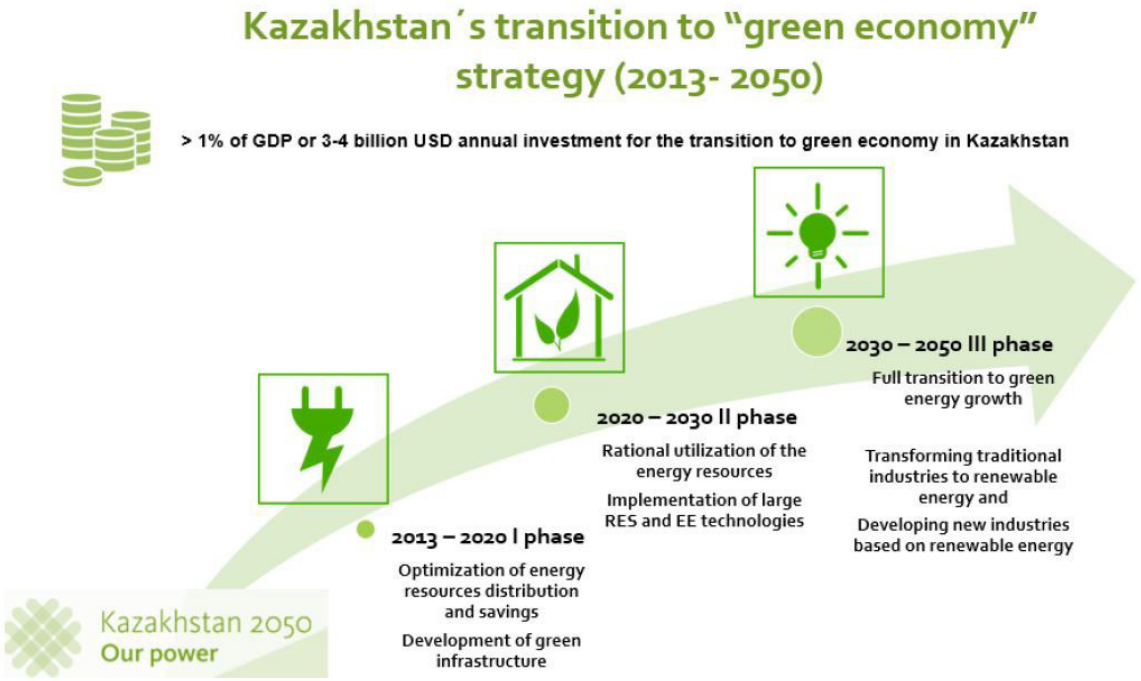

Figure 3. Kazakhstan's Transition to green economy according to Andrukonyte, 2019

Kyrgyzstan According to the law of the Kyrgyz Republic "On renewable energy sources", issued by the МИНИСТЕРСТВО ЮСТИЦИИ КЫРГЫЗСКОЙ РЕСПУБЛИКИ (Ministery of Justice of the Kyrgyz Republic), 2008 , the objects of regulation of this law are the production, consumption and sale of heat, electric energy and fuel using renewable energy sources, as well as the production and supply of equipment and technologies in the field of renewable energy sources in the territory of the Kyrgyz Republic.

The state policy in the field of renewable energy is based on the following principles:

- The objectives of the state policy in the field of renewable energy are to strengthen energy security by increasing the share of renewable energy, developing competitive energy systems and ensuring environmental protection;
- State policy in the field of renewable energy is implemented within the framework of national and regional programs;
- Ensuring environmental protection and rational use of natural resources, health protection of the population and labour protection in the implementation of measures aimed at the development of the renewable energy sector;
- State support for the use of renewable energy sources;

- Creation of a system of legal, financial and economic mechanisms that ensure the economic interest of producers and consumers of renewable energy sources, in order to be included in the fuel and energy balance of renewable energy sources;
- Attraction of investments and support of entrepreneurship;
- Guarantees for the sale of generated renewable energy;
- Ensuring the competitiveness of systems using renewable energy sources , excluding the conditions for creating an artificial monopoly in the field of renewable energy sources and renewable fuels;
- Information support of technical and technological advances in the field of renewable energy sources;
- Wide involvement of the public and scientific and technical potential in the process of developing renewable energy sources;
- Encouraging cooperation between the subjects of the electric power industry and producers of renewable energy sources in order to supply energy or replace traditional energy;
- Encouragement of activities aimed at decentralised and autonomous generation of electricity and heat;
- Involvement of the population in the use and production of renewable energy equipment;
- Ensuring interdepartmental and intersectoral cooperation in the field of renewable energy.

On November 15, 2020, the regulation "On the conditions and procedure for the implementation of activities for the generation and supply of electricity using renewable energy sources" came into force in Kyrgyzstan. It defines new rules for the country's green energy market.

Now the State Committee for Industry, Energy and Subsoil Use has the right to accept applications from all participants in the market of renewable energy sources to issue certificates free of charge to them. This document will allow companies to officially work in the renewable energy sources sector, receive land plots and enjoy all other preferences from the state.

Also in Kyrgyzstan, there is a program for the development of a *green economy* for 2019–2023. Within the framework of this document, it is planned to increase the well-being of the population, effectively using resources and at the same time preserving the natural ecosystems of the country.

Tajikistan At the moment, the relationship in the field of development and the use of renewable energy sources on the territory of the Republic of Tajikistan is regulated by the law of the Republic of Tajikistan "On the use of renewable energy sources", issued by the Government of the Republic of Tajikistan, 2015.

This law regulates the legal relations arising between government bodies, individuals and legal entities in the field of rational and efficient use of renewable energy sources.

The law defines the legal and economic framework for increasing the level of energy-saving, reducing the level of anthropogenic impact on the environment and climate, savings and preservation of non-regenerating and energy sources for future generations.

The main objectives of the state policy in the field of energy are:

- Reliable and high-quality provision of the growing needs of the republic in energy resources and products, ensuring the country's energy security;
- Ensuring environmental protection, as well as protecting the population from harmful impacts from energy activities;
- Creating the necessary conditions for the consistent transition of the energy sector to market relations, attracting domestic and foreign investments in it, providing energy enterprises with economic independence and ensuring their development on the basis of market competition;
- Improving the efficiency of the fuel and energy complex through the introduction of advanced technologies, energy conservation, the use of renewable energy sources, reducing the unit costs of energy resources in the production of the gross national product.

A number of documents have been prepared for the development of renewable energy sources, including:

- Law of the Republic of Tajikistan "On the use of renewable energy sources", issued by the Government of the Republic of Tajikistan, 2015;
- By-laws to the Law of the Republic of Tajikistan "On the use of renewable energy sources";
- Resolution of the Government of the Republic of Tajikistan "On the approval of the rules for maintaining State Cadastre of Renewable Energy Sources", issued by the Government of the Republic of Tajikistan, 2011;
- Collection of regulatory legal acts and current national standards for renewable energy sources.

State regulation in the field of energy is carried out through legal support, licensing, taxation, lending, financing, implementation of investment, social, scientific and technical policy, control over compliance with the legislation of the Republic of Tajikistan by the enterprises of the fuel and energy complex. Licensing of activities in the field of energy is carried out following the law of the Republic of Tajikistan "On licensing of certain types of activities", issued by the Government of the Republic of Tajikistan, 2004. Energy projects and programs for the construction of large energy objects undergo a mandatory state examination, the procedure for which is determined by the government of the Republic of Tajikistan.

The United Nations Economic Commission for Europe (UNECE) summarise the situation in Косимбек Олимбеков, United Nations Economic Commission for Europe (UNECE), n.d.

Turkmenistan In Turkmenistan, a special regulatory framework in the field of energy-saving and support of renewable energy sources is practically not formed, these problems are solved within the framework of general regulation of economic development and energy.

At the same time, in 2012–2013, the country developed a "National strategy of Turkmenistan on Climate Change", issued by the Ministery of Justice of Turkmenistan, 2012, according to which it is planned to develop an *Action Plan* containing measures for both climate change mitigation and adaptation of economic sectors countries to the proposed changes. The plan will cover questions development of all sectors of the economy with a particular focus on industry, transport and housing and communal services. The priority areas will be the following:

- Introduction of energy efficient and energy saving technologies;
- Development of the renewable energy sector;
- Technological modernisation to ensure future development
- and the competitiveness of the economy.

The adoption of the State Energy Saving Program for 2018-2024 and the entry into the International Renewable Energy Agency (IRENA) demonstrates the country's commitment to the development of renewable energy and energy efficiency in line with the UN's Sustainable Development Goals. The next step on this path was the adoption of the "National Strategy for the Development of Renewable Energy in Turkmenistan until 2030", issued by the Ministery of Foreign Affairs of Turkmenistan, 2020, which was approved by presidential decree in December 2020.

Uzbekistan In accordance with the decree of the President of the Republic of Uzbekistan "On measures to radically improve the management system of the fuel and energy industry of the Republic of Uzbekistan", issued by the President of the Republic of Uzbekistan, 2019, the Ministry of Energy was formed, which is entrusted with the function of an authorised body for the implementation of a unified state policy in the field of the use of renewable energy sources.

In May 2019, the Laws of the Republic of Uzbekistan "On the Use of Renewable Energy Sources", issued by the МИНИСТЕРСТВО ЭНЕРГЕТИКИ РЕСПУБЛИКИ УЗБЕКИСТАН (Ministery of Justice of the Republic of Uzbekistan), 2019, and "On Public-Private Partnership", issued by the Ministery of Justice of the Republic of Uzbekistan, 2019, were adopted, which create a regulatory and legal basis for accelerating the implementation of renewable energy projects.

In addition, by the resolution of the Cabinet of Ministers approved the Regulation on the connection to the unified electric power system of business entities producing electric energy, including from renewable energy sources, which defines the main technical aspects of the integration of renewable energy facilities into the United Energy System of Uzbekistan.

At the same time, in accordance with the decree of the President of the Republic of Uzbekistan "On measures for accelerated development and ensuring financial stability of the electric power industry", issued by the President of the Republic of Uzbekistan,2018, inter alia, it was instructed to develop a modern scheme for organising the production of electricity, while providing for the widespread attraction of private, including foreign, direct investments in enterprises for the production of electricity, including on the basis of public-private partnership (PPP) and work with potential investors on new investment projects in the field of electricity on the basis of PPP based on the available resource base, modern technological trends and the use of alternative sources of electricity.

In this connection, to date, the Ministry of Energy, to diversify the generation structure towards increasing the specific share of renewable energy sources, is carrying out a set of measures aimed at implementing investment projects in the field of renewable energy sources on the principles of public-private partnership.

Following the decree of the President of the Republic of Uzbekistan, the Ministry of Energy, together with the involved ministries and departments, as well as with the technical assistance of international financial institutions (i.e. World Bank, Asian Development Bank), has developed a concept for fuel and energy supply of the country for 2020-2030.

In order to stimulate the use of renewable energy sources, the law of the Republic of Uzbekistan "On the use of renewable energy sources", issued by the МИНИСТЕРСТВО ЭНЕРГЕТИКИ РЕСПУБЛИКИ УЗБЕКИСТАН (Ministery of Justice of the Republic of Uzbekistan), 2019, provides a number of benefits and preferences:

- Exemption of manufacturers of renewable energy installations from paying all types of taxes for a period of five years from the date of their state registration;
- Exemption of energy producers from renewable energy sources from paying property tax for renewable energy installations and land tax for areas occupied by these installations (with a nominal capacity of 0.1 MW and more), for a period of 10 years from the date of their commissioning;
- Property tax of individuals is not levied on property owned by persons using renewable energy sources in residential premises with complete disconnection from existing energy networks, for a period of three years starting from the month of using renewable energy sources;
- Persons who use renewable energy sources in residential premises with complete disconnection from the existing energy networks are exempt from the land tax, for 3 years starting from the month of using renewable energy sources.

3. Climate Goals

Within the 2030 Agenda for Sustainable Development The United Nations, n.d. the UN defined 17 goals, which are an urgent call for action by all countries to end poverty and other deprivations and to improve health and education, reduce inequality, and spur economic growth.

These goals are known as Sustainable Development Goals (SDG), out of which SDG #12 Responsible consumption and production and SDG #13 Climate Actions are related most with energy transition. So we will show how the Central Asian countries comply with these goals.

All countries in this region are witnessing and very much affected by the ongoing climate change since it is expected that the climate will become even dryer and rainfall will be more sparse but stronger when it occurs. Therefore irrigation will become less reliable and flooding will occur more often according to The Third Pole, Ryskeldi Satke, 2021 and The Third Pole, 2020.

All Central Asian countries have committed to the Paris agreement and therefore agreed to substantially reduce greenhouse gas emissions. The non-profit organisation New Climate Institute, whose main supporter is The Potsdam Institute for Climate Impact Research, publishes regularly in Climate Action Tracker, 2020, which monitors the actions of different countries and compares them to the promised actions to be taken. Actual readings are available only for Kazakhstan. Regarding the economical strength and the commitment of the countries under inspection one may assume that the other four countries are on the same path if not behind Kazakhstan.

The INDC[3] targets, leading to reduction of greenhouse gases as of 2017 are listed in table V.

Meanwhile, Kyrgyzstan, Tajikistan and Uzbekistan have updated their INDC targets as NDC[4] targets by 2021. These updates comprise more ambitious targets and concrete steps towards the goals. In addition, control measures were described. All reports can be found in the United Nations Framework Convention on Climate Change (UNFCCC), 2021

Also, Kyrgyzstan, Tajikistan and Turkmenistan are pointing at the fact, that they are middleincome countries with one of the lowest greenhouse gas emissions in Central Asia. Although the urgent need for a global energy transition is accepted, the main concern for these countries is economic development and social stability. Projections show, that economic growth is strongly related to greenhouse gas emissions. So the decrease of emissions must reach rates of up to 90 % by 2050 in order to stay at the current level. For a net reduction by then, the emissions must decrease even further.

[3]Intended Nationally Determined Contributions
[4]Nationally Determined Contributions

Table V: Planned Greenhouse Gas Reductions, given in The Third Pole, Timur Idrisov, 2021

Country	Planned Reduction
Kazakhstan	15 % - 25 %
Kyrgyzstan	11.49 % - 13.75 %
Tajikistan	10 % - 20 %
Turkmenistan	none
Uzbekistan	specific emissions per unit of GDP by 10 %

3.1 Kazakhstan

Kazakhstan published very ambitious goals for their climate strategy. In a summit held on December 12, 2020, Kazakh President Kassym-Jomart Tokayev announced that Kazakhstan will reach carbon neutrality by 2060 as The Astana Times, 2020 reports. The summit also served as a preparation for COP 26, held in Glasgow in November 2021. On this summit president Tokayev declared:

" In this challenging context, on behalf of all Kazakh citizens, I wish today to reaffirm our strong commitment to fighting climate change and our intent as a nation and government to take increasingly bold targeted action under the Paris agreement. In that spirit, we pledge to reach carbon neutrality by 2060. Kazakhstan will develop and adopt an ambitious long-term development strategy to lower emissions and decarbonise our economy to reach the goal. "

According to the Paris Agreement, Kazakhstan committed to reduce greenhouse gas emissions by 15 % below 1990 levels (including LULUCF[5]) by 2030 in Republic of Kazakhstan, 2016.

When excluding LULUCF emissions and using projections from the latest National Communication and UNFCCC[6] inventory data, Kazakhstan's target is equivalent to 17 % below 1990 levels or 5 % above 2010 levels by 2030.

Although Kazakhstan formulates the most ambitious plans of all countries in Central Asia, how to reach the climate goals of the Paris agreement, the NDC targets dated in 2016 have not been updated yet. As far as Kazakhstan is concerned, the results are disappointing, and it looks as if the announcements are mere lip services. Concerning the goals of the Paris agreement, Climate Action Tracker, 2020 states as of September 15, 2021:

> *" We rate the conditional NDC targets as **Almost sufficient** when compared to modelled emissions pathways. The **Almost sufficient** rating indicates that Kazakhstan's internationally supported target for 2030 is not yet consistent with the Paris Agreement's 1.5°C temperature limit but could be, with moderate improvements. If all countries were to follow Kazakhstan's approach, warming*

[5]Land Use, Land-Use Change and Forestry
[6]United Nations Framework Convention on Climate Change

could be held below - but not well below - 2°C. The conditional target is close to the upper limit of this rating category, meaning that a small change in the numbers could lead to a worse rating. "

Furthermore Climate Action Tracker, 2020 states:

*" We rate the unconditional NDC target as **Insufficient** when compared with its fair-share contribution to climate action. The **Insufficient** rating indicates that Kazakhstan's fair share target in 2030 needs substantial improvements to be consistent with the Paris Agreement's 1.5°C temperature limit. Kazakhstan's target is at the least stringent end of what would be a fair share of global effort and is not consistent with the Paris Agreement's 1.5°C limit unless other countries make much deeper reductions and comparably greater effort. If all countries were to follow Kazakhstan's approach, warming would reach over 2°C and up to 3°C. "*

3.2 Kyrgyzstan

The government of the Kyrgyz Republic describes its status concerning the UN's SDG[7] in a voluntary review Kyrgyz Republic, 2020. In this paper, the Kyrgyz Republic commits to the Sustainable Agenda in general.

" The Kyrgyz Republic is committed to the implementation of the 2030 Agenda for Sustainable Development. The SDGs have been included in public policies and are reflected in the National Development Strategy (2018–2040) of the Kyrgyz Republic, and the "Unity, Trust, Creation" (2018–2022) Program of the Government of the Kyrgyz Republic, based on people-centred approach. "

As far as SDG #12 is concerned, the main emphasis is put on handling waste. But some small improvements in energy transition are noted in Kyrgyz Republic, 2020:

" Despite the lack of government regulation and incentives for responsible production and consumption, there are positive examples of rational consumption and production models from enterprises and companies. More than 2,000 projects have been implemented using energy efficient and resource saving technologies such as renewable energy sources, drip irrigation, organic product farming, and the processing and recycling of waste. "

Meanwhile, Kyrgyzstan has updated its NDC targets in 2021, as stated in Kirgiz Republic, 2021. Especially concerning the climate goals, it is intended to unconditionally reduce greenhouse gas emissions by 16.63 % by 2025 and by 15.97 % by 2030, under the business-

[7]Sustainable Development Goals

as-usual scenario. Should international support be provided, greenhouse gas emissions will be reduced by 2025 by 36.61 % and by 2030 by 43.62 %, under the business-as-usual scenario.

The energy sector is responsible for 60 % of the greenhouse gas emissions. Therefore the mitigation capacity in this sector will be realised thanks to a decrease in the consumption of fossil fuels and an increase in the generation of energy based on renewable energy sources as well as the modernisation of energy supply systems, according to Kirgiz Republic, 2021.

Louise Chamberlain from *The Third Pole* The Third Pole, Louise Chamberlain, n.d. evaluates the content:

> " The NDC report lays out a vision for the sustainable and balanced development of the country, taking into account both the impacts of the climate crisis and the environmental and socio-economic problems that the country is facing. It also sets out a climate change strategy for 2030, with concrete, fully funded and achievable actions; and recognises the importance of adopting a Low-Carbon Development Strategy and a National Adaptation Plan."

Nevertheless one has to keep in mind, that the growing economy will result in growing emissions of greenhouse gases. Projections show a linear increase from 3.8 MT CO_2 in 2020 to over 34.5 MT CO_2 in 2050, which is almost a tenfold increase. To keep the emission at the current level, a planned reduction of 90 % by 2050 is needed. This goal is not yet formulated.

3.3 Tajikistan

The Republic of Tajikistan is a landlocked country in Central Asia, with more than 93 per cent of the territory covered by mountains. This means that water management is one of the main concerns. Tajikistan has selected two strategic developments to nationalise the SDGs:

1. ensuring energy security and efficient use of electricity and
2. ensuring food security and access of the population to quality nutrition.

Because of the national topology, the use of hydro-power is very obvious. Tajikistan already disposes of many large hydro-power stations and will rely on hydro-power shortly, as stated in Republic of Tajikistan, 2017:

> " According to the specific indicators of the hydro-power potential per one square kilometre of the area and per capita Tajikistan holds the first and second places in the world respectively. In terms of the use of resources of production of green power, the country is the sixth in the world.
>
> Hydro-power industry is a key source of power supply for Tajikistan's population and national economy. The development of a large-scale capacity hydro-power

> industry in the Republic of Tajikistan for the future can be significant, where there are more than 80 selected and surveyed dam locations for the construction of large hydroelectric power stations only. “

Although hydro-power is obvious in Tajikistan, building new large-scale hydro-power stations is not advisable due to the big damage large water reservoirs do to the environment. Tajikistan regards itself on a good course to energy transition, as stated in Republic of Tajikistan, 2017:

> “ The construction of large, medium and small hydro-power stations in Tajikistan is also of great importance as a support tool for the Kyoto Protocol to reduce greenhouse gas emissions and the Paris Climate Agreement. In this direction, the country has great potential.
>
> Technically possible and economically feasible to develop hydro-power resources of Tajikistan make 317 billion kWh per year, of which about 5 % have already been developed. “

Meanwhile, Tajikistan has updated its NDC targets in 2021, as reported in Republic of Tajikistan, 2021. Especially concerning the climate goals, it is intended to unconditionally reduce greenhouse gas emissions to exceed 60-70 % of greenhouse gas emissions as of 1990 by 2030. Furthermore, the conditional reduction, subject to significant international funding and technology transfer, is not to exceed 50-60 % greenhouse gas emissions as of 1990 by 2030.

Further concrete steps are not listed.

3.4 Turkmenistan

Turkmenistan is supported very much by the United Nations in reaching the targets of the Paris Agreement. Concerning environmental sustainability and energy efficiency – one of the strategic areas –, the UN continued the dialogue with the Government on defining the country’s NDC targets. One of the milestones reached in 2020 was the adoption of the “National Strategy and Law of Turkmenistan on Renewable Energy”. The *2020 UN Turkmenistan Annual Results Report* reports in Republic of Turkmenistan, 2017 about the steps taken:

> “ In 2020, the UN-Government cooperation further evolved under the national motto of the year “Turkmenistan — Homeland of Neutrality”. Turkmenistan realised important initiatives in the domestic and international arena, and the UN actively engaged in supporting the Government in this process.
>
> The UN and the Government of Turkmenistan signed the new Cooperation Framework 2021-2025 (CF) on 14 March 2020, the first such partnership agreement in the Europe and Central Asia region, reaffirming and strengthening the strategic partnership on the 2030 Agenda for Sustainable Development. Fully aligned with the SDGs, the new CF offers a coherent and integrated UN support to the development needs

> of the country towards the achievement of SDGs. The increase in the number UN entities signing the CF from 8 to 19 testifies to the ambition of the new CF and the Government's commitment to intensify collaboration with the UN. "

In its Nationally Determined Contributions as stated in Republic of Turkmenistan, 2016, Turkmenistan is acknowledging the dynamic economic development as a primary objective and pays particular attention to optimising the structure of energy, protection and restoration of the environment and ecological systems. It also actively participates in international efforts and international cooperation to address climate change and implement the provisions of UNFCCC and the Kyoto Protocol.

As a national commitment the INDC report, in Republic of Turkmenistan, 2016 is stated:

> " The policy of Turkmenistan to mitigate climate change is reflected in main government programs, especially in the "National Strategy of social and economic transformation of Turkmenistan until 2030" and the "National Strategy of Turkmenistan on Climate Change". Adaptation to climate change is a major focus of the "National Strategy of Turkmenistan on Climate Change". The Strategy will be implemented through the "National Action Plans for Adaptation and Mitigation", which in future should become an integral part of national programs and plans for socio-economic development."
>
> There is no update yet of the INDC, dated in 2016.

3.5.Uzbekistan

Republic of Uzbekistan, 2020 reports in the *Uzbekistan – United Nations Country Results Report 2020*, that Uzbekistan is taking the first steps towards the SDGs by establishing governmental commissions:

> *" In 2020, Uzbekistan presented its first Voluntary National Review of the SDGs at ECOSOC's[8] High-level Political Forum. To promote enhanced public monitoring and oversight of SDG implementation, a bicameral Parliamentary commission on SDG oversight, headed by the Chair of the Senate and Speaker of the Legislative Chamber, was established. The President also proposed the adoption of a UN General Assembly (GA) resolution on enhancing the role of parliaments in achieving the SDGs and ensuring human rights during the 75th session of the GA. "*

As Outcome 6 in Republic of Uzbekistan, 2020, it is noted that by 2020 the rural population benefits from the sustainable management of natural resources and resilience to disasters and climate change. In Uzbekistan 50 % of the population is living in rural areas. Although the GDP is the second largest in Central Asia, the GNI per capita is among the poorest.

[8]UN's Economic and Social Council

Meanwhile, Uzbekistan has updated its NDC targets in 2021 in Republic of Uzbekistan, 2021. Overall, it has ambitious goals and good suggestions. Especially concerning the climate goals, it is intended to reduce the specific emission of greenhouse gases per unit GDP by 35 % by 2030 compared to the level of 2010.

Uzbekistan claims to be one of the most vulnerable countries in terms of climate change. Therefore it is afraid of shortage of water resources, increased desertification and land degradation, increase in the number of droughts and other dangerous phenomena. These events will endanger agricultural production and may pose a threat to the country's food security.

Republic of Uzbekistan, 2021 also states in its updated NDC report:

> *"The Law "On the Use of Renewable Energy Sources", issued by the* МИНИСТЕРСТВО ЭНЕРГЕТИКИ РЕСПУБЛИКИ УЗБЕКИСТАН *(Ministery* of Justice of the Republic of Uzbekistan), 2019 and the Law "On Public-Private Partnership", issued by the Ministery of Justice of the Republic of Uzbekistan, 2019 in Uzbekistan create the legal and regulatory framework to accelerate the implementation of renewable energy projects. According to the country's longterm development plans, it plans to increase the share of power generation, based on renewable energy sources to least 25 % by 2030. To achieve this target, it is planned to construct new renewable energy sources facilities with a total capacity of 10 GW, including 5 GW of solar, 3 GW of wind and 1.9 GW of hydro-power plants. The development of hydro-power in the country follows the path of tapping the potential of small rivers, irrigation canals, reservoirs, and watercourses.
>
> For the first time in its history, Uzbekistan launched a solar power plant with a capacity of 100 MW, which will save up to 80 million cubic meters of natural gas annually and prevent about 160 thousand tons of greenhouse gas emissions. "

A projection of the planned steps and the intended energy transition in Uzbekistan can be seen in figure 4, published by the Ministery of Energy of the Republic of Uzbekistan, 2021.

According to the State Committee for Nature Protection of the Republic of Uzbekistan, Национальное сообщение (National Communication), 2020, the development in Uzbekistan follows the direction of

- Installation of photo-voltaic converters in rural areas, which will provide remote rural settlements with electricity and quality drinking water.
- Creation of large photo-voltaic stations in the energy sector.
- Introduction of solar set-top boxes in boiler heating systems.

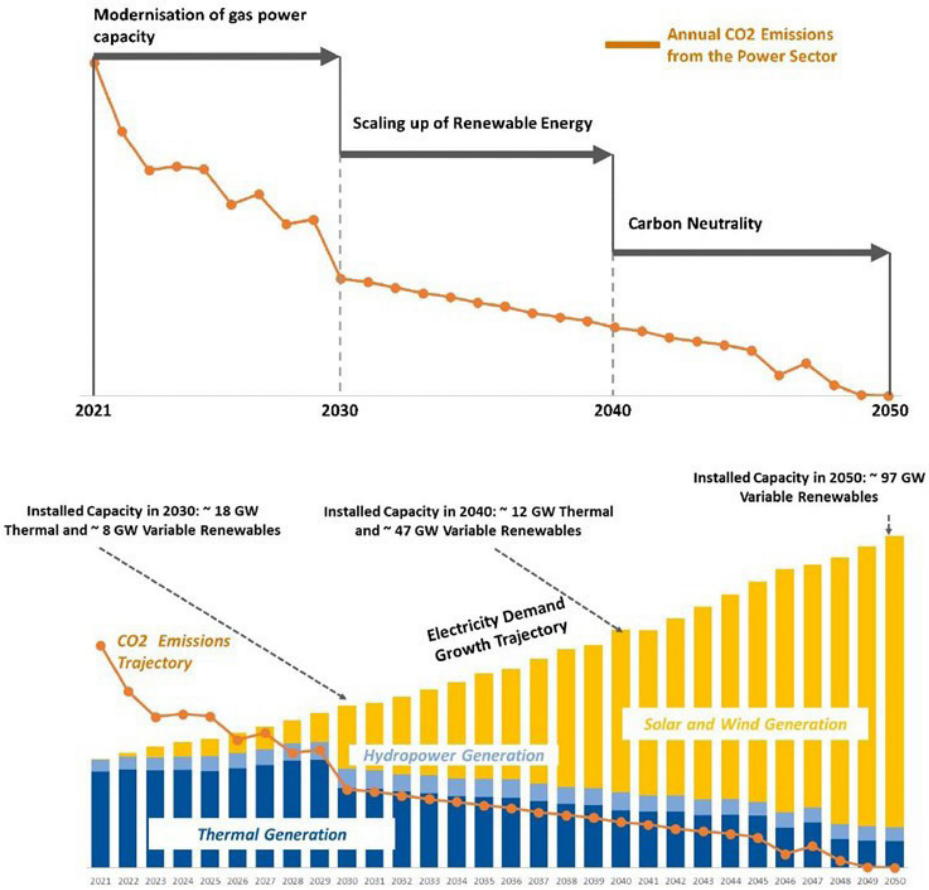

Figure 4. Plan of Energy Transition in Uzbekistan, published by the Ministery of Energy of the Republic of Uzbekistan, 2021

The main objectives and structure of investments in the development of renewable energy sources in Uzbekistan include, as stated in Национальное сообщение (National Communication), 2020:

Ensuring electrification of remote farms by 2030 through the introduction of photovoltaic production with annual capital investments of $ 2.45 million.

Provision by 2030 of 3 % of the electric power generation at the expense of photo voltaic devices operating in parallel with the grid, which will require up to $ 40 million in capital investments annually.

Modernisation of heat supply capacities and provision by solar-fuel attachments of up to 80 % of hot water supply needs by 2030, which will require investments in the amount of about $ 22.5 million annually.

4. Implementation

The successful implementation of the SDGs depends on many different factors. To identify these factors we have to define when implementation will be successful. Of course,

the number of installed GW of renewable energy sources and the reduction in greenhouse gas emission can be measured. But also the sufficient supply of energy must be ensured. Given that in many rural regions supply is still insufficient, this is a question of quality of life. The energy transition costs a lot of money. If these costs a refinanced by the revenue of the energy, then energy costs will rise, and mainly the poor people will be affected. This will surely lead to a disapproval of the energy transition. All these negative effects of an energy transition have to be avoided, the extra costs for the people have to be balanced by refunding. So a successful energy transition must also take into account these socio-economic effects and minimise the reservations against it.

4.1 Key Success Factors

Defining goals by social consensus The goals of the energy transition must be part of a social consensus. It must be in everybody's mind that the switch to renewable energy resources is inevitable. The goals and the reasons must be widely understood and commonly accepted.

Political structures as an obstacle Political structures must not act as obstacles to the energy transition but must support them. Activities enabling the use of renewable energy must be approved easily by the government. The politicians must foster the transition.

Few top-down activities, understanding instead of prescribing The prerequisites of an energy transition must be organised by the government. But the activities must be motivated out of understanding, not prescribing. The diversity of individual solutions and ideas must be used and accepted. So top-down activities must be met by bottom-up ideas.

Level of education, universities, local experts To enable people to participate in the energy transition and not only endure it, the level of education is also very important. People must understand the necessity and the rules of the energy transition; they must accept the consequences that follow the transition and must be able to cope with the changes in everyday life. This intellectual act needs public education. Local experts must support the people in this transition process.

Political/economic promotion, promotion culture Government must promote the energy transition. It also needs a culture of promotion that is not indoctrination but conviction. A communication strategy must be implemented to inform everybody transparently about the ongoing changes.

Promoting systemic thinking, lecture series The energy transition is not driven by single instances, since all the instances are mutually dependent and influence each other. Therefore, the energy transition must be handled as a complex change of system and must be planned by systemic thinking. People must be educated to systemic thinking, and study programs must be adopted to systemic thinking.

Support pilot projects Although there is a well defined goal (climate neutrality), the energy transition does not follow a master plan or a blueprint, simply because it has never

been done before. So it needs small steps that can be tested and evaluated in pilot projects. These prototypes must be supported by the government. Failure must be seen as a chance to learn, not as defeat and loss.

A very nice example of a pilot project is a solar power park in Tajikistan (figure 5). In November 2020, the solar park was inaugurated in Murghob in the Pamir Mountains in Gorno-Badakhshan Autonomous Region. The plant is Tajikistan's largest solar plant and the highest in Central Asia at 3'600 meters above sea level. It also connects to the existing Tojikiston 1.5 MW hydro power plant (HPP) and the power produced will improve electricity provision for approximately 8'000 people in Murghab and surrounding areas. The 220 kW solar park was the result of a collaboration between the Tajik government, USAID and Pamir Energy. The project also includes a 180 kW storage system.

Figure 5. Murghob Solar Park in the Pamir Mountains on 3,600 m above sea level, picture taken from USAID, 2020

We will focus our discussion on the implementation of the energy transition in Kazakhstan because data are available and the transition has already begun in Kazakhstan. Kazakhstan is a fossil-rich country with an enormous potential for renewable energies, that are not hydro-power (non-hydro renewable energies). Karatayev and Clarke, 2015 note some aspects:

- The resources of coal, uranium, crude oil and natural gas in Kazakhstan are among the

top 20 countries worldwide.

- Kazakhstan has much Uranium at its disposal: 15 % of world's resources, 38 % of total production, 90 % go into export.
- Domestic gas pipelines are underdeveloped.
- Electric grid is ageing and needs refurbishing, some connections are weak.

On the path to 1.5°, or even to 2.0°, the reduction of the use of fossil energy, in the best case to zero, is unavoidable. This decarbonisation of the world will obviously lead to a very reduced demand for coal, crude oil and gas, albeit on different time scales. This will also reduce the global market for fossil energy and destabilise countries, whose economies still depend on the export of fossil energy. But the share of non-hydro renewable energies is still negligible (less than 1 %).

Up to now, electrical energy is mainly produced, where it is needed. The only exception are hydro-power stations. But even then, energy-consuming industry has often been placed as close as possible. When electrical energy becomes the backbone of energy supply, electric connectivity is one of the key factors. Energy must be transported across the country. But the electrical grid in Central Asia is deteriorating and not capable of transporting huge amount of electrical energy across the country.

Figure 6 shows the main electricity lines in Central Asia. The electrical grid was built by the USSR in the 1980s. The power transmission network of the Central Asian countries was interconnected to form the Unified Energy System of Central Asia (UESCA). It interlinked approximately 83 power plants (30 % hydro-power plants and 70 % thermal power plants with a total capacity of 25 GW) located across the Central Asian countries with 220 kV and 500 kV transmission lines Mehta et al., 2021. After independence, the interests of the Central Asian countries drifted apart, and Turkmenistan and Uzbekistan withdrew themselves from the Unified Energy System in 2003 and 2009, respectively.

Mehta et al., 2021 describe the actual situation:

> *" The power sectors of Kyrgyzstan and Tajikistan rely mainly on hydro resources, and the power demand of these countries is higher in the winter than in the summer. Due to the cold winters, the river flows decrease, which leads to reduced power production and power shortages. In the summer, the opposite is the case. The regions have therefore established an energy exchange to meet seasonal demand. Uzbekistan and Turkmenistan export natural gas to Kazakhstan, Kyrgyzstan, and Tajikistan, while Uzbekistan and Turkmenistan (downstream countries) have minimal water resources and therefore require water to flow from upstream countries (Tajikistan and Kyrgyzstan) for irrigation purposes during the summer and spring.*
>
> *Kazakhstan, Uzbekistan, and Turkmenistan are directly dependent on their neighbours for water. Because of the winter power shortages, Kyrgyzstan and Tajikistan collect and*

store water for winter when they experience high power demand. As a consequence, the downstream countries do not receive enough water for agriculture. Because of the unequal and scattered distribution of the energy and water resources in Central Asia, significant tensions can arise between the fossil fuel-rich countries of Kazakhstan, Turkmenistan, and Uzbekistan; and the fossil fuel-poor countries of Tajikistan and Kyrgyzstan."

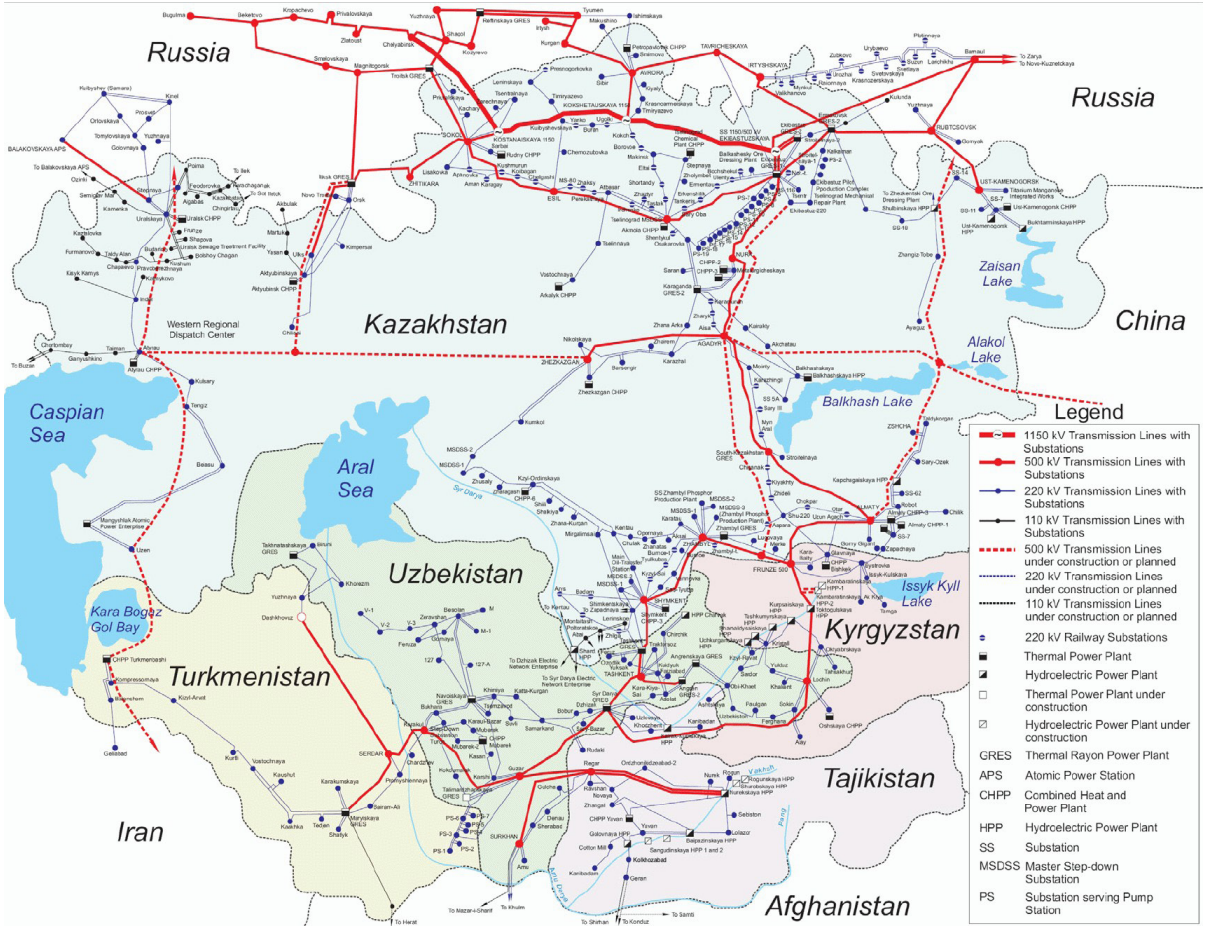

Figure 6. Electrical Grid in Central Asia, published by Global Energy Network Institute, n.d.

4.2 Technical Potential

As mentioned before, the resources of renewable energies in Central Asia are abundant. Sunlight is available plentiful in the dry steppe. The potential for solar energy amounts to 324,000 TWh: the sun shines between 2200 h and 3000 h per year with an intensity of 1200 to 1700 kWh/m^2. Kazakhstan's land area sums up to 2.7 million km^2. If one assumes an efficiency of only 10 % for photo voltaic installations, the enormous amount may be computed. The annual electricity consumption of Kazakhstan is 17 to 20 GWh with 13 GW peak power. So Kazakhstan is able to produce its demand of electrical energy by PV alone. Less than 200 km^2 should suffice for that. Of course one has to take into account

the needed peak power.

A comparison of technical potential for renewable electrical energy is given in table VI.

Table VI. Technical Potential for Installed Renewable Electricity Capacity in GW according to Shadrina, 2020

Country	Wind	Solar	Biomass
Kazakhstan	345.0	3,760	0.3
Kyrgyzstan	1.5	267	0.2
Tajikistan	2.0	195	0.3
Turkmenistan	10.0	655	none
Uzbekistan	1.6	593	0.8

Every implementation of the use of renewable energy sources has to take into account that these energy sources a volatile. A very strong disadvantage, which has often been used as counter-argument, is the fact that renewable energy sources largely depend on the weather and are not available every time: the sun is not shining when it is cloudy, or during the night; the wind may blow too slow or too fast; water may not be available to a sufficient degree during dry seasons. So any implementation of renewable energy sources always has to be a mix of different sources and must necessarily include means of storage.

The mix of sources includes a backup solution if all else fails. One needs energy sources that can be switched on regardless of the current weather. But luckily there are alternatives, that can be retrieved on demand. All these sources share a common feature: they are not volatile, but rely on stored energy. One already used storage of energy is a water reservoir. The water can be released as needed. The problem is the dual use of water as irrigation which requires availability of water downstream at certain times.

Another storable form of renewable energy is biomass. Either the biological material can be stored for a limited time, or the product of biomass, methane, can be stored in conventional storage devices.

Other forms of storing energy are under investigation and a focal point of research: storing electrical energy in batteries, storing hot water in suitable geological formations, producing high-energetic hydrocarbons from carbon dioxide and water.

Another interesting way of storing energy may be the production if hydrogen. It is called *green hydrogen*, if it is produced with energy from renewable energy sources. The easiest way is to use electrical energy in electrolysis for splitting water into hydrogen and oxygen. Hydrogen can be converted into electrical energy by fuel cells very efficiently, producing water. Hydrogen is also a very valuable raw material for chemical industry and steel production. Today the so called synthesis gas is obtained from methane in a chemical process releasing carbon dioxide.

The main disadvantage of hydrogen is the difficulty of storing it directly. Hydrogen

has the ability to diffuse through metal; so conventional storing and transporting suffers a big loss. Furthermore, to reduce the storage volume or increase the amount of stored energy per unit volume, hydrogen has to be liquefied, either by low temperature or high pressure or both.

So the conversion of hydrogen together with carbon dioxide delivers methane, which can be handled with conventional methods. Methane can also be used to gain electrical energy in fuel cells. To keep the process *green*, the loop of the used carbon dioxide must be closed, so that carbon dioxide is a means of transportation, and no additional CO_2 will be emitted into the atmosphere.

For countries depending on fossil fuels, the production and trade of green hydrogen may be an alternative to the current trading model. When the world will be decarbonising, these models may become an interesting future for Central Asia, since it disposes of an abundant amount of renewable energy sources and the necessary uninhabited areas to harvest them.

The significant barriers for using this huge amount of renewable energy are:

Political and regulatory framework focuses on fossil fuels. A shift of focus is necessary.

Lack of awareness in combination with social poverty and poor education. The awareness of the people must be raised by public education.

Low electricity tariffs combined with subsidies for fossils make renewable energies unprofitable. The electricity tariffs must be adopted to the new strategy without putting too much strain on the poor.

Inefficient but incumbent power technology leads to high energy demand per GDP unit. Power technology, grids and industrial production must be improved.

High-risk business environment leads to low national or international investments. A stable regulatory framework must be introduced, corruption must be fought and legal certainty by independent courts must be improved.

5. Economy and Society

The energy transition places great burdens on society and the economy. For the energy transition to become a success, it is necessary to have a good acceptance in society and a certain resilience in the economy. A complete overview of the social and economical situation in Central Asia can be found in Lemp et al., 2020.

The economies of the countries in Central Asia are in a different state. As shown in table VII, Kazakhstan has supremacy. It has the second largest population after Uzbekistan and has the largest GDP per capita.

Turkmenistan has a strong standing. It has the largest growth in GDP, per capita as well as in total, and the second-largest GDP per capita.

Uzbekistan is the most dynamic country in Central Asia. It has the largest population and the second-largest growth in GDP in total, although its GDP per capita is much smaller

than Kazakhstan's or Turkmenistan's.

Kyrgyzstan and Tajikistan have lost precious time to revolution. Their GDP per capita is by far the smallest, and also the growth of GDP is the smallest.

Table VII. Economical Strength of Central Asian's Countries according to Shadrina, 2020

Country	Population in millions	Population Growth in %	GDP per Capita	GDP Growth in %	GDP per Capita Growth in %
Kazakhstan	18.3	0.39	24,738	3.47	3.04
Kyrgyzstan	6.3	1.29	3,447	1.93	0.60
Tajikistan	9.1	1.93	3,061	2.28	0.31
Turkmenistan	5.9	1.61	17,129	5.04	3.39
Uzbekistan	32.5	1.68	6,240	4.49	2.76

5.1 Social Acceptance

To achieve social acceptance, there must exist an excellent communication concept to convince, or at least persuade the bigger part of the society.

Convincing may happen through rational arguments and emotional feelings. The arguments are obvious: the climate changes inevitably; we can only slow down the change. And the change will affect everybody. Meteorologists predict a warmer climate leading to more vapour in the atmosphere and therefore heavier weather events, like draughts, rainfall, floods. Nobody can foresee exactly the local or regional effects, but one can describe the general development.

Besides the arguments there are also feelings about the energy transition. Since the transition implies a change in everyday life and in usual habits, it imposes stress and anxiety on most people. So an emotional campaign has to accompany the transition phase as well. Some of these anxieties are quite real: e.g. energy prices will most likely rise during the transition. In a poor population this poses an existential risk. One may appeal e. g. to heroic patriotism or romantic love of nature.

5.2 Legal Situation

The energy transition technically follows a certain path and priorities have to be set. This is done by authorities through laws and regulations. Since the transition process takes a longer time, typically some decades, the legal situation should be quite stable during this time, although some adjustments have to be done meanwhile.

For the energy transition to take place, huge investments are necessary, that will pay out in some decades. So public investors, and even the public sector, rely on transparent and stable rules, based on which they can plan and act efficiently. So it is essential to put up a reliable scaffold of rules and regulations.

5.3 Investment climate

Directly linked to the legal situation is the climate for investments. For investors

to come, there must be a chance for the investments to pay out at a fair rate and within a reasonable time frame. Especially corruption is poisonous to the investment climate, because the rules may shift suddenly and unpredictably if there is a change in political hierarchy or leadership. Table VIII presents an evaluation of political institutions and of market functionality on a scale from 0.0 to 1.0. The mean value is given as Total Quality Index.

Table VIII. Institutional Quality Index according to Shadrina, 2020, on a scale from 0.0 to 1.0

Country	Political Institutions	Market	Total Quality Index
Kazakhstan	0.2287	0.7018	0.4652
Kyrgyzstan	0.2528	0.5120	0.3824
Tajikistan	0.0836	0.3689	0.2262
Turkmenistan	0.0453	0.0667	0.0560
Uzbekistan	0.0728	0.3832	0.2280

5.4 Poverty

The burdens of the energy transition must be shared fairly.

The main concern for an energy transition is how the costs of the change will be distributed. The more the investments will be refinanced by price, the more the energy prices will rise. On one hand, it will change the behaviour of the people towards less energy consumption. On the other hand, there are necessary expenditures for energy, which concerns most the poor people. As mentioned for social acceptance, there must be a program to facilitate the financial burden for the poorer part of the population.

Also, craftsmen and small industries must be protected from extraordinary strain since they are the backbone of employment and therefore contribute a large part to the economical strength and resilience of society.

5.4 Think Tanks

If all of the mentioned problems have to be solved and overcome, many new ideas will be needed. To generate new ideas and methods, free-thinking must be fostered. Many problems will arise, that cannot not yet be foreseen.

Experience shows that all of the problems are interconnected; energy transition is not a monocausal strain of operation. So people are needed who are able to think and act in an interconnected manner. It will be the task for educational institutions to train local experts and to enable persons for this task.

Think tanks must be set up, where people from different disciplines work together for new ideas and solutions. The results must be evaluated and should contribute to the decisions taken by politicians.

6. Findings and Conclusions

According to Shadrina, 2020, the development of the countries of Central Asia lies on different paths towards energy transition. Russia and Kazakhstan are on a similar path; they share mutual standards and are competitors. Kyrgyzstan and Tajikistan have no profound reforms yet; they are depending on Russia and China.

The Central Asian countries can be divided in three types:

Proactive: existence of nation's vision, delivery of policies, combination of domestic and international capacities — Kazakhstan and Uzbekistan

Reactive: retain priority for hydro-power, signalling intention for renewable energies, no measurable goals, no regulatory mechanisms — Kyrgyzstan and Tajikistan

Indifferent: abundant hydrocarbons, relatively wealthy, utterly reclusive, no renewable energies at all, no agenda — Turkmenistan

With regard to these three types, it must be noted:

- Higher developed countries have a higher commitment to renewable energies.
- All economies depend on external resources (innovation and capital).
- Countries of lower income have riskier dependencies on socio-economic factors.
- Institutional quality is critical (economic openness and learning qualities).
- Proactive countries act as an anchor e.g. by regular international symposiums.
- Reactive countries should learn and follow since they are already facing problems (energywater-nexus, climate change, energy poverty, deteriorating infrastructure).
- Indifferent countries will run into severe problems because of their dependency on China or Russia.

Central Asia needs well educated local experts on different levels to:

- Further develop the legal basis to shape and communicate the energy transition,
- Plan and install the technical equipment to enable the energy transition,
- Run the energy business in an economical and profitable way.

The awareness in Central Asia must be raised by

- Informing people explaining the necessity of energy transition
- Educating people to understand the goals of energy transition
- Assuring people that the energy transition is not a thread even for the poorer people

In our opinion, the further development of the energy transition in Central Asia will be dominated by the following questions:

Share of renewable energy: Will the share renewable energy has in the total mix

be growing in the future? Although there are commitments the growing economy and the social development may outweigh all such efforts. The countries of Central Asia point to the fact, that their economical development is lagging behind and there is an urgent need to catch up. This is undeniable, but makes the needed efforts even larger.

Availability of renewable energy: Will renewable energy be available throughout Central Asia? Since the generation of renewable energy is decentralised and distributed over a larger area than energy from fossil sources, a reliable and sufficient electrical grid and network of gas pipelines for hydrogen is necessary. The actual grids have deteriorated.

Secure and cheap access to energy: Will everybody have secure access to energy at reasonable prices? The need for energy will rise with the economical prosperity of the people. Raising prosperity is the main concern of all countries in Central Asia because poverty especially in rural areas is a severe problem. So again a reliable grid throughout Central Asia must be maintained.

Decarbonisation of global economy: What could serve as a substitute for fossil energies as export goods? The main source of income is raw materials and mineral resources for most countries in Central Asia. If the demand for crude oil, coal and uranium will decrease globally, it must be compensated by other exporting goods. On the other hand, the energy demand will increase globally. So the countries of Central Asia must start investing in generating renewable energies including green hydrogen for export.

Access to reliable data: How can honest data be collected in a public and reliable manner? Honest collection means presenting data, that are not manipulated in any way to support political goals. The ability to control the energy transition needs a sound basis of reliable data. This includes technical data like global radiation and wind strength, economical data like energy consumption and production figures and sociological data like population growth and individual need for energy. Then decisions can be taken based on scientific advise and clearly communicated goals on a given timeline.

Local experts Will there be enough local experts that can implement the energy transition in Central Asia? Education is a very crucial part of the energy transition. Local experts in all fields of education are needed for the transition to become a success. Therefore it is necessary to invent study programs at higher education institutions as well as strategies in public communication.

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