ENABLING PV in Kazakhstan

Project partners

eclareon

BSW GERMAN SOLAR ASSOCIATION

Funded by

Federal Foreign Office

Published by:
eclareon GmbH
Albrechtstrasse 22
10117 Berlin, Germany
E: info@eclareon.com
T: + 49 30 8866740-0
Fax: + 49 30 8866740-11
www.eclareon.com
Person responsible for content under §55 paragraph 2 RStV: Christoph Urbschat (eclareon)
Funding body: Federal Foreign Office (German: Auswärtiges Amt)
Project number: (Förderkennzeichen - FKZ): AZ45220010
Editing date of publication: 14.12.2022

Authors:

Julian Scheider, Alik Aylarov, Éléonore Ray, eclareon GmbH

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Definition
BAT	“Best-Available-Technology”-principle
BRELL	Related energy systems of Belarus, Russia, Estonia, Latvia and Lithuania
CAPEX	Capital Expenditures
CHP	Combined Heat and Power
CIS	Commonwealth of Independent States
DCF	Discounted Cash Flow
DSCR	Debt Service Coverage Ratio
EK REC	East Kazakhstan Regional Energy Company
EMS	Emissions Monitoring System
ESC	Energy Supply Companies
GDP	Gross Domestic Product
GRES	Combined-cycle gas-fired Power Station
GTI	Global Tilted Irradiation - global solar radiation on an inclined surface
GW	Gigawatt
GWh	Gigawatt per hour
ITA	International Trade Administration
IRR	Internal Rate of Return
JSC	Joint Stock Company
KEGOC	Kazakhstan Electricity Grid Operating Company
KOREM	Kazakhstan Electric Power and Capacity Market Operator
KREM	Committee for the Regulation of Natural Monopolies and Protection of Competition
KUS	Kazakhstan Utility Systems LLP
kV	Kilovolt
kW	Kilowatt
kWp	Kilowatt peak
kWh	Kilowatt per hour
LCOE	Levelized Costs of Electricity
LLCR	Loan Life Cycle Coverage Ratio
LTD.	Limited Liability Company
MW	Megawatt
MWh	Megawatt per hour
NDC SO	National Dispatcher Center of the System Operator
NEG	National Electric Grid
NP	Non-Commercial Partnership

NPV	Net Present Value
OJSC	Open Joint-Stock Company
PAO	Public Joint Stock Company
PP	Power Plant
PPA	Power Purchase Agreement
PV	Photovoltaic
REC	Regional Energy Company
REgC	Regional Electricity Grid Companies
RES	Renewable Energy Sources
RFC	Calculation and Finance Centre for the Support of Renewable Energy Sources
R&D	Research and development activities
SME	Small and Medium Business Enterprises
TPP	Thermal Power Plant
TW	Terawatt
TWh	Terawatt per hour
UES	Unified Energy System (or UPS)
UES SO	System Operator of Unified Energy System
UNDP	United Nations Development Programme
USSR	Union of Soviet Socialist Republics
VAT	Value Added Tax
WACC	Weighted Average Cost of Capital

Objectives of the ENABLING PV Project

The market for solar PV installations has become increasingly international over the last decade. While the first solar boom mainly encompassed developed countries, who supported renewable energies (RE) with often similar support schemes mainly based on feed-in tariffs, the landscape for solar energy today is different and much more diverse. Having either already reached or being on the verge of reaching cost competitiveness with conventional energy sources in many countries, the number of RE markets and business models that work in those markets have multiplied in the last years. And just as every project is different, so are the conditions and regulatory frameworks in every country.

It is in this context of an increasingly international PV market that the company eclareon, a consulting company specialized in renewable energies, started to investigate business models and the business environment for PV in different countries under the label “ENABLING PV” in 2013. One year later the first study was published and today the series covers the solar markets of Tunisia, Jordan, Brazil, Argentina, Nigeria, Angola, Iran, Pakistan and Azerbaijan, among others.

The label “ENABLING PV” demonstrates the intention of this report: enabling the growth of solar PV based energy around the globe. In order to achieve this, projects need to be realised and the foundation for this is the collection, distribution and discussion of country specific knowledge. **ENABLING PV reports shall provide a starting point for those investors and solar entrepreneurs who are interested to expand their business to new markets.**

This report on PV potential in Kazakhstan is partly the result of eclareon activities in Kazakhstan in 2022 and 2023, including meetings with local stakeholders, workshops and educational projects. Moreover, the information gathered for the first edition of this report in 2019 is still included unless it was found no longer relevant or applicable.

Additional work with partners from Kazakhstan and new workshops are planned for 2023. Moreover, by presenting the results of the current study, the goal of this report is to find interested partners locally and develop pilot projects for photovoltaic systems in the country.

Berlin, December 14th, 2022

Julian Scheider

Project Manager, “ENABLING PV in Kazakhstan“

Задачи проекта ENABLING PV

В течение последнего десятилетия, рынок солнечных фотоэлектрических установок становится все более интернациональным. Первый солнечный бум случился в основном в развитых странах, которые решили поддержать возобновляемые источники энергии используя зачастую аналогичные схемы поддержки, основанные главным образом на льготных тарифах. Сегодня ситуация в области солнечной энергетики уже иная и схемы стали разнообразнее. В последние годы, ВИЭ во многих странах уже стали конкурентоспособными или находятся на грани конкурирования с традиционными источниками энергии с точки зрения капитальных затрат, число рынков и бизнес-моделей, работающих на этих рынках, увеличилось в несколько раз. И, как различны между собой разные проекты, так и рамочные условия в каждой стране отличаются друг от друга.

Именно в этом контексте растущего международного рынка фотоэлектрической энергии консалтинговая фирма eclareon в 2013 году приступила к изучению бизнес-моделей и бизнес-среды для фотоэлектрической промышленности в разных странах под маркой проекта "ENABLING PV". Первое исследование было опубликовано в 2014 году, и, на сегодняшний день, серия исследований охватывает такие страны, как Тунис, Иордания, Бразилия, Аргентина, Нигерия, Ангола, Иран, Пакистан и Азербайджан, среди прочих .

Название "ENABLING PV" демонстрирует намерение этого отчета: способствовать росту и развитию солнечной энергетики по всему миру. Для этого необходимо реализовывать проекты, основой которых является сбор, распространение и обсуждение знаний, специфичных для данной страны. **Отчеты "ENABLING PV" должны стать отправной точкой для тех инвесторов и предпринимателей в области солнечной энергетики, которые заинтересованы в расширении своего бизнеса на новые рынки.**

Данный отчет о потенциале фотоэлектрической энергии в Казахстане частично является результатом деятельности eclareon в Казахстане в 2022 и 2023 годах. Во второй половине 2019 года были организованы встречи и семинары с представителями энергетического сектора, компаниями, учреждениями, университетами и потенциальными инвесторами для обсуждения возможного применения фотоэлектрических систем и определения пилотных проектов. Информация, собранная для первого издания данного отчета в 2019 году, по-прежнему включена в него, если только она не была признана утратившей актуальность или применимость.

На 2023 год запланирована дальнейшая работа с партнерами из Казахстана и новые семинары. Кроме того, целью является презентация результатов текущего исследования, поиск заинтересованных партнеров на месте и разработка пилотных проектов по фотоэлектрическим системам в стране.

Executive Summary

The Republic of Kazakhstan is the largest country in Central Asia in terms of area. The main economic activities are industry and services. A major producer of coal, crude oil and natural gas, Kazakhstan fully meets its domestic energy requirements and exports large quantities of these fossil fuels abroad.

Kazakhstan's energy sector, through many market, systemic and innovative reforms, is a self-sufficient and independent entity. Due to the large coal reserves in the region, thermal power plants play a major role in the energy sector, many of which are inherited from the Soviet past and half of which have been in operation for more than 30 years. Because of the regional division of the energy sector, Kazakhstan has joint energy systems with neighbouring countries, making the country partially energy dependent.

The development of the renewable energies sector in Kazakhstan is still at an early stage. However, global trends as well as the favourable natural conditions especially of the southern regions of the country for large-scale RES deployment, induced the government of Kazakhstan to develop a concept for the country's transition to a green economy. As a result, 1,700 MW of RES capacities were already installed by 2019. One key objective of this report was to identify economically viable business models that can enable Kazakhstan to realize its renewable energy potential.

This ENABLING PV report presents various business models, each of which provides the necessary development vector as to how solar power can be implemented and utilised in different market segments, considering the varied associated factors.

In this context the international consultancy company eclareon GmbH, which specializes in renewable energy and energy efficiency, has analysed the current processes and potential barriers in the Kazak photovoltaic sector. Moreover, this study includes key data on the electricity market situation in the Republic of Kazakhstan as a whole that is used for the above-mentioned business case analysis.

All the information published in this report can be used for the purpose of developing the renewable energy sector in Kazakhstan, both for internal energy sector players and external stakeholders.

The legal, regulatory and market conditions for the development of photovoltaic systems are a fundamental factor for attracting RES investors. These conditions and a cost-benefit analysis from an investor's perspective are described in the study for five different PV business models.

A main finding of this report is that small-scale photovoltaic systems are already cost-competitive when applied to the agricultural sector of Kazakhstan, in particular in farms, which often face difficulties with centralised electricity supply. These small-scale photovoltaic systems applied in agriculture are another focus area of this study.

Сводное Резюме (Executive Summary)

Республика Казахстан является крупнейшей по площади страной в Центральной Азии, основными видами экономической деятельности которой являются промышленность и сфера услуг. Обладая широкими запасами углеродного сырья, Казахстан полностью обеспечивает внутренние энергетические потребности, экспортируя в большом количестве излишки за рубеж.

Энергетический сектор Казахстана, путем многих рыночных, системных и инновационных реформ, является самостоятельной и независимой структурой. Благодаря крупным запасам угля в регионе, в энергетическом секторе большую роль занимают тепловые электростанции, многие из которых являются наследием советского прошлого и половина из них эксплуатируется более 30 лет. По причине регионального деления энергетического сектора, Казахстан имеет совместные энергетические системы с соседними странами, что делает страну частично энергозависимой.

Казахстан стоит на начальном этапе развития сектора ВИЭ. Мировые тренды, а также экономическая предрасположенность южного региона Казахстана к развитию ВИЭ, побудили Правительство Казахстана разработать Концепцию по переходу страны к «Зеленой экономике», в рамках которой уже к 2019 году были реализованы 1,700 МВт ВИЭ объектов. Нашей задачей было выявить экономически оправданные бизнес-модели, которые позволят региону добиться поставленных целей.

В данном отчете ENABLING PV представлены различные бизнес-модели, каждая из которых показывает возможный вектор развития того, как солнечная энергетика может быть внедрена и использована в различных сегментах рынка, учитывая разносторонние сопутствующие факторы.

Именно в этом контексте международная консалтинговая компания eclareon GmbH, специализирующаяся в области возобновляемой энергетики и энергоэффективности, провела анализ актуальных процессов и возможных барьеров, происходящих и существующих в казахстанском фотоэлектрическом секторе. Настоящее исследование включает в себя ключевые данные по ситуации на рынке электроэнергии в Республике Казахстан в целом, а также анализ выявленных для страны потенциальных привлекательных бизнес-кейсов.

Ключевым аспектом проекта является предоставление наиболее значительной и развернутой информации об актуальном состоянии фотоэлектрического рынка в Республике Казахстан. Вся исследовательская информация, публикуемая в данном докладе, может быть использована с целью развития ВИЭ сектора в Казахстане как для внутренних участников энергетического сектора, так и сторонним заинтересованным сторонам.

Правовые, нормативные и рыночные условия для развития фотоэлектрических систем в Республике Казахстан являются основоположным фактором для привлечения инвесторов в проекты ВИЭ. Данные пункты наряду с анализом затрат и выгод с точки зрения инвестора для пяти различных бизнес-моделей фотоэлектрических систем в регионе описаны в исследовании, которые также могут быть использованы для дальнейших научно-исследовательских и практических работ.

Учитывая интерес Правительства Республики Казахстан в развитии сектора ВИЭ, центральным пунктом при составлении бизнес-моделей были выявлены крупные солнечные парки, поставки электроэнергии из которых контролируются и обеспечиваются государством за счет внедренного «Единого закупщика энергии». Данный механизм позволяет инвестировать в крупные ВИЭ объекты на основании обязательных контрактов по покупке электроэнергии государством.

Маломощные фотоэлектрические системы могут быть успешно внедрены в сельскохозяйственный сектор Республики Казахстан, в частности в фермерские хозяйства, которые зачастую испытывают трудности с централизированным электрообеспечением. Эти маломасштабные фотоэлектрические системы, применяемые в сельском хозяйстве, являются еще одним направлением данного исследования.

1. Electric Power Sector of Kazakhstan

1.1 Country overview

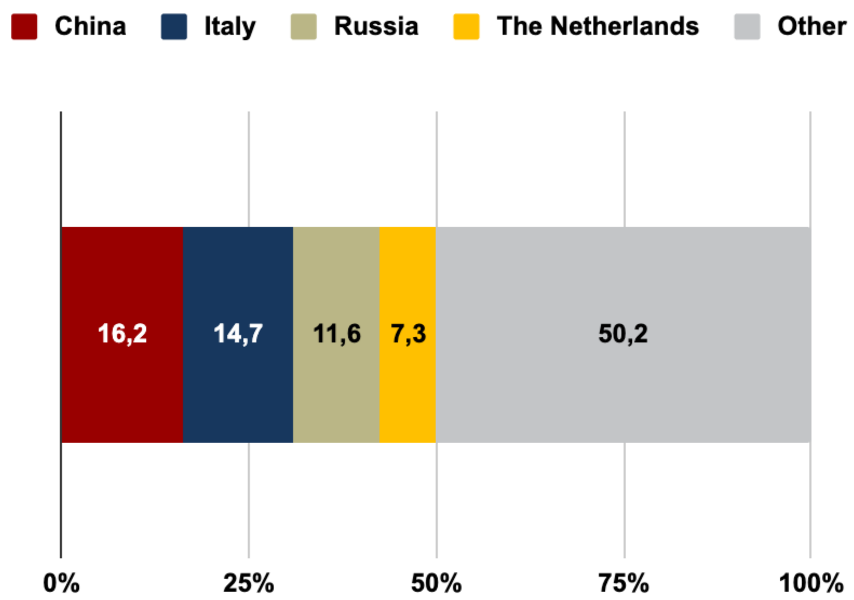
The Republic of Kazakhstan is the largest Central Asian country, located in the centre of the Eurasian continent. **The country was founded after the collapse of the USSR in 1991. Today more than 19.7 million people live in Kazakhstan. With a territory of 2.7 million km^2 Kazakhstan is the second largest country in the CIS and the ninth largest in the world** [1]. It borders Russia to the west and north, China to the east, and the Central Asian countries Kyrgyzstan, Turkmenistan and Uzbekistan to the south. The total length of the borders is 12,200 km, 600 km of which are adjacent to the Caspian Sea. Kazakhstan is the country with the lowest population density in the CIS – only 7.22 inhabitants per km^2. This is primarily due to the harsh continental climate with its characteristic warm summers and cold winters. Different climatic conditions render Astana the second coldest capital in the world with an average annual temperature of +3.5°C, while the average temperature in the southern regions is +15.8°C. Annual precipitation reaches 255.46 mm and the average temperature is 7.16°C [2].

Figure 1: Kazakhstan on the world map

Source: eclareon 2022, map generated by Pixel Map Generator, amCharts

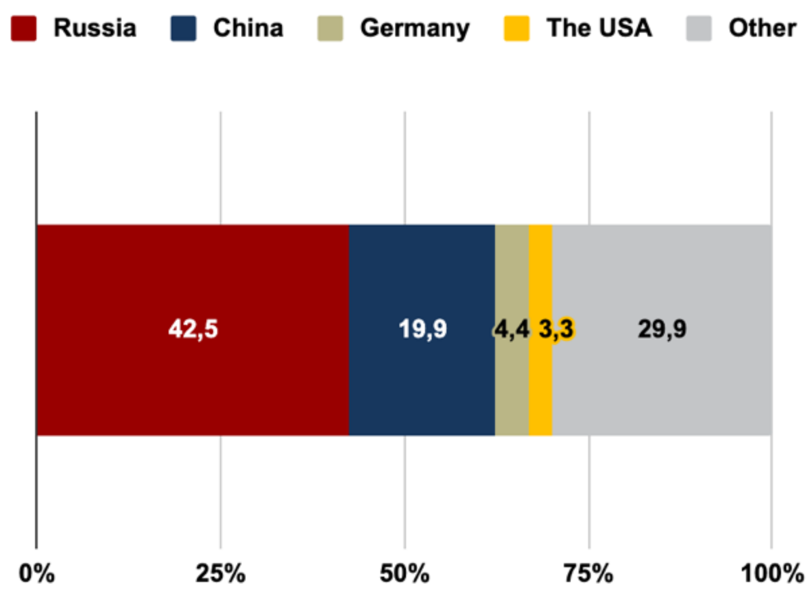
In 2021, the services sector contributed 53.8% to the GDP, the industrial sector 29.6% and agriculture 5.1% [3]. The extraction and export of hydrocarbons (natural gas, oil) ensured rapid growth of the country's GDP. Between 2000 and 2010, the average GDP growth rate was 9.4% until the global financial crisis hit in 2008. However, GDP growth fell to 1.2% in 2009, mainly caused by a sharp drop in oil prices, which fell by 71.9% within 3 months [41]. Since 2010, the average GDP growth rate per year stood only at 4.2%. In 2021, Kazakhstan went through a recession due to the coronavirus and the GDP decreased by 2.5%. Nevertheless, GDP per capita at purchasing power parity (constant 2011 international USD) has been growing steadily, increasing by a factor of 3.7 since 2000 and amounting to USD 26,111 in 2021 per inhabitant (USD 28,684 in current international PPP) [11]. This is, except Russia, the highest figure among CIS countries [11]. Kazakhstan's main exports are natural resources, including oil, copper, aluminium, zinc and uranium, ferrochrome and grain. About 50% of natural gas produced in Kazakhstan is used locally as fuel for power plants [47]. According to Kazakhstan’s Committee on Statistics, the main export partners of the country are China (16.2% of total exports in 2021), Italy (14.7%), Russia (11.6%), and the Netherlands (7.3%) [4]. The main imported goods are broadcasting equipment, cars and valves, packaged medicaments and chemical products, and food products. Kazakhstan's main import partners are Russia (42.5% of total imports in 2021), China (19.9%), Germany (4.4%) and the USA (3.3%) [4].

Figure 2: Kazakhstan’s Exports by Country in 2021



Source: eclareon 2022 based on Committee on Statistics of the Republic of Kazakhstan [4]

Figure 3: Kazakhstan’s Imports by Country in 2021

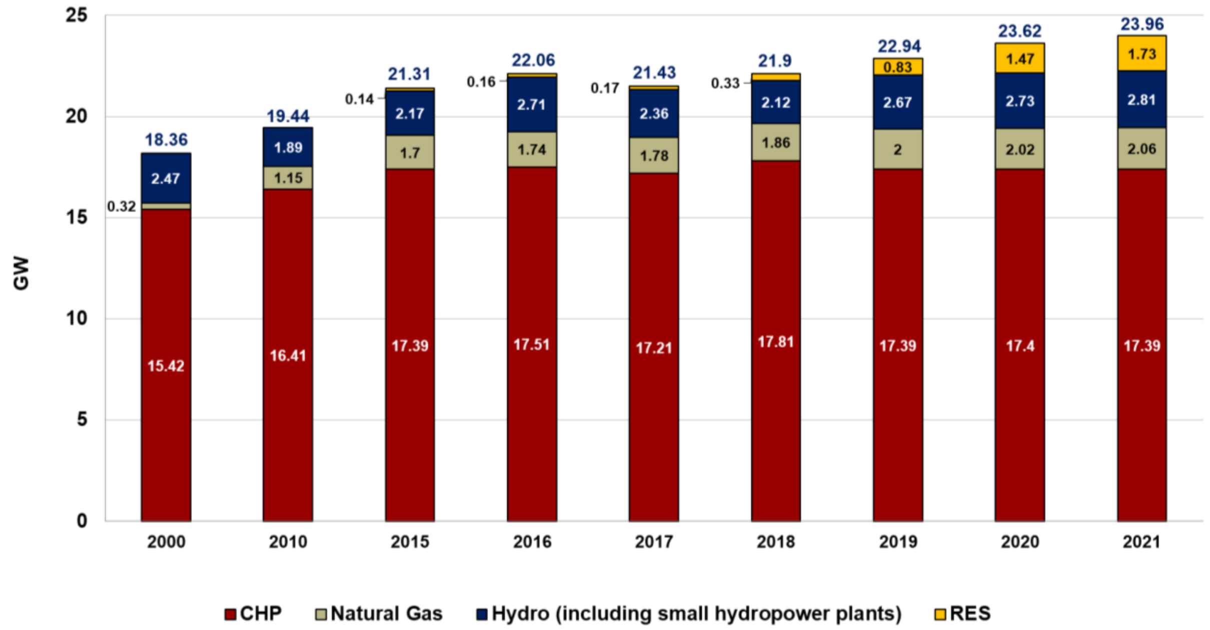


Source: eclareon 2022 based on Committee on Statistics of the Republic of Kazakhstan [4]

1.2 Installed Capacity and Electricity Generation

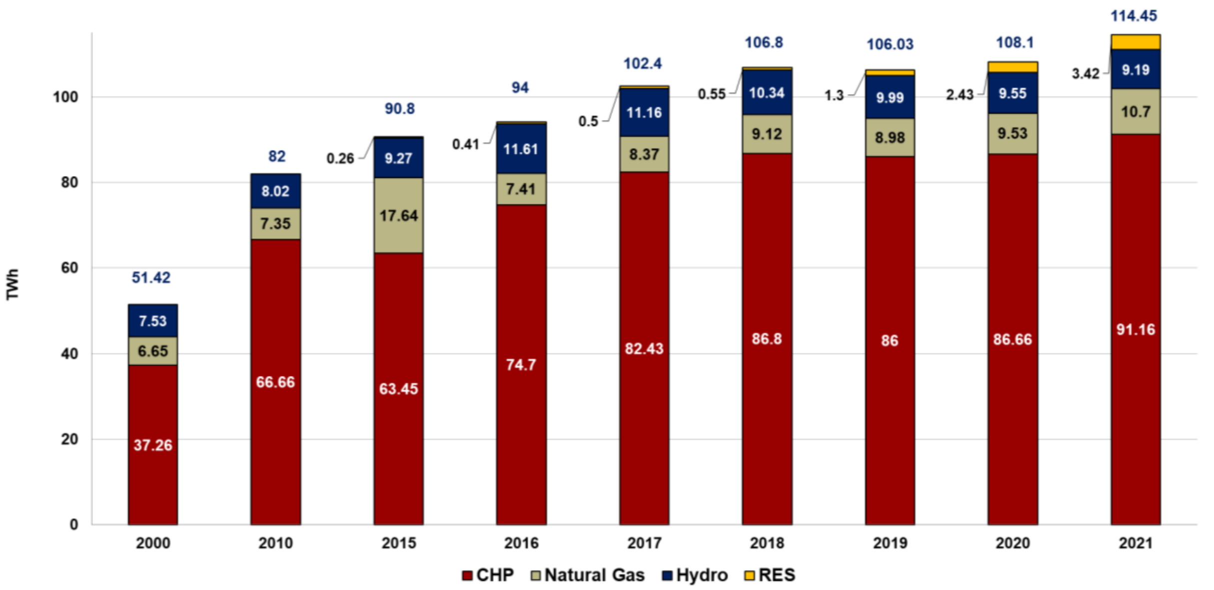
Kazakhstan is one of the world's most important primary energy producers. The country ranked 11th in the world in crude oil extraction (about 2 million barrels per day) in 2022 [95]. Kazakhstan fully covers its electricity demand through domestic generation. **In the last two decades, installed capacity of power-generating facilities has been constantly growing. Between 2010 and 2021, the total installed capacity of power generation facilities increased by 31% from 18.24 GW in 2010 to appr. 24 GW in 2021 (Figure 4). Electricity generation has also increased by 38.5% since 2010, reaching 114.45 TWh in 2021.**

Figure 4: Total installed capacity of power generation facilities in Kazakhstan



Source: eclareon 2022 based on: Annual reports of the KEGOC System Operator and the Ministry of Energy [9][50]

Figure 5: Electricity generation by source of energy in GWh (from 2000 to 2021) in Kazakhstan



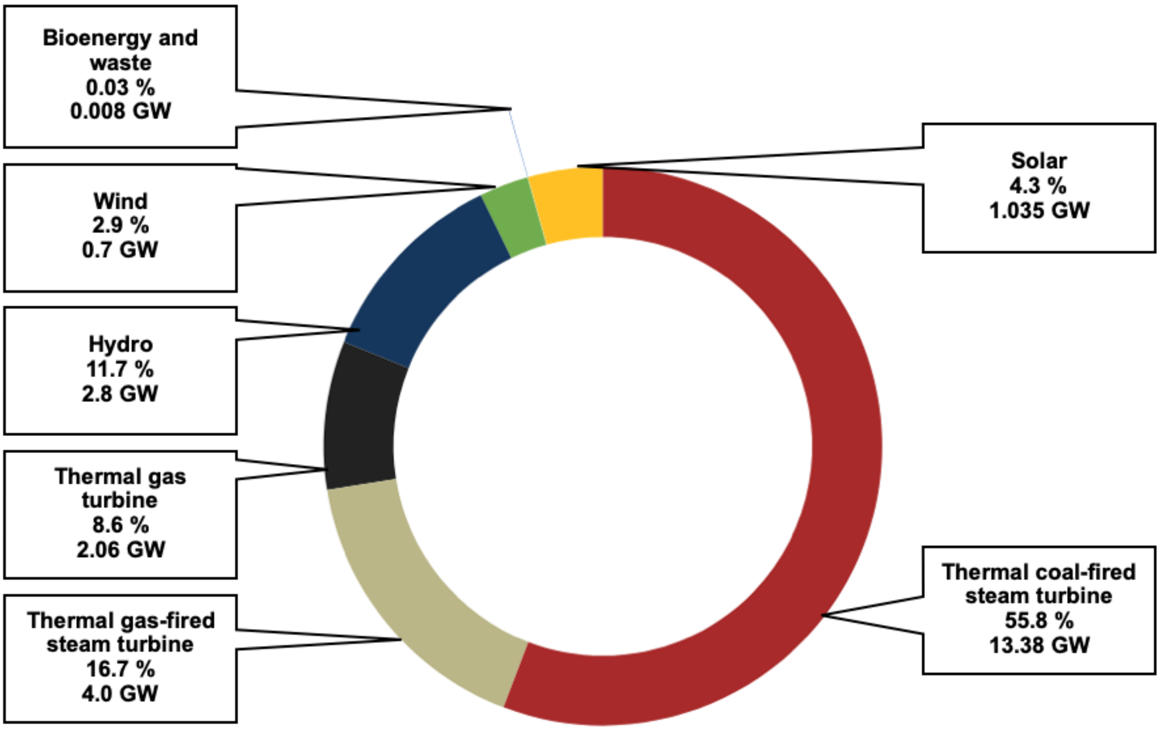
Source: eclareon 2022 based on: Annual reports of the Samruk Energy JCS and Ministry of Energy [9] [50] [58]

The legacy of the Soviet past is still apparent in Kazakhstan's electricity sector, despite modernisation and structural adjustments of mechanisms for managing the energy sector. The entire electric power sector is united in one entity, namely the **Unified Energy System (UES *or United Power System – also known as UPS*)**. The UES comprises all power plants, transmission lines and transformer substations.

Given the use of outdated power generation facilities and the operation of some facilities at half-capacity**, the de-facto used capacity for energy generation is significantly lower than the installed 24 GW, namely between 19 and 20.2 GW [15][97].** In 2021, Kazakhstani power plants generated **114.45 GWh of electricity,** of which **1.64 GWh** were generated by solar power plants [50].

Kazakhstan's installed capacity suffices to cover its domestic electricity demand. However**,** due to the regional division of the energy sector, the country also does need to export and import electricity. **Although RES-based electricity production has increased in the last years, RES still play an insignificant role in electricity production. In 2021, less than 0.5% of electricity was generated from RES. About 65% of the country's electricity were generated by coal-fuelled power plants, which are concentrated in the country's north [47].**

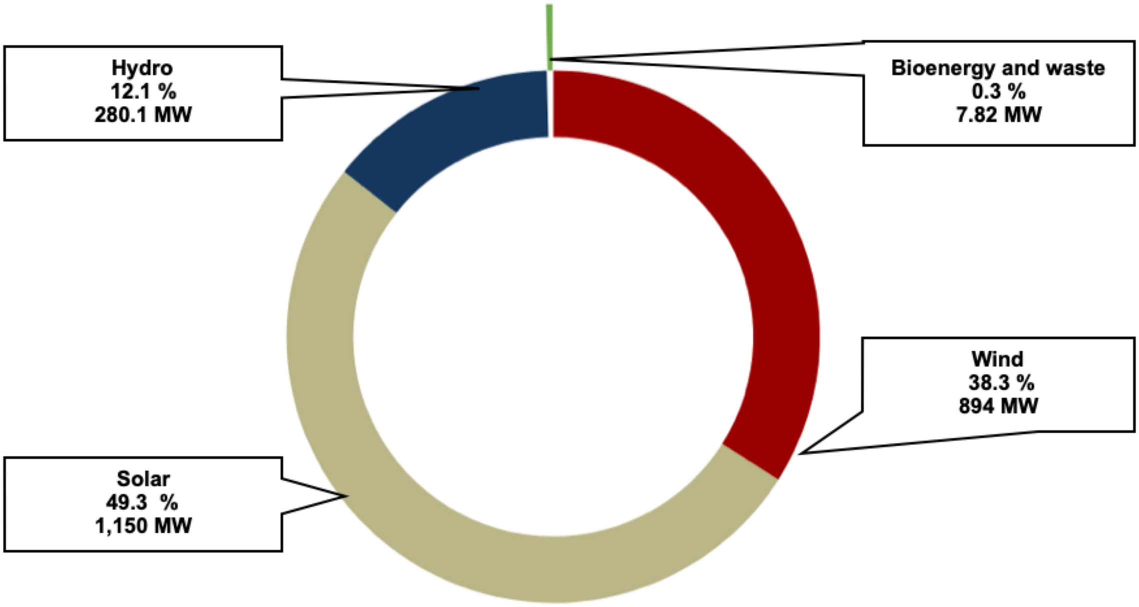
Figure 6: Proportion of different energy sources in total installed capacity in Kazakhstan in 2021



Source: eclareon 2022, based on National Energy Report Kazenergy 2021 [47] and Ministry of Energy of Kazakhstan 2021 [96]

With regards to installed capacity, the share of solar generation facilities was 4.3% in 2021, a twofold increase since 2019 [13][50]. According to other official data by the Ministry of Energy in Kazakhstan, the total installed capacity of electricity generation facilities based on RES at the end of September 2022 was **2,332 MW, of which solar power plants accounted for almost half of all the entire installed capacity (Figure 7) [96]**.

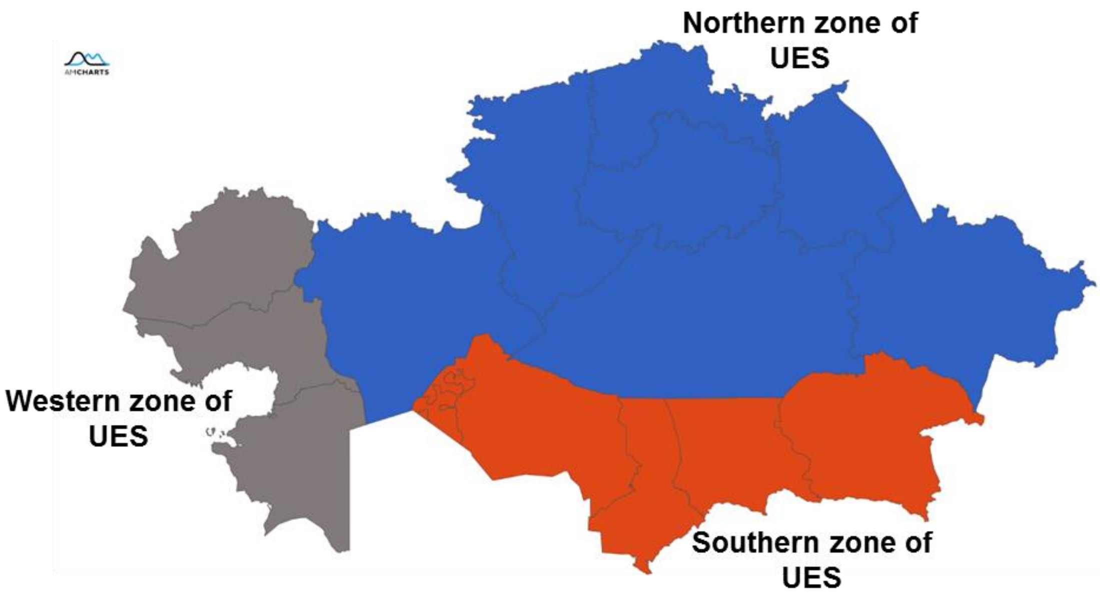
Figure 7: Installed capacity of RES facilities in Kazakhstan in MW and % of total RES capacity in the country (end of September 2022)



Source: eclareon 2022, based on Ministry of Energy [96]

As of January 1st, 2022, there are 190 power plants in Kazakhstan, that use different energy and fuel sources [42]. Dispatching and coordination is under the responsibility of "KEGOC" Ltd.- the System Operator of the Unified Energy System (UES). The Unified Energy System (UES) is divided into **3 energy zones: The northern zone (including the central zone), the southern zone, and the western zone (Figure 8).** Each zone is part of the UES and interconnected [42].

Figure 8: Schematic representation of the three energy zones of the UES of Kazakhstan



Source: eclareon 2022, based on KEGOC System Operator [42], map generated with Pixel Map Generator, amCharts

- **The northern zone of the Unified Energy System (UES)** includes the regions of Akmola, East-Kazakhstan, Pavlodar, Karaganda, North-Kazakhstan, Kostanai, the Aktobe regions and the capital of the republic, Astana city. Kazakhstan's significant coal deposits are located in the northern zone. Consequently, **67%** of the country's generating capacity is also installed in the northern zone with power plants being mainly fuelled by locally extracted coal. In the past, the electricity surplus in the northern zone was sold either to Russia or transferred to the southern zone to cover that zone's deficit. **In 2021, 88 TWh of electricity was generated in the northern zone**, which accounted for 76.7% of the country's total electricity generation. Meanwhile, consumption was much lower, at 74 TWh, which corresponds to 64.84% of the country's total electricity consumption [42][47].

- **The southern zone of the Unified Energy System (UES)** includes the regions of Almaty, Zhambyl, Kyzylorda and Turkestan, as well as Almaty city, Shymkent city, and the Baikonur district. In 2021, 12.2 TWh was produced in the southern zone which corresponds to 10% of the total Kazakh generation and to about 50% of the country's required capacity. **Regional consumption in 2021 was 25.5 TWh or 21.25% of the total national consumption**. The power capacity deficit in the southern zone is compensated by electricity supplied from the northern zone [42][47].
- **The western zone of the Unified Energy System (UES)** includes the regions of Atyrau, West-Kazakhstan and Mangistau. Kazakhstan's rich oil and gas deposits, including offshore ones, are concentrated in the Western zone. The western zone is not directly connected with the other two zones of the Unified Energy System (UES) of of Kazakhstan, i.e. the northern and southern zone. Hence, the western zone of the Unified Energy System is interconnected with the electricity system of the Russian Federation [51][55]. **The western zone of the Unified Energy System (UES) produced 13.3 TWh in 2021, 12.5% of the country's total generation**. In 2021, electricity consumption in the Western zone reached 14.55 GWh, 13% of total national consumption making it the most balanced energy zone in terms of supply and demand in the country [7][42][47].

The uneven distribution of generation capacities across the country leads to grid losses when electricity is transmitted to the south of the country via obsolete long-distance power lines. In addition, the electrical equipment of most thermal power plants in Kazakhstan has been worn off. As of January 1st, 2022, more than 50% of the thermal power plants have been operational for over 30 years. Due to these factors, national grid losses amounted to 10-15% in 2021 [47][49]. For instance, in the power grid operated by the East Kazakhstan Regional Energy Company (EK REC) 12% of the generated electricity was lost in 2021. In 2021, the actual losses in the power grids of EK REC amounted to 0.45 TWh out of 3.9 TWh of the total transmitted electricity, according to the organization's annual report [79]. Accurate and official data on the transmission losses on the national level are currently not available.

Despite the need to import electricity into the southern region, Kazakhstan is a net exporter of electricity. Since 2018, Kazakhstan has been a net importer of electricity from Russia following an increase in national electricity demand. In 2021, Kazakhstan's net imports from Russia amounted to 0.46 TWh. However, the balance of electric energy exported to other countries of Central Asia was 1.02 TWh [47].

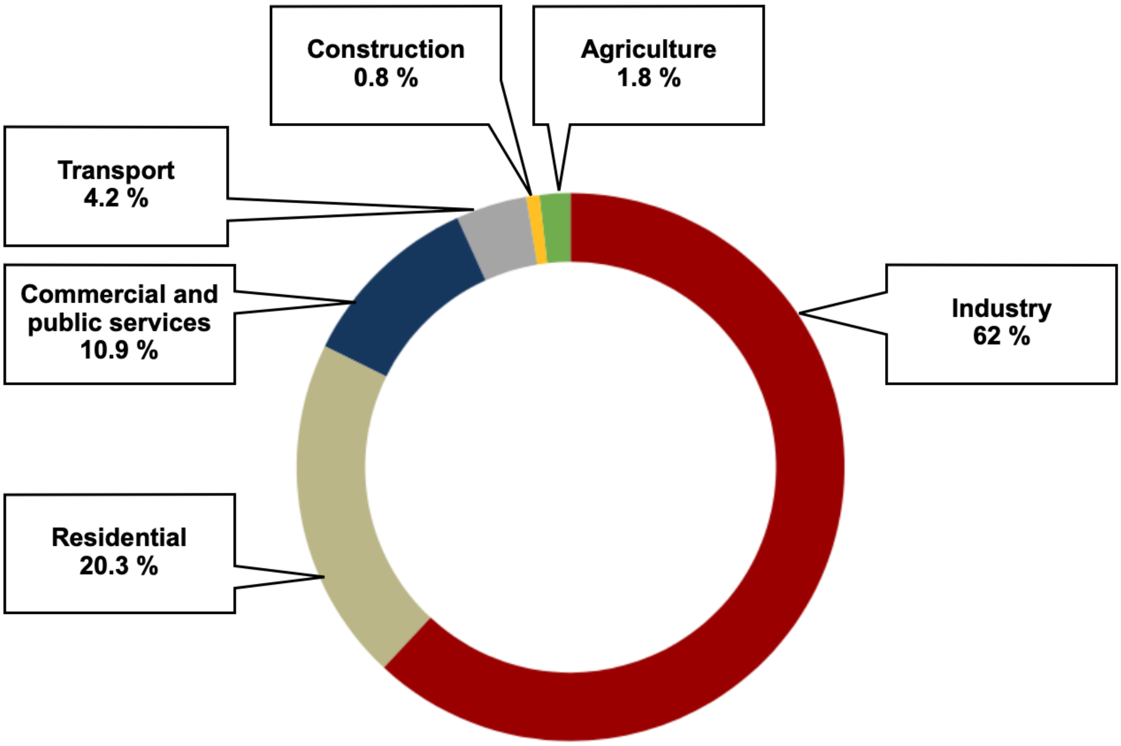
1.3 Electricity Consumption and Demand

Electricity consumption rapidly decreased after the collapse of the USSR and reached its minimum in 1999 with **2.8 MWh per capita, 2 times less than in 1990**. This decrease was mainly caused by the wear and tear of old and obsolete power-generating equipment as well as the economic instability of the country. In 1999, the government adopted a program for the development of the electric power industry, encompassing the time period until 2030. The program included the creation of the Unified Energy System of Kazakhstan, the commissioning of new capacities, and the replacement of obsolete equipment.

Thanks to the reconstruction and modernisation of the power sector and economic stabilisation, electricity consumption began to grow rapidly. **In 2020, per capita consumption in Kazakhstan amounted to 4.94 MWh**. For comparison, in Germany this figure was 6.69 MWh, in the USA it was 11.73 MWh, and 3.99 MWh in China for the same year [14].

With over 60% of total electricity consumption, the industrial sector consumed the largest share of electricity produced in Kazakhstan in 2020. Large industrial consumers include enterprises such as Akusuk Ferroalloy Plant, Arcelor Mittal Temirtau, Kazakhstan Electrolysis Plant, and NC Kazakhstan Temir Zholy.

Figure 9: Electricity consumption by sector in 2020 in Kazakhstan



Source: Eclareon 2022 based on Committee on Statistics, Ministry of National Economy of the Republic of Kazakhstan, 2021 [53]

The demand for electricity in the country has been growing constantly in recent years. Electricity consumption increased by more than 8% between 2019 (105.7 TWh) and 2021 (113.89 TWh) [42]. According to local authorities, this increase in electricity demand is the result of crypto-miners, who immigrated from China where they were confronted with legal restrictions [98]. Also Kazakh authorities have imposed severe limitations on crypto-activities since 2022, claiming that such activities were responsible for the instability of the grid and power outages. In April 2022, the Minister of Digital Development obliged crypto-mining businesses to provide information about their legal entity, their electricity consumption, and their technical set-up before they can start their operations [111].

According to the Conceptual Development of the Ministry of Energy, electricity consumption in Kazakhstan will reach 152.9 TWh by 2035 [99]. Experts predict an increase from 136 billion kWh by 2030 to 172 billion kWh by 2050 [37]. Anticipating this growing electricity demand, in

2021, President Tokayev urged for the construction of a nuclear power plant [115]. In September 2022, the director of nuclear power plants, Timur Zhantikin, listed four companies competing for the construction – Chinese National Nuclear Corporation, EDF (France), Korean Hydro & Nuclear Power, and Rosatom (Russia). The supplier will be selected in early 2023. The power plant shall be located near Lake Balkhash in the Almaty region and commissioning is planned for 2032 [112]. Although experts doubt its economic viability [114], the construction of nuclear power plants shall prevent future electricity shortages. In addition, it shall support, along with renewable energy sources, the government on its path towards a desired low-carbon economic development [96].

1.4 Electricity Market Stakeholders

The current status of Kazakhstan's electricity market is the result of a lengthy and large-scale reform process, including market liberalization and the introduction of sectoral regulation. Today, both public and private companies operate in Kazakhstan's energy market, thereby allowing the government to control a strategically important market while incentivizing at the same time the inflow of private capital.

Electricity market actors can be divided into the following categories:

- Electricity Sector Regulator: Ministry of Energy
- Institutional Infrastructure Organisations: Committee for the Regulation of Natural Monopolies and Protection of Competition (KREM) of the Ministry of National Economy; Kazakhstan Electric Power and Capacity Market Operator (KOREM); Calculation and Finance Centre for Support of Renewable Energy Sources (RFC)
- Technological Infrastructure Organisations: Kazakhstan Electricity Grid Operating Company (KEGOC); "Energoinform"; and the National Dispatch Center of the System Operator (NDC SO)
- Electricity Producer: Holding for the Management of State Assets (JSC Samruk)
- Power Grid Operator: Kazakhstan Electricity Grid Operating Company (KEGOC)
- Power Supply Organisations (Distributors)

1.4.1 Electricity Sector Regulator

Kazakhstan's Ministry of Energy is the main **supervising body of the** energy sector. The Ministry defines and implements the main direction of the state policy in the field of the electric power industry, ensures energy security and energy independence, as well as the development of the fuel and energy industries, and the extraction and use of mineral resources. [45].

In 2008, the Government of Kazakhstan established the **Samruk-Kazyna National Welfare Fund,** which merged the "Samruk" Public Asset Management Holding and the Kazyna State Sustainable Development Fund. Samruk-Kazyna owns and controls the main public actors of Kazakhstan's power sector. These are, among others, the following organisations:

- The Kazakhstan Electricity Grid Operating Company (KEGOC), the technological infrastructure organisation of the sector
- Kazakhstan Electric Power and Capacity Market Operator (KOREM), which is a commercial infrastructure organisation

- JSC “Samruk-Energo”, the largest electricity producer, operating large combined heat and power plants and hydropower plants

1.4.2 Institutional Infrastructure Organisations

The Committee for the Regulation of Natural Monopolies and Protection of Competition (KREM) operates under the supervision of the Ministry of National Economy of Kazakhstan and is responsible for tariff regulation in the country.

The Kazakhstan Electric Power and Capacity Market Operator (KOREM) is responsible for conducting power spot trades and organising tenders for the construction of RES-based electric power installations [36].

1.4.3 Technology Infrastructure Organisations

The technological infrastructure organisations include **KEGOC, “Energoinform” and the National Dispatch Centre of the System Operator (NDC SO):**

- KEGOC was established in 1996 as the **System Operator of the Unified Energy System (UES)** and is the national power transmission company and system operator. Its main tasks are the transmission of electric energy through the national grid, technical dispatching of supply to the grid, as well as balancing production and consumption of energy.
- **“Energoinform”** is owned by KEGOC and provides maintenance of grid equipment and telecommunication services for KEGOC's activities. The company’s responsibilities include automated metering and control [42].
- **The National Dispatch Centre of the System Operator (NDC SO)** is a subsidiary of KEGOC and provides centralised operational dispatching for the production, transmission and consumption of electric energy. NDC SO also controls the technical condition and safe operation of the Unified Energy System and manages interstate electric energy flows**.**

1.4.4 Electricity Producers

Energy-generating companies produce and sell electricity to distribution companies in the wholesale and retail markets. Both public and private power generation companies operate in Kazakhstan. The largest state-owned company is **Samruk-Energo JSC ("Samruk-Energo")**, which is owned by the similarly wholly state-owned **Samruk-Kazyna JSC**. The graph below shows the capacity and generation of the largest energy producers (Figure 10). "Samruk-Energo” **holds 25.6% of the total installed capacity of power plants** and produces about **31.1% of the country’s power generation, see Table 1.**

Table 1: Power generation of the largest power generating companies of Kazakhstan in 2021

Company	Power generation, GWh
Samruk-Energy JSC	35,609
Eurasian Resources Group (ERG)	19,915
Central-Asian Electric Power Corporation JSC (CAEPCO)	6,239
Kazakhmys Energy LLP	6,601
Kazakhstan utility systems (KUS) LLP	6,597

Company	Power generation, GWh
Zhambyl SDPP JSC	2,139
Kazzinc LLP	2,974
Other (partially public)	34,373
Total	**114,448**

Source: Annual report of Samruk-Energy 2021 [9][15]

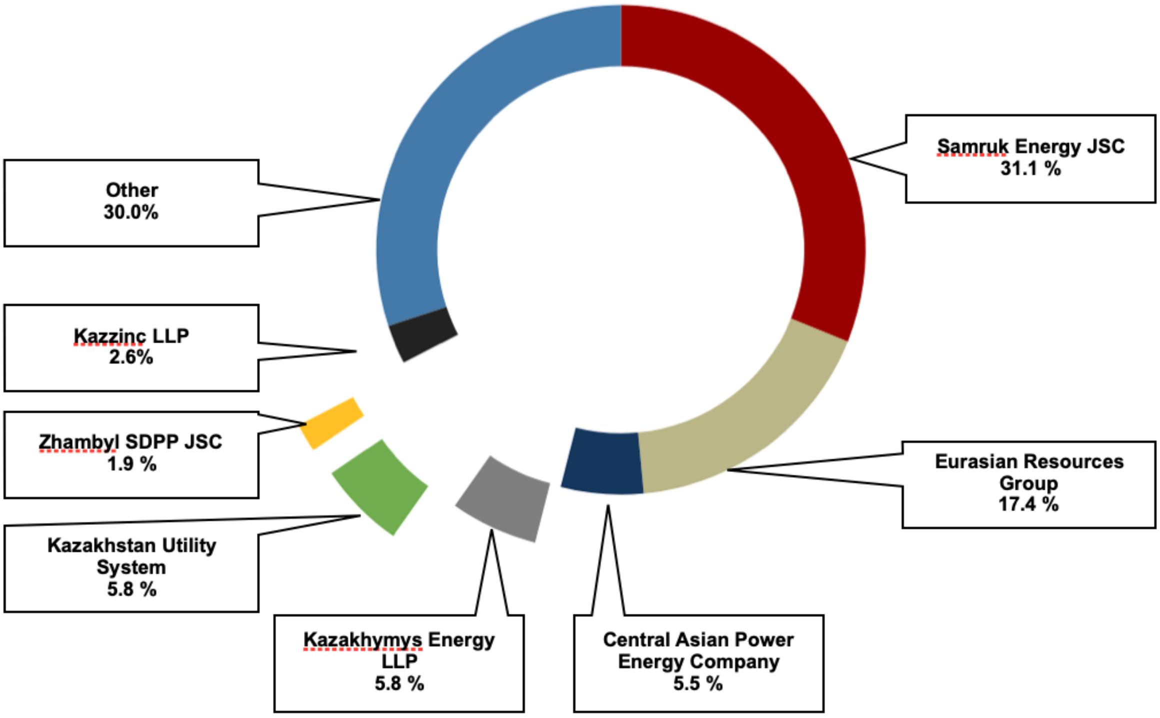
Energy is generated by 190 power plants (including RES), most of which are privately owned. In official governmental communications, power plants are divided into power plants of national importance, power plants of industrial importance, and power plants of regional importance [42].

Power plants of national importance are the largest power plants producing and selling the lion's share of electricity in Kazakhstan. These include the thermal power plants "Ekibastuzskaya GRES-1", "Ekibastuzskaya GRES-2", "ERG", "Eurasian Group" as well as the hydropower plants "Kazzinc", "Bukhtarma", "AES Ust-Kamenogorskaya" and "AES Shulba".

Power plants of industrial importance are thermal power plants, which generate electric and thermal energy for power and heat supply of large industrial enterprises and small settlements ("CHP-3 of Karaganda Energy Center", "PVS CHP of Karaganda smelting plant", "CHP-2 of ArcelorMittal Temirtau JSC", "Balkhash CHP", "Zhezkazgan CHP").

Regional power plants are cogeneration plants with a specific regional importance. They sell electric energy through the grids of regional power grid companies and energy transmitting organisations and provide heat supply to nearby cities.

Figure 10: Share of power generation in Kazakhstan by major energy generating companies in 2021



Source: eclareon 2022, based on the annual report of JSC "Samruk-Energo" 2021 [9]

1.4.5 Grid Infrastructure Operators

- The most important actor for Kazakhstan's grid infrastructure is the **National Electricity Grid Operator which is owned** by KEGOC. It plays an important role for connecting Kazakhstan's regional power systems amongst each other and with those of neighbouring countries (Russian Federation, Kyrgyz Republic, and Uzbekistan). The National Electricity Grid Operator also transmits electricity generated in power plants to wholesale consumers. Its infrastructure consists of substations, switchgear, and transmission lines of 0.4-1,150 kV.
- **Energy transmitting organisations** transmit energy through either their own, or other power networks (via rent, lease, trust management, or other types of agreement) to wholesale and retail market consumers, as well as to energy-supplying organizations based on power transmission contracts. As of January 1st, 2021, the number of energy transmitting organisation in Kazakhstan amounted to 130 [138]. As the Ministry of Energy plans to consolidate the number of regional energy companies, also the number of energy transmitting organisations shall be reduced to 110 by 2023 [37].

1.4.6 Electricity Sales Companies

Energy sales companies purchase electricity from power-generating companies or via centralised bidding activities. Then, they supply this electricity to their customers. At present, 16 energy sales companies are **operating in all regions of Kazakhstan**. Most consumers in Kazakhstan are not allowed to freely choose their energy sales companies, as usually there is just one energy sales company per region (except for the regions of Akmola and North-Kazakhstan which have two energy sales companies each) [38].

1.5 Electricity Infrastructure

1.5.1 On-Grid Power Generation

As mentioned above, Kazakhstan's energy system is officially divided into the northern, southern and western zone. The northern and southern zone are interconnected by power transmission lines, while the western zone is interconnected with the Russian electricity grid. At the end of 2021, 384 overhead power transmission lines with a total length of 26,973 km existed in Kazakhstan. In total, there are 81 electric substations with a voltage of 35 -1,150 kW and an installed transformer capacity of 38,743 MVA. [42].

On 25 January 2022, a blackout hit Uzbekistan, Kyrgyzstan, and Kazakhstan due to imbalanced distribution. This blackout lasted for several hours and shows the bad status of the nowadays obsolete Soviet infrastructure [134]. In the whole country, electricity grids are in a very bad condition and it is estimated that about 60% of the overall infrastructure is obsolete and needs to be renovated [48]. This percentage can go up to 80%, and even 100% in some regions. 65% of the production equipment is obsolete on average, 83% of the electricity network, and 80% of the heating network [139]. Between 2021 and 2022, the number of emergency shutdowns has increased by 22% and the duration of these shutdowns has gone up on average by another 16% [132]. These are the main reasons why, in 2022, the government started 14 projects for the expansion and improvement of the network [96].

It is also due to the infrastructure problems that grid-connected consumers, both households and industrial consumers, often suffer from poor connection quality and power supply interruptions [39][93].

1.5.2 Off-Grid Power Generation

Data on distributed (off-grid) generation in Kazakhstan is not publicly available. Since government institutions do not keep statistics on off-grid areas, it is difficult to estimate the volume of electricity generation from off-grid diesel/gas/petrol generators. In 2018, there were at least 5,000 settlements in Kazakhstan with limited electricity supply and over 2,000 villages, and farms with no electricity supply at all, located in the many remote, rural and scarcely populated areas of the country [89]. Even when electricity networks are available in remote areas, they are often weak: grids in rural areas may have a maximum voltage of 170-180 V, which often does not allow farmers to use their electrical equipment at its full capacity [141]. Cut-off from the central power supply, farmers and villagers generally use portable gasoline and diesel generators to generate electricity, while coal and firewood are used for heating and cooking. Diesel and gas generation is also used by companies operating in rural areas that, due to their activities, require stable electricity supply in areas without a connection to the electricity grid. Among such companies are uranium ore mining, oil processing, ski resorts, and gas supply companies [77].

1.6 Electricity Markets, Prices, Tariffs and Costs

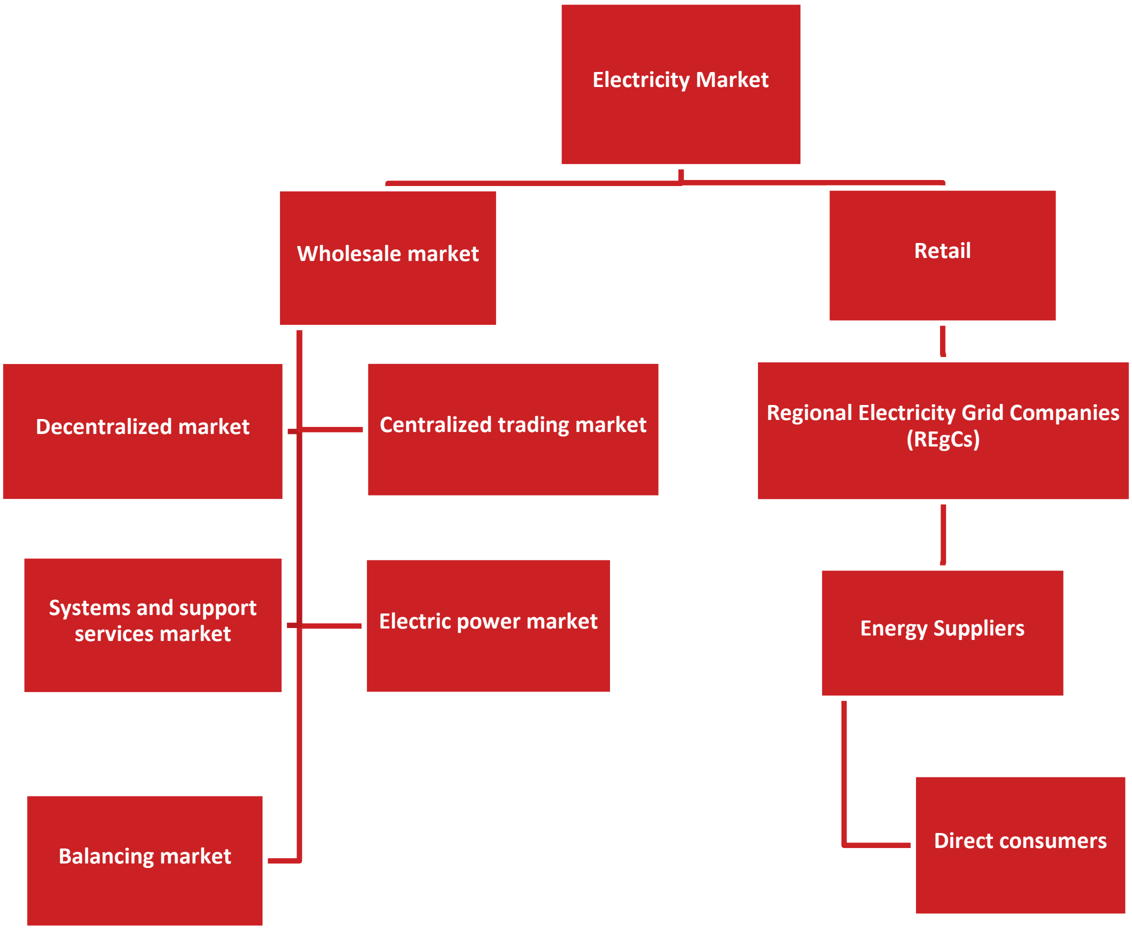
1.6.1 Electricity Market Structure

Like many countries, Kazakhstan has wholesale and retail electricity markets, as well as various tariff accounting mechanisms. **On the wholesale electricity market,** energy generating companies sell electricity to companies supplying energy, as well as to wholesale consumers with access to the national or regional electricity grids [42].

Since 2019, Kazakhstan also has a capacity market. So, not only electricity but also capacity is sold on the wholesale market.

The market structure is schematically shown below (Figure 11) [32].

Figure 11: Schematic structure of electric energy and capacity market in Kazakhstan



Source: eclareon 2022, based on the National Energy Report, Kazenergy 2019 [48]

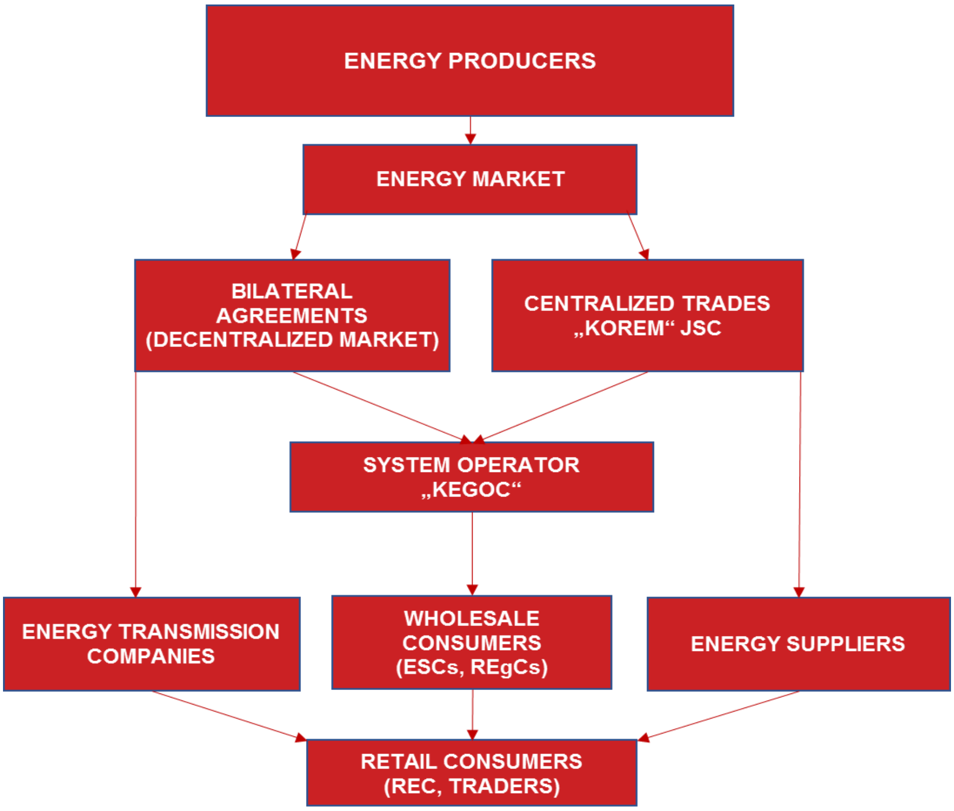
The stakeholders of the wholesale electricity market are:

- **Energy generating companies** supplying at least 1 MW of average daily (base) capacity to the wholesale market
- **Power transmission companies and distribution grid operators**
- **Energy sales companies** (without own power grids) buy electricity at the wholesale market and resell at least 1 MW of average daily (base) capacity

- **Electricity consumers** who purchase electricity at the wholesale market (at least 1 MW of average daily (baseload) capacity)
- **The System Operator**, JSC "Kazakhstan Electricity Grid Management Company KEGOC" (henceforth System Operator UES)
- **The operator of centralised trade regarding electric energy and capacity**, **JSC KOREM**
- **The Calculation and Finance Centre** for Support of Renewable Energy Sources (henceforth RFC), a subsidiary of KEGOC [47]

The relationships of the listed players on the energy market are shown below (Figure 12).

Figure 12: Scheme of the electricity market in Kazakhstan



Source: eclareon 2022, based on the National Energy Report Kazenergy 2019 [48]

In 2021, the total volume of electric power transmission through the National Electricity Grid of KEGOC amounted to 54.65 TWh (47% of electricity production volumes) [48].

1.6.2 Electricity Pricing Mechanisms - Decentralized Market

The first pricing mechanism **for the purchase and sale of electric energy** in the Kazakh electricity market are long-term bilateral agreements on a so-called decentralized market . They entail bilateral agreements by actors of the wholesale market for a long-term period, which can cover weeks, months, quarters or years [30]. The transactions under bilateral contracts dominate the total volume of electricity transmission through the grids of a system operator. Power sale and purchase contracts are divided into two types:

- Contracts for the purchase and sale for the **physical supply of electric energy through the national electric grid**. Such contracts are registered by the system operator who also verifies the availability of access to the national electric grid for power-generating companies and consumers. In the case of transferability, the UES System Operator dispatches energy to the necessary technical requirements.
- Electric power purchase and sale contracts for the **transmission or transit of electric power through the power grids of neighbouring countries.** These contracts also need to be registered by the UES System Operator.

1.6.3 Electricity Pricing Mechanisms - Centralized Trading Market

The market of centralized electricity trading organizes short-, medium- and long-term electricity trading, and can thus objectively indicate current market prices. **In 2022, the total volume of transactions in the centralized trading market amounted to 1% of the total volume of electricity transmitted through the networks of the System Operator, which was 757 GWh. In previous years, the share of centralised trade amounted to 28%, indicating a drastic decline in centralised trade volumes which resulted from the withdrawal of the electricity production of the two largest plants** - Ekibastuz GRES-1 and GRES-2 - **owned by Samruk company [47].**

The following types of centralized trade are conducted on the market for centralized trade:

- **Spot trade in "one day ahead" and "within the operating day":**

"Day-ahead" spot bids are held in the form of an auction, where the market operator draws up sorted charts of supply and demand from the bidder's requests for the purchase and sale of electricity. KEGOC submits the auction results to the UES System Operator for approval [33].

Spot trades **"within the operating day"** are carried out as continuous counter trades online. KEGOC pairs certain buyers and sellers, as well as transaction prices to the UES System Operator to include in the daily 'schedule' of delivery and consumption [32].

The spot trades represent about 1% of the total amount of all transactions in the centralized market, i.e. 19.6 GWh in 2021 and 0% in 2022 [38].

- **Medium- and Long-term Electric Power Trading:**

The market operator determines the schedule of electric energy trading for different periods (week, month, quarter, year). Following the results of the bidding, the price of purchase and sale for each transaction as well as the volume for each "seller-buyer" pair are determined. **99% of transactions on the centralised auctions of electric energy are concluded for the medium- and long-term. Medium-term usually covers weeks or months, while long-term contracts cover quarters or years. While the transaction volume reached 21,010 GWh in 2018, it plummeted in 2021 to 1,286.3 GWh and in 2022 to 757 GWh [38].**

1.6.4 Balancing Electricity Market

The main task of balancing the market in real-time is the physical and subsequent financial settlement of hourly imbalances which arise during the operational day between the actual and contractual values of production and consumption of electricity**.** On the electricity balancing market, the physical settlement of imbalances is performed by the System Operator (KEGOC JSC), and the financial settlement is performed by the Settlement Centre (Energoinform JSC, a subsidiary of KEGOC JSC).

It must be noted that the generation structure faces a lack of flexibility to respond to fluctuations in daily electricity production and consumption. In December 7th, 2020, the amendments to the Law "On the Electric Power Industry" urged the development and construction of flexible generation. However, given the construction delays, the problem is still lingering in the short term. A program named ARCHM to control the capacity of certain power plants was initiated but it provides insufficient flexibility to resolve the problem [47][125].

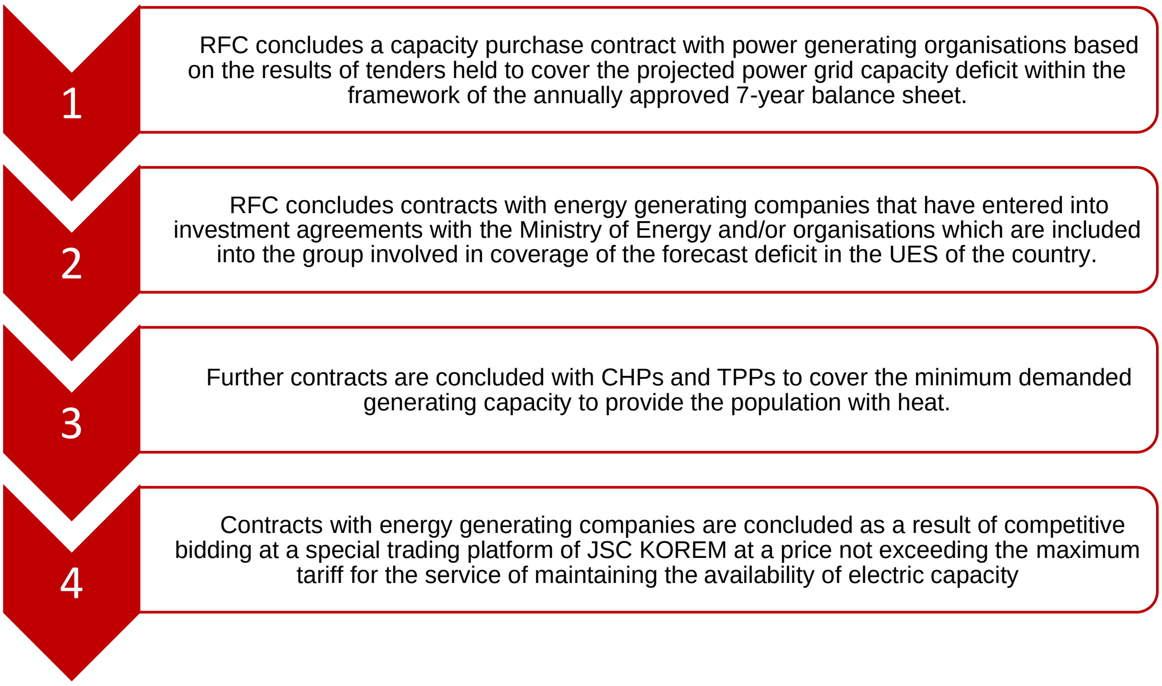
1.6.5 Electric Power (Capacity) Market

The electric capacity market was created to attract investment to maintain power capacities and commission new capacities to cover demand sufficiently. The market has been operating since January 1st, 2019 through the purchase and provision of a centralized power availability service [34].

The market for electric capacity is based on the "Single Purchaser" model, where the RFC (takes on the role of the Single Purchaser [65].

The sale of capacity services within the capacity market is carried out in a centralized and decentralized zone. Bidding on the capacity market is carried out **separately for each UES zone**. In addition, joint auctions are held for the Northern and Southern zones (due to the capacity of transmission lines), and separate auctions for the Western zone. Following the results of the auctions, the volume of capacity purchased and sold and the list of energy-generating players included in the volume of auctions are determined [34]. Centralized purchase of capacity from energy producers is carried out in the following sequence:

Figure 13: Centralized purchase of capacities from power-generating organizations

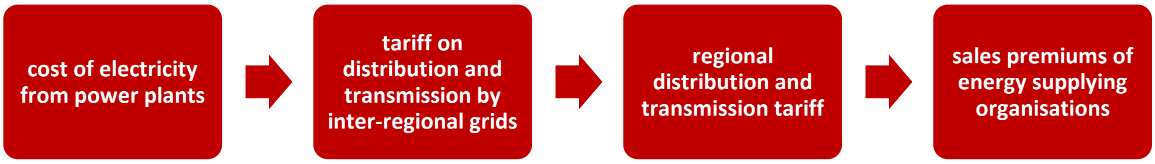


Source: eclareon 2022, based on materials of RFC, 2018 [42]

1.6.6 Formation of Electricity Prices

Electricity tariffs for final customers are calculated by summing up all required payments and the cost for electricity transmission and sales services. These include the following:

Figure 14: Final-customer tariffs in Kazakhstan



Source: eclareon 2022

All electricity tariffs in Kazakhstan are defined and regulated by the government. The electricity tariff in Kazakhstan today is composed of the following components**: the cost of electricity generation (55%), transportation (40%), and the distribution surcharge of energy suppliers (5%) [40].**

All tariffs in the power sector can be classified according to the following types (all tariffs are shown excluding VAT:

- **Tariffs for power plants** that cover the cost of electricity production. They are approved by the Ministry of Energy for each group of power plants individually (currently there are 47 power plants in Kazakhstan). The Ministry also sets ceiling prices for 5 years, taking into account the maximum cost of electricity production for each group in relation to the cost of the previous year at the time of the tariff calculation [48]. The marginal tariffs of energy-generating companies noticeably vary from 1.46 KZT/kWh (0.0029 EUR/kWh) to 16.62 KZT/kWh (0.033 EUR/kWh) [9]. The average ceiling tariff in 2021 fluctuated between 8.44 KZT/kWh (0.017 EUR/kWh) to 10.213 KZT/kWh (0.020 EUR/kWh). The planned tariff for 2023 is 9.34 KZT/kWh (0.019 EUR/kWh) [35].

- **Tariffs for transmission of electricity through the power grids of KEGOC JSC** are set by Kazakhstan's antimonopoly committee (the Committee for the Regulation of Natural Monopolies, Protection of Competition and Consumer Rights of KREM of the Ministry of Economic Development and Trade of the Republic of Kazakhstan). The tariff calculation of KEGOC JSC is based on the following parameters:

  - **Tariff for transmission of electricity**. From October 1st, 2021 to September 30th, 2022 the tariff was **2.797 KZT/kWh (0.0056 EUR/kWh). In 2023, the tariff will be 2.848 KZT/kWh (0.0057 EUR/kWh).**
  - **Tariff for technical dispatching**. In 2022 the tariff was **0.306 KZT/kWh (0.00061 EUR/kWh). It will be 0.314 KZT/kWh (0.00063 EUR/kWh)** in 2023.
  - **Tariff for balancing production/consumption of electric energy**. Between 2022 and 2023 the tariff will slightly increase from **0.098 KZT/kWh (0.00020 EUR/kWh) to 0.102 KZT /kWh (0.00020 EUR/kWh).**

  Due to this, the total tariff of KEGOC in 2022 was **3.201 KZT/kWh (0.0064 EUR/kWh), and in 2023, 3.264 KZT /kWh (0.0065 EUR/kWh).** Noticeably, a gradual and planned increase in prices is undertaken by the authorities. **The forecast price in 2025 is 3.562 KZT /kWh (0.0071 EUR/kWh) [35].**

- **Tariffs for transmission and distribution of electric energy through regional grids.** Such tariffs are set individually by local departments of the antimonopoly authority for each region. The surcharge depends on the network topology, grid length, voltage levels, number of consumers, and other technical features. *At the same time, the tariff also depends on the scheme of electric energy delivery. This depends on* *which power source (station) is supplied and through which electric networks it is delivered.* The average tariff for Regional Electricity Grid Companies in **2022** was **5.63 KZT/kWh (0.011 EUR/kWh) [35].**

- **Tariffs of Energy Supply Companies (ESCs).** Sales mark-ups of ESCs are set by the antimonopoly authority, however ESCs have the right to demand the increase of their electricity tariffs from the antimonopoly committee [16].

- **Tariffs of KOREM JSC include the following elements:**

  1. **Tariff for services to ensure the readiness of the trading system for centralised electricity trading**, paid by all wholesale market participants. In 2022 this amounted to 0.0033 KZT/kWh (0.00001 EUR/kWh).
  2. **Tariff for provision of services for the purchase and sale of energy by bidders**, paid by all bidders of centralized auctions. In 2022 this amounted to 0.002 KZT/kWh (0.00426 EUR/kWh).
  3. **Tariff for provision of services for the centralized trading of electric capacity**. In 2022, this amounted to KZT 2,000,000 (EUR 4,010) from each participant in the centralized trading of electric capacity.

4. **Tariff for services referring to the execution of tenders for the construction of newly commissioned generating units with shunting generation mode.** In 2022, this tariff amounted to KZT 2,000,000 (EUR 4,000) for each participant.
5. **Tariff for services referring to the holding of auctions/ tenders for the selection of projects using renewable energy sources**. In 2022, a distinctive tariff according to the size of the project was introduced as follows:
   i. From 0.1 to 1 MW, KZT 500,000 (EUR 1,002) per bidder
   ii. From 1 to 10 MW, KZT 750,000 (EUR 1,503) per bidder
   iii. More than 10 MW, KZT 2,000,000 (EUR 4,010) per bidder [35]

1.6.7 Electricity Tariffs for End Users

In total, there are **three main price categories** on the electricity market**:**

1. **Electricity prices to be paid by consumers on the wholesale market:** electricity pricing is regulated by taking into account the price ceiling, which is determined by bilateral contracts, or by auctions for short-, medium- and long-term periods. The table shows the results of centralised trading for December 2021.

Table 2: Prices for wholesale market consumers

Name	Minimum price in KZT / kWh	Maximum price in KZT / kWh
Spot trades	**0**	**23.1** (0.02026 EUR/kWh)
Bidding for medium and long periods	**7.9** (0.00896 EUR/kWh)	**9.7** (0.02132 EUR/kWh)

Source: Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, Tariffs are shown without VAT

2. **Electricity tariffs paid to industrial customers/ power generating companies:**

Industrial customers include power generating companies operating in Kazakhstan and supplying electricity to the wholesale and retail markets. There is a special marginal tariff for industrial consumers, which is defined in relation to the type of generation. The minimum ceiling price for hydropower plants is 4.5 KZT/kWh (0.0096 EUR/kWh), and the maximum tariff for gas turbine power plants (GRES) is set at 12.68 KZT/kWh (0.027 EUR/kWh) (for more details see Table 3).

Table 3: Tariffs for industrial customers in 2019

Name	Price in KZT/ kWh at maximum tariff*	Price in EUR/kWh at maximum tariff*
Coal-fired power plants	8.8	0.18764
Coal combined heat and power stations	7.5	0.0169
Gasovyna KES	9.47	0.02019
Gas CHPs	7.6	0.0162
GTES	12.68	0.02704
Hydropower plants	4.5	0.0096

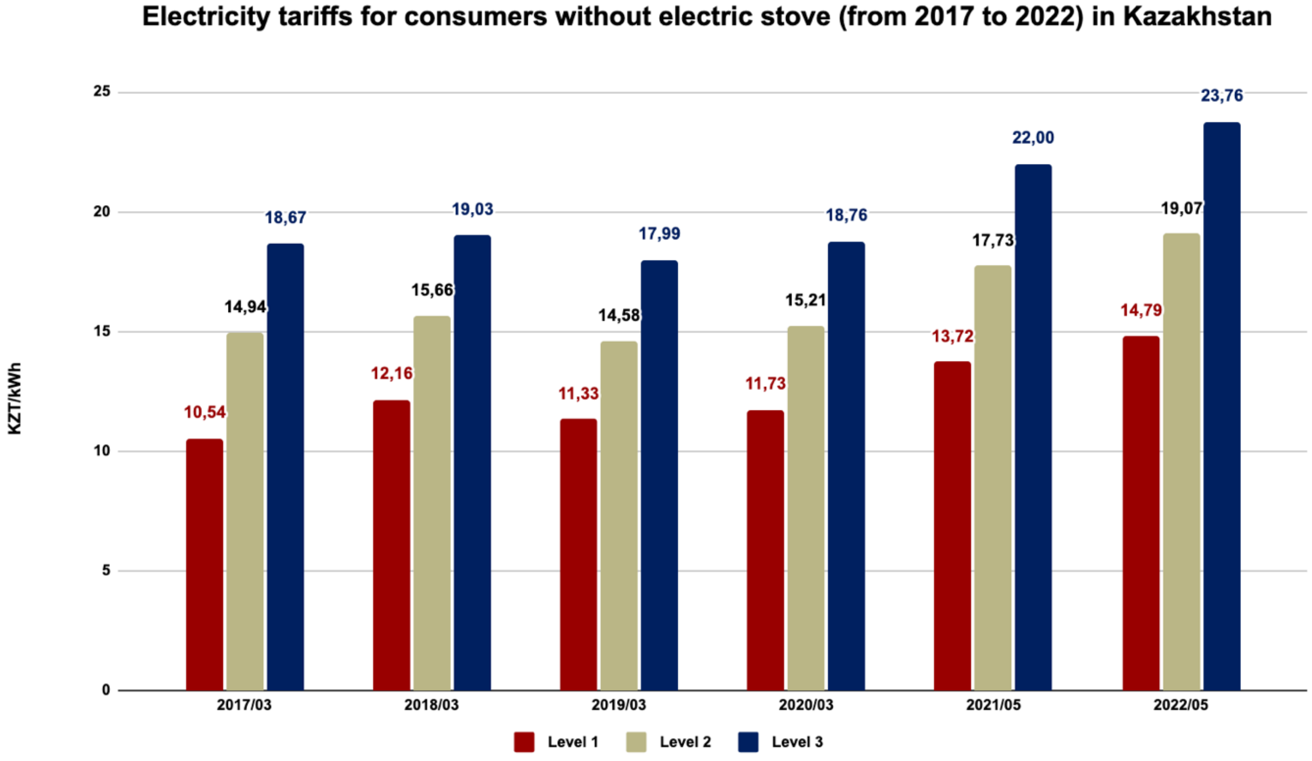
Source: Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, Tariffs are shown without VAT [51]

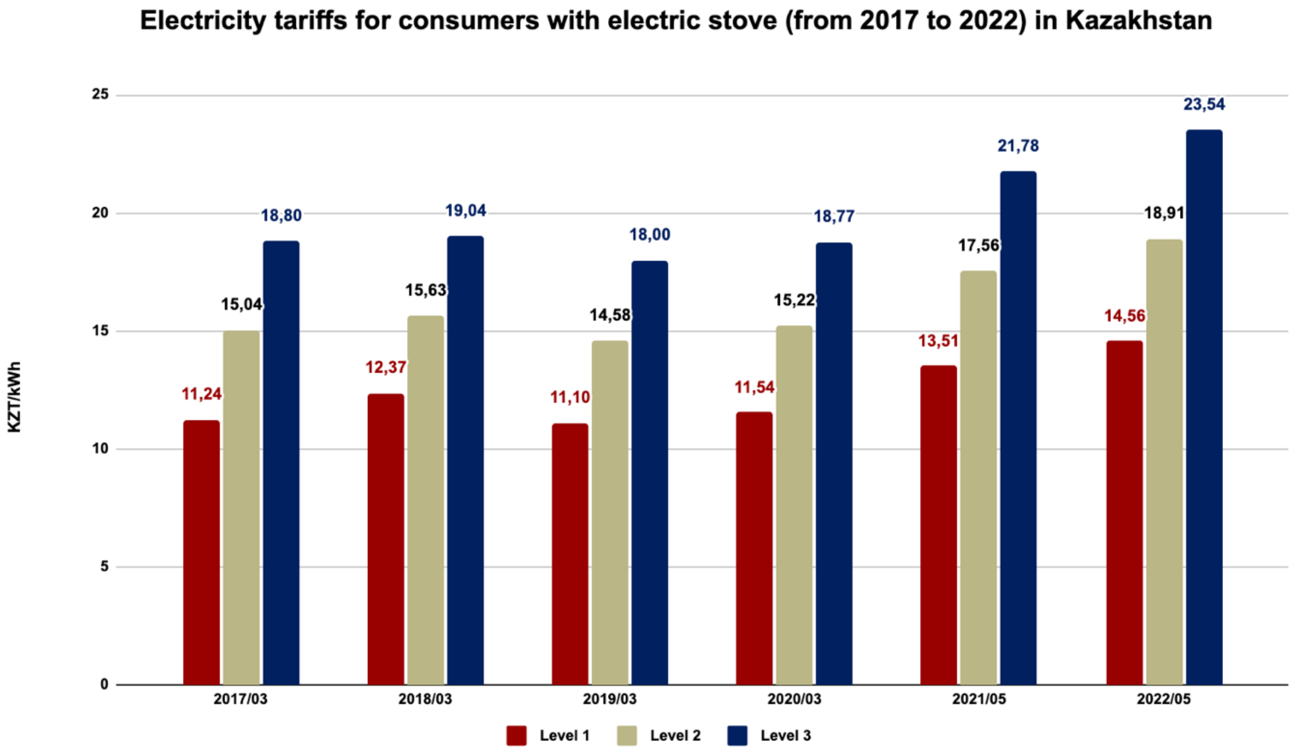
3. **Tariffs to be paid by the population (household consumers) on the retail market:** these are set by the local executive authority on tariffs, in accordance with the tariff ceiling set by the Ministry of Energy.

From 2009 to 2017 electricity tariffs in Kazakhstan differed depending on time of day and volume of electricity consumption. There was a minimum and maximum tariff, which was approved by KOREM. Mid-2017 the Government of Kazakhstan abolished this system [17] and introduced three different types of tariff that depend on different criteria such as the volume of energy consumption and on the presence or absence of electric stoves in a household [100][101][102]. Consumers using electric stoves include residents who do not have a gas connection [18].

- **the first level tariff** applies to electricity use to up to 100 kWh per individual. The average price in Kazakhstan for May 2022 was 14.56 KZT/kWh (0.03 EUR/kWh) for this category.
- **second level tariff** is paid by individuals consuming more than 100 kWh and up to 190 kWh per individual. The average price in Kazakhstan for May 2022 was 18.91 KZT/kWh (0.038 EUR/kWh) for this category.
- **the tariff of the third level** applies to individual consumers with more than 190 kWh consumed per individual. The average price in Kazakhstan for May 2022 was 23.54 KZT/kWh (0.048 EUR/kWh) for this category.

Figure 15: Tariffs for residential consumers by type





Source: eclareon 2022, based on materials of the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan [100][101][102]

Residential electricity tariffs vary between Kazak cities primarily due to their geographical location. As explained above, electricity transit times vary due to some regions' structural deficit of generation capacity. Therefore, the final cost of electricity in remote areas is sometimes more than three times more expensive than in other parts of the country [16]. The most affordable tariffs for consumers (taking into account location and average monthly salary) can be found in Atyrau, Astana, Aktobe, and Semey, that are mainly located in western Kazakhstan. Less affordable tariffs can be found in cities like Kostanai, Taldykorgan (Almaty Oblast), Taraz, Shymkent, Almaty, and Aktay [103].

1.7 Development of the Hydrogen Market

In 2020, "green" hydrogen produced from RES globally accounted for less than 5% of total hydrogen generation. Kazakhstan ranks among the countries with the highest potential for green hydrogen exports [105]. Although Kazakhstan plans to develop a viable hydrogen strategy, the future role of the country in the global hydrogen economy is yet to be defined [47]. Today, the legislation is still in its infancy and hydrogen, given its high cost, does not yet play a role in the Kazakh power generation system.

Green hydrogen can be used as a low-carbon alternative in segments of the heavy industry that cannot be directly electrified or in energy storage, especially for RES. Other applications are considered in the field of transport such as fuel cells for cars. However, given the high availability of low-cost fuel products in Kazakhstan, the future of hydrogen projects in the country seems to lie first and foremost in the production and export of green hydrogen [106].

On November 7th, 2022 the European Commission and Kazakhstan's government signed an agreement to develop supplies of green hydrogen and raw materials to manufacture equipment [104]. The agreement includes three objectives:

1.) increasing the resilience of raw material, battery, and renewable hydrogen supply chains;
2.) enhancing the cooperation on capacity-building, skills, and research & innovation;
3.) ensuring closer economic ties through the adoption of common ESG standards and the modernization of mining processes and technologies.

Kazakhstan's vast steppes in western and central areas provide the space for the large-scale wind and solar parks needed for profitable green hydrogen production. In July 2022, HYSARIA ONE, a subsidiary of the German SVEVIND Energy Group, announced its plans to develop with Kazakh Invest a 40 GW wind-solar-hydrogen plant in the Mangystau region. 20 GW will be dedicated to the production of two million tonnes of hydrogen per year, mainly intended for local activities of industrial green products, or exports to Eurasia [107]. The financial investment decision and the commissioning are expected in 2026 and 2032, respectively [117]. Besides, in September 2022, KazMunaiGas (KMG) signed a Memorandum of Understanding with GreenSpark to carry out joint research to analyse data and gain practical experience in operating electrolysers by using solar power [116].

Nevertheless, many obstacles remain to ensure the competitiveness of hydrogen in Kazakhstan [105]. The small size of the domestic market limits economies of scale and market opportunities. Moreover, the quantities of water required for production raise questions about the sustainability of such an undertaking in Kazakhstan, whose water resources are rather limited combined with a high degree of water stress [142]. Moreover, exports must travel long distances without the possibility of maritime transport which is a challenge taking into account that, for transport, hydrogen needs to be refrigerated to -253˚C to be liquefied, or it needs to be compressed to 700 times atmospheric pressure. These transport challenges are combined with risks of energy loss especially in a country with extreme temperatures [106].

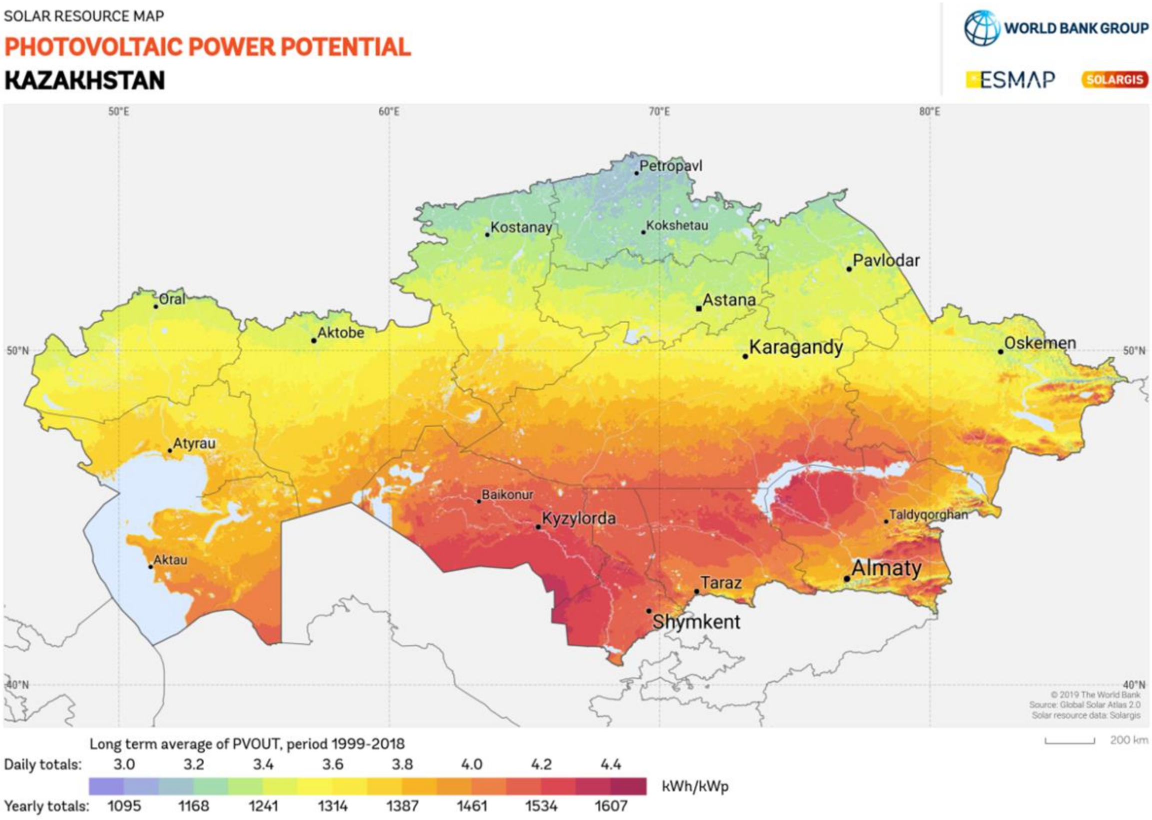
Using the existing gas pipelines for exporting hydrogen could be a viable option. However, the main export routes are currently closed as a result of the Ukraine conflict. Furthermore, alternative routes through the South Caucasus could saturate the current pipelines.

2. PV Investment

2.1 Solar Irradiation and state of the Solar Energy Market in Kazakhstan

Kazakhstan has considerable natural potential for the large-scale development of renewable energy projects. The **average number of sunshine hours per year is 2,392 which corresponds to 100 days**. Therefore, the total estimated resource potential of Kazakhstan for solar energy is about **2,200-3,000 sunshine hours per year, 2,500 TWh per year**. This is 25 times more than the present consumption and production of electricity.

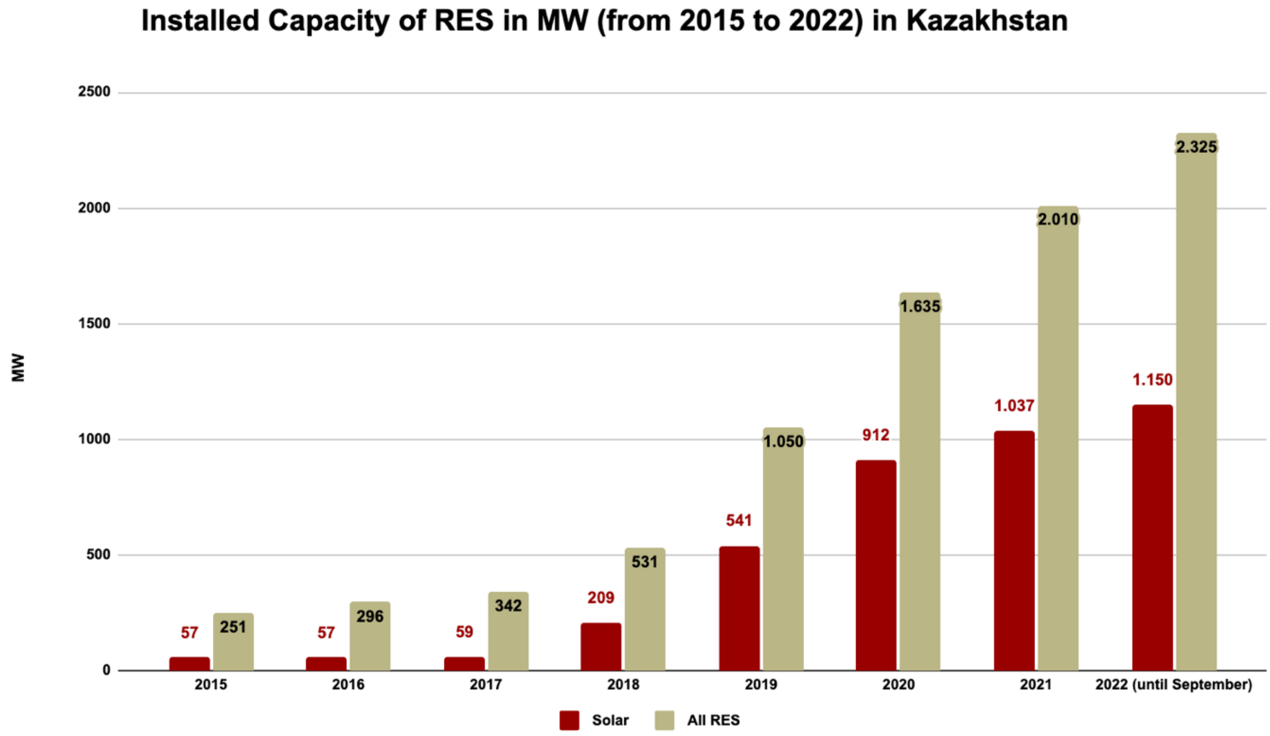
Figure 16: Photovoltaic Power Potential of Kazakhstan



Source: Global Solar Atlas [60]

The average output of a PV installation in Kazakhstan ranges between 1,095 kWh / kWp and 1,607 kWh/kWp which is higher than in most European countries [21]. The southern region is the most favourable for solar energy where the number of sunny days per year exceeds 120 days. Considering the region's considerable deficit of electric power, the southern region could play a vital role in the implementation of "green" economy solar projects in Kazakhstan. According to plans by the Ministry of Energy of Kazakhstan, in the region **RES projects with a total capacity of 2,615 MW will be implemented** until 2025 [22]. **In 2021, the total installed capacity of RES in Kazakhstan amounted to 2,010 MW, of which 49 were solar power plants [42]**. RES-based generation accounted for merely 0.5% of the entire installed capacity in Kazakhstan. **Solar PV power plants' installed capacity increased twofold from 541.7 MW in 2019 to 1,038 MW in 2021 [23][24]. In the same period, electricity generation by solar tripled from 563.4 million kWh to 1,642 million kWh [13][50].**

Figure 17: Installed capacity of RES facilities and solar power plants in Kazakhstan



Source: eclareon 2022, based on the Ministry of Energy of the Republic of Kazakhstan [50][52]

2.2 Stakeholders of the PV Market in Kazakhstan

There are three major stakeholders in the photovoltaic sector in the country:

- The Department of RES of the Ministry of Energy of Kazakhstan is the central executive body that implements the RES programs and policies of the country. Moreover, it coordinates the RES sector and approves the annual schedule for RES auctions.
- Calculation and Finance Centre for Support of Renewable Energy Sources (RFC), a subsidiary of KEGOC, was created in 2013 and is responsible for the centralised purchase and sale of energy from RES power plants.
- Kazakhstan Electric Power and Capacity Market Operator (KOREM) organizes auctions of RES projects jointly with the Ministry of Energy and RFC.

2.3 Development of Solar and RES Policies

The development of solar power in Kazakhstan has started relatively late. In 2009, Kazakhstan ratified the Kyoto Protocol and since then, Kazakhstan has embarked on the path of green development. The government, represented by former president Nursultan Nazarbayev, adopted a new political course and targeted to attract annual investments with the amount of 1% of GDP, which is equivalent to USD 3-4 billion per year to support this course [25]. Investments shall come from both foreign countries and the state budget itself. Therefore, the government of Kazakhstan set up institutional and legislative frameworks to introduce RES systematically to attract foreign investors. **In 2009, Kazakhstan adopted the law "On Support of Renewable Energy Sources"** with the objective to create favourable conditions for the development of RES.

In 2012, the Government of Kazakhstan adopted the "Kazakhstan 2050" strategy, which aims at directing the country's long-term economic development toward a sustainable and efficient economic model, to a "green economy" which prioritizes the development of RES. In 2013, the President of Kazakhstan signed the underlying "Concept on Transition of the Republic of Kazakhstan to a Green Economy". The main strategic objectives of renewable energy development of this concept are:

- **3%** share of RES in total electricity production by 2020
- **10%** share of RES in total electricity production by 2030
- **50%** share of RES in total electricity production by 2050

Prior to 2013, the country already endeavoured to develop the institutional and legislative framework for the implementation of RES projects, but this did not lead to a significant growth in renewable energy deployment. Therefore, the government began to introduce amendments and to adopt some legislative changes. The positive impact of these changes became apparent in 2015 when the total capacity of construction applications for RES facilities amounted to 7 GW [47][48]. This high volume led the government of Kazakhstan to limit the commissioning of new facilities by introducing amendments to the legislation regarding the gradual commissioning of RES. Furthermore, in line with the "Concept of Transition toward a Green Economy", an action plan was published in 2020.

In Kazakhstan's plans to transition to a green economy, solar energy is given special attention. Within the framework of a joint project of the Ministry of Energy and UNDP the **Atlas of Solar Resources of Kazakhstan** was created. This atlas contains resource maps, maps for assessment of solar energy potential, climate maps, maps of solar energy objects and maps of limitations and prerequisites for the location of solar energy objects [22].

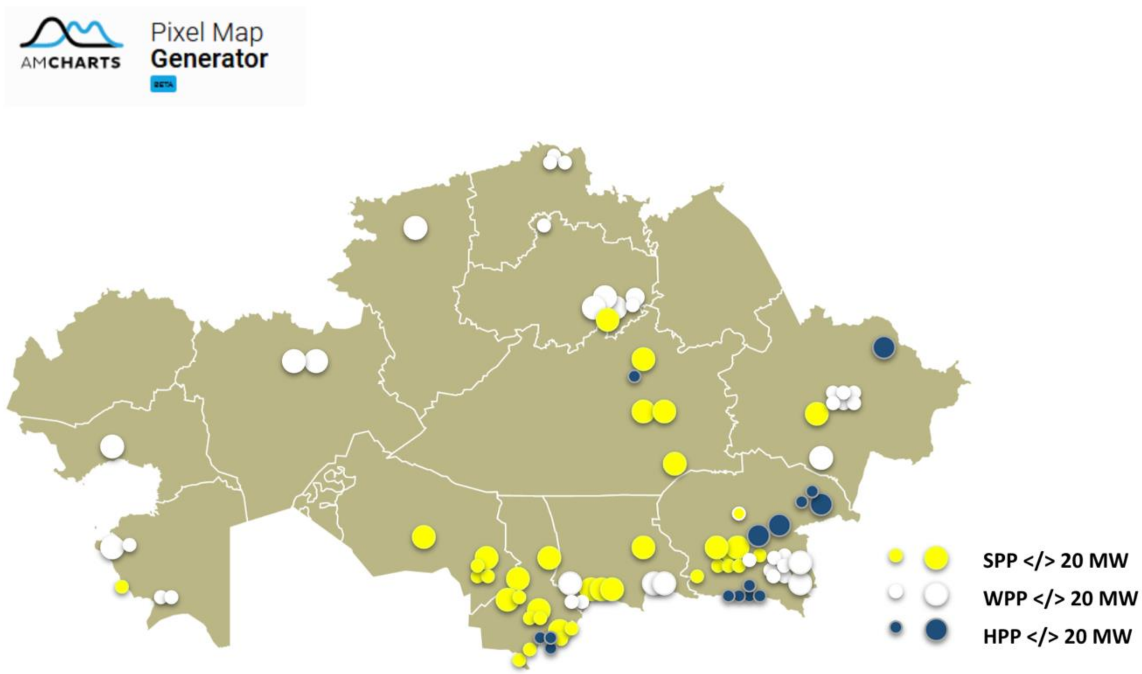
As part of its commitments within the framework of the Paris agreements, Kazakhstan established a New Environmental Code in July 2021 consolidating the missing mechanisms to meet its international environmental obligations. Under the new Code, four categories of activities are defined based on their level of environmental impact (see criteria in Appendix II of New Code). Article 127 specifies that fees can be charged for a detrimental environmental impact.

A draft concept for the development of the electric power industry of the Republic of Kazakhstan until 2035, developed by the Ministry, is still to be submitted at the time of writing of this report. This concept intends to reform the operating model based on the centralized purchase and sale of electricity and focuses on actions related to renewable energy, coal, gas and nuclear power generation, and smart grids [99]. The electricity generation sector has already prepared a package of measures to develop energy sources, ensure transparency of investment spending and strengthen state control.

These modifications of the legal framework are driven by the implementation of the European Carbon Border Adjustment Mechanism (CBAM) which will enter into force in October 2023 [131]. Since more than 40% of Kazakhstan's exports go to EU countries, domestic producers, exporting to Europe, will have to comply with the CBAM mechanism according to [140]. The CBAM aims to reduce and mitigate the environmental impact of the largest stationary emitters by implementing carbon certificates between EU and non-EU producers. It is a system based on the purchase of certificates by importers. The price of the certificates will be determined by the weekly auction price of EU ETS allowances per tonne of CO_2 emitted. While as of today most financing still goes to CO_2-intensive industries, CBAM, combined with the new renewable energy legislation in Kazakhstan, creates strong incentives to shift financing to greener sectors of the economy [136].

Investment in Kazakhstan's renewable energy sector has been rising in recent years. In 2018, the first pilot auctions offered 1,000 MW of installed capacity for RES installations, 29% (290 MW) of which were intended for solar power plants [67]. In 2020, 250 MW of RES were auctioned in the third auction, including 55 MW on solar energy. In 2021, the actual purchase volume for solar energy amounted to 40 MW [89]. The auctions also led to price reductions over time, averaging 42.5% for renewable energy installations [113].

Figure 18: Installed RES objects within the framework of auctioning in Kazakhstan by type of generation



Source: eclareon 2022, based on calculations by the Renewable Energy Calculation and Finance Center, 2021, map generated by Pixel Map Generator, amCharts [62]

The following companies are involved in solar energy projects implemented through auctions:

Table 4: Private companies-winners at auction in 2018 - 2022 in the solar energy sector of Kazakhstan

Company name	Home country of bidding company	Installed capacity, MW	Auction price, KZT/kWh	Auction price, EUR/kWh
2018				
"URBASOLAR SAS"	Switzerland	5	28	**0.06**
"Hydroenergy company JSC	Bulgaria	10	29	**0.062**
"TechnoBasalt"	Ukraine	3	28.99	**0.062**
"MISTRAL ENERGY"	Kazakhstan	50	25.8	**0.055**
"KK-KIUNSEN"	Korea	10	19.63	**0.042**
"DSTO Solar"	Kazakhstan	10	19.6	**0.042**

Company name	Home country of bidding company	Installed capacity, MW	Auction price, KZT/kWh	Auction price, EUR/kWh
"Hydroenergy company JSC	Bulgaria	50	18.6	**0.04**
"Hydroenergy company JSC	Bulgaria	10	19.58	**0.042**
"DALA SOLAR"	Kazakhstan	2	18	**0.038**
"Shell Kazakhstan B.V. Branch"	Netherlands	50	22.9	**0.049**
"Avelar Solar Technology"	Russia	50	22.5	**0.048**
"Avelar Solar Technology"	Russia	20	18.6	**0.04**
2019				
"Solar System"	Kazakhstan	10.5	9.9	**0.021**
"KazSolar 50"	Kazakhstan	26	16.97	**0.036**
“Arm Wind”	Italian	50	12.49	**0.025**
2020				
“UBS QZ”	Kazakhstan	10	14.99	**0.030**
“UBS Solar”	United Kingdom	10	15.62	**0.031**
“HEVEL KAZAKHSTAN”	Kazakhstan Russia	20	14.58	**0.029**
“HEVEL KAZAKHSTAN”	Kazakhstan Russia	20	16.96	**0.034**
2021				
“Next Eco Energy“	Kazakhstan	20	12.87	**0.026**
2022				
“Tsesis”	Russia	20	16.95	**0.034**
“Damona”	Russia	20	16.95	**0.034**

Source: RFC RES JSC, results of auction tenders in 2018, 2019, 2021 and 2022 [61]

Generally, small RES projects do not have separate regulatory and incentive mechanisms. However, some exceptions exist: For instance, social assistance programs for RES exist that target residents of settlements without connection to the grid. **In this case, buyers of small RES units (up to 5 kW) produced in Kazakhstan can receive subsidies up to 50% of the installation costs. Farmers can receive subsidies up to 80% of the installation costs if the PV system’s energy is used for agricultural activities**. Subsidy applications are created and received by regional *akimats* (governs) and are later transferred to the national Ministry of Energy. However, this program has not gained a lot of momentum mainly because of the high equipment costs [57][128]. A small number of companies sell turnkey solar systems. There are marketed to customers to receive government subsidies, reimbursing up to **80% of the installation cost [73]**. Solar turnkey systems, using both local and international equipment, are offered with capacities **from 1 kW to 30 kW** and cost **from KZT 220,000 (EUR 472) to KZT 3,200,000 (EUR 6,860) [74][75]**.

2.4 PV Business Models

In accordance with the business model classification selected for this report, five business models for the Republic of Kazakhstan are described in the following sections.

2.4.1 Model 1: PV parks ≥100 MW

Photovoltaic parks, a type of large-scale power generation, have gained popularity worldwide and are often an integral part of a country's energy system. As PV technology becomes cheaper, fossil fuel powered generation becomes more expensive and demand for electricity increases, the construction of powerful solar power plants becomes an attractive business model for investors.

Since 2018, solar parks in Kazakhstan, with capacities ranging from a couple of dozen to hundreds of MW, have been built based on government tenders. Generally, the project with the lowest bid price for 1 kWh is awarded with the tendered market volume or project. International, non-Kazakh companies can also participate in tenders and even participate in tenders for several projects on different sites for the construction of power plants. The capacity is drawn at the auctions and the goal is to achieve the RES targets set by the government to increase the total share of RES in the country's energy mix. As of January 1st 2022, there are 54 PV parks in Kazakhstan with a total capacity of 1,150 MW. Among the major projects are the Kashpagai district solar power plant, with a capacity of 100 MW, and the Burnoe 1 and 2 solar power plants, with a total capacity of 100 MW [62].

Photovoltaic parks in Kazakhstan are part of the country's Unified Energy System (UES) and supply electricity to the grid. The only purchaser of electricity is the Calculation and Finance Centre for Support of Renewable Energy Sources (RFC), which sells the generated electricity to conditional consumers[1].

Such projects are attractive for investors due to some advantages, such as the government's guaranteed purchase of solar energy (through RFC). In addition, competition between investors participating in tenders for constructing such solar power plants encourages the reduction of planned electricity prices. During the auctions, a maximum price of electricity for a RES facility is set, and bids from participants with a higher price are not considered.

The 2018 auctions fixed an upper limit for auctions at KZT 34.61 (approximately EUR 0.07). This limit was set at KZT 29 for 1 kWh (about EUR 0.06) in 2019. Then, the upper limit decreased drastically to KZT 16.97 (0.03 EUR/kWh) in 2020, which is close to the lowest tariff for solar power generation in the United Arab Emirates, a country that is endowed with more solar resources than Kazakhstan. The maximum price for the 2021 and 2022 auctions was set to KZT 16.96 (0.03 EUR/kWh) and the lowest price bid was at 12.49 KZT/kWh (0.03 EUR/kWh), offered by the international company ENI through its local subsidiary ArmWind LLP for 50MW. In 2021, "Next Eco Energy" offered a bid price of 12.87 KZT/kWh (0.03 EUR/kWh) for 20 MW, the second lowest tariff recorded by that time after the one by ENI.

[1] **Conditional consumers** are power-generating companies whose power plants are powered by fossil fuels such as coal, gas, petroleum products and nuclear energy.

2.4.2 Model 2: PV systems for agricultural consumers, 500 W - 8 kW

Given its many rural and remote areas, there is a substantial demand in Kazakhstan for photovoltaic systems to provide energy to farms. Such systems are small in capacity and can be either connected to the electricity grid or work independently as off-grid solar systems.

Farmers are one of the most promising customer groups for small-scale PV systems. According to the 2007 agricultural census, almost half of the farms in Kazakhstan did not have access to the electricity grid. Given the increased wear and tear of the grids and the development of agriculture in the country, the share of such farms may even have increased by the time this report is written.

Based on a decree of the government of the Republic of Kazakhstan dated April 29th, 2014, up to 80% of the PV investment costs for farmers can be reimbursed by the state. The upper limit of this subsidy is set to KZT 2.5 million (EUR 5,323). According to the decree, the installed capacity of the solar **system should not be more than 2 kW.** This decree has already incentivized 235 farmers in the West-Kazakhstan region to install PV systems [85].

For farmers, both hybrid diesel-PV solutions and pure PV systems (e.g. solar water pumps) are potential use cases. It should be noted that the payment of stated subsidies can be delayed. For example, in 2018, only 107 out of 589 applications filed with the regional agricultural agency for subsidies, were reimbursed on time, while payments of subsidies to the remaining applications were suspended on the grounds of document forgery [88]. The procurement costs of one panel were relatively low in 2021 (KZT 33,000, i.e. the equivalent of EUR 70) and there were intermediaries reselling panels for 5 to 10 times the procurement price. These intermediaries also often benefited from public subsidies with fictitious contracts [88][129][135].

2.4.3 Model 3: Decentralized PV and Hybrid Systems

Decentralised systems are installations that are not connected to the electricity grid and do not benefit from any kind of subsidy mechanism. Consumers generate electricity by using diesel or gas or another type of generator, or by installing a RES system. Potential users of such installations include for example mining companies, and communities or towns located in remote areas.

In Kazakhstan, which has a substantial mining industry, mining companies exploit various deposits, from ores to fossil fuels. RES are potentially attractive to this target group. The growing importance of the mining industry in Kazakhstan is reflected in the increasing number of companies operating in the mining industry. There were 285 mining companies in mid-2022 compared to only 55 in April 2021 [126]. It is also known that international mining companies, switching their energy supply from generators to PV and hybrid solutions, can harness these solutions as they are more mobile and can be transferred in case drilling or development sites change. Due to high energy consumption, KEGOC had to limit the electricity supply even to registered mining sites at peak hours, thereby threatening the lucrative mining market [127]. This could encourage the departure of some mining companies but could also promote decentralised energy production with the help of RES [126].

Decentralised PV and hybrid systems for residential consumers. Many remote settlements in Kazakhstan still need to be connected to the grid and depend on diesel generation. In 2018, there were about 2,000 of such settlements [88]. Photovoltaic systems can play a crucial role in providing these settlements with reliable access to energy in the future. Existing diesel and gasoline generators can be complemented by photovoltaic systems that can reduce fuel consumption. A good solution could be to equip off-grid communities with local hybrid solar-diesel installations. Such projects should be supported by the state or local municipalities because most of these settlements do not have the financial resources to purchase the necessary equipment, even with existing subsidies. At the same time, even areas connected to the electricity grid suffer from poor supply quality due to the frequently obsolete transmission lines. In such areas, alternative energy generation is often used in parallel to the grid. In addition, due to the country's size and low population density, often electricity needs to be transmitted over hundreds of kilometres which leads to transmission losses of up to 30%.

2.4.4 Model 4: On-grid PV systems up to 100 kW with feed-in options

A private owner of a RES plant in Kazakhstan has the right to connect such a system to the local power grid and sign an electricity purchase and sale contract with a sales company. Provided that the rules and requirements stipulated in Order No. 309 of the Minister of Energy of the Republic of Kazakhstan are met, such a consumer receives compensation for the surplus energy from his RES system fed into the grid based on the retail prices. Apart from the right to feed into the grid, these RES systems are not subject to other subsidies and support measures.

However, it needs to be added that local network operators often refuse to connect an RES system to the grid by claiming that the additional loads could lead to network failures.

2.4.5 Model 5: Off-grid PV systems for private use up to 5 kW

Under the existing support schemes, private households in areas without grid access are eligible to a government subsidy for the installation of RES equipment with a capacity of up to 5 kW peak. This subsidy covers up to 50% of equipment expenses. However, this scheme has not yet been successful due to local content rules [128][129] which stipulate that the equipment needs to be produced in Kazakhstan to be eligible for the subsidy. The prices for such equipment are usually very high and the subsidy targets primarily private households in remote areas which usually have low-income population. Households do not have the resources to purchase RES equipment in the first place, even considering the 50% subsidy. As of June 2022, the Ministry of Energy is hence considering to remove this unpopular condition [129].

3. Regulatory and Business Framework

3.1 Regulation and Support Schemes for PV and RES

Issues relating to the transmission and consumption of energy are regulated by Law No. 588-II of July 9, 2004 "On Electric Power Industry".

Currently, the mandatory purchase of electricity from RES sources at a **fixed rate** is determined by auctions and **indexed for a period of 15 years**. This support scheme for RES projects was defined in 2018. Prior to this, fixed tariffs had been in place since 2013, allowing more RES projects to be implemented. To date, the state regulates the introduction of energy-generating capacities, setting capacity targets for the RES sector.

Since 2009, the main law supporting RES projects is the Law "On Support of Renewable Energy Sources", which defines the basic conditions for electricity and heat production from RES, including the following economic and technical aspects:

- setting of tariffs by local executive bodies for each RES project separately
- obligation of all regional power grid companies, including the system operator, to purchase electricity from RES to compensate for grid losses
- exemption from service fees of power transmission companies, including network and distribution companies for power plants using renewable energy sources
- priority dispatching of RES generated electricity by the system operator and regional power grid companies

In 2013, the notions of fixed tariffs and **a single purchaser of RES, represented by the** Calculation and Finance Centre for Support of Renewable Energy Sources (RFC) **(a subsidiary of KEGOC),** were introduced into the law. This led to the creation of a pooling system for electricity purchases from RES companies. At the same time, the rules for the centralized purchase and sale of RES electricity and the relationship between RES companies and the government are set out in Order No. 164 of the Minister of Energy of Kazakhstan. The fixed tariff obliges the single purchaser to purchase all generated energy from the RES power plant. The RFC gives a **15-year fixed tariff to** the investor, which **is indexed to the inflation rate. In 2014,** the Government of Kazakhstan set various fixed tariffs for each type of RES facility which are shown in the table below:

Table 5: Fixed tariffs for RES objects (2021)

Type of RES facility	Price in KZT/ kWh at fixed tariff*	Price in EUR/kWh at fixed tariff*
Wind power plants	22.68	0.045
PV plants, except for power installations using photovoltaic modules based on Kazak silicon	34.61	0.069
Small hydropower plants	16.71	0.033
Biogas plants	32.23	0.064
Power plants using PV modules based on Kazak silicon	70	0.14
Hydrodynamic waterpower	41.23	0.082

Source: Kazenergy, National Energy Report 2021 [48]. Tariffs are shown without VAT

These fixed tariffs **apply to projects that were contracted before the introduction of the auction bidding mechanism in 2014-2018.** In 2022, a draft amendment was waiting for final approval to introduce fixed tariffs at KZT 41.23 per kWh for facilities using hydropower. In 2022, an amendment introduced the indexation of the auction prices for RES. The investor must choose between two options which will remain effective during the entire duration of the PPA:

- **One-time indexation -** the price of energy is adjusted between the publication of the auction winners and the commencement of the supply of energy
- **Annual indexation -** allows for annual adjustment of auction prices according to the consumer price index or the fluctuation of the KZT/USD exchange rate

Renewable energy generation companies in Kazakhstan are exempt from paying for electricity transmission services. In addition, there is a procedure for granting investment preferences depending on the type of **investment and investment priority [27]**.

- **Investment projects are exempted from** customs and value added tax on. Also, investment projects can receive a **state grant** with a maximum size of 30% of the investment volume.
- **Special investment projects,** additionally to the preferential treatment outlined above, receive preferential corporate income, land and property taxes.
- **Investment priority projects** receive further investment subsidies. At the **end of February 2020,** a resolution was signed, which designated all RES projects as **priority investment projects [28].** According to paragraph 284 of the Entrepreneurial Code of the Republic of Kazakhstan, an **investment priority project is defined as the:**
    - **Establishment** of new production facilities providing for investments in the amount of not less than *two million times the amount of the* monthly estimated indicator (KZT 2,405), as established on the date of application for investment preferences, investment of around **EUR 10 million.**
    - **Expansion or renewal** of existing production facilities, providing for investments in the amount of not less than *five million times the amount of the* monthly estimated index (KZT 2,405), as established on the date of application for investment preferences, investment of around **EUR 25 million.**

RES projects can benefit from the following preferential treatment:

1. Tax exemptions:
    - Exemption from corporate income tax for a period of 5 years, dating from the state registration of manufacturers of RES units
    - Exemption from property tax, for a period of 10 years, dating from the commissioning of plants
    - Exemption from property tax for a period of 10 years, dating from the commissioning of power generation units
2. The state support scheme for RES investment reimburses up to 30% of the purchase, construction and installation cost of equipment, excluding value added tax and excise duties provided by the working program of the investment contract [29].
3. Exemption from customs on the import of equipment.

4. State non-refundable in-kind grants for up to 30% of the investment volume [46]. The in-kind grants include land plots, buildings, equipment, machinery, measuring and regulating instruments and devices, vehicles (except for passenger cars), production and household equipment. The natural grant is provided free of charge for the duration of the contract. If the investor fulfils all obligations, the Ministry of Investment and Development transfers the grant on a non-reimbursable basis [68].

To receive these benefits, one needs to become a legal entity of the Republic of Kazakhstan and apply for these benefits. The application requires a business plan, documents regarding the estimated cost of construction, installation and the costs of purchasing raw materials, equipment and materials for the project, and confirmation on project financing. It should be noted that the government may unilaterally terminate the investment contract in case investment requirements are not met.

3.1.1 Regulations on the electricity trade and purchase for private photovoltaic systems

For owners of private RES systems separate rules for electricity trade and its purchase from the grid have been developed. The grid connection of RES system are governed by the order of the Minister of Energy of Kazakhstan № 309 of August 10, 2016. In contrast to large PV parks, the purchaser of energy from a private "prosumer" is the local power supply company, that owns the grid to which the RES system is connected. The order introduces the concept of the "Net Consumer" which means that the owner of the RES system has the right to use the electricity generated by the private RES system, to buy electricity from the local electricity grid, and to supply surplus energy to this electricity grid for a compensation from the energy supply company.

The main provisions of the Order are as follows:

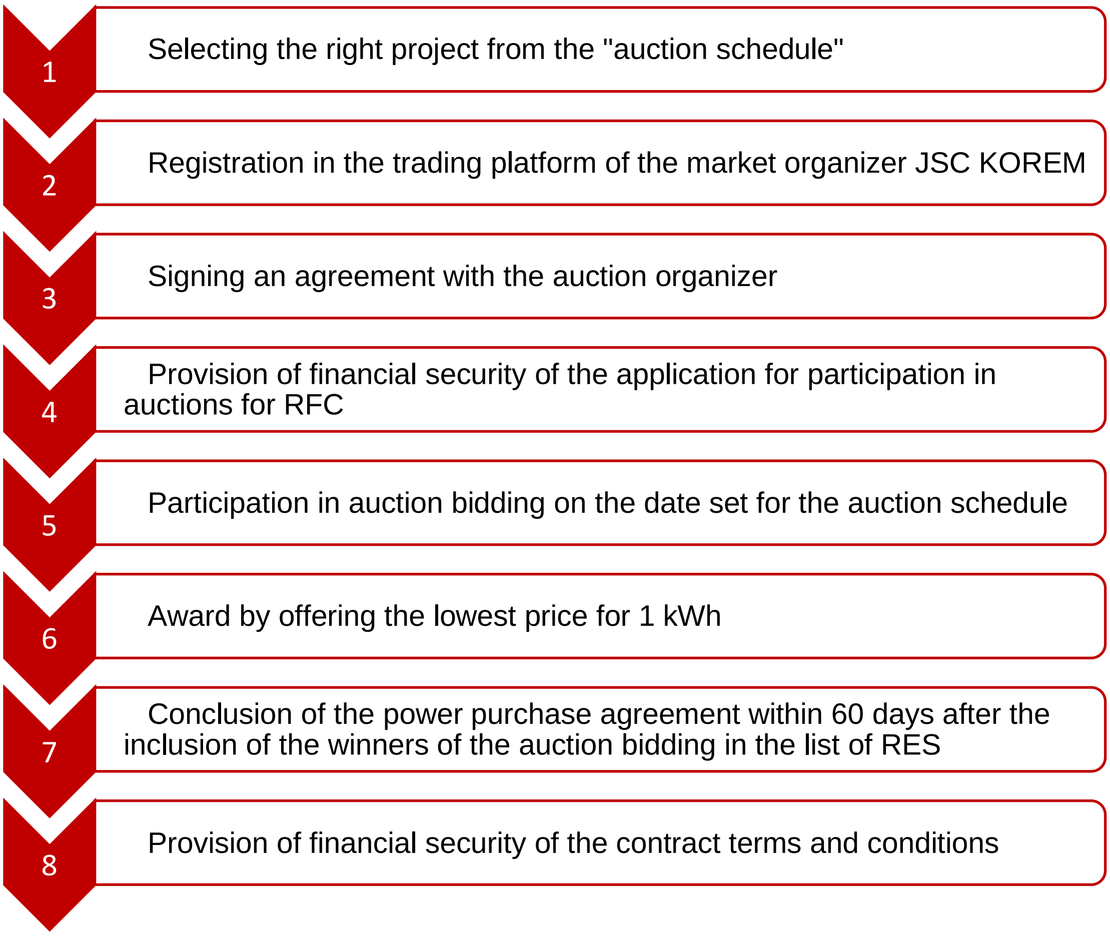
- In order to connect the RES system to the power grid, the net consumer provides full documentation of a RES system, including forecasts of power generation, to the local grid and sales companies.
- An electricity purchase and sales contract is to be concluded with the net consumer.
- It is mandatory to have a metering device that registers the grid’s power consumption and the consumer’s net power consumption.
- The sales company servicing this consumer pays the margin of energy consumed from and energy supplied to the grid by the consumer (i.e. in case of excess of own output over consumption). In this case, the electricity tariff valid for this consumer is applied and could be called a feed-in tariff.

3.1.2 Auction Bidding Mechanism

In 2018, Kazakhstan introduced an auction mechanism to select renewable energy projects. The auctions are held online on an independent trading platform operated by JSC KOREM. The Ministry of Energy of Kazakhstan defines the required capacity for the year and a maximum auction price. The lowest bidder receives the right to implement the project at the determined auction price. Based on this price, the RFC pledges to buy the generated energy from the producer on a contractual basis. The selection of projects is RES type (wind, solar, hydro, bio), and by size (small (up to 10 MW) and large (over 10 MW) power plants).

The following graph shows the main steps of the RES auctions in Kazakhstan:

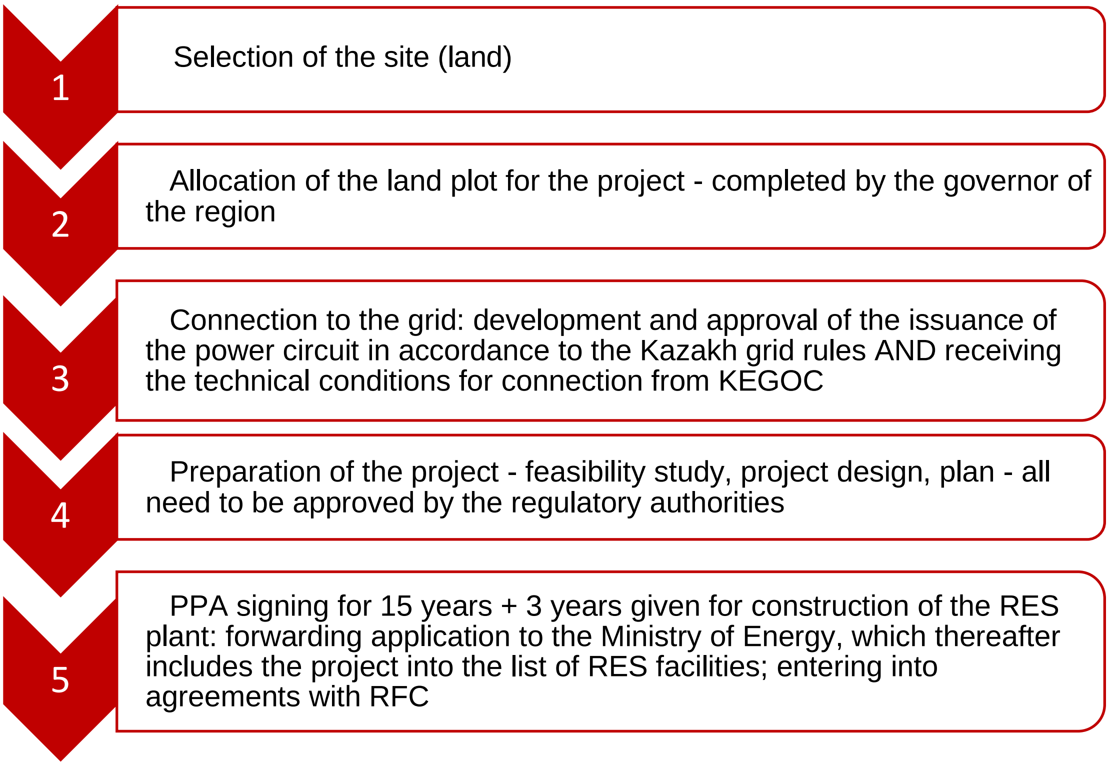
Figure 19: Implementation scheme for construction of RES facilities through RFC



Source: eclareon 2022 based on "RFC on RES" [80]

In short, the main steps to develop a RES project in Kazakhstan are the following ones:

Figure 20: Common implementation of the RES project in Kazakhstan

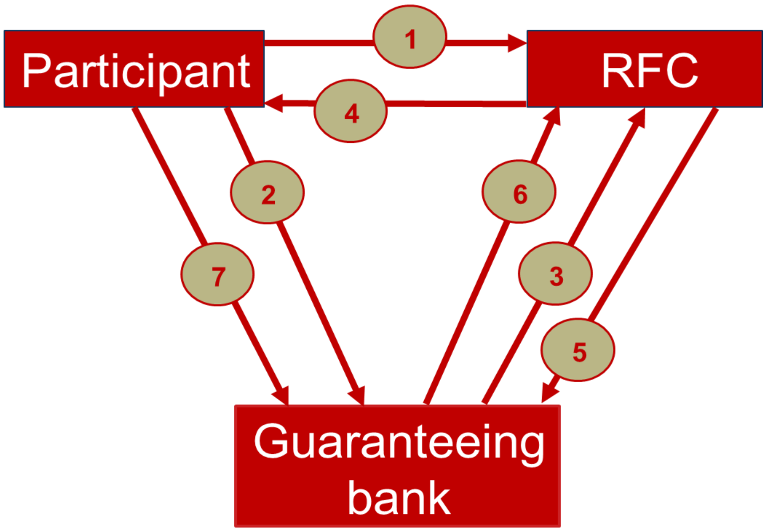


Source: eclareon 2022 based on Association of RES of Kazakhstan, 2018 [91] [92]

The auctions are scheduled annually by the Ministry of Energy of Kazakhstan and published on the RFC website. The trading platform is open for registration at different points in time depending on the auction type [56]. The auction participants need to back up their application by a financial security of KZT 2,000 (EUR 4,265) per 1 kW of bid capacity. Financial security of the application should be issued in favour of RFC. Two types of financial security are accepted:

- **Bank guarantees** are written unilateral commitments of the bank to the beneficiary with the payment of the amount in favour of RFC. The bank guarantee can be provided both from domestic and international banks.
- **Standby letters of credit** are similar to bank guarantee obligations of the bank to the beneficiary to make payment in case the auctioneer cannot fulfil their obligations.

Figure 21: Scheme of issuing a bank guarantee and standby letter of credit for participants in auctions for RES projects



Source: eclareon 2022 based on materials of Halyk Bank of Kazakhstan [63]

1. The bidder submits their intention to participate in an auction
2. The participant applies for a bank guarantee
3. The guaranteeing bank sends the bank guarantee to RFC
4. RFC awards projects to the successful bidders
5. If the awarded bidder does not sign the PPA or fails to fulfil its obligations under the purchase agreement, RFC claim the financial security from the guaranteeing bank
6. The guaranteeing bank pays the amount upon request for payment from RFC
7. The participant reimburses the amount of the claim to the guaranteeing bank

If the bidder won the bid and received the right to implement the project within 60 days, the purchasing agreement by the RFC is concluded. **Such contracts are in the form of Power Purchasing Agreements (PPA).** The purchase price is determined by the auction. As mentioned earlier, it must not exceed the ceiling tariff, which in turn is calculated **for 15 years ahead [62]**. If the bidder has not been selected, the financial security related to the bid will be fully redeemed within three days. The conclusion of the purchase agreement leads to the provision of another financial security within one month, which is issued similarly to the financial security required during the application process, i.e., through a bank guarantee or standby letter of credit. The amount of this security is KZT 10,000 (EUR 21.32) per 1 kW of installed capacity. For solar power plants, this collateral is valid for at least 25 months from the purchase agreement's signing.

In case of construction delays, the investor can be fined with up to 30% of the financial collateral. In case of delays with regards to the commissioning of the power plant, the amount increases to 70% [48]. The 30% of the financial collateral can be called if construction and installation works have not started within 12 months. Commissioning of a PV plant should occur 24 months **after signing the purchase agreement**. For other RES including bioenergy it should take place within 36 months and for hydropower plants within 48 months. In case this period is not met, 70% of the financial collateral can be requested. However, it should be noted that it is possible to extend the completion of each RES facility for 12 months, if at the time of application, 70% of the total amount of work on the construction of the facility has already been completed [64].

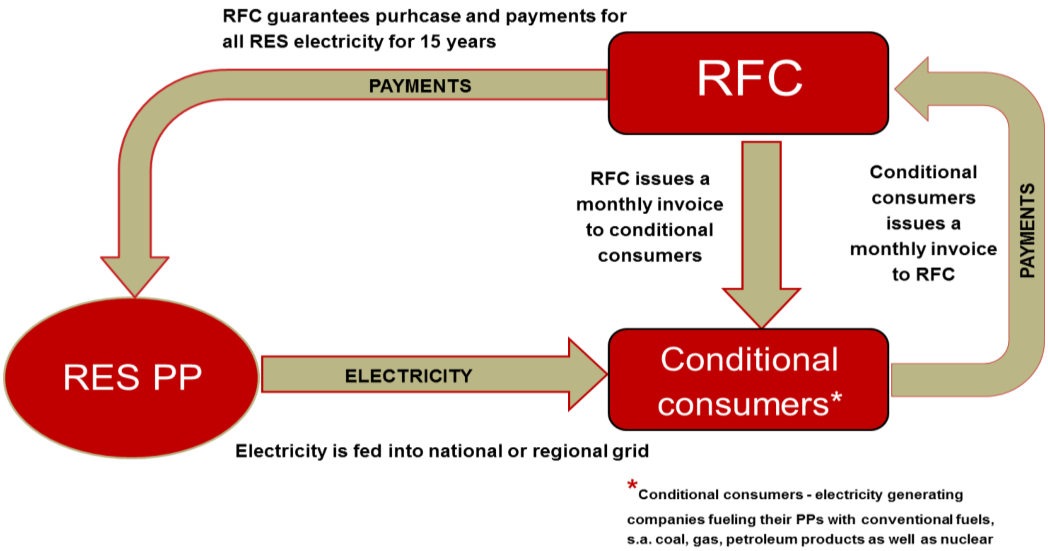
Since 2019, **project auctions have been held, enabling investors to sell a RES facility,** accompanied by the pre-project technical documentation.

The first project under the auctions mechanism was the construction of a 50 MW solar power plant in the Turkestan region near the city of Turkestan, which is located in the southern zone of the Unified Energy System (UES) [70]. The winner of the auction was the Kazakh private company Arm Wind LLP, setting the final price at 12.49 KZT/kWh (0.0266 EUR/kWh) (excluding VAT). This tariff is the lowest in the solar energy market in Kazakhstan recorded hereto.

As aforementioned, based on the electricity purchase agreement, RFC buys electricity from a RES facility and then resells it to "**conditional customers**", meaning electricity generating companies that use coal, gas, petroleum products, and nuclear. Conditional consumers include large power generating companies such as Ekibastuz GRES-1 and GRES-2, Kazakhmys Energy, and Eurasian Energy Corporation.

The RES electricity trading cycle is shown below:

Figure 22: The scheme of purchase and sale of the generated electricity by RES stations



Source: eclareon 2022, based on Halyk Bank of Kazakhstan [63]

3.2 Codes and Standards

3.2.1 Rules of Power Transmission and Technological Connection to the Grid

The self-consumption scheme is available for all **RES facilities up to 100 kW [81]**. Based on the law "On the support of renewable energy sources", the RES constructing and operating company has the right, after determining the nearest point of connection to the electricity grid, to apply for the connection of the RES facility to the grid. To determine the most suitable connection point, it is necessary to submit an application to the power transmission company**. For this, the following information is needed: name and type of the installation, location of the site, permissible power transmission of the installation, expected productivity, expected power consumption from the installation, technology and method of installation, commissioning date, minimum generation of active power in MW (load)** and other technical specifications [76]. After determining the nearest connection point, an application for technical specifications is submitted, which is developed by the power transmission company in case the **parameters of the connected installation will not exceed the thresholds of the grid**. If a RES facility has capacity ranging from 0.1 to 10 MW, the application is to be approved by the energy distributing organization. The system operator manages the application if the capacity exceeds 10 MW.

3.2.2 State Standards for Solar Energy

Since Kazakhstan plans the commissioning of new RES capacities, all projects must pass through RFC. This limits the construction of new capacity and limits the investment volume of potential investors to a specific capacity. The government itself defines specific areas for RES projects based on existing and planned capacities.

3.3 Terms of Trade, Investment and Import

3.3.1 Inflation and Interest Rates

In 2022, the annual inflation in Kazakhstan amounted to 20.3 %, which is significantly above the multi-year averages (5-8%) and inflation targets (4-5%) [71]. The high inflation rate is directly linked to Russian invasion of Ukraine which began in February 2022. The National Bank of the Republic of Kazakhstan identifies the reorientation of supply chains and the increase in grain harvest as the main factors of this sudden increase. Given a re-gained stability of grain prices and the softening of the overall inflationary environment, it forecasts an inflation rate of 11-13% for 2023 and 7-9% for 2024 [72]. Kazakhstan's financial and banking sectors are directly exposed to Western sanctions because 15% of the sector are subsidiaries of Russian banks [121]. Nevertheless, the country, a major exporter of hydrocarbons, will benefit from the rise in fuel prices. In addition, the metals and food exports should allow for an inflow of foreign currency [118].

At the end of 2022, the **base interest rate** in Kazakhstan was at 16.75%, which is 0.35% above the average annual interest rate in 2019 [72].

3.3.2 Import Conditions for Photovoltaic Modules

On the basis of the abovementioned support schemes, a special regime for PV products has been introduced, which exempts imported equipment from customs. The exemption is given for no more than 5 years and is valid for the following equipment**:**

- Technological equipment for a PV power plant
- Spare parts, raw materials and materials for a PV power plant

3.4 Financing of Photovoltaic Power Plants

Although loans in Kazakhstan are primarily directed towards CO_2 intensive sectors, investments in RES have reached USD 1.8 billion in 2021 [136]. Investors are particularly targeting renewable energy, especially solar and wind [124].

Given the current circumstances, the banking sector can hardly finance large investments. However, financing RES projects could become more attractive for Kazakhstan's banks driven by the CBAM mechanisms (see Section 2.3) [136].

The most active among the country's financing institutions is the **Development Bank of Kazakhstan (DBK).** As of January 1st, 2023, the DBK has already implemented more than ten power projects in Kazakhstan, including hydropower, solar power and wind power plants.

International financial institutions have shown a strong interest in RES projects in Kazakhstan. On average, 70% of projects in the country are financed by international financial institutions. However, financing costs in Kazakhstan are relatively high with an annual interest rate of 12-13%, while RES projects in more mature markets are financed at 1.5-3% per year [87][118].

The Eurasian Development Bank (EDB) is the leading institution among foreign banks in financing RES projects [84]. Their financing program of **USD 600 million** covers support for all types of RES projects until 2023. Currently, the bank plans to allocate about 42% of their funds to Kazakhstan.

Apart from the EDB, the **European Bank for Reconstruction and Development (EBRD)** and the **Asian Development Bank** have also shown interest in financing renewable energy projects in Kazakhstan. As of April 2022, the EBRD has financed the installation of 800 MW of renewable energy spread across 14 projects in Kazakhstan for a cumulative investment amount of **USD 500 million [118]**. The EBRD and the Green Climate Fund committed **USD 50.4 million** for building a 50 MW solar power plant in Chulakkurgan (located in South Kazakhstan) [119]. Costing a total of **USD 57.67 million**, the power plant was commissioned in early 2020 [120].

4. Selected Business Models

This section is dedicated to the profitability analysis of a utility-scale PV project in Kazakhstan. Sample calculations of typical projects include cash-flow modelling and sensitivity analyses to provide an outlook of profitability changes related to system prices, energy yield, and remuneration.

For the business case, we have used the solar radiation values of Kapchagay in the south-eastern part of the country. According to data from the global solar atlas, the solar radiation in the region corresponds to 1,761 kWh/m^2 (global tilted irradiation (GTI) at an optimum angle). After applying a performance ratio of 0.85 to this irradiation, the specific yield used (and shown in the graphs and figures) is 1,499 kWh/kWp/a. Please note that the specific annual PV yield in Kazakhstan depends heavily on the project's location. The solar irradiation (again GTI at optimum angles) varies in Kazakhstan between approx. 1,300 kWh/kWp/year in the north to 2,000 kWh/kWp/year in the south.

The results of the updated business models were compared with similar business models built in 2020 based on the conditions of the respective year. The economic attractiveness of most models worsened, mainly due to an increase in the inflation rate in Kazakhstan, which was around 20% at the end of 2022. Given the above-described prices for PV parks, which in 2022 won auctions with a price of around 17 KZT/kWh (0.034 EUR/kWh), the profitability of these business models is deemed to be rather limited. According to data from local stakeholders, the average payback of large PV parks awarded through public auctions has an amortisation period of 24 years which is not very attractive for most investors. **Therefore, the economically most attractive option for the development of the PV market in Kazakhstan as of early 2023 is in remote rural areas that suffer from a lack of reliable grid electricity. Especially farms are located in such areas and should hence be seen as a target group for PV solutions.**

The following business model calculations are based on a real request from a farmer in the city of Aktobe who needs photovoltaic power to power a solar pump. This particular farmer will be fully financed through economic support from the Eurasian Development Bank but debt financing was not taken into account in the calculations because, mainly due to inflation-induced high interest rates, bank loans to finance PV system are currently quite expensive. If the situation stabilises in the future, debt financing could be taken into account.

4.1 Methodology of Profitability Analysis

An Excel based discounted cash flow analysis (DCF) was used for the profitability analysis. The DCF methodology evaluates a project using the concept of the time value of money.

All future cash flows are estimated and discounted to their present values. The **net present value** (NPV) is the sum of all positive and negative cash flows, including the initial investment. The NPV allows for the comparison of investments with different durations and cash flow profiles over their lifetime at the present point in time. Besides NPV, the **internal rate of return** (IRR) for both the equity and the entire project were calculated, and the **amortization period** (payback time) for the invested capital. These parameters give an indication of the attractiveness of a PV investment. Please note that we have used discounted cashflows for the calculation of the amortization period but that we also show an undiscounted payback period in the project overview charts. By definition, these undiscounted payback periods are always shorter than the discounted payback periods because the time value of money concept is ignored which basically means that 1 KZT today will still be worth 1 KZT at any time in the future.

Another key parameter calculated is the **levelized cost of electricity** (LCOE) which makes it possible to compare power plants of different generation technologies and cost structures.

Finally, ratios such as the **debt service coverage ratio** (DSCR) and the **loan life (-cycle) coverage ratio** (LLCR) provide information about whether the project cash flows suffice to reimburse the debt invested in a project. These values should be at least > 1 which would mean that free project cash flows would suffice to pay back debt. As said above, for this particular business case, debt financing was not taken into account due to the currently high interest rates in Kazakhstan.

4.2 3 kWp Solar Water Pump

Assumptions for this PV Business Case

A 3 kWp PV system provides the electricity needed to operate a solar water pump. With the extracted water the owner of the system can irrigate agriculturally used land. The amount of water that will be pumped depends on the ground water resources in the area and the efficiency of the pump. This business case assumes that the water pump is already in place, but is operated by a privately owned diesel genset. The PV system substitutes the genset, therefore, the profitability and the payback period of the PV system are based on fuel savings. A chemical battery is not part of the PV system configuration but a physical storage unit like a water tank is already in place. Like this, the fields can be irrigated during the night to decrease evaporation losses and the overall efficiency of the PV system is increased, because it is able to operate in periods where no irrigation is needed. In addition, it must be pointed out, that a water pump can only be installed in areas with sufficient and sustainable water resources, the potential problem of overextraction of groundwater needs to be closely monitored.

The size of a PV system for an application like this depends heavily on the depth of the water resources, the size and efficiency of the pump and the demand for water. Solar water pump systems can range from single digit kWp to several 10 kWp, but systems around 3-5 kWp are common and are considered sufficient for the most demanded use cases in Kazakhstan. Compared to a residential PV system, the price per kWp for the PV component of the irrigation system is lower since the installation is ground mounted and hence less expensive than usual rooftop mounted systems. The irradiation values match 1,896 kWh/m^2 GTI_{opta} and 1,522 kWh/kW PV_{out}.

The applied direct PV consumption, that determines which share of the solar irradiation can effectively be converted into “useable” electricity, was set to rather low 60% since the PV system only powers one single appliance. This value can be increased by raising the storage capacity or other efficiency-oriented measures. The PV system performance was assumed to decrease by 0.7% per year accounting for the wear and tear of the system.

The lifetime of the PV system was set rather conservatively to 20 years. An increase based on the lifetime of the PV modules to 25 years would be reasonable as well provided that the system is installed professionally and with “high enough” quality.

Total turnkey PV system costs (capital expenditure, Capex) for the PV system were calculated to be around 700,000 KZT/kWp. Total system costs amount to 2,100,000 KZT.

The operation costs were reported to account for about 2% of the system costs which is a rather high value.

The PV system in the business case was financed with 100% equity provided by the owners of the PV system. The main motivation for a typical customer is not a high return on investment (as would be the case for institutional investors described in the previous business case) but rather the access to reliable electricity and the perspective to secure crop yields by irrigating fields during periods when natural rainfall does not provide enough water for the crops. Still, it is assumed that typical customers would not like to lose money either and would therefore expect that their investment would recover the inflation rate. Therefore, the business case was modeled with a modest discount rate for the equity investment of 10%. The long-term inflation rate was set to 6%.

Additional equity is not required during the operations phase of the project. The customer self-consumes the PV electricity which leads to savings in fuel purchases for his generator. The amount of savings depends on the price of fuel and also on the efficiency of the generator, meaning the kWh that can be produced by 1 liter of fuel. In addition, the amount of kWh that can be saved depends also on the PV consumption, meaning the %-value of useful electricity generated that can also be used at the time when consumption shall take place. Good system configuration leads to a proper dimensioning of the system and high direct consumption rates. For the business case it was assumed that 60% of the electricity generated by the PV system will directly be used. This value could be higher depending on the rainfall patterns, crop water requirements and other water needs of the farm, e.g., for livestock.

With regards to the generator efficiency, it was assumed that the generator needs 1 liter of fuel to produce 2.5 kWh of electricity. The fuel is purchased for 239 KZT/liter. In addition, costs for lube oil that regularly needs to be exchanged were considered in savings as well. Fuel prices were assumed to increase by 10% p.a. This is more than the assumed long-term inflation rate of 6%. Given that the customer already owns a generator and also wants to keep it as a backup system neither generator purchase or replacement costs nor other operating costs were taken into account for this business case.

As said before, investment costs for small scale solar systems can be subsidized with 50%, in agricultural even with up to 80%. This subsidy, if granted, makes obviously a big difference for the PV system owner. In the following we will present the same calculation without a subsidy and by applying a subsidy of 50%.

Financial results for this PV Business Case (without subsides)

In summary, the assumptions and results for the business case described above without taking into account an investment subsidy are the following:

Figure 23: Project Overview – 3kWp solar water pump (unsubsidized)

PV System		
Project Duration	Years	20
PV System Size	kWp	3.0
Nominal storage capacity	kWh	-
Total PV system costs /kWp	KZT/kWp	700,000
Investment subsidy	KZT	-
Total PV System Cost	KZT	2,100,000
Performance Factor	%	90%
Degradation	% p.a.	0.70%
Applied Solar Yield	kWh/kWp/a	1,499
Average Yearly Generation	kWh/a	4,182
Fixed Operation Costs PV	% p.a.	2.00%
Battery Replacement Interval	Years	4

System Operation - Savings		
Applied Direct PV Consumption	%	60.00%
Applied Battery PV Consumption	%	-
Genset Efficiency	kWh/ltr	2.5
Average Replaced Fuel Consumption p.a.	ltr/year	1,004
Fuel Price (1st Ops Year)	KZT/ltr	239.00
Oil costs as % of fuel costs	%	10.00%
Fuel Price Escalation	% p.a.	10.00%
Genset CAPEX fee saved	USD p.a.	-
Genset OPEX fee saved	USD p.a.	-
Generator related savings (average)	KZT/kWh	194.60

Financing			
Debt (Gearing)	-	KZT	-
Loan Tenor		Years	-
Debt Interest Rate		%	-
Initial Equity		KZT	2,100,000
Additional Equity		KZT	-
Discount Rate		%	10.0%
Longterm Inflation Rate		%	6.0%

Results		
Net-Present Value	KZT	2,439,088
Equity IRR	%	20%
Project IRR	%	20%
Amortization - discounted payback period	Years	9.17
Undiscounted payback period	Years	6.35
LCOE (no subsidy)	KZT/kWh	77.45
Min DSCR**	x	-
Min LLCR***	x	-

* LCOE: Levelized Cost of Electricity

** DSCR: Debt Service Coverage Ratio

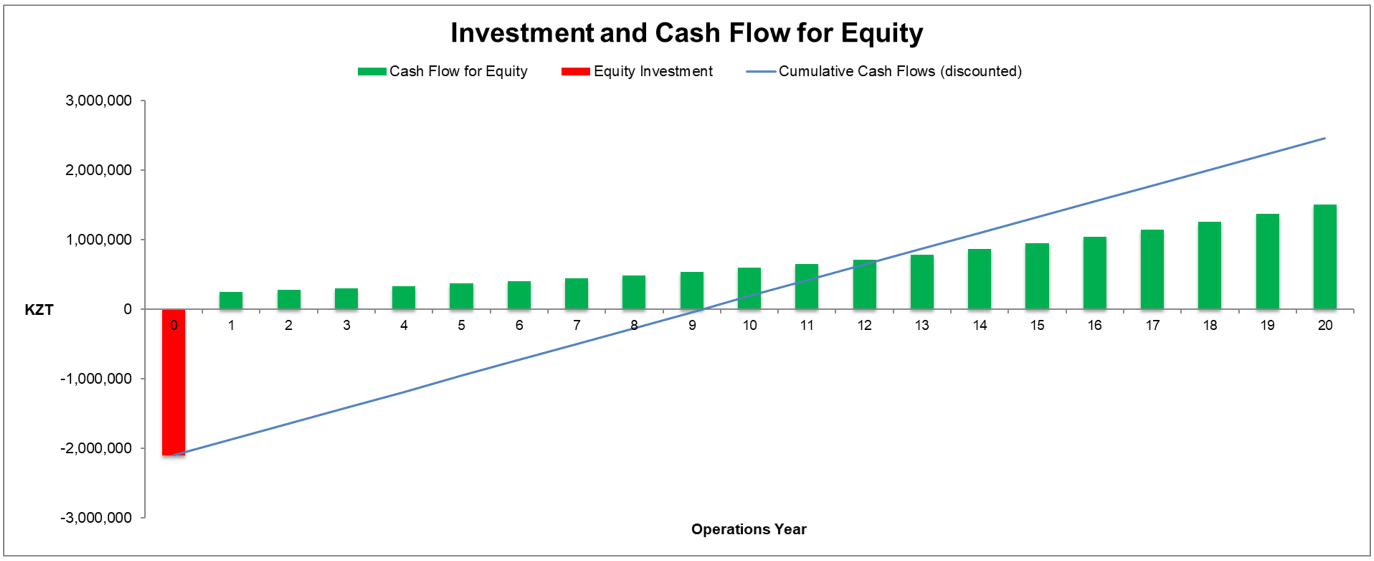
*** LLCR: Loan Life Coverage Ratio

Source: eclareon, 2022

Without subsidies the results for this business case are a positive net present value of KZT 2,439,088 and an internal rate of return of 20% which means that the PV system is an economically viable investment under the assumptions described above. The equity investment is paid back after approx. 9 years, longer using discounted cash flows, sooner if cash flows are not discounted.

Looking at more detail at the unsubsidized business case, the equity cash flow for the base case looks as follows:

Figure 24: Equity Cash Flow – 3kWp solar water pump (unsubsidized)



Source: eclareon, 2022

Sensitivity of results for the Business Case (unsubsidized)

The following figures show how two key economic performance indicators of the investment, the discounted payback period (amortization) and return on equity (Equity IRR), change when certain of the assumptions described above are modified.

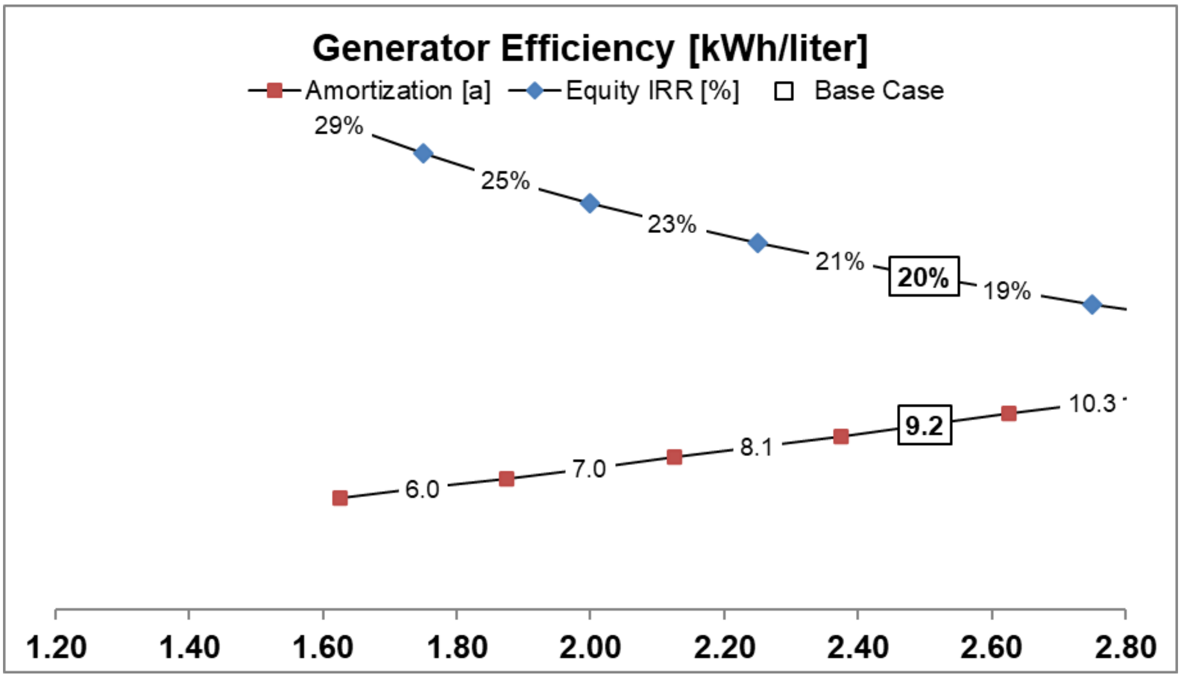
The specific yield shows the kilowatt hours produced by a PV system per kWp of capacity and per year. It is calculated on the basis of the solar radiation multiplied by the performance factor of the PV system. This factor includes the technical conditions for the efficiency of the PV system, the efficiency, orientation and inclination of PV modules, possible shadowing, etc.

It can be seen that the financial results for the PV installation improve when the system would be built at a site with higher irradiation: the equity IRR increases and the payback period decreases when more electricity can be harvested.

Another parameter that has an impact is the generator efficiency. The more kWh can be generated with one liter of fuel, the more efficient the generator is and the less attractive becomes the PV investment. Inversely, if less kWh can be generated with a liter of fuel, the shorter the payback for the PV system will be. As can be seen in the graph below, a kWh/liter ratio of 2 instead of 2.5 as in the base case, would reduce the discounted payback period from approx. 9 years to 7 years. Inversely, if 1 liter of fuel generates more than 2.5 kWh of electricity the payback period would be extended.

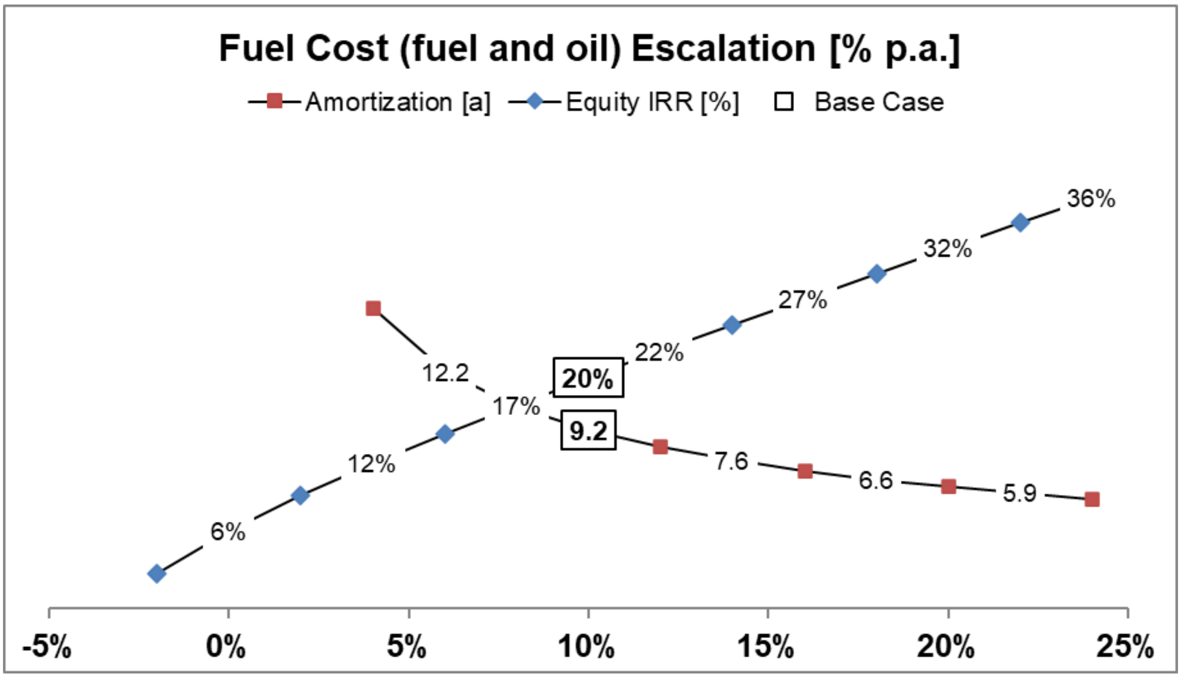
The fuel price and also its future development play a very important role for the business case. The more expensive fuel products are today and the more they increase in the future, the higher the PV-induced savings will be.

Figure 25: Generator Efficiency - 3kWp solar water pump (unsubsidized)



Source: eclareon, 2022

Figure 26: Fuel Cost (fuel and oil) Escalation - 3kWp solar water pump (unsubsidized)



Source: eclareon, 2022

Financial results for this PV Business Case (50% subsidy)

In summary, the assumptions and results for the business case described above taking into account a subsidy of 50% of the investment subsidy are the following:

Figure 27: Project Overview – 3kWp solar water pump (50% subsidy)

PV System			
Project Duration		Years	20
PV System Size		kWp	3.0
Nominal storage capacity		kWh	-
Total PV system costs /kWp		KZT/kWp	350,000
Investment subsidy		KZT	1,050,000
Total PV System Cost		KZT	1,050,000
Performance Factor		%	90%
Degradation		% p.a.	0.70%
Applied Solar Yield		kWh/kWp/a	1,499
Average Yearly Generation		kWh/a	4,182
Fixed Operation Costs PV		% p.a.	2.00%
Battery Replacement Interval		Years	4
Financing			
Debt (Gearing)	-	KZT	-
Loan Tenor		Years	-
Debt Interest Rate		%	-
Initial Equity		KZT	1,050,000
Additional Equity		KZT	-
Discount Rate		%	10.0%
Longterm Inflation Rate		%	6.0%

System Operation - Savings		
Applied Direct PV Consumption	%	60.00%
Applied Battery PV Consumption	%	-
Genset Efficiency	kWh/ltr	2.5
Average Replaced Fuel Consumption p.a.	ltr/year	1,004
Fuel Price (1st Ops Year)	KZT/ltr	239.00
Oil costs as % of fuel costs	%	10.00%
Fuel Price Escalation	% p.a.	10.00%
Genset CAPEX fee saved	USD p.a.	-
Genset OPEX fee saved	USD p.a.	-
Generator related savings (average)	KZT/kWh	194.60
Results		
Net-Present Value	KZT	3,835,885
Equity IRR	%	36%
Project IRR	%	36%
Amortization - discounted payback period	Years	4.14
Undiscounted payback period	Years	3.34
LCOE (no subsidy)	KZT/kWh	67.61
Min DSCR**	x	-
Min LLCR***	x	-

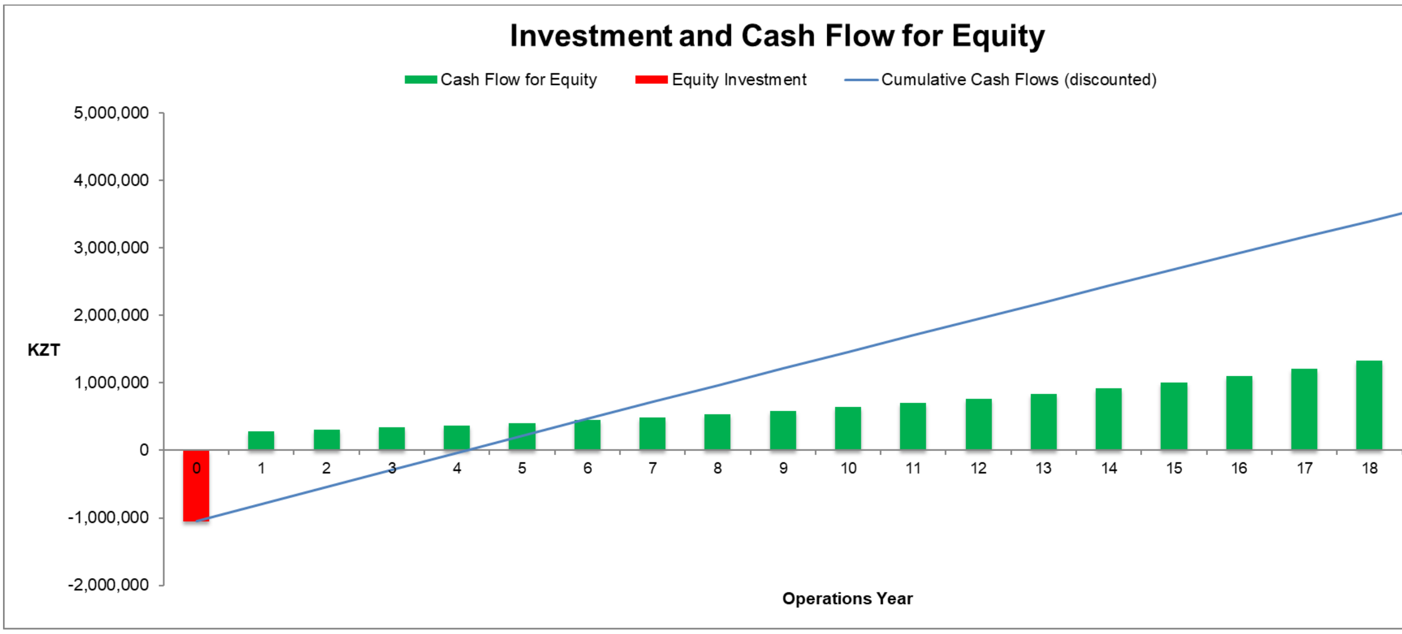
* LCOE: Levelized Cost of Electricity
** DSCR: Debt Service Coverage Ratio
*** LLCR: Loan Life Coverage Ratio

Source: eclareon, 2022

With subsidies the net present value increases to 3,835,885 KZT and the internal rate of return to 36%. The equity investment is now paid back after approx. 4 years which is a substantial improvement compared to the 9 years without subsidies.

Looking at more detail at the subsidized business case, the equity cash flow for the base case now looks as follows:

Figure 28: Equity Cash Flow – 3kWp solar water pump (50% subsidy)



Source: eclareon, 2022

In essence, the state subsidies of 50% (or even more) can make the business case much more attractive for potential investors. However, it needs to be taken into account that this subsidy is linked to local content requirements and that the locally manufactured equipment may not be available or only be available at a higher price.

5. Conclusion

Kazakhstan's PV market has a high natural potential for the large-scale deployment of renewable energies. However, the current market and business environment only offers limited opportunities for small and medium-sized enterprises.

Electricity consumption in Kazakhstan has been constantly increasing in recent years. Forecasts suggest that there will be a capacity shortage in the medium run due to the high level of obsolescence of the existing energy infrastructure and electricity generation facilities, mainly consisting of out-dated grid infrastructure and thermal power stations inherited from the Soviet Union. A severe black-out in 2022 showed the urgent need for modernization and replacement of existing equipment. According to the official plans of the government, an increase in investment in renewable energies shall be an important aspect of the necessary overall modernisation of the energy sector.

Kazakhstan, also pushed by its strong economic ties to the European Union, has actively been working to improve the legislation governing the energy sector. New laws provide strong incentives for companies from the energy sector, the industry and the service sector to adopt less CO_2-intensive production. While these regulations first need to be implemented by large companies in the short run, smaller companies will have to follow suit and become greener in the future as well.

To meet its Paris Agreement commitments, the government of Kazakhstan aims to integrate 50% of renewable energy into its energy mix by 2060. Although this is a long-term period, there has been a visible interest in recent years with regards to scaling-up renewables. An example of this is the public auction scheme which awarded solar energy projects for bidding prices as low as 0.034 EUR/kWh in 2022.

With regards to new power generation facilities the government seems to prioritize wind energy over solar and is also determined to develop nuclear energy. Nevertheless, solar energy still has potential to be used for the future production of green hydrogen, the development of large parks and to power remote areas that are not connected to the grid. Hydrogen production is a new focus of Kazakhstan's energy policy, especially with regards to energy exports. Large installations could be built in yet undeveloped and desert areas but the lack of suitable infrastructure in such areas would need to be solved first.

The market for small-scale PV systems could be promoted by abolishing the local content rules that need to be respected today in order to receive a government subsidy of up to 50% of the investment. As was shown in section 4 of this study, this subsidy makes the investment into small scale systems economically much more attractive.

The electricity market shows a number of weaknesses linked to a growing demand that is not always anticipated and the necessary modernization of the infrastructure. Also, documented cases of corruption exist. Moreover, despite official documentation efforts, and the launching of a new institutional website, access to information remains a challenge. Such barriers are to be taken into account by investors.

Investors interested in the Kazakh market should pay specific attention to the following:

- Institutional developments regarding the implementation of the new renewable energy law and the amendment on the removal of local content rule
- Tracking market developments and government initiatives related to the production of green hydrogen
- Consulting the new Kazakhstan website for reliable data. It is recommended to contact the institutions through different communication channels.

Investing in large RES projects as of early 2023 is very challenging because of the very low auction prices. According to local sources, the point of these auctions in Kazakhstan is not to profit from directly from the RES projects, but rather to gain access to the market for imported equipment. This equipment can be resold and the profits can be used for business development within the country.

If the Kazakh economy regains momentum, also the RES market could grow provided that the the political will massively expand renewables is maintained. Policy support is needed because of the still high importance of the oil and coal industry for the country’s power sector.

References

[1]. Committee on Statistics of the Republic of Kazakhstan. "Basic social and economic indicators", online: https://stat. gov. kz/, access mode: 27th November 2022

[2]. Climate Change Knowledge Portal, “Kazakhstan – Climatology”, online: https://climateknowledgeportal.worldbank.org/country/kazakhstan/climate-data-historical, access mode: 27th November 2022

[3]. Committee on Statistics of the Republic of Kazakhstan, "Statistics of national accounts”, online: https://stat.gov.kz/official/industry/11/statistic/7, access mode: 27th November 2022

[4]. Committee on Statistics of the Republic of Kazakhstan, "Statistical collection on foreign trade of Kazakhstan" for 2021, online: https://stat. gov. kz/official/industry/31/publication, access mode: 27th November 2022.

[5]. The Electric Power Council of the Commonwealth of Independent States, "Electric Power Engineering of the Commonwealth of Independent States. Annual Compendium", online: http://energo-cis. ru/rumain675/, access mode: 5th April 2020

[6]. Kursiv, "KEGOC: South of Kazakhstan is rapidly increasing energy consumption", online: https://kursiv. kz/news/otraslevye-temy/2019-02/kegoc-yug-kazakhstana-bystro-naraschivaet-potreblenie-elektroenergii, access mode: 5th April 2020

[7]. Kazakhstan Electric Power Association, "Report on Functioning of Electric Power and Capacity Market" for 2021, online: https://kea.kz/storage/app/media/council/reports/2021_12.pdf, access mode: 10th December 2022

[8]. Taldau - information and analytical system under the Ministry of National Economy of the Republic of Kazakhstan, "Price Statistics" for 2018”, online: https://taldau. stat. gov. kz/ru/Search/SearchByKeyWord, access mode: 13th April 2020

[9]. JSC "Samruk-Energo", "Integrated Annual Report" for 2021, online: https://www.samruk-energy.kz/en/shareholders-and-investors/annual-reports-on-the-results-of-the-company-s-activities, access mode: 27th November 2022.

[10]. World Bank, "Central Asia Regional Electricity Export Capacity Study", online: http://documents. worldbank. org/curated/en/804681468023338970/pdf/338770v10RUSSIAN0REEPS1Main1Report. pdf, access mode: 10th April 2020

[11]. World Economic Outlook Database, “GPD per Capita PPP (constant 2017 international $)”, online: https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD?end=2021&locations=KZ-AM-AZ-KG-BY-UZ-RU-TJ-MD&name_desc=false&start=1999, access mode: 10th December 2022

[12]. System operator of JSC "KEGOC", "National Power System", online: https://www.kegoc.kz/en/electric-power/elektroenergetika-kazakhstana/, access mode: 10th December 2022

[13]. Ministry of Energy of Kazakhstan, "Information on power generation by RES facilities" for 2021, online: https://www.gov.kz/memleket/entities/energo/documents/details/255825?lang=ru, access mode: 10th December 2022

[14]. Indexmundi, "Electricity consumption per person by country", online: https://www. indexmundi. com/map/? v=81000, access mode: 20th December 2022

[15]. Samruk-Energy JSC, "Electricity and Coal Market Analysis of Kazakhstan", online: http://energo-cis.ru/wyswyg/file/news/Самрук%20-%20Аналит_обзо%202021.pdf, access mode: 10th December 2020

[16]. Kursiv, "Rating of Kazakhstan's regions on electricity availability", online: https://kursiv. kz/news/tendencii-i-issledovaniya/2018-09/reyting-regionov-kazakhstana-po-dostupnosti-elektroenergii https://kursiv. kz/news/tendencii-i-issledovaniya/2018-09/reyting-regionov-kazakhstana-po-dostupnosti-elektroenergii, access mode: 10th April 2020

[17]. Inbusiness.kz, "The deputies demanded the return of differentiated tariffs", online: https://inbusiness. kz/ru/news/vernut-differencirovannye-tarify-na-elektrichestvo-potrebovali-deputaty, access mode: 6th April 2020
[18]. Tengrinews, "Industry", online: https://tengrinews. kz/zakon/agentstvo_respubliki_kazahstan_po_regulirovaniyu_estestvennyih_monopoliy/promyishlennost/id-V090005602_/, access mode: 3rd April 2020
[19]. zakon.kz, "In Astana from July 1, differentiated tariffs for electricity will be introduced for the population by the volume of consumption", online: https://online. zakon. kz/Document/? doc_id=30430843, access mode: 5th April 2020
[20]. Ecosolar, "Potential Development of solar energy", online: http://ecosolar.kz/ru/content/potencial-razvitiya-solnechnoy-energetiki-v-rk, access mode: 5th April 2020
[21]. Global Solar Atlas, "Solar Insolation in Kazakhstan", online: https://globalsolaratlas. info/map? c=48.531157.66.928711.5& r=KAZ, access mode: 10th December 2022
[22]. Solar Atlas of Kazakhstan, "Atlas of Solar Resources of the Republic of Kazakhstan", online: http://atlassolar. kz/, access mode: 10th December 2022
[23]. Ministry of Energy of the Republic of Kazakhstan, "Information on power generation by renewable energy facilities" for 2019, online: http://www. gov. kz/memleket/entities/energo/documents/details/12625?lang=ru, access mode: 10th December 2022
[24]. Ministry of Energy of the Republic of Kazakhstan, "Information on power generation by renewable energy facilities" for 2022, online: https://www.gov.kz/memleket/entities/energo/documents/details/361460?directionId=4910&lang=ru, access mode: 10th December 2022
[25]. Greenkaz, "Concept on transition of the Republic of Kazakhstan to "green economy", online: https://greenkaz. org/images/for_news/pdf/npa/koncepciya-po-perehodu. pdf, access mode: 5th April 2020
[26]. zakon.kz, "Law of the Republic of Kazakhstan on support of use of renewable energy sources", online: https://online. zakon. kz/Document/? doc_id=30445263#pos=132;-36, access mode: 4th December 2022
[27]. Calculation and Finance Centre for Support of Renewable Energy Sources, "Investment Preferences", online: https://rfc. kegoc. kz/investors/preference, access mode: 4th December 2022
[28]. Kazakhstan Electricity and Capacity Market Operator, "RES projects included in the list of priority investment projects", online: https://www.korem.kz/rus/press-centr/novosti_otrasli/?cid=0&rid=9119, access mode: 4th January 2023
[29]. Investment portal, "Investment subsidies", online: http://investinkostanay. kz/ru/page/invest-subs, access mode: 17th April 2020
[30]. The Electric Power Council of the Commonwealth of Independent States, "Rules of Organisation and Functioning of the Wholesale Electric Energy Market of RK", online: http://energo-cis. ru/wyswyg/file/Zakon/Nacional/Kazahstan/%D0%9F%D1%80%D0%B0%D0%B2%D0%B8%D0%B%D0%B0%20%D0%BE%D1%80%D0%B3%D0%B0%D0%BD%D0%B8%D0%B7%D0%B0%D1%86%D0%B8%D0%B8%20%D0%BE%D0%BF%D1%82%D0%B2%D0%BE%D0%B3%D0%BE%20%D1%8%D0%BD%D0%BA%D0%B0%B0-%D0%B3%D0%BE%D1%82%D0%BE%D0%B2.pdf, access mode: 17th April 2020
[31]. Tengis News, "Industry", online: https://tengrinews. kz/zakon/pravitelstvo_respubliki_kazahstan_premer_ministr_rk/promyishlennost/id-V1500012562/, access mode: 4th January 2023
[32]. Kazakhstan Electric Energy and Power Market Operator, "Trading within a Day", online: https://www. kz/rus/kak_torgovat/torgi_v_techenie_sutok/, access mode: 4th January 2023
[33]. Kazakhstan Electric Energy and Power Market Operator, "Bidding for the Day", online: https://www. kz/rus/kak_torgovat/torgi_za_den/, access mode: 4th January 2023
[34]. Kazakhstan Electric Energy and Power Market Operator, "Power Trading", online: https://www. kz/rus/kak_torgovat/torgi_moshnost/, access mode: 4th January 2023

[35]. Kazakhstan Electricity and Capacity Market Operator, "Tariffs of Energy Producing Organisations" for 2022, online: https://www. kz/rus/analitika/tarify_ore/, access mode: 20th December 2022
[36]. KOREM, “Mission and vision”, online: https://www. kz/rus/o_kompanii/missija_i_videnie/, access mode: 4th January 2023
[37]. Informburo, "In Kazakhstan, the number of energy transmission companies is being reduced", online: https://informburo. kz/novosti/v-kazahstane-sokratili-chislo-energoperedayushchih-kompaniy-80324.html access mode: 7th April 2020
[38]. KOREM, “Trades outputs”, online: https://www.korem.kz/eng/, access mode: 10th January 2023
[39]. Zakon.kz, "Forecast of electricity consumption in Kazakhstan. Wear and tear of electrical equipment", online: https://www. zakon. kz/4999652-prognoz-potrebleniya-elektroenergii-v. html access mode: 7th April 2020
[40]. Inform.kz, "Kazakhstan plans to reduce electricity tariffs for energy supplying organisations", online: https://www.inform.kz/ru/v-kazahstane-planiruyut-snizit-tarify-na-elektroenergiyu-dlya-energosnabzhayuschih-organizaciy_a3617515, access mode: 7th April 2020
[41]. RBS.ru, “Oil Shock. How and why oil prices were falling in the XXI century", online: https://www. rbc. ru/photoreport/15/10/2014/543e53a0cbb20f71659d9494, access mode: 7th April 2020
[42]. KEGOC JSC, “Annual Report 2021”, online: https://www.kegoc.kz/upload/iblock/03f/rlhcthzy0nxlp27c7of9418e6v8ndv4j.pdf, access mode: 10th December 2022
[43]. 365 info.kz, "Kazakhstan has fully provided itself with electricity and is increasing its exports", 05.2019, online: https://365info. kz/2019/05/kazahstan-polnostyu-obespechil-sebya-elektrichestvom-i-narashhivaet-ego-eksport, access mode: 7th April 2020
[44]. Energoinform, "Annual report of JSC Energoinform", for 2018, online: http://www. energoinform. kz/index. php/about/investoram-i-edinstvennomu-aktsioneru/godovoj-otchet/item/745-godovoj-otchet-ao-energoinform-za-2018-god, access mode: 7th April 2020
[45]. Committee of atomic and energy supervision and control of the ministry of energy, “Activities”, online: https://www.gov.kz/memleket/entities/kaenk/about/structure/departments/activity/1214/1?lang=en, access mode: 10th December 2022
[46]. Kazakhstan Electricity and Capacity Market Operator, "Guidelines for investors on implementation of RES projects in Kazakhstan", online: https://vie.korem.kz/uploads/%D0%A0%D1%83%D0%BA%D0%BE%D0%B2%D0%BE%D0%B4%D1%81%D1%82%D0%B2%D0%BE%20%D0%B4%D0%BB%D1%8F%20%D0%B8%D0%BD%D0%B2%D0%B5%D1%81%D1%82%D0%BE%D1%80%D0%BE%D0%B2%20%D0%BF%D0%BE%20%D1%80%D0%B5%D0%B0%D0%BB%D0%B8%D0%B7%D0%B0%D1%86%D0%B8%D0%B8%20%D0%BF%D1%80%D0%BE%D0%B5%D0%BA%D1%82%D0%BE%D0%B2%20%D0%92%D0%98%D0%AD%20%D0%B2%20%D0%9A%D0%B0%D0%B7%D0%B0%D1%85%D1%81%D1%82%D0%B0%D0%BD%D0%B5_2019_USAID_23.9.2019.pdf, access mode: 12th April 2020
[47]. KAZENERGY - Kazakhstan Association of Oil and Gas and Energy Complex Organisations, "National Energy Report", 2021, online: https://www.kazenergy.com/upload/document/energy-report/NationalReport21_en.pdf, access mode: 10th December 2022
[48]. KAZENERGY - Kazakhstan Association of Oil and Gas and Energy Complex Organisations, "National Energy Report", 2019, online: http://www.kazenergy.com/upload/document/energy-report/NationalReport19_ru.pdf, access mode: 10th December 2022
[49]. IEA, ”Kazakhstan 2022 – Energy Sector Review”, online: https://iea.blob.core.windows.net/assets/fc84229e-6014-4400-a963-bccea29e0387/Kazakhstan2022.pdf, access mode: 10 December 2022

[50]. Ministry of Energy of the Republic of Kazakhstan, "Information on power generation by renewable energy facilities" for 2015, 2016, 2017, 2018, 2019, 2020, 2021, online: https://www.gov.kz/memleket/entities/energo/documents/2?activities=3459irections=215ang=ru , access mode: 10th December 2022
[51]. Kazakhstan Electricity Grid Operating Company, "Annual Reports" for 2010, 2015, 2016, 2017,2018, 2019, 2020, 2021 online: https://www.kegoc.kz/en/for-investors-and-shareholders/raskrytie-informatsii/annual-reports/, access mode: 10th December 2022
[52]. Ministry of Energy of the Republic of Kazakhstan, "Information on power generation by renewable energy facilities" for 2022, online: https://www.gov.kz/memleket/entities/energo/documents/details/361460?directionId=4910&lang=ru, access mode: 10th December 2022
[53]. Ministry of Energy of the Republic of Kazakhstan, "Fuel and Energy Balance of the Republic of Kazakhstan" for 2014-1018, online: https://stat. gov. kz/official/industry/30/publication, access mode: 10th December 2022
[54]. Energy portal of Kazakhstan, "Kazakhstan's needs in electricity are increasing: consumption grew by 2% per year", online: http://www. energyprom. kz/ru/a/monitoring/nuzhdy-kazahstana-v-elektroenergii-uvelichivayutsya-potreblenie-vyroslo-na-2-za-god, access mode: 13th April 2020
[55]. Kazakhstan business portal, "KEGOC spreads networks to the West", online: https://inbusiness. kz/ru/news/kegoc-raskinet-seti-na-zapad , access mode: 15th April 2020
[56]. KOREM, “Participation in the auctions”, online: https://vie. kz/rus/uchastie_v_torgah/registration/, access mode: 15th April 2020
[57]. Informburo, "Subsidy program for RES stations in villages has not become popular. It's about high prices for equipment", online: https://informburo. kz/novosti/programma-subsidirovaniya-dlya-stanciy-vie-v-syolah-ne-stala-populyarnoy-delo-v-vysokih-cenah-na-oborudovanie. html, access mode: 15th April 2020
[58]. Samruk Energy JCS, "Integrated Annual Report for 2017”, online: https://www.samruk-energy.kz/images/anual-report-year/3.pdf, access mode: 27th November 2022
[59]. Kazakhstan Electric Energy and Power Market Operator, "Conclusion of the Contract", online: https://rfc. kegoc. kz/investors/contract-conclusion, access mode: 10th April 2020
[60]. Global Solar Atlas, online: https://globalsolaratlas. info/map?c=48.56025.66.928711.5& r=KAZ, access mode: 19th December 2022
[61]. Calculation and Finance Center for RES Support, "Results of conducted auctions", online: https://rfc. kegoc. kz/auctions/results, access mode: 19th December 2022
[62]. Calculation and Finance Center for RES Support, "RES Map", online: https://rfc. kegoc. kz/vie/yamaps, access mode: 19th December 2022
[63]. Halyk Bank of Kazakhstan, "Commercial offer of second-tier banks of Kazakhstan on issue of bank guarantees/reserve accounts", online: https://rfc. kegoc. kz/media/docs/441/5bb3572640fa5.pdf, access mode: 18th April 2020
[64]. Kazakhstan Electricity and Power Market Operator, “Q&A”, online: https://vie. kz/rus/vopros_otvet/, access mode: 19th December 2022
[65]. Calculation and Finance Center for RES Support, "About RES Sector", online: https://rfc. kegoc. kz/vie/about, access mode: 19th December 2022
[66]. Information-legal system regulations of the Republic of Kazakhstan, "On making additions to some legislative acts of the Republic of Kazakhstan on investment to the law of February 20, 2012 № 567-IV", online: https://zakon. uchet. kz/rus/docs/Z1200000567, access mode: 20th April 2020
[67]. Energy media, "Kazakhstan. Results of the first auction tenders for selection of RES projects", online: https://eenergy. media/2018/11/05/kazahstan-itogi-pervyh-auktsionnyh-torgov-po-otboru-proektov-vie-astana-2018/, access mode: 20th April 2020

[68]. Online.zakon.kz, "Legislation in the field of renewable energy sources in Kazakhstan", online: https://online. zakon. kz/Document/?doc_id=31647811#pos=6;-106, access mode: 10th December 2022.
[69]. Calculation and Finance Center for RES support, "Project Auctions", online: https://rfc. kegoc. kz/page/proyektnyye-auktsiony, access mode: 10th December 2022.
[70]. Calculation and Finance Center for RES support, "Pre-project documentation "SES 50 MW". Pilot project of Sanitary and Epidemiological Station". online: https://rfc. kegoc. kz/media/docs/729/5d71000b6cee0.pdf, access mode: 10th December 2022.
[71]. National Bank of the Republic of Kazakhstan, "Inflation expectations November 2022", online: https://nationalbank.kz/en/page/inflyacionnye-ozhidaniya, access mode: 10th December 2022.
[72]. National Bank of the Republic of Kazakhstan, Press release, "The base rate was raised to 16.75%", 05.12.2022, online: https://www.nationalbank.kz/file/download/85621, access mode: 10th December 2022
[73]. Kazakhstan Today, “Anticor revealed embezzlement in the supply of solar panels: 40 billion tenge in subsidies went to the wind”, online: https://www.kt.kz/rus/state/40_1377925980.html, access mode: 10th December 2022
[74]. Information agency "Agroinform", "Investment subsidies started", 20.08.2014, online: https://agroinfo. kz/investicionnye-subsidii-nachaty/, access mode: 4th January 2023
[75]. Greendem, "Presentations and documents of GREENDEM LLP, Price list for autonomous solutions in power supply, lighting and heating", online: https://greda. kz/promo_docs, access mode: 4th January 2023
[76]. Food and Agriculture Organisation of the United Nations database, "On Approval of the Rules for Determining the Nearby Electricity or Heating Grid Connection and Renewable Energy Connections", online: http://extwprlegs1.fao. org/docs/pdf/kaz112214.pdf, access mode: 19th April 2020
[77]. Wilson Kazakhstan, "Implemented projects", online: https://www. fgwilson. kz/gallery, access mode: 19th April 2020
[78]. Company "Greendem", "In WKO 103 farms purchased solar power generators", online: https://greda. kz/n36043-zko-103-fermerskih. html"https://greda. kz/n36043-zko-103-fermerskih. html, access mode: 19th April 2020
[79]. East Kazakhstan Regional Energy Company, "Annual Report 2021”, online: http://www.besk.kz/images/docs/2022/Годовой%20отчет%202021%20рус.pdf, , access mode: 20th January 2023
[80]. Calculation and Finance Center for RES support, "Selection of RES projects, rules for organizing and conducting auction tenders", online: https://rfc. kegoc. kz/auctions/selections, access mode: 4th January 2023
[81]. The information portal "Zakon.kz", "RES in every house", the main barriers to the development of small-scale RES projects in Kazakhstan", online: https://www. zakon. kz/4982286-vie-v-kazhdyyyy-dom-osnovnye-barery-dlya. html, access mode: 20th April 2020
[82]. Eurasian Development Bank, "The EDB Council approved the program of financing renewable energy projects until 2023 at $600", online: https://eabr. org/press/news/sovet-eabr-utverdil-progr2ammu-finansirovaniya-proektov-vie-do-2023-g-na-600-mln/, access mode: 20th April 2020
[83]. Eurasian Development Bank, "Eurasian Development Bank will allocate KZT 23.2 bln. for construction of a 50 MW wind power plant near Ereimentau city", online: https://eabr. org/press/releases/evraziyskiy-bank-razvitiya-vydelit-23-2-mlrd-tenge-na-stroitelstvo-vetrovoy-elektrostantsii-moshchno/, access mode: 20th April 2020
[84]. Eurasian Development Bank, "State Support promotes RES", online: https://eabr. org/press/news/gospodderzhka-raskruchivaet-vie/, access mode: 20 April 2020
[85]. Energy media, "Over 100 farms bought solar generators in WKO", online: https://eenergy.media/2018/08/08/svyshe-100-fermerskih-hozyajstv-zakupili-solnechnye-energogeneratory-v-zko/ , access mode: 20th April 2020

[86]. Development Bank of Kazakhstan, "Solar power plant with capacity of 100 MW introduced in Almaty region", online: https://www.kdb.kz/pc/news/press-releases/8178/ , access mode: 27th April 2020.
[87]. Akimat-Pavlodar, "The rules of subsidy to reimburse part of the expenses incurred by a subject of agro-industrial complex in case of investment", online: https://akimat-pvl.gov.kz/post.php?id=1430, access mode: 27th April 2020.
[88]. Inbusiness.kz, "The shadow of subsidies fell on solar panels", online: https://inbusiness.kz/ru/news/na-solnechnye-paneli-upala-ten-ot-subsidij, access mode: 27th April 2020.
[89]. KOREM, “Auction Results”, https://vie.korem.kz/eng/analitika/resultaty_torgov/, access mode: 4th January 2023
[90]. Eurasian portal for river basin management, "Interactive map ofthe best practices on the use of water, land and energy resources, as well as the environment of Central Asia", online: http://www.riverbp.net/innovation/map-best-practices/en/base/compare?fid=97&sid=2 , access mode 3rd April 2020.
[91]. Ministry of Justice, “On approval of the Rules of subsidies for reimbursement of part of the costs incurred by the subject of agro-industrial complex, for investment”, online: https://adilet.zan.kz/rus/docs/V1800017320, access mode: 4th January 2023
[92]. Association of RES of Kazakhstan, Presentation of the CEO of the Association, online: https://nur.nu.edu.kz/bitstream/handle/123456789/2469/Arman%20kashkinbekov_AREK.pdf?sequence=1&isAllowed=y, access mode: 7th May 2020
[93]. Kazakhstan Electric Power Association, Electric Power Industry News, "More than half of Kazakhstan's electricity networks are in a worn-out state", online: http://www.kea.kz/readNews.php?did=1183: access mode: 7th May 2020
[94]. Zakon.kz, "RES in every house" main barriers for development of small-scale RES projects in Kazakhstan“, August 2019, online: https://www.zakon.kz/4982286-vie-v-kazhdyy-dom-osnovnye-barery-dlya.html, access mode: 7th May 2020
[95]. World population Review,”Oil Production by country 2022”, online: https://worldpopulationreview.com/country-rankings/oil-production-by-country, access mode: 10th December 2022
[96]. Ministry of Energy in Kazakhstan,” Concept for the Development of the Electric Power Industry of the Republic of Kazakhstan until 2035”, online: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjV-IiXk4j8AhW_UaQEHT5oC0UQFnoECBUQAQ&url=https%3A%2F%2Fwww.gov.kz%2Fapi%2Fv1%2Fpublic%2Fassets%2F2022%2F9%2F26%2F2185d071a18197ff496dd0d00eba4866_original.379086.docx&usg=AOvVaw0b5N3E-wfmLIalpY0NaVBl, access mode: 20th December 2022
[97]. International Trade Association, “Kazakhstan – Country Commercial Guide ‘Power Generation’”, online: https://www.trade.gov/country-commercial-guides/kazakhstan-power-generation#:~:text=Electricity%20in%20Kazakhstan%20is%20generated,available%20capacity%20is%2019%2C004%20MW, access mode: December 10th 2022
[98]. The Diplomat, “Kazakhstan’s Power Shortages: Crypto-miners and geopolitics”, online: https://thediplomat.com/2021/11/kazakhstans-power-shortages-crypto-miners-and-geopolitics/, access mode: 10th December 2022
[99]. Prime Minister of the Republic of Kazkhastan, “Fulfilment of President’s instructions Kazakhstan develops concept for electricity sector development until 2035”, online: https://primeminister.kz/en/news/fulfilment-of-presidents-instructions-kazakhstan-develops-concept-for-electricity-sector-development-until-2035-1102612, access mode: 20th December 2022
[100]. EnergyProm, “Electricity Tariffs for the population of the republic of Kazakhstan have risen by 6% since the beginning of the year”, online: https://www.energyprom.kz/ru/a/reviews/tarify-na-elektroenergiyu-dlya-naseleniya-rk-podnyalis-na-6-s-nachala-goda-za-god-ceny-dlya-kazahstancev-ne-ispolzuyushih-

elektroplity-podskochili-na-10-dlya-ispolzuyushih-na-15, access mode: 20th December 2022
[101]. EnergyProm, "Electricity Generation increased by 4.5% over the year, while the increase in tariffs for the population was 9%", online: https://www.energyprom.kz/ru/a/reviews/generaciya-elektroenergii-uvelichilas-na-45-za-god-rost-tarifov-dlya-naseleniya-sostavil-4, access mode: 20th December 2022
[102]. EnergyProm, "Electricity prices have increased by almost 9% over the year", online: https://www.energyprom.kz/ru/a/monitoring/tarify-na-elektroenergiyu-vyrosli-pochti-na-9-za-god, access mode: 20th December 2022
[103]. KOREM, "Overview of electricity market Kazakhstan in 2020", online: https://www.korem.kz/rus/press-centr/novosti_otrasli/?rid=9280&cid=0, access mode: 24th December 2022
[104]. European Commission, "COP 27: European Union concludes a strategic partnership with Kazakhstan on raw materials, batteries and renewable", online: https://ec.europa.eu/commission/presscorner/detail/en/IP_22_6585, access mode: 24th December 2022
[105]. UNICASE, "Kazakhstan: Green Hydrogen in Kazakhstan Barriers", online: https://www.mondaq.com/renewables/1194500/green-hydrogen-in-kazakhstan-barriers, access mode: 24th December 2022
[106]. ABD Institute, "Toward Hydrogen Economy in Kazakhstan", online: https://www.adb.org/sites/default/files/publication/836516/adbi-wp1344.pdf, access mode: 24th December 2022
[107]. PV Magazine, "The Hydrogen stream: 45 GW project in Kazakhstan, new push from Norway", online: https://www.pv-magazine.com/2021/06/29/the-hydrogen-stream-45-gw-project-in-kazakhstan-new-push-from-norway/, access mode: 24th December 2022
[108]. Energy Transitions Commission, "Making the Hydrogen Economy Possible", online: https://www.energy-transitions.org/wp-content/uploads/2021/04/ETC-Global-Hydrogen-Report.pdf, access mode: 24th December 2022
[109]. European Hydrogen Backbone, "Estimated Investment Costs" , online: https://ehb.eu/page/estimated-investment-cost, access mode: 4th January 2023
[110]. European Commission, "A hydrogen strategy for a climate-neutral Europe", online: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0301, access mode: 4th January 2023
[111]. Minister of Digital Development, "On the approval of rules about digital mining activities", online: http://zan.gov.kz/client/#!/doc/167156/rus, access mode: 4th January 2023
[112]. AstanaTimes, "Kazakhstan to Select Supplier for Nuclear Power Technological Solutions in 2023", online: https://astanatimes.com/2022/09/kazakhstan-to-select-supplier-for-nuclear-power-technological-solutions-in-2023/#:~:text=The%20Kazakh%20government%20announced%20in,may%20be%20narrowed%20to%202032, access mode: 9th January 2023
[113]. Minister of Energy, "The maximum price reduction in the 2022 auction was 42.5% for WES projects and 0.05% for SES", online: https://www.gov.kz/memleket/entities/energo/press/news/details/473591?lang=ru, access mode: 9th January 2023
[114]. Kursiv, "Nuclear power plant construction will cost 5 billion", online: https://kz.kursiv.media/2017-10-30/stroitelstvo-aes-v-kazakhstane-oboydetsya-v-5-mlrd/, access mode: 9th January 2023
[115]. Eurasianet, "Kazakhstan looks to nuclear amid cryto-driven energy shortage", online: https://eurasianet.org/kazakhstan-looks-to-nuclear-amid-crypto-driven-energy-shortage, access mode: 9th January 2023
[116]. KGM, "KGM Engineering attended the green hydrogen production project launch in Kazakhstan", online: https://www.kmge.kz/en/kmg-engineering-attended-the-green-hydrogen-production-project-launch-in-kazakhstan/, access mode: 9th January 2023

[117]. HYSARIA ONE, “Important milestones achieved: Investment Agreement signed”, online: https://hyrasia.energy/2022/10/27/important-milestone-achieved-investment-agreement-signed/, access mode: 9th January 2023
[118]. The Astana Times, “EBRD supports Kazakhstan’s green agenda initiatives new reforms”, online: https://astanatimes.com/2022/04/ebrd-supports-kazakhstans-green-agenda-initiatives-new-reforms/, access mode: 9th January 2023
[119]. Power technology, “EBRD to support power plan in Kazakhstan” online: https://www.power-technology.com/news/ebrd-solar-plant-kazakhstan/, access mode: 9th January 2023
[120]. EBRD, “Chulakkurgan Solar”, online: https://www.ebrd.com/work-with-us/projects/psd/chulakkurgan-solar.html, access mode: 9th January 2023
[121]. Informburo, “What is the market share of Russian bank subsidiaries in Kazakhstan?” online: https://informburo.kz/novosti/kakuyu-dolyu-na-rynke-kazaxstana-zanimayut-docki-rossiiskix-bankov, access mode: 9th January 2023
[122]. Development Bank of Kazakhstan, “A new solar power plant was built near Balkhash” online: https://www.kdb.kz/pc/smi-of-brk/?ELEMENT_ID=12655, access mode: 9th January 2023
[123]. Development Bank of Kazakhstan, “Funding projects” online: https://www.kdb.kz/projects/on-financing/?arrFilter_644=4245286173&set_filter=Фильтровать, access mode: 9th January 2023
[124]. Kursiv, “The accumulated volume of investments in renewable energy in Kazakhstan will exceed $1.8 billion”, online: https://kz.kursiv.media/2021-04-07/nakoplennyy-obem-investiciy-v-vozobnovlyaemuyu-energetiku-kazakhstana/, access mode: 9th January 2023
[125]. KEGOC, “KEGOC’s Development Strategy for 2022 – 2031”, online: https://www.kegoc.kz/upload/iblock/859/859d1f43fe88abd447ca4051a8aa6cda.pdf, access mode: 9th January 2023
[126]. Blue screen, “Is there a future for mining activities in Kazakhstan”, online: https://bluescreen.kz/longread/11619/iest-li-budushchieie-u-mainingha-v-kazakhstanie, access mode: 14th January 2023
[127]. Kursiv, “How to retain miners in Kazakhstan?”, online: https://kz.kursiv.media/2022-02-04/kak-uderzhat-majnerov-v-kazahstane/, access mode: 14th January 2023
[128]. Foodindustry, “Renewable energy and farm resilience”, online: https://foodindustry.kz/vozobnovlyaemye-istochniki-energii-i-ustojchivost-ferm/, access mode: 14th January 2023
[129]. Forbes Kazakhstan, “How Kazakh farmers have tamed the sun's energy”, online : https://forbes.kz/process/energetics/kak_kazahstanskie_fermeryi_priruchili_energiyu_solntsa/, access mode: 14th January 2023
[130]. Kursiv, “Kazakhstan exports up 20% in nine months”, online: https://kz.kursiv.media/2021-12-13/eksport-kazakhstana-uvelichilsya-na-20-po-itogam-devyati-mesyacev/#:~:text=Темпы%20роста%20экспорта%20за%20январь,драгоценные%20металлы%2C%20феррохром%20и%20пшеница, access mode: 14th January 2023
[131]. European Commission, “Carbon Border Adjustment Mechanism”, online: https://taxation-customs.ec.europa.eu/green-taxation-0/carbon-border-adjustment-mechanism_en, access mode: 4th January 2023
[132]. RITM EVRAZII, “Kazakhstan's electricity sector in plans and realities”, online: https://www.ritmeurasia.org/news--2022-10-30--elektroenergetika-kazahstana-v-planah-i-realijah-62793, access mode: 4th January 2023
[133]. Mondaq, “New Environmental Code in Kazakhstan”, online: https://www.mondaq.com/waste-management/1045606/new-environmental-code-in-kazakhstan-, access mode: 4th January 2023
[134]. Radio Liberty, “Power went out in number of regions in Kazakhstan”, online: https://www.azattyq.org/a/31669909.html, access mode: 4th January 2023

[135]. GreenDem, "SDEK has launched a solar power plant", online: https://greda.kz/n46241-sdek-zapustil-solnechnuyu.html, access mode: 4th January 2023
[136]. World Bank, "Banking the transition to net-zero: How Kazakhstan can leverage green finance to reduce emissions.", online: https://blogs.worldbank.org/europeandcentralasia/how-kazakhstan-can-leverage-green-finance-to-reduce-emissions, access mode: 4th January 2023
[137]. Solar Power Association of Kazakhstan, magazine Qazaq Solar2, 2020, online: https://spaq.kz/eng/zhurnal-qazaq-solar, access mode: 7th May 2020
[138]. Ministry of Energy, "Electric Power", online: https://www.gov.kz/memleket/entities/energo/activities/215?lang=ru, access mode: 4th January 2023
[139]. Kazakhstan Today, "Level of wear and tear on power grids in some cities in Kazakhstan reaches 80%", online: https://www.kt.kz/rus/economy/uroven_iznosa_elektrosetey_v_nekotoryh_gorodah_1377941433.html, access mode: 24th January 2023
[140]. Kursiv, "Finance is the key to global transformation", online: https://kz.kursiv.media/2022-11-17/finansy-yavlyajutsya-kljuchom-k-globalnym-preobrazovaniyam/, access mode: 24th January 2023
[141]. Forbes.kz, "How Kazakh farmers are getting used to solar energy", online: https://forbes.kz/process/energetics/kak_kazahstanskie_fermeryi_priruchili_energiyu_solntsa/ , access mode: 30th January 2023
[142]. World Resources Institute, "Ranking the World's Most Water-Stressed Countries in 2040", online: https://www.wri.org/insights/ranking-worlds-most-water-stressed-countries-2040, access mode: 26th August 2022