# From coal to renewables

A power sector transition in Kazakhstan

**ANALYSIS**

Agora Energiewende

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# From coal to renewables

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### ANALYSIS

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A power sector transition in Kazakhstan

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# Preface

Dear reader,

Kazakhstan has not been at the centre of global climate policies and attention in the past. Today, the country ranks 7th globally in terms of carbon intensity, and its economy is highly dependent on fossil fuels – both for export and for national energy production. And recent political developments also make it an interesting case. The Kazakh government is seeking to diversify its economy and has committed to carbon neutrality by 2060. The changes announced are fundamental and pose a significant challenge.

All the more so given Kazakhstan's increasingly important geopolitical role – with its two big neighbours Russia and China seeking to strengthen their influence, and the European Union as its largest investor. The EU recently stepped up its cooperation with Kazakhstan, the biggest Central Asian country, with a particular focus on energy and climate policies.

This publication aims to provide an up-to-date overview of Kazakhstan's power sector, focusing especially on the role of coal, the need for modernisation and the vast potential for renewables. If the country succeeds in its commitment to carbon neutrality, it will set an example not only to neighbouring countries in Central Asia, but also to other medium-sized carbon-heavy economies around the world.

We hope you find this report useful.

Markus Steigenberger
*Managing Director, Agora Energiewende*

## Key findings at a glance:

1. **Kazakhstan's economy depends heavily on fossil fuels, with coal power plants generating two-thirds of the country's electricity.** Its long-term targets - increasing the share of renewable and nuclear energy in power production to 50 Percent by 2050, and achieving carbon neutrality by 2060 – have spurred considerable initial investment in wind and solar PV. The share of renewables (excluding large hydropower) reached 4.5 Percent in 2022, and wind and solar PV are competitive against electricity generated by thermal facilities.

2. **The necessary modernisation of Kazakhstan's power system can go hand in hand with a transition to renewables.** As the average age of the coal power fleet is 50 years, scaling up renewables to replace thermal power technologies would enable the country to avoid investing in future stranded assets.

3. **In order to speed up renewables deployment, a change in the policy environment is needed.** Currently, high fossil fuel subsidies, low tariffs for coal and natural gas electricity, the predominance of CHP power plants in the production of electricity and heat, and transmission and distribution bottlenecks in addition are all hindering the expansion of wind and solar PV.

4. **For a transition to a renewable power system, the following three steps are needed.** First, the modernisation and further development of grids capable of integrating high shares of renewable energy. Second, improvements in energy system flexibility through demand-side management, energy storage systems, hydropower capacity, and other options. Third, a clear coal phase-out plan that includes support for structural change in regions currently economically dependent on coal.

# Content

# 1 Introduction

Kazakhstan is a large emitter of greenhouse gases (GHG). In 2021, it ranked 24th in global fossil fuels $CO_2$ emissions, 13th in per capita emissions, and 7th in terms of the $CO_2$ intensity of GDP,[1] and its share in global fossil fuels $CO_2$ emissions was 0.75%.[2] An important feature is that the volume of Kazakhstan's emissions is not commensurate with the size of its economy. In 2021, Kazakhstan's share of global GDP comprised just 0.37%.[3]

Kazakhstan is rich in oil, natural gas and coal, and it is a net exporter of fossil fuels. In addition, coal provides the basis for its domestic electric power sector, accounting for about 67% of the country's electricity generation[4] and 65% of its fossil fuels $CO_2$ emissions.[5] This means that Kazakhstan's energy sector and the whole economy are highly dependent on fossil fuels.

At the same time, Kazakhstan has set ambitious climate and decarbonisation goals – it aims to increase the share of renewable and alternative energy in its electric power generation up to 50% in 2050 and to become carbon neutral by 2060. The first implementation efforts for achieving these goals are already visible. For example, in just five years, Kazakhstan has increased the share of solar PV and wind in its electric power mix from almost 0% to 3.7% by the end of 2022.[6] The President of Kazakhstan, Kassym-Jomart Tokayev, has repeatedly confirmed the intention of the country and its leadership to take bolder and more targeted steps to combat climate change[7]. In January 2022, he said that Kazakhstan has already embarked on the decarbonisation of the economy and intends to achieve carbon neutrality by 2060.[8] There is still a very long way to go, but the first results and the high level of decarbonisation ambition suggest that Kazakhstan may become a positive example of transformation for other fossil fuel-dependent non-Western economies.

In this paper, we explore the current situation of the power sector in Kazakhstan, the age of its existing coal-fired power fleet and the prospects for its phase-out or at least phase-down, the competitiveness of solar PV and wind electric power, and the obstacles to and opportunities for its large-scale deployment.

1 Global Carbon Atlas (2022). Fossil Fuels Emissions. URL: http://www.globalcarbonatlas.org/en/$CO_2$-emissions.

2 Our World in Data (2022). Kazakhstan: $CO_2$ Country Profile. URL: https://ourworldindata.org/$CO_2$/country/kazakhstan.

3 The World Bank (2022). GDP, PPP (current international $). URL: https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?most_recent_value_desc=true.

4 Ember (2022). Global Electricity Review 2022. URL: https://ember-climate.org/insights/research/global-electricity-review-2022/.

5 Global Carbon Atlas (2022). Fossil Fuels Emissions. URL: http://www.globalcarbonatlas.org/en/$CO_2$-emissions.

6 The Ministry of Energy (2022). Information on the production of electricity by renewable energy facilities in 2022. URL: https://www.gov.kz/memleket/entities/energo/documents/details/403997?lang=ru (in Russian).

7 Smakova A. (2020). Kassym-Jomart Tokayev: I want to reaffirm our intention to fight climate change. URL: https://informburo.kz/novosti/kasym-zhomart-tokaev-ya-hochu-eshchyo-raz-podtverdit-nashe-namerenie-borotsya-s-izmeneniyami-klimata.html (in Russian).

8 Kazinform (2022). Kazakhstan has embarked on decarbonization of the economy - Kassym-Jomart Tokayev. URL: https://www.inform.kz/ru/kazahstan-vstal-na-rel-sy-dekarbonizacii-ekonomiki-kasym-zhomart-tokaev_a3890597 (in Russian).

# 2 Key economic and social indicators

Kazakhstan is a country in Central Asia which used to be a part of the former Soviet Union. Its neighbouring countries include Russia, China, Kyrgyzstan, Uzbekistan and Turkmenistan (Figure 1). The country has recently experienced high levels of natural population growth, and in 2021 its population comprised 19 million people, compared to 14.9 million in 2000.[9] Kazakhstan has a pronounced continental climate with long hot summers and long cold winters. The terrain is largely flat with low hills; a significant proportion of the country is classified as steppe. Kazakhstan covers a vast area – it is the largest landlocked country in the world (though it has a shoreline at the Caspian Sea) and the world's 9th largest country by area (2 724 902 km²).[10]

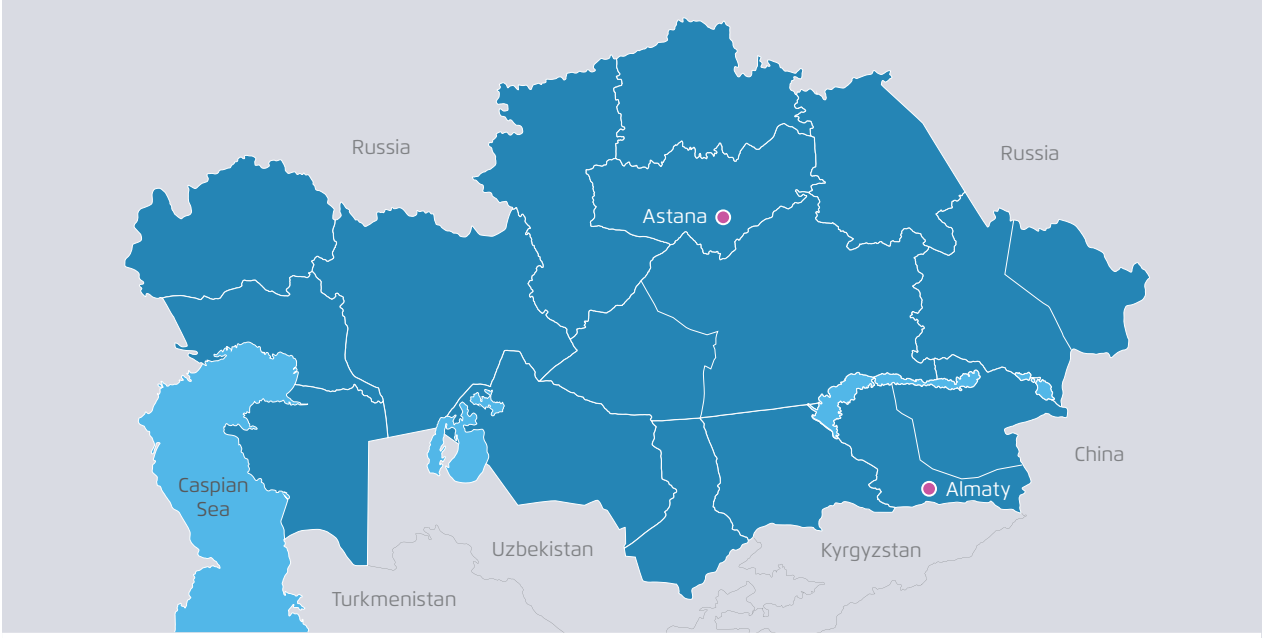
Since 1997, the capital of Kazakhstan has been Astana (originally Akmolinsk), which in 2019–2022 was called Nur-Sultan. The population of Astana has increased from 0.3 million people in 1997 to 1.3 million people in 2022.[11] Astana is now the second largest city in the country. Up to 1997, the capital of Kazakhstan was Almaty, which still retains the status of the largest city with a population of 2.0 million people, as well as the status of financial and economic centre of the country.

9 The World Bank (2022). Population, total – Kazakhstan. URL: https://data.worldbank.org/indicator/SP.POP.TOTL?locations=KZ.

10 World Data. Kazakhstan. URL: https://www.worlddata.info/asia/kazakhstan/index.php.

11 PopulationStat (2022). Population. URL: https://populationstat.com/kazakhstan/astana.

Map of Kazakhstan Figure 1




Astanatimes.com (2022)
Note: in 2022, three new regions (Abai, Ulytau and Jetisu regions) were created in Kazakhstan. Shown here are the new borders of the regions.

It occupies 41st place in the world measured by GDP in current international US dollars with purchasing power parity (PPP), as of 2021 ($543 billion).[12] The World Bank classifies Kazakhstan as an upper-middle-income economy, along with such countries as China, Brazil, South Africa and Russia.[13]

Kazakhstan is a major producer and exporter of all fossil fuels. As of 2018, it occupied 9th place in the world in terms of coal production, 17th in crude oil production, and 24th in natural gas production, and was accordingly the 9th, 9th and 12th largest exporter of these fuels.[14] Most of Kazakhstan's fossil fuel has been exported through Russia, but due to the Russian invasion of Ukraine Kazakhstan has started to look for new routes which bypass Russia. In addition, Kazakhstan acts as a transit country itself, for Turkmen and Uzbek natural gas deliveries to China and Russia. Kazakhstan is also the world's largest producer of mined uranium – in 2021, it provided 45% of global supplies.[15] Interestingly, Kazakhstan does not use its uranium itself – its only nuclear power plant in Aktau (a BN-350 reactor) was closed in 1999.

The fossil fuel sector, and especially the oil industry, forms the backbone of Kazakhstan's economy. In 2020, income from oil, natural gas and coal made up 9.3%, 1.0% and 0.6% of Kazakhstan's GDP respectively,[16] and 45% of the state budget came from the oil industry.[17] In 2021, oil accounted for over 50% of the country's exports.[18] Other important export products include metals and grains.

In the last two decades, Kazakhstan has experienced rapid economic growth and a significant reduction in poverty. In 2000-2007, average annual GDP growth was 10%; in 2010-2014, it was 6% (Figure 2). The poverty rate declined from almost 60% in 2002 to 4% in 2019.[19] Now the country is characterised by a growing middle class. The main reason for these speedy improvements was the massive development of fossil fuel resources coupled with high oil prices. However, there are still significant regional differences in living standards.

These trends were also accompanied by rapid population growth, which also began in the early 2000s and has not stopped since (Figure 3).

Kazakhstan is characterised by inefficient use of its resources. Enerdata estimates that Kazakhstan has one of the most energy-intensive economies in the world. In 2021, Kazakhstan ranked eighth in the world by this indicator, behind (in ascending order) Uzbekistan, Nigeria, Canada, Taiwan, Kuwait, Russia and Iran. The energy intensity of Kazakhstan's GDP

12 The World Bank (2022). GDP, PPP (current international $). URL: https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD?most_recent_value_desc=true.

13 The World Bank (2022). The World by Income and Region. URL: https://datatopics.worldbank.org/world-development-indicators/the-world-by-income-and-region.html.

14 IEA (2020). Kazakhstan energy profile. URL: https://www.iea.org/reports/kazakhstan-energy-profile.

15 World Nuclear Association (2022). World uranium mining production. URL: https://world-nuclear.org/information-library/nuclear-fuel-cycle/mining-of-uranium/world-uranium-mining-production.aspx.

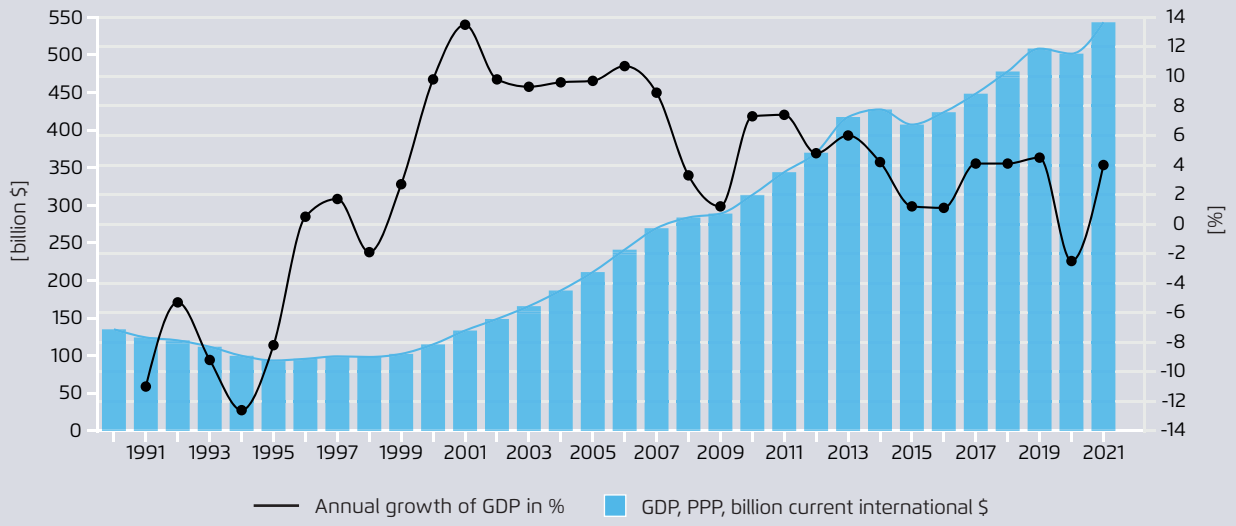
16 The World Bank (2022). Data. URL: https://data.worldbank.org/indicator/.

17 Kaztag (2021). Dependence of Kazakhstan's budget on oil revenues increased to 45% in 2020. URL: https://kaztag.kz/ru/news/do-45-vyrosla-v-2020-godu-zavisimost-byudzheta-kazakhstana-ot-neftyanykh-dokhodov-mne (in Russian).

18 Economic Research Institute (2022). Results of foreign trade of the Republic of Kazakhstan for 2021. URL: https://economy.kz/ru/Novosti_instituta/id=4092/arch=2021_33 (in Russian).

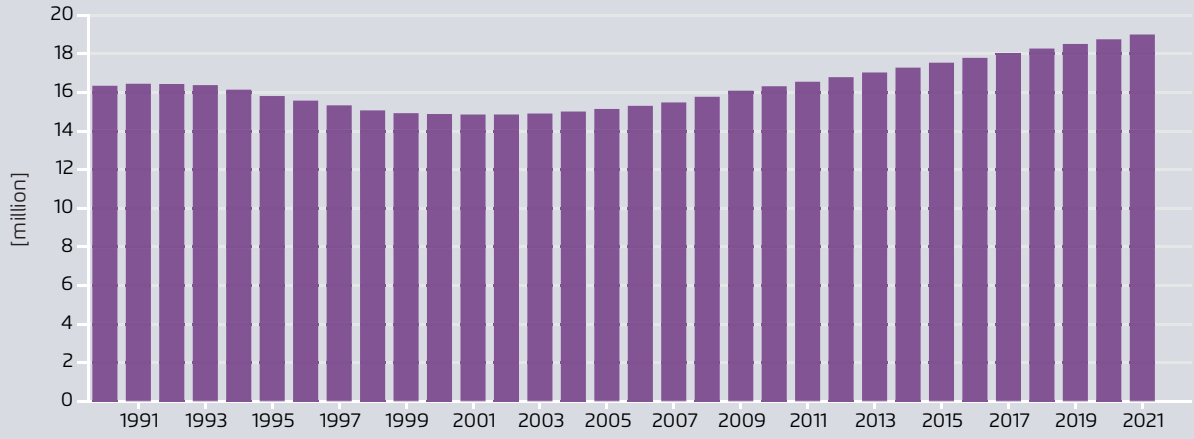
19 The World Bank Group (2022). Kazakhstan – Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099420411012246024/pdf/P1773690ad92b401b089700f5be8659ecf0.pdf.

Kazakhstan's GDP and annual growth of GDP (%), 1990–2021 Figure 2




The World Bank (2022)

Population of Kazakhstan, 1990–2021 Figure 3




The World Bank (2022)

amounted to 0.156 koe/$15p, which is three times higher than in the country with the lowest value – the UK (0.053 koe/$15p) and 40% higher than the global average.[20]

20 Enerdata (2022). Energy intensity. URL: https://yearbook.enerdata.net/total-energy/world-energy-intensity-gdp-data.html.

# 3 Climate ambition

Kazakhstan signed and ratified the Paris Agreement as well as submitted its first nationally determined contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2016. The unconditional target of its NDC is to reduce GHG emissions by 15% by the end of 2030 compared to 1990, including land use, land-use change and forestry (LULUCF). There is also a conditional target – a 25% reduction by the end of 2030 compared to 1990, subject to additional international investments, low-carbon technology transfer and green climate funds availability.[21]

Climate Action Tracker rates Kazakhstan's conditional NDC target as almost sufficient and its unconditional target as insufficient. It also estimates that to be consistent with the 1.5 °C limit, , the country needs to decrease its emissions by 31%-43% by 2030 compared to the 1990 level.[22] Kazakhstan's GHG emissions have increased over the past decade, and in 2019 GHG emissions including LULUCF were 2% lower than in the 1990 base year.[23]

This makes achieving NDC goals impossible without changing business as usual practices.

Kazakhstan plans to update its NDC and is now working to merge the mitigation and adaptation components into a single document.[24] However, as of early 2023, this work is still in progress.[25]

In December 2020, Kazakhstan's president Tokayev pledged that Kazakhstan will achieve carbon neutrality by 2060[26]. Achieving this target will require a fundamental shift away from the current fossil economy and making the energy transition to renewables a policy priority. As of today, however, Climate Action Tracker rates the comprehensiveness of Kazakhstan's carbon neutrality target as poor.[27]

21 UNFCCC (2016). Intended Nationally Determined Contribution - Submission of the Republic of Kazakhstan. URL: https://unfccc.int/sites/default/files/NDC/2022-06/INDC%20Kz_eng.pdf.

22 Climate Action Tracker (2022). Kazakhstan. Country Summary. URL: https://climateactiontracker.org/countries/kazakhstan/.

23 The World Bank (2021). Effective air quality management in Kazakhstan and its impact on greenhouse gas emissions. URL: https://documents1.worldbank.org/curated/en/099450003142235154/pdf/P170870149c3140d154c61413a1b8ef13c60a49a6a58.pdf (in Russian).

24 Climate Promise. UNDP (2022). Kazakhstan. URL: https://climatepromise.undp.org/what-we-do/where-we-work/kazakhstan.

25 UNFCCC (2022). NDC Registry. URL: https://unfccc.int/NDCREG.

26 Climate Ambition Summit (2020). Kassym-Jomart Tokayev President of Kazakhstan. URL: https://www.climateambitionsummit2020.org/ondemand.php.

27 Climate Action Tracker (2022). Kazakhstan. Country Summary. URL: https://climateactiontracker.org/countries/kazakhstan/.

# 4 The power sector today

## 4.1 Generation and consumption of electric power

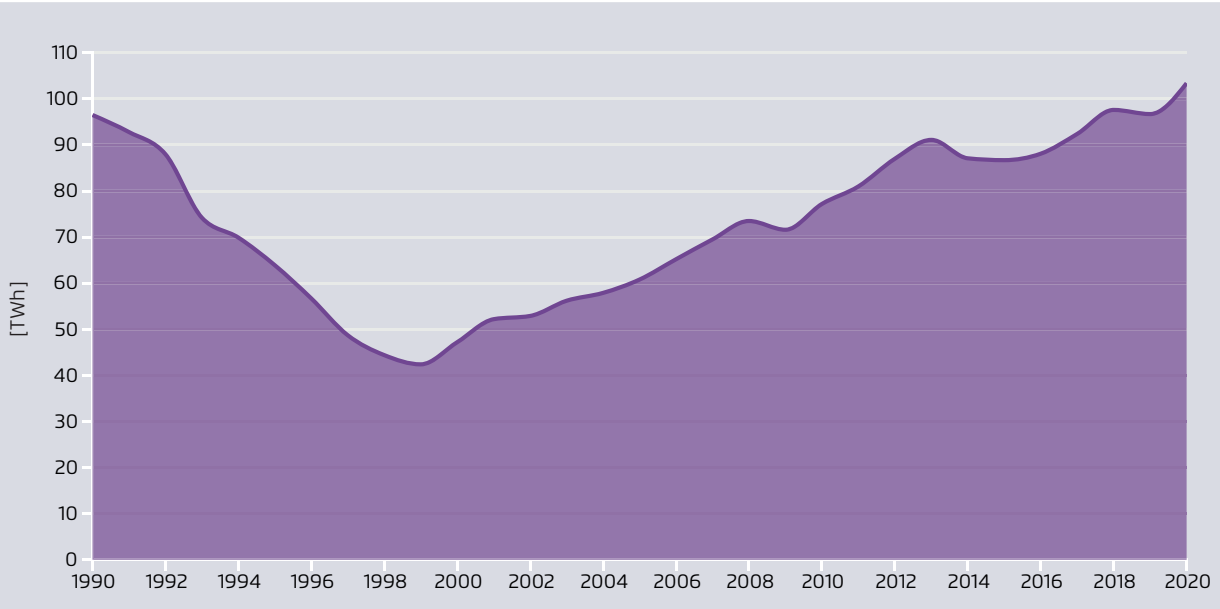
Due to the disruption of economic ties with other member republics after the collapse of the Soviet Union, Kazakhstan experienced a sharp industrial decline (Figure 2) which resulted in a significant drop in demand for electricity (Figure 4) and a drop in the volume of electric power generation (Figure 5). Growth in both demand for electric power and its generation resumed only in 2000 due to the economic boom caused by higher oil prices and the strategic development of the oil industry. In 2020, Kazakhstan generated 27% more electric power than in 1990, and its consumption of electric power reached the 1990 level in 2018.

In early 2022, the energy system of Kazakhstan comprised over 200 power plants with a total installed capacity of 24 GW. The volume of electric power generation in 2021 amounted to 114.4 TWh.[28]

The power sector in Kazakhstan consists of bilateral, spot, balancing (operates in a simulation mode), system and ancillary services and capacity markets. Its wholesale power market is liberalised, and is dominated by bilateral contracts between generating

28 Ministry of Energy of the Republic of Kazakhstan (2022). Concept for the development of the electric power industry of the Republic of Kazakhstan until 2035. URL: https://www.gov.kz/memleket/entities/energo/documents/details/349883?lang=ru (in Russian).

Electricity consumption in Kazakhstan in 1990–2020 Figure 4




IEA (2022)

companies and large consumers as well as regional electricity distribution companies.[29]

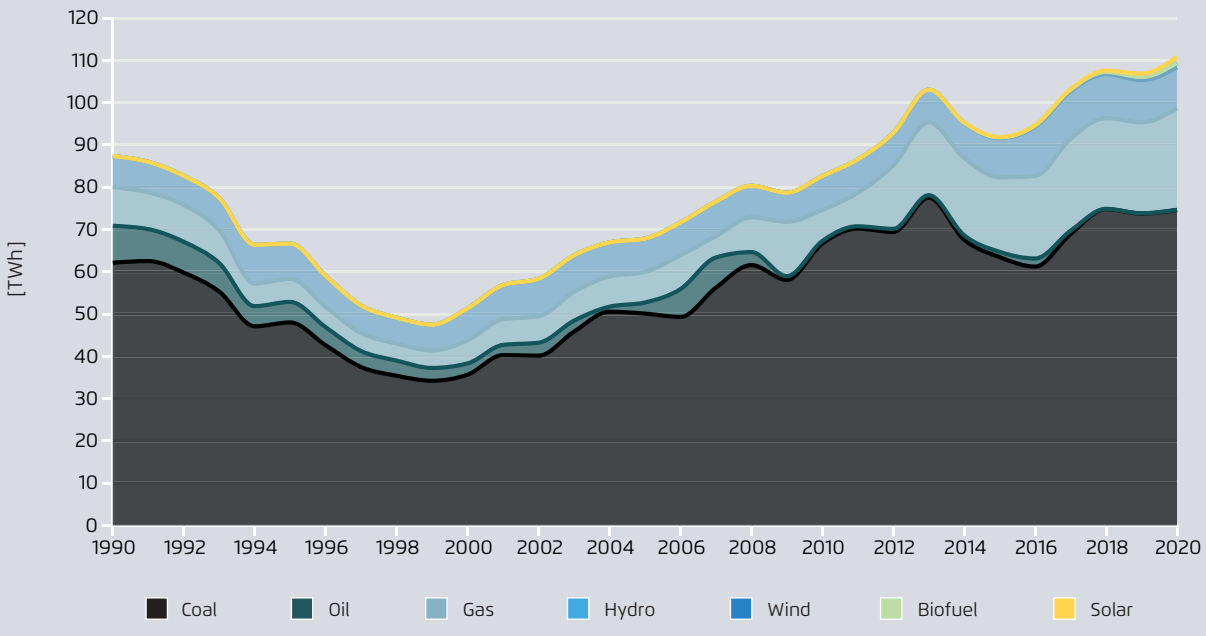
Electricity generation is dominated by the state-owned company Samruk-Energy. However, there are also many private generators. Transmission is carried out by the state-owned KEGOC national transmission grid operating company and system operator. Regional distribution is operated by 21 regional distribution companies. The retail market is competitive, with many retail supply companies. Kazakhstan, along with Russia, Belarus, Armenia and Kyrgyzstan, is a member of the Eurasian Economic Union (EAEU). Within the framework of this union, a common electricity market was planned by 2019, but in 2020 its launch was delayed until 2025.

Coal has always played the central role in the electric power sector in Kazakhstan, providing for 67% of total power generation in 2021 (Figure 5). Around 80% of Kazakh electric power is generated in the northern part of country (especially in the Pavlodar and Karaganda regions), mostly near the coal mines that produce cheap coal. The southern part of the country is dominated by natural gas generation and is also supplied with electricity from the north and with imported electricity[30]. Apart from coal, two other significant sources of electric power in Kazakhstan are natural gas (20% of generation) and hydropower (9%), with most hydropower plants stemming from

29 World Bank (2017). Stuck in transition: reform experiences and challenges ahead in the Kazakhstan power sector. URL: https://documents1.worldbank.org/curated/en/104181488537871278/pdf/113146-PUB-PUBLIC-PUBDATE-2-27-17.pdf.

30 EBRD&CIF (2019). Renewable energy in Kazakhstan. URL: https://www.ebrd.com/documents/ict/renewable-energy-in-kazakhstan.pdf.

Electricity generation in Kazakhstan in 1990–2020 Figure 5




IEA (2022)

the Soviet era. Solar PV and wind are two emerging sources that reached a combined share of 3.7% of electricity generation in 2022, while the share of RES without large hydro reached 4.5%.[31]

Kazakhstan has recently experienced soaring and highly energy-intensive cryptocurrency mining activity, which has been blamed for a significant growth in electricity consumption (6% in 2021 compared to 2020) and for increasing power blackouts. Most of the mining activity was illegal, with miners paying nothing for electricity. As of January 2022, Kazakhstan was the third largest cryptocurrency mining country in the world, accounting for 13.2% of the global hashrate, behind only the U.S. (37.8%) and mainland China (21.1%).[32] In June 2021, China imposed a ban on mining and circulation of cryptocurrency because it significantly increased the load on the Chinese power system, which led to emergency shutdowns across entire regions. This prompted the relocation of many mining farms to other countries, including to Kazakhstan. After several months of zero hashrate, cryptocurrency mining activities in mainland China were registered again in September 2021, which suggests that significant underground mining activity has sprung up in the country.[33] Kazakhstan has also started to impose restrictions on cryptocurrency mining (e.g. a tax of 1 tenge or 0.2 cents per 1 kWh consumed by registered miners, starting from 1 January 2022[34]), and Kazakhstan's grid operator KEGOC has cut off electricity for cryptocurrency miners.[35] By the end of 2022, new restrictions followed. In December 2022, the law "On Regulating Digital Assets in Kazakhstan" and several related pieces of legislation were approved that will ensure that miners consume electricity from the grid only at times when there is an excess, and will pay taxes, including corporation tax.[36] This will decrease Kazakhstan's attractiveness for cryptocurrency miners.

As the cryptocurrency mining story shows, Kazakhstan is already facing a shortage of electricity. In addition, there has been an increase in electricity consumption due to the removal of COVID-19 restrictions. In a longer-term perspective, over the period 2022-2027 Kazakhstan's Ministry of the National Economy expects strong economic growth, with annual GDP increases between 2.2% and 4.4% .[37] Population growth is also expected to continue – by 2027, the population will increase by 7% compared to 2022 to reach 20.6 million people.[38] Given these trends, consumption and production of electricity will also grow. In particular, by 2035, compared to 2022, electricity production will increase by 33%, to

31 The Ministry of Energy (2022). Information on the production of electricity by renewable energy facilities in 2022. URL: https://www.gov.kz/memleket/entities/energo/documents/details/403997?lang=ru (in Russian).

32 University of Cambridge (2022). Cambridge Bitcoin Electricity Consumption Index. URL: https://ccaf.io/cbeci/mining_map.

33 University of Cambridge (2022). Cambridge Bitcoin Electricity Consumption Index. URL: https://ccaf.io/cbeci/mining_map.

34 Tassev L. (2022). Kazakhstan Introduces Surcharge for Electricity Used by Crypto Miners // Bitcoin.com. URL: https://news.bitcoin.com/kazakhstan-introduces-surcharge-for-electricity-used-by-crypto-miners/.

35 Bloomberg (2022). Kazakhstan Unplugged Bitcoin Miners Before Blackout Hit Region. URL: https://www.bloomberg.com/news/articles/2022-01-25/kazakhstan-unplugged-bitcoin-miners-before-blackout-hit-region.

36 Sputnik (2022). How Kazakhstan will regulate cryptocurrency mining. URL: https://ru.sputnik.kz/20221207/kak-v-kazakhstane-budut-regulirovat-mayning-kriptovalyut-30085997.html (in Russian).

37 The Ministry of the National Economy of the Republic of Kazakhstan (2022). Forecast of the socio-economic development of the Republic of Kazakhstan for 2023–2027. URL: https://www.gov.kz/memleket/entities/economy/documents/details/310234?lang=ru (in Russian).

38 Ibid.

152.9 billion kilowatt-hours.[39] This makes the energy transition and the development of modern electric power technologies even more of a priority, including for reasons of energy supply security

## 4.2 Transmission and distribution systems

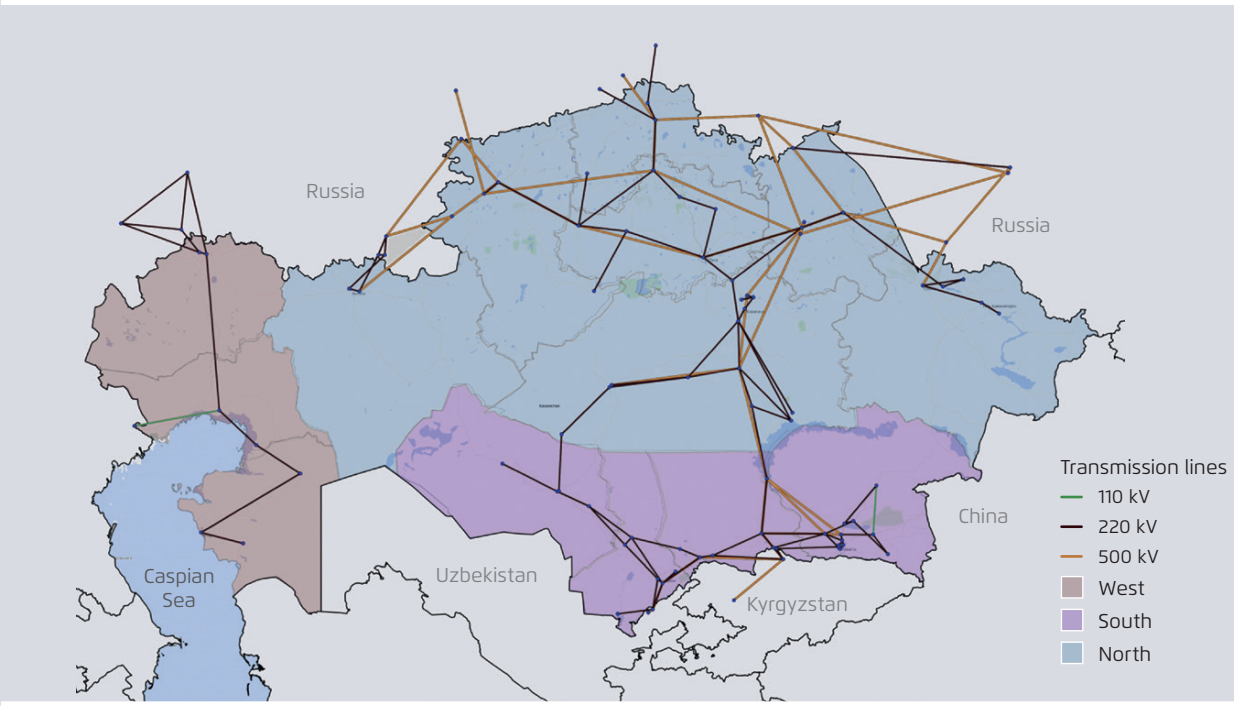
The unified energy system of Kazakhstan is divided into three zones - northern, southern and western (Figure 6). The northern zone produces a surfeit of electric power and has a connection with the southern zone. It was also historically well connected to the Russian energy system. The southern zone is energy deficient and covers its deficit through supplies from the north. In the Soviet era, southern Kazakhstan was part of the energy interconnection system of Central Asia, together with Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan. The southern zone still exchanges significant amounts of electricity with Kyrgyzstan and Uzbekistan today. The western zone is isolated from the northern and southern zones and has connections to Russia. The western zone has always had difficulties with electricity supply due to its isolation, and this problem has been on the agenda of the Ministry of Energy for years. In the future, it is planned to connect all three zones together.

The country's energy grid was built in the Soviet era and has not been significantly modernised since.[40] It

39 The Ministry of Energy of the Republic of Kazakhstan (2022). The concept of development of the electric power industry of the Republic of Kazakhstan until 2035. URL: https://www.gov.kz/memleket/entities/energo/documents/details/349883?lang=ru (in Russian).

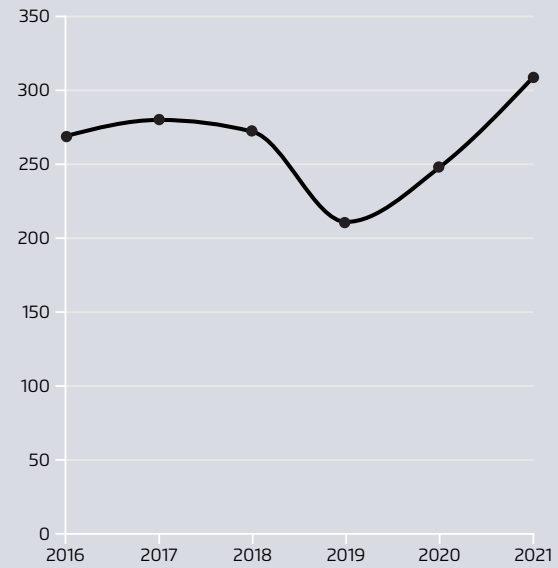
40 Irvin J. (2021). Energizing Kazakhstan: Renewable Energy Opportunities // Green FDC. URL: https://greenfdc.org/energizing-kazakhstan-renewable-energy-opportunities/.

Energy zones of the energy system as of 2015 Figure 6




Assembayeva M. et al. (2019)

Number of unscheduled outages in its electric power networks of KEGOC — Figure 7




KEGOC (2017-2021)

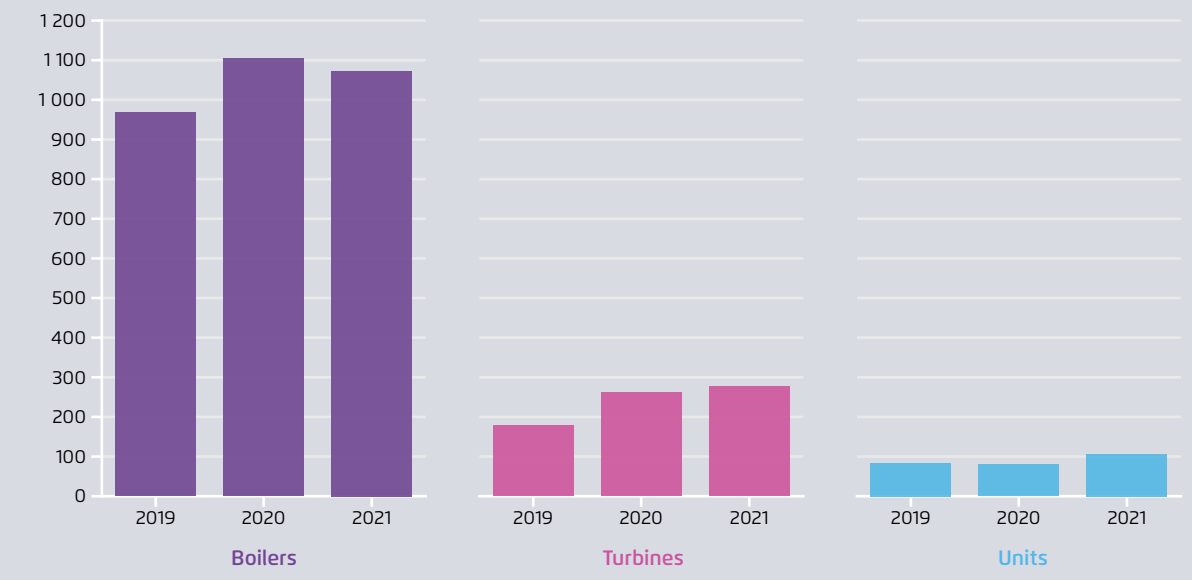
is characterised by historical underinvestment and a need for large infrastructure development. The transmission and distribution networks are highly inefficient due to outdated equipment, large distances and a continental climate, all of which leads to significant electricity losses. Transmission losses comprise 6%–7%, and distribution losses are around 14% on average, varying from 6% to 18%. Most distribution lines have been in operation for over 40 years.[41]

In 2021, KEGOC (Figure 7) registered 309 unscheduled outages in its electric power networks, which was 25% higher than in 2020. In addition, in recent years emergency shutdowns of power plant boilers, turbines and power units have become more frequent and longer (Figure 8, Figure 9). Emergency shutdowns of generating equipment significantly reduce the reliability of the national electric power system.

Obviously, Kazakhstan's electricity transmission and distribution systems need modernisation. The western energy zone is not connected with the rest of the country, and the connection between the northern and southern zones is weak. This presents not only obstacles to the integration of variable renewables but also challenges for the security of supply. Furthermore, plans for increasing VRES power generation need to be taken into account, so that grid planning can be aligned with renewables development.

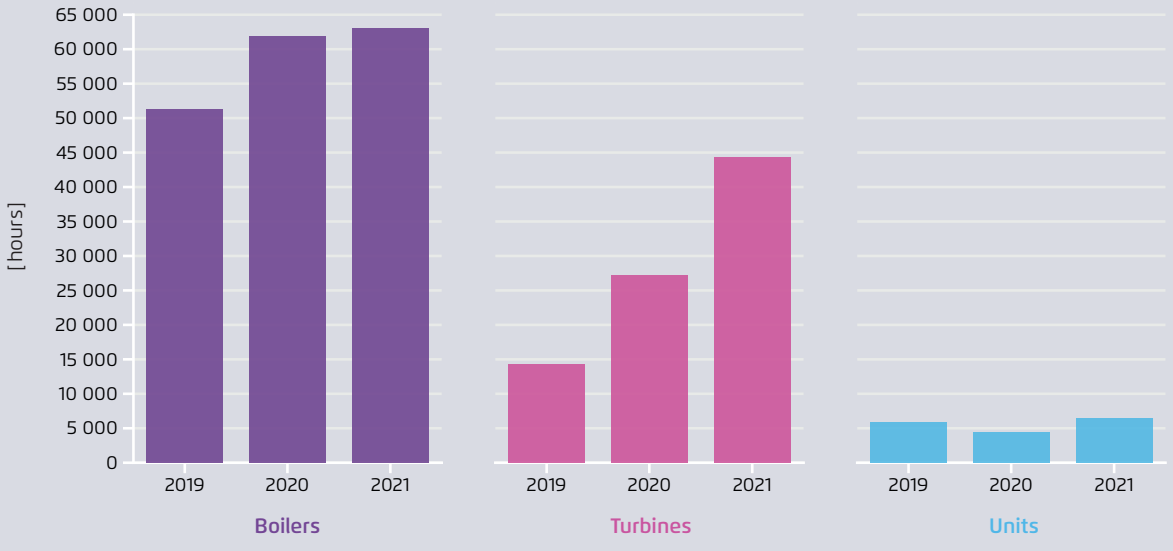
41 The Ministry of Energy of the Republic of Kazakhstan (2022). The concept of development of the electric power industry of the Republic of Kazakhstan until 2035. URL: https://www.gov.kz/memleket/entities/energo/documents/details/349883?lang=ru (in Russian).

Number of emergency shutdowns of thermal power plant boilers, turbines and units Figure 8




KEGOC (2021)

Cumulative duration of emergency shutdowns of thermal power plant boilers, turbines and units Figure 9




KEGOC (2017-2021)

# 5 The role of coal power

## 5.1 Coal mining and its economic significance

Kazakhstan has coal reserves for more than 250 years and ranks 8th in the world in terms of proven coal reserves of all types, from brown to hard coal.[42] In total, there are about 25 coal mining companies, and all of them are private. 65% of all coal is mined by two companies – Bogatyr Coal, which belongs to Samruk-Energy, and ERG.[43] Coal is supplied to domestic and foreign consumers via railroads operated by the Samruk-Kazyna-owned railway monopoly Kazakhstan Temir Zholy, and its transportation is subsidised.

In Kazakhstan, as in many other countries of the former USSR, coal mining is considered socially significant. It creates about 1.5% of the country's GDP[44] and provides direct employment to 30 000 – 40 000 people [45]. On a national scale, this is relatively small. However, there are a number of single-industry towns in Kazakhstan which are largely dependent on coal enterprises. For example, the city of Ekibastuz in the Pavlodar region, with a population of about 150 000, provides more than half of Kazakhstans' energy-producing coal and more than a quarter of the country's electricity generation, and the city's economy is 65% dependent on the coal industry.[46]

Trade unions in Kazakhstan are not truly independent and often act more like ministries, which leads to an under-representation of the rights and interests of coal miners as well as of other workers. This situation is historically determined and typical of many countries of the former Soviet Union. Nevertheless, strikes and protests have been regular occurrences over the past few years.

Coal in Kazakhstan is relatively easy to mine in open pits and has low production costs. However, its export is limited due to its high ash, sulfur and moisture content and relatively low heating value. In recent years, Kazakhstan has exported about 20% of its coal production, and almost all exports were to the countries of the former Soviet Union,[47] especially to Russia, as some Russian power plants in the Urals and Siberia were designed to burn coal from Kazakhstan's Ekibastuz basin.

The country had a strategy for the development of the coal industry up until 2020. Some representatives of the coal industry now admit that the industry is in a state of uncertainty because of the government's plans to decarbonise the economy and believe that a

42 Kalmykov D.E., Malikova A.D. (2017). Charcoaled // CINEST. URL: https://bankwatch.org/wp-content/uploads/2018/01/KZ-Coal_RU.pdf (in Russian).

43 Kazenergy (2021). National energy report. URL: https://www.kazenergy.com/ru/operation/ned/2117/ (in Russian).

44 Strategy 2050 (2021). Coal industry: in search of the sources of growth. URL: https://strategy2050.kz/ru/news/ugolnaya-promyshlennost-v-poiskakh-to-chek-rosta/ (in Russian).

45 PWC (2022) Energy Transition is a Basis for the Decarbonization of Kazakhstan. URL: https://rfc.kegoc.kz/media/energy-report.pdf (in Russian).
Express (2022). There are no alternatives to coal in Kazakhstan - coal miners. URL: https://exk.kz/news/133820/altiernativy-ughliu-v-kazakhsta-nie-niet----ugholshchiki (accessed in December 2022, in Russian).

46 Kazinform (2021). Brainstorming on a comprehensive plan for the development of the city was held in Ekibastuz. URL: https://www.inform.kz/ru/mozgovoy-shturm-po-kompleksnomu-planu-razvitiya-goroda-ustroili-v-ekibastuze_a3800269 (in Russian).

47 S&P Global (2022). Kazakhstan preps draft order on coal export ban for six months to secure supplies. URL: https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/coal/080522-kazakhstan-preps-draft-order-on-coal-export-ban-for-six-months-to-secure-supplies.

strategy for the development of the coal industry up until 2060 is needed.[48]

There are many supporters of coal power in Kazakhstan. In light of the plans and need for decarbonisation, discussion of new, more environmentally friendly uses for coal with higher added value (coal chemistry) is becoming more and more frequent in the country. A coal phase-out is periodically discussed at different levels, including the official level. However, few local experts consider it possible even in the long term (up to 2060), and there are as yet no specific plans for a phase-out or even a phase-down. In any event, in order to reduce carbon emissions, a shift to low carbon-emitting sources such as RES will be required.

## 5.2 Age, location and main characteristics of the coal power fleet

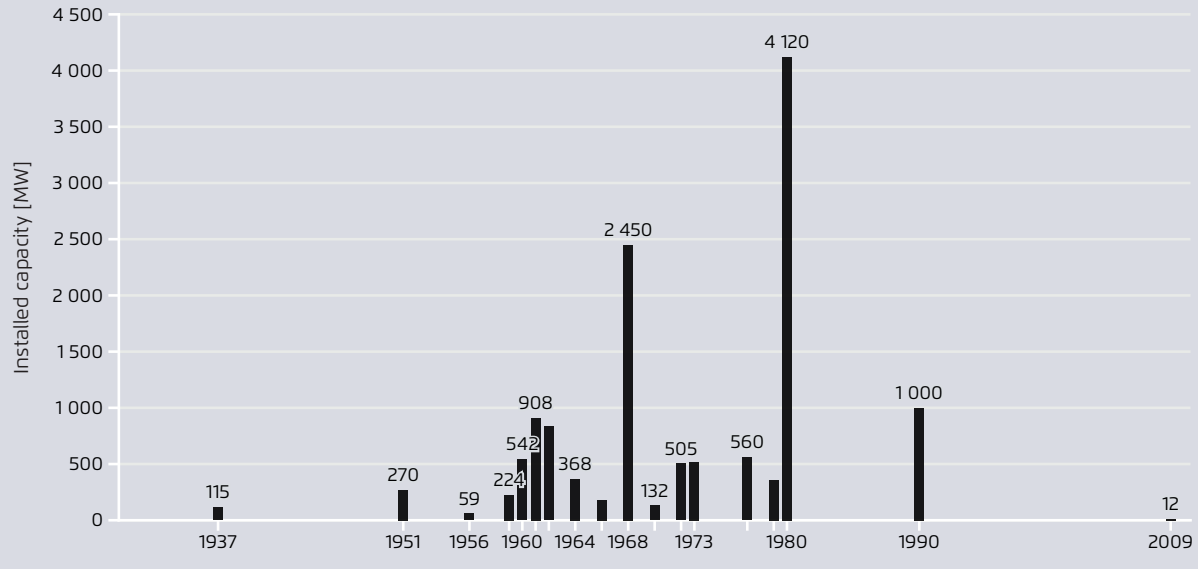
All Kazakhstan's coal power plant blocks were built during the Soviet era, with the only exception being Ekibastuz CHP, which replaced its old turbines with new ones in 2009. Some blocks still in operation today were built more than 60 years ago. Significant expansion of the coal power fleet took place in the 1960s and 1970s (Figure 10) in the context of intensive industrial development at that time, especially in the extractive industries.

The average capacity-weighted age of coal-fired power plant blocks in Kazakhstan is 50 years,[49] which is significantly higher than the standard period of

48 Express (2022). There are no alternatives to coal in Kazakhstan - coal miners. URL: https://exk.kz/news/133820/altiernativy-ughliu-v-kazakhstanie-niet----ugholshchiki (accessed in December 2022, in Russian).

49 Calculated by the authors on the basis of Assembayeva M. et al. (2019). Spatial electricity market data for the power system of Kazakhstan // Data in Brief. – Vol. 23. URL: https://doi.org/10.1016/j.dib.2019.103781.

Commissioning of blocks of coal power plants — Figure 10




Estimated on the basis of Assembayeva M. et al. (2019)

operation – 40 years.[50] In practice, coal-fired power plants often operate much longer than 40 years. Historically, coal-fired power plants around the world have been decommissioned after an average of 46 years of operation.[51] The extension of operating life can be almost infinite, provided that individual items of equipment are repaired or replaced in a timely manner. However, as the age of the power plant increases, so do the costs of maintaining it in working condition.

An interesting fact that follows from the analysis of the data presented in the table is that if Kazakhstan decided to phase out coal power plants after 40 years of operation, by 2030 there would be only 12 MW of capacity left (21 years old), representing just 0.1% of today's fleet.

Most of Kazakhstan's coal power plants are located in the Pavlodar (65% of installed capacity) and Karaganda (17% of installed capacity in the old borders of the region) regions. The Pavlodar region encompasses Ekibastuz coal basin, which provides many local power plants with coal. About 60% of the country's coal is mined in the Pavlodar region[52]. However, many other regions in the northern and eastern parts of the country burn coal to produce electric power (Figure 11).

The average efficiency of Kazakhstan's coal power plants is estimated at just 32%. This is significantly lower than the 42% figure for most industrialised countries.[53]

Big cities in Kazakhstan are equipped with district heating systems built in the Soviet era. These systems are based on CHP power plants, 80% of which run on

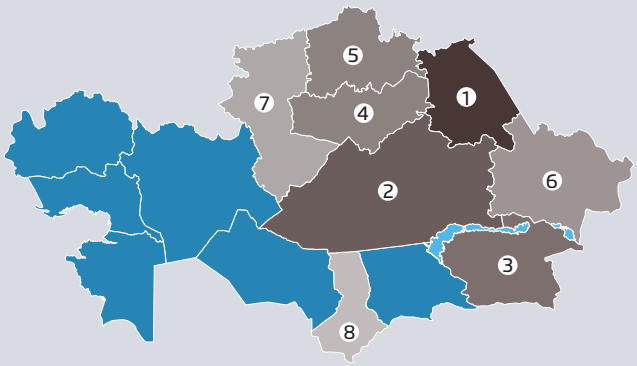
50 Lazard (2021). Lazard's Levelized Cost of Energy – Version 15.0. URL: https://www.lazard.com/media/sptlfats/lazards-levelized-cost-of-energy-version-150-vf.pdf.

51 Cui et al. (2019). Quantifying operational lifetimes for coal power plants under the Paris goals // Nature Communications. - V. 10, 4759. URL: https://doi.org/10.1038/s41467-019-12618-3.

52 Prime Minister of the Republic of Kazakhstan (2019). Pavlodar region: Increasing industrial production and focusing on entrepreneurship. URL: https://www.primeminister.kz/en/news/reviews/pavlodar-region-increasing-industrial-production-and-focusing-on-entrepreneurship.

53 Kalmykov D.E., Malikova A.D. (2017). Charcoaled // CINEST. URL: https://bankwatch.org/wp-content/uploads/2018/01/KZ-Coal_RU.pdf (in Russian).

Regional distribution of coal-fired power plants — Figure 11




1 Pavlodar region, 35 units, 8 427 MW
2 Karaganda region, 36 units, 2 221 MW
3 Almaty region, 14 units, 627 MW
4 Akmola region, 12 units, 562 MW
5 North Kazakhstan region, 12 units, 562 MW
6 East Kazakhstan region, 10 units, 405 MW
7 Kostanay region, 6 units, 267 MW
8 South Kazakhstan region, 3 units, 17 MW

Compiled on the basis of Assembayeva M. et al. (2019). Spatial electricity market data for the power system of Kazakhstan. Data in Brief. – Vol. 23. URL: https://doi.org/10.1016/j.dib.2019.103781.
Note: in 2022, three regions of Kazakhstan were divided into two regions each. Here are the old borders of the regions.

coal. Most of these facilities need modernisation: their average boiler efficiency is only 40%, and heat losses in the network reach 36%. In smaller towns, district heating is often not available, and heat is supplied by individual heating systems. 55% of households are individually heated, and 55% of these use coal for that purpose.[54]

The coal-based electric power system in Kazakhstan has little flexibility, and this will hinder the integration of large volumes of variable renewable energy, which is planned in the coming years. CHP power plants normally need to run at a constant load to ensure an uninterrupted supply of heat to their customers. There are therefore limits on how well they can respond to changes in electric power demand. However, even CHP plants can increase their flexibility by using large thermal energy storage systems. These storage systems have a discharge duration of several hours (e.g. 6 hours) which allows a complete halt to generation for several hours while the stored heat is used.[55] This still requires plant modernisation.

Lignite coal-fired power plants normally have to operate at a nominal load (baseload) for most of the time and can be switched on/off only a few times a year. However, minimum load reduction retrofits (e.g. through indirect firing, switching from two-mill to single-mill operation, etc.) can allow the power plant to stay online at very low loads. Hard coal power plants are more flexible, but they can also be retrofitted to become even more flexible. German and Danish experience shows that even ageing coal power plants are able to adjust their output on a 15-minute basis (intraday market) or even on a 5-minute basis (balancing market).[56]

Targeted retrofits may increase the flexibility of Kazakh coal-fired power plants and of the electric power system as a whole and make them more ready for substantial RES deployment, if there are no better options (or they are insufficient) than keeping coal power plants online. Better options might include flexible gas-fired and hydropower plants, some of which are already installed in Kazakhstan, as well as storage systems. In addition, the flexibility of the power system can be increased by demand-side management, by flexible biomass/biogas power plants, and by grid development to enable the transportation of electric power over greater distances. Overall, although the predominance of ageing coal power plants is of course a challenge to RES integration, it is surmountable.

## 5.3 Challenges of managing a gradual phase-down of coal-fired generation

Currently, there is no reliable information about plans to build new and/or shut down existing coal-fired thermal power plants in the country.[57] On the one hand, Kazakhstan's President Kassym-Jomart Tokayev has been saying that by 2050 all coal-fired power plants would be decommissioned.[58] On the other hand, there is an unequivocal understanding that the existing coal power plants will not be

54 The World Bank Group (2022). Kazakhstan – Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099420411012246024/pdf/P1773690ad92b401b089700f5be8659ecf0.pdf.

55 Agora Energiewende (2017). Flexibility in thermal power plants. URL: https://www.agora-energiewende.de/en/publications/flexibility-in-thermal-power-plants/.

56 Ibid.

57 Express (2022). There are no alternatives to coal in Kazakhstan - coal miners. URL: https://exk.kz/news/133820/altiernativy-ughliu-v-kazakhstanie-niet----ugholshchiki (in Russian).

58 Informburo (2021). Tokayev: 10 most polluted cities of Kazakhstan will be gasified by 2025. URL: https://informburo.kz/novosti/tokaev-10-samyh-zagryaznyonnyh-gorodov-kazahstana-gazifici-ruyut-k-2025-godu (in Russian).

closed.[59] The Ministry of Energy regards a complete coal phase-out as unacceptable, since some regions of the country have not yet been gasified. Moreover, the ministry plans to build new coal blocks and upgrade existing ones[60].

The National Concept for Transition to a Green Economy up to 2050 foresees the gradual replacement of existing old coal-fired capacities with new modern coal-fired plants, with the exception of those situated in large cities (principally Almaty, Astana, Karaganda), where energy generation will be switched to gas and new gas power plants will be built. According to this document, the amount of electricity produced by coal power plants would remain at the level of 2012 until 2030 but its share will decrease from 78% in 2012 to 44%-53% in 2030 and 14%-50% in 2050, depending on the precise scenario.[61]

In some regions, phasing out coal generation is a socially important issue and work is already under way. For example, in Almaty, the level of air pollution is assessed as high.[62] Pollution is caused by emissions from the CHPP-2 and CHPP-3 plants, private residential buildings, and traffic on roads. Samruk-Energy is working on the modernisation of boilers and their transfer from coal to natural gas at the Almaty CHPP-2 plant in order to minimise harmful emissions. It is estimated that when CHPP-2 is converted to gas, the annual amount of pollutant emissions into the atmosphere will be reduced by more than 80%. At the same time, natural gas is a much more expensive fuel for Almaty than coal from Ekibastuz. Its price in 2019 was 2.3 times higher than that of coal. CHPP-2 provides about 50% of the district heat and electricity for Almaty.[63] The work is due to be completed in 2026.[64] It is important to note that its modernisation was undertaken in response to an initiative from the residents of the city and environmentalists - they demanded the switch to a more environmentally-friendly fuel – gas. Similar solutions are needed for CHPP-1 and CHPP-3, also located in the Almaty region. Currently they are scheduled for expansion through the construction of combined cycle power plants. At the end of May 2022, the President of Kazakhstan, Kassym-Jomart Tokayev, ordered the conversion of CHPP-2 in Almaty to gas to begin as soon as possible.[65]

It is obvious, then, that Kazakhstan needs large investments in order to modernise its ageing coal-fired power fleet. These investments may be directed into building new coal-fired power plants which have better environmental characteristics and higher flexibility but still carry a very high risk of quickly becoming stranded assets. Alternatively, the ageing of the coal power fleet may be regarded as a window of opportunity for the adoption of new renewable energy systems coupled with related technologies that provide for system flexibility (e.g. energy storage, grid development, demand response, etc.).

59 Informburo (2021). Can Kazakhstan abandon coal and avoid electricity shortages? URL: https://informburo.kz/interview/mozet-li-kazaxstan-otkazatsya-ot-ugly-a-i-ne-dopustit-deficita-elektroenergii (in Russian).

60 Zakon.kz (2022). Kazakhstan is not ready to abandon coal-fired power plants by 2035. URL: https://www.zakon.kz/6024684-kazakhstan-i-k-2035-godu-ne-gotov-otkazatsia-ot-ugolnykh-elektrostantsii.html (in Russian).

61 Decree of the President of the Republic of Kazakhstan on May 30, 2013, #557. Concept for transition of the Republic of Kazakhstan to Green Economy. URL: https://online.zakon.kz/Document/?doc_id=31399596 (in Russian).

62 Forbes (2021). Cities of Kazakhstan with the dirtiest air are named. URL: https://forbes.kz/news/2021/11/04/newsid_262545 (in Russian).

63 E2Energy (2020). Transfer of Almaty CHPP-2 to gas. Briefly about the most important. URL: https://eenergy.media/archives/16365 (in Russian).

64 Kapital (2022). Transfer of Almaty CHPP-2 to gas will cost 324 billion tenge. URL: https://kapital.kz/gosudarstvo/106302/perevod-almatinskoy-t-ets-2-na-gaz-oboydet-sya-v-324-mlrd-tenge.html (in Russian).

65 Ibid.

# 6 Renewable energy opportunities

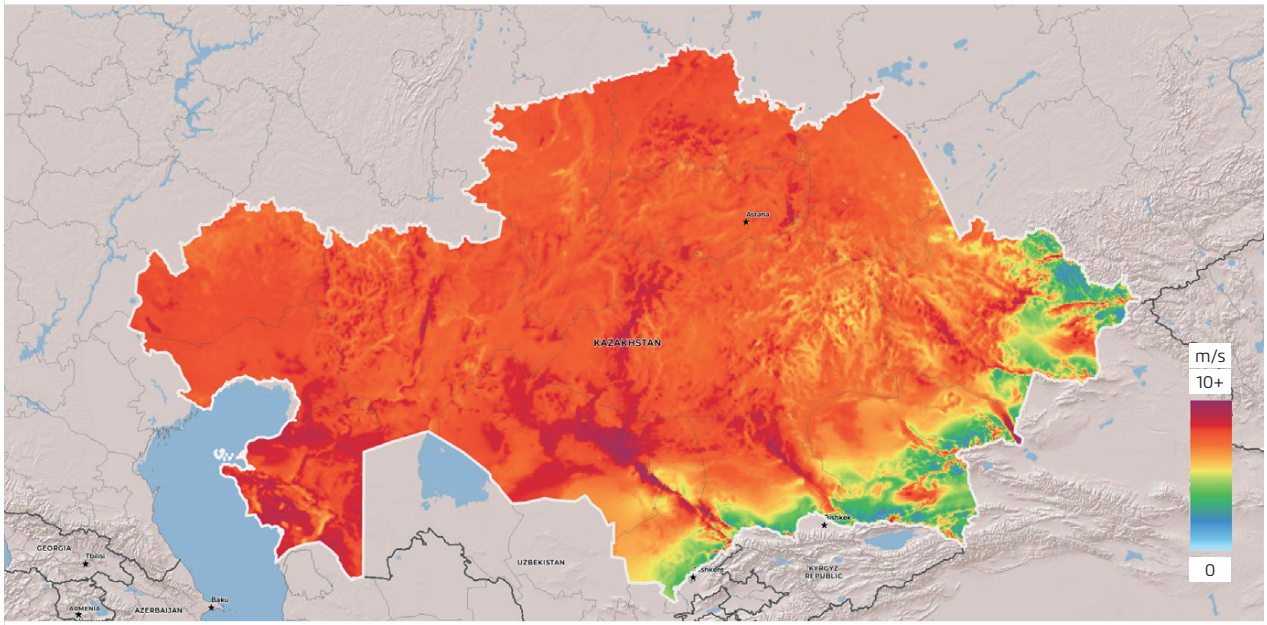
## 6.1 Solar PV and wind potential

Kazakhstan is blessed with large areas with attractive solar and wind conditions across the country. Due to its low population density, land use is much less of a problem than in many other regions in the world such as central Europe or Southeast Asia. Mean wind speed in some regions of Kazakhstan is 8-9 m/s at a height of 100 m, which is ideal for low-cost electric power generation (Figure 12). The most promising areas for wind power development are the Caspian Sea region and the central and northern regions. The central and northern regions of the country are covered by the northern energy zone, which accounts for 67% of installed capacity and 65% of electricity consumption in the country.[66] The Caspian Sea region belongs to the isolated western energy zone.

In the southern part of the country, solar irradiance reaches up to 4.79 kWh/m$^2$ per day (Figure 13), which is higher than in Germany and the UK, both of which rely on solar PV much more than Kazakhstan (Table 1). The most promising areas for the development of solar PV energy in Kazakhstan are in the south - the Almaty, Kyzylorda, Zhambyl and Turkestan regions, where wind power potential is relatively weak. Southern regions are facing a shortage of electricity, which has to be supplied from the northern regions over long distances. The development of solar PV generation in the south could improve this situation. In addition, as follows from the above, physical solar

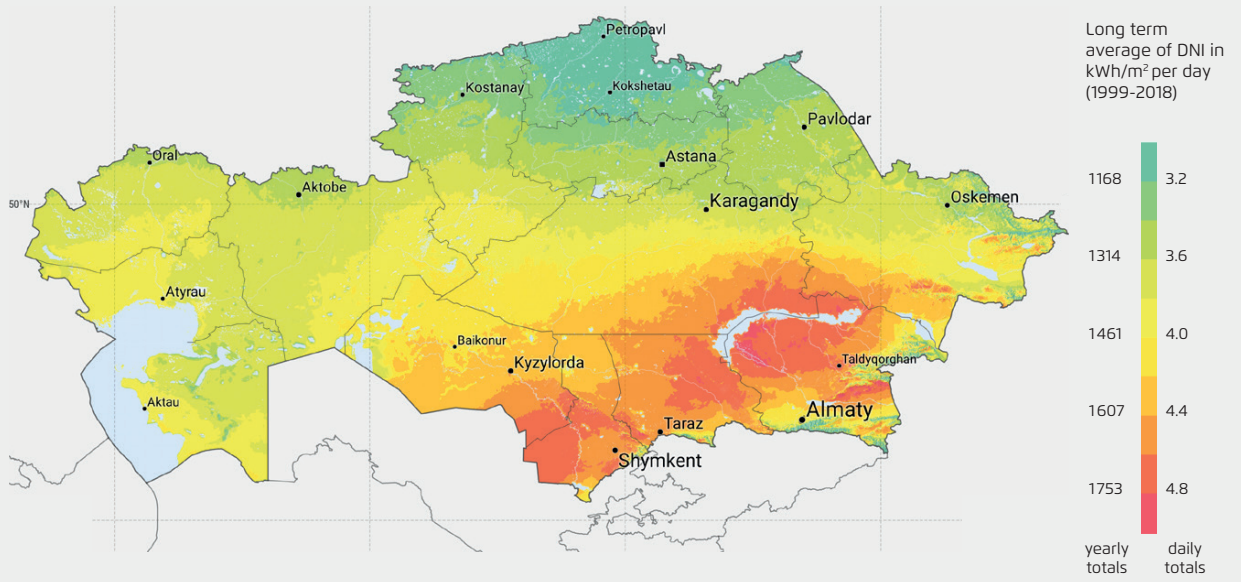
66 KEGOC (2021). Annual Report 2021. URL: https://www.kegoc.kz/ru/for-investors-and-shareholders/raskryt-ie-informatsii/annual-reports/.

Mean wind speed in Kazakhstan at the height of 100 m — Figure 12




Global Wind Atlas (2023)

Direct normal irradiation Figure 13




Global Wind Atlas (2023)

and wind potentials complement each other very well throughout the country. Grid development will provide a backbone for stable electric power supply from RES and will allow supply from wind and solar PV to be balanced with each other as well as with demand in urban conglomerates.

As regards the economic potential of solar PV and wind power, there is a very widespread belief that they are uncompetitive in Kazakhstan due to the abundance of cheap power produced from local coal. However, according to the official data, solar PV and wind power projects which won auctions in 2022, i.e. new RES generation, were often offering comparable or lower prices per kWh than existing natural gas power plants (Figure 14). And the highest tariff cap for coal power from existing power plants was equal to the lowest auction price for new wind generation.

It is important to note that, as mentioned in section 5.1, the average capacity-weighted age of coal-fired power plant blocks in Kazakhstan is

Tariff caps for existing conventional power generation and auction prices for new renewable power generation in 2022 Figure 14


Agora Energiewende (2023). Compiled by the authors on the basis of Order of the Minister of Energy of the Republic of Kazakhstan of December 14, 2018 No. 514. On the approval of marginal tariffs for electrical energy (as amended and supplemented as of June 30, 2022).

Direct normal irradiation (DNI) in selected countries and Kazakhstan — Table 1

| Country | Minimal DNI, kWh/m² per day | Maximal DNI, kWh/m² per day | Share of solar PV in power mix in 2020 |
|---|---|---|---|
| USA | 1.46 | 7.80 | 3.94% |
| China | 0.98 | 7.58 | 3.91% |
| Germany | 2.32 | 3.24 | 8.61% |
| UK | 1.24 | 2.79 | 4.08% |
| Kazakhstan | 3.04 | 4.79 | 2.59% |

Global Solar Atlas.
URL: https://globalsolaratlas.info/global-pv-potential-study and Ember (2022). Global Electricity Review 2022.
URL: https://ember-climate.org/insights/research/global-electricity-review-2022/.

50 years,[67] which is significantly higher than the standard operating life of 40 years.[68] A similar situation obtains with gas-fired power plant blocks – their average capacity-weighted age in Kazakhstan is 42 years,[69] while the standard period of their operation is estimated at 20 years.[70] The capacity of that part of the coal-fired fleet that is younger than 40 years is 1 GW (8% of the installed coal-fired capacity), and that of the gas-fired fleet younger than 20 years is 0.8 GW (17% of the installed gas-fired capacity).[71]

This means that almost all existing thermal generation facilities in Kazakhstan are already amortised and still not much cheaper or in some cases even more expensive than new build solar PV and wind power plants. And tariffs for existing thermal power plants do not fully reflect long-run modernisation and replacement costs, nor environmental externalities. Moreover, tariffs for thermal generation have been increasing (Figure 15) and are expected to continue this trend, while solar PV auction prices have been fairly stable after a significant decline in 2018, and wind auction prices have shown a decline (Figure 16).

When compared to auction prices in other countries, projects in Kazakhstan are relatively attractive. In 2021, GWEC cited the 400 MW Durnat al-Jandal wind power project as the most cost-efficient, with a tariff of 0,0199 $/kWh. This project was submitted by Masdar (UEA) and EDF-EN (France)[72] and it was only one-third cheaper than wind power projects in Kazakhstan.

67 Calculated by the authors on the basis of Assembayeva M. et al. (2019). Spatial electricity market data for the power system of Kazakhstan // Data in Brief. – Vol. 23. URL: https://doi.org/10.1016/j.dib.2019.103781.

68 Lazard (2021). Lazard's Levelized Cost of Energy – Version 15.0. URL: https://www.lazard.com/media/451881/lazards-levelized-cost-of-energy-version-150-vf.pdf.

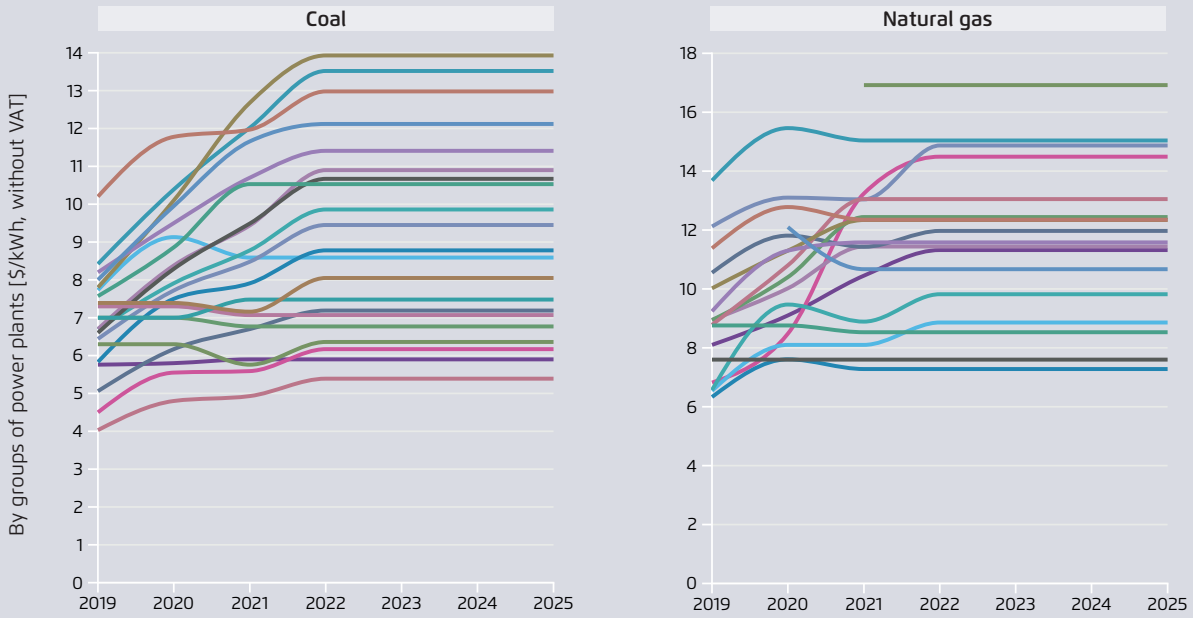
69 Ibid.

70 Lazard (2021). Lazard's Levelized Cost of Energy – Version 15.0. URL: https://www.lazard.com/media/451881/lazards-levelized-cost-of-energy-version-150-vf.pdf.

71 Calculated by the authors on the basis of Assembayeva M. et al. (2019). Spatial electricity market data for the power system of Kazakhstan // Data in Brief. – Vol. 23. URL: https://doi.org/10.1016/j.dib.2019.103781.

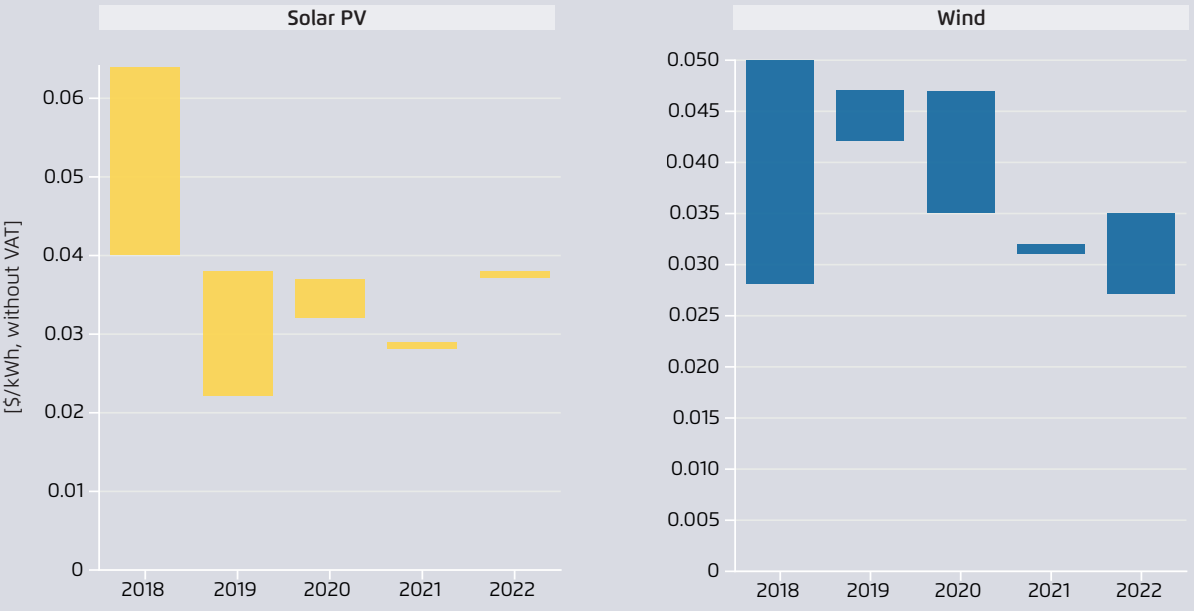
72 GWEC (2021). Global Wind Report 2021. URL: https://gwec.net/wp-content/uploads/2021/03/GWEC-Global-Wind-Report-2021.pdf.

Generation tariffs for Coal and Natural gas Figure 15




Agora Energiewende (2023). Compiled by the authors on the basis of Order of the Minister of Energy of the Republic of Kazakhstan of December 14, 2018 No. 514.

Auction prices for Solar PV and Wind Figure 16




Financal Settlement Center of Renewable Energy (2022)

## 6.2 Regulation of the renewable energy sector

The history of renewable energy support in Kazakhstan dates back almost 15 years, but in fact, the strategic development of this industry began only a few years ago. This significant delay has been blamed on faults in the legislative framework in the beginning which were later eliminated, on the persistent lack of the political will to achieve the goals set in the RES sphere, and on path dependency.

In 2009, Kazakhstan adopted its first renewable energy law.[73] This law introduced project-based tariffs for renewable energy that were to be set individually following negotiations with regulators. Individual tariffs were not transparent, so projects were not attractive to foreign investors. In 2013, the renewable energy law was amended to introduce a technology-specific feed-in tariff mechanism for selected renewable energy technologies. This significantly increased the attractiveness of the Kazakh renewable energy market to international investors. Also in 2013, Kazakhstan created a Cost Clearing and Settlement Centre as the single purchaser of renewable power. In 2017, the renewable energy law was amended once again to replace fixed feed-in tariffs with the auction procedure first implemented in 2018. As a result, the selection process for RES projects has become more competitive and transparent and more in line with international best practice.

In 2018-2021, Kazakhstan held 41 renewable energy auctions, where projects with a total capacity of 1.3 GW were selected. A total of 196 companies from 12 countries took part in these auctions – from Kazakhstan itself, Russia, China, Turkey, the Netherlands, France, UAE, Bulgaria, Italy, Germany, Malaysia and Spain. Some 60 companies have signed 15-20-year contracts with Kazakhstan's single purchaser of renewable energy. At the auctions, auction prices decreased by up to 72%.[74]

In 2013, Kazakhstan adopted the "National Concept for Transition to a Green Economy up to 2050".[75] According to this document, the country should achieve a 50% share of renewable (solar, wind and hydropower) and alternative (nuclear) energy sources in its electric power mix by 2050. The document also contains a couple of shorter-term goals (Table 2), the first of which – 3% of solar PV and wind in the power mix by 2020 – has already been met (in 2021). Immediately after the adoption of the concept, the 50% goal set for 2050 was not taken seriously. However, in recent years, it has been mentioned increasingly by a variety of stakeholders, including representatives at the highest official levels.

RES goals of Kazakhstan and their status Table 2

| Year | Goal* | RES type | Status |
|---|---|---|---|
| 2020 | 3% | Solar PV and wind | Achieved in 2021 |
| 2030 | 15% | RES | In the process |
| 2030 | 30% | RES and nuclear | In the process |
| 2050 | 50% | RES and nuclear | In the process |

* In the power mix.
Compiled by Agora Energiewende on the basis of official sources.

In 2021, another, more concrete medium-term goal for RES was announced – the President of Kazakhstan, Kassym-Jomart Tokayev, set the government

73 Ministry of Justice of the Republic of Kazakhstan (2009). Law "On supporting the use of renewable energy sources". URL: https://adilet.zan.kz/rus/docs/Z090000165_ (in Russian).

74 Ministry of Energy of the Republic of Kazakhstan (2022). Concept for the development of the electric power industry of the Republic of Kazakhstan until 2035. URL: https://www.gov.kz/memleket/entities/energo/documents/details/349883?lang=ru (in Russian).

75 Decree of the President of the Republic of Kazakhstan of May 30, 2013, #557. Concept for transition of the Republic of Kazakhstan to Green Economy. URL: https://adilet.zan.kz/rus/docs/U1300000577 (in Russian).

the task of increasing the share of renewable energy in electricity generation to 15% by 2030.[76]

At the moment, the key official RES goals in Kazakhstan are thus:

→ Medium term – 15% renewable power by 2030;
→ Long term – 50% renewable and alternative (nuclear) power by 2050.

In 2012, the Law on Energy Savings and Energy Efficiency was adopted, which was later amended many times, most recently on 31 August 2022.[77] This law is not directly related to renewable energy; however, it is worth mentioning since it addresses an adjacent sphere. The law prohibits the sale or use of electric incandescent lamps of 25 watts and above, mandates energy efficiency class labels for all electricity consuming equipment, introduces energy service contracts, obliges large consumers to register with the State Energy Register and to provide data on their actual energy consumption, and to prepare action plans for energy saving and energy efficiency and undergo regular energy audits. The law also makes it mandatory for large energy consumers to bring in comprehensive non-departmental expertise for projects in the sphere of energy saving and energy efficiency. In addition, according to the law, new buildings must be equipped with metering devices and comply with energy saving and energy efficiency requirements.

In 2013, Kazakhstan became the first country from the former USSR to introduce an emissions trading scheme (ETS). At the moment, Kazakhstan's ETS covers the power sector and district heating as well as the extractive industries and manufacturing, all in all representing 46% of total national GHG emissions.[78] So far, this experience has not been successful, due to the extremely low number of transactions; this in turn can be explained by the large number of free quotas and the relatively high benchmark emissions intensity for coal power plants. Meanwhile, the sectors not included in the ETS (e.g. the residential and services sectors) are increasing their energy consumption and emissions.[79]

In 2021, Kazakhstan adopted an updated version of the Environmental Code[80] first introduced in 2007. The code establishes the "polluter pays" principle and requires large new investment projects to apply best available techniques in emissions management. According to the requirements of the new Environmental Code, from January 1, 2023 large enterprises must install automated emission monitoring systems. The document also includes an outline of Kazakhstan's ETS. The Environmental Code is not directly related to the RES sector, but its updated version supports RES development in several ways.

In 2022, the Concept for the development of the electric power industry of the Republic of Kazakhstan

76 Kazinform (2021). I set the task to increase the share of renewable energy sources in power generation to 15% by 2030 - Head of State. URL: https://www.inform.kz/ru/uvelichit-dolyu-vie-v-elektrogeneracii-do-15-k-2030-godu-poruchenie-glavy-gosudarstva_a3792969 (in Russian).

77 Law of the Republic of Kazakhstan „On energy saving and energy efficiency" of 13 January 2012 (with amendments and additions as of 31August 2022. URL: https://online.zakon.kz/Document/?doc_id=31112351&pos=2;-109#pos=2;-109 (in Russian).

78 ICAP (2022). Kazakhstan Emissions Trading System. URL: https://icapcarbonaction.com/en/ets/kazakhstan-emissions-trading-system.

79 IEA (2022). Kazakhstan 2022 Energy Sector Review. URL: https://iea.blob.core.windows.net/assets/fc84229e-6014-4400-a963-bccea29e0387/Kazakhstan2022.pdf.

80 Environmental Code of the Republic of Kazakhstan (2021). URL: https://adilet.zan.kz/rus/docs/K2100000400 (in Russian).

up to 2035[81] was adopted. According to this document, by 2035, installed RES capacity will increase to 40.1 MW (almost double that in 2022), while the share of RES will increase to 30% of total installed capacity (in 2022 - 19%, including HPPs). In order to further successfully integrate RES within the energy system, the concept requires an increase in flexible capacities and the construction of energy storage facilities.

In 2023, the Strategy for Achieving Carbon Neutrality of the Republic of Kazakhstan by 2060 was adopted[82] following long discussions. The document notes that the gradual withdrawal of the Kazakh economy from coal dependence is crucial for the achievement of carbon neutrality by 2060, and the development of RES will be a key condition for successful decarbonisation. The strategy also prioritises the electrification of energy consumption in all economic sectors and the transition to the use of hydrogen, biofuels and synthetic low-carbon fuels in processes that are difficult or impossible to electrify, as well as the use of carbon capture and storage technologies. However, the document does not contain any quantitative targets and provides only very general outlines for Kazakhstan's low-carbon development.

It should be noted that from the very beginning, international development banks played a significant role in the formation of the RES support system in Kazakhstan and in the development of the appropriate regulation. In 2008, the government of Kazakhstan signed a Sustainable Energy Action Plan (SEAP) which paved the way for the further involvement of EBRD in the country's renewable energy sector.[83] EBRD subsequently participated in the preparation of Kazakhstan's first renewable energy law, which was adopted in 2009. In 2010, the Clean Technology Fund (CTF) started to provide technical assistance on RES to Kazakhstan. In 2012, EBRD provided its first loan to Kazakhstan, for the rehabilitation of the Shardara hydropower plant. Both EBRD and CTF later contributed significantly to the improvement of the first renewable energy law and to the improvement of the whole renewable energy framework.

Kazakhstan's official announcements regarding renewable energy have undergone dramatic changes in recent years. Thus, in 2014, a year after the adoption of the concept in principle for the country's transition to a green economy, the then President of Kazakhstan, Nursultan Nazarbayev, said: "I personally do not believe in alternative energy, such as wind and solar, which supposedly will one day replace (traditional energy sources) (...) Oil and gas is our main strong point, and we should not be concerned that our economy is based on raw materials."[84] In 2021, the President of Kazakhstan, Kassym-Jomart Tokayev, said: "I am a firm supporter of the clean energy, and green technologies as a whole. I support the construction of power plants using renewable energy sources."[85]

81 Ministry of Energy of the Republic of Kazakhstan (2022). Concept for the development of the electric power industry of the Republic of Kazakhstan until 2035. URL: https://www.gov.kz/memleket/entities/energo/documents/details/349883?lang=ru (in Russian).

82 Strategy for achieving carbon neutrality of the Republic of Kazakhstan until 2060. URL: https://adilet.zan.kz/rus/docs/U2300000121 (in Russian).

83 EBRD&CIF (2019). Renewable energy in Kazakhstan. URL: https://www.ebrd.com/documents/ict/renewable-energy-in-kazakhstan.pdf.

84 Forbes (2014). Nazarbayev urges to use raw material income to create modern industries. URL: https://forbes.kz/news/2014/09/30/newsid_69328 (in Russian).

85 Official website of the President of the Republic of Kazakhstan (2021). The Head of State held a meeting on the development of the electric power industry. URL: https://akorda.kz/en/the-head-of-state-held-a-meeting-on-the-development-of-the-electric-power-industry-2641630.

## 6.3 Obstacles and opportunities

Like many other former Soviet Union countries and economies which are rich in fossil fuels, Kazakhstan has for a long time lacked the political will to implement energy transition measures. In recent years, due both to a growing understanding of the inevitability of the global energy transition and the need to fit into the emerging low carbon energy landscape, this has started to change. However, many other factors still limit renewable energy development in the country.

One of these factors is high fossil fuel subsidies and low tariffs for coal and natural gas electricity, which make renewables less competitive. Kazakhstan is dependent on subsidised coal and natural gas, which has resulted in underinvestment in new power generation technologies. For example, domestic supplies of natural gas are below cost price, and rises in natural gas tariffs are limited to 15% per year. These subsidies are financed through the export of natural gas, since prices on international markets are much higher. Households are cross-subsidised through higher electric power tariffs for industrial and municipal consumers.[86] This impedes the emergence of prosumers and forces industrial consumers to switch to self-generation based on fossil fuels. As a result, due to a smaller customer base, the power and heating sectors and the transmission and distribution grids attract less investment. As in many other Central Asian countries and in Russia, fossil fuel subsidies in Kazakhstan are driven by fears of political unrest, and energy prices are a very sensitive social issue. For instance, in January 2022, a sudden and significant rise in prices for liquified petroleum gas (LPG) for vehicles contributed to the most widespread protests in the country since the dissolution of the USSR.[87]

Another obstacle is the dominant position of CHP power plants producing both electricity and heat. They were inherited from the Soviet Union, and their existence and importance are explained by the fact that Kazakhstan has harsh climate conditions, with temperatures ranging between +50°C and -50°C, which makes affordable heat extremely socially important. CHP can supply cheap heat to large districts in a centralised manner, and its replacement would entail not only the substitution of electric power production with SPPs or WPPs for electric power, but also finding a new reliable and cheap source of heat.

At the same time, Kazakhstan has a shortage of flexible power plants and is dependent on parallel operation with the Russian power system.[88]. If this is not addressed, it will increasingly impede the integration of variable renewable power given the growing need to quickly power up or down baseload capacities to complement VRES. As a result, the growth of renewable power may be curtailed, and/or the construction of new VRES power plants may be postponed. In 2021, Kazakhstan introduced auctions for the construction of new flexible large gas-fired and hydropower capacities. The first auction was held in July 2021.[89] In addition, the introduction of auctions for RES projects with energy storage systems is being discussed.

86 The World Bank Group (2022). Kazakhstan – Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099420411012246024/pdf/P1773690ad92b401b089700f5be8659ecf0.pdf.

87 The World Bank Group (2022). Kazakhstan – Country Climate and Development Report. URL: https://documents1.worldbank.org/curated/en/099420411012246024/pdf/P1773690ad92b401b089700f5be8659ecf0.pdf.

88 IEA (2022). Kazakhstan 2022 Energy Sector Review. URL: https://iea.blob.core.windows.net/assets/fc84229e-6014-4400-a963-bccea29e0387/Kazakhstan2022.pdf.

89 Kapital.kz (2022). Turkish company wins auction for power plant construction. URL: https://kapital.kz/economic/107233/auktsion-na-stroitel-stvo-elektrostantsii-vyigrala-turetskaya-kompaniya.html (in Russian).

Potential local investors normally have limited access to affordable bank loans. Changing legal requirements and high local economic risks make capital more expensive and more difficult to access. The construction of many solar PV and wind power plants in Kazakhstan was only made possible by the financial support and guarantees provided by the EBRR.[90] This poses challenges for local contributions to and the local ownership of the Kazakhstan energy transition.

Last but not least, Kazakhstan covers a large territory and is thus prone to infrastructure bottlenecks. The internal transport infrastructure is weak, which might prove critical for some RES projects, especially in the wind energy sector. The electric power network is also underdeveloped – it is ageing, its transmission capacity is low, and it has severe geographical limitations (e.g. the western regional zone is isolated, and large quantities of electric power have to be transported from the northern to the southern regional zones).

90 Nabiyeva K. (2020). Fostering the energy transition: Prospects for renewable energy and energy efficiency in South East and Eastern Europe, South Caucasus and Central Asia // Friedrich Ebert Stiftung. URL: https://library.fes.de/pdf-files/id-moe/16818.pdf.

# 7 Conclusions

Kazakhstan's electric power system, including generating facilities and transmission and distribution grids, needs comprehensive infrastructure investment. This is true regardless of whether the system continues to focus on coal as a source of electricity or switches to a climate neutrality strategy. It is clear already that in the coming years new investments in thermal power plants, especially those that burn coal, will face a high risk of eventually turning into stranded assets. In Kazakhstan, coal generation is still cheaper than renewable power, but only because almost all coal power plants are more than 30 years old and their initial building costs were paid off long ago, and because of the availability of cheap local coal. However, this situation will not persist indefinitely. Kazakhstan therefore now has both a perfect opportunity and an urgent need to modernise its electric power system through renewable energy development and through efficient integration of RES into the grid.

This prospect looks especially attractive given the fact that solar PV and wind energy are already competitive in many cases in Kazakhstan against the ageing existing thermal fleet. Such a modernisation is also needed to achieve the announced RES targets: a 15% share for RES in generation by 2030 and a 50% share for alternative energy (i.e. RES and nuclear) in generation by 2050. Without these changes, even the integration of 15% of renewable power might prove extremely problematic.

In order to advance Kazakhstan's electric power system modernisation through renewables, the following three areas will need to be addressed.

First, modernisation and further development of the grids is necessary. The western energy zone is isolated from the rest of the system, and the connection between the northern and southern zones is weak. In addition, the plans for high shares of VRES in the power generation need to be taken into consideration in advance, so that the sequence would not be grid expansion following new generation in the usual way, but grid planning and VRES deployment in parallel.

Second, the challenge of increasing energy system flexibility must be met. Kazakhstan has already introduced auctions for flexible gas-fired power plants and hydropower plants, and auctions for RES plus storage are under discussion. There are many other potential sources of flexibility that should be considered as well. Examples of such options include demand side management, flexible biomass/biogas power plants, and grid development to enable the transportation of electric power over greater distances. What is especially important for Kazakhstan, as a country that produces two-thirds of its electric power from coal-fired power plants, is that there are numerous technical possibilities to increase the flexibility of the existing coal fleet, allowing the rapid integration of variable renewables. This should be taken into account when decisions are made on the modernisation of existing power plants or the construction of new coal and gas plants.

Third, Kazakhstan needs a strategy on how to reduce and eventually phase out coal as the dominant basis for power generation. The policy goals adopted, and especially the goal of carbon neutrality by 2060, as well as the fact that Kazakhstan's coal power fleet is over 30 years old, do not leave much scope for building new coal power plants or upgrading the existing ones. As our research shows, if Kazakhstan decides to phase out coal power plants after the end of the standard period of their operation (40 years), there will be only 12 MW of capacity left by 2030, representing just 0.1% of today's fleet. This principle – decommissioning coal power plants after the end of the standard period of their operation – could become the basis for a coal phase-down plan. At the same time, some of the younger coal power plants could be

allowed to stay in operation a little longer if they were upgraded to increase their flexibility and to integrate more variable renewable power.

It is important to note that coal phase-down policies need to address questions of social impact in regions economically dependent on coal, e.g. the city of Ekibastuz and the whole Pavlodar region. Another consideration is that a coal phase-down will lead to the end of extremely cheap electric power and therefore possibly to social unrest. However, electricity price distortions need to be reduced anyway. This may be achieved, for example, through the introduction of targeted support for the most vulnerable categories of energy consumers while at the same time electricity prices are gradually increased.

In summary, Kazakhstan has set demanding long-term energy transition targets, but the challenges that lie ahead are also demanding. There is a need for further analysis of the opportunities for a managed phase-down of coal and phase-in of renewables alongside flexibility options in the power sector. Such an analysis could suggest more concrete measures that may be taken by Kazakhstan to meet the national targets that have been set.

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Agora Energiewende develops scientifically sound, politically feasible ways to ensure the success of the energy transition – in Germany, Europe and the rest of the world. The organisation works independently of economic and partisan interests. Its only commitment is to climate action.

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