# 7. Energy and industrial transitions in Kazakhstan

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Kazakhstan is a hydrocarbon-rich country with large mineral endowments and a unique geopolitical position in the Eurasia region. The country has made a solid commitment to accomplish the national targets in the Paris Agreement and reduce GHG emissions by 15% in 2030 compared to 1990 levels, with a conditional goal to reduce emissions by 25% and achieve carbon neutrality by 2060. The national sovereign fund (Samruk-Kazyna), which owns industrial and commercial firms accounting for about 40% of national GDP, has initiated several energy innovation initiatives to curb emissions and stimulate economic development in its portfolio, contributing to national carbon reduction efforts. This chapter highlights the unique position of Samruk-Kazyna in Kazakhstan to channel capital towards long-term socioeconomic and environmental objectives in a manner that may not be feasible for private investors in similar emerging market economies. Unlike private investors who face pressure to prioritise short-term returns, the long-term value of Samruk-Kazyna's portfolio is intricately tied to climate change and its enduring effects. This linkage presents an opportunity to integrate climate risk into the core of its corporate strategy while also providing an economic foundation for the nation.

## Country context

Kazakhstan is the ninth-largest country in the world by land area, spanning 2.7 million square kilometres of steppe and mountainous landscape. It borders China, Kyrgyzstan, Russia, Turkmenistan and Uzbekistan. With a population of 20 million, it is the second most populous country in Central Asia after Uzbekistan. Along with the other Central Asian countries, Kazakhstan gained independence from the Soviet Union in 1991. Since independence, the country has reoriented towards becoming a market economy. Its GDP has grown steadily at 5% per year on average between 1995 and 2022, reaching a per-capita GDP of around USD 11 500.

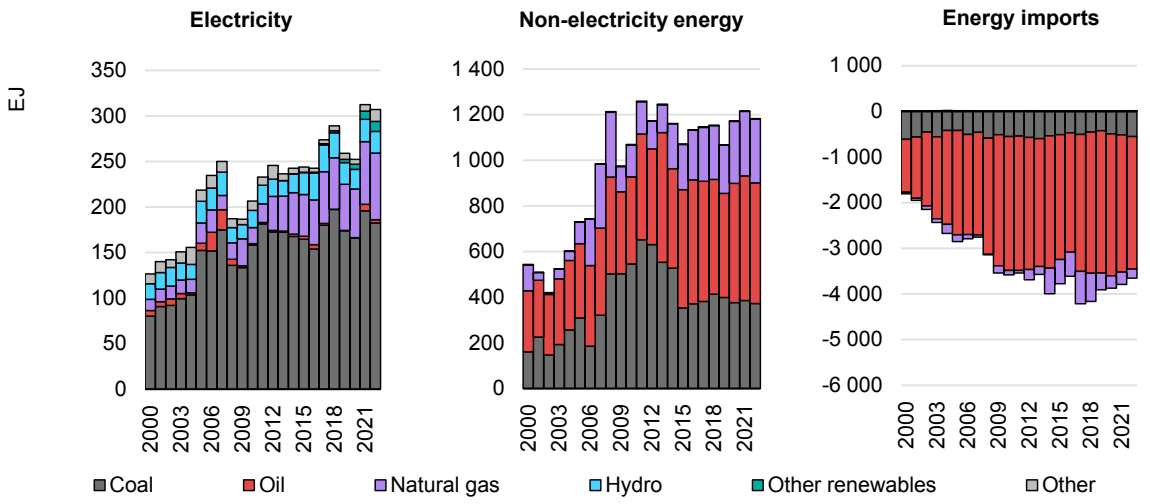
In 2012 the government adopted the Kazakhstan-2050 strategy, prioritising investment and the country's economic outlook. The strategy aims to make Kazakhstan one of the top 30 most developed countries by 2050. To date, growth has been led by extractive industries, including the oil, natural gas and mining sectors, which have enabled it to have a net trade surplus since 1998. Oil and natural gas revenues represent 17% of GDP and mining also represents 17%. However, the outlook for Kazakhstan's oil sector is clouded by uncertainty over whether the Caspian Pipeline Consortium, which carries about 80% of Kazakhstan's oil exports, will continue to be able to transport oil through Russia. Since 2021 inflation has exacerbated economic fragility, reducing export demand, real incomes and foreign direct investment (FDI), thereby weakening the national currency. In response, the government has taken measures to raise FDI and grow the contribution of agriculture, manufacturing and tourism to the economy. These measures include establishing Special Economic Zones (SEZs) across various regions, each equipped with the necessary infrastructure and a special legal regime. Participants in the SEZs benefit from a specific legal framework, entailing exemptions from tax obligations such as corporate profit tax, property tax, social tax, land tax and VAT on goods sold within the SEZ territory. In the global ease of doing business ranking, Kazakhstan ranked 25th out of 190 countries in 2022.

Despite consistent economic growth, there remains an income inequality gap – Kazakhstan's Gini index has been rising since achieving a low of 27 in 2015 and now stands at 29, still much lower than the level of 36 in 2001. Poverty rates have fallen from 35% in 2006 to 9% in 2017. The unemployment rate has also dropped, from 13% in 2000 to 5% in 2020.

## Energy sector context

Kazakhstan is one of the world's biggest fossil fuel producers, extracting roughly 2% of global oil supplies, 1% of global natural gas supplies and 1% of global coal supplies each year. Domestic energy supplies are dominated by fossil fuels, which meet 98% of final energy needs (38% from coal, 36% from oil and 24% from natural gas). Electricity generation in Kazakhstan is 65% from coal, 26% from natural gas and 8% from hydropower. Other renewable electricity sources make up just 3% of the total. Electricity demand has risen broadly in line with economic growth (in purchasing power parity terms) over the decade to 2022, a change in pace compared with the period from 1995 to 2015 when GDP grew four times faster than electricity demand. Some of this growth has been attributed to the emergence of cryptocurrency mining as an economic activity in Kazakhstan, and there are extensive opportunities to improve energy efficiency. Kazakhstan is a net exporter of electricity, but to balance total power supply and demand it has net imports from Russia, which are expected to rise in the near term.

**Figure 7.1 Kazakhstan's energy sources for electricity and other uses, and level of imports, 2000-2021**






Notes: Electricity and non-electricity energy are shown on a final consumption basis. Imports are shown net of exports. "Other" refers to imported or exported electricity.
Source: IEA (2024), World Energy Balances.

The Ministry of Energy is the primary government department responsible for implementing energy policies and supervising and regulating Kazakhstan's energy production and distribution companies.

While electricity transmission and distribution are undertaken by Kazakhstan Electricity Grid Operating Company (KEGOC), a regulated state-owned entity, a competitive market exists for wholesale power supply and most generators are privately owned. Overall, four large companies produce 62% of electricity, with many plants continuing to operate beyond their original design life. The average age of coal-fired power plants in Kazakhstan is 55 years, and that of gas-fired power plants is 40 years, while hydroelectric power plants have an average age of 56 years. The age of the power and heat networks contributes to the high losses that can reach 35% of the energy input. Cost recovery for operating power plants and networks is made more challenging by subsidised consumer tariffs as part of the countries' social policy to ensure affordable energy for all segments of society.

The potential for renewable energy in Kazakhstan is high, but the current share of renewable energy in the total energy mix varies between 1 and 2%. A range of efforts have been made to increase the share of renewable energy and reduce the reliance on coal, starting in 2009 with the Law on Support for the Use of Renewable Energy. In line with these efforts, the Development Concept for the Electric Power Industry of the Republic of Kazakhstan for 2023-2029 outlines a set of target indicators, including the aim to achieve a 12.5% share of electricity from renewable sources by 2029. The Ministry of Energy has also formulated

plans for holding auction trades from 2024 to 2027, with the intention to auction up to 6 720 MW of renewable energy projects by 2027.

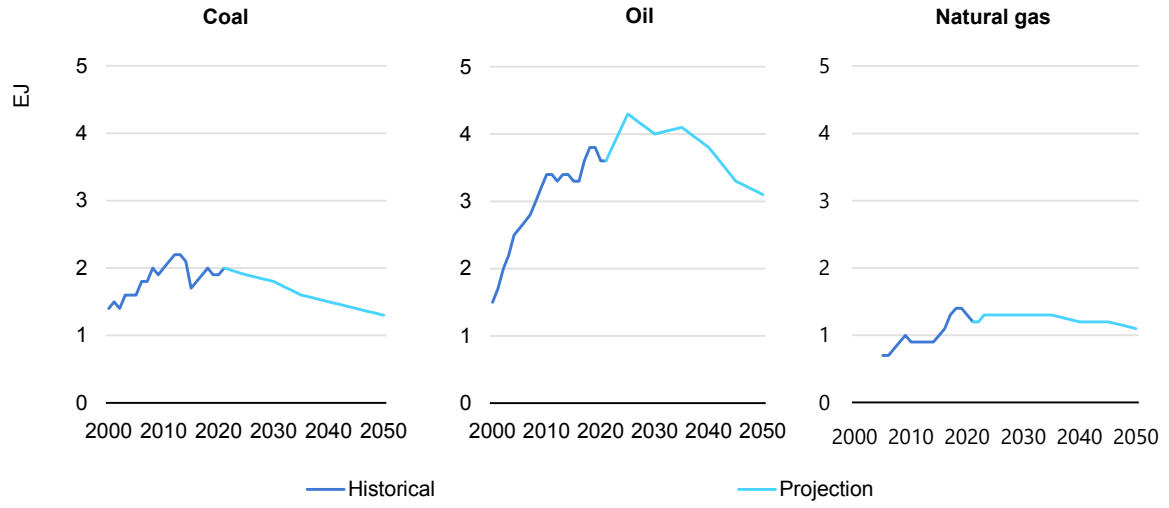
In 2012, as part of the Kazakhstan-2050 strategy, a target was articulated for 50% of total energy consumption to be from alternative and renewable energy sources by 2050. In 2013 a Concept of Transition to a Green Economy was published, and priorities for more efficient use of natural resources were outlined, including modernising energy infrastructure and increasing the use of renewable energy. This policy gave more responsibilities to the Ministry of Ecology and Natural Resources under its accountability for green economy matters, including regulations on emissions, pollution, waste management and environmental impact assessments. For renewable energy, KEGOC is responsible for designing, constructing and operating transmission infrastructure, and collaborates with the Ministry of Energy to identify potential sites for renewable energy projects.

In 2014 two further strategic plans raised ambitions for cleaner energy sources and further diversified ministerial responsibilities in this area. The State Programme of Industrial and Innovative Development for 2015-2019, under the supervision of the Ministry of Industry and Infrastructure Development, set an agenda to enhance energy security, improve environmental security, modernise energy-related infrastructure, adopt novel energy-efficient technologies and reduce energy intensity. The Fuel and Energy Sector until 2030 Concept, overseen by the Ministry of Energy, separately covered a similar agenda. In parallel, the Ministry of National Economy, the Ministry of Investment and Development, the National Bank of Kazakhstan and the Development Bank of Kazakhstan developed the Nurly Zhol programme for the period 2015-2019 to boost trade and encourage economic and trade corridors, including energy

Through a partnership with the United Nations Development Programme (UNDP), financial incentives have been introduced to support environmentally friendly projects in Kazakhstan, and provide technical assistance and capacity building. These mechanisms have been developed in co-operation with partners such as the Astana International Financial Centre Green Finance Centre – a Belt and Road Initiative institution chaired by the President of Kazakhstan – to promote a market for green bonds. To date, progress towards the renewable energy goals has been promising, with the supply of non-hydro renewables growing by 34% per year on average between 2014 and 2021. Chinese investment in Kazakh energy projects has shifted towards renewables from fossil fuels. The cost of solar energy in Kazakhstan was 55% lower in 2020 than in 2014, and the cost of wind energy fell by 14% over the same period. However, renewables only grew from 0.1% of final energy consumption to 0.7% between 2014 and 2020 and are hindered by the influence of hydrocarbon interests in the decision-making process and faltering capital availability due to lower exports and economic growth since 2019.

Spurred by the Russia-Ukraine war, which has highlighted the vulnerabilities of dependence on Russia for access to export markets for fuel, and by Kazakhstan's ratification of the Paris Agreement on climate change, the country's energy planning now focuses on reducing economic reliance on oil and domestic consumption of coal. Policy statements endorse solar, wind and hydropower initiatives and consider nuclear power in the energy mix. Under its climate commitments, Kazakhstan aims to cut all greenhouse gas emissions by 15% by 2030 compared to 1990 levels and reach carbon neutrality by 2060. The government's stated intention is to halve the share of coal in the electricity mix by 2050 (Figure 7.2).

**Figure 7.2 Kazakhstan's annual coal and gas production since 2000, with projection to 2050 based on official government indicators**






Source: SEI et al. (2023), The Production Gap: Phasing down or phasing up? Top fossil fuel producers plan even more extraction despite climate promises as modified by the IEA.

In general, Kazakhstan aims to align as much as possible with the environmental law of the European Union, where much of its exports are shipped. An example of this is the 2021 Environmental Code, which tightens the regulations for large industrial installations. The Environmental Code shares implementation responsibilities among the Ministry of Ecology and Natural Resources and regional and local government authorities.

## Innovation context

Kazakhstan's economy is based mainly on exports of raw materials rather than innovative and high added-value products. The country's innovation and technological development are characterised by:

- A low share of high-tech product exports in the total volume of manufacturing industry exports, amounting to just 6.9% (2021).
- Expenditure on technological innovation amounting to 0.51% (2021).
- A relatively low proportion of registered enterprises in the manufacturing sector that report in surveys that they are engaged in some kind of innovation activity, at 12.9%. (2021).
- A low share of innovative products in GDP at 1.7%. (2021).

These indicators highlight the ongoing challenges in transitioning towards a more innovation-driven economy.

Overall, just 0.1% of GDP is allocated to R&D, in contrast to countries with development aspirations – for instance, average spending on R&D in the OECD countries stood at 2.7% of GDP for the year 2022. It is worth noting that the highest intensity of R&D activity is observed in Japan, Sweden, Austria and Germany, where the corresponding indicators have surpassed 3% of GDP. Kazakhstan also does not demonstrate a high rate of patents, probably due to low R&D expenditure.

The state is the primary investor in scientific research, accounting for 58% of R&D expenditure in Kazakhstan, compared to 33% coming from the private sector. In the past, this reliance on public funds has been enshrined in laws such as that On Commercialisation of Scientific and Technical Activity Results. It is notable that the balance of public and private R&D expenditure is not significantly different in other developed countries. In the case of Australia, for instance, a sparsely populated country with mineral-rich deposits like Kazakhstan, public R&D expenditure stands at 72% of the total and the private sector at 28%. However, Australia devotes the equivalent to 1.8% of its GDP to R&D, which is distinctly higher than Kazakhstan's allocation.

To further encourage private sector investment in R&D and increase collaboration between the public and private sectors, legislation was passed in 2017 that obliges companies in the extractive industries to allocate 1% of their total annual income to R&D. However, despite changes in 2020 to improve accountability and transparency, this obligation has yet to deliver its stated aims of fostering organisational change, technological efficiencies, and increased integration of digital solutions into processes.

The government published a resolution in 2018 entitled Concept of Industrial-Innovative Development of the Republic of Kazakhstan for 2021-2025, which contains targets for the value-added and productivity of the manufacturing sector by 2025. However, the document dropped the target stated in its predecessor of increasing R&D spending from 0.2% of GDP in 2013 to 2% in 2020, and also discontinued a target related to the share of innovative projects and initiatives among all contracts.

It is recognised that additional measures will be required to improve co-ordination among research actors in Kazakhstan and increase the rate of success in translating R&D into scaled-up production. In 2024 the Ministry of Science and Higher Education introduced a new law that seeks to address a range of barriers to a more innovative business culture in Kazakhstan, including the introduction of financial tools, improvements to social conditions for scientists and other non-financial measures. It remains to be seen whether this can help develop more knowledge-intensive firms, improve the availability of human capital for R&D and increase the sharing of information among experts, investors and innovators.

# The case of Kazakhstan's sovereign wealth fund

## Creation of Samruk-Kazyna as a central co-ordinator of economic reform

As a post-Soviet economy, Kazakhstan's institutions have a history of central planning and the close involvement of government in strategic and investment decisions, despite liberalisation measures in recent decades. Shifting to a more dynamic economy has proven challenging for Kazakhstan when such a large share of national wealth is concentrated in a small number of sectors and businesses related to resource extraction. Such concentration tends to create political dependencies in these industries, makes it harder for new entrants to grow market share and exposes the country to fluctuations in commodity prices and geopolitical uncertainty.

To address these challenges, the government devised two typically centralised responses. One was a fund managed by the central bank and accountable to the country's president to manage revenues from natural resources and protect the economy from commodity price cycles. The other was a state-owned holding company to maximise the long-term value and competitiveness of all state-owned enterprises in the global market.

The National Fund of the Republic of Kazakhstan (NFRK) was created by presidential decree in 2000 at a time when the high oil price environment created sufficient political support for the idea. It was initially funded by the returns of 11 hydrocarbon companies and three metal and mineral mining companies, later reduced to six hydrocarbon companies by removing the mining sector. The NFRK was first capitalised by selling the government's share in the TengizChevroil consortium, which operates one of the world's largest oil fields.

The Samruk-Kazyna Sovereign Welfare Fund holding company was created in 2008 from the merger of Samruk (an institution that had been tasked with

preparing state-owned assets for privatisation) and Kazyna (a national fund focused on long-term investments). Initially, Samruk-Kazyna's portfolio included five companies that held monopolies in sectors including the railways, natural gas, electricity distribution, postal services and telecommunications. Since then, 17 more companies from the energy and transport sectors have been added, and Samruk-Kazyna's total assets account for about 40% of the country's GDP (Table 7.1).

**Table 7.1. Selected Kazakh state-owned enterprises controlled by Samruk-Kazyna**

| Company | State ownership share | Business area |
|---|---|---|
| Kazakhstan Temir Zholy | 100 | National railway company |
| KazPost | 100 | National postal company |
| KEGOC | 100 | Kazakhstan electricity grid operating company, subject to natural monopoly regulation |
| QazaqGas | 100 | National gas company |
| Samruk-Energy | 100 | Largest electricity producer in Kazakhstan, which owns the world's largest coal mine and largest CHP plants |
| Samruk-Kazyna Ondeu | 100 | Chemical investment company |
| Tau-Ken Samruk | 100 | National mining company |
| KazMunaygas | 90 | Largest oil and gas company in Kazakhstan |
| KazAtomProm | 75 | The world's largest uranium extractor |
| KazakhTelecom | 52 | National telecom company |
| AirAstana | 51 | The national airline, the largest in Kazakhstan and Central Asia |

Source: Samruk-Kazyna (2021), Portfolio companies.

Samruk-Kazyna has a mandate to develop its subsidiaries and direct investments in line with a long-term national strategy and maintain the national economy in the short term. The portfolio companies have a responsibility to generate revenue, maintain infrastructure and support employment in their sectors while remaining aligned with the overall government vision. As a sovereign wealth fund, it can participate in networks, including the International Forum of Sovereign Wealth Funds and the Extractive Industries Transparency Initiative.

## Responses to a changing national vision for the energy sector

Kazakhstan's dual target to reduce economic reliance on oil exports via Russia and achieve carbon neutrality by 2060 has significantly changed the national energy policy vision. These government objectives emerged into a policy-making environment shaped by the co-ordinating presence of Samruk-Kazyna. In this regard, Samruk-Kazyna faces internal tensions. Its revenues, and those of NFRK, are heavily dependent on hydrocarbons – its firms are collectively responsible for around 13% of Kazakhstan's total $CO_2$ emissions (of which Samruk-Energy is responsible for 70%) – and yet it also possesses unique capacities to implement the necessary technological changes in the country. Given the range of different ministerial actors and responsibilities present in the area of energy sector modernisation, the unifying role of Samruk-Kazyna is a potential strength for co-ordinated decision-making.

To align with Kazakhstan's signing of the Paris Agreement, Samruk-Kazyna adopted a Low-Carbon Development Concept and began disclosing its companies' direct and indirect $CO_2$ emissions (Box 7.1). The companies in the funds' portfolio aim to achieve carbon neutrality by 2060, with a 10% reduction in carbon emissions expected by 2032. These measures affected firms representing 40% of Kazakhstan's GDP in one step.

**Box 7.1 Low-Carbon Development Concept of Samruk-Kazyna**

Published in 2021, Samruk-Kazyna's Low-Carbon Development Concept for energy transitions explores two scenarios and compares them with a business-as-usual baseline. The two scenarios have different levels of emission reductions by 2032, on the way to the 2060 goal. The 50 activities identified in the document have an estimated implementation cost of USD 20-25 billion. For the R&D projects, the costs can be covered by the existing regulation requiring 1% of extractive industries' revenues to be spent on R&D.

Five of the six proposed R&D projects relate to hydrocarbon technologies:

- Coal enrichment and gasification (to be executed by Samruk-Energy).
- Analysis of the possibility of implementing carbon capture, utilisation and storage (CCUS) technologies (the potential for carbon storage tanks) (Samruk-Kazyna).
- Investigation of the possibility of using enhanced rock weathering technology to absorb carbon dioxide (Samruk-Kazyna).
- CCUS pilot project according to the assessment of the potential for $CO_2$ injection to increase oil recovery from developed oil reservoirs (KazMunayGas).

- Investigation of the possibility of implementing the project "Biofuels, including sustainable aviation fuel" (Air Astana).

The non-hydrocarbon-related project is a 5 MW and 20 MWh stationary electricity storage pilot.

The document also publishes the $CO_2$ emissions trends for Samruk-Kazyna and its companies. This aligns with the government's 2021 policy of tightening the existing national emissions trading system (ETS), taxing more of the emissions from processes, goods and services not covered by the ETS and improving monitoring and verification. It is noted that since its establishment in 2013 the ETS has faced some challenges in accounting for production growth and posing risks to the quota market. There are, however, plans to enhance the monitoring and assessment methods for greater effectiveness by also enlarging the number and type of emitters included in the ETS in the coming years. The investment considerations in the document align with the government's intention to create a "taxonomy" of allowable investments consistent with the 2060 goal.

A central pillar of Samruk-Kazyna's strategy for contributing to the government's goals is nuclear power. Kazakhstan has large uranium reserves and plans exist for a 2 800 MW nuclear power plant to be developed by Samruk-Kazyna's nuclear subsidiary, KazAtomProm, in collaboration with international partners such as China National Nuclear Corporation, Korea Hydro & Nuclear Power, ROSATOM and Electricité de France. This would be the country's first commercial nuclear plant since its only Soviet-era power station closed in 1999. Samruk-Kazyna has stated that it considers nuclear to be the lowest-cost means of meeting climate, energy security and social goals and it created a new project company – Kazakhstan Nuclear Power Plants Ltd – to co-ordinate development of multiple nuclear power plants. The affordability of energy for the Kazakh population, reflecting the widespread use of district heating derived from the country's coal power plants, is an especially important consideration in national energy policy.

In the area of renewable energy, Samruk-Kazyna subsidiaries own three wind power plants and plan to expand them further. The Ministry of Energy, together with Samruk-Kazyna and its subsidiary KazMunayGas, signed an agreement for a 1 GW wind farm with French energy company TotalEnergies in 2023. KazMunayGas has also signed an agreement with the Italian energy company ENI to explore joint renewable energy projects to help meet the firm's goal of 300 MW of renewable capacity by 2031. Another Samruk-Kazyna company, Kazakhtelecom, is assessing renewable and other low-emissions options for supplying power to data centres. Samruk-Kazyna's strategic planning indicates that it will also explore a geothermal energy pilot project.

Samruk-Kazyna has also begun considering technologies requiring more innovation and market reform before investment can proceed. Among these are smart grids, CCUS, and hydrogen for use in power generation and vehicles. Samruk-Kazyna companies already produce hydrogen from steam-reforming natural gas, and are now exploring methane pyrolysis as a technology that can replace steam reforming without associated $CO_2$ emissions. However, at present, methane pyrolysis remains in development, with one operational demonstration project in the United States and several pilot plants in development around the world to test a range of competing technological options. Samruk-Kazyna is also considering the use of CCUS to avoid emissions from steam reforming.

Samruk-Kazyna's Low-carbon Development Concept also foresees the continued development of fossil fuels in the period to 2032, something that is not consistent with climate goals. Kazakhstan's coal industry has around 40 000 employees, of which more than 12 000 belong to Samruk-Kazyna companies. Coal transport accounts for 16% of the total domestic freight turnover of the railway industry. Many towns in Kazakhstan are dependent on Samruk-Kazyna coal activities, and concerns about the cost of energy transitions are high following unrest that accompanied higher liquefied petroleum gas (LPG) prices in 2022. In line with the vision for the energy sector prior to the Low-Carbon Development Concept, Samruk-Energy is rehabilitating four coal plants as a means of reducing reliance on electricity imports and does not intend to reverse subsidised electricity tariffs. Also, the company is converting a coal-fired power plant to operate on natural gas and foresees a key role for natural gas-fired power to substitute coal.

Broad plans have been made to implement the Samruk-Energy Green Transformation, under which restructuring of conventional power plants will be conducted and investment will increase the share of renewable electricity supply capacity to 10% by 2025. In support of this initiative and the broader need to increase renewable power in the country, Kazakhstan established a competitive auction system in 2018 to allocate long-term offtake contracts to private sector renewable electricity projects. For the 14 projects totalling 440 MW that were awarded contracts in the 2022 auction, the prices were 50% lower than in prior auctions, something that has been attributed in part to improvements to regulatory framework, infrastructure, and international financial support from the United Nations Development Programme (UNDP) and European Bank for Reconstruction and Development (EBRD). At USD 0.033 per kWh, the awarded tariff is significantly lower than residential and commercial consumer prices, which are USD 0.045 per kWh and USD 0.049 per kWh. Still, this has not yet impacted the profitability of fossil fuel plants, and greater effort is needed to encourage Samruk-Energy and the companies in its portfolio to expand their renewable energy activities.

# Policy choices to address energy innovation priorities

Clean energy technology development features among the objectives of Samruk-Kazyna's strategic plan and the government's Concept of Scientific Development 2022-2026. The strategic plan's scenarios emphasise the importance of technologies such as electric (and natural gas-fuelled) vehicles, electric trains and sustainable aviation fuels for reducing emissions more quickly.

To build the capacity for selecting, testing and improving these technologies, Samruk-Kazyna has taken a lead in co-ordinating projects through its companies. These projects have elements of funding (resource push), capacity building (knowledge management), partnerships with international entities (knowledge management) and involvement of potential customers at large firms (market pull).

## Resource push

Under pressure to modernise and transform its subsidiaries in line with energy transitions, Samruk-Kazyna has significantly reformed its R&D spending strategy since 2021. The reforms include:

- A new structural unit to co-ordinate R&D and improve the sustainability and self-sufficiency of funding.
- Greater transparency of procurement processes used to fund R&D projects, including opening tenders to public bids rather than allocating contracts directly to Samruk-Kazyna companies such as KMG Engineering and the Institute of High Technologies.
- Audits of the funding processes and evaluation of the scientific excellence.
- A first internal corporate R&D planning document with technical and practical instructions on scientific projects, their classification, the decision-making process and other relevant guidelines.
- A new portfolio company focusing on R&D and commercialisation of intellectual property, starting with projects in the areas of CCUS, hydropower and underground coal gasification.

A spur for these reforms was a government decision in 2021 to strip companies in the extractive industries – including the Samruk-Kazyna companies KazAtomProm, KazMunayGas, Samruk-Energy and Qazaq Gas – of their responsibility to choose how to spend the 1% of their revenues that they been obliged since 2017 to spend on R&D. The lack of impactful results of this regulation led the government to allocate the 1% directly to the state budget for allocation to projects by the Ministry of Energy and the Ministry of Industry.

### Socio-political support

Various measures have been taken to increase support for clean energy technologies in Kazakh society. At the highest level of government, President Tokayev has publicly recognised the challenges of climate change and air pollution and made commitments to carbon neutrality. In a meeting with foreign investors, he has emphasised the priority of improving the investment situation for non-extractive and environmentally friendly sectors. The Expo 2017 international exhibition in Astana had a central theme of "Future Energy" and hosted leaders in clean energy and sustainable development, along with various educational and awareness-raising activities.

## Samruk-Kazyna energy innovation initiatives

Samruk-Kazyna's initiatives relating to clean energy R&D and innovation have so far focused on individual large-scale projects, most of which build on the existing expertise of its holding companies in hydrocarbon extraction and processing. They include:

- Underground coal gasification for hydrogen production. Samruk-Energy is funding and operating an R&D project to see if hydrogen can be competitively produced from coal that is hard to mine without extracting the coal from the subsurface. While it has not yet entered a construction phase, it is an ambitious step for Samruk-Energy as the technology has not yet operated at scale anywhere in the world with separation and storage of the resulting $CO_2$ generated by the gasification process.
- A vapour capture system to reduce methane flaring at a natural gas facility. KazMunayGas has launched a pilot project to measure methane and other combustible pollutants at its natural gas sites with a view to developing a system for capturing and selling or using them if possible.
- CCUS and $CO_2$ storage. KazMunayGas has partnered with Shell Kazakhstan to co-operate on CCUS R&D and a possible joint implementation project. This includes assessing two potential $CO_2$ storage reservoirs, which are estimated to be able to store over 40 million tonnes of $CO_2$, but are so far undeveloped. KazMunayGas has also initiated a project on technology to store $CO_2$ while increasing the output of mature oil fields. These efforts are complemented by grants made available by the Ministry of Science and Higher Education in 2023 for geological studies on $CO_2$ storage and scientific work on $CO_2$ absorbents for CCUS.
- Natural gas-fuelled vehicles. KazMunayGas and Kazakhtelecom have been replacing their fleet with vehicles that run on natural gas, including compressed natural gas. Kazakhtelecom plans to convert 30% of its fleet to natural gas by the end of 2024.

- Electric and natural gas trains. Kazakhstan Temir Zholy, the national railway company, plans to pilot battery-powered shunting locomotives and liquefied natural gas (LNG) powered locomotives. Several tens of battery-power locomotives are in testing or construction around the world, and a handful of LNG locomotives already operate in the United States and Europe.
- Sustainable aviation fuel. Air Astana is not yet engaging in R&D projects in this technology area, but it has begun studies to learn more about the options.
- Smart electricity grid technologies. KEGOC has initiated a smart grid project that will assess international experience with digital technologies for power grids, develop a roadmap for their adoption and educate government officials and other stakeholders.

# Findings

It is too early to know whether Samruk-Kazyna's strategy of co-ordinating R&D and developing clean energy technologies that can contribute to future economic growth will bear fruit. However, the ambitious clean energy technology projects under development would probably not exist today if it were not for two key factors:

- The rapidly changing national vision for energy after the signing of the Paris Agreement and commitment to the 2060 carbon neutrality target.
- The ability of a centralised institution like Samruk-Kazyna to formulate a strategic response that aligns closely with this vision and co-ordinates corporate actions in an economy dominated by powerful state-owned enterprises, many of which have significant vested interests in fossil fuels.

By grouping the activities of its state-owned enterprises under a mandate to manage the revenues of its raw materials exports in a way that mitigates the risks of price volatility and short-term decision-making, Kazakhstan also created a platform for climate change action. This has the advantage of closely aligning the goals and management of the energy companies in Samruk-Kazyna with government priorities while reducing transaction and co-ordination costs. Samruk-Kazyna is uniquely placed in Kazakhstan to mobilise capital towards long-term socioeconomic and environmental goals in a way that is not possible for private investors in other similar emerging market economies that are under pressure to prioritise nearer-term returns. The long-term value of Samruk-Kazyna's portfolio is closely linked to climate change and its long-term impacts, making it easier to integrate climate risks into the heart of its corporate strategy. The presence of various companies in different sectors under the control of Samruk-Kazyna has enabled it to act as both developer and potential customer for clean energy R&D and projects, for example by engaging Air Astana and Kazakhtelecom in projects.

The outlook for clean energy in Kazakhstan and the success of Samruk-Kazyna's strategy are linked to the country's strong tradition of stepwise policy planning. Legislative documents and processes underpin a transparent planning process that takes long-term strategies such as Kazakhstan-2050 seriously. Long-term plans align well with short- and medium-term strategies such as the Strategic Development Plan to 2025, five-year programmes, sectoral approaches and subnational development plans. In February 2023 the country's first national low-carbon development strategy was issued to update previous strategy documents in line with the newer targets to reduce $CO_2$ emissions by 2030 and achieve carbon neutrality by 2060.

While Kazakhstan is a frontrunner in Central Asia for developing clean energy innovation policies and has the resources to attract significant foreign direct investment in areas like renewable energy, its experiences in the past decade also highlight some notable challenges and learnings. They indicate areas where Kazakh policy makers might focus their attention in future and how other countries wishing to follow a similar path might design policy measures to accommodate these lessons (Table 7.2).

**Table 7.2. Risks and challenges faced in the implementation of Samruk-Kazyna's clean energy technology plans**

| Area of risk | Description | Types of possible action |
|---|---|---|
| Historic and continued reliance on income from hydrocarbons, metals and mineral exploitation. Carbon lock-in of the labour market and the economy | The technology expertise within Samruk-Kazyna's companies is strongly weighted toward resource extraction and fuels. This creates innovation opportunities in areas such as hydrogen and CCUS, but also a potential technology selection bias. | Map any gaps in human capital for R&D and work closely with universities to ensure they can be closed.<br><br>Seek to ensure that low-emissions energy sources cannot be at a disadvantage due to tariff or regulatory design, compared with more emitting sources.<br><br>Establish consultation processes to listen to different stakeholder views and engage them in the process of scenario design as a means of discussing alternative future paths.<br><br>Communicate clearly how clean energy technology projects will benefit local communities and the economy, and ensure the future of major employers. |
| | The set of institutions that have evolved with the fossil fuel-intensive economic model do not produce sufficient domestic human capital for R&D and deployment of nuclear and renewable energy projects. | |
| | Non-hydro renewable energy sources face higher consumer tariffs than those for fossil fuel and hydropower generation, reducing the perceived market value of new renewable technologies. | |

| Area of risk | Description | Types of possible action |
|---|---|---|
| Historic and continued reliance on income from hydrocarbons, metals and mineral exploitation. Carbon lock-in of the labour market and the economy (continued) | The fossil fuel energy system, especially in relation to coal, is a major employer and Samruk-Kazyna has a duty towards communities that rely heavily on its fossil fuel activities, potentially slowing the pace at which it can transition to cleaner energy. On the other hand, this social awareness can ensure smoother technological change. | |
| | The politics of climate policymaking may focus intensely on how to protect existing industries rather than generate new economic value through innovation. This is observable in extensive current discussions about emissions trading and carbon border adjustments. | |
| Capital constraints | The structure of R&D spending and business ownership in Kazakhstan does not strongly incentivise private spending on energy R&D, yet experience in other countries indicates that innovation can be more effective when public funds catalyse more private innovation spending. | Consider tax incentives for private sector R&D spending and investment in innovative start-ups.<br><br>Continue to make R&D funding publicly open to bidders based on transparent evaluation. |
| | Financial markets and markets for clean energy products are relatively immature in Kazakhstan, which has created some reliance on development banks and other international investors for renewable energy projects. This model has been effective for early-stage developments, but could limit the speed with which the country is able to deploy innovative technologies. | Shore up the regulatory frameworks and incentives to ensure that they can attract private sector investment in clean energy R&D and new-to-Kazakhstan technologies. |
| Institutional co-operation and exchange | There is room for improvement in co-ordinating the various initiatives and parties involved to reduce administrative costs and time required to meet targets. | The Ministry of Science, together with the Ministry of Energy and the Ministry of Infrastructure and Industrial Development, have developed policy tools, such as the Science Law and joint orders, to streamline R&D efforts that align with the low-carbon vision. This could be developed further |
| | A lack of close co-operation between actors could delay innovation activities or make them unnecessarily expensive. New institutions, such as the | |

| Area of risk | Description | Types of possible action |
|---|---|---|
| Institutional co-operation and exchange (continued) | Ministry of Ecology, Geology and Natural Resources, created in 2019, are less well integrated into existing power structures. | with efforts to create industry–academia partnerships and networks and international linkages to experts.<br><br>All relevant ministries could have formal input into the R&D strategies of Samruk-Kazyna and the energy R&D spending of ministries to avoid duplication and set common technology expectations. |
| Monitoring and evaluation | Without the articulation of ex ante objectives and the ex post evaluation of outcomes it is difficult to maximise the effectiveness of energy innovation policies, which often target intangible advances. However, documents such as Samruk-Kazyna's strategic plan, and the government's Concept of Scientific Development 2022-2026 do not include provisions or accountability for monitoring and evaluation.<br><br>There is no formal process for reviewing Samruk-Kazyna against its climate or long-term strategic goals, creating a risk that its performance might be judged only by short-term financial performance. This is a well-debated issue on the role of sovereign wealth funds in financing the energy transition. | Establish systems for setting policy objectives in line with ex ante impact assessments and assign responsibility for evaluation at various stages of implementation.<br><br>Engage with international partners to understand the options for innovation policy evaluation.<br><br>Increase the level of knowledge of and data available on new technologies from the public and private sectors (including internationally) to address information asymmetries and enable ex ante and ex post impact assessments to help guide Samruk-Kazyna's technology spending. |
| Centralisation of decision making | Samruk-Kazyna has significant potential as a co-ordinating entity aligned with the government's long-term priorities, but centralisation also carries risks of politicised and rigid investment decisions. A lack of distinction between governing and overseeing bodies can reduce transparency and accountability. When the entity setting the goals is also responsible for meeting them and they are not legally enshrined, long-term objectives can become subordinated to | Samruk-Kazyna could explore partnerships with private sector firms, innovation incubators, and national and international organisations, for example on pilot projects.<br><br>Mechanisms that combine small investments by public and private actors into larger investment projects might help scale up innovative technologies and increase collaboration. |

| Area of risk | Description | Types of possible action |
|---|---|---|
| Centralisation of decision making (continued) | near-term pressures relating to prices or job security. | |
| | Innovation often stems from competitive forces and market opportunities, which can be hindered by highly centralised control and interdependency of the key companies in the markets. | |
| Infrastructure | The absence or poor quality of critical infrastructure can significantly hinder clean energy innovation, and the government typically needs to guide and facilitate investment in this area. | Any expectations for the development of coal gasification, CCUS, smart grids or hydrogen will need to match reasonable expectations for the availability of associated pipelines and networks. |

Kazakhstan's approach to fostering clean energy innovation via Samruk-Kazyna can provide valuable insights for other emerging market and developing economies facing the challenges of energy transition and carbon lock-in. This is especially the case for resource-rich countries that face tensions between maintaining revenues from fossil fuels and grasping the opportunities presented by clean energy technologies in markets that disadvantage $CO_2$-emitting activities. The experience of Samruk-Kazyna indicates one approach to using revenues from depletable resources to invest in clean energy technologies that align with a strong government vision of a clean energy future. The case study demonstrates how policy can build upon existing strengths, existing socio-economic conditions and evolving institutional and economic trends. It also highlights challenges with such an approach (e.g. administrative costs, co-ordination issues and principal–agent problems) that are likely to need to be addressed before it yields success.