Assessment Report on Classification of Energy and Mineral Resources and its Management in the Republic of Kazakhstan

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Executive Summary

The report of the researchers of the Institute of Hydrogeology and Geoecology named after U.M. Akhmedsafin gives a review of energy and mineral resources of the Republic of Kazakhstan. The report shows their role in the economy of the country, as well as the role of the state for resource management, based on the current legislation in the area of exploitation of natural resources and environment protection. The report describes counteracting measures of the state against the global economy crisis events. It also reviews the existing classification systems of mineral resources of the country. Statistics on energy production and extraction of mineral resources are provided. Besides, the report considers social and ecological aspects of energy production and extraction of mineral resources. It provides data on the development of non-traditional renewable energy resources and the results of scientific research in this area, as well as information about the training system for technical and scientific staff and about the state of energy and natural resource management system of the country.

Introduction

The Republic of Kazakhstan is located almost in the middle of the Eurasian continent. Kazakhstan shares borders with the Russian Federation in the north, north-west and north-east, with China in the south-east, with Uzbekistan in the south-west, and with the Kyrgyz Republic in the south. The area of the country within its present borders is 2,794.9 thousand km^2. By its administrative-territorial structure, Kazakhstan is divided into 14 regions and 3 cities of national significance. The cities of national significance are Nur-Sultan, the capital of the country, Almaty and Shymkent, which have a population of over 1,000,000 people. As of the beginning of 2019 the population of Kazakhstan was 18.7 mln people.

Kazakhstan is a land of complex and various terrains: about 10% of its territory are high mountains, the rest of the territory are lowlands, plains, plateaus and highlands. The terrain of south-west, north and central regions is mainly flat with small altitudes up to 200-300 m above sea level. There are mountains in the south-east of the Republic. Their peaks are 5-6 thousand meters above sea level. The highest point of Kazakhstan is located in Tian Shan mountain system, it is Khan Tengri peak (its height is 6995 m). The terrain of Kazakhstan is shown in the physiographic map, presented in Annex I. Inland basins (Caspian Sea, Aral Sea, Lake Balkhash), deep depressions and dry basins are common in the terrain of Kazakhstan.

The climate of Kazakhstan is arid, except the south-east and east mountain regions. The average temperature in January is from -18°C in the north and east of the country to -3°C in the southernmost part. The average temperature in July is from +19°C in the north to +28°C, +30° C in the south. The continental character of the climate of Kazakhstan increases from the west to the east and from the south to the north. The average January temperature in the flat part of the territory is -17°C in the north and -1°C in the south. The average July temperature is +19°C in the north and +30°C in the south. The average annual temperature is about 8°C in the north and +14°C in the southernmost part. Winter is long and cold in the north. In some years the temperature can go below -52°C, but there can be also thaw periods, when the temperature goes up to + 5°C. The highest temperature is not more than +41°C in the north and +49°C in the south.

The territory of Kazakhstan is located in four climatic zones, such as forest-steppe, steppe, semi desert, and desert. Flat lands with the highest moisture content of the north part of the country belong to the forest-steppe zone. The shortest season is spring, which lasts 1.5 month, summer lasts 3 months, and winter lasts from October to April. A big territory in the north of the country is located in the steppe zone. There are strong winds in this area.

The geographical position of Kazakhstan determines significant differences of climate conditions between north and south regions, and central, west and east regions as well. This heterogeneity is more noticeable in winter, when the territory of Kazakhstan is under the influence of the western extension of the Siberian anticyclone. In summer, thermal depression is formed in the territory of Kazakhstan, because of warming of the underlying surface. In the mid-seasons south cyclones pass through the territory of Kazakhstan, and they determine the weather changeability.

The high-pressure axis stays along the 50^{th} parallel above the territory of Kazakhstan most time of the year. This high-pressure belt is often formed due to the merging of the western extension of the Siberian anticyclone with the eastern extension of the Azores anticyclone. Therefore, anticyclonic weather is very common in Kazakhstan, except northernmost and south regions. The annual quantity of precipitation in the flat territory is 350 mm in the north and 100 mm in the south. There are minimum quantities of precipitation (100-125 mm) in Aral Kyzyl Kum and near Lake Balkhash. The annual quantity of precipitation in the mountain regions of Tian Shan is within the wide range from 400 to 900 mm, depending on the altitude above sea level and slope exposure. The annual quantity of precipitation is up to 1000 mm on the western slopes of Altay, while the eastern slopes are still dry. The annual quantity of precipitation goes up in the altitudes of 1800-2000 m above sea level, and it goes down slowly as the altitude exceeds this level.

Role of energy and minerals production in national economy

Kazakhstan is very rich in mineral resources. Oil, coal, various ore and non-metallic deposits are the priceless treasure of the republic. Some of these mineral resources make Kazakhstan famous in the world. They include chrome iron ore deposits, polymetallic deposits, copper, tungsten, molybdenum and uranium ores. The location of main deposits is shown in Annex II [1]. The location of main fuel and energy complex enterprises is shown in Annex III.

Kazakhstan takes the first place in the world on developed reserves of zinc, tungsten and barytes, the second place on copper and fluorite reserves, the third place on manganese reserves, the forth place on molybdenum reserves, and it is among top ten countries with the largest gold reserves.

Our country possesses 10% of the world reserves of iron ore and 25% of the world uranium reserves. Kazakhstan ranks the 13th position in the list of countries with the developed oil reserves.

The mining sector provides over 30% of GDP and constitutes over 60% of industrial production.

The oil sector is the most important segment of the country's economy. The share of the oil sector comprises almost 25% of the general structure of GDP.

Revenues of the oil sector provide a half of all fiscal revenues of the country.

Almost 70% of all export of the country in value terms is export of oil and gas condensate, a significant share of the tax on extraction of mineral resources (85%).

One of the most important resources of Kazakhstan is groundwater. 2905 groundwater deposits and groundwater sites for different purposes have been developed in Kazakhstan.

Total operational reserves of groundwater are: 42,765.16 thousand m^3 per day (15.60 km^3 per year), or about 24% of forecast resources with mineralization up to 10 g per litre – 176,105 thousand m^3 per day (64.28 km^3 per year), and 38% of forecast resources with mineralization up to 1 g per litre – 110,789 thousand m^3 per day (40.44 km^3 per year). The reserves of fresh water are 36,892.60 thousand m^3 per day (13.19 km^3 per year), or 86% of the total volume.

The distribution of forecast operational reserves of groundwater in Kazakhstan is shown in Annex IV.

Government policies and programmes in energy and mineral resources

According to the Constitution, adopted by the national referendum on August 30, 1995, the Republic of Kazakhstan is a unitary, democratic, secular, legal and social state with a presidential form of government. It has three independent branches of power, that is, executive, legislative and judicial. The highest values of the government are the individual, his rights and freedom.

The President of the Republic of Kazakhstan is the head of the state, its highest-ranking official; he determines the main objectives of domestic and foreign policy of the state and represents Kazakhstan at home and abroad. The President of the Republic of Kazakhstan is a symbol and guarantor of the unity of the people and the state's power, the inviolability of the Constitution and the rights and freedoms of the individual and the citizen. The President of the Republic of Kazakhstan ensures coordinated operation of all branches of the state power and their responsibility to the people. The President is elected for a 5-year term, he must be at least 40 years old, must have lived in Kazakhstan for at least 10 years, must be fluent in the official language (Kazakh).

The Government holds executive power in the Republic of Kazakhstan.

The Government heads the system of executive bodies and supervises their activity. The Government is a collegiate body, and it is responsible to the President for all its activities. In some cases, prescribed by the Constitution, the Government is responsible to the Majilis of the Parliament and the Parliament. The

Members of the Government report to the houses of the Parliament in the case, prescribed by sub-paragraph 6 of article 57 of the Constitution.

The Government is formed by the President of the Republic of Kazakhstan, as prescribed by the Constitution.

The bicameral Parliament holds the legislative power.

The Parliament of the Republic of Kazakhstan is the highest representative body of the Republic, which performs legislative functions. The Parliament is constituted of two houses, that is, the Senate and the Majilis, working on a regular basis. The Senate is composed of deputies, as prescribed by the Constitution. Two deputies are sent from each region, each city of national significance and the capital of the Republic of Kazakhstan. Fifteen Senate deputies are appointed by the President of the Republic in order to ensure that all societal interests and groups are adequately represented.

The Majilis consists of 107 deputies. They are elected as prescribed by the Constitution. A deputy of the Parliament cannot be a member of both houses at the same time.

Deputies of the Senate are elected for a six-year term. Deputies of the Majilis are elected for a 5-year term.

The legislative power is actually controlled by the President. The Government reports to the President, not to the Parliament (see legislative acts, regulating the relations in the area of energy and natural resources, below).

The Constitutional Court and the system of local courts hold judicial power.

Justice in the Republic of Kazakhstan is administered only by the court. Judicial power is exercised through civil, criminal and other forms of legal proceedings, established by law. In some cases, prescribed by law, criminal proceedings are conducted with the participation of jurors. The courts of the Republic are the Supreme Court of the Republic, local and other courts of the Republic, established by law. The judicial system of the Republic is established by the Constitution of the Republic and the constitutional law. It is prohibited to establish any special and emergency courts under any name.

Judicial power is exercised on behalf of the Republic of Kazakhstan; and its purpose is protection of rights, freedoms and legitimate interests of citizens and organizations, enforcement of the Constitution, laws, other normative legal acts, international treaties of the Republic. Judicial power extends to all cases and disputes arising on the basis of the Constitution, laws, other regulatory legal acts, international treaties of the Republic. Decisions, sentences and other rulings of courts are binding throughout the territory of the Republic [3].

The Government of the Republic of Kazakhstan develops and determines the main directions of the state policy on electrical energy and mineral resources.

The Ministry of Energy of the Republic of Kazakhstan conducts the management in the area of electrical energy.

The Committee on Atomic and Energy Supervision and Control of the Ministry of Energy of the Republic of Kazakhstan carries out supervision and control in the area of electrical energy.

The Committee on Regulation of Natural Monopolies, Protection of Competition of the Ministry of National Economy of the Republic of Kazakhstan is a state body that conducts management of competition protection, restricts monopoly activities on certain markets, controls and regulates the activities, related to the state monopoly, in accordance with the legislation of the Republic of Kazakhstan. The Committee also provides cross-sector coordination, regulation and control of the activities of natural monopolies on the regulated markets, to the extent permitted by the legislation of the Republic of Kazakhstan. It also controls and regulates the activities of energy-producing and energy-supplying organizations in accordance with the

Law of the Republic of Kazakhstan "On Electrical Energy". Other special executive, permitting and controlling functions are also performed by the Committee.

The National Welfare Fund Samruk-Kazyna JSC conducts the management of revenues. The National Welfare Fund Samruk-Kazyna JSC is a state holding company, which owns and manages national companies in different sectors of the economy, including electrical energy, telecommunication, transport and national institutes of development. The National Welfare Fund Samruk-Kazyna JSC was established to increase the competitive ability and stability of the national economy, as well as to prevent possible negative influence of global markets on the economic growth in the country.

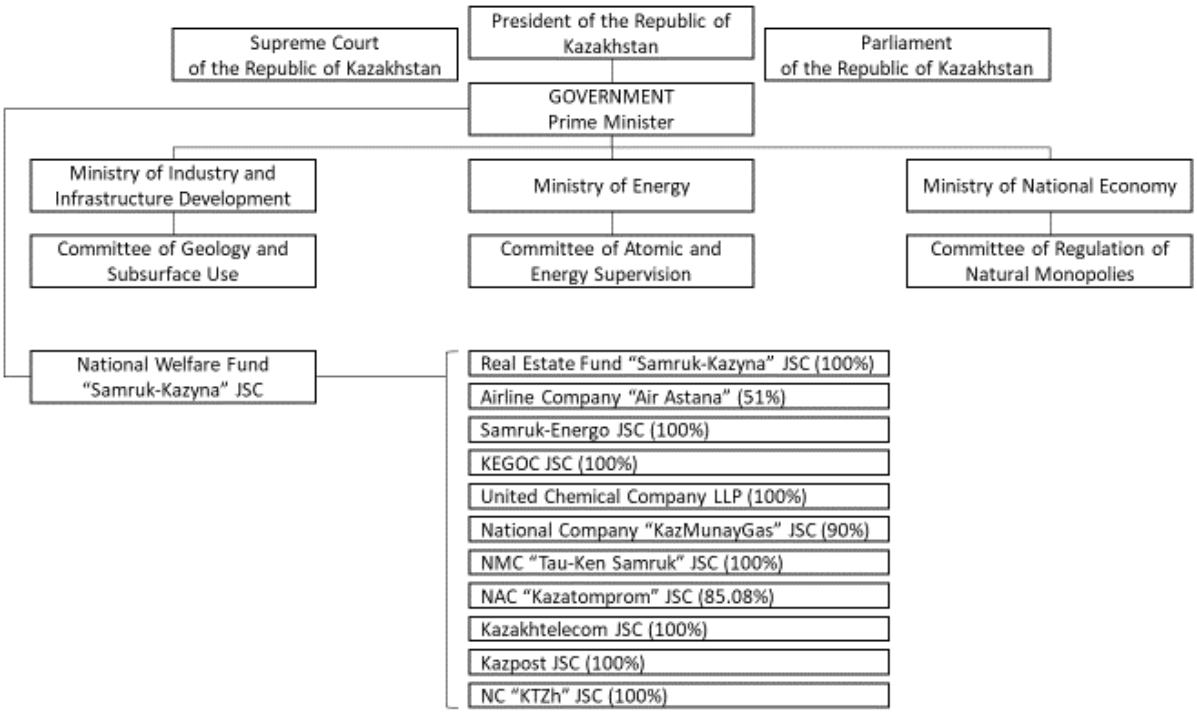
The main purpose of the activities of the Fund is to conduct the management of blocks of shares (shares of participation), which it owns on the right of ownership, of national institutes of development, national companies and other legal entities, in order to maximize their long-term value and to increase their competitive ability in global markets. The Fund owns the following portfolio companies:

- AirAstana JSC, (51% of shares);
- Real Estate Fund Samruk-Kazyna JSC was established on March 6, 2009. The sole shareholder of the Real Estate Fund is Samruk-Kazyna JSC. The Real Estate Fund is an operator of an anti-crisis program NurlyZher.
- Samruk-Energo JSC is the biggest multi-industry energy holding company, successfully integrated in the international balance of energy, which creates value for its shareholders. It is aimed at formation of a high-performance system of energy supply, which will ensure stable development of all industries of Kazakhstan. The sole shareholder of Samruk-Energo JSC is the National Welfare Fund Samruk-Kazyna JSC.
- KEGOC JSC, Kazakhstan Electricity Grid Operating Company Joint-Stock Company, is a subsidiary company of Samruk-Kazyna JSC. It was established on September 28, 1996, by the decision No.1188 of the Government of the Republic of Kazakhstan "On some measures of reconstruction of the energy system management of the Republic of Kazakhstan".
- United Chemical Company LLP (100% of shares).
- National Company KazMunayGaz JSC is a Kazakhstani operator of exploration, production, processing and transportation of hydrocarbons, representing the interests of the state in the oil and gas industry of Kazakhstan (90% of shares). The group of companies of National Company KazMunayGas JSC, founded in 2002, includes more than 190 organizations.
- National Mining Company Tau-Ken Samruk JSC is the national mining company. 100% of shares of NMC Tau-Ken Samruk JSC are owned by the National Welfare Fund Samruk-Kazyna JSC.
- National Atomic Company Kazatomprom JSC is the national operator of the Republic of Kazakhstan for import and export of uranium, rare metals, nuclear fuel for nuclear power plants. Since 2009, Kazakhstan has been the world leader in natural uranium mining. The assets of the national atomic company include the whole complex of enterprises, involved in the chain of production of final products, that is, from exploration, uranium mining, production of nuclear fuel cycle to science, social security and training of staff. National Welfare Fund Samruk-Kazyna JSC owns 85.08% of shares.
- Kazakhtelecom JSC is the largest telecommunications company in Kazakhstan, and it has the status of a national telecommunications operator.
- Kazpost JSC is the postal operator of the Republic of Kazakhstan. It represents the Postal Administration of Kazakhstan in the Universal Postal Union, and it is one of the basic elements of the national infrastructure. The sole shareholder is the National Welfare Fund Samruk-Kazyna JSC.
- NC KTZ JSC, National Company Kazakhstan Temirzholy, is a national transport and logistics holding company, which provides infrastructure for growth of national economy and development of

transport and logistics system of Kazakhstan. The sole shareholder of NC KTZ JSC is the National Welfare Fund Samruk-Kazyna JSC.

The described structure is presented in Figure 1.

Figure 1 – Structure of the state hierarchy, including regulation of subsoil use



Legal basis for development of energy and mineral resources is determined by the legislation of the Republic of Kazakhstan. Main legislative acts, regulating the relations in the area of energy and natural resources are:

1. The Code of the Republic of Kazakhstan ON SUBSURFACE AND SUBSURFACE USE (with amendments and additions dated May 24, 2018). The aim of the Code is to ensure the sustainable development of the mineral resources base of the Republic of Kazakhstan for the economic growth of the state and the welfare of the society. The tasks of the Code are:
   1) protection of the state ownership of the subsurface;
   2) implementation of the state policy and regulation of relations in the field of subsurface use;
   3) protection of interests of the state, citizens of the Republic of Kazakhstan and the rights of subsurface users;
   4) ensuring the growth of the mineral resource base of the Republic of Kazakhstan;
   5) establishing the grounds, conditions and procedure for the emergence, implementation, modification and termination of rights of subsurface use;
   6) provision of the legal framework for the sustainable development of subsurface use;
   7) creating the conditions for attracting investments for the geological study of the subsurface and subsurface use;
   8) strengthening the rule of law in the field of subsurface use.

   Legal regulation of relations in the field of subsurface use is based on the following principles:

   1) the principle of rational management of the state fund of subsurface resources;
   2) the principle of ensuring environmental safety when using subsurface;
   3) the principles of availability of information in the field of subsurface use;
   4) the principle of payment for subsurface use;
   5) the principle of conscientiousness of subsurface users;

6) the principle of stability of conditions of subsurface use.

2. THE ECOLOGICAL CODE OF THE REPUBLIC OF KAZAKHSTAN (with amendments and additions dated April 11, 2019). regulates the protection, restoration and preservation of the environment, the use and restoration of natural resources in economic and other activities related to the use of natural resources and the impact on the environment within the territory of the Republic of Kazakhstan. The main tasks of the Ecological Code of the Republic of Kazakhstan are:
   1)) ensuring the sustainable development of the Republic of Kazakhstan;
   2) ensuring the environmental security;
   3) ensuring the ecosystem approach to regulation of ecological relations;
   4) state regulation in the field of environmental protection and state management in the field of the use of natural resources;
   5) ensuring implementation of compulsory measures to prevent pollution of the environment and any harm to it;
   6) ensuring responsibility for violation of the environmental legislation of the Republic of Kazakhstan;
   7) ensuring compulsory compensation for damage caused to the environment;
   8) ensuring a fee-paying and permissive procedure for the environmental impact;
   9) ensuring the use of the best environmentally friendly and resource-saving technologies when using natural resources and impacting the environment;
   10) cooperation, coordination and publicity of the activities of state bodies on the environmental protection;
   11) encouraging natural resource users to prevent, reduce and eliminate environmental pollution, to reduce waste, etc.
3. THE LAND CODE OF THE REPUBLIC OF KAZAKHSTAN (with amendments and additions dated April 3, 2019). The tasks of the Land Code of the Republic of Kazakhstan are: establishing the grounds, conditions and limits for the emergence, modification and termination of the right of ownership to a land plot and of the land use right; establishing the procedure for exercising the rights and obligations of land owners and land users; regulation of land relations in order to ensure the rational use and protection of land, the recovery of soil fertility, the preservation and improvement of the environment; creating conditions for the equitable development of all forms of farming; the protection of land rights of individuals and legal entities and the state; the creation and development of the real estate market; strengthening the rule of law in the field of land relations.
4. THE WATER CODE OF THE REPUBLIC OF KAZAKHSTAN (with amendments and additions dated April 19, 2018). The tasks of the Water Code of the Republic of Kazakhstan are: the achievement and maintenance of the environmentally safe and economically optimal water use and protection of water resources, water supply and water disposal in order to maintain and improve the living conditions of the population and the environment.
5. THE CONCEPT FOR THE DEVELOPMENT OF THE FUEL AND ENERGY COMPLEX OF THE REPUBLIC OF KAZAKHSTAN UNTIL 2030 is approved by the Government of the Republic of Kazakhstan in order to develop the fuel and energy complex (FEC) and improve the efficiency of use of energy resources. The main tasks of the FEC are:
   1) modernization and construction of new assets for generation and transmission of electrical energy and heat, oil processing;
   2) development of domestic energy and fuel markets, the consistent liberalization and development of competition;
   3) intensification of exploration by attracting investment;
   4) modernization of industry and transport, the implementation of modern technologies in order to improve the efficiency of energy sources and to reduce the negative impact on the environment;

5) development of technologies and infrastructure for alternative types of energy sources: renewable energy sources (RES), nuclear energy, processing of oil-associated gas, gas transportation, coal-chemical production;
6) promoting the integration of the Republic of Kazakhstan into international associations; creating a common energy market within the Common Economic Space.

6. THE CONCEPT FOR DEVELOPMENT OF THE GEOLOGICAL INDUSTRY OF THE REPUBLIC OF KAZAKHSTAN UNTIL 2030 is aimed at development of the geological industry. The main tasks of the geological industry are:
   1) improvement of the state system of program-target planning and conducting geological exploration works; the consideration of possibility to finance early and, accordingly, riskier regional and prospecting stages of exploration of solid minerals, hydrocarbons and groundwater by the state;
   2) improvement of the legal framework and the technical regulatory framework in order to increase investment attractiveness for implementation of innovative technologies for the geological study of the subsurface and reproduction of the mineral resource base, for the development of the equal competition environment;
   3) development of public-private partnership mechanisms by attracting the world's leading exploration, mining and oil-producing companies to participate in the implementation of projects on the state geological study of the subsurface;
   4) development of infrastructure in the field of development and implementation of innovative technologies in the geological industry;
   5) providing manpower for the geological industry.

Classification and management framework for energy and mineral reserves/resources

Currently, Kazakhstan is taking an important step, which is motivated by the current situation and global economy, that is, transition from classifications of the State Commission on Mineral Reserves to international systems, such as CRIRSCO (Committee for Mineral Reserves International Reporting Standards) for solid minerals, and SPE-PRMS (Society of Petroleum Engineers-Petroleum Resources Management System) for raw hydrocarbon reserves [4].

The State Commission on Mineral Reserves (SCR) was founded in 1927 in order to create a unified metering system of developed reserves and to ensure an objective assessment of mineral reserves at the country level.

According to the classification of SCR, reserves and resources are divided into five main classes and marked with symbols A, B, C_1, C_2 and P_1, P_2 and P_3, depending on the level of reliability of geological survey data [5,6,7].

The SCR classification has been improved many times, but at the present moment it remains incomprehensible for international specialists, and it is not accepted by stock markets, which is an obstacle to attracting foreign investments.

The legal basis for start of works in this direction is the 74th step of the Nation's plan – 100 specific steps", which involves increasing of transparency and predictability of subsurface resources management by implementation of CRIRSCO, an international system of reporting standards for mineral reserves [8].

Solid minerals

In 2015, thanks to the 74th step of the "Nation's plan – 100 specific steps", the Public Association "Professional association of independent experts of subsurface PONEN" and Association of Legal Entities KAZRC were established. They developed Kazakhstani Code of public reporting on the results of geological

surveys, on mineral resources and mineral reserves KAZRC [9]; and in 2016 Kazakhstan became the CRIRSCO 10th member.

As of today, the following countries and/or regions (names of reporting codes) are members of CRIRSCO: Canada (CIM), Australia and New Zealand (JORC), the European Union (PERC), the USA (SME), the RSA (SAMREC), Russia (NAEN), Chili (IMEC), Mongolia (MPIGM), Brazil (CBRR), Kazakhstan (KAZRC), Turkey (UMREK), Columbia (CCRR), Indonesia (KCMI) [10].

Since June 28, 2011 any submission of reports should be done in accordance with the Kazakhstani Code of Public Reporting KAZRC. This requirement is stipulated by the Code of the Republic of Kazakhstan named "On Subsurface and Subsurface Use" [11].

As for the SCR system, it will be effective in the transition period, which will last up to January 1, 2024 [11].

Classification of resources and reserves by CRIRSCO pattern (including KAZRC Code) is illustrated in Figure 2; estimated interrelation between resources and reserves of solid minerals, according to the standards of CRIRSCO and SCR, is shown in Table 1 [12].

Figure 2 – Classification of resources and reserves by CRIRSCO pattern (including KAZRC Code)

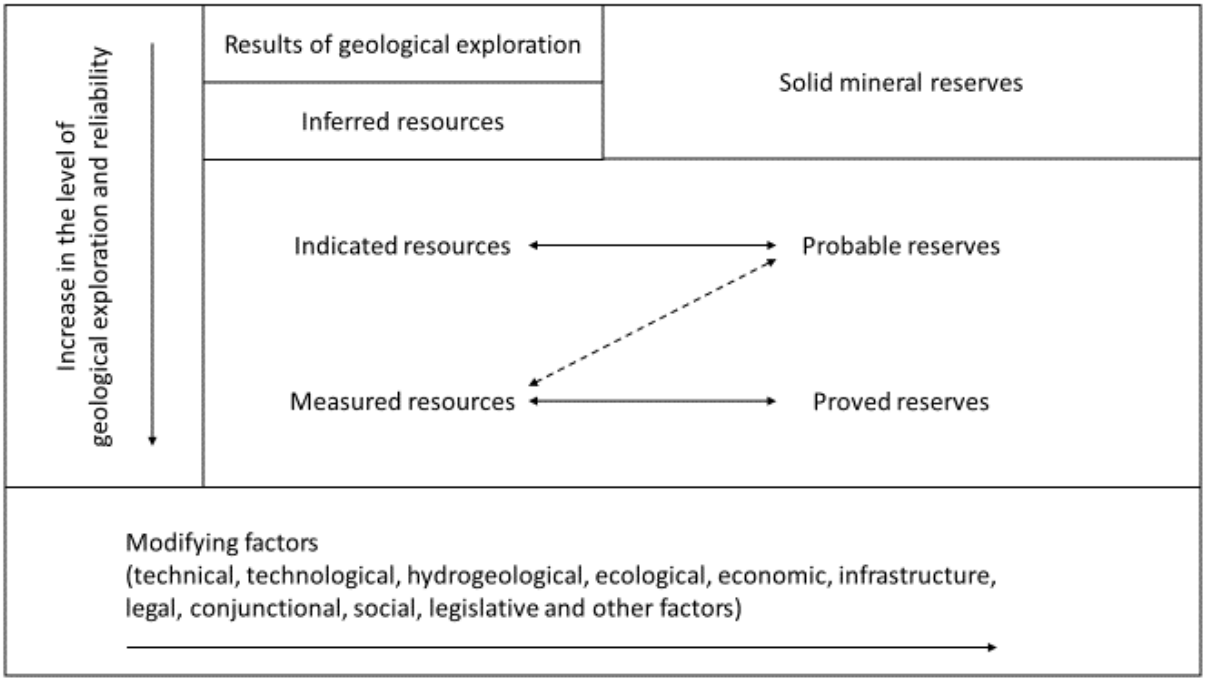


Table 1 – Estimated interrelation between resources and reserves of solid minerals, according to the standards of CRIRSCO and SCR

Mineral resources CRIRSCO	Resources and reserves SCR	Mineral reserves CRIRSCO	Operational reserves SCR
Inferred	P1 forecast resources		
Indicated	C2 reserves of all deposits of all complexity groups and C1 reserves of deposits of the third group	Probable	Operational reserves of inferred deposits
Measured	C1 reserves of deposits of all complexity groups and A and B reserves of deposits of the first and the second groups	Proven	Operational reserves of developed deposits

Raw hydrocarbons

The use of SPE-PRMS system is not stipulated by the law, however, on the official website of the Committee on Geology and Subsurface Use of the Ministry of Industry and Infrastructure Development of the Republic of Kazakhstan [4] there is information about the transition to the international system of reporting standards SPE-PRMS for raw hydrocarbons, which is recommended by consultants of Lloyd's Register and Adam Smith International group of companies.

It was preceded by work of the abovementioned consultants, funded by the European Bank of Development and Reconstruction, on harmonization of Kazakhstani regulations in subsurface use, preparation of geological survey reporting, assessment of mineral resources and reserves in line with international reporting standards.

Alongside with transition, it is planned to implement the Central Commission on hydrocarbon reserves on January 1, 2024 [11].

Groundwater

The classification system of groundwater has not been changed. The possible reason is that there is no unified system of classification of groundwater reserves.

The existing United Nations Framework Classification (UNFC) includes only geothermal resources [13].

UNFC was developed under the authority of the UN European Economic Commission, and its common aim is to develop an international classification system for energy and mineral resources, reporting and management standards. Although at first UNFC was developed for mineral and oil and gas sectors, renewable energy has also been included in the classification; and the classification has become more widely used recently.

The foundations of UNFC are the fossil energy and mineral reserves and resources of 2009 (UNFC 2009) [17] are three fundamental criteria:

- Economic and social viability of the project (E)
- Status and validity of a field development project (F)
- Geological exploration (G)

A comparison of the classification of the Republic of Kazakhstan and UNFC-2009 is given in Table 2.

Table 2 – Comparison of the classification of the Republic of Kazakhstan and UNFC-2009

	Kazakhstan category system	UNFC-2009 categories	UNFC-2009 class
Reserves	A, B, C1	E1, F1, G1, G2, G3	Commercial projects
	C1, C2	E2, F2, G1, G2, G3	Potentially commercial projects
Resources	C2, C3	E3, F3, G1, G2, G3	Non-profit projects
	P1, P2, P3	E3, F3, G4	Exploration projects

As of today, some European countries, Australia, New Zealand, the Russian Federation and the Philippines conduct assessment of geothermal energy resources, using UNFC.

SCR classification is used in the Republic of Kazakhstan (similar to the Russian Federation); the commission on groundwater reserves has been named as the State Commission on Subsurface Examination (SCSE), since the Code came into force in 2018 [11].

Moreover, since the Code of the Republic of Kazakhstan "On Subsurface and Subsurface Use" came into force, the period of examination has been shortened significantly (by 40%) [14, 15]; registration procedures of production document have been simplified, the period of registration has been shortened [11, 16].

Taking the above mentioned into consideration, one can state that significant changes of the legislation have been implemented in order to attract foreign investments and to reinforce the mineral resources base; and the advanced Australian model was taken as a basis.

Energy and mineral resource endowments

Kazakhstan is very rich in mineral resources; it joins the group of world leaders for the diversity of mineral resources (Table 3).

Table 3 – Mineral resources of the Republic of Kazakhstan

Natural resource	Number of deposits	Reserves	World ranking
Gold, thousand tons	349	2.3	15
Silver, thousand tons	195	49	2
Copper, mln tons	124	40	3
Lead, mln tons	93	15.5	3
Zinc, mln tons	90	32	4
Iron, mln tons	63	20	8
Chromium, mln tons	17	355	1
Manganese, mln tons	42	677	3
Molybdenum	51	1.1	4
Uranium, thousand tons	56	903	2
Oil, bln tons	249	4.6	12
Gas, trln m^3	252	1.7	19

According to the US Geological Survey, the share of mineral resources of Kazakhstan in the world mineral complex in percentage is as follows: chromium - 48%, lead - 13.84%, uranium - 12%, zinc - 11%, molybdenum - 9 %, silver - 5.7%, copper - 4.3%, gold - 2% and iron - 1.5%.

Annual production, trade, review of current status and outlook

Oil

The volume of oil production in Kazakhstan is going up in recent years, due to the development of Kashagan deposit. In 2017, 86.2 mln tons were produced [17]. According to recent reports, oil production in the Republic will be 90.3 mln tons in 2018 or 4.7% more than in 2017 (according to the message of Kanat Bozumbayev, the Minister of Energy, on the press-conference held on December 26, 2018) [18]. Oil production under three big projects will be 53.9 mln tons, including 13.2 mln tons in Kashagan (120% to the plan of 2018), 28.6 mln tons in Tengiz (103.3% to the plan of 2018), 12.1 mln tons in Karachaganak (100.8% to the plan 2018).

Oil export will be 71.5 mln tons or 102.4% by 2017. The volume of oil processing will be 16.1 mln tons; it will increase by 8% by 2017. The dynamics of oil production in the Republic of Kazakhstan is shown in Figure 3.

Figure 3 – Dynamics of oil production, including gas condensate, in Kazakhstan, thousand tons

Gas

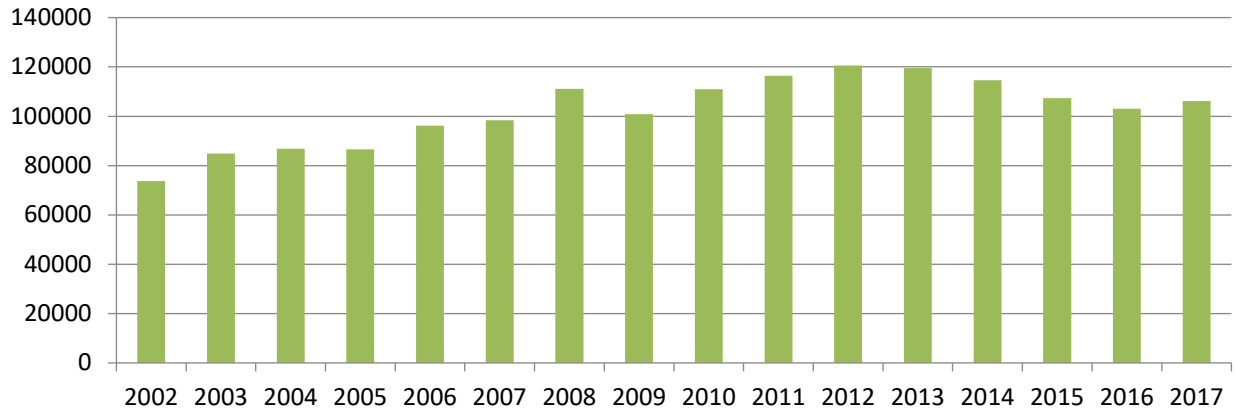
Currently, Kazakhstan takes the 22nd place in the world and the 3rd place in the CIS after Russia and Turkmenistan in the list of countries with proven reserves of "blue fuel". Gas reserves are estimated at 3.9 trln m^3, including 2.6 trln m^3 of associated gas and 1.3 trln m^3 of natural non-associated gas. 52,921.1 mln m^3 of gas were produced in 2017 [17] (Figure 4). In 2018, 54.8 bln m^3 of gas were produced; it is 3.6% more than in 2017. About 30% of gas is used inside the country, 30% of gas is exported. The remaining gas is injected into the formation to maintain formation pressure, in order to increase extraction of liquid hydrocarbons, and it is also used by subsurface users for their own process needs [18].

Figure 4 – Dynamics of gas production in Kazakhstan, mln m^3

Coal

According to the Report of Samruk-Energo JSC of 2017, the main part of the mined coal is used by the electrical power industry of the Republic of Kazakhstan (51%), and 31% of coal is exported. The rest volume is used for public utility needs of people and in the industrial enterprises (13% and 5% correspondingly). Bogatyr Komir is one of the biggest companies in the world in open-pit coal mining; its balance reserves are 2.75 bln tons. Production capacity of the company is 42 mln tons of coal per year, including 32 mln tons in Bogatyr coal deposit, 10 mln tons in Severniy coal deposit [19]. The dynamics of coal mining in the Republic of Kazakhstan is shown in Figure 5 [17].

Figure 5 – Dynamics of coal mining, thousand tons



Uranium

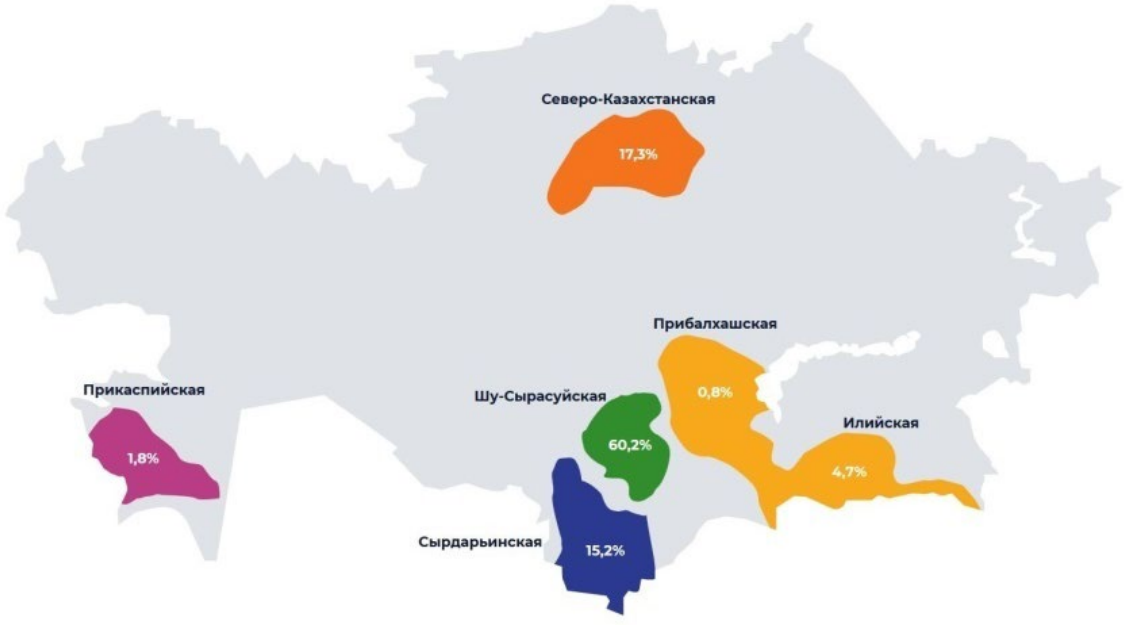
Kazakhstan takes the first place in the world on uranium production, and the second place after Australia on the developed uranium reserves. In 2017, Kazakhstan produced 39.3% of world uranium, Canada was the second (22% of world uranium production), Australia was the third (9.9%). Top three countries have provided 71.2% of world uranium.

According to the data of the World Nuclear Association, in 2017, five big world companies, producing uranium provided 65% of world production. The biggest company among them is NAC Kazatomprom JSC, which provided 21% of world uranium production.

Kazatomprom, together with its subsidiaries, dependent and joint organizations are developing 26 deposits in the Republic of Kazakhstan, which are consolidated into 13 mining assets (Figure 6). The main method of uranium production is in situ leaching (ISL), which was used for the first time in 1960s. In 2017, this method provided 50% of world uranium production.

The ISL method, compared to traditional methods, ensures a lower cost of production and has a less negative impact on the environment.

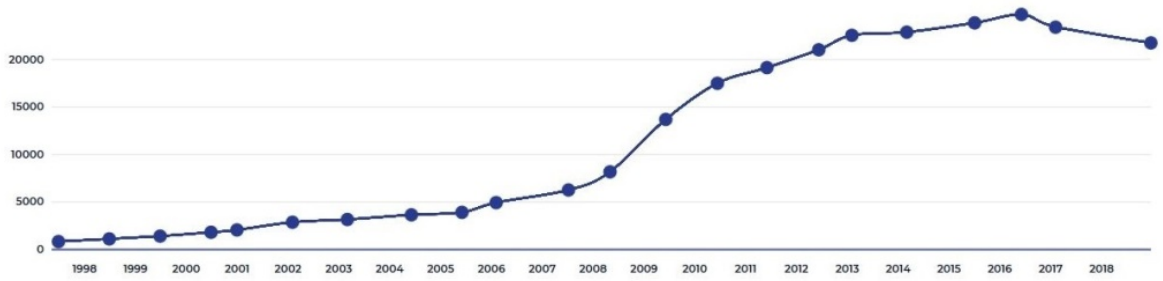
Figure 6 – Uranium production regions in Kazakhstan



Kazatomprom has a unique competitive position, thanks to favorable geological conditions of the Republic of Kazakhstan, which are very suitable for in situ leaching. 100% of uranium is produced using the ISL

method. Kazatomprom is an absolute leader in uranium production, using the ISL method (~20% of world uranium production in 2017), and it is considerably superior to its main competitors (Figure 7). All processes of uranium production are automated and continuously monitored; technical equipment of the deposits fully complies with the international safety and environment requirements, such as OHSAS 18001 and ISO 14001 [20]. It is planned to increase annual production of uranium from 21.705 thousand tons in 2017 up to expected 22.750-22.800 thousand tons in 2019 [21].

Figure 7 – Dynamics of uranium production in Kazakhstan



Other mineral resources

Dynamics of iron ore, copper ore and aluminum ore (bauxite) mining are presented in Figures 8, 9 and 10, respectively.

Figure 8 – Dynamics of iron ore mining, thousand tons

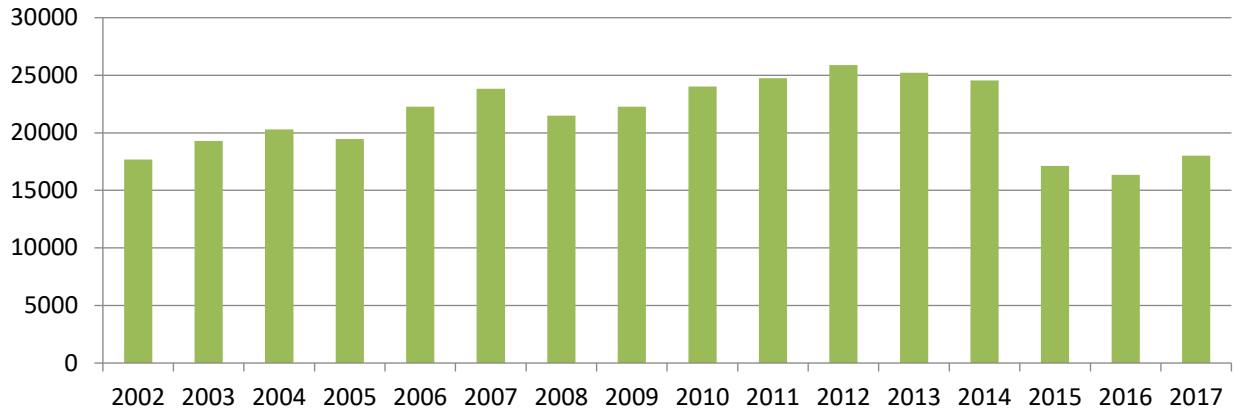


Figure 9 – Dynamics of copper ore mining, thousand tons

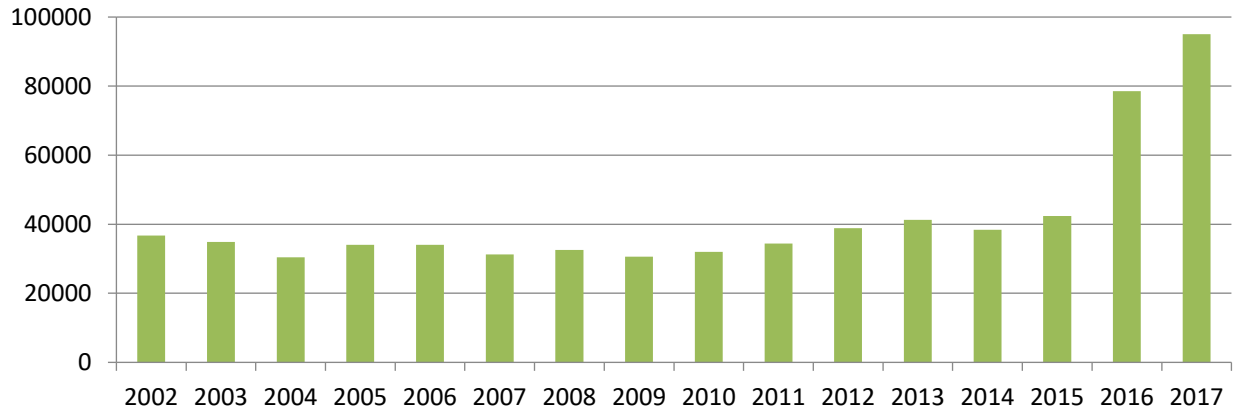


Figure 10 – Dynamics of aluminium ore mining (bauxite), thousand tons

Energy production

Gross installed capacity of all power plants of Kazakhstan is 18 992.7 MW of electrical energy. Production is divided by the type of a power plant as follows:

- TPP (thermal power plants) — 87.7 %;
- CPP (condensing power plants) — 48.9 %;
- CHPP (combined heat and power plants) — 36.6 %;
- GTPP (gas-turbine power plants) — 2.3 %;
- HEPP (hydroelectric power plants) — 12.3 %.

About 70% of electrical energy of Kazakhstan is produced by coal burning, 10.6% by gas flaring, and 4.9 % by oil burning; 14.5% of electrical energy is produced from hydropower and renewable energy resources.

Thermal power

The main volume of electrical energy is produced at 37 thermal power plants, which work on coal from Ekibastuz, Maykuben, Torgay and Karaganda coal basins. The largest hydroelectric power plant in Kazakhstan is Ekibastuz GRES-1. It has 8 power generating units, their installed capacity is 500 MW each; available capacity of the plant is 3500 MW. Aksu (Yermakov) GRES produces the biggest volume of electrical energy.

Nuclear power

The only nuclear power station of Kazakhstan was located in Aktau and worked from 1973 to 1999. It had a fast neutron reactor with the capacity of 350 MW. Currently, atomic energy is not used in Kazakhstan, although uranium reserves are estimated at 900 thousand tons (according to the IAEA records). Major deposits are in the south of Kazakhstan (South Kazakhstan region and Kyzylorda region), in the west in Mangystau and in the north.

At the moment the government is considering construction of a new nuclear power station. Several nuclear research reactors are used in the country.

Hydroelectric power

Kazakhstan is rich in water resources. Gross capacity of all water resources of the country is 170 billion kW per year. Main rivers are the Irtysh, the Ili and the Syrdarya. Economically efficient water resources are mainly in the east (the Altai Mountains) and in the south of the country. The biggest HEPP are Bukhtarminskaya, Shulbinskaya, Ust-Kamenogorskaya (on the Irtysh river) and Kapchagayskaya (on the Ili river). They provide 10% of the country's electricity.

They plan to increase the use of water resources for electrical energy production in the medium term. In December 2011, Moinakskaya HEPP (300 MW) was commissioned; Bulakskaya HEPP (80 MW), Kerbulakskaya HEPP (50 MW) and several small hydroelectric power plants are being designed.

Non-traditional renewable energy resources

Renewable energy resources bring no more than 0.2% of total amount of electrical energy.

Installed capacity of renewable energy resources in the first half-year period of 2018 is 427.5 MW. The capacity of small hydroelectric stations is 198.2 MW, wind farms capacity is 121.45 MW, solar plants capacity is 107.56 MW, bioelectric plants capacity is 3 thousand kW.

Kazakhstan is the first country in Central Asia, which created institutional conditions for transition to "green economy". The Ecological Code was adopted in 2007, the Law on supporting the use of renewable energy resources was adopted in 2009 and the Concept on transition towards "green economy" was adopted in 2013. Kazakhstan is actively cooperating with international financial institutes in development of infrastructure for renewable energy resources.[1]

The national energy industry is being modernized in the country. As of today, there are 50 enterprises, which use renewable energy resources with gross capacity 295.7 MW [22].

Wind energy

In December 2011, the first wind farm Korday WF (first part) was commissioned in Zhambyl region. Its capacity is 1500 kW. In December 2014, 9 wind turbines were built, and it increased the capacity up to 9 MW (Figure 11).

Figure 11 – Wind farm in Korday, 2015

Solar energy

Although a possible annual duration of solar energy use is 2200-3000 hours per year, and the estimated capacity is 1300-1800 kW per m2, solar energy is still not widely used in Kazakhstan.

In 2010, KazPV project was started in Kazakhstan. Its main aim is to create a complete vertically-integrated production of photovoltaic modules, using Kazakhstani silicon. KazSilicon produces silicon in Ushtobe (Almaty region). The raw material is processed by KazakhstanSolarSilicon in Ust-Kamenogorsk, and finally silicon cells are produced. Photovoltaic modules are assembled by AstanaSolar in Astana.

[1] 10 June – 10 September 2017, EXPO-2017, an International Specialized Exhibition under the egis of the International Exhibition Bureau was held in Astana. The topic of the exhibition was "Energy of Future". 115 states and 22 international organizations participated in EXPO-2017.

At the end of 2012, the first part of solar plant Otar was commissioned in Korday district of Zhambyl region. Its capacity is 504 kW, the designed capacity is 7 MW.

Social and ecological aspects of energy and mineral resources production

The Kazakhstan National Fund (hereinafter the National Fund) was established in 2000 in order to ensure stable social and economic development of the country and to decrease the external influence. The National Fund accumulates direct taxes from the oil and gas sector that constitute 74% of all revenues of the state budget. The National Fund fully accumulates the share of the Republic of Kazakhstan under the Agreements on production sharing, it also almost fully accumulates rent export tax (96%), bonuses (88%), incomes from natural resource users against the compensation claims to oil sector organizations (90%), excess profit tax (96%).

Within the framework of the "Global energy-ecological strategy" and following the decisions of the UN Conference RIO+20, Kazakhstani scientists have developed a draft of the Concept of sustainable energy strategy of future Kazakhstan till 2050. The main parameters of the concept are presented in Table 4 [24].

Table 4 – Main and external target parameters of the "Strategy of sustainable energy of future Kazakhstan till 2050" in 2050

MAIN PARAMETERS	
Electrical energy consumption	300±5 bln kW per hour
Capacity of major energy funds	55±5 GW
Share of renewable energy resources, including hydropower	More than 51%
C02 emission per capita	Not more than 3.9 tons per person per year
Volume of oil reservation for future generations	2 bln tons of forecast reserves, extracted with the use of existing and forecast technologies
Total capital investment	US$ 300 bln, in 2012 prices
Duration of the sufficient energy flow for implementation of 10-year development plans for Kazakhstan and its regions	Next 10 years after adoption of each 10-year plan
Tariff increase due to sustainable energy	No more than by US$ 21 per month in relation to population, in 2012 prices
EXTERNAL PARAMETERS	
Growth of a gross domestic product per capita	5.3 times
Energy consumption ratio of a unit of a gross domestic product in 2050 to the corresponding unit in 2012	0.5
Population growth	Up to 25 mln people

Technical efficiency and innovations

Kazakhstan places great importance on improvement of efficiency and implementation of innovations of Kazakhstani scientists and engineers. In 2017 an international exhibition EXPO-2017 was held in Astana, where successful Kazakhstani innovative projects in production, construction, housing and public utilities and transport were presented. Here are some of them:

- Multi-level and multi-row rotary type wind farm;

- Hybrid wind and solar plant “The Great Steppe Energy KazZhelKuat-VRTB” for electrical energy production;
- Innovative accumulators for renewable energy, electric cars and electronics;
- Innovative technology of electrical energy production from gas cleaning, air cleaning in the premises and waste utilization;
- Stand-alone hybrid plant with solar emission concentration;
- Construction of an energy-saving melting reactor for non-waste processing of technogenic waste;
- Development of a self-regulating generator drive of a wind turbine;
- Development of a silicon solar battery with planar concentrate.

A legislative framework has been created in the Republic of Kazakhstan for the development of a network of technology parks (so-called “technoparks”) on the basis of the Strategy for Industrial-Innovative Development of the Republic of Kazakhstan for 2003-2015 approved in 2003 by the Decree of the President of the Republic of Kazakhstan. The main objective of technology parks is to identify, disclose, develop the innovation capacity of the country and its regions, as well as to satisfy the demands of the economy for innovative products. Now there are national and regional technoparks in the Republic of Kazakhstan.

National technoparks contribute to the creation of new industries in the republic that will ensure the future competitiveness of the Kazakhstani economy. A distinctive feature of national technoparks is that the regime of free economic zones (FEZ) with preferential taxation is focused on the industry sectors.

Regional technoparks provide a gradual increase of the technological level of the economy and create conditions for small and medium science-intensive and technological businesses. Regional industrial enterprises, scientific organizations and higher educational institutions are systemic components of regional technoparks.

The tasks of technoparks are as follows:

- development of business plans and marketing research;
- management of projects and search for financing sources;
- material and technical support of the project preparation: provision of premises, telecommunication services, provision of access to laboratory equipment;
- accounting, legal and translation support of the project;
- assistance in testing, patenting, certification, creating a prototype;
- provision of consulting services.

Some Kazakhstani technoparks include the so-called business incubators, i.e. buildings or several buildings where, for a limited time (from 2 to 5 years), newly created small enterprises rent their premises. The main objective of the business incubator is to “grow up” high-tech companies from the earliest stages, from the moment of inception of an idea.

There are the following technoparks in Kazakhstan:

1. Technopark “Algorithm” LLP, Uralsk. The areas of activities include mechanical engineering for the oil and gas industry, instrument engineering, petrochemistry, environmental technologies.
2. Almaty Regional Technopark is aimed at the development of construction technologies, the production of construction materials; the development of the chemical industry, metallurgy, and mechanical engineering.
3. Technopark KazNTU named after K.I. Satpayev, Almaty (www.tpntu.kz). It is created to ensure the dynamic development of science-intensive technologies, the implementation of scientific, technical and technological innovations in the industry, the commercialization of the results of research and development.

4. East Kazakhstan Regional Technopark Altai LLP, Ust-Kamenogorsk. The area of its activity is production and processing of non-ferrous metals, information technologies, mechanical engineering, environmental technologies, production of new materials, etc.

The innovation infrastructure of the Republic of Kazakhstan has a number of privileges. For example, in the FEZ PIT of Alatau the corporate tax is reduced by 50%; the participants are fully exempt from land and property taxes; the turnover on sales of services is exempt from VAT; the participants are exempt from customs payment for imported goods; concessional financing by development institutions is provided.

Data and knowledge management

The Committee of Statistics, National Center for State Scientific and Technical Expertise JSC, the Republican Geological Fund were established in Kazakhstan to ensure the data and knowledge management.

The Committee of Statistics is an authorized body which develops and implements the state policy on statistics. It also develops and implements the statistics improvement programs in the Republic of Kazakhstan. The Committee of Statistics is a part of the Ministry of National Economy of the Republic of Kazakhstan.

In accordance with the current legislation and the tasks entrusted, the Committee performs the following duties:

1. develops and implements the state policy on state statistics;
2. ensures the accumulation, maintenance and updating of information statistical databases on the socio-economic situation of the republic and its regions;
3. carries out international cooperation within its competence and concludes the agreements in the framework of cooperation;
4. performs other duties stipulated by this Law, other Laws of the Republic of Kazakhstan, Acts of the President of the Republic of Kazakhstan and the Government of the Republic of Kazakhstan.

The Committee of Statistics collects operational data about: healthcare, investment, culture, population, education, crimes, communications, energy and commodity markets, enterprise finance, national accounts, gender statistics, indicators of the state program on industrial-innovative development, domestic trade, science and innovations, environmental protection, industry, construction, transport, tourism, prices and tariffs, etc.

The Republican Center for Geological Information Kazgeoinform Limited Liability Partnership (RCGI) was established by Resolution No. 376 dated June 25, 2018 of the Government of the Republic of Kazakhstan under the Committee of Geology and Subsurface Use of the Ministry of Industry and Infrastructure Development in order to carry out the collection of geological information.

The duties of the RCGI include: the collection of geological information fully owned, owned and used by the state; storage, summarization and systematization of the information; providing it to the interested persons as a National Operator for collecting, storing, processing and providing the geological information.

The National Center for State Scientific and Technical Expertise was established by Decree No. 831 dated July 19, 2011 of the Government of the Republic of Kazakhstan. The Center deals with the creation of state resources for scientific and technical expertise in the country's scientific sphere, including the information on the scientific potential in general. It collects, processes, and analyzes documents, including PhD and Master thesis defended in the republic, reports on research and development activities, scientific and technical programs, deposit research papers, publications of Kazakhstani scientists; over 10 thousand documents are processed every year. It provides access to the domestic and international information resources for corporate and individual subscribers, including the state administration bodies of the republic; it also provides the whole range of associated information services.

There is a vocational education and training system for all sectors of the national economy of Kazakhstan. The intermediate vocational education system includes colleges and vocational schools. In 2018, 769 of these schools worked well; 489.8 thousand students were studying there. A higher education system includes 124 higher education institutions, mainly universities. In 2018, 524.5 thousand students were studying there [18]. Specialists for fuel and energy and mining industries are trained in 23 largest universities of Kazakhstan.

The European Qualification System is adopted in the education system of Kazakhstan, which includes a bachelor's degree program, a master's degree program and a PhD program of postgraduate education.

Conclusions on the state of energy and mineral resources management in Kazakhstan

In recent years significant changes have been made to legislation of the Republic of Kazakhstan in order to attract domestic and foreign investment for the mineral resource base. They have started the transition from the State Commission classification of mineral reserves to international classification systems.

The transition to CRIRSCO classification system of solid minerals is also being performed in Kazakhstan. In 2016 the country became the 10th member of CRIRSCO. Moreover, it is planned to use the SPE-PRMS system for classification of hydrocarbons.

UNFC is being tested for classifying geothermal resources. The classification system of groundwater has not been changed. The possible reason is that there is no unified system of classification of groundwater reserves. Under present conditions, groundwater, as an integral part of water resources and as the most precious mineral, is an important strategic resource for water supply security and sustainable development of any state. Groundwater is the most extracted raw material in the world with a total water withdrawal of about 982 km^3/year (31.14 thousand m^3/s). The annual renewable resource amount is 12,700 km^3/year (402.7 thousand m^3/s). In the 20th century, the extraction of groundwater increased by 5 times.

Taking into account the world experience, groundwater reserves are considered mainly as a source of fresh water to ensure drinking water supply. According to the UN experts, in the 21st century water will become a more important strategic resource than oil and gas, as one ton of fresh water is already more expensive than oil in arid climate (in Sahara Desert and in North Africa, in the center of Australia, the RSA, the Arabian Peninsula, Central Asia).

The lack of clean fresh surface water makes many countries use groundwater resources more actively. The reason is that groundwater, as a source of water supply, has a number of advantages in comparison to surface water. Groundwater usually has better quality; it is better protected from pollution and contamination; it is not subject to seasonal and long-term fluctuations; and in most cases groundwater does not require expensive treatment. During last 25-30 years, more than 300 mln wells have been drilled in the world for water production. In many European countries (Belgium, Germany, Hungary, Denmark, Romania, Switzerland) groundwater use exceeds 70% of total water consumption. In Denmark, Lithuania and Austria, groundwater is the only source of freshwater for the population.

The problem of ensuring water security in the situation of limited and vulnerable surface water resources is an important component of the national security program of the Republic of Kazakhstan. According to expert assessment, as a result of rapidly growing water demand and a reduction of sustainable water reserves, the lack of water is expected to be 13 km^3 by 2030, and by 2050 it can reach 20 km^3 (70% of water demand). The most acute problem is the unsatisfactory state of drinking water supply of the population. Groundwater is the only strategic water resource of the country in this situation.

The total amount of inferred groundwater resources is 2038 m^3/s (64.3 km^3/year or 62.7% of the average long-term surface water resources). The inferred fresh groundwater resources are estimated at 1282 m^3/s

(40.4 km^3/year). More than 1.5 thousand groundwater deposits have been explored in the country; the amount of the proven operational reserves is 488 m^3/s (15.4 km^3/year or 38% of the inferred freshwater resources).

Thus, in order to solve the problems of drinking water supply hydrogeologists should establish clearly the amount of water of desired quality that can be extracted from the productive aquifer without harming the environment or minimizing the damage during the estimated period.

It seems relevant to develop a special UNFC for groundwater which will be used all over the world and will provide groundwater resource classification, reporting and management systems.

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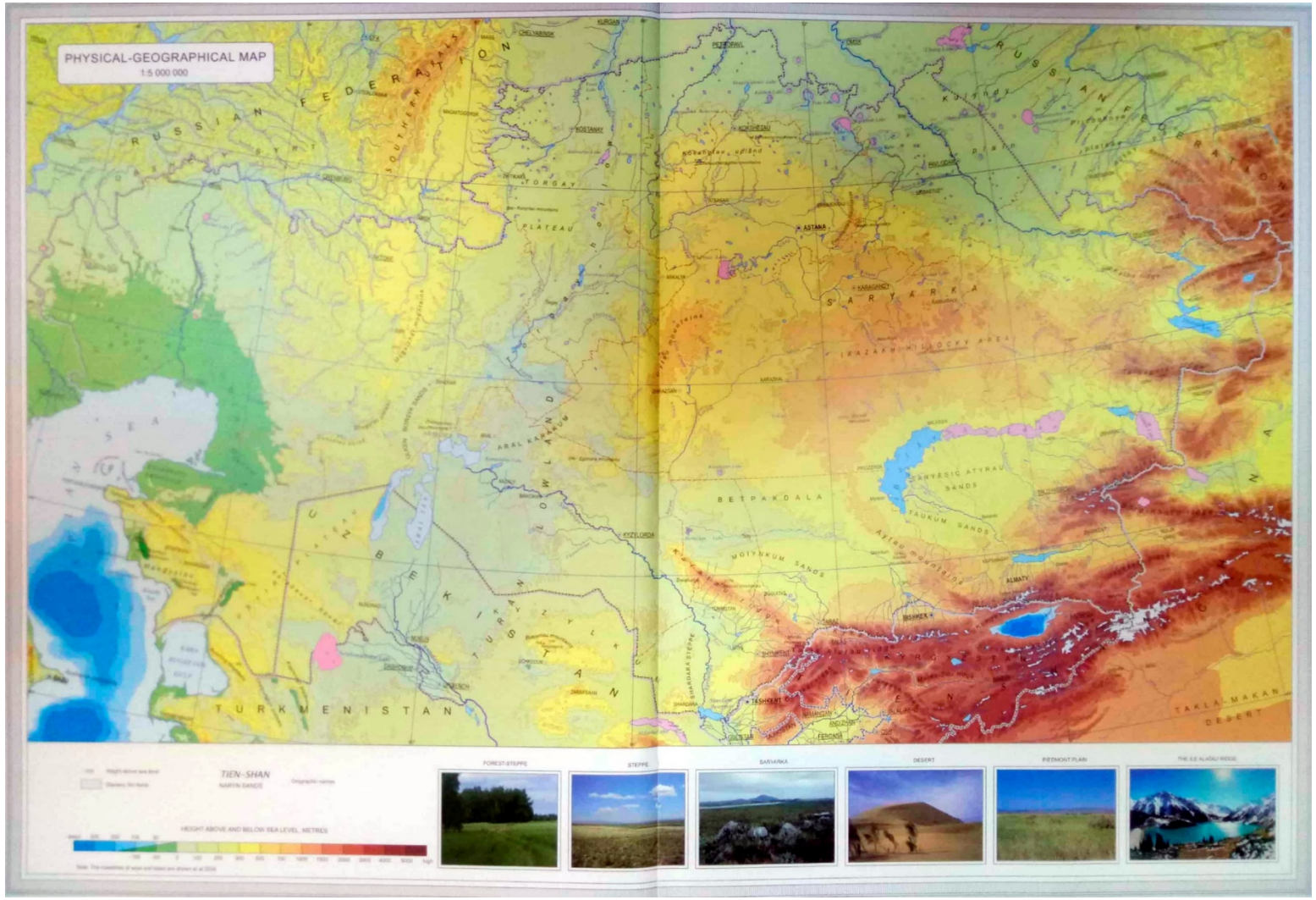
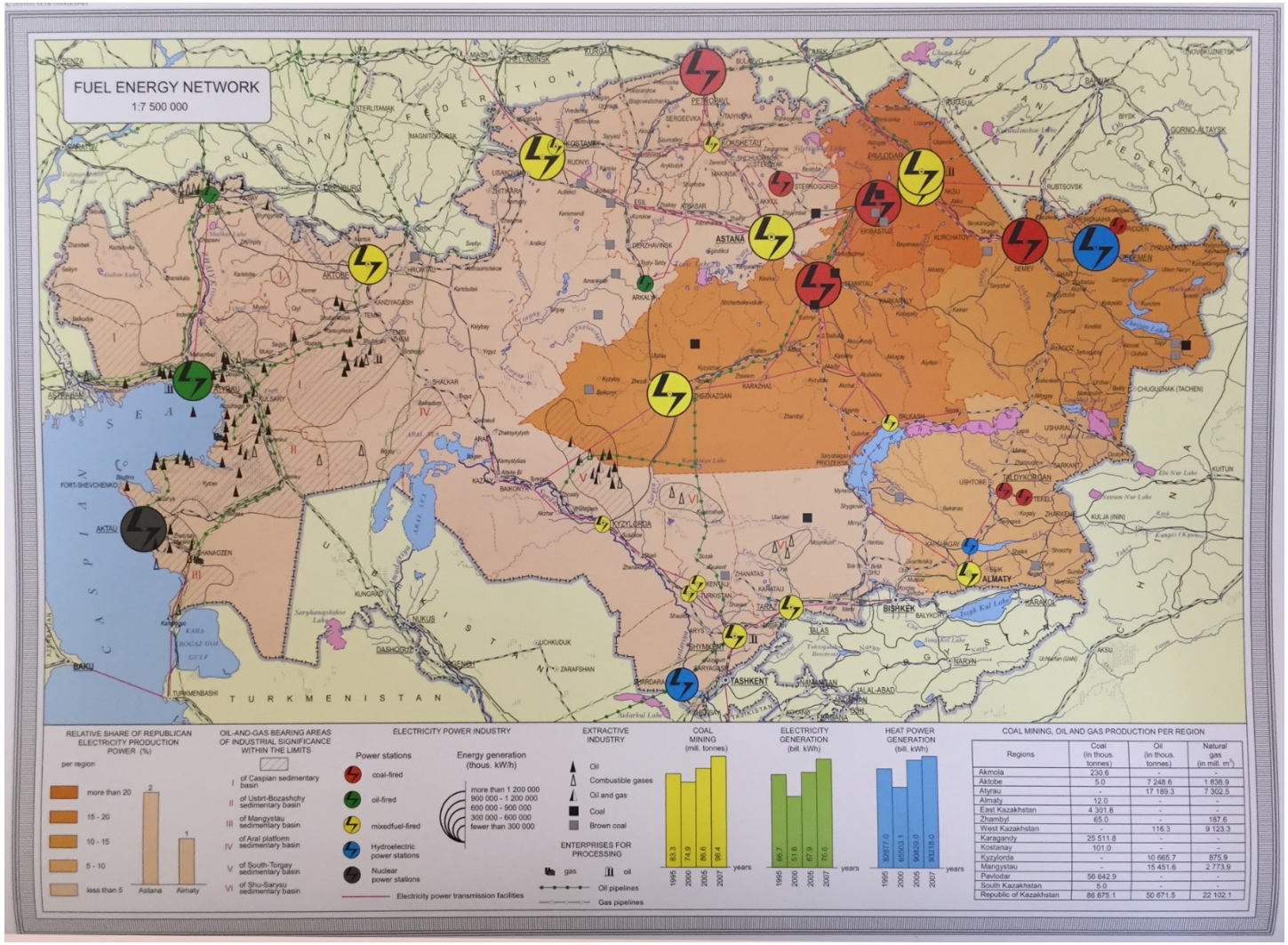
Annex

Annex I – The terrain of Kazakhstan in the physiographic map



Annex II – The location of main deposits in Kazakhstan

Annex III – The location of main fuel and energy complex enterprises in Kazakhstan



Annex IV – The distribution of forecast operational reserves of groundwater in Kazakhstan