Center for the New Environmentally Friendly Technologies
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DOOMED TO COAL

OVERVIEW
COAL MINING AND COAL ENERGY GENERATION IN KAZAKHSTAN
STATUS AND PROSPECTS

Karaganda, 2017

Content

List of abbreviations

GDP	Gross domestic product
HVTL	High voltage transmission line
HPP	Hydro power plant
EU	European Union
PRC	People's Republic of China
MNPEP	Mangystau Nuclear Power Engineering Plant
RK	Republic of Kazakhstan
RF	Russian Federation
REC	Regional energy company
LNG	Liquefied natural gas
TPP	Thermal power plant
CHPP	Combined heat and power plant

List of tables

List of diagrams

List of figures

Figure 4.2 – Legend to the map-scheme of the consolidated figures of soil contamination in the area around Karaganda CHPP-3

List of units of measure

Gcal - Gigacalorie
KV - Kilovolt
KWh - Kilowatt hour
tons - tons of oil equivalent
MVA - megavolt-ampere

Introduction

This survey presents a primary review of open sources of information describing the state and prospects of development of coal-mining and energy-generating industries in Kazakhstan and their expected impact on the environment.

The level of extraction and use of coal for energy generation in the past, present and future periods up to 2050 is assessed in accordance with existing state, sectoral and departmental plans.

Despite almost total lack of available information we also made an attempt to assess the investment climate in the field of coal use, including with the involvement of Chinese investments.

We have made an expert assessment of the current public and expert opinions on the prospects and options for the use of coal in Kazakhstan.

This survey is not intended to be an academic assessment of the situation neither its findings are flawless. The survey provides a primary picture, and can be used as an initial material for more complete and comprehensive research.

It should be noted that the sources cited in the survey often contradict each other. In the framework of this paper there was no task to determine the degree of reliability of the data found and used. As far as possible, the primary sources of information were used: legislative documents, official reports and documents. Media articles were used as sources of information in the absence of other available sources.

Note: On the cover of the survey there is a diagram which shows the frequency of occurrence of terms used in the English version of the Concept of the Transition of Kazakhstan to the Green Economy, combined with the map of Kazakhstan. Despite the fact that the term “coal” looks small on this map (on the lower right of the map) compared with other more frequently used terms – the present survey shows that the coal was, is now and will remain in the nearest future the main source of energy in Kazakhstan.

1. Review of the current state of the coal industry

1.1. Extraction, production of coal

In terms of primary energy resources (million tons of oil equivalent), Kazakhstan is among the world's 20 leading countries – it occupies the 18th place in the world (diagram 1.1).[1]

The main share in the structure of extracted energy resources in Kazakhstan is made up of coal reserves (46%) and uranium (30%), hydrocarbons account for up to 25% (diagram 1.2). In energy equivalent uranium constitutes the largest share of export (255,8% million toe or less than $ 2,5 billion), and in monetary terms – oil (79,2 million toe or $ 56,4 billion) (diagram 1.3).[2]

Kazakhstan is one of the ten countries with the largest deposits of coal in the world. It ranks 8th in the world according to its confirmed coal reserves of all types: from lignite to stone coal (diagram 1.4). Proved coal reserves in Kazakhstan are estimated at 34,2 billion tons (4% of the global volume), including lignite reserves – 62%, stone coal – 38%. Kazakhstan annually enters into top 10 world leaders in coal mining (107,3 million tons in 2015).

The resource base of power generation coal of Kazakhstan is characterized by a large volume, high ash and sulfur content. Coking coal is characterized by considerable explored reserves and high enough quality.

Having in mind considerable volume of undeveloped reserves (Kazakhstan is provided with coal for more than 250 years) the country put little efforts for geological exploration of coal deposits. The developed and prepared for development deposits account for 62% of reserves of categories A + B + C_1, of which 29% is on the balance sheet of operating enterprises. As already mentioned above, the overwhelming majority of coal reserves are situated in the deposits of Central Kazakhstan: Karaganda, Ekibastuz and Maykuben coal basins, Shubarkol, Borly, Kuu-Chek and Jubilee (Karazhyra) coal deposits have been exploited. In the central part of the republic there is a large Turgai lignite basin, which has a number of promising large deposits suitable for open pit exploitation.

At present there are 34 operating coal mining enterprises in Kazakhstan, the largest of which are coal mines Bogatyr (Bogatyr Komir LLP), Zhalyn (Saryarka-ENERGY LLP), Karazhira (Karazhira LTD LLP), Kuznetsky (Open Mine Kuznetsky LLP), Kumiskuduksky (Sat Komir Mining Company JSC), Shubarkol (ENRC, Transnational company Kazchrome); Coal department of ArcelorMittal Temirtau JSC, Association of Coal Industry Enterprises Gefest.

The share of large coal producers in Kazakhstan in the total volume of production in the country is about 98%. About 30% of the total steam coal is produced by the private company ERG (Eurasian Group, formal name is ENRC), and about 20% is produced by the represents state interests Samruk-Energo JSC and the private company RUSAL (Russian Aluminum). Almost all coking coal is extracted by a private company ArcelorMittal (mainly for own use). Coal is supplied to consumers inside and outside the country via the rail network operated by railway monopoly Kazakhstan Temir Zholy JSC (KTZ) owned by the Samruk-Kazyna.
Major part of coal is extracted by the open cast method and has a low production cost, but due to the high ash content and structural features of coal – exports are limited. Table 1.1 shows the quality of coal reserves by deposits.

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[1] National Energy Reports, KAZENERGY Association
[2] National Energy Reports, KAZENERGY Association

Table 1-1 – Quality of coal reserves by deposits

Coal deposits and basins	Average ash content in the deposit,%	Calorific value, kcal / kg
Karaganda basin	29,5	5200
Including coking coal	24,0	5700
Shubarkol deposit	8,0	5593
Kuu-Chekinsk deposit	41,0	4260
Borlinsk deposit	46,0	3472
Ekibastuz basin	42-44	3830-4060
Maykubensk basin	22,4	4057
Jubilee (Karazhyra) coal deposit	20,4	4438

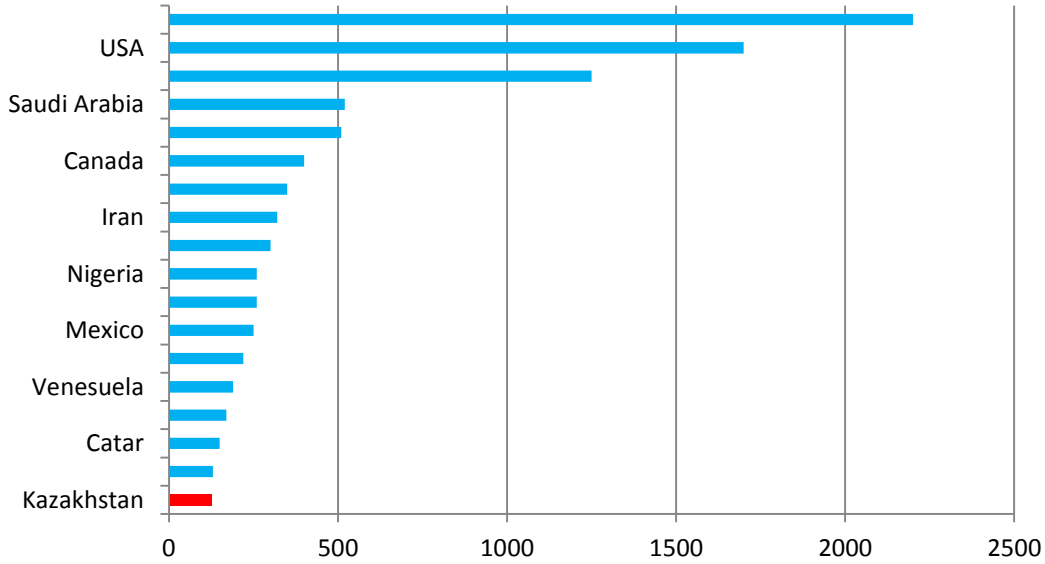

Diagram 1.1 – Production of primary energy resources by countries, mln tons

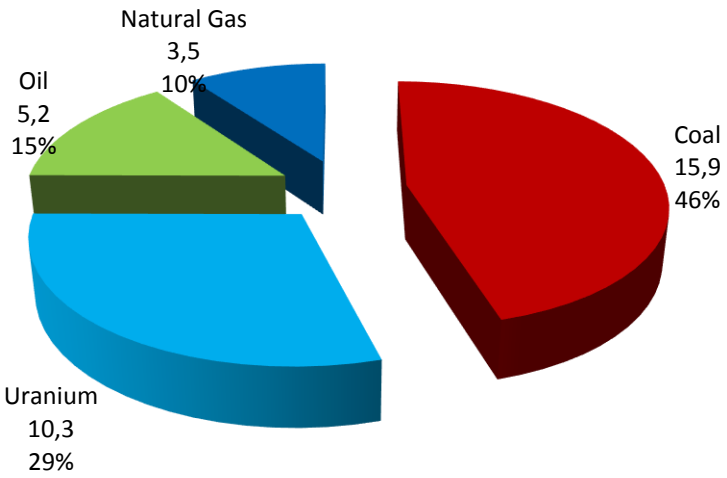

Diagram 1.2 – Proved reserves of fossil energy resources in Kazakhstan, billion tons

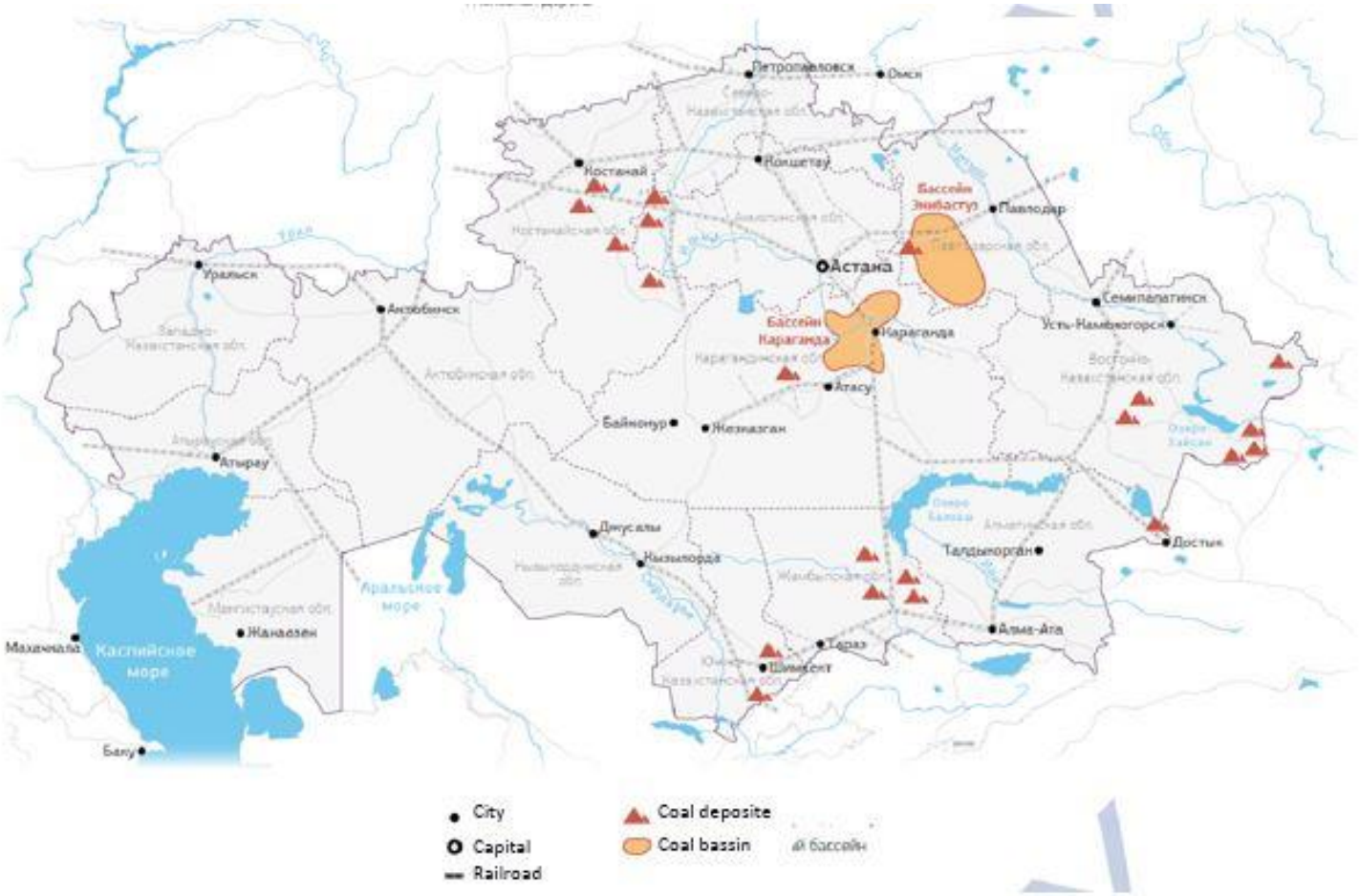

Figure 1.1 – Map of coal basins and coal deposits

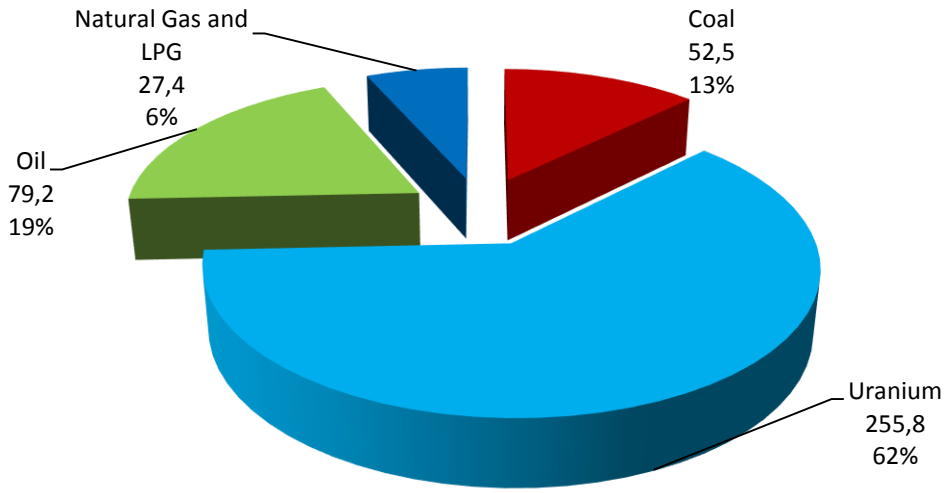

Diagram 1.3 – Production of primary energy resources in Kazakhstan by types, mln tons

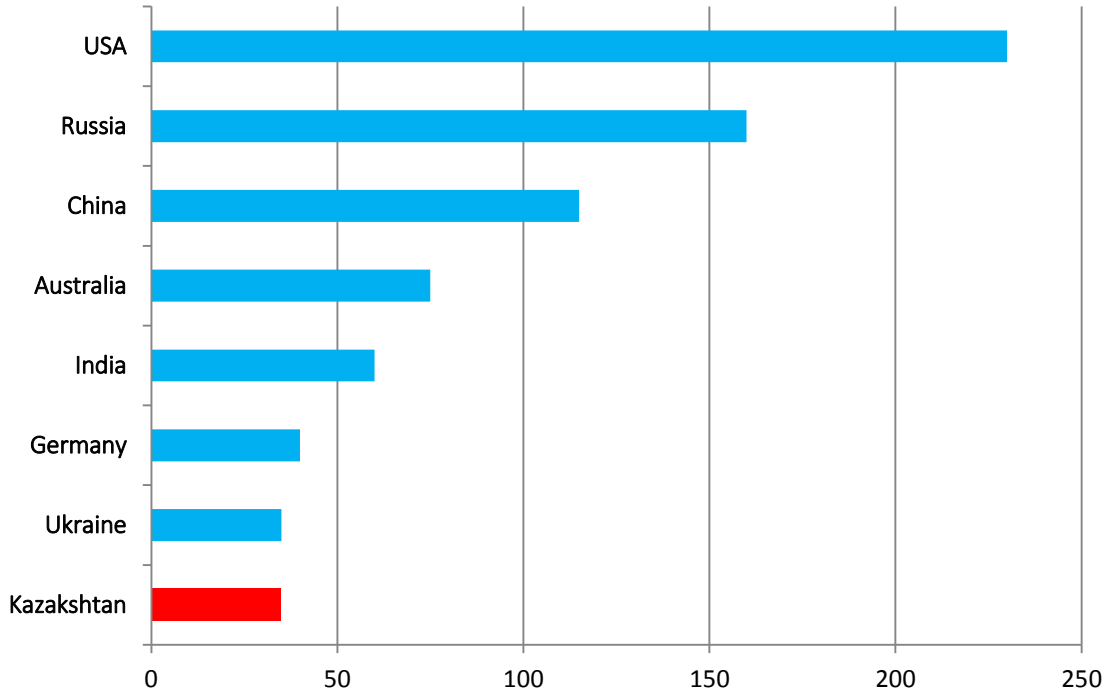

Diagram 1.4 – Volumes of proved coal reserves by countries, billions tons

"In January-May, 2017, there has been produced 45,1 million tons of coal in the republic, that is 18.4% more than for the same period last year. In money equivalent the increase is even greater: 122,2 billion tenge against 77,3 billion tenge for the first 5 months of 2016. The share of mining sector in the republic's industrial output increased from 1,1% to 1,4%."[3]
Interestingly, the increase in coal production in Kazakhstan is taking place against the backdrop of a worldwide decline in coal production. "World coal production fell by 6,2%, or 231 million tons, which is the biggest decline in history. Production in China fell by 7,9%, or 140 million tons, which is also a record decline. Production in the United States declined by 19%, or 85 million tons."[4]

3 https://365info.kz/2017/06/shahtery-zakrepilis-v-rossii-i-vyshli-na-rynki-evropy/
4 http://www.abctv.kz/ru/news/ugol-vozvrashaetsya-v-shahtu

1.2.Domestic consumption

In terms of primary energy consumption, Kazakhstan is on the 34th place in the world.[5] Coal is the main fuel of the economy of Kazakhstan – currently it accounts for more than 50% of primary energy consumption in the country (diagram 1.5). The volume of coal consumption in 2015 constituted 33,3 million tons of oil equivalent.

The main consumers of primary energy resources (including coal) are (in descending order):

- Energy sector – 47,71%;
- Industry – 20,36%;
- Transport – 16,24%;
- Utilities and the population – 15,69% (diagram 1.6).[6]

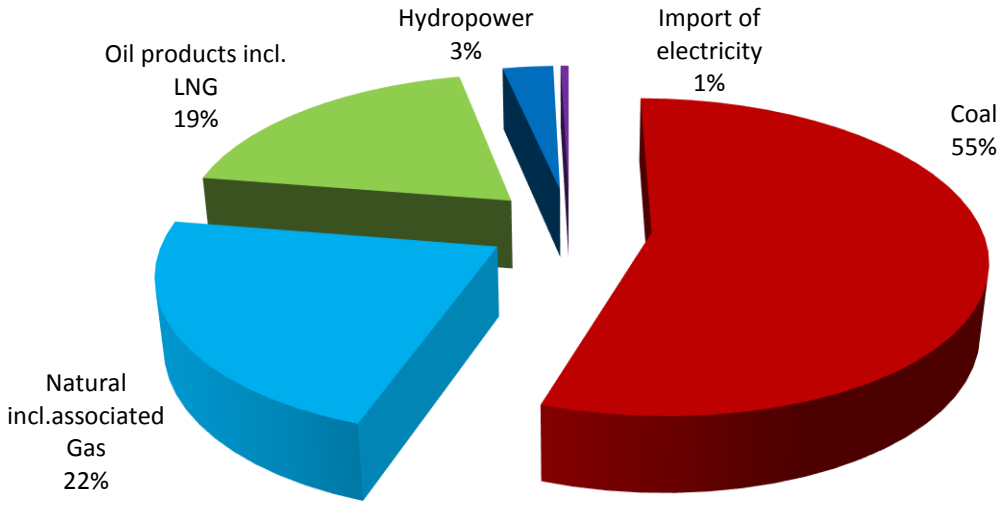

Diagram 1.5 – Consumption of primary energy resources in the Kazakhstan by types,%

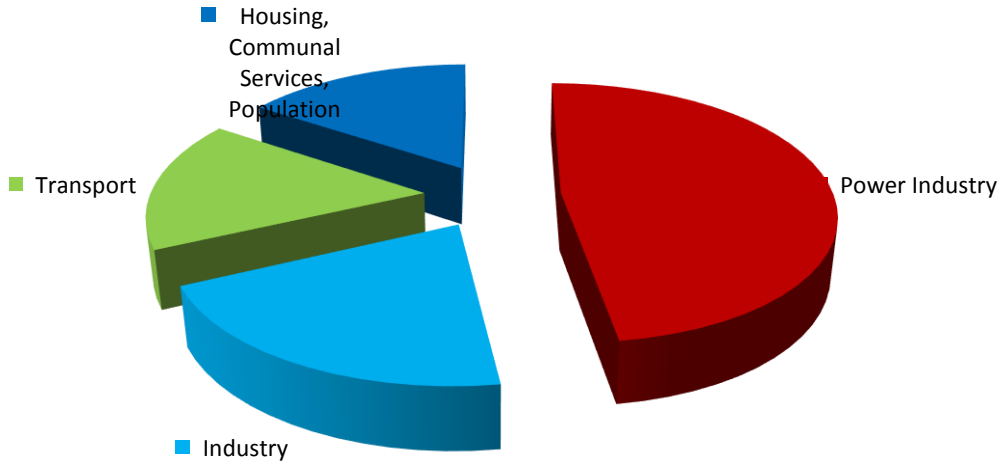

Diagram 1.6 – Distribution of primary energy consumption by main economic sectors

5 Source: National Energy Report of KAZENERGY, Association of legal entities KAZENERGY

6 Source: National Energy Report of KAZENERGY, Association of legal entities KAZENERGY

1.3.Export

According to official data, Kazakhstan exports more than 25% of coal mined in the country. According to the Committee on Statistics of the Ministry of National Economy, in 2015 Kazakhstan exported almost 28 million tons of stone coal for a total sum of $ 437 million (compared to 26 million tons in 2014). It is high-ash Ekibastuz coal that is mainly exported as its enrichment is unprofitable. Export to the EU and China is limited by the high shipping cost.[7]

The largest volume of coal in 2015 was exported to the following countries (diagram 1.7):
1) Russia – it has been exported to this country more than 21,5 million tons worth more than $ 247,7 million. It is noted that Russia has been the main buyer of Kazakh coal for number of years in a row; according to the Kazakhstan Association of Oil, Gas and Energy Companies KAZENERGY, over 90% of coal exported to Russia is a coal from the Ekibastuz Basin. Mainly, it is supplied to the Ural power plant; this situation has developed historically, since a number of power plants built in Russia were designed specifically for burning coal from the Ekibastuz Basin;
2) Finland – almost 3,3 million tons of coal for $ 62 million;
3) Kyrgyzstan – 1,5 million tons of coal for $ 40.3 million;
4) Ukraine – 0,8 million tons of coal for $ 68 million;
5) China – 465,2 thousand tons of coal for $ 9,1 million:
6) Great Britain – 292.2 thousand tons of coal for $ 7 million;
7) Belarus – 26,8 thousand tons of coal for $ 308 thousand.

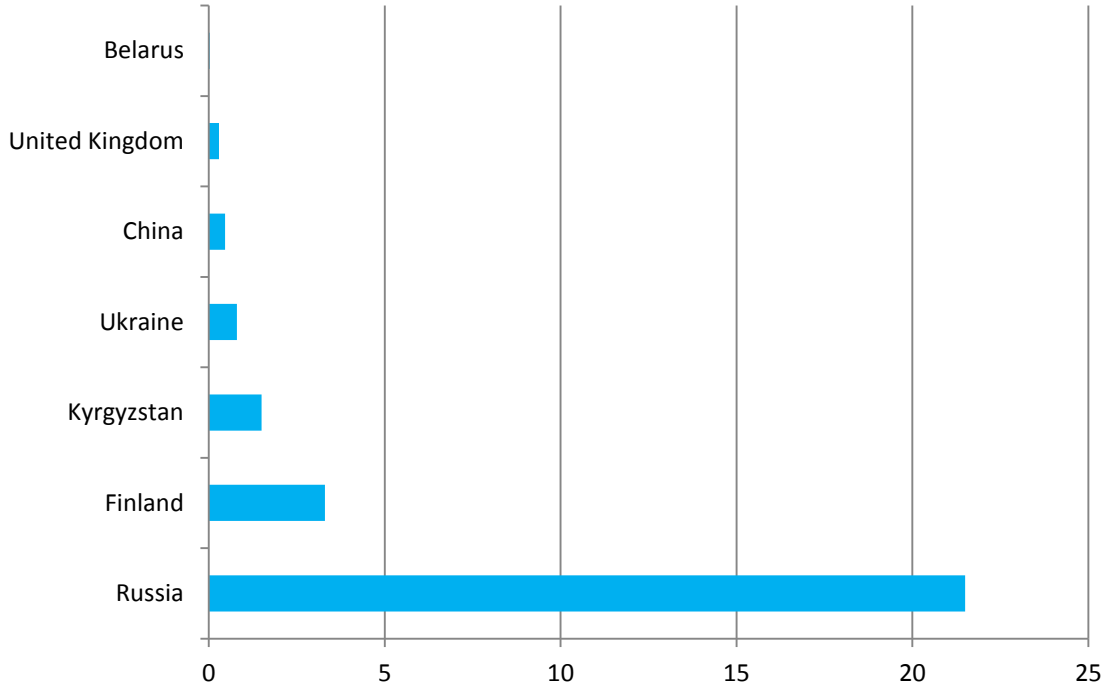

Diagram 11.7 – Main exporters of Kazakhstan coal as for 2015

The balance of resources and coal distribution is presented in diagram 1.8, where it is evident that in the last two years the share of coal import has increased, and the volume of coal production, on the contrary, has decreased.[8]

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7 Committee on Statistics of the Ministry of National Economy of the Kazakhstan, http://www.stat.gov.kz

8 Committee on Statistics of the Ministry of National Economy of the Kazakhstan, http://www.stat.gov.kz

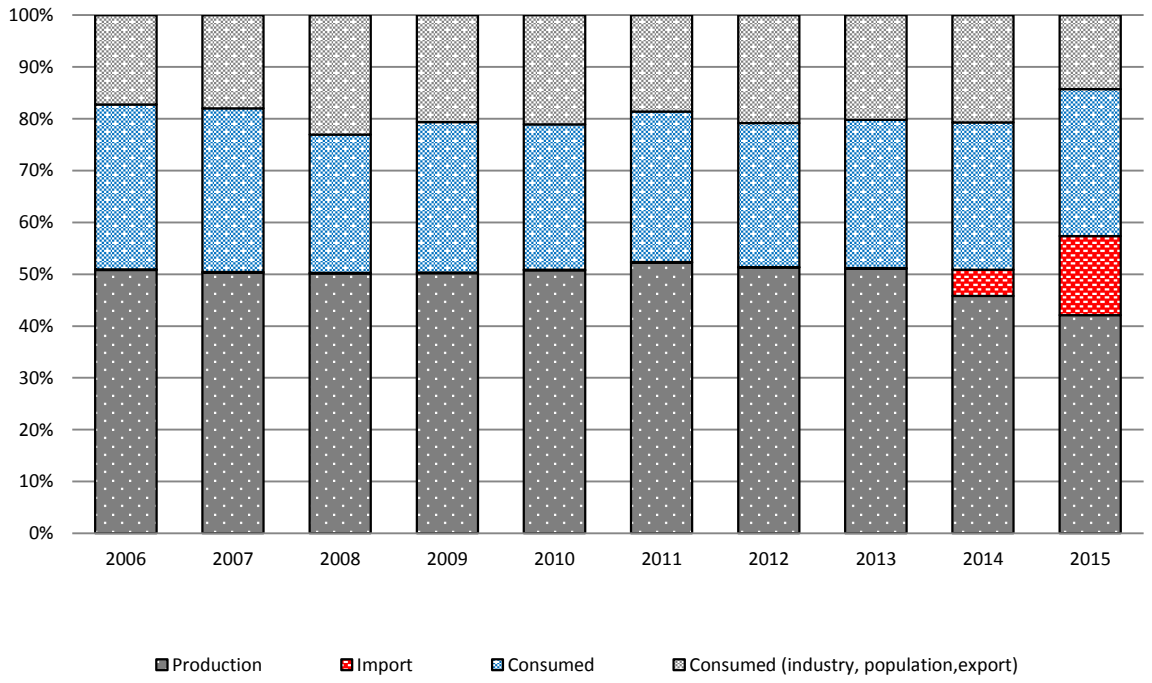


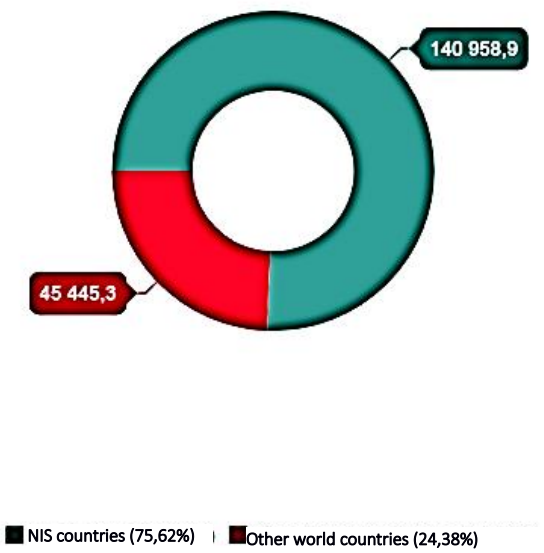
Diagram 1.8 – Balance of resources and coal distribution including lignite for the period 2006-2015, thousand tons.

"In January-April, 2017, Kazakhstan exported 9,3 million tons of coal for a total sum of $ 186,4 million. The increase compared to the same period in 2016 is significant: the physical volume of shipment has increased by more than 20%, and in monetary terms, sales have increased by 2,3 times.

In many respects this is connected with entering new markets. The export of coal to Switzerland for four months amounted to $ 19,9 million, to Cyprus – $ 4,7 million. Sales to Finland have increased by 2,2 times: the total volume of export increased from $ 8,3 to $ 18,5 million".[9]

9 https://365info.kz/2017/06/shahtery-zakrepilis-v-rossii-i-vyshli-na-rynki-evropy/

Coal export January-April 2017 (USD thousands)



Coal's Exporters Contries (USD thousands)

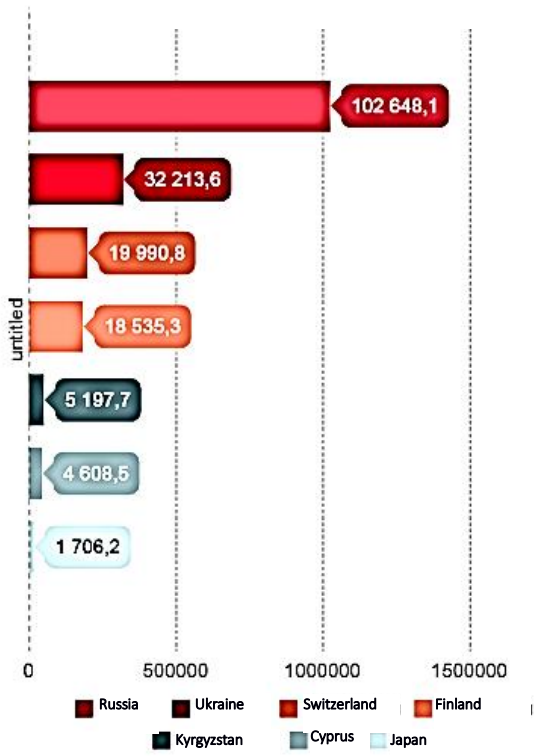


Diagram 1.9 – Export of coal in January-April 2017

1.4. Investments in coal mining and coal processing

It is difficult to assess the real situation with investments including foreign ones in the coal sector, since we did not find any open source documents confirming the investments were actually made. This review provides information found in media regarding plans on various investment projects. The degree of implementation of such plans according to open sources could not be clarified.

There are mentions in the media about the agreement on implementation of project of the comprehensive coal processing with the participation of KazMunaiGas JSC - Processing and Marketing, China Kingho Energy Group, JV Arbat LLP[10],[11] (Shubarkol Premium JSC[12]) and Open Cast Mine Kuznetsky LLP. The agreement is aimed to develop a modern coal-chemical industry in Kazakhstan, the processing plant would produce diesel fuel, synthetic natural gas and other petrochemical products.[13] "JV Arbat LLP presented the project "Construction of coal-chemical plant and open cast coal mine in Nurinsky district." According to the company the cost of the project is 57 billion tenge, designed capacity 3-4 million tons of coal and 300,000 tons of semicoke per year. It is planned to create about two thousand jobs. The products will be supplied both to domestic consumers and to the countries of near and far abroad."[14]

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10 Investors - the Republic of Kazakhstan, - Vostok Development LLP - 67% of the authorized capital, SNB Energy LLP – 33%. http://geology.gov.kz/ru/presstsentr/informatsiya/nedropolzovateli-respubliki-kazakhstan/item/too-sp-arbat

11 In 2016 JV Arbat LLP was renamed into joint-stock company "Shubarkol Premium" https://dfo.kz/ru/DfoObjects/objects/teaser-view/13854133?OptionName=ExtraData

12 MIR Kazakhstan https://i5.memst.kz/content/detail.php?ELEMENT_ID=3311

13 https://kapital.kz/economic/35907/kazahstan-i-kitaj-podpisali-soglashenij-na-14-mlrd.html

14 In Karaganda region there is a project implemented for the exploration and production of coal bed methane http://www.inform.kz/en/v-karagandinskoy-oblasti-realizuetsya-proekt-po-razvedke-i-dobyche-metana-iz-ugol-nyh-plastov_a2676217

Under the terms of the agreement the parties intended to create a company that would invest in, design, build and operate the about mentioned facilit.
In addition, we found an information about the establishment of a joint venture – Karagandy CCI LLP in 2015 according to the agreement between KazMunaiGas JSC - Processing and Marketing and China Kingho Energy Group[15]. Interfax-Kazakhstan agency was informed by the press service of KazMunaiGaz - Processing and Marketing (KMG-PM) that in 2015 the joint Kazakh-Chinese enterprise Karagandy CCI LLP[16] planned to process 2,5 million tons of coal and produce about 500 thousand tons of liquid synthetic fuel per year."[11].
In 2017, news about Karagandy CCI LLP continues to appear with similar wording in future tense – "Kazakhstan Karagandy CCI LLP together with Chinese company China Kingho Energy Group plan to build a coal processing complex in the oblast"[17]. The level of implementation of these plans could not be clarified – according to media reports "Technical and economic indicators are still unknown – they have not been calculated yet, since the projects are at the stages of obtaining documentation."

The use of coal is also foreseen in the Agreement on strategic cooperation between Samruk-Kazyna JSC and the State Grid Corporation of China, which includes, among other things "construction of power grid infrastructure, exploration and development of new energy resources," "creation of electric ties between China and Kazakhstan and principles of parallel operations;- construction of large coal thermal power plants (TPP) and renewable energy sources (RES) at the territory of Kazakhstan;
- organization of electricity supply from Kazakhstan to China;
- transit of electricity through China to third countries;
- use of the advanced technology of ultrahigh voltage direct current electric power transmission;
- use of coal, wind and solar resources in Kazakhstan.
In addition, within the framework of the agreements reached, it is planned to exchange technologies of electric power equipment and study the possibilities of joint manufacture of electric power equipment in Kazakhstan.

The chairman of the board of LLP JV Tau Gold Copper, Yevgeny Ionin, stated regarding the need to create a consortium of enterprises interested in the development of coal chemistry in Kazakhstan, that "now there are a lot of Czech, Chinese, Russian investors, they wander all over the Ministry of Investment and Development, and we know how to approach this pool, we know these investors in person, they have been working here for a long time, they have a lot of analytical agencies here." "We want to regulate this market of coal chemistry ... so that starting from January 15, 2017, one could sell its technologies on it..., and from January 15, 2018 it [the consortium] will sell them on the stock exchange, because we will put this consortium to the Hong Kong IPO. And there are partners who are engaged in this for a long time and have experience in the sale of technology will give us a hand naturally."[18]
A representative of Shubarkul Komir JSC has also reported about the project "on production of activated coals from small fractions of special coke. Such coal can be used in water purification, water treatment, flotation of polymetallic ores and other important processes." The project is planed to be implemented in Karaganda oblast[19].
It is interesting that Kazakhstan investors are investing money in the Russian coal mining industry, probably because they do not want to lose revenues from the export of Kazakh coal to Russia because of measures taken in Russia on import substitution. For example, Coal of Kazakhstan LLP

15 https://www.pnhz.kz/press_center/news/?ELEMENT_ID=961
16 http://businessnavigator.kz/ru/branch/TOO_KARAGANDY_CCI_KARAGANDY_SISIAY_2974/
17 "A new coal processing complex will be built in Karaganda region", http://www.nv.kz/2017/06/26/159921/
18 http://abctv.kz/ru/news/uglehimiya-v-kazahstane-soyuz-mecha-i-orala
19 http://mcopanacea.cl.informa.ru/?ns=1&cs%5B69%5D=on&os%5B5%5D=on&fulltext=on&word=clr&ampperiod_count=1&sortby=agency&page=3

intends to invest up to 5 billion rubles in 2017-2018 in coal mining in the Kuzbass coal basin in Russia.
It is assume that the money will spent on the re-equipment and opening of new mine faces at the Zarechnaya and Alexievskaya mines. In July, Zarechnaya Coal Company plans to spend at least 300 million rubles on projects. It is assumed that the new money will allow the company as a whole to produce 500 thousand tons of coal per month, starting from September this year."[20]

20 http://minexforum.com/ugol-kazaxstana-investiruet-v-kuzbasskie-razrezy/

2. Review of the current state of the energy generating industry

2.1. Electric power

The electric power system of the USSR based on the Unified Power System (UPS), which unified 11 large interconnected regional power pools.
The power stations of Kazakhstan were part of two such power pools. The power pool of Northern Kazakhstan served the northern and eastern parts of the country, which were characterized by high level of industrial development, while the southern part of Kazakhstan belonged to the power pool of Central Asia (together with Turkmenistan, Uzbekistan, Tajikistan and Kyrgyzstan). These two power pools provide Kazakhstan with electricity today. It is now call "Northern energy zone" and "Southern energy zone" (see Figure 2.2).

The power pool of the North-Eastern part of Kazakhstan is partly the heir of a part of bigger energy system of Russia, which was divided in 1999. In spite of the fact that a significant part of the electricity is transferred to the South of the country due to the well-coordinated work of the Northern and Southern energy pools, there is still significant transfer of electricity between Southern part of the country and Kyrgyzstan and Uzbekistan. The share of the Northern energy zone accounts for 66% of the electricity consumed in the country, while the South energy zone consumes about 22% (Table 2.1).[21]

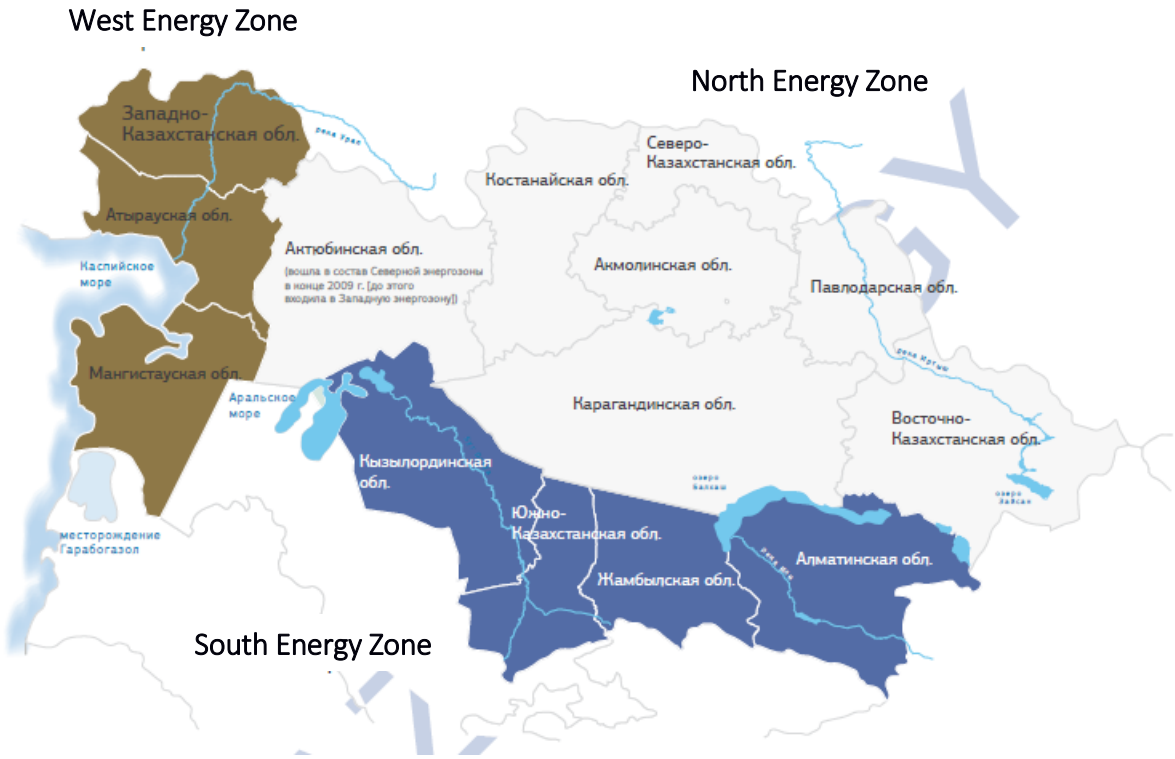

Figure 2.1 – Territorial division of Kazakhstan into energy zones

Table 2-1 – Electricity consumption in regional energy pools of Kazakhstan (million kWh)[22]

	2009	2010	2011	2012	2013	2014	Dynamics in %	
							2009-12	2012-14
Total in	77959,6	83767,1	88136,0	91444,2	89640,8	91661,0	17,3	0,2

21 Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (KOREM JSC)
22 Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (KOREM JSC)

Kazakhstan								
Northern energy zone	53916,5	58327,2	60588,7	62554,1	60785,9	60865,0	16,0	-2,7
Southern energy zone	9026,8	9263,5	9581,6	9885,1	10232,3	10940,0	9,5	10,7
Western energy zone	15016,3	16176,4	17965,7	19005,0	18622,6	19856,0	26,6	4,5

The Western energy zone, which includes the western regions of the country (Atyrau, Mangistau and West-Kazakhstan oblast), still operates in isolation from the rest of Kazakhstan's energy system.
Until 2009, this situation was typical for the Aktobe oblast, when it was joined by a 500 kV line to the Northern energy zone. For a period of time the western oblast (Atyrau, Mangistau and West-Kazakhstan oblast) were completely isolated from the USSR UPS, but in the 1980s these areas were connected to the Interconnected Power System (IPS) "Srednya Volga" in Russia by two high-voltage lines of 220 kV and by one 500 kV line constructed from Samara and Saratov in the direction of Uralsk. Until the end of the 1980s, these areas operated in parallel with the "Srednya Volga" integrated power system (Srednya in Russian means medium).

2.1.1. Power generation

The national electric power system of Kazakhstan, which covers a vast territory of 2,717,300 km2 (more than the territory of Western Europe), includes three energy zones, two of which (the Northern and Southern energy zones) are connected by transmission lines, and the third one (Western energy zone) operates separately from them[23].
At the end of 2016, the electricity production in Kazakhstan is carried out by 118 electric power stations of various forms of ownership. The total installed capacity of Kazakhstan's power plants as of January 1, 2017 is 22055,5 MW; the available capacity is 18789,1 MW. (link «14»)
The leading positions on electricity generation in 2015 are occupied by 6 coal power plants in Kazakhstan with the corresponding shares in energy generation:

- AEC JSC – 16,2%;
- Ekibastuz GRES - 1 LLP – 11,8%;
- GRES of Kazakhmys Energy LLP - 5%;
- Almaty Electric Stations JSC – 4,4%;
- CHP-1,3 Karaganda-Energocenter LLP – 3,8%;
- Ekibastuz Station GRES – 2 JSC – 3,5%.

The total share of electricity production by the above-mentioned power plants in 2015 amounted to 41 261,2 million kWh, or 45,4% of the total electricity production in the Republic of Kazakhstan.

[23] The North and West energy zones of Kazakhstan are connected by several transmission lines with the power system of Russia, while the South energy zone is connected by transmission lines to the energy systems of Uzbekistan and Kyrgyzstan. The authors note.

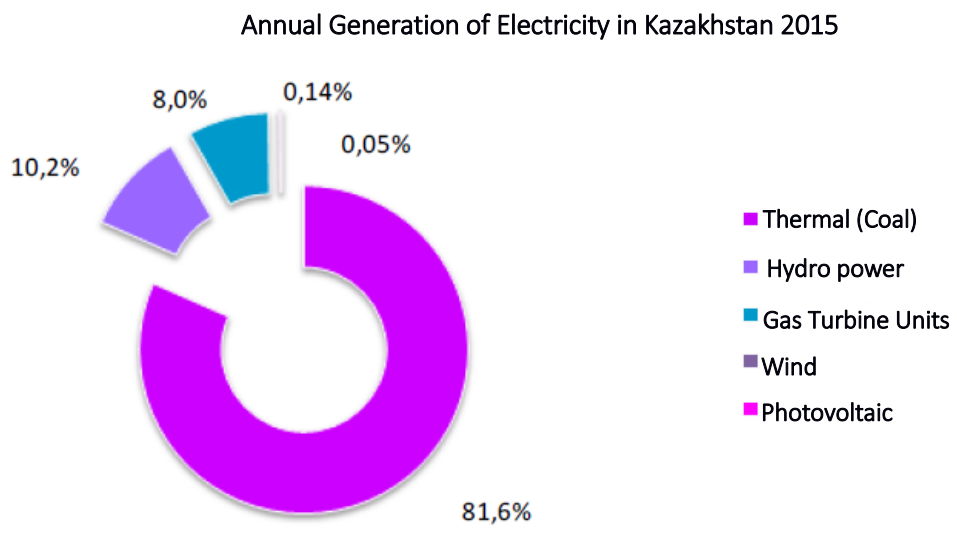

Diagram 2.1 - Shares of various sources of electricity generation in 2015[24]

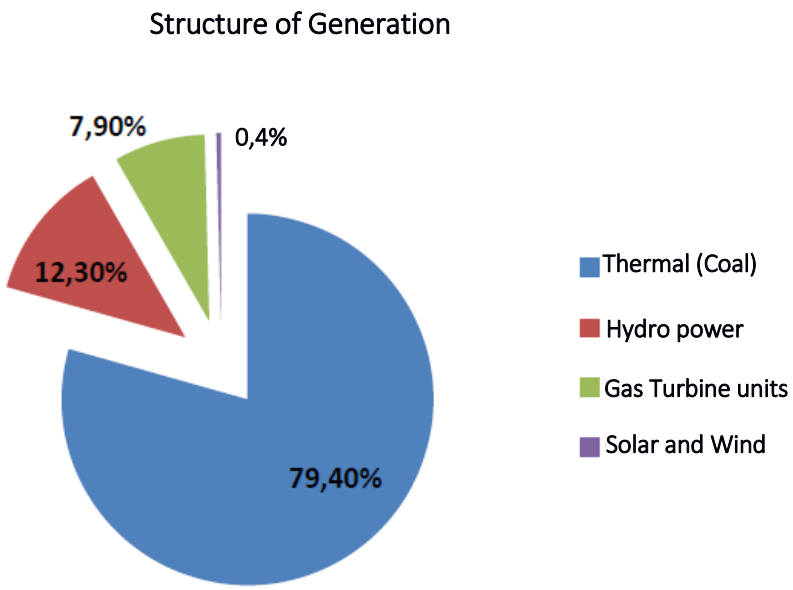

Diagram 2.2 – Shares of various sources of electricity generation in 2016.[25]

In terms of oblasts, by the end of 2015, Pavlodar (38,3% and 21%, respectively) and Karaganda (16,5% and 18% respectively) account for the largest volume of generation and consumption of electricity. It should be noted that this is a typical phenomenon for these areas.

Compared to foreign countries, the energy efficiency of power plants is rather low. Thus, the efficiency of coal condensing power plants in Kazakhstan is on average 32%, while in the advanced foreign countries – 42%.

In accordance with the Law on Electricity, KEGOC a state-owned electric power company is responsible for electricity transmission and for operation of 500-220 kV transmission lines – acting as a system operator, which exercises overall control and management of Kazakhstan's electric power system.

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24 Annual report of KEGOC JSC, 2015, http://www.kegoc.kz/sites/default/files/content-manager/godovoy_otchet_2015g_na_sayt_eng.pdf

25 Annual report of KEGOC JSC in 2016, http://www.kegoc.kz/sites/default/files/content-manager/godovoy_otchet_ao_kegoc_za_2016_god.pdf

The electricity market is divided into wholesale and retail segments. The wholesale segment, with minimum purchase of electricity in amount of 1 MW/h, includes the following components:

- A decentralized market where participants purchase and sell electricity on mutually agreed terms;
- A centralized market regulated and operated by the state-owned Kazakhstani operator of the electricity and capacity market (KOREM);
- Balancing market to eliminate imbalances on a daily basis;
- The market of system services, including power transmission and capacity reservation.

The structure of the electric power industry in Kazakhstan is shown in Figure 2.1.
The main problems of the electric power industry in Kazakhstan are:

1. Aging of generating equipment (75% for TPPs and 90% for HPPs);
2. High specific fuel consumption, low efficiency of stations;
3. Shortage of maneuverable capacities to cover peak loads;
4. Aging of fixed assets of transmission networks (60%);
5. Significant losses in main (5,7%) and distribution transmission networks (13%);
6. High level of environmental impact (high level of emissions of harmful substances, no utilization of ash and slag wastes).

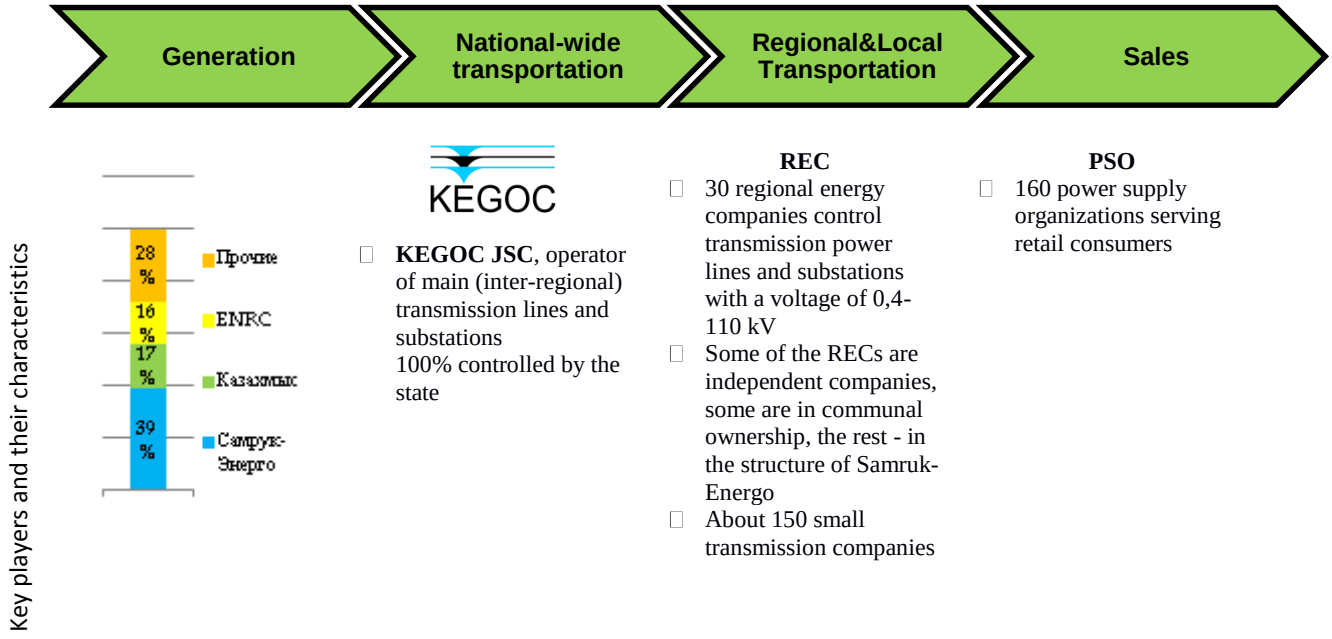

Figure 2.2 – Structure of the electric power industry of Kazakhstan

According to the approved forecast balance of electricity generation and capacity for the period 2017-2023[26], it is planned to annually put into operation new coal generation capacities in amount of 7% of the existing values in 2017 up to 20% in 2023, with a gradual decrease in the surplus of the total (from all sources) generation from 15% to 8% in the period until 2023. In the same period, it is planned to increase the consumption and coal generation by 105% and 115%, respectively (see Table 2 -3).

[26] Order of the Minister of Energy "On approval of the forecasted balance of electricity generation and capacity for 2017-2023" # 460, October 26, 2016.

Table 2-2. The forecast balance of electricity of the unified power system of the Republic of Kazakhstan for the period 2017-2023[14]

#	Name	Forecast						
		2017	2018	2019	2020	2021	2022	2023
1	Consumption	90,6	93,8	96,8	100,6	102,1	103,5	105,0
2	Generation	103,9	105,0	105,8	107,0	108,2	111,6	113,4
3	Generation on existing stations	96,0	92,6	91,6	90,9	90,1	88,7	86,6
4	Generation on planned stations	6,8	10,8	12,1	13,5	14,6	18,6	21,6
5	Generation on renewable sources	1,4	2,0	2,5	3,0	3,9	4,7	5,6
6	Deficit (+), excess (-)	-13,7	-11,6	-9,4	-6,8	-6,5	-8,5	-8,8

Due to the high aging of existing generating capacities .... the new generating capacities are created in Kazakhstan by building new ones and restoring existing power plants. By 2013, projects with total capacity of 1,341 MW have been completed

- Construction of the Ural GTPP with a capacity of 54 MW;
- Expansion of Atyrau TPP by 75 MW;
- Construction of a gas turbine power plant at the Akshabulak deposit of 87 MW;
- Construction of the 300 MW Moinak HPP;
- Restoration of power unit No.2 at Aksu power plant for 325 MW;
- Restoration of power unit No. 8 at Ekibastuz GRES-1 with a capacity of 500 MW.

In addition, "the power industry of the north of Kazakhstan is now actively rehabilitated, the new large blocks are constructed and restored. For example, there have been restored the 300 MW power unit No. 2 of Aksu TPP that was dismantled for spare parts in the 90s of the last century; works are underway to restore 500 MW blocks No. 8, 2, 1 of Ekibastuz GRES-1, also dismantled while the station was owned by the US corporation AES; the construction of 660 MW unit No. 3 of Ekibastuz GRES-2 begins; the construction of boilers 7 and 8 at Astana CHPP-2 with the first flue gas desulphurization system in Kazakhstan is underway; the Astana CHPP-3 is being built."[27]

[27] https://forbes.kz/process/probing/pyil_vekov

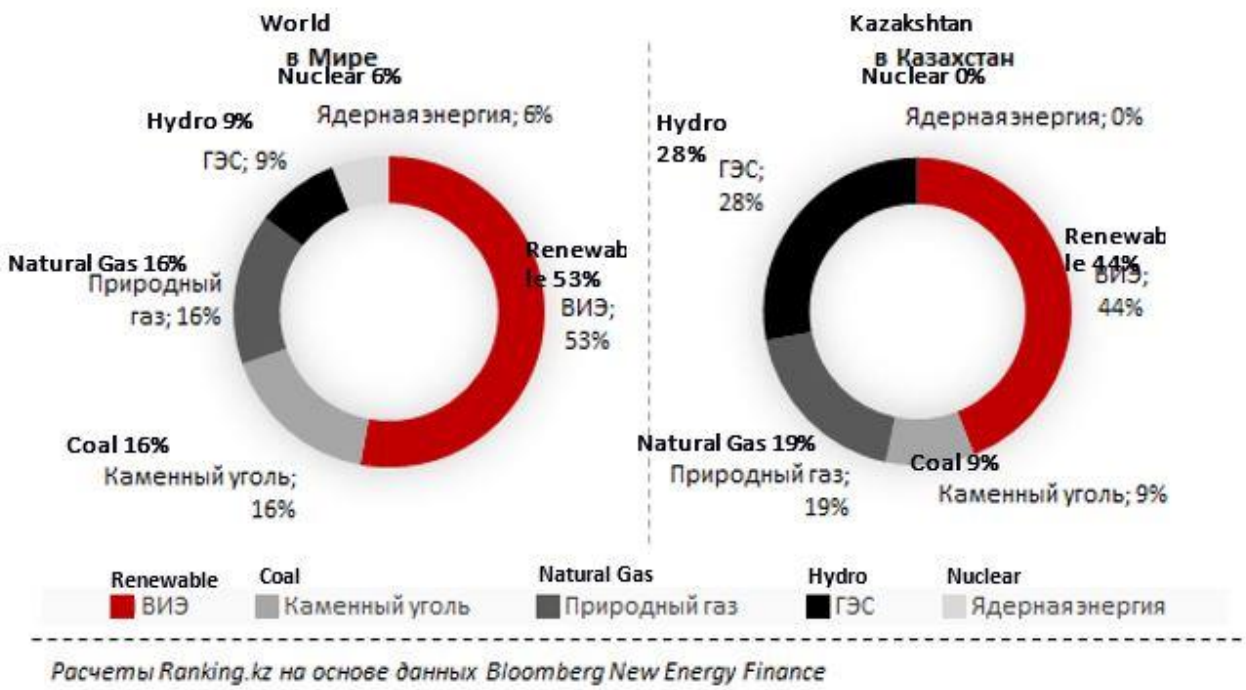

Diagram 2.3 Putting into operation of generating capacities in the world and in Kazakhstan in 2015 with a breakdown by types of energy sources.[28]

"In 2016 there implemented four renewable energy projects in Kazakhstan with a total capacity of 50,39 MW, in 2017 it is planned to put into operation 12 renewable energy facilities with an installed capacity of 114,25 MW."[29]

From the above data, it can see that RES are ahead of traditional sources in terms of the relative increase, but are certainly lagging behind in terms of the capacity of the newly commissioned (restored) facilities.

2.1.2. Power consumption

Kazakhstan ranks third among the CIS countries in terms of electricity consumption. According to the Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, the total apparent consumption of electricity reached its maximum in 1990 and amounted up to 104,7 billion kWh, and to date this is the highest figure. In 90s of the last century, the total power consumption fell sharply by more than half (by almost 52%) and in 1999 it constituted 50,3 billion kWh. Kazakhstan was one of the few countries of the former USSR, where the rate of reduction in electricity consumption has outpaced the decline in gross domestic product (GDP) (in percentage terms) in the initial transition period.
According to the results of 2015, the total energy consumption in Kazakhstan has decreased by 17,3% and in 2015 amounted up to 64,572,7 thousand toe (Diagram 2.6).[30]

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[28] http://ranking.kz/ru/a/infopovody/v-mire-proizoshlo-smeshenie-invvesticiy-v-storonu-vie-v-2015-godu-proekty-vie-sozdali-bolee-poloviny-536-ot-novyh-moshnostej-po-vyrabotki-elektroenergii

[29] https://express-k.kz/news/lenta_novostey/kazakhstan_planiruet_v_2017_g_proizvesti_94_2_mlrd_kvtch_elektroenergii-94713

[30] Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, http://stat.gov.kz/faces/wcnav_externalId/ecolog-G-26?lang=en&_afrLoop=2079924557686078#%40%3F_afrLoop%3D2079924557686078%26lang%3Dru%26_adf.ctrl-state % 3Dtap9wywnn_30

The economy of the republic is characterized by high energy intensity of GDP in comparison with similar indicators of developed countries. By this indicator Kazakhstan lags far behind not only the developed countries of the world (10-17 times), but also Russia and Belarus, whose economic structures are very similar to Kazakhstan one.

High energy consumption in the industrial sector of Kazakhstan is due, first of all, to such energy-intensive industries as mining and metallurgy. 69,7% of total electricity consumption and 51,7% of total heat consumption in the country fall to the industrial sector, while in the European Union the share of electricity consumption by the industrial sector averages 24%.

There was carried out an energy audit at four enterprises of metallurgy, energy generating and machine-building industries with the involvement of foreign and domestic experts, the results showed a significant energy saving potential from 13% to 40%: Kazzinc JSC - 13%, Aksu ferroalloy plant JSC - 15% , Khimpharm JSC - 32%, Petropavlovsk Heavy Machinery Plant JSC - 40%.[31]

In addition, the housing sector consumes 11% of electrical energy and 40% of heat. According to expert data, about 70% of buildings do not meet modern energy efficiency requirements. Because of this they lose up to 30% of heat through the walls. On average, the level of heat consumption for buildings in Kazakhstan is 270 kWh / m2, which is significantly higher than the average European figures – 100-120 kWh / m2.

In the general structure of electricity consumption in Kazakhstan, the major share is occupied by large industrial enterprises, their share is 38% of the total consumption in the republic, while Aksu Ferroalloy Plant JSC consumes more than 6% of the whole electricity of the country. A significant share of industry in the total consumption of electricity is due to the prevalence of heavy industry in the economy with a significant aging of assets of industrial enterprises and use of obsolete technologies.

In the period 2017-2023 the Ministry of Energy plans to increase energy consumption by 14%, from 90,6 to 105 billion kWh.[14]

31 Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (JSC "KOREM")

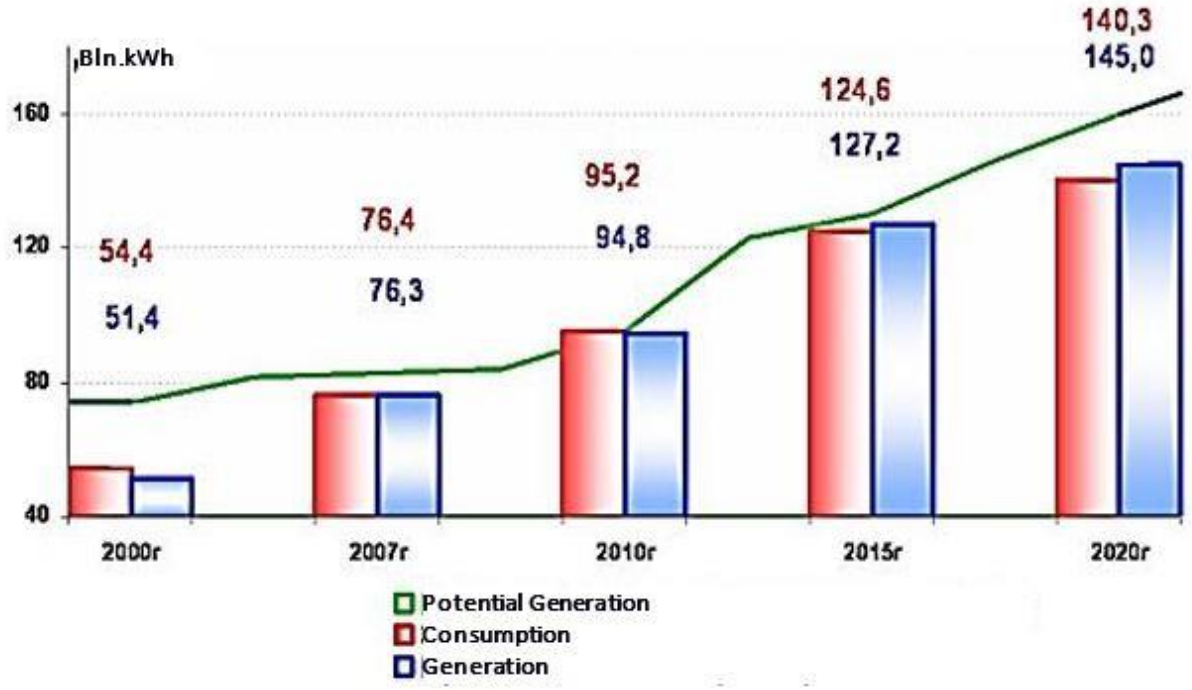

Diagram 2.4 – Ratio of planned and actual numbers of installed capacities for power generation, volumes of generation and consumption of electricity in the Republic of Kazakhstan in the period 2000-2020.

2.1.3. Import and export of electricity

The Republic of Kazakhstan provides itself with electricity with a surplus. The ratio of the volumes of exported and imported energy varies significantly from year to year, depending on the availability of hydro resources of the Central Asian countries and the general state of the electricity market.

Diagram 2.5 - Import and export of the electric power in Kazakhstan, mln kWh, 2008-2014. (Source KOREM).

"The balance of electricity in the republic in the Q1 2017 is characterized by following indicators:
Power exchange (output) from Kazakhstan to Russia amounts to – 824,8 million kWh.
Power exchange (output) from Kazakhstan to Central Asia amounted to – 1,0 million kWh».[32]

2.1.4. Electrical network

The electrical network of the Republic of Kazakhstan consists of substations, electricity distribution plants and transmission lines connecting them, with a voltage of 0,4-1150 kV, intended for transmission and (or) distribution of electric energy. The National Electric Grid is the backbone in the Unified Energy System of the Republic of Kazakhstan. The National Electric Grid is managed by KEGOC JSC.

KEGOC operates 297 35-1150 kV transmission lines with a total length of 24,533 km and 76 electric substations with an installed transmission capacity of 35 875,05 MVA.

Within the framework of the existing ownership structure in the electricity distribution and transmission segment, part of the 200 kV networks belong to the Regional Energy Company(REC), which complicates the optimization of the operation of the Unified Energy System of Kazakhstan and its development. In addition, a large quantity of power transmission companies lead to high

[32] Report of KOREM JSC for the 1st quarter of 2017, http://www.korem.kz/details/ndownload.php?fn=4049&lang=eng

specific cost for electricity transmission services because the economies of scale in the allocation of costs for maintenance of electrical networks and overhead costs are neglected.

High aging of grid assets is a major problem in the transmission and distribution sector. Electricity losses in transmission lines are slightly higher than in developed countries, which are characterized by shorter transmission distances and greater market capacity. In Kazakhstan there are typically long-distance networks between the main centers of consumption and generation. In addition, the Republic of Kazakhstan is characterized by sharply continental climate, which adversely affects the losses due the corona discharge in electric networks with a voltage of 220 kV and higher (the share of losses on the corona discharge is 20-30% of total losses). In this connection, taking into account the indicated objective factors, the normative technical losses in the national electric grid of about 6-7% are practically optimal.

In 2013, the Kazakhstan Development Bank in its review of the electric power industry announced that "further development of Kazakhstan's economy requires additional volumes of electricity generation[33]", although it does not support this statement with any arguments and calculations. It should noted that Kazakhstan is characterized by a wide range of equally well-reasoned statements, both about the need for additional energy generation, and about the absence of such need. In fact, in recent years, a stable positive balance of the energy balance in Kazakhstan as a whole has been observed, which is reflected in the energy balances approved in 2016 for the period 2016-2023[34]. In the same survey it was noted that "it is necessary to develop electric grid facilities with a voltage of 220-500 kV and above, mainly backbone, interregional and inter-state power transmission lines."

The main issues on National Electrical Grid that need to be addressed is the limited capacity of the networks in the main areas: North-South and North-East, the lack of communication between Western Kazakhstan and the Unified Energy System Kazakhstan, and insufficient level of technical equipment.

Investments in the renewal, modernization and construction of electrical grid from 2016 to 2030 are estimated at level of 2,5 trillion tenge (in 2011 prices), including: in the backbone network – 0,8 trillion tenge, in distribution network – 1,7 trillion tenge.[35]

In this regard it is planned to implement a number of priority projects for the development of the National Electrical Grid until 2025:

- “Construction of the 500 kV North-East-South transit” to strengthen the connection of East region with the Unified Energy System of Kazakhstan. It should ensure the delivery of the full capacity of the Shulbinsk HPP while the counter-regulator - Bulaksk HPP – is put into operation, increasing the reliability of electricity supply in the Eastern energy zone, Almaty oblast and strengthening of North-South transit;

- “Output of Balkhash TPP capacity” will ensure the delivery of capacity of the Balkhash thermal power plant that is under construction;

- "Connection of the power grid of Western Kazakhstan with the Unified Energy System of Kazakhstan" will improve the reliability of electricity supply to consumers in the Western zone of the Unified Energy System of Kazakhstan, will ensure the delivery of the capacity of the proposed power plant in Aktau;

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33 Kazakhstan Development Bank "Review of the Electric Power Industry of the Republic of Kazakhstan in 2013".

34 Order of the Minister of Energy "On approval of the forecasted balance of electricity generation and capacity for 2017-2023" # 460, October 26, 2016. http://energo.gov.kz/assets/old/uploads/files/2016/11/%D0%9F%D1%80%D0%B8%D0%BA%D0%B0%D0%B7%20460%20%D1%80%D1%83%D1%81.pdf

35 Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (KOREM JSC)

- "Construction of 220 kV Uralsk-Atyrau and Kulsary-Tengiz transmission lines" in order to strengthen the electrical connections between the oblast in the Western zone of Kazakhstan;
- "Construction of a 500 kV Kazakhstan-Kyrgyzstan interstate transmission line" in order to improve the reliability of electricity supply in the three southern regions of Kazakhstan and the north of the Kyrgyz Republic;
- "Construction of 500 kV Astana Substation and 500 kV Nura-Astana HVL" in order to ensure the reliability of electricity supply in Astana and Akmola oblast.
- "Construction of the 500 kV Nura-Zhezkazgan line" in order to ensure the reliability of the power supply of the Zhezkazgan energy center.
- “Torgay TPP capacity output" on the basis of Torgay coal deposit in Kostanay oblast.

2.1.5. Energy market

KOREM JSC is the operator of the centralized auction market and is an integral part of the infrastructure of the electricity market of the Republic of Kazakhstan.
The current model of the electric energy market is based on the principle of voluntary participation in centralized auction. This led to such negative effects as lack of access to cheap electricity for consumers, violation of the principle of equal access, non-transparency of bilateral transactions and creation of hidden schemes for electricity speculation.
There are should noted the following unresolved problems of the wholesale electricity market, which negatively affect the liquidity of the centralized auction electricity market:

1. At present, the wholesale electricity market is a "tough oligopoly," which is the result of the existing structure of electricity generation, so up to 50% of electricity supplies comes from the country's three largest power stations. This prevents consumers from freely choosing the supplier of electricity.
2. There was no mechanism developed to ensure construction of new generating capacities, reconstruction and capital repairs on existing units, as it believed that the market itself would provide price signals to investors. This approach led to the fact that the industry faced a serious problem - the deficit of generating capacities in the power system. After the introduction of marginal tariffs for electricity, ensuring the implementation of the principle - "tariff in exchange for investment," in 2009 the price of electricity from energy sources increased by 30-50%.
3. The balancing market of electric energy is not functioning as for its normal work all the players should have deployed the Automated system of commercial metering of electricity within a limited period of time defined by Law. This work has dragged on for several years and until now the issue of equipping with ASCME devices has not been resolved[36].

Despite the increase in prices, wholesale electricity prices in Kazakhstan are competitive compared to other countries in the world.

2.2. Thermal power

A common feature of the energy balance of the CIS countries is the availability of a well-developed system of district heating and Kazakhstan is no exception. The share heat supply through the centralized system was 15-17% over the past years.

36 http://www.korem.kz/uploads/file/Concept_draft.doc

The number of heat supply sources in 2015 was 2,527 units, including breakdown by capacity[37]:
Up to 3 Gcal/h - 163 units,
From 3,1 to 20 Gcal/h - 598 units,
From 20,1 to 100 Gcal/h - 180 units,
Over 100,1 Gcal/h - 110 units.
At the end of 2015, the number of installed boilers (power generation units) was 5,992 units.
The length of thermal and steam networks in 2015 constituted 11880,4 km, including the longest in the following regions (in descending order):

- Karaganda oblast - 1 973,6 km;
- Almaty city - 1 263,3 km (for comparison: the length of networks in Almaty oblast, excluding the city of Almaty, is 548,8 km);
- East-Kazakhstan oblast - 1 107,3 km;
- Kostanay oblast – 806,6 km;
- South-Kazakhstan oblast – 728,3 km, etc.

According to official data in 2015 the amount of thermal energy produced in Kazakhstan constituted 83,12 million Gcal. Thermal energy is produced by following sources: 40 thermal power plants (which account for 45% of the heat produced in the country); 28 large boiler-house plants (35% of the produced thermal energy) and 886 small boiler-house plants (less than 100 Gcal/h), which makes about 20% of the produced heat. In majority of cases the above-mentioned facilities are substantially aged (thermal power plants, boiler houses and heating networks); depreciation of heat-generating equipment is estimated at level of 70%. About 24% of heat networks also require immediate replacement (in some areas about 50% of networks are depreciated). In accordance with the "Concept of development of the fuel and energy complex of the Republic of Kazakhstan until 2030" written in 2014, no more than 75% of the produced heat reaches the end user. Such a high degree of depreciation is the result of inadequate maintenance due to a shortage of financing for decades, and as a consequence, neglect of the requirements of technological exploitation (including the use of poor quality coal and water) and the lack of an effective management system.

As it was mentioned earlier, the cost of thermal energy in Kazakhstan is regulated by the state, while the tariff for CHPP plants is based on the so-called heat-sharing method for combined heat and power generation. The distribution of the variable costs between the generation of heat and power at the CHPP using this method is calculated by several approved methods: physical, exergy, and ORGRES one (only at Mangystau Nuclear Power Engineering Plant).

The physical method shifts most of the cost to heat generation with lower cost for electricity generation, and the exergy method, on the contrary, allows to reduce the cost of heat generation artificially by increasing the cost of electricity. Both methods have physical and economic grounds and are used in practice since 2005, while the division of costs between the generation of heat and electricity - the conventionality necessary to calculate the economic parameters of the plant. However, given that the tariffs for thermal energy are often set at a level too low to cover the costs of its generation and to stimulate sufficient investments in thermal power assets (due to the Government's policy of curbing the growth of tariff for heat), in practice, the methodology for redistributing of costs from the generation of heat to generation of electricity, in fact, legitimizes the "subsidization" of thermal energy at the expense of electric energy.
The CHPP remains to be the key source of heat supply, and given that the fuel utilization factor at CHP plants is higher than at condensing power plants and boiler-house plants, they are physically more efficient.
However, in practice, due to the social factor, heat tariffs are put too low, and therefore CHP plants may be less profitable than condensation power plant and boiler-house plants. The tie-in of the CHPPs to the heat consumption schedule and restrictions in the tariff policy does not allow the

[37] Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (KOREM JSC)

CHPPs to demonstrate economical advantages of cogeneration. In addition, another important factor in the low profitability of CHPPs is the reduction of thermal loads comparing to design values. As a result of the general economic downturn that began as early as the end of 1990s, the consumption of heat (steam) by industry, as well as by medium and small businesses, has sharply reduced. As a result, the main consumers of heat from the CHPPs were public sector enterprises and housing stock (i.e. consumers who tend to experience difficulties with paying for heat and electricity). At the same time, CHPP plants that supply industrial consumers demonstrate acceptable economic indicators (for example, Pavlodar CHPP-3, which supplies steam to the Pavlodar refinery).

The reason for high costs and losses in the heat economy is the depreciation of equipment and infrastructure as a result of a long period without investments. Currently, the lack of sufficient investment is based on the fear of investors that their investments will not pay off with the existing methodology for heat tariff calculating. At present, the tariff is calculated by "cost plus" method, while the growth of heat tariff is restricted, since it should not lead to an increase of the projected inflation above the target level. Thus, operators of CHPPs and boiler-house plants lack incentives for investment, since any increase in efficiency leading to a reduction in the cost of heat production will lead to a reduction in the heat tariff in the next tariff period, rather than an increase in operating profit.
Heat industry needs a methodology for setting of a long-term tariff, in which the basic value of heat tariff would be fair (i.e. cover costs and ensure return on investment).

One of the possible ways to solve the issue of heat tariff formation may be the transition to an economic model that will determine the cost for generation of heat and electricity, and calculate the specific fuel consumption individually for each CHPP with simultaneous use of two (or more) methods. It will help to define the optimal tariff for electricity and heat, to increase the profitability of the CHPP taking into account the conditions of the region where it is located. This approach will help to determine the optimal tariff for heat (and electricity) for each CHPP. However, such an approach will not help to solve the issue of competitiveness of CHP plants operating in the heating mode (in comparison with power plants operating in the condensing mode) because the amount of electricity generated depends on the heat load. And the non-market support mechanisms for CHPPs operating in the heating mode (for example, the guaranteed purchase of electricity from the CHPP's, while CPP's electricity will be sold on market conditions without any obligation to purchase it) will contradict the goals of the market – to support the most efficient generation.

Despite the obvious arguments in favor of centralized heat supply and cogeneration in particular, choosing of the most efficient source of thermal and electric energy at a time when the CHPP main heating equipment is depreciated and heat load is lost, will force the market to decide whether to maintain the CHPPs at any cost or to close inefficient ones. The artificial maintenance of the CHPPs involves the risk that the owners of the CHPP will lose the motivation to increase its efficiency (especially in the case of guaranteed purchase of electricity and/or capacity, when such a mechanism will launched). At the same time, such a privileged position of the CHPPs will deprive the condensation power plan and other power stations of motivation for investments, since the efficiency of the power plant will not be a criterion for selection of generation. Setting of a fair tariff for heat, in turn, will help to avoid the use of non-market methods of supporting the CHPPs and stimulate an increase in the efficiency of all types of power plants. While the issue of closing of inefficient CHPPs (10-15%) should carefully weighed with all the pros and cons, technical and economic arguments (in addition to general arguments in favor of cogeneration efficiency) and the availability of alternative sources of electricity and heat generation should become the main ones.
The choice in favor of the supply of heat from modern (high-tech) boiler-house plant will be a weighty argument for the consumer in the long term in case this is justified economically by the

final price of heat (and electricity from another source). Taking into account the development of gas networks, the combined-cycle cogeneration plant projects can recommended for consideration.
The method of "alternative boiler house", developed in Russia, limits the tariff for the heat generation and transfer to the marginal value – the lowest price at which the new boiler house replacing heat from central sources pays off. At the same time, the tariff for thermal generation cannot be higher than the tariff for an "alternative boiler house", which will become a constraint for growth.
In a situation where the economic and technical arguments for the generation of heat are in favor of the CHPP, the tariff for thermal energy, at a minimum, should cover the costs of the CHP plant for its generation (be on the verge of break-even).

The priority mandatory loading of CHPP during the heating season will have an additional positive effect on the economy of these power plants.

Increasing the profitability of CHPPs through further differentiation of prices for heat for different groups of consumers, can exacerbate the problem of "cross subsidizing" between consumer groups, without solving the problem of modernization and increasing the efficiency of the sector. Thus, the government of Kazakhstan in the near future will have to make decisions on reforming of the heat market simultaneously with changes at the wholesale electricity and capacity market.

3. Trends and dynamics in the production and consumption of coal at the domestic and foreign markets of Kazakhstan over the past 10 years

3.1. Coal industry

For the last 25 years (1990-2015) the biggest amount of coal in Kazakhstan was produced in 1990-1992, and in monetary terms it was the lowest indicator (Diagram 3.1). In the following period, the volume of coal produced has never reached the same level as observed in 1990-1992.
In the last 10 years (2006-2015) there is an increase in coal production and its value, while in the last 5 years (2011-2015) the coal production reached its maximum in monetary terms for the entire observed period (Diagram 3.21).
The last 5 years (2011-2015) are characterized by the following factors:

1. The number of coal mining enterprises decreased by 25% (diagram 3.3, 3.2);
2. The share of coal in the total volume of extracted natural resources in Kazakhstan increased by 1,5% (diagram 3.3);
3. The share of coal in export, on the contrary, decreased (diagram 3.4);
4. Coal consumption at the domestic market has increased (diagram 3.5).
5. The share of coal in export during the last five years, on the contrary, has declined (diagram 3.6).

The distribution of coal at the domestic market is characterized by an increase in coal consumption for industrial and other needs, and coal consumption for electricity and heat generation remained at the same level during these 10 years (diagram 3.7) .6).[38]

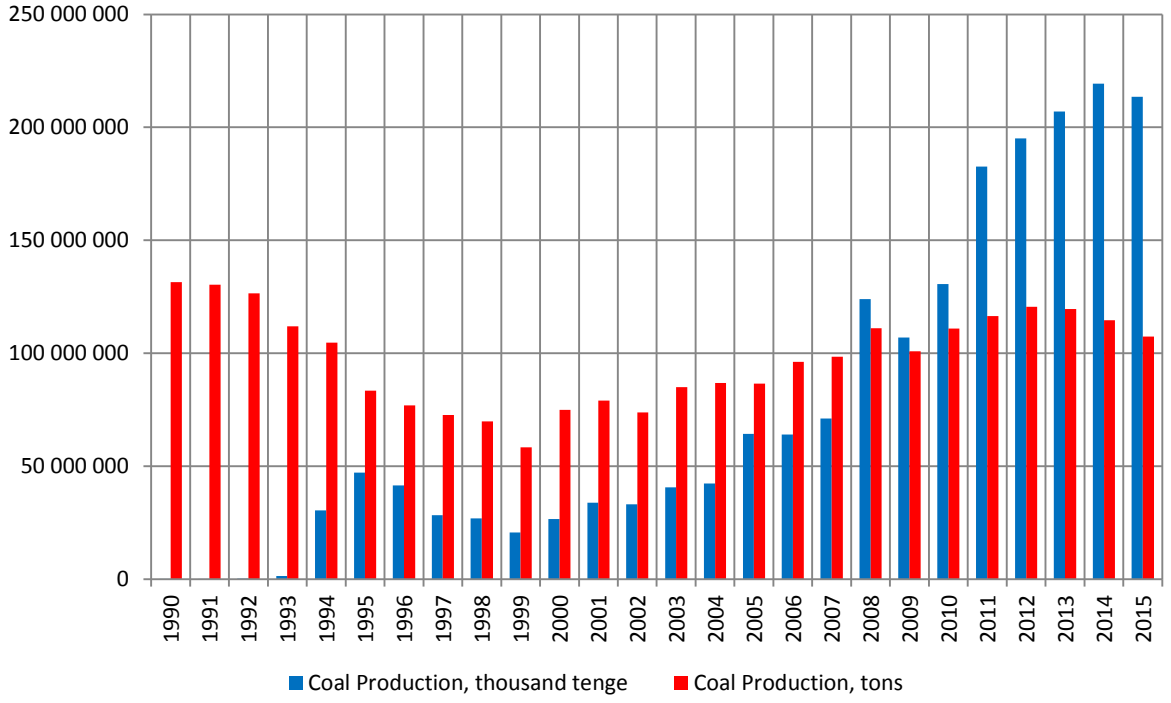

Diagram 3.1 - Dynamics of coal production in monetary terms comparing to coal production volumes (tons) for the period 1990-2015.

[38] Committee on Statistics of the Ministry of National Economy of the Republic of Kazakhstan, http://www.stat.gov.kz

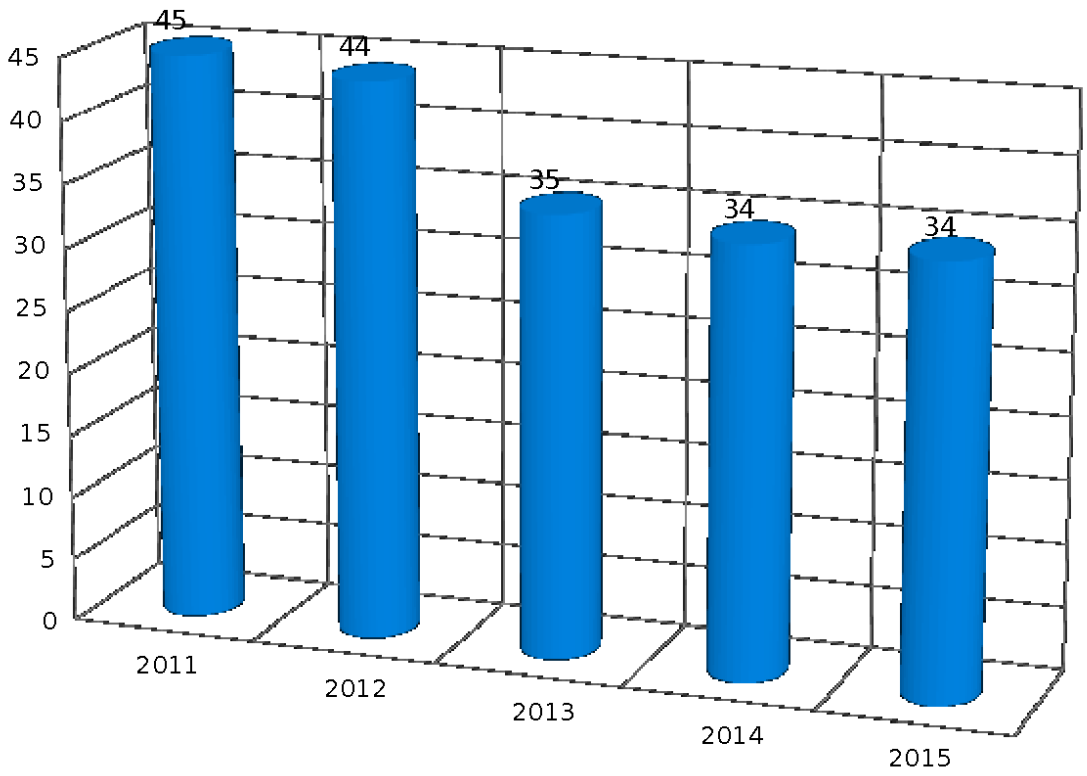

Diagram 3.2 - Number of operating coal mining enterprises in 2011-2015, units

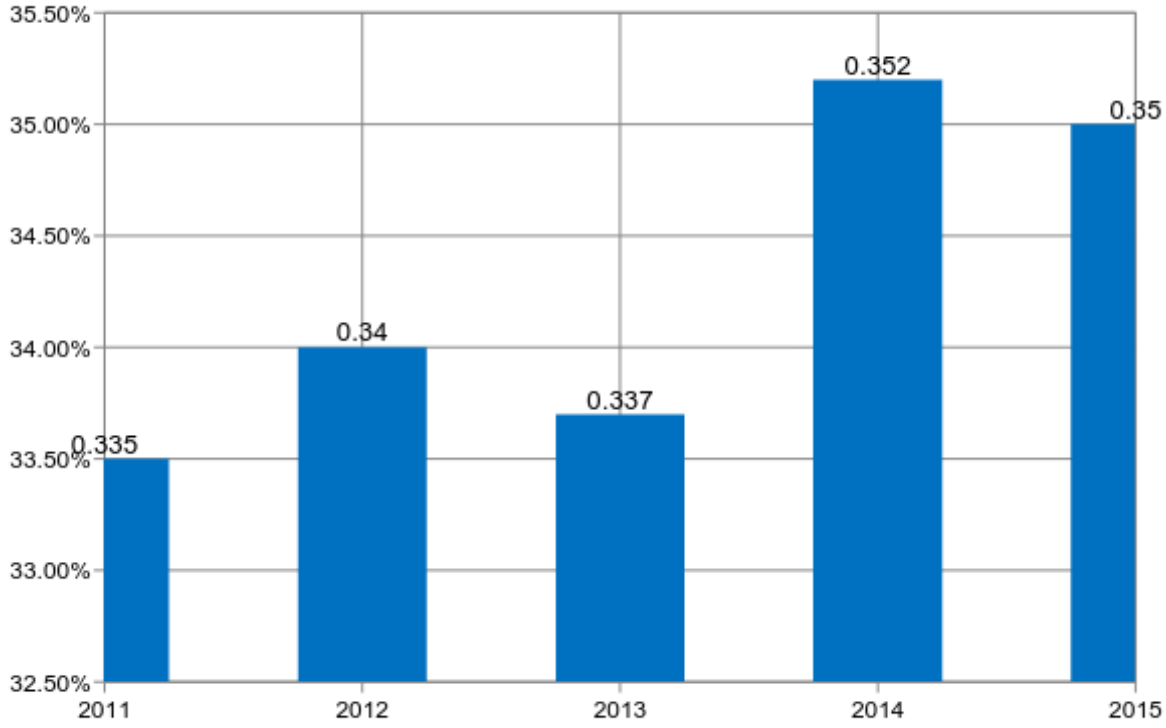

Diagram 3.3 - The share of coal in the total volume of exported natural resources for the period 2011-2015.

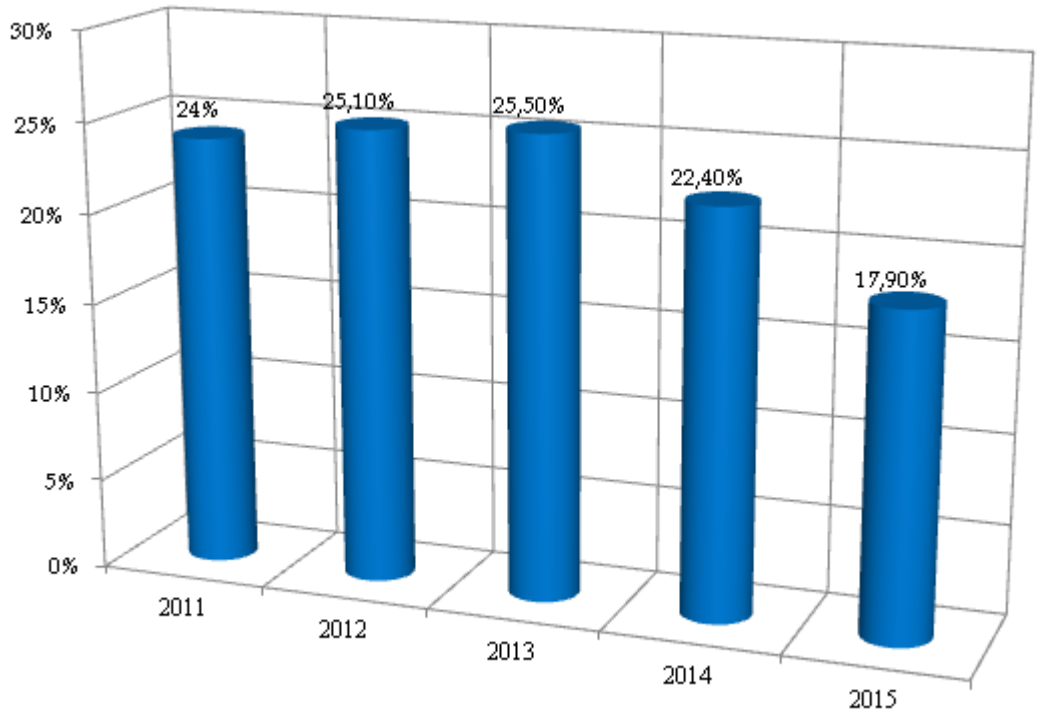

Diagram 3.4 - The share of coal in exports for the period 2011-2015,%

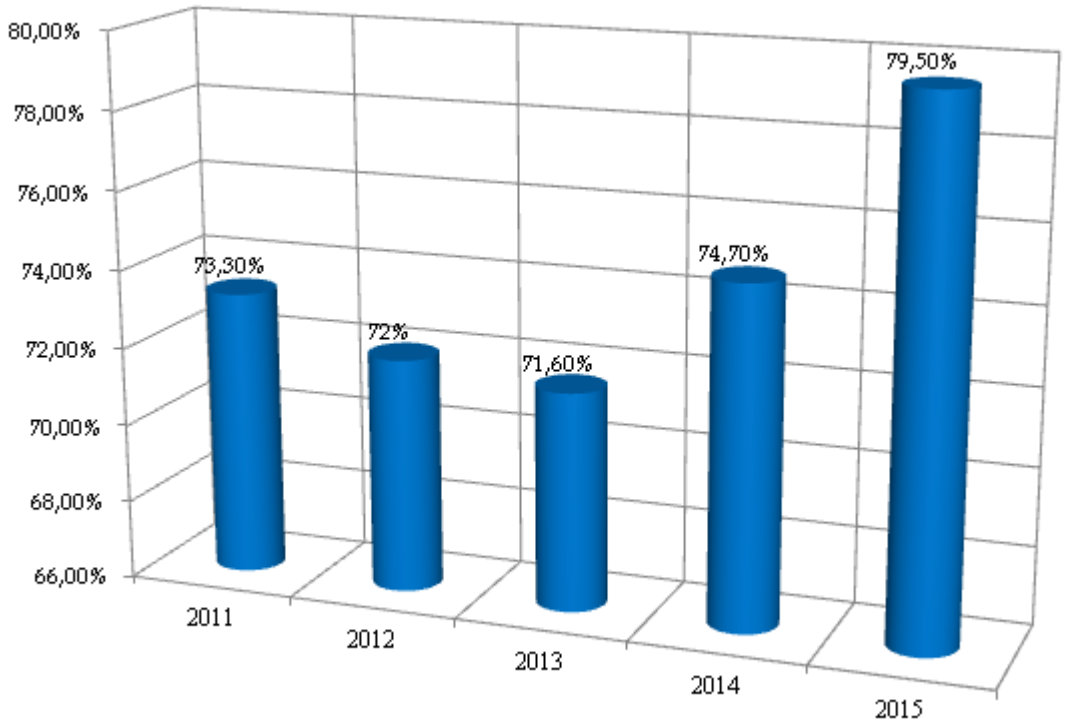

Diagram 3.5 - Share of coal consumption at the domestic market for the period 2011-2015,%

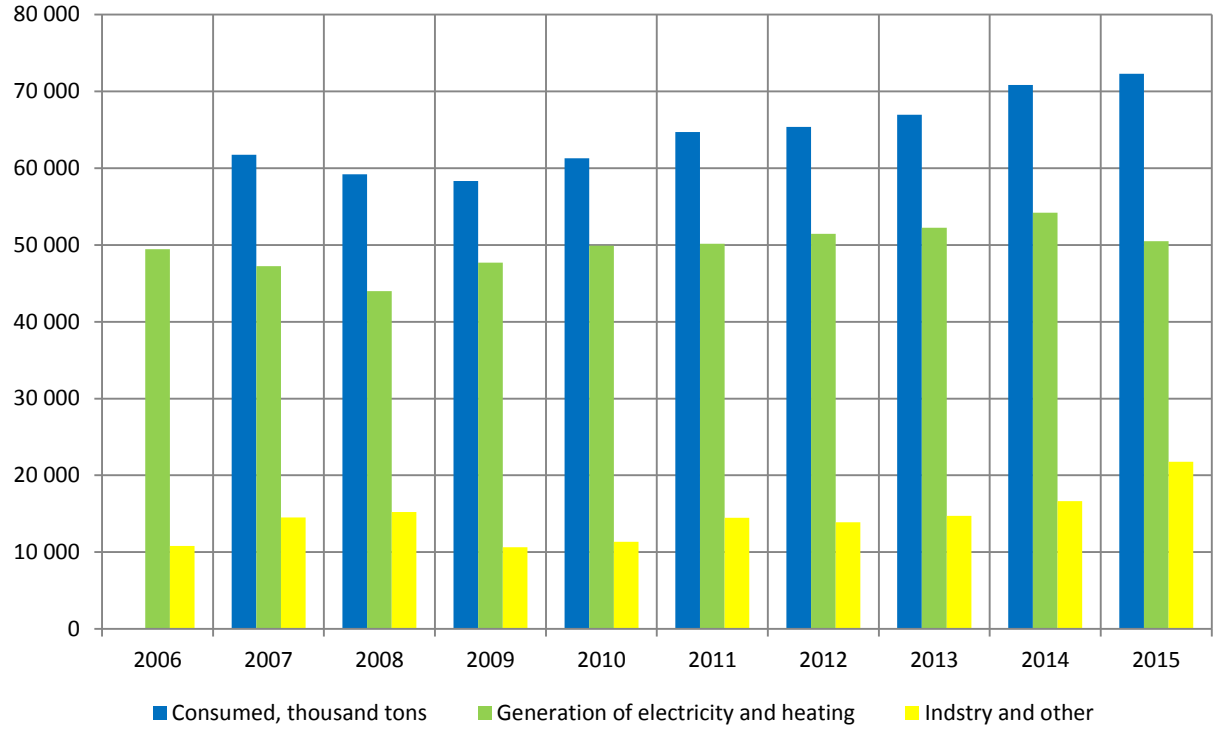

Diagram 3.6 - Distribution of coal by purposes of use at the domestic market for the period 2006-2015,%

3.2. Power industry

The production of electricity (diagram 3.7) in recent years (2012-2015) is characterized by the highest levels of coal consumption for the whole period of 1990-2015, while the production of heat energy during the same period, on the contrary, is decreasing. The largest volumes of heat energy generation were observed in 1990-1992, during the last 10 years (2006-2015) the levels of heat generation are more or less stable, however, in the last three years (2013-2015) there has been a decrease in the heat generation.

Diagram 3.10 shows electricity generation by leading power plants of the republic for the period 2012-2015. It should noted that a number of major power plants in recent years has reduced production volumes (EEK JSC, LLP "Ekibastuz GRES-1", JSC "Station Ekibastuz GRES-2").

In the last 10 years (2006-2015) the following tendencies are observed[39]:

1. the level of electricity production and consumption in the country is constantly growing (diagram 3.8);
2. almost all electricity is produced by thermal and gas turbine power plants (Diagram 3.9), the share of electricity produced by hydroelectric power plants remains at the same level.

The last five years (2011-2015) are characterized by the following factors in the energy sector:

1. A number of major power plants have reduced electricity production: AEC JSC, Ekibastuz GRES-1 LLP, Ekibastuz Station GRES-2 LLP (Diagram 3.10);
2. The final energy consumption in Kazakhstan has decreased by 14,2%; as of the end of 2015 the final energy consumption amounted to 38 779 thousand toe (Diagram 3.11);

[39] The final energy consumption characterizes the final consumption of energy supplied to the end user for use for all energy purposes, both in total and in breakdown by main consumers (industry, transport, households, services and agriculture) in accordance with the International Standard Industrial Classification (ISIC).

3. The level of energy intensity has decreased by 29,4% (Diagram 3.12); while in 2011 the energy intensity level constituted 1,8 toe per thousand US dollars, then in 2015 the energy intensity level constituted 1,27 toe per thousand US dollars. In order to understand the reasons for such a high energy intensity of GDP comparing to other countries, it is necessary to analyze the spheres of consumption of primary fuel and energy resources (coal, oil, gas). Thus, the main consumers of energy resources are energy sector (47,71% of the total primary energy resources), industry (20,36%), transport (16,24%), housing and utilities and population (15,69%).

In the context of oblast, the largest electricity consumption by industry is recorded in Kyzylorda, West Kazakhstan and South Kazakhstan oblast (diagram 3.13); a decrease in electricity consumption is observed in the East Kazakhstan and Karaganda oblast.

Over the past 10 years, the level of electricity consumption and generation has been growing and, is distributed by energy zones of the country as following[40]:

1. The growth of electricity production is observed in North and South zones only. In the Southern and Western zones the electricity production remains almost at the same level (Diagram 3.14);
2. There is an increase in electricity consumption in Northern and Southern zones, after the decline in 2010 the level of consumption in the Western zone remains almost at the same level (Diagram 3.15);
3. As noted above the electricity production in the Northern Zone exceeds its consumption (Diagram 3.16);
4. The level of consumption in the South zone is higher than production (Diagram 3.17);
5. In Western zone in the period from 2006 to 2009 the level of electricity consumption exceeded the volume of its production. Starting from 2010 electricity generation and consumption in Western zone remains practically at the same level - there is no electricity deficit. (Diagram 3.18).

As of the end of 2015 the import of energy resources to Kazakhstan decreased by 22% compared to 2011 and amounted to 9083,4 thousand toe (Diagram 3.19).

The balance of thermal energy distribution (diagram 3.20) is characterized by the reduction in 2015 of heat energy consumption in all categories (including level of heat consumed, losses, as well as the level of heat supplied to enterprises, the population and for export); for the rest of the period, the distribution balance indicators remain almost at the same level.

40 Annual reports of Kazakhstani operator of the market of electric energy and capacity JSC (KOREM JSC)

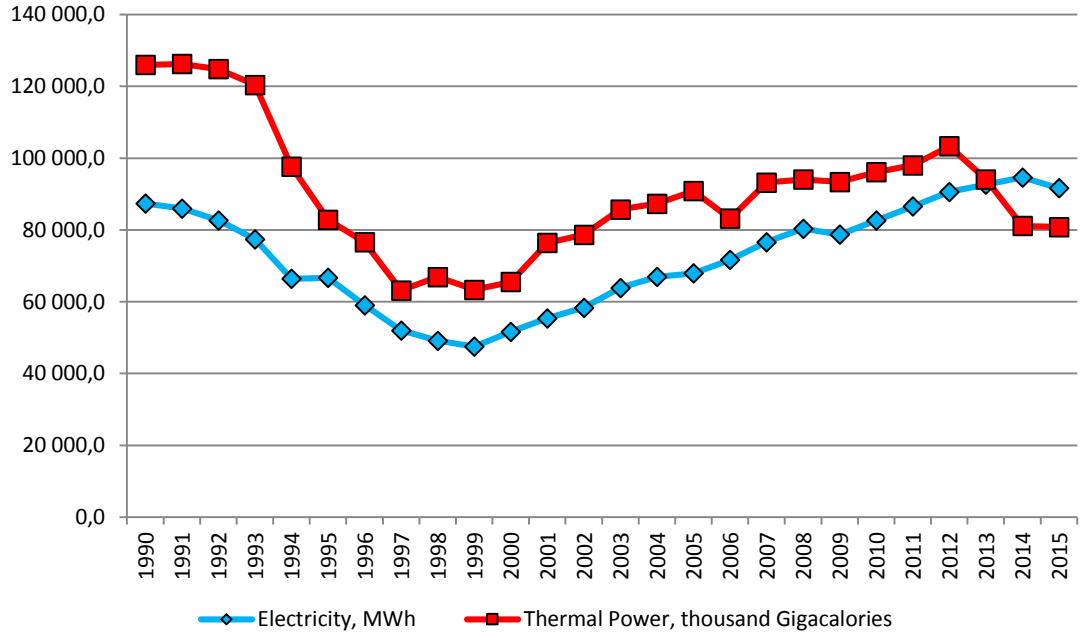

Diagram 3.7 - Production of electricity (million kWh) and heat (thousand Gcal) for the period 1990-2015.

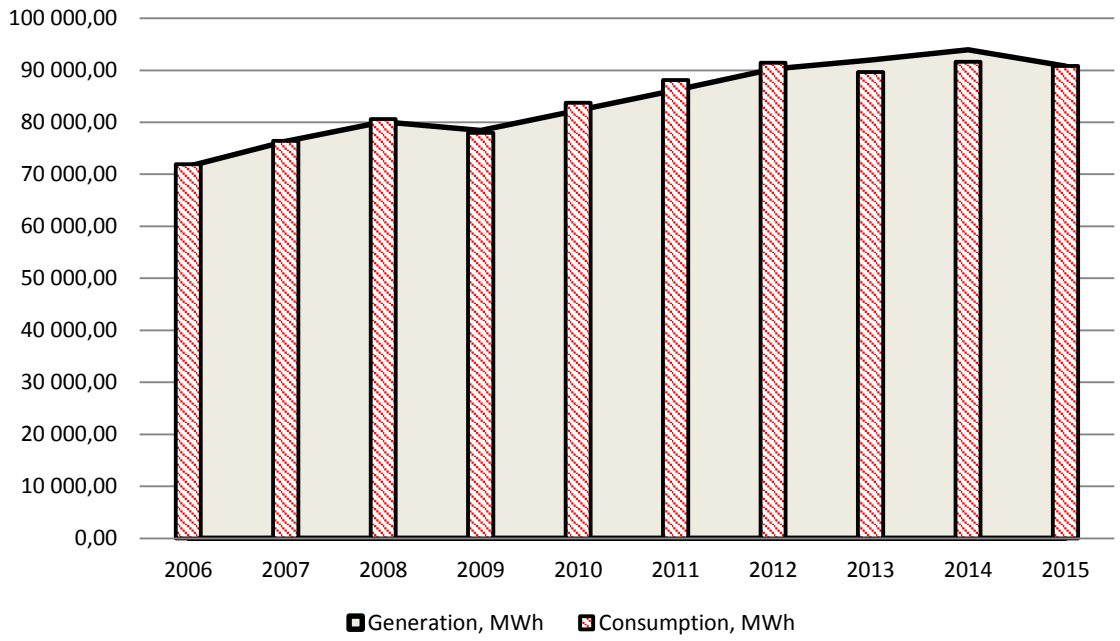

Diagram 3.8 -Production and consumption of electricity for the period of 2006-2015, million kWh

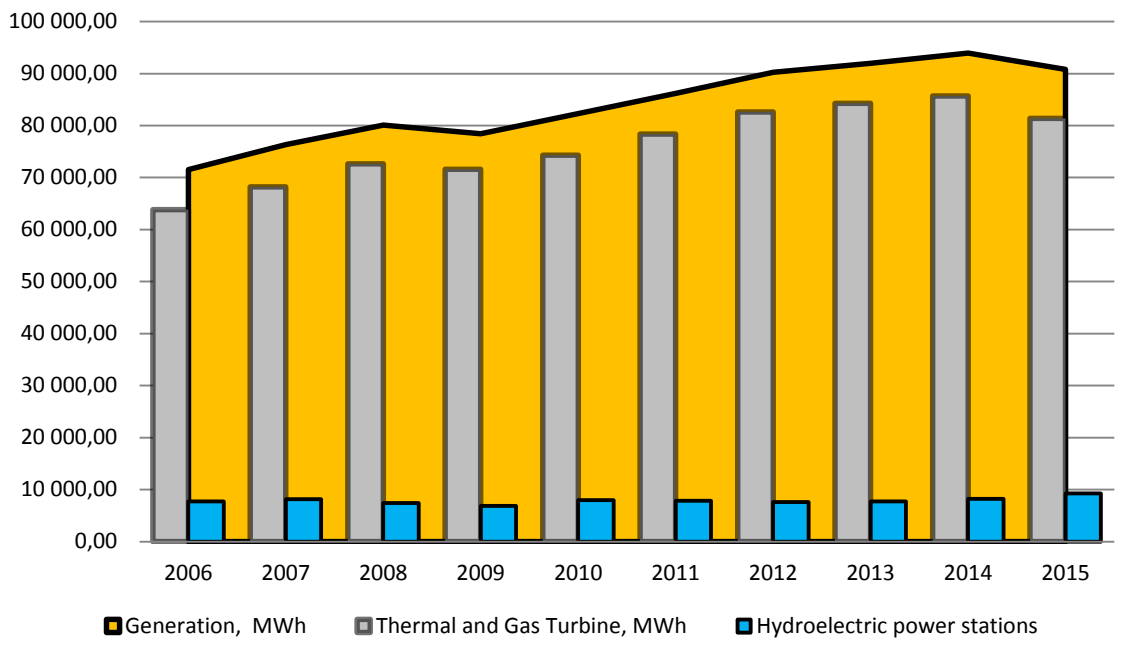

Diagram 3.9 - Electricity generation (million kWh) for the period of 2006-2015 by types of power plants

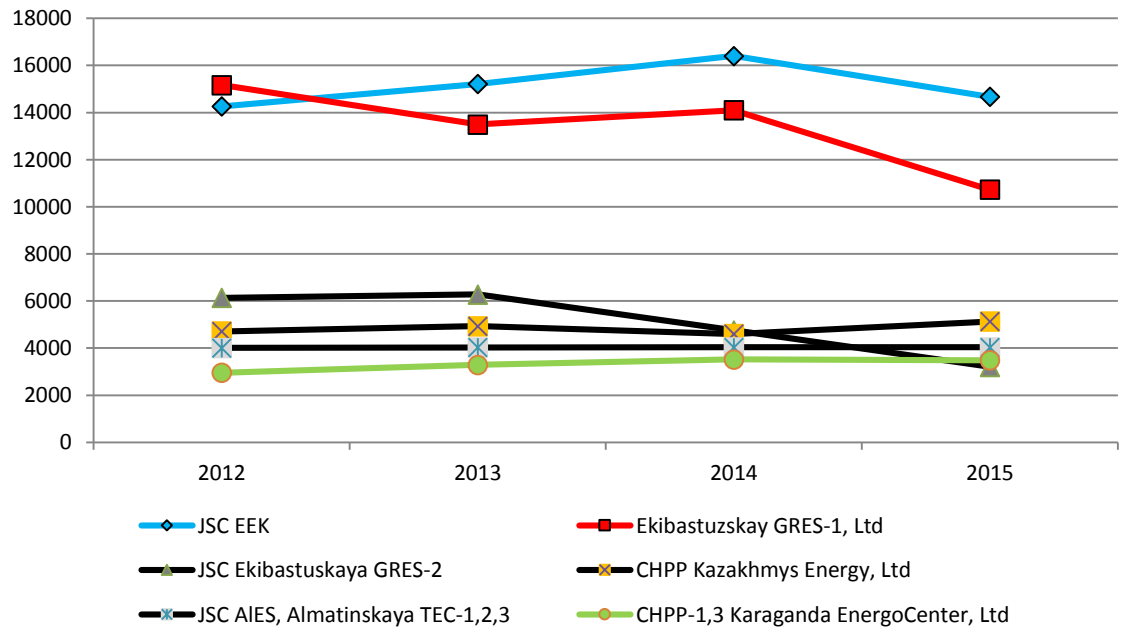

Diagram 3.10 - Electricity production (million kWh) by leading power plants for the period of 2012-2015

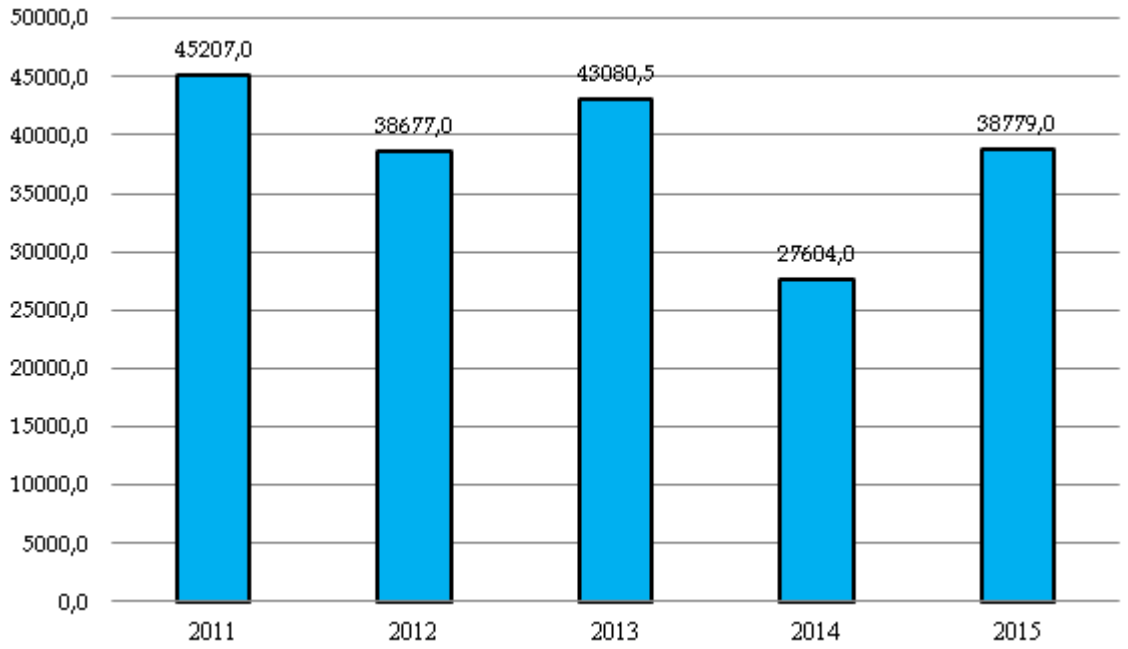

Diagram 3.11 - Total final energy consumption for the period of 2011-2015, 1000 tons

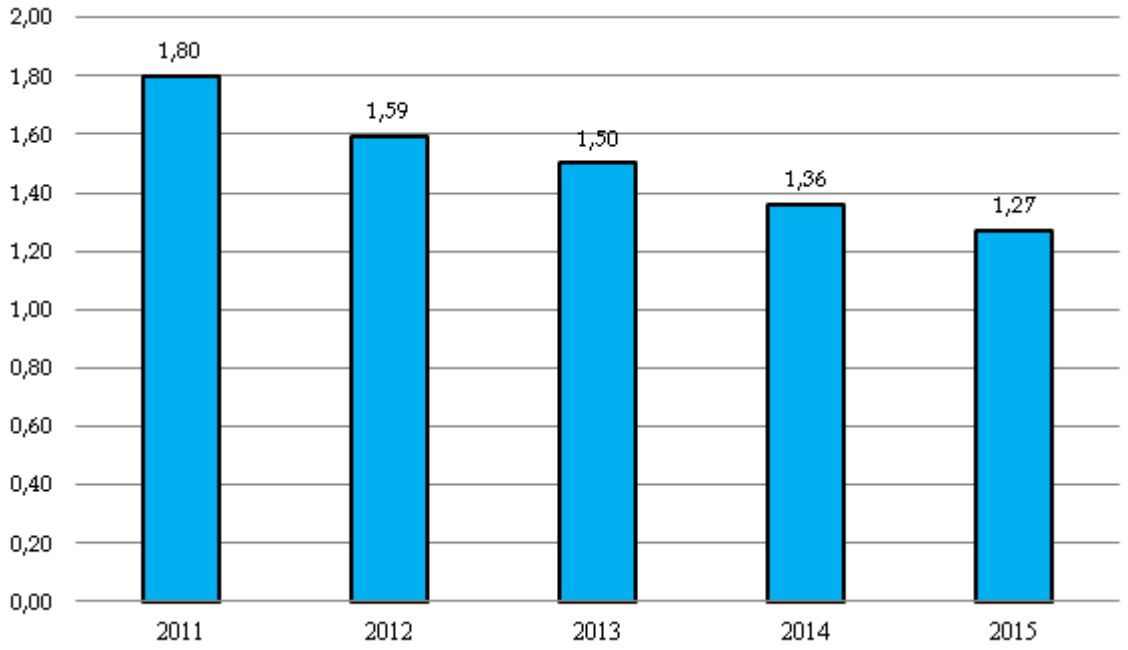

Diagram 3.12 - Energy intensity of GDP for the period of 2011-2015, toe per thousand USA dollars in the prices of the year 2000.

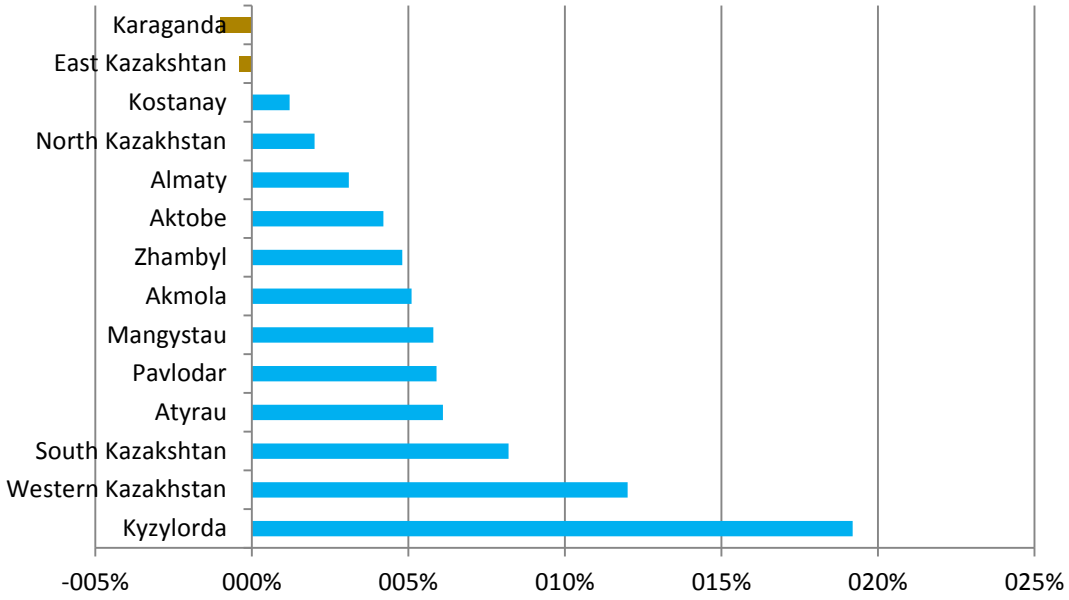

Diagram 3.13 - Average growth of electricity consumption level per year by the industry of Kazakhstan by oblast over the past 10 years

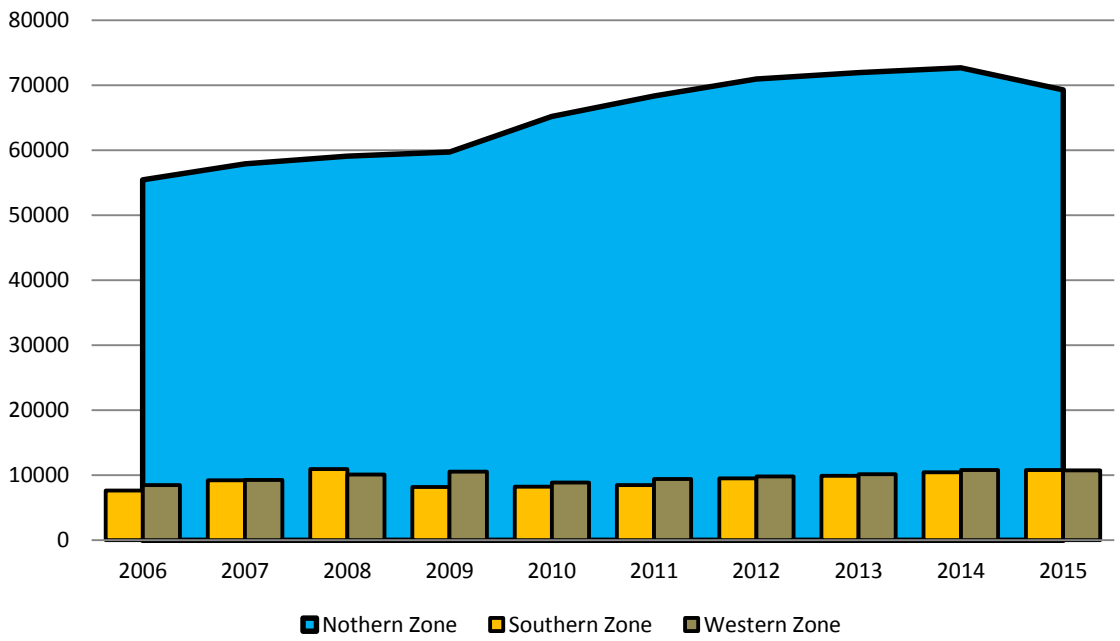

Diagram 3.14 - Electricity production by zones for the period of 2006-2015, million kWh

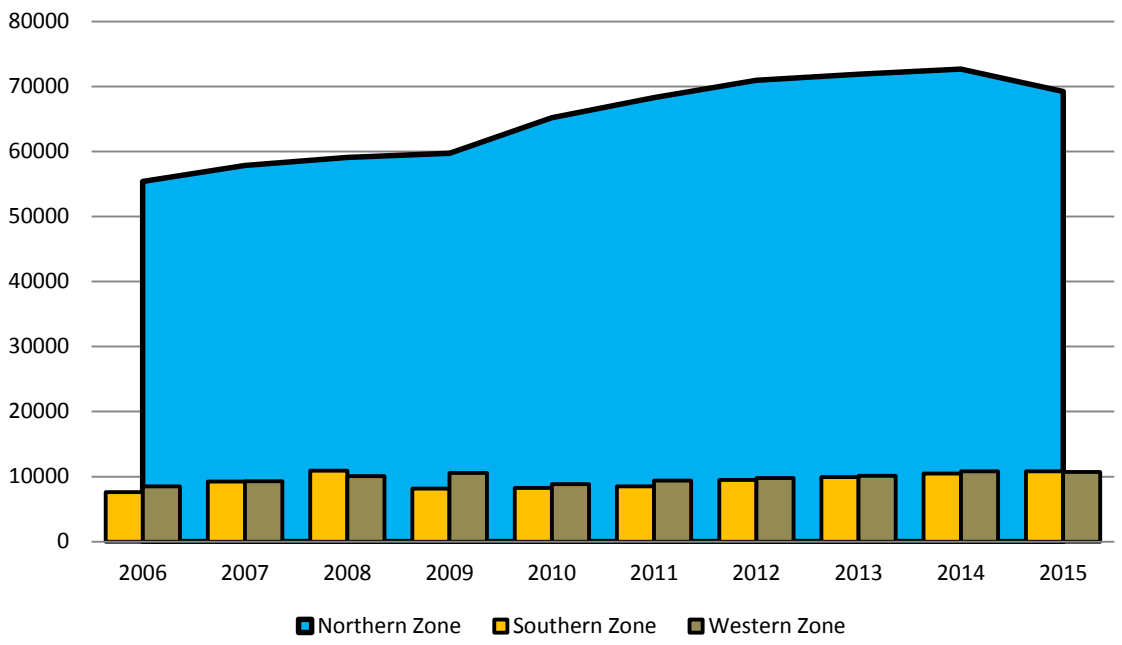

Diagram 3.15 - Electricity consumption by zones for the period of 2006-2015, million kWh

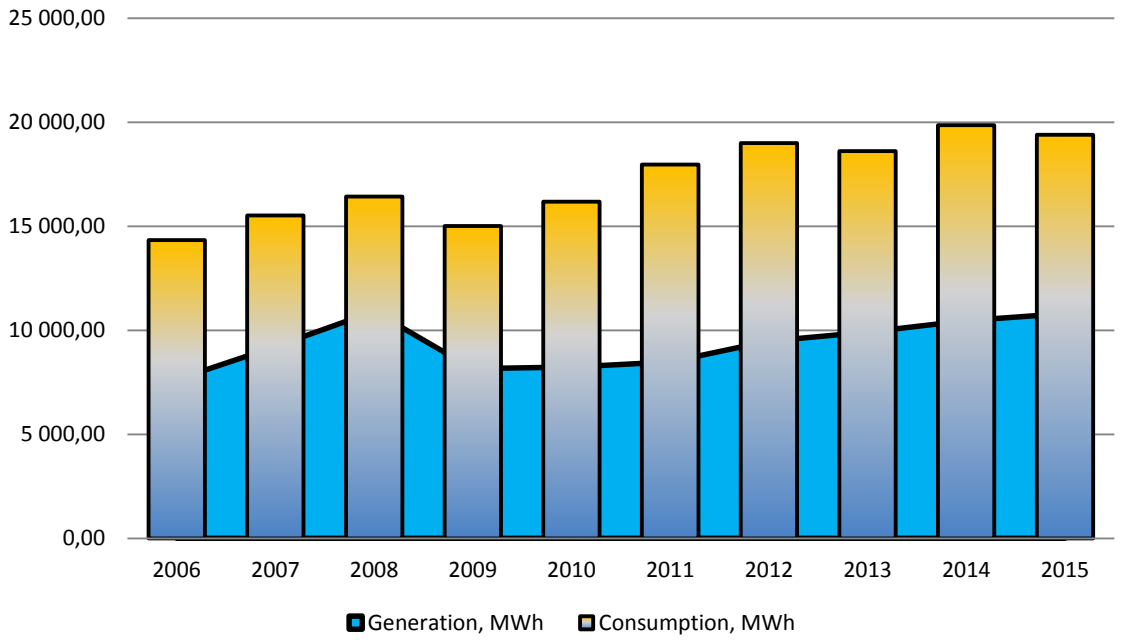

Diagram 3.16 - Balance of electricity production and consumption in the Northern Zone for the period of 2006-2015, million kWh

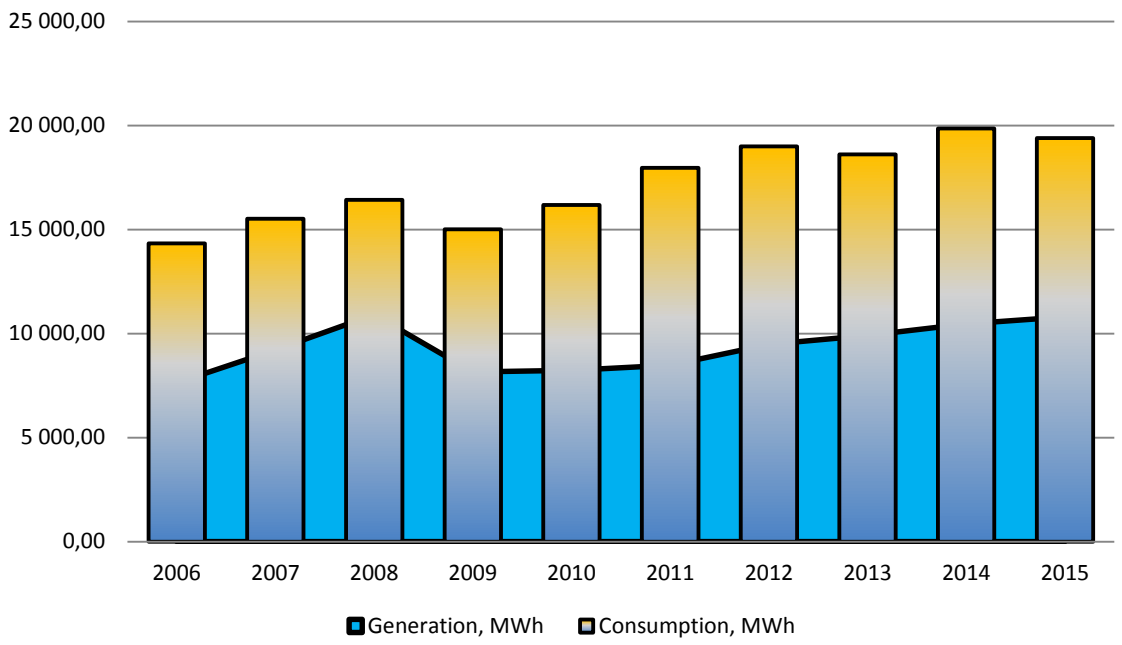

Diagram 3.17 - Balance of electricity production and consumption in the Southern Zone for the period of 2006-2015, million kWh

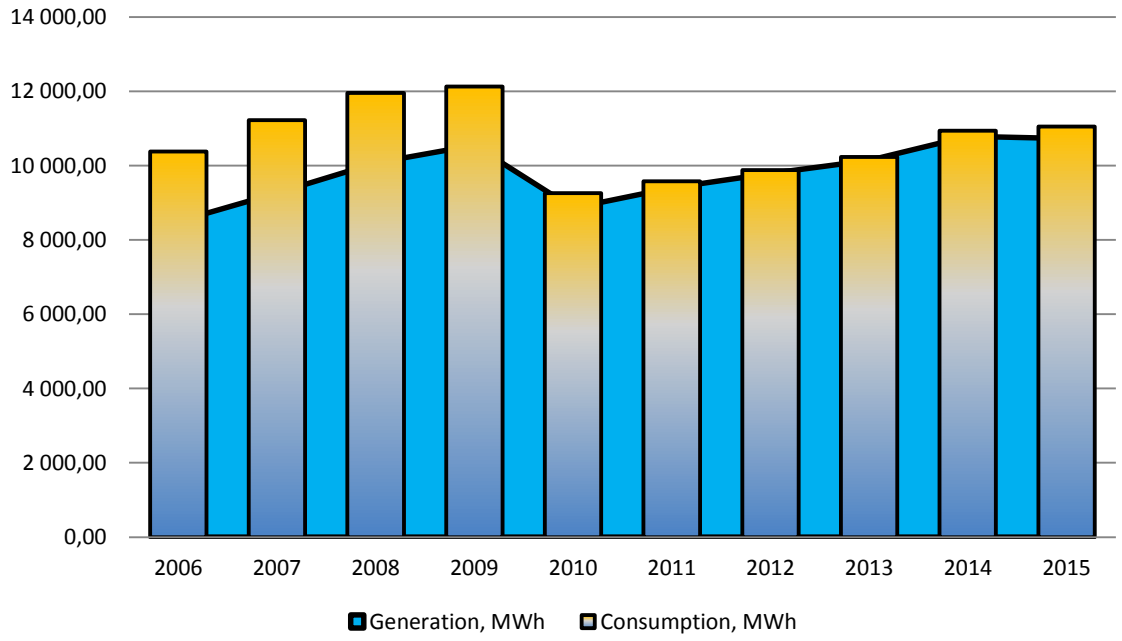

Diagram 3.18 - Balance of electricity production in the Western zone for the period of 2006-2015, million kWh

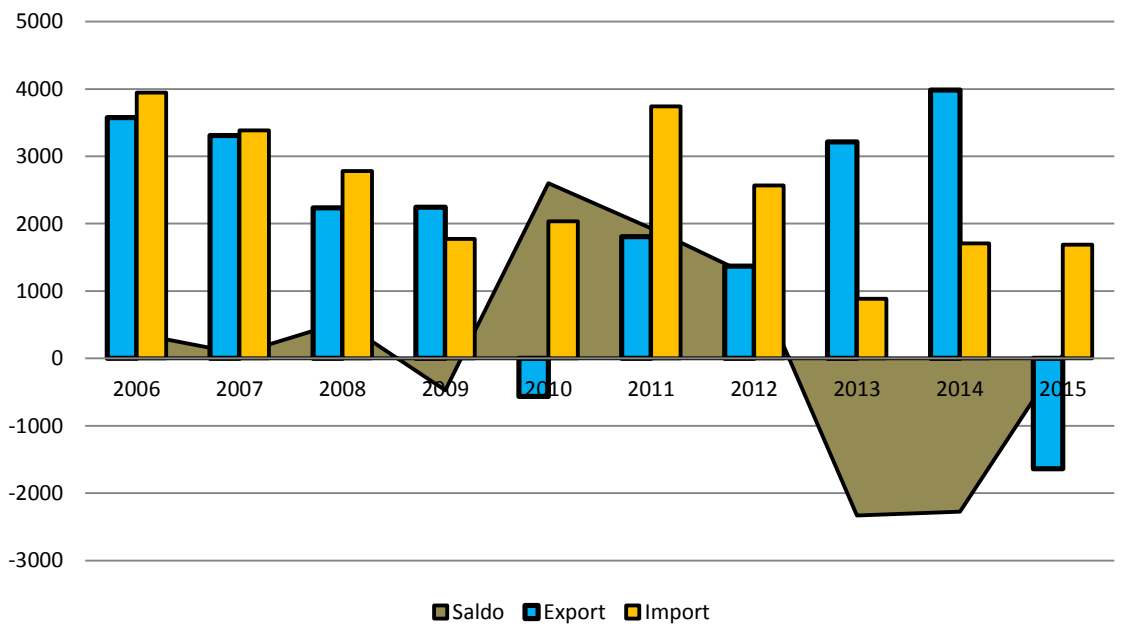

Diagram 3.19- Import-export of electricity for the period of 2006-2015, million kWh

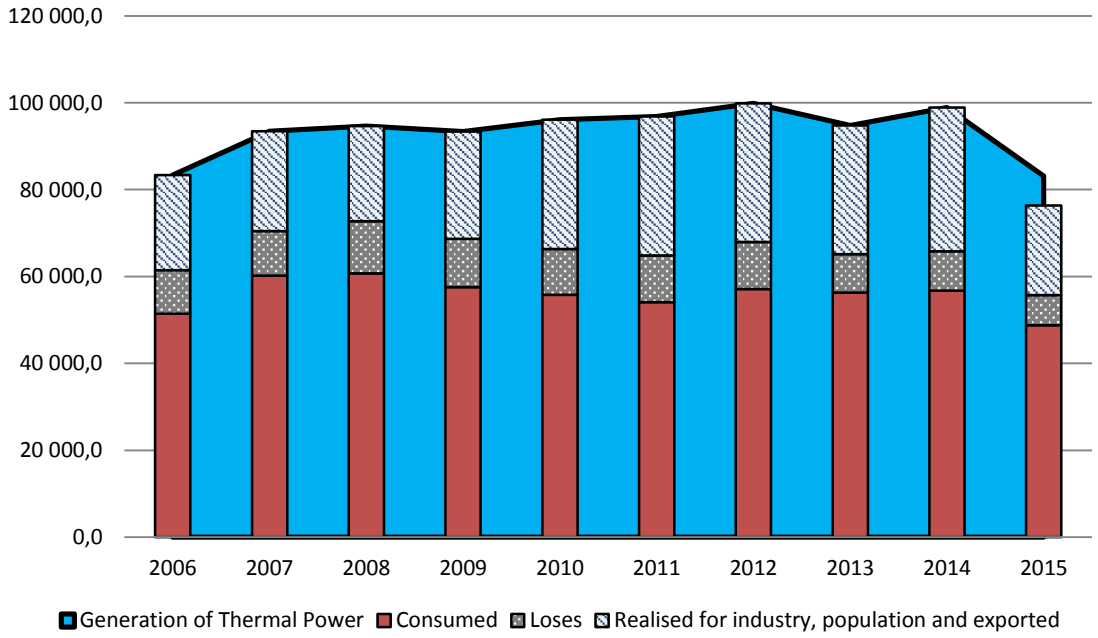

Diagram 3.20 - Thermal energy balance (thousand Gcal) for the period of 2006-2015

Within the framework of the Concept for the Development of the Fuel and Energy Complex of the Republic of Kazakhstan until 2030, approved by the Government of the Republic of Kazakhstan on June 28, 2014, # 724, the following results are expected to be achieved in the energy sector, see Table 3.1.

Table 3-1 - Forecast of the main parameters of Kazakhstan's energy sector[41]

Commissioning of new generating capacities	+2005 MW to the level of 2013	+3884 MW to the level of 2015	+1645 MW to the level of 2020
Construction 220-500 kV transmission lines	+380 km to the level of 2013	+3145 km to the level of 2015	+5340 km to the level of 2020
Depreciation of fixed assets in the electricity generation segment	70%	60%	40%
Depreciation of fixed assets in the electricity transmission segment	60%	50%	30%
The share of wind and solar energy the generation of electricity	3%	10%	
The share of gas power stations in the generation of electricity	20%	25%	
Reduction of carbon dioxide emissions in the electricity sector	Level of 2012	-15 % (from 2012 level)	
The total volume of attracted investments in the industry (in prices of 2011)	8,3 trillion tenge		

The Northern zone keeps surplus: the electricity produced in this zone is sufficient to cover the shortage of power in the South Zone through the North-South transit until 2030, the third phase of which is planned for commissioning in 2018. However starting from 2030 the projected increase in the South's load will exceed the capacity of the above-mentioned transit, which can lead to a potential shortage of 470 MW. The Western zone until 2030 remains self-balancing with some excess capacity.

Table 3-2 - Balance of capacity of the Unified Energy System of Kazakhstan in 2017-2030

Indicator	2017	2018	2019	2020	2025	2030
Maximum consumed electric power	17000	17500	18000	18500	20500	23600
Required power reserve	1641	1991	2018	2049	2210	2248
Generation	19849	20594	21379	22422	24158	26100
Shortage (+) / Surplus (-)	-1209	-1104	-1362	-1874	-1448	-252

Considering the huge potential for increasing of energy efficiency, energy saving is set as one of the strategic tasks of the state. In this regard, in September 2013 the Program "Energy Saving - 2020" was approved. The goal of this program is to create conditions for reducing of the energy intensity of the GDP of the Republic of Kazakhstan and increasing of energy efficiency by reduction of energy consumption and reduction of inefficient use of fuel and energy resources. Within the framework of this Program an annual 10% reduction of the GDP energy intensity level was planned for 2013-2015, and by 2020 the reduction of the energy intensity of GDP should drop by no less than 40% from the 2008 level.

The technical potential for energy saving in the republic is estimated at level of 27,75% of the total consumption of primary energy resources – 17,36 million toe. At the same time, in the conditions of Kazakhstan it will be economically justified to use only part of this potential – about 19% of the total primary energy resources consumption or about 12 million toe. The required investments for the realization of economic potential constitute $ 4 billion.

[41] The concept of development of the fuel and energy complex of the Republic of Kazakhstan until 2030. http://adilet.zan.kz/eng/docs/P1400000724

Since almost 20% of the existing power generation capacities in Kazakhstan were put into operation before the 1970s, the country can (if practically and economically viable) switch from the widespread use of coal (the share of which is approximately 70%) as a fuel for power plants to a more diversified scheme based on a wider application of gas, renewable sources and nuclear energy.

However, given the large amount of cheap coal in Kazakhstan and the complex of large coal thermal power plants, it is assumed that the country will rely heavily on coal over the next two decades. Although over time, the share of coal for power generation is likely to gradually decline "In the long term, until 2030, the power coal will be mainly used for internal coal based energy generation of the Republic of Kazakhstan. Taking into account the plans for commissioning and closure of generating capacities, the demand for coal will continue to grow: by 2030 the capacity of new coal power plants will constitute 20% of the total installed capacity, while the share of old coal power plants will decrease from the current 60% to 39%. The total demand for energy coal for heat and electricity generation in Kazakhstan will increase by 2030 from the current 53 to 76 million tons, or by 50%."

4. The impact of coal mining and coal consumption on the environment of Kazakhstan

Majority of coal deposits in Kazakhstan are characterized by a high moisture content and a relatively low calorific value, as well as a high content of ash and sulfur. These characteristics, combined with the presence of significant amounts of methane in most fields, lead to the fact that coal mining and consumption in Kazakhstan have greater environmental impact than in many other regions of the world, despite the fact that individual deposits (for example, in the Ekibastuz Basin) are highly economically competitive due to extremely low production costs.
As it is known, the main type of fuel of Kazakhstan is coal that is mainly extracted in Ekibastuz, Karaganda and Kuznetsk deposits. Combustion of fossil fuels for electricity and/or heat generation, and especially electrical energy industry with its huge CHP plants, is one of the foundations of the functioning of modern society and the economy of Kazakhstan.
As a result of burning of coal it is annually produced in Kazakhstan about 19 million tons of ash and slag mixtures, to date there are more than 300 million tons of waste have been accumulated in in the ash dumps. About 250 million tons of fine aerosols are annually emitted to the atmosphere, which, as is known, can significantly change the balance of solar radiation near the earth's surface. Aerosols serve as condensation nuclei for water vapor and precipitation formation; And when inhaled can cause various respiratory diseases.
In addition, in terms of greenhouse gas emissions, the major part is emitted by the energy sector, which mainly use coal as fuel (84%). The share of the energy sector accounts for more than 80% of the total amount of greenhouse gas emissions nationwide.
Partly due to the negative environmental consequences of coal mining and burning, as well as due to the difficulties of coal shipment to Russia and other countries, an assessment of opportunities for the extraction and use of methan of coal mine ventilation air and coal bed methane is currently underway. Kazakhstan is distinguished by particularly gassy coal mines. The concentration of methan in ventilation air reaches potentially dangerous values (on average 18-24 m3/t, locally up to 33 m3/t) in deep mines, in particular in the Karaganda basin. Thus, the extraction (drainage) of methane here is mandatory in order to ensure the safety of mining. The capture and use of methane, rather than just releasing it into the atmosphere, will also help to reduce greenhouse gas emissions.

The Ekibastuz coal is commonly used as a solid fuel in Kazakhstan, it is characterized by high ash content (30-40%). Ash of Ekibastuz coals contains up to 30% of aluminum oxide. Only with the ash of Ekibastuz GRES it is annually dumped about 6 million tons of aluminium oxide. Therefore, the ash of Ekibastuz coals is virtually an inexhaustible source of raw materials for the production of alumina. In addition, the ash contains other trace elements, for example, vanadium.

In accordance with the world, standards for air protection emissions of coal-dust from thermal power plants are currently limited by four components: flying ash, oxides of sulfur, nitrogen and carbon.

Table 4-1 - Current norms of atmospheric emissions of harmful substances in Kazakhstan in comparison with EU standards for existing power plants, mg/m3

Type of emissions	Kazakhstan	Interim standards	European Union
Particulate matter (ash)	1200-1600	300-600	50-100
Sulphur dioxide (SO2)	2000-3000	1000-1500	400
Nitrogen oxide (NOx)	600	650	500

The standards set by the legislation of Kazakhstan are lower than requirements needed to achieve significant changes in the field of environmental protection.

"In Kazakhstan, it is acceptable that 7-14 kg of particulate matter (depending on the capacity of the boilers at the station), 13-25 kg of sulfur dioxide, 7-11 kg of nitrogen oxides are emitted into the atmosphere for one ton of reference fuel is burned. In the USA, these are already other figures: 0,5-1,5 kg of particulate matter per tons, 9,5-19 kg of sulfur dioxide, 4-10 kg of nitrogen oxides. The difference in ash processing figures is even more striking: in Kazakhstan less than 8% is processed (the rest is stored in ash dumps), in EU countries – 90%."[42]

The calculations for one of the Ekibastuz GRES with a capacity of 4 million kW showed that measures for reduction of dust, sulfur and nitrogen oxides emissions to the standards of the new technical regulation (of 2007) "Limits for emissions from the combustion of various types of fuels in boilers of thermal power plants" would lead to an increase of the cost of the energy by 1,5 times[43]. Considering such significant upcoming spending, the energy sector already by 2010 was able to quickly change the above-mentioned regulations in terms of lowering the requirements (including for "old" power plants)[44].

It should also noted that the current methodology for calculation of emissions and payments for emissions from coal combustion, does not require metering of emissions of heavy metals, including mercury. In 2002-2003, experts of the Almaty Institute of Energy and Communications collected coal samples from Central Kazakhstan and studied the content of mercury in them.-The results of the studies are presented in Table 4.2. And the following calculations conclusively prove that coal mining and burning is a powerful and constant source of toxic emissions of mercury into the environment.

Table 4-2 – Average content of mercury in coals of Central Kazakhstan

№	Coal basin	Average concentration, mcg/kg
1	Shubarkol open cast mine, Karaganda oblast	6
2	Kuucheckin open cast mine, Karaganda oblast	12
3	Molodezhniy open cast mine, Karaganda oblast	14,5
4	Shakhtisk mine, Shakhtinsk, Karaganda oblast	13
5	Dolinsk mine, Dolinka, Karaganda oblast	Less than 5
6	Kirovsk mine, Karaganda	5
7	Mine No. 22 "50 Years of October", Karaganda	8
8	Mine No. 12, Shahan, Karaganda oblast	212
9	Tentek mine, Shahan, Karaganda oblast	8
10	Stepnaya mine, Shahan, Karaganda oblast	12
11	Kostenko mine, Karaganda	5

42 https://forbes.kz/process/probing/pyil_vekov

43 Kazakhstan: Energy security, energy independence and sustainability of energy development. Status and prospects. Analytical study. - United Nations Development Program in Kazakhstan. Institute of Energy Studies. - Astana. 2009.

44 "Reverse course. There were attempts to solve the problem of "dirty" thermal power plants in Kazakhstan, but somehow unsuccessful, because of the uncoordinated actions of the Ministry of Environmental Protection and the Ministry of Industry, the KazNIPI Energoprom noted. For example, in 2007, the Government of the Republic of Kazakhstan approved the technical regulation "Limits for emissions from the combustion of various types of fuels in boilers of thermal power plants". This document established the identical limits for emissions from the existing and new boiler plants starting from 2013, and most of the existing CHP plants turned out to be "outlawed". The stations needed to be urgently reconstructed, accordingly, huge money was required. The problem was solved in elegant way by significantly lowering restrictions for emissions of harmful substances ... - "in the summer of 2010, a new regulation was adopted. Now in Kazakhstan it is considered permissible to operate boilers of new CHP plants with the emission of particulate matter of 100-200 mg/Nm3, in Europe – 30, nitrogen oxide in Kazakhstan – 500 mg/Nm3, in Europe – 200, sulfur oxide in Kazakhstan – 780 mg/Nm3, in Europe – 200". https://forbes.kz/process/probing/pyil_vekov

12	Erementau open cast mine, Akmola oblast	6
13	Bogatyr open cast mine, Ekibastuz, Pavlodar region	16,5
14	Vostochny open cast mine, Ekibastuz, Pavlodar region	14
15	Severny open cast mine, Ekibastuz, Pavlodar region	68

Within the framework of this report we tried to calculate the volume of heavy metals emitted with flying dust as a result of coal combustion. Based on the calculation results (Table 4.3), it can concluded that about 541 thousand tons of heavy metals were emitted into the atmosphere with the ash from the combustion of coal for heat and electricity generation in Kazakhstan in 2015. The volume of emissions of heavy metals of the 1st class of hazard constituted 50,9%, the volume of emissions of heavy metals of the 2nd class of hazard – 3,8% and the volume of heavy metals emissions of the 3rd class of hazard – 42,5%.

Table 4-3 – Amount of heavy metals in ash from coal combustion for electricity and heat generation in Kazakhstan in 2015, kt.

Name of heavy metal	class of hazard of heavy metal	Specific emission of heavy metals in ash, t/t of coal burnt		The volume of coal consumed in the electricity and heat generation in Kazakhstan in 2015, kt	Emissions of heavy metals with ash, thousand tons / year
arsenic	1	490	0,000490	50 505	24,7
beryllium		30	0,000030		1,5
cadmium		30	0,000030		1,5
lead		2100	0,002100		106,1
zinc		2800	0,002800		141,4
mercury		5	0,000005		0,3
chromium	2	370	0,000370		18,7
cobalt		40	0,000040		2,0
copper		300	0,000300		15,2
barium	3	1900	0,001900		96,0
strontium		1800	0,001800		90,9
vanadium		850	0,000850		42,9
total					541,2

The city of Karaganda is a typical example of a large industrial city, where practically all energy is produced from coal, both for the needs of industry, and for the production of electricity and heat. The impact of coal combustion on the environment on the example of Karaganda demonstrates all the negative factors of coal use as a source of energy. CHPP-3, located in the northern part of Karaganda, the main producer of electrical and thermal energy (raw materials: coal and heating oil). In 1991-1993 years there was carried out an ecological and geochemical mapping of chemical pollution in Karaganda-Temirtau industrial region. The probes of the land[45] were taken in the framework of the research and the following results were obtained:

1. The amount of dust falling within a radius of 1-3 km around the CHPP-3 constitutes on average 2500 kg/km2 per day (from 1500 to 4300), which is 2-5 times higher than the average dust volume in Karaganda and 40 times more than baseline values of Karaganda-Temirtau industrial district (60 kg/km2 per day).[46]

[45] "Ecological and geochemical mapping of chemical pollution in Karaganda-Temirtau industrial district", 1992-1994, KazIMRS (Kazakhstan Institute of Mineral Raw Materials) of the Academy of Sciences of the Republic of Kazakhstan, Karaganda geochemical survey company, PO Karaganda Regional Ecological Museum

[46] Survey data on the environment in surrounding of enterprises of Karaganda for development of methodological manuals for compiling an ecological passport of enterprise based on the classification of the company's waste to obtain environmental permit, Kazmekhanobr, Geochemical survey company. Karaganda, 1991-1993.

2. Dust depositions contain high level of selenium, mercury, phosphorus, molybdenum and other elements. Operation of CHPP-3 and the influence of nearby industrial enterprises that also work on coal (Teplopribor JSC, Kazstroypolimer, railway station Sortirovochnaya) led to soil pollution in the area around the station with Pb, Zn, Cd, Hg, Se (I class); Cr, Cu, Mo, Sb (II class); Mn, Bi, P (III class).
3. A landfill site for ash and slag wastes poses a particular danger to the environment - 270 hectares ash dump site of the CHPP located on the north-eastern outskirts of the city of Karaganda. Ash and slag wastes contain a number of toxic elements in concentrations exceeding the baseline, and in some cases exceeding the threshold limit values for soils on P, Se, Be, Cu, W, Bi, F, Hg, Mn, Sr. In case there are "dry" spots on the ash disposal area the ash-and-slag waste is easily carried by the wind along the main wind directions. This caused visible chemical contamination of soils in the eastern and north-eastern directions from the ash dump to the dacha massifs of Karaganda and Kokpekty villages (Bukhar-Zhyrau rayon, Karaganda oblast). The breakthrough of the ash dyke dam in 1996 resulted in environmental pollution (Figures 4.1-4.2). In 2004, the reclamation of the ash dump was carried out, at present the ash dump is closed.

In general, the coal and fuel and energy industries make a big contribution to the air pollution in the city of Karaganda. Despite the relatively low content of toxic elements in air emissions and industrial waste, the city's areas in the lower parts of the modern relief are subjected to the greatest pollution.

Another problem of the Karaganda coal basin is the air pollution caused by the mine methane, which is released during the exploitation of coal deposits. Approximate reserves of methane contained in industrial coal beds of the Karaganda coal basin are about one trillion cubic meters. Every year, several hundred million cubic meters of methane are emitted into the atmosphere (in 2001 – 323 million m3). Only about one percent of it is disposed and is burned in the boiler houses of mines, which is clearly insufficient.

The project of utilization of mine methane was included in the list of priority environmental problems of the Karaganda oblast. The implementation of the methane utilization project will allow to stop its emissions into the atmosphere, rationally use fuel resources, ensure the safety of mining operations.

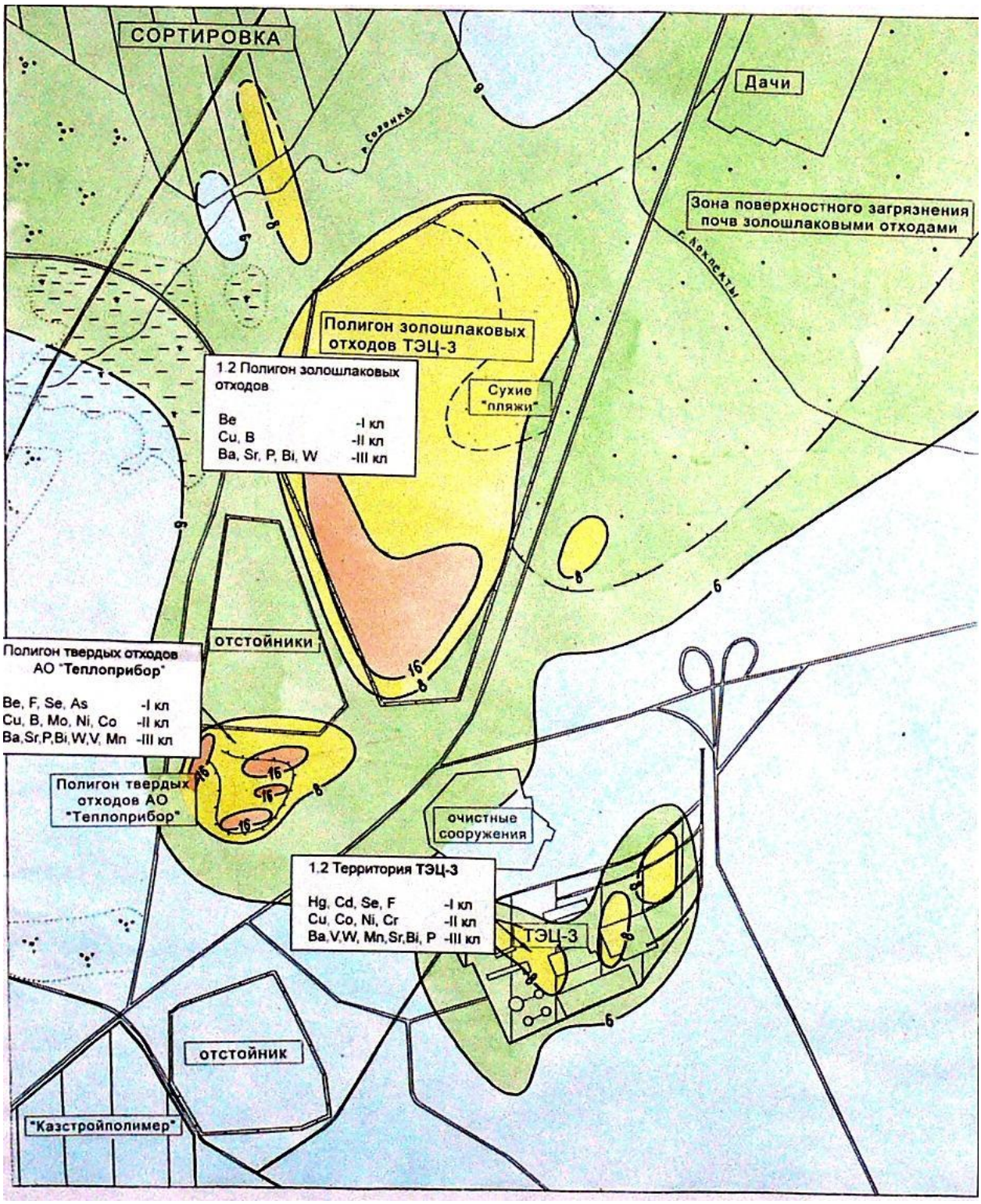

Figure 4.1 – Map-scheme of the total soil pollution index of soil contamination in the area around Karaganda CHPP-3

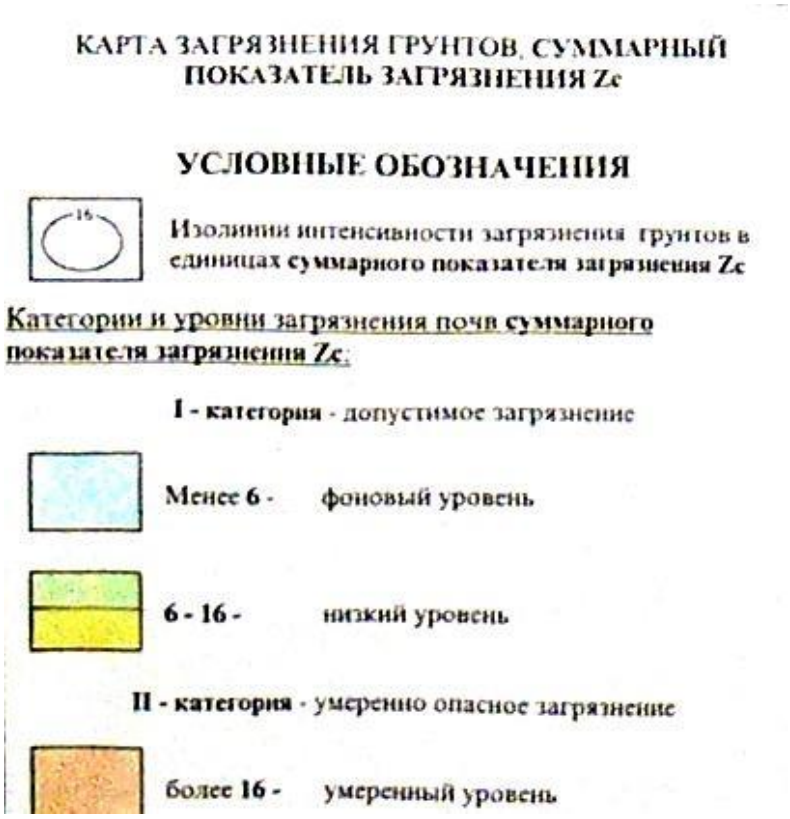

Figure 4.2 – Legend to the map-scheme of the total soil pollution index in the area around Karaganda CHPP-3

5. Strategic plans and prospects for coal consumption. Factors of influence.

The following documents which contain elements of strategic planning for coal based heat and electricity generation, production, consumption and sales of coal on the market were found in public access.

- Kazakhstan-2050 Strategy: a new political course of the successful state[47]
- The concept of Kazakhstan's entering into the top 30 most developed countries of the world[48]
- The Concept of the transition of the Republic of Kazakhstan to the "green economy"[49] and the Action Plan for the implementation of the Concept on the transition of the Republic of Kazakhstan to the "green economy" for 2013-2020[50]
- The state program of infrastructural development "Nurly Jol" for 2015- 2019

[47] The "Kazakhstan-2050" strategy: the new political course of the state http://www.akorda.kz/upload/%D0%A1%D1%82%D1%80%D0%B0%D1%82%D0%B5%D0%B3%D0%B8%D1%8F%20%D0%9A%D0%B0%D0%B7%D0%B0%D1%85%D1%81%D1%82%D0%B0%D0%BD-2050.doc

[48] The concept of Kazakhstan becoming one of the 30 most developed countries in the world, https://egov.kz/cms/en/law/list/U1400000732

[49] The concept of the transition of the Republic of Kazakhstan to the "green economy", approved by the Decree President of the Republic of Kazakhstan dated May 30, 2013 No. 577, https://strategy2050.kz/static/files/Concept_Rus.pdf

[50] On approval of the Action Plan for the implementation of the Concept on the transition of the Republic of Kazakhstan to the "green economy" for 2013-2020, Resolution of the Government of the Republic of Kazakhstan # 750 of July 31, 2013. http://adilet.zan.kz/rus/docs/P1300000750#z0

- Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for 2014-2018[51] Program for the development of the electric power industry of the Republic of Kazakhstan for 2010-2014
- Long-term development strategy of Samruk-Energo JSC[52] for 2015-2025
- Concept for the development of the gas sector in 2030. Decree of the Government of December 5, 2014 #1275
- Decree of the Government, General Gasification Scheme 2015 - 2030, 04-11-14_1171
- State Program on Forced Industrial and Innovative Development of the Republic of Kazakhstan for 2010-2014[53]
- Astana, 2010 http://adilet.zan.kz/rus/docs/U100000958_#z12

5.1. Kazakhstan-2050 Strategy: a new political course of the successful state

The Strategy 2050 sees the perspectives of coal based heat and electricity generation as "Gradual switch of coal CHP plants to natural gas and the construction of new gas thermal power stations through the creation of necessary infrastructure in major cities of the country". However, the experience of the authors' interaction with the representatives of the Ministry of Energy shows that these plans have not yet implemented at the level of the current plans for industrial development and budget planning.
An "accelerated transition to a low-carbon economy" is also planned. In order to make the transition among other measures **"By the year 2050, at least half of total energy demand in the country should be covered by alternative[54] and renewable energy sources"**, and the planning in the electric power industry should be carried out "with due consideration of modern traditional technologies and RES."

Such a goal would entail a reduction in the existing share of coal generation (70%[55]). In the medium term, it is planned to "implement projects for the development of wind, solar energy, as well as bioelectrical energy produced by processing of agricultural crops and waste. The aggregate share of wind, solar and bioenergy will reach 3% of the total electricity production by 2020."

It is also envisaged that **"CO2 emissions in the production of electricity will be reduced from 1,000 g/kWh to 350 g/kWh."** Unfortunately, it is not specified for what kinds of generation this value is planned.

Strategy-2050 also provides **"Ensuring the whole population of the country access to clean air" and "Raise of standards for dust, sulfur dioxide and nitric oxide emissions", "Bringing emission standards of industrial enterprises in line with the standards of the European Union"** which is important, given the significant air pollution from coal-fired power plants.

The strategy Kazakhstan-2050 prescribes "To increase the volume of extraction and supply of the natural resource to markets in order to use the current high demand in the interests of the country" provided that "All extracting enterprises must implement only environmentally friendly production."

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51 Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for 2014 - 2018, Annex to the order of the Minister of Energy of the Republic of Kazakhstan from October 28, 2014 #79,

52 Long-term development strategy of Samruk-Energo JSC for 2015-2025, approved by the decision of the Board of Directors of Samruk-Energo JSC #06/15 of October 15, 2015,

53 State Program on Forced Industrial and Innovative Development of the Republic of Kazakhstan for 2010 - 2014, http://adilet.zan.kz/eng/docs/U100000958_#z12

54 Analysis of strategic documents shows that atomic energy is also referred to "alternative" types of energy.

55 Authors note.

Concerning the prospects of nuclear power, Strategy-2050 plans to **"Develop services for the design, construction and operation of nuclear reactors, fuel enrichment, management and maintenance of nuclear power plants**, reprocessing and disposal of spent nuclear fuel."

5.2. The concept of Kazakhstan's entering into the top 30 most developed countries of the world

"6. Climate change. ... In the long term, the greatest risk for Kazakhstan will be the scarcity of water resources, which will limit the development of industries requiring high water consumption, in particular, the mining and metallurgical complex and coal based energy sector."

"3.5. Development of alternative energy. ... **A gradual switch of coal-fired CHP plants to natural gas and the construction of new thermal power stations operating on this type of fuel will be carried out by creating necessary infrastructure in major cities of the country.** "

5.3. The Concept of the transition of the Republic of Kazakhstan to the "green economy"

The Concept foresees "the maximum prolongation of lifetime of existing coal, gas and hydro power stations, since this solution is able to ensure the lowest cost of electricity." In addition, "installation of dust and gas purification equipment is envisaged in the framework of modernization of existing coal plants to improve air quality and compliance with environmental standards."

The Concept considers three scenarios for the development of the electric power industry - Baseline, Green with "expensive" gas, and Green with "cheap" gas.

Correspondingly, under the Baseline scenario foresees significant increase in the coal generation until 2050 (by 80% of the current level [2012])

The Green scenario with "expensive" gas foresees a moderate increase in coal generation until 2030, (40% of the current level [2012])

And, finally, the Green scenario with "cheap" gas foresees the preservation of coal generation until 2030 at the current level, and a decrease after 2030 due to the withdrawal of old capacities.

Under any scenario the Concept assumes the construction of nuclear power plants, including - "Construction of 1,5 GW by 2030 and 2 GW by 2050".

RES in all scenarios should be developed at the following rates: - "Commissioning of 4,6 GW of wind power and 0,5 GW of solar capacities by 2030".

Gas generation should be introduced by "switching of CHPPs in large cities to gas and commissioning new capacities for balancing of RES" which, however, is not supported by specific quantifiable targets.

Strategic Development Plan of the Republic of Kazakhstan until 2020

- The share of gas power stations in the generation of electricity reached 20%;
- The NPP[56] and Balkhash TPP are built and put into operation;

[56] The plan does not specify the location of the planned nuclear power plant. In the media, Balkhash Lake, the city of Aktau and Kurchatov were consistently named as planned nuclear power plant sites.

- The Beyneu-Bozoy-Shymkent gas pipeline provides gas to the entire southern part of the country in the amount of up to 6 billion cubic meters per year;
- **Gas infrastructure development in Akmola and Karaganda oblast will be carried out;**
- The share of alternative sources of energy (solar and wind) in the generation of electricity will constitute at least 3%;
- The share of alternative energy sources in the total energy consumption will be more than 3%;
- There will be a decrease of the CO2 emissions level from the electric power industry to the level of 2012

5.4. Strategic Plan of the Ministry of Energy of the Republic of Kazakhstan for 2014-2018

The strategic plan of the Ministry of Energy of the Republic of Kazakhstan states and assumes **a further reduction of coal production**, as "Reduction of the consumption of [Kazakh[57]] coal by the Russian energy producing enterprises leads to decrease of production." To counteract the risk of loss of the coal market in Russia it is envisaged to "Sign the joint indicative balance of coal of the Russian Federation and the Republic of Kazakhstan for 2015-2020."

Coal Production 2012-2014 гг. (without enriched coal products), mln.tons

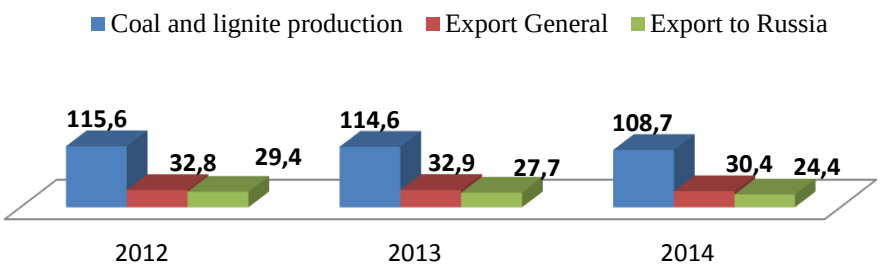


Diagram 5-1 Volumes of coal production and export in 2012-2014.

Regarding the prospects for the development of nuclear energy and its possible impact on the share of coal-fired power generation, it was also noted that "The existing scientific and technical potential of the nuclear industry is not capable to fully develop other areas of research and projects in the field of nuclear energy." It is interesting to note that this very pragmatic and close to reality conclusion runs counter to the intentions of the development of nuclear energy, repeatedly voiced in the media by representatives of the Ministry of Energy of the Republic of Kazakhstan.

In order to mitigate the risk of man-made catastrophes associated with sudden emissions of coal and gas it is planned "To implement new methods for degassing of coal seams during operation, to discuss and approve the way the methane will be industrially extracted.

In the description of the priorities of the development of the coal industry, it is noted that in the Republic of Kazakhstan the coal mining capacities are largely ahead of the demand of the traditional coal market, that is, the domestic market for thermal coal.
In this regard, **the priority area for the development of the coal industry is the development of coal processing**, which can provide a qualitative change in the consumer properties of products

[57] Authors note.

and, accordingly to increase its market price, and most importantly - will allow **to go beyond the market of steam coal and create a new direction in the coal industry – coal-chemical one**, to produce of new generation of coal products with a high level of processing.

One of the most important directions for the development of the coal industry is the **use of coal for the production of hydrocarbon raw materials and raw materials for petro-chemistry - complex coal processing (coal chemistry).**

In Kazakhstan, work is underway to implement a project for deep processing of coal to produce synthetic liquid fuels. The implementation of the project can provide the country's domestic market with diesel fuel, will help develop the central region of the Republic of Kazakhstan (new jobs, social and tax deductions, development of small and medium-sized businesses, etc.).

The plan also includes the following target indicators of development:

№ п/п	**Target indicator**	**Responsible**	**Source of information**	**units**	**Reporting year**	**Plan (fact) of the current year**	**Planning period**				
					2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
1	2	3	4	5	6	7	8	9	10	11	12
Strategic direction 1. Development of electric power industry, coal industry and the sphere of nuclear power use											
Goal 1.1. Uninterrupted power supply of the growing demand of the country's economy for electricity and social obligations in the coal industry											
1.	Electricity generation *	Vice-minister Jaxaliev B.M.	Data of KEGOK JSC	Billion kWh	90,2	91,9	92,1	91,4	**91,0**	92,7	93,0
2.	Growth of the available capacity of power plants in Kazakhstan	Vice-minister Jaxaliev B.M.	Data of KEGOK JSC	MW	15304	16160	16255	16350	16700	17100	17400
4.	The share of gas power stations in the generation of electricity	Vice-minister Jaxaliev B.M.	Departmental data	%	17,5	18,4	18,5	18,6	18,7	18,8	18,9
7.	The share of land plots transferred to local executive bodies after the re-cultivation the mines and open cast mines of the former Karagandaugol Production Association	Vice-minister Jaxaliev B.M.	Departmental data	%	-	-	8,4	11,2	12,4	17,2	17,3
8.	Growth of labor productivity:	Vice-minister Jaxaliev B.M.									
	- in the electric power industry		Departmental data	Million kWh / person	6,52	6,59	6,61	6,57	**6,52**	6,66	6,68
	- in the coal industry:		Departmental data	Tons / person							
	• open cast mines				**4120**	**4040**	**3820**	**3640**	**3707,3**	**3707,3**	**3719,5**
	• mines				**706,2**	**737,5**	**780,6**	**746,6**	**700,7**	**714,3**	**714,3**

Goal 2.2. Covering of the demand of domestic of the economy for natural gas											
25.	Level of access of the population to gas	Vice-Minister Mirzagaliev M.M.	Departmental data	%	29,12	30,61	32,10	42,31	**43,8**	43,95	44,15
Strategic direction 3. Improvement of the quality of the environment											
Goal 3.1. Reduction of emissions to the environment, development of renewable energy sources and transition to a "green economy" *											
30.	The volume of pollutants:	**Vice-Minister Magauov A.M.**	Departmental data	Mln ton							
	- emissions				-	-	5	5	4,9	4,9	4,8
	- discharges				-	-	5	5	4,9	4,9	4,8
31.	Limit value of greenhouse gas emissions in relation to 1990 **	**Vice-Minister Magauov A.M.**	Departmental data	%	**73**	**76**	**79**	**81**	**83**	**86**	**89**
32	The amount of electricity generated by renewable energy sources ***	Vice-minister Jaxaliev B.M.	Departmental data	Billion kWh	0,45	0,51	0,58	0,7	1,0	1,6	2,0

Section 6. Resources

Resources	Units	Reporting period 2014	Current period plan 2015	Planning period		
				2016	2017	2018
1	2	3	4	5	6	7
Financial: Total:	Thousand tenge	89 901 750	75 887 735	51 192 878	44 256 798	39 524 149
Including:	Thousand tenge	89 901 750	75 887 735	51 192 878	44 256 798	39 524 149
Goal 1.1. Uninterrupted power supply of the growing demand of the country's economy for electricity and social obligations in the coal industry						
Budget program 009 "Elimination of the consequences of the opeation of mines and open cast coal mines of the former production association Karagandaugol	Thousand tenge	1 037 907	1 081 857	1 102 984	1 700 119	1 450 829
Budget Program 041 "Development of Heat and Power Industry"	Thousand tenge	54 389 338	46 959 114	26 659 360	24 462 054	21 192 625
Total for goal 1.1	Thousand tenge	55 427 245	48 040 971	27 762 344	26 162 173	22 643 454
Goal 1.2. Creation of conditions for nuclear energy safety and development of nuclear industry						

Budget program 011 "Creation of Technopark" Park of Nuclear Technologies "in the city of Kurchatov	Thousand tenge	200 000	125 635	-	-	-
Budget Program 036 "Development of Nuclear and Energy Projects"	Thousand tenge	4 121 586	3 847 766	5 070 320	2 800 829	2 761 760
Total for goal 1.2	Thousand tenge	4 321 586	3 973 401	5 070 320	2 800 829	2 761 760
Goal 2.2. Covering of the demand of domestic of the economy for natural gas						
Budget program 003 "Targeted development transfers to the oblast budgets, budgets of Astana and Almaty cities for the development of the gas transportation system"	Thousand tenge	17 170 267	10 873 833	6 373 925	4 317 197	3 250 457
Total for goal 2.2	Thousand tenge	17 170 267	10 873 833	6 373 925	4 317 197	3 250 457

As can be seen from the above tables, it is not planned to allocate sufficient funds to implement the declared goals to switch from coal to gas in power generation, since in order to solve this problem one would need an amount of money that is two orders bigger, as there are no transfer gas pipelines in most regions with predominantly "coal based" generation. It was planned to spend on the development of the gas transportation system about $ 134 million in the period of 2015-2018, after the devaluation of the exchange rate in 2015 this amount dropped to $ 74 million. Such funds are clearly not sufficient for the development of the gas transportation system in regions where it is not available at all or its capacity is insufficient for "gas based" generation.

Resources	Units	Reporting period 2014	Current period plan 2015	Planning period	Resources	Units
Goal 3.1. Reduction of emissions to the environment, development of renewable energy sources and transition to a "green economy"						
The budget program 034 "Implementation of the Concept for the transition to a green economy" and the Partner Program "Green Bridge"	Thousand tenge	-	60 704	161 995	84 770	-
Budget program 038 "Reducing of greenhouse gas emissions"	Thousand tenge	178 815	138 595	162 453	157 201	157 347

The amount of funding allocated for "reducing emissions to the environment, the development of renewable energy sources and the transition to a green economy" also appear to be insufficient even at the initial stage of the solution of the declared tasks; thus for the period of 2015-2018 in the program "Reducing of greenhouse gas emissions" it is budgeted an amount equivalent to $ 1,8 million for the whole Kazakhstan.

5.5. Long-term development strategy of Samruk-Energo JSC for 2015-2025

As mentioned above, Samruk-Energo JSC is one of the largest players on the coal and power generation market of Kazakhstan with a 28% share of energy generation in Kazakhstan and a share of the coal market of about 50% (2014).

Samruk-Energo JSC acts in accordance with the Long-term Development Strategy of Samruk-Energo JSC for 2015-2025. Among, the second level strategic objectives the Strategy foresees a "High-tech development in traditional generation", including "development of innovations and clean coal technologies, carbon capture and storage" (without a detailed disclosure of the meaning of "clean coal technology" and any disclosure of the essence of technologies for carbon capture and storage.

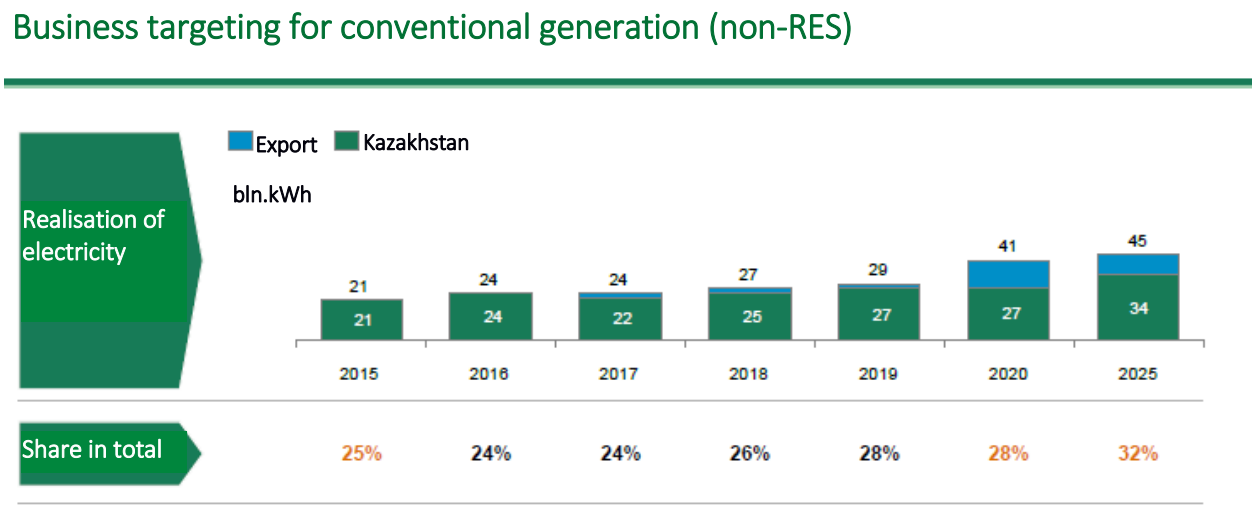


Diagram 5.1 – Strategic plan of Samruk-Energo JSC to increase electricity sales.

The diagram shows that it is planned to increase the volume of electricity sales from 21 billion kWh in 2015 to 45 billion kWh with a significant increase of the export share. The strategy of Samruk-Energo JSC foresees diversification of types of electricity generation with an increase of the RES share in the total amount of electricity generated (see the Diagram below).

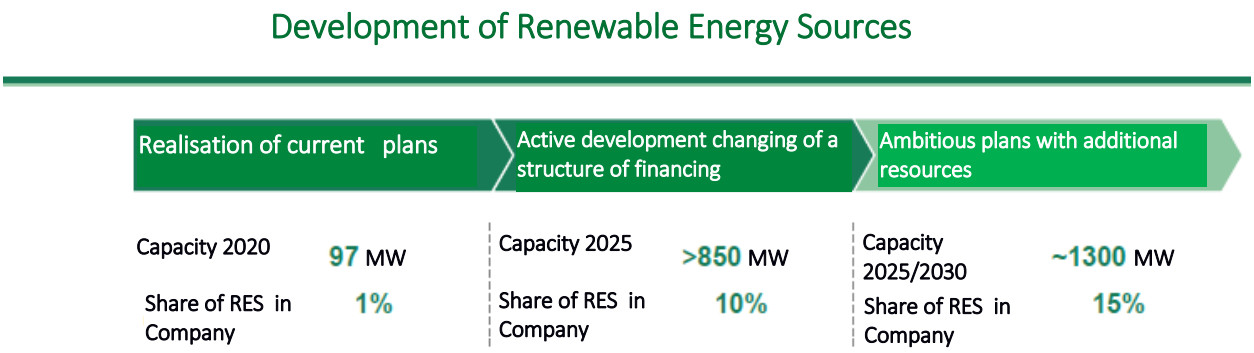
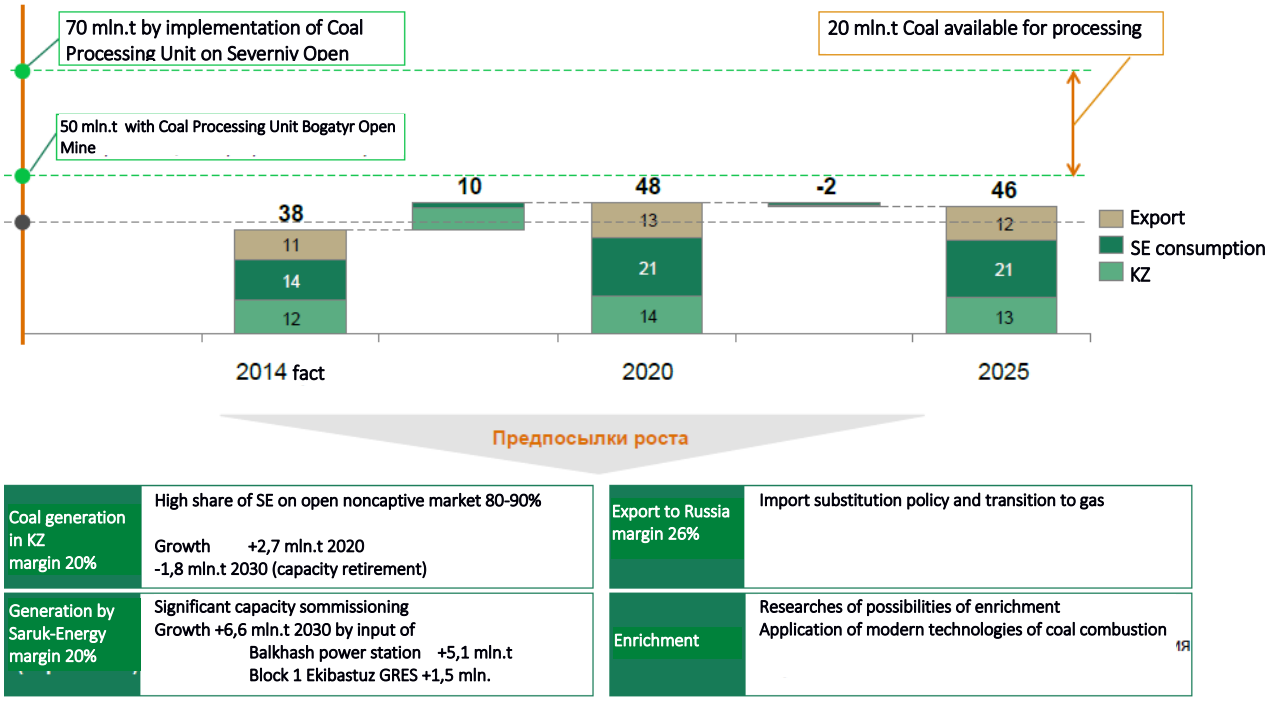


Diagram 5.2 – Strategic plans of Samruk-Energo JSC on development of RES

Despite the fact that the Strategy of Samruk-Energo JSC contains concrete plans for the development of renewable energy sources with measurable numerical indicators ("to achieve 10% share by 2025"), the Strategy sees no alternative to further increase of coal production and coal based power generation.
It is planned to increase coal production from 38 million tons in 2014 to 46 million tons in 2025 (see Diagram below).



* Captive power - electricity for own consumption.

Diagram 5.3 – Increase of coal production by Samruk-Energo JSC in the period of 2015-2025.

5.6. Program for the development of the electric power industry of the Republic of Kazakhstan for 2010-2014

The "Program for the development of the electric power industry of the Republic of Kazakhstan for 2010-2014"[58] (hereinafter – Program) is of a conceptual nature and is developed as one of the fundamental parts of the strategy for implementation of the Strategic Development Plan of the Republic of Kazakhstan until 2020 and the State Program on Forced Industrial and Innovative Development of the Republic Kazakhstan for 2010 – 2014.»

Objectives of the Program, including:

"Modernization, reconstruction of existing and construction of new generating capacities, **development of the coal industry**."

"Inclusion of renewable energy sources into the balance ".

58 Program for the development of the electric power industry of the Republic of Kazakhstan for 2010-2014

Indicators of results

"To increase electricity generation in 2014 up to 97,9 billion kWh with predicted consumption of 96,8 billion kWh[59]. See the prognosis of electricity balance in Kazakhstan for 2010-2014 in Appendix 1.
The share of renewable energy in total electricity consumption will constitute more than 1,0% in 2014.
At the beginning of the 2011 there will be initiated stage-by-stage construction of wind power stations in the Shchelek corridor - Almaty oblast, with a capacity of 50 MW at the first stage.

Implementation of wind power stations projects Almaty oblast in the Dzungar gate area, with a capacity of 50 MW at the first stage, in the East Kazakhstan oblast – with a capacity of 24 MW, in the Mangistau oblast – with a capacity of 40 MW, and in the Karaganda oblast – 10 MW. It is also expected to continue work on the development and implementation of small hydro power plant projects in Almaty, Zhambyl and South-Kazakhstan oblast, with an installed capacity of at least 100 MW.

Provision of coal production in 2014 in amount of 123,0 million tons.

"In order to meet coal demand, coal production is projected to increase from 94,3 million tons in 2009 to 123,0 million tons in 2014. The forecasted demand for coal by consumers in the Republic of Kazakhstan by 2015 will be at level of 94,2 million tons, including 68,2 million tons for the energy-producing enterprises of the country."

As it was shown above, the forecast for the growth of coal mining in this program, up to 123 million tons in 2014, was never fulfilled. In fact, in the period of 2012-2014 the extraction of coal and lignite decreased from 115 to 107 million tons.

Provision of industrial and environmental safety

It was noted that the Program should "ensure the gradual transition of power plants to the higher requirements established by the Technical Regulations: first, for ash emissions by replacing old dust flying ash separators with new ones (not necessarily electrostatic precipitators) and nitrogen oxides (due to technical methods inside the boiler), ensure the possibility to reconstruct boilers in the conditions of operating CHPP, to reduce emissions with minimum costs, to put into operation new modern boiler units."
When comparing the emission levels with foreign standards, it is noted that "at the present level energy sources in Kazakhstan have a high level of particulate matter intensity, which is undoubtedly connected with the use of high-ash Ekibastuz coals that have no analogues in the world. Emissions of nitrogen oxides and sulfur dioxide, on average in the industry at the current stage of development, can be considered permissible, however, given the existing requirement of the Ministry of Health of the Republic of Kazakhstan on summarizing of the harmful effects of nitrogen and sulfur dioxide emissions, the development of the industry especially in large industrial centers should come along with decrease of emissions of all pollutants."

This program contains an expanded list of promising projects that should have been implemented by energy-generating enterprises, for the most part "for own and borrowed funds" and at the expense of the republican budget. A precise analysis of the implementation of this program lies outside the range of tasks of this analysis, but even a primary review of the data presented allows us

[59] The indicator was not reached. In 2014 electricity generation amounted to 939 billion kWh. Authors note.

to say that many of the submitted projects have not been implemented. For example, the planned Balkhash coal thermal power plant was not built, for the construction of which it was planned to allocate about $ 3,5 billion (as of 2010) from the National Welfare Fund and the Republican budget funds. The Balkhash TPP was planned to be built on the shore of Lake Balkhash on the industrial site, where the works of the zero construction cycle (design, exploration, partial construction of foundations, etc.) were partially carried out in the USSR.

The variety of reasons why, according to media reports, the Balkhash TPP has never been built is impressive even for an experienced reader. For example, it was reported that it was the world financial crisis, the lack of sufficient coal in the region, the lack of a sufficient number of wagons for the delivery of coal by rail, the insufficient capacity of existing railroads, which theoretically can not pass through the required volumes of coal and so on and so forth. Such a variety of reasons, in our opinion, speaks of an insufficient technical and economic justification for the project itself, that is, in the end, about the insufficient level of strategic planning.

At the end of the history of the Balkhash TPP, it should be added that during the previous decade, from 2000 to 2010, the site for the Balkhash TPP appeared in the mass media according to state officials as a nuclear power plant construction site. The current status of plans for this site is reliably unknown.

6. Public opinion and opinion of the expert community

In our opinion, as a whole, there is no public opinion on Kazakhstan on the question "Is it necessary to reduce the use of coal in the energy sector?" It will be noted below that when analyzing the public opinion on coal energy generation in various parts of Kazakhstan, it is necessary to take into account the existing regional specifics.

The experience of the authors of the report, as well as the experience of the work of the Karaganda environmental NGOs (CINEST, EcoMuseum, EcoObraz), as well as informal surveys conducted in the framework of the present study among other environmental NGOs say that this question is not even in the public mind. Numerous attempts to put such or similar questions to the public have stumbled in the past either on persistent rejection or on their complete disregard. For example, the Karaganda Regional Ecological Museum has consistently assigned coal heat and power generation as the main source of environmental pollution in the city of Karaganda since the 1990s. EcoMuseum has reflected this and continues to show its point of view in dozens of different materials in the media, in museum expositions and during many hundreds of excursions held in the museum. Despite this, so far no other organization in Karaganda supports such a view, although for Karaganda, the harmful influence of coal, it is obvious – the city is literally surrounded by numerous coal mines, quarries, coal-dressing factories, three coal combined heat and power plants, countless stores of coal mining wastes.

One of the reasons that "lying on the surface" thoughts about the importance of the harmful influence of coal and the need to reduce "coal dependence" do not take root in the public consciousness of Kazakhstan, is, in our opinion, the lack of alternative for use of coal in many regions of Kazakhstan. As shown in the previous chapters, due to various reasons, practically throughout the whole territory of Kazakhstan, coal is a non-alternative source of energy for the coming decades (see also Chapters "Barriers for replacement of coal with other sources for electricity generation, as well as measures needed to reduce coal consumption").

The lack of alternative to coal as a source of energy, both actual and objective, as well as mental and seeming, is currently unresolved, and perhaps now, is an insurmountable barrier in the current structure of the economy and the existing levels of development of public consciousness and civil society.

There is a situation where the viewpoint of the perniciousness of "coal dependence" has been present in various forms for many years in the public consciousness, but has not been transformed into a pronounced "positive" public opinion on this issue. The opinion of both representatives of states and members of civil society expressed in the media does not contribute to changing public opinion either. Conclusions are not made as they can be used for analysis. In favor of reducing dependence on coal, and toward "improving" and "developing" the existing coal mining industry.

Such a dissonance between the objective nature of the situation and the conclusions drawn is typical for both the top level of government and for representatives of civil society and the population. For example, the Prime Minister of the Republic of Kazakhstan, Mr. Bakytzhan Sagintayev, at a special meeting of the Government devoted to the situation in the coal sector, including the issue of production and export, reminded representatives of coal industry that "the solution of certain issues depends not on the Government, but on the activity and the quickness of the industry workers themselves." He proposed the miners to direct their activity in order to "find other areas of sale of their products, to search for potential consumers in the border regions of the Russian Federation and the Central Asian republics. The prospect of coal exports to China is also tempting, but there, as

Prime Minister Bakytzhan Sagintayev reminded, the energy policy is aimed at reducing of coal consumption rather than its increase"[60]

M. Nikiforov, a chairman of the coal trade unions of Kazakhstan, makes similar conclusions in response to a question about the prospects of the coal industry in connection with Kazakhstan's accession to the Paris Agreement. "The coal industry approached the risks so closely that the Minister of Energy of the Republic of Kazakhstan publicly announced that the proposed collapsing of coal Projects will directly affect the vital interests of single-industry towns and mining families. At the same time, the Government does not exclude that it will be necessary to disburse funds for resettlement of people. But the problem can be looked at and from a different angle: how to save jobs, save cities and industry? In my opinion, the main task of the Kazakh coal miners today is to look for new markets and new spheres of coal use. To develop its deep processing, to receive from it various factions. Kazakhstani coals are one of the highest quality and are the best suited for these purposes."[61]

The problem of "vital interests of single-industry towns" mentioned by M. Nikiforov is another obstacle in public opinion for advancing the ideas of switching from coal to other sources of energy. In Kazakhstan, there are many such cities indeed, both in the coal mining and metallurgical regions into which coal is unintentionally "embedded" both as a source of energy and as an unchangeable part of the metallurgical processes. For such cities and for entire regions, the very idea of minimizing mining and using of coal sounds like a death sentence to their social and economic well-being. Under such conditions, public opinion is not capable of accepting the idea of changing the coal paradigm. In our opinion, this situation will continue in the foreseeable future in the absence of effective preventive measures to diversify industry and economy of such cities and regions.

The intensity of regional specificity of the relation to the idea of switching from coal to other energy sources mentioned above varies depending on energy sources available. In some regions of Kazakhstan, coal has never been used in industrial power generation, for example in Mangistau oblast, where gas is used as an energy source, and earlier, along with gas, nuclear energy was used. The southern region of Kazakhstan is the only region where the idea of switching from coal to other energy could be realized in the foreseeable future, and therefore is suitable for rooting in the public consciousness. The only major project to replace coal with gas for power generation was carried out at a CHPP plant in the city of Almaty.

In Central, Eastern and Northern Kazakhstan, the idea of replacing of coal with gas also has little chance of developing in public opinion, firstly, due to the lack of gas fields in these regions, and, secondly, due to the lack of a gas transportation system capable of Deliver to these regions gas from the west and south of Kazakhstan. In these regions, gas is represented in the economy in very limited quantities, as it is delivered only in liquefied form from Russia by rail, which makes it economically uncompetitive as an alternative fuel for centralized energy generation.

Expert opinion

This may seem surprising, but the idea of "withdrawal" from coal dependence is not widespread in the expert community of Kazakhstan. It would seem that experts have much more knowledge and information about the negative aspects of "coal dependence" compared to "average person" and should have an objective view of this problem. But in fact, the experts know less about the "dark side" of coal dependence, because of their professional approach historically established to the

60 http://www.kazpravda.kz/articles/view/neobhodimo-chetko-videt-perspektivu1/

61 http://metalmininginfo.kz/archives/4530

problem of the environmental impact of coal use. The practical absence of experts who retained independence from industry serving as their employer, also explains the almost complete lack of an expert opinion in the expert community about the need to replace coal with other energy sources. The steps taken by Kazakhstan to develop alternative energy are not considered in the expert community as the beginning of a strategic transition to low-carbon energy and the economy. Such changes are perceived as a "tribute to fashion" and decoration of the Kazakhstan energy market to create a favorable image for Kazakhstan in the international arena. When communicating within the expert community, Kazakhstani experts often express thoughts about the "impossibility" of replacing coal with other energy sources. A typical answer to the examples of such successful replacements in European countries is the phrase "You do not take Europe as an example, we are not Europe!"

In 2016, one of the European development institutions undertook an initiative study of the possibility to stimulate the replacement of coal by gas through the use of economic instruments. It is amazing, but the proposed ideas were meet with either indifferent disregard from some departments or an incomprehensible-hostile misunderstanding by other departments, the high-ranking experts of which sincerely did not understand why to develop such methods at all. This story clearly shows the width of the gap between the strategic goals of low-carbon development set in Kazakhstan and the actual tactical situation in the expert environment, since experts who sincerely do not believe in the possibility and necessity of coal replacement for gas work for the same departments that developed plans for decarbonization of the economy of Kazakhstan!

7. Barriers to replace coal with other sources of electricity generation, as well as measures necessary to reduce coal consumption.

A brief analysis made it possible to identify the main barriers to the replacement of coal by alternative sources of hydro generation:

- Partly declarative nature of the goals set for the decarbonization strategy of the country and the replacement of coal for gas, not supported by specific approved plans to achieve the goals set
- The contradiction between the need for the growth of electricity production in strategic documents and the absence of a reasoned justification for such growth
- Lack of legislative and regulatory support for the tactical implementation of the strategic objectives for low-carbon development
- It should noted that Kazakhstan is characterized by a wide range of equally "well-reasoned" statements, both about the need for additional energy generation, and about the absence of such need. In fact, in recent years, a stable positive balance of the energy balance in Kazakhstan as a whole has been observed, which is reflected in the energy balances approved in 2016 for the period 2016-2023[62]
- The strong dependence of the country's economy, and primarily of local budgets, on fees for environmental pollution (coal replacement for gas will cause a decrease in these sources of income for local budgets)
- The absence of economic methods to stimulate the replacement of coal by other sources of generation
- The overwhelming share of coal generation in the country's energy balance
- The lack of hydroelectric potential due to the arid plain in most of Kazakhstan
- Lack of gas transportation infrastructure
- Lack of production of liquefied gas
- Absence of large gas deposits in the central, northern and eastern regions
- Huge distances between gas-rich regions and other parts of the country,
- High energy consumption of mineral and raw materials and metallurgy industry
- Coal and coal-dependent metallurgical monocities and mono-regions

Measures to reduce the consumption of coal for power generation, which can be practically implemented in the foreseeable future, include the following actions:

- Increasing the level of payments for emissions of pollutants into the environment (increasing such payments above the critical level makes it profitable for a business to invest in improving the efficiency of coal combustion and purifying emissions, and, consequently, reducing the volume of fees).
- Development and implementation of measures to economically stimulate the transition from coal to gas (reducing payments for emissions of pollutants during gas combustion). Development and implementation of economic incentives for investment in the creation and development of capacities and infrastructure for the liquefaction, transportation and delivery of associated petroleum gas and methane of coal seams to the consumer.
- Development and implementation of government programs to diversify the economy in coal-dependent regions.

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[62] Decree of the Minister of Energy "On approval of the forecasted balances of electricity generation and capacity for 2017-2023" # 460 of October 26, 2016, https://www.google.kz/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjMmfn_9_zUAhVKJJoKHan1Ds0QFgglMAA&url=http%3A%2F%2Fenergo.gov.kz%2Fassets%2Fold%2Fuploads%2Ffiles%2F2016%2F11%2F%25D0%259F%25D1%2580%25D0%25B8%25D0%25BA%25D0%25B0%25D0%25B7%2520460%2520%25D1%2580%25D1%2583%25D1%2581.pdf&usg=AFQjCNHS5H2J_9nAZP_KFYebkzervqIQAQ

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Appendix 1. Forecast balance of electricity in Kazakhstan[63]

The balance of capacity of the North zone for the period up to 2030, MW

	Name	Forecast								
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1	Maximum consumed electric power	9 790	10 360	10 630	10 900	11 170	11 430	11 700	12 910	14 640
2	Required capacity reserve	829	970	1 001	1 001	1 004	1 007	1 032	1 065	1 099
3	Generation	12 773	13 218	14 523	14 572	14 691	14 816	15 856	16 823	18 598
4	Deficiency (+) Excess (-)	-2 155	-1 889	-2 893	-2 672	-2 518	-2 379	-3 125	-2 848	-2 859
5	Flows to the South Zone	1 269	1 350	1 350	1 350	1 558	1 064	1 172	2 035	2 300

Input of generation capacity in the Northern Zone for the period up to 2030.

	Name	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1	CHPP-2 JS Astana Energy 240 mW extention		120	120						
2	Ekibastuz GRES*-1 (blocks.1,2) 1000 MW	500		500						
3	Ekibastuz GRES-2 extension of 1290 MW			630					660	
4	CHPP*-3 Astana 240 MW					120	120			
5	CHPP Kokshetau 180 MW							180		
6	Gas Turbine Unit Aktobe CHPP expansion of 50 MW		50							
7	ZhGTES-56 expansion of 48 MW (Zhanazhol gas turbine power unit)		48							
8	PGU RBZ 40 MW (unknown abbreviation)		40							
9	Semipalatinsk CHPP-3 250 MW							250		
10	Ust-Kamenogorsk CHPP 103 MW expansion		103							
11	Karaganda CHPP-4 330 MW							330		
12	CHP-3 LLP" "Karaganda-Energocenter" expansion of 150 MW	150								
13	Turgai Central Heating Plant 1320 MW								1 320	

The balance of capacity of the West zone for the period up to 2030, MW

№	Name	Прогноз Forecast								
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1	Maximum consumed electric power	1 580	1 760	1 840	1 920	2 000	2 090	2 180	2 530	2 920
2	Required capacity reserve	184	214	221	232	237	244	249	389	387
3	Generation	1 830	2 183	2 246	2 416	2 381	2 381	2 351	3 555	3 470
4	Deficiency (+) Excess (-)	-66	-209	-185	-264	-144	-47	79	-636	-163

Input of generation capcity in the West Zone for the period up to 2030.

№	Название Name	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1			140							
2	Gas Central Heating Plant GSU IGHK 50 MW		50							
3	Power station "Kashagan" "Agip KCO extension of 150 MW		150							

[63] "Program for the development of the electric power industry of the Republic of Kazakhstan for 2010 - 2014". http://www.akimvko.gov.kz/assets/ru/files/technology1_z_2.doc

4	JSC" Atyrau CHPP "" extension of 185 MW		185							
5	CHPP JSC "ANPZ" expansion of 12 MW	12								
6	Gas turbine unit in the Uralsk city 150 MW				75				75	
7	Gas turbine unit in the Uralsk city 150 MW		100		100					
8	Kalamkas Gas turbine unit 90 MW		90							
9	Zhanaozen CHPP 12 MW	12								
10	PGU 250 MW								250	

The balance of capacity of the South zone for the period up to 2030, MW

№	Name	Forecast								
		2014	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1	Maximum consumed electric power	3 630	3 880	4 030	4 180	4 330	4 480	4 620	5 060	6 040
2	Required capacity reserve	361	383	396	408	750	767	768	756	762
3	Generation	2 722	2 821	2 852	2 861	3 522	4 182	4 215	3 780	4 032
4	Deficiency (+) Excess (-)	1 269	1 442	1 574	1 727	1 558	1 064	1 172	2 035	2 770
5	Flows from North Zone	1 269	1 350	1 350	1 350	1 558	1 064	1 172	2 035	2 300
6	Flows from Central Asia	0	92	224	377	0	0	0	0	470

Input of generation capacity in the South Zone for the period up to 2030.

№	Name	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2025**	**2030**
1						660	660			
2	Kerbulak Hydropower station 33 MW							33		
3	Hydropower stations 19-22 on the Shelek River 60.8 MW	14	14	13	17					
4	Hydropower station -29 on the Shelek River 34.8 MW	35								
5	Mine Hydropower stations-1,2 on the river Koksu 42 MW		19	23						
6	Hydropower Plant Kyzylbulak on the river Koksu 53 MW							53		
7	PSU CKZ-U plant 18 MW	18								
8	Chain of Merken hydropower stations 5-7 17.63 MW		18							
9	Gas turbine unit Kenlyk 87 MW		87							
10	CHPP-3 Shymkent expansion of 50 MW	50								