THE MODERN TRENDS IN ENERGY AND NUCLEAR INDUSTRY OF KAZAKHSTAN*

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Abstract

Kazakhstan has the potentials to be self-sufficient in energy resources in perspective and also to export such resources to other countries. This article describes the energy sector of the Kazakhstan, the perspectives of the development the energy and nuclear industry and shows the problems and methods of its solutions. The energy sector of the Kazakhstan has the diversified sources of energy resources. The open market of electricity will generate the investments and direct them on the development on more efficiency use of these resources. Rehabilitation of old power stations and its modernisation will allow to cover the future needs of the Kazakhstan. The nuclear industry of Kazakhstan has the infrastructure, high-qualified staff, enterprises, reactors and investments for the development. The energy police of the Republic of Kazakhstan are directed to find the balance between different sources of energy to decrease the emissions of greenhouse gas.

1. INTRODUCTION

Kazakhstan has the considerable resources in uranium approximately 1.17 billion tonnes. The Republic of Kazakhstan has the developed industrial infrastructure by the exploration, extraction and exploitation the uranium mining and production the thermonuclear elements for the nuclear stations. Kazakhstan has the scientific staff and potential for the development the nuclear industry.

Kazakhstan is a member of MEGATE and the national joint-stock company "Kazakhstanatomenergoprom" - is a member of the London uranium institute.

Kazakhstan’s uranium and production are sold in 14 countries of the world including USA, Canada, France, Germany, Great Britain, Japan, Russia and others.

The necessity of development of nuclear industry is based on next reasons:

(1) Lack or shortage of other energy resources;
(2) Strategic need of the nuclear potential by using in applied and military aims;
(3) Including the nuclear industry in energy sector can stabilise this sector and decrease the emissions and influence on environment.
(4) The Kazakhstan nuclear industry can enter to the world market with the commercial product.

The economic base of the nuclear industry is:

(1) The own resources of uranium;
(2) The developed industry by working up the resources, its enrichment and production the commercial product;

Machine-building industry, which can produce the equipment and materials for the nuclear reactors;

Scientific staff and management which can provide the production management, control and safety.

Kazakhstan has the enterprises and scientific staff that were the part of the former Soviet Union system of nuclear production.

2. THE ENERGY SECTOR OF THE REPUBLIC OF KAZAKHSTAN

The energy sector of the Kazakhstan is more capitalised part of the economy that is why it is more important to estimate foresee the new possible progressive directions of the development of its components and to adopt the modern instruments for its realisation. It is more important for the Republic of Kazakhstan to realise the long-term strategy of the development because of the important role of energy sector in the economy of the Republic of Kazakhstan.

The real provision of the energy resources is more significant for the new independent countries like Kazakhstan. The development and modernisation of internal system of energy provision of electricity on the base of local energy resources and export/import exchange with other countries are necessary.

The universal principles are that the main projects by the development the energy base can continue further quantitative growth and qualitative improvement of the energy sector of the Republic of Kazakhstan are defined.

The task of the energy sector is reliable and safety (in ecology and technical aspects) provision the population, communal services and industry of the Republic of Kazakhstan with fuel, coal, electricity, heating and etc. The task also includes the improvement of the structure of energy complex, liquidation the gaps and deficits, improvement of environment, solution social and political purposes in the Republic of Kazakhstan.

Four main items of the energy policy of the world which realise by the energy policy of the Republic of Kazakhstan are:

- material security of the energy complex for the sustainable economic growth;
- social security of human needs in energy services by cheaper prices;
- support the reliable work of energy system which can guarantee the energy security;
- safety of environment and climate change.

3. ENERGY RESOURCES

Kazakhstan has the all kinds of the energy resources. The main resource of the energy sector is the coal. The coal is mainly produced in the Ekibastuz region (west north of Kazakhstan).

The huge investments have been directed in the coal industry and coal power electricity stations and defined the main aspects of its development.
The coal fields mainly are situated in North and Central of Kazakhstan, where also situated mineral and fossil fuel deposits. They are the main industry potential of Kazakhstan. The main sources of the electricity also are situated in North and Central Kazakhstan. These regions have enough energy resources and have the surplus of them.

The region of South Kazakhstan has not enough the energy resources. The main part of existing resources is hydro resources. The development of hydro resources is very difficult in this region because of infrastructure. The local and foreign investors are going to build two large hydro stations. On the river Charyn is Mainak hydro station and on the river Ili is Kerbulak hydro station. Local authorities are going to build about 50 small hydro stations.

The expected scale of the exploitation the energy resources can not cover future demand on the energy resources. The energy sector of South Kazakhstan is based on the import of coal and natural gas from other regions. The region also produces the black product as the waste of refinery. Yet the main part of the demand on electricity is covered by the import.

The region of Western Kazakhstan – is the main fossil fuel region of Kazakhstan. Historically, the electricity provision of Akjubinsk and Uralsk regions is provided from the electricity station, which are situated in Russia. Yet Kazakhstan has the possibility fully provide the needs of the electricity by the development of existing energy resources in short time and provide the additional import resources.

4. THE CONSUMPTION OF ENERGY RESOURCES

The structure of energy resources defines the structure of the generation of electricity. This structure is characterised by the next indicators (% of the volume of generation of electricity):

- Combined heat and power system - 75-81%
- Gas-fired combustion turbines - 12-13%
- Hydro stations - 6-11%
- Nuclear power plant in Aktau - 0,7%

The whole length of power lines the is 464133 km. including:

i) 1421 km of lines with a voltage of 1150 kV
ii) 5455 km of lines with a voltage of 500 kV
iii) 20241 km of lines with a voltage of 220 kV
iv) 44475 km of lines with a voltage of 110 kV
v) 62088 km of lines with a voltage of 35 kV
vi) 203938 km of lines with a voltage of 6-10 kV
vii) 122058 km of lines with a voltage of 0,4 kV
5. COMMON CHARACTERISTICS OF KAZAKHSTAN

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<tr>
<th></th>
<th>1990</th>
<th>1995</th>
<th>1997</th>
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<tbody>
<tr>
<td>Population (million)</td>
<td>16,79</td>
<td>16,6</td>
<td>15,86</td>
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<tr>
<td>Electricity consumption GW(h)</td>
<td>104,7</td>
<td>74,38</td>
<td>57,12</td>
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<tr>
<td>Electricity consumption per man kW(h)</td>
<td>6236</td>
<td>4480</td>
<td>3600</td>
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<tr>
<td>GDP (billion $)</td>
<td>37,55</td>
<td>22,08</td>
<td>22,4</td>
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<tr>
<td>GDP per capital ($)</td>
<td>2236</td>
<td>1330</td>
<td>1412</td>
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<tr>
<td>Rated capacity of power stations GW</td>
<td>17,57</td>
<td>18,42</td>
<td>17,927</td>
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<tr>
<td>Electricity generation GW(h)</td>
<td>87,4</td>
<td>66,98</td>
<td>52,17</td>
</tr>
<tr>
<td>Export of electricity GW(h):</td>
<td>11,01</td>
<td>4,89</td>
<td>3,44</td>
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<tr>
<td>Russia</td>
<td>10,78</td>
<td>2,01</td>
<td>3,37</td>
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<tr>
<td>Central Asia</td>
<td>0,23</td>
<td>2,88</td>
<td>0,08</td>
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<tr>
<td>Import of electricity GW(h):</td>
<td>28,34</td>
<td>12,28</td>
<td>8,39</td>
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<tr>
<td>Russia</td>
<td>18,37</td>
<td>6,2</td>
<td>6,4</td>
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<tr>
<td>Central Asia:</td>
<td>9,97</td>
<td>5,22</td>
<td>1,99</td>
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<tr>
<td>Uzbekistan</td>
<td>7,83</td>
<td>0,43</td>
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<td>Kyrgyzstan</td>
<td>1,92</td>
<td>0,78</td>
<td>0,79</td>
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<tr>
<td>Tadjikistan</td>
<td>-</td>
<td>0,31</td>
<td>-</td>
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<tr>
<td>Turkmenistan</td>
<td>-</td>
<td>1,68</td>
<td>1,18</td>
</tr>
<tr>
<td>Net import</td>
<td>17,34</td>
<td>7,4</td>
<td>4,95</td>
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6. THE ELECTRICITY GENERATION

The huge generation of electricity in Kazakhstan was in 1989 and consisted of 88,9 GW(h) per year. The installed capacity of power station is 1682 GW(h) with number of used hours 5285. The modern installed capacity of power station allows reach the potential of electricity generation to 95 GW(h) per year with the intensive of used hour as in 1989.

The Ekibastuz energy complex is intensively developed in North Kazakhstan. It provides the electricity supply for consumers of Kazakhstan, Western Siberia (Russia) and Central part of the Russia. The development of Ekibastuz allows Kazakhstan to be energy independent and make the export of electricity. The unique overhead lines with voltage 1150 kV and 500 kV including the transmission line Siberia – Kazakhstan – Ural can provide the large transportation of electricity. These transmission lines are the main element of the infrastructure of modern economy of Kazakhstan. They allow solve the main part of the economic problems by the supply the electricity for a long-term period.

The levels of the development the energy sector are mainly influence on the development of the economy of the Republic of Kazakhstan. The independent energy provision and energy security are the conditions of the stable energy supply in the economy. This can provide the base for the economic security of the Kazakhstan.

In 1990 the power stations of Kazakhstan generated 87,4 GW(h). In further time the combined heat and power plant, in Ekibastuz GRES-2, combined heat and power plant in Karaganda TEC-3, the gas-fired combustion turbine in Aktubinsk (Akturbo) and Shulbinsk hydro station were built on the territory of Kazakhstan. The full installed capacity of them is more 7 GW(h).
As a result of this potential the generated capacity is more than 95 GW(h). This level of consumption is expected to the period after 2015.

By the different problems the generation of electricity on the power stations decrease significantly after the decrease of the demand on electricity. In 1997 the generation of electricity was 52,2 GW(h), the level of consumption was 57,1 GW(h).

The main problem before the economy of Kazakhstan is a recovery of the generation of electricity on the power stations and it is not important who is the owner of them.

The rehabilitation of power station is the wide world experience. This way may allow generate the electricity with low expenses and in short time. This is more important for the society. The old power stations have the building, infrastructure, means of communications, heat grid lines for the heat capacity, high-qualified staff, and solved as a rule social problems.

The energy equipment on the power stations and electricity grid lines have not repaired since 1990\textsuperscript{th} and had not maintenance. The equipment exhausts all its resources and need the modernisation and installation of the new equipment and technology.

The recovery of power station is one of the significant problems of the energy sector. The South and West zones of Kazakhstan have not enough capacity for the generation of electricity. These zones have the deficit in electricity.

Under the conditions of recovery and maintenance the energy sector the forecast growth of demand on electricity can not cover without building the new capacity of generation the electricity. The new power station can keep the balance in the system when the old power station will be modernised and will be excluded from the system. Ones of the main current problems are building the new power stations and increasing the capacity of the existing power stations which have the necessary infrastructure and high-qualified staff.

The main problems of the development the energy sector:

i) The recovery of generation on existing power stations by the rehabilitation and reconstruction as more cheaper and quick solution;

ii) Keeping the capacity on power stations on the installed level and to put into the new equipment and new technology on them;

iii) To increase capacity on the existing power station, building the power stations to cover the internal needs of Kazakhstan and create potential for export. To improve the structure of generated capacities and to create the reserves of peak capacity;

iv) Wider use of natural gas and casing head gas or dissolved natural gas;

v) Development economical competitive renewable energy resources;

vi) Further development of the national electricity grid lines and building the new transmission lines, reconstruction and rehabilitation of them for the improvement the structure of energy sector and development the internal and external markets.

The main tool of energy policy and solution the problems of its development is market. In 1995 the “the law of electricity energy” of the Republic of Kazakhstan was approved. This law became the base of the reform in energy sector. All main power stations were privatised and became the participants of energy market. The company KEGOC is operator of the wholesale energy market and organises the management under the
interregional and interstate transmission electricity lines. The company KEGOC is not buyer or seller of the electricity and capacity. This company is responsible only for the transportation of electricity.

At this moment the wholesale market of electricity is formed. The company KEGOC together with Ministry of Energy, Industry and Trade work out the legislation by the further improvement of the energy market. The Government of the Republic of Kazakhstan realises the policy of step-by-step privatisation of local distribution companies to create the open retail market. The process of privatisation in the internal energy market will be continued till creation open competitive energy market.

Among the possible variants of further development of energy sector on long-term perspective is the variant of building the nuclear power plant with capacity 3×640 MW (or 13.5 GW(h)). The capacity of nuclear power plant will be increased according the growth of demand on electricity. The government will accept the decision after public consideration of feasibility study of this station. According the international standards, methods and after international expertise this station will be built.

7. THE PERSPECTIVES OF THE DEVELOPMENT THE NUCLEAR INDUSTRY IN KAZAKHSTAN

The nuclear-power complex of Kazakhstan was formed as an integral part of the nuclear industry of the former Soviet Union and in many aspects it is closely connected with enterprises and scientific centres in Russia and Ukraine.

The nuclear industry consists of 7 mines by the extraction of uranium, 2 factories producing uranium oxide (in Aktau and Stepnogorsk), 1 factory processes UF₆ and VO₂ and produces thermonuclear elements for the reactors.

Kazakhstan State Corporation of nuclear power industry and enterprises coordinates the activity of nuclear complex. The corporation includes Caspian metallurgical and Tselinograd mine-chemistry plants, Ulbinsky metallurgic plant. Their main activity was processing and enrichment of the products of uranium mining companies. Today they are mainly produced the rare-landed elements, noble metals, mineral fertilisers and consumer goods.

Only one nuclear power plant in Kazakhstan has operated since 1972 as a part of Mangyshlak energy plant on the basis of the fast neutrons nuclear reactor BN-350, which exhaust all its resources. It is suggested to replace the existing reactor in Aktau by small capacity reactors as BMN-170 which also is a fast neutrons nuclear reactor. This reactor is produced as mono-block, equipped with shut down and after cooling functions that keep the work of the reactor in safe mode, independently from the support and maintenance systems and activities of technical staff. The existing nuclear power plant generates 125 MW and also produces the fresh water (10,000 t per day) and some steam which is used for technical purposes.

Mangyshlak power plant supplies Aktau and other inhabited places near Caspian Sea with energy and fresh water.

The research and production association “Luch” which is located in Semipalatinsk has the special technical equipment and high-qualified scientific and technical staff. On the territory of the Republic of Kazakhstan four scientific reactors are situated. Three of them are
situated in Semipalatinsk. These reactors are used for the testing of nuclear missile engines, researches in nuclear materials of reactor and testing safe operation on the nuclear power stations.

The nature is disposed so that Kazakhstan has almost half of all the proven uranium resources in CIS. Uranium is produced in Kazakhstan but there are no consumers of the uranium inside the Kazakhstan. The Kazakhstan’s uranium also can not find the consumers in CIS. Kazakhstan should offer the uranium to the world market in compliance with MAGATE regulations and to the countries which signed the convention of non-distribution the nuclear weapons.

The orientation on the construction of nuclear power plant can lead to the problem of radioactive waste utilisation. In Soviet time the wastes from the nuclear enterprises and nuclear plants were utilised on the territory of Russia and Kyrgyzstan. Now it is necessary to create the own system of utilisation. This problem can be solved with low expenses for Kazakhstan. The radioactive waste can be utilised on the territory of Semipalatinsk nuclear test polygon or saline mines of Azgirsky nuclear test polygon.

8. THE REAL ACTIVITIES FOR THE REDUCTION OF CO₂ EMISSION

The growth of concentration the CO₂ in atmosphere can be the main factor which can restrict the using fossil-fuel and coal in the future because of increase the temperature of the land surface as a greenhouse effect.

According the development the energy sector the economic analysis show that it is necessary to make the reconstruction and modernisation combined heat and power plants. The part of combined heat and power plants in the economy of the Kazakhstan is 48% in 1990 from all volume of generated electricity.

The main effective directions to decrease fuel expenditures by electricity generation of the large coal central steam plants are:

(i) Further development and improvement of combined heat and power plants;
(ii) Improvement the heat scheme of large coal central steam plant, creation combined cycle plant, building the new power plants and to transform turbo-generator power plant into compressed air storage power station.

The significant factor for the reduction CO₂ emission is the activities by the effective using of the fuel or energy efficiency. The potential of the energy efficiency in Kazakhstan is very high. The government Republic of Kazakhstan together with USAID worked out and approved by decree the National Program of Energy Efficiency.

The realisation of the short-term and middle-term programs of this national program will allow decrease the expenditures on the fuel on 25% and by the long-term program on 40%.

The specialists of Kazakhstan considers the natural energy resources of Kazakhstan, technical and scientific development and the results of expertise and they choose the next activities of the reduction of CO₂ emissions in energy sector:

(1) The modernisation of large coal central steam plants;
(2) Construction the new hydro stations, wind station;
(3) Consideration the project by the construction the nuclear plant;
(4) Using the other renewable source of energy.

To decrease the restrictions which connect with concentration of the CO₂ emission in atmosphere we can make the conclusion that to develop the energy sector have to consider the balance of generation heat and power between different sources of energy and try to safe the environment.

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