研究ノート

The Development of Nuclear Energy in Kazakhstan and its Integration to the Country's Energy Sector

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Kazakhstan has one of the largest reserves of energy resources in the world. However, despite the sizable gas, oil and coal production, the country is currently importing electricity from neighboring states to respond to its energy production shortage. The Kazakh government has expressed its desire to develop nuclear energy with the consequent establishment of full nuclear fuel cycle by 2014 (Government of Kazakhstan, 2010). In this scenario, energy security has become a key element to respond coherently to the current energy situation and the governmental strategy for the future of the country.

The objective of this paper is to examine the integration of nuclear energy into Kazakhstan's energy sector. For this purpose, it will present an overview of the energy sector of Kazakhstan. This synopsis will include the identification of the major energy resources and challenges of the sector, as well as the stages of nuclear energy development as laid out by the Kazakhstan's government plan. Furthermore, this paper will present an analysis of the nuclear energy's position in Kazakhstan's energy sector to provide a short evaluation of its efficiency and ability to meet the country's growing energy demand.

1. Overview of Energy Sector in Kazakhstan

Kazakhstan is rich in energy reserves, particularly of oil and coal. It is the major oil producer in Central Asia and one of the top 10 states in oil reserves worldwide. Its output in 2007 was calculated to be 1.3 million barrels per day (International Energy Agency, 2011) (Dorian, 2005). The oil proven reserves of the country are estimated to be 39.6 billion barrels (Kaiser, Pulsipher, 2006). Consequently, the share of oil and gas sector in the Kazakhstan's GDP was estimated to be around 30% (Kaiser, Pulsipher, 2006). The state invests $4-5 billion into the oil industry annually (Kaiser, Pulsipher, 2006), which indicates the importance of the energy sector in Kazakhstan's economy as well as the

prospective of a sector which is still under development. The major oil fields of Kazakhstan are Tengiz, Karachaganak, Kashagan and Kurmangazy, with the latter being still under exploration (Kaiser, Pulsipher, 2006).

The country's gas sector is similarly significant, and includes 83 deposits of natural gas, with 17 of them being exclusive gas reserves and with overall gas reserves estimated to be 1.90 tcm (Dorian, 2006). Natural gas is unevenly distributed around Kazakhstan, with 40% of the reserves being located in Karachaganak field (Kaiser, Pulsipher, 2006). The scattered location of gas reserves is a major challenge for its distribution, for instance, having major gas fields in the Western part of the country and the most demand in the South (Kaiser, Pulsipher, 2006). As a result, Kazakhstan has been forced to import gas from Uzbekistan and Turkmenistan, while having enough domestic reserves of natural gas, which it is unable to distribute efficiently.

Kazakhstan has 37 coal reserves and is a major coal producer in Central Asia (Dorian, 2006). As in the case of natural gas, coal deposits in Kazakhstan are located far from industrial facilities and concentrated in specific parts of the country, particularly in central region (Dorian, 2006). However, in comparison to natural gas, coal is the major fuel for electricity production in Kazakhstan, being used in the heat-and-power plants that are located around the country.

In general, the energy sector in Kazakhstan is based on the production of coal, oil and gas, but due to the geographical location of the energy resources and poor transportation system the country has restricted capabilities to provide energy for its population, particularly in the form of electricity. The country's deficit of electrical power has pushed the country to implement a strategy of energy import from the neighboring countries. As a response to this, the government of Kazakhstan is searching for the alternative supplies of electrical power, to meet the demand in its Southern region.

2. Challenges of Kazakhstan's Energy Sector

The energy sector of Kazakhstan faces significant structural and technical challenges. According to Ordabayev (2010), many of the energy generation related problems are linked to the outdated facilities, the lack of modern technological equipment in electricity generation plants and the expiration of the exploitation period of those facilities. Thus, 41% of electricity generating

facilities has been working for over 30 years, contrasting with the standard period of exploitation in developed countries which is set to a maximum of 5-7 years (Ordabayev, 2010). Aside from that, there is high rate of overexploitation of electrical networks up to 65-70% (Ordabayev, 2010). The exhaustive use of the electrical equipment leads to the high frequency of industrial accidents and power blackouts (Ordabayev, 2010). As a result, the inefficient and irregular energy supply has weakened the energy sector of the country. This situation poses an important threat to the energy security of the country.

Another challenge of the energy sector is the insufficient use of renewable and hydropower sources of energy in Kazakhstan (Ordabayev, 2010). The use of hydropower, in particular, is expected to cover the need for electricity in peak seasons (Ordabayev, 2010). So far, the use of renewable energy in Kazakhstan is estimated to be around 0.5% (Raimkulov, 2011). This figure is projected to become more than 1% and expected to generate annually up to 1 bln kWt/h by 2014. Furthermore, the state programs aim to increase the share of renewable energy up to 3% by 2020 (Raimkulov, 2011). The considerable amount of CO_2 emissions resulting from the heat-and-power plants, and the impact of those emissions in climate change should encourage the country to reconsider the use of heat-and-power facilities and focus on environmentally friendly options to energy production. Such strategy would satisfy the regulations stipulated in Kyoto protocol and help face the energy production challenges of the country in a sustainable manner.

Kazakhstan's challenge of balancing the unevenly distributed energy resources availability and production is also a key factor for achieving energy security. This particular problem is partly a result of the legacy of the former Soviet energy network. Responding to the energy unbalance, where 42% of electrical power being generated in Pavlodar oblast in the north of Kazakhstan (Ordabayev, 2010) and the largest demand for electricity comes from Almaty and other southern regions, will significantly improve the efficiency of the energy sector of the country. Taking into consideration all mentioned challenges of the energy sector, the government of Kazakhstan has implemented several state programs to address them (Raimkulov, 2011). The development of energy sector plays a significant role in the strategies included within the state program for rapid industrial-innovative development in 2010-2014. In the 5 years included in this program, more than 320 investment projects will be

established. The outcome is expected to be the generation of 97.9 bln kWt/h to respond to a demand of 96.8 bln kWt/h (Ordabayev, 2010).

While energy security is already being taken into account by the governmental planning for the country modernization, it is still necessary to understand the factors that are needed to prevent large-scale power blackouts and energy deficit. Thus, the next sections of this paper will explore how nuclear energy development can be incorporated into the energy sector and whether it can meet the challenges of it or not.

3. The Development of Nuclear Energy in Kazakhstan

The nuclear energy sector in Kazakhstan has a long history starting from the Soviet Union, when the industry was established and Kazakhstan was the base for the uranium production and nuclear tests and research. From the late 1980s and to early 2000s the nuclear industry in Kazakhstan experienced a downfall of uranium production and an overall crisis of industry (Kazatomprom, 2011). The extraction of uranium in Kazakhstan fell from almost 4,000 tonnes to 900 tonnes during the period from 1990s to 1997 (Kazatomprom, 2011). The managing company of nuclear industry in Kazakhstan, which was Kazakhstan State Atomic Power Engineering and Industry Corp (KATEP) with 51% of shares owned by the state, was not able to sustain efficient management of the industry further on (Caroll, 1997).

Precisely at this point the government of Kazakhstan decided to pay attention to the problems of the nuclear industry and try to revive it. In 1997 by the Decree of the President of Kazakhstan the National Atomic Company, *Kazatomprom*, was established with the main goal to restore and develop nuclear industry in Kazakhstan (Nazarbayev, 1997). *Kazatomprom* took control of the former KATEP and its associated companies as well as its financial burdens. The decree emphasized the importance of the atomic industry for the development of the country and thus became one of the strategic interests of the country. *Kazatomprom* was declared a 100% state-owned company which should deal with exploration, research, mining, export and trade of uranium, operating nuclear power plants, and to cooperate with the industries and companies involved in the nuclear industry field (Nuclear Threat Initiative, 2003). The company faced numerous challenges in the Kazakhstan's nuclear

industry. As mentioned before, the decrease in uranium production was observed parallel with the uranium price depreciation in the world markets, the stagnation of atomic industries in the partnering countries, especially in Russia, and outflow of specialists (Nuclear Threat Initiative, 2003). Moreover, the company acquired the dramatic situation of the previous nuclear industry company which was significantly indebted to the employees and foreign banks (Kazatomprom, 2011). In order to solve the above-mentioned issues *Kazatomprom* developed a strategic plan of actions with the main goal to revive the nuclear industry in Kazakhstan (Kazatomprom, 2011).

From 2000s *Kazatomprom* started consistent policy for the reconstruction of the nuclear industry in Kazakhstan. Getting the financial credits, company was able to cover the debts and financing of production was provided (Kazatomprom, 2011). Moreover, Kazakhstan got access to the US and European uranium markets ending the restrictions on Kazakh uranium due to legal anti-dumping charges. The production of uranium in Kazakhstan has increased and the country was ranked sixth in terms world's uranium output in 2000 (Kazatomprom, 2011).

Achievements in nuclear industry in previous years considered, the period of 2001-2002 could be viewed as a post-crisis period for the nuclear energy sphere in Kazakhstan (Kazatomprom, 2011). *Kazatomprom* signed agreements and got access to uranium market of China and South Korea. The production of uranium was continuously increasing and thus the transfer of new technologies was needed. Kazakhstan was able to obtain new drilling machines for the uranium mining, which resulted in more efficient exploration and exploitation of the mines.

In 2004 *Kazatomprom* declared a strategic plan of achieving "15,000 tonnes of uranium production in 2010" in World Nuclear Association symposium (Dzhakishev, 2006). The establishment of new uranium mines contributed to the development and growth of nuclear industry in Kazakhstan. From 2003 to 2006 Kazakhstan was expanding and deepening cooperation with foreign countries, like Japan, China, and Russia, in the nuclear industry sphere.

In 2008 the idea of the full nuclear fuel cycle in Kazakhstan started to take its shape by the signing of international agreements of *Kazatomprom*. On June 11, 2008 *Kazatomprom* signed a significant agreement with French company *Areva* for nuclear fuel cycle development. The contract established a

joint venture Katco (51% *Areva* and 49% *Kazatomprom*) in production of 4000 tonnes of uranium up to 2039, which would be sold by *Areva* (World Nuclear News, 2008). Moreover, the agreement also stipulated the production of 1200 tonnes of uranium in Ulba Metallurgy Plant for the fabrication of nuclear fuel pellets, among which 400 tonnes would be used for French nuclear reactors (on the basis of *Kazatomprom* 51% and *Areva* 49%) and 800 tonnes used by *Kazatomprom* entirely (Kazatomprom, 2011). This agreement signified the commitment of Kazakhstan to establish transnational vertical integrated company for the nuclear fuel cycle.

Kazakhstan was able to develop nuclear industry field to the competitive level in global market in the short period of time. Within 8 years national company *Kazatomprom* not only revived the nuclear industry from the crisis but became the one of the key players in the sphere of global uranium production. This result could not be achieved without the consistent commitment and strategic plan of action from Kazakh government as well as foreign investments. After the collapse of the Soviet Union and first decade of independence the main strategy of Kazakhstan in general and nuclear industry, in particular, was to overcome the crisis and stagnation. The future strategic goals for the country would be to achieve industrial and economic development and play a leading role in nuclear industry.

4. Future Prospects in Nuclear Energy Development in Kazakhstan

In 2010 government of Kazakhstan has issued a state program on "The development of nuclear industry in Kazakhstan from 2010-2014 with prospects for 2020" which has laid out crucial aspects of growth of the industry (Government of Kazakhstan, 2010). The commitment of the government to develop and secure the position of Kazakhstan as a world's important player in uranium production sphere was emphasized by Kazakh high officials. President of Kazakhstan Nazarbayev has emphasized in his annual messages to the people of Kazakhstan to make a target of achieving rapid industrial growth and economic prosperity (Akorda, 2011). The administration of Kazakhstan has developed strategic plan of development "Kazakhstan-2030," additionally the plan Kazakhstan-2020 of economic development of the country were proposed. Nazarbayev in 2006 has put a target for Kazakhstan to be on the list of the 50

most competitive countries in the world. However, for the fulfillment of all the proposed plans for modernization and industrial growth the huge supplies of energy resources are needed.

In 2009, as was expected and planned by the government, Kazakhstan became the world's largest uranium producer with 28% of world production. However, it is not the ultimate level that Kazakhstan can achieve. *Kazatomprom* expressed their willingness to increase this figure up to 30% of world's production by 2015 (Kazatomprom). Kazakhstan was consistently increasing the production of uranium from 2001 to 2009 starting from 2000 tonnes to 14,020 tonnes of uranium per year (WNA, 2010). The target of becoming the world's largest producer of uranium was achieved due to the exploration and construction of new mines upgrade and extension of nuclear fuel production (Vinokurov, 2008). Consequently, the ambition of becoming the largest uranium producer was fulfilled in the matter of 10 years.

The next step of Kazakhstan in the development of nuclear energy is to establish full nuclear fuel cycle on its territory in order to become independent from Russia. Currently, Kazakhstan is operating uranium mining and fuel pellets production on its territory, while conversion and enrichment, as well as fuel rods production is made in Russia. The issue of Kazakhstan's commitment to nuclear nonproliferation and financial constraints of developing all the facilities for full nuclear fuel cycle in the recent time made it easier for Kazakhstan to collaborate with Russia (Kassenova, 2008). The prospect is to establish common enrichment facility with Russia which could be used by *Kazatomprom*, with the restriction for Kazakhstan's experts' access to enrichment technology but to operate the process itself (Kassenova, 2008). Furthermore, Kazakhstan and Russia are promoting the use of International Uranium Enrichment Center (IUEC) in Angarsk, Russia for the access to nuclear fuel by other countries.

It is necessary to mention that Kazakhstan is collaborating with Russia on nuclear fuel cycle stages, although it is also diversifying its partners in the nuclear energy sphere. For instance, *Kazatomprom* bought 10% share of Westinghouse Electrics, leading nuclear reactors producer, in 2007 (Vinokurov, 2008). From this deal, *Kazatomprom* gained access to world's nuclear fuel markets as well as technical assistance in the production of fuel assemblies (Kassenova, 2008).

Kazakhstan is actively negotiating with Japan on nuclear fuel exports, not only of uranium, but also fabricated fuel assemblies (WNA, 2010). Kazakhstan would like to supply 40% of the Japanese need for natural uranium and fabricated fuel from 2010 (Muzalevsliy, 2010). Japanese partners are engaged not only in the uranium exports agreements, but also technical assistance to the National Nuclear Center and research conduction of the feasibility of the nuclear energy sector development in Kazakhstan (WNA, 2010).

In addition to Japan, the cooperation of Kazakhstan with China in the field of nuclear industry is also increasing and developing. In 2006 China's Guangdong Nuclear Power Group Holdings (CGNPC) signed an agreement with *Kazatomprom* for the Chinese participation in Kazakh uranium mining projects and Kazakhstan's investment to China's nuclear industry (WNA, 2010). This agreement makes Kazakhstan the main supplier of uranium to CGNPC, overtaking French company *Areva* and starting selling to China nuclear fuel by 2013 (Kassenova, 2008).

The other strategic purpose of nuclear energy development is to produce domestic nuclear power and meet the needs of electricity demand. From 1973 to 1998 Kazakhstan had operated the only nuclear reactor in Aktau which was dedicated for water desalination and electricity generation (Government of Kazakhstan, 2002). Since the date of exploitation has been expired, in 1998 the reactor was closed, from that time Kazakhstan did not operate any nuclear reactors on its territory. However, for the full realization of nuclear energy development it is required to start constructing and operating at least one nuclear power plant. The project is to start construction of nuclear power plant in Aktau in 2011 based on the Russian type of nuclear reactors (WNA, 2010).

The nuclear power plant in Aktau is supposed to meet the energy needs of the western part of Kazakhstan which is now reliable on the supply of electricity coming from Uzbekistan (Kassenova, 2008). There are also projects to build nuclear power plants near Lake Balkhash for the electricity supply to Almaty city (WNA, 2010). The poor supply of electricity and increasing demand for this city makes energy supply a major concern for government officials. Only in the southern part of Kazakhstan the deficit in electricity will be 1.9-2 bln kWt per hour by 2030, notice this figure will be achieved with the introduction of new South-Kazakhstan State District Electrical Plant (Government of Kazakhstan, 2002). 80% of the electricity sector of Kazakhstan is dependent

on the heat-and-power plants, which cannot meet the domestic demand for the energy (Vinokurov, 2008). Moreover, the electricity grid of Kazakhstan was built during Soviet times; hence, after getting independence the northern and southern parts of Kazakhstan were not connected by common electricity grid. Consequently, it appeared that the largest producer of energy is Pavlodar oblast in north of Kazakhstan, whereas the most consumption is coming from the southern part (Vinokurov, 2008).

The development of nuclear energy is projected to cover the development and enlargement of all stages of nuclear fuel cycle inside the country. Uranium mining is already developed, however, all the other stages like fuel pellets production, construction of reactors, waste storage and management of nuclear power plant is still need to be developed. The nuclear energy development in Kazakhstan is so far directed for the purposes of Kazakhstan's nuclear industry and international cooperation. The development of nuclear energy in Kazakhstan will be alternative source of electricity supply. However, the actual use of nuclear power is the long-term strategy, as was laid out in the state program from 2014 (Government of Kazakhstan, 2010). Considering the events in Fukushima nuclear power plant, the construction of nuclear plant in Kazakhstan is quite debatable issue.

Conclusion

The development of nuclear energy in Kazakhstan is an important and strategic decision. It is evident that nuclear energy development is associated with numerous risks and challenges and requires substantial financial investments. The development of nuclear energy could bring the innovative and industrial growth to Kazakhstan and support the economy of the country. However, in the context of energy sector the analysis of Kazakhstan has shown that the role of nuclear energy in the country seems to be rather minor. The country would still, in the short-term, rely on hydrocarbons and the percentage of nuclear power generation would be small. According to the state program, nuclear energy is not projected to be generated throughout the country, but rather in specific areas. Although, nuclear energy could be targeted to generate additional electricity for southern regions of Kazakhstan, where there is shortage of electricity, still nuclear energy would only supplement other efforts

made by Kazakhstan's government to resolve the issue. Thus, the development of nuclear energy in Kazakhstan is important for the export of nuclear industry products rather than for covering the overall domestic energy needs.

Appendix

Source: Lonely Planet, at http://www.lonelyplanet.com/maps/asia/kazakhstan/ (January 24, 2012)

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