



The Electric Energy Sector of Kazakhstan: State and Vision for the Country Taking into Account the International Trends

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ABSTRACT

The main objective of this paper is the study of the modern state of the electric energy sector of the Republic of Kazakhstan, as well as the determination of some promising directions of the country in view of the global trend of the electric energy sector. The desk study, trend analysis, and literature review were used as the methods of the research. The conducted research allowed concluding that many factors had significant influence on a rapid change of the global energy sector and the way energy was produced and consumed as well (including the climate change, development of new sources of energy, application of innovative technologies). Nowadays, the electric energy sector of the Republic of Kazakhstan is facing a lot of intrinsic factors (including the need to modernize infrastructure), as well as the changes in global markets which require long-term planning and the environment for attracting new investments. It is necessary to take into account the global energy environment during the development of a growth strategy, including some changes in the dynamics and organization of the world production and demand in energy, development of renewable energy resources, and implementation of “smart” networks.

Keywords: Electric Energy Sector, Fuel and Energy Complex, Alternative Sources, Renewables, Energy Infrastructure

JEL Classifications: Q20, Q42

1. INTRODUCTION

The electric energy sector is a key component of modern society. It mainly determines the social and economic development in every country.

The fuel and energy complex is a driving force for industrial development and economic growth in the Republic of Kazakhstan because its share in total industrial production is more than 60% (KAZENERGY, 2017).

Kazakhstan is particularly prominent as an energy producer and supplier within the Central Asia region; it has abundant reserves

of energy resources. This country leads the world in the production of uranium and ranks among the top 10 countries for coal and top 20 for oil. Over the past two decades, it has doubled its oil output; uranium output has increased by nearly 30 times.

Extractive industries have a large proportion in the economic structure of Kazakhstan being characterized by little additional cost and high consumption of energy. The energy output of Kazakhstan’s economy is 2-3 times higher than the aggregate figure within the countries of the Organization for Economic Cooperation and Development. This structure of the economy may lead to a shortage of electric power for domestic consumption (Rodilla and Batlle, 2010).

2. LITERATURE REVIEW

Since achieving independence in 1991, Kazakhstan's power sector has made significant changes on its way of upgrading; Kazakhstan's energy sector was considered to be the leading one among former Soviet states. Kazakhstan became one of the first post-Soviet states which implemented a progressive multimarket model consisting of the bipartite, spot, balancing intermediate and capacitive submarkets.

The country has reached a significant improvement in the supply and demand balance, and quality of services. The wholesale electricity market was liberalized and functioned mainly on the basis of bipartite contracts between producers, large consumers, and regional electricity companies for the direct sale of energy. The government of Kazakhstan has created a legislative, technical and organizational infrastructure for the functioning spot energy market, which increasingly complements bipartite contracts as a marketable trading platform for short-term transactions.

The excess energy consumption of production derived from the Soviet system concealed the need for long-term energy planning, while energy prices were too low to attract big investors. With the onset of the investment crisis of the 2000s, there was a serious concern that additional capacities of the existing and planned production might not be sufficient to meet the continuing significant energy demand.

Instead of market mechanisms for increasing prices and reflecting the gap in supply and demand, the Government of Kazakhstan addressed this issue through administrative, command and control measures, including the implementation of tariff regulation, regeneration, and oligopolization of energy production, as well as restrictions on spot transactions in the electricity market, elimination of zonal tariffs for energy transmission.

According to international experts, the energy system of Kazakhstan has achieved significant success and is functioning quite well, especially in comparison with the Central Asian countries (Aldayarov et al., 2017). However, the country's energy sector faces a number of problems, reflecting the downturn in world primary goods prices, the consequent reduction in industrial production and a fall in electricity demand. Some of the most important problems are the high energy output of GDP, the lack of power generation capacity, the urgent need for investment, inefficient regulation and reversal of industry reforms.

Despite notable progress, sectoral reforms in the electric power industry in the Republic of Kazakhstan remain mainly incomplete and require adjustments to the strategic course with current trends in the global energy sector.

Nowadays, it is important for Kazakhstan to form an overall vision of the future development of the energy sector as one of the key sectors of the country's fuel and energy complex, taking into account changes in global energy production and consumption with a focus on clean energy, development of innovative technologies, development of new energy sources, energy market volatility, climate change, etc.

Most international companies and organizations emphasize the growth trend in global energy consumption (for example, IEA (2018a); BP (2018), Statoil (2014), IRENA (2016)) predicting an increase in global energy demand by 30% in 2030, IEA (2014) - by 37% in 2040 compared with 2014, despite the reduction in energy output of developed countries. Energy consumption has changed over the past 40 years: OECD countries have significantly reduced the growth rate of energy demand through the implementation of energy efficiency and energy saving measures, primarily for households and productions, as well as the development of natural resources and the use of culture (Nielsen et al., 2018).

Currently, a global energy transformation is taking place in the world, which can bring both opportunities and threats to the development of the energy sector (Wang et al., 2017). Analysis of the literature sources has revealed a number of common factors, which together will determine the characteristics of the global energy market.

1. The growth of the economy. To a large extent, the prospects for the country's economic development are determined by the availability of natural resources, the educational level of labor resources, the volume of investment in production, as well as the historically established economic system of the state (Larionov et al., 2018). Research on the economics of power engineering distinguishes two main regularities of the post-industrial world. One of them is an increase in energy efficiency which has direct impact on economic growth (Yang, and Shi, 2018). The second pattern is that the global economy is developing in conditions of estimated constancy of energy consumption per capita (Makarov et al., 2012). At the same time, the intensity of energy consumption varies in different sectors and countries (Zhong, 2018).
2. The development of digitalization and new technologies. The growing impact of information and communication technologies in the energy sector is a major trend. This can also be applied to intelligent control systems (for example, cyberphysical devices and the Industrial Internet of Things) (Moyer and Hughes, 2012) and the digitalization of the infrastructure, which collects data and integrates these systems at a completely new level using cloud computing and big data (for example, intelligent networks) (Panajotovic et al., 2011; Moyer and Hughes, 2012). These solutions, in turn, require new provisions to ensure data security and protect against new types of cyberthreats (Ryabov, 2015).
3. Due to the development of technology, cost reduction, and widespread connectivity, the energy sector is on the verge of a new digital era with broad implications for all stakeholders in the energy sector, from producers and public utilities to producers and consumers (Turk et al., 2018).
4. Climate change and environmental issues. The problems of supporting and using energy resources, as well as environmental safety, equally open up opportunities for achieving sustainable growth, contributing to climate change mitigation (Winkler et al., 2011). Although electricity is a clean and relatively safe form of energy, the production and transmission of electricity affects the environment. Fossil fuel-

fired power plants pose environmental problems, including the issues about land and water use, air emissions, climatic and visual impacts, solid waste disposal, ash removal (for coal) and noise (Karakosta et al., 2013). Renewables are often viewed as a solution to the problem of climate change in the world and to some environmental problems (Deloitte Center for Energy Solutions, 2016). Despite uncertainty regarding the incentives created by the state, as well as competition due to historically low natural gas prices, alternative sources of energy continue to become more widespread (IRENA, 2015).

5. The need to attract investment in upgrading the infrastructure of the power supply network. The power systems of most countries were created in the middle of the last century and are currently in need of renewal and modernization. According to the report of the International Energy Agency, the global energy sector is on track to greater electrification (IEA, 2018b). At the same time, what is alarming is that the share of fossil fuels in global energy investments has been growing since 2014, and investments in renewable energy have been declining.

3. METHODS

This study is aimed at identifying and analyzing the most significant trends and challenges in the global energy sector and determining the key problems of the energy sector in the Republic of Kazakhstan. Based on the analysis of trends and a literature review concerning the topic, conceptual directions for the development of the electric power industry have been identified in order to strengthen the security, reliability, and sustainability of the energy complex of the Republic of Kazakhstan.

The following methods were used in the study: literature review, desk study, and trend analysis. First of all, a significant number of publications were analyzed. This literature has been selected from recent publications related to energy and, in particular, current trends in the global energy market. The selected sources include forecasts and projection data from national and international organizations and research institutions related to the energy sector; industry research of consulting companies and investment banks; scientific papers published in subject journals on energy; papers published in the Scopus and Web of Science databases; Kazakhstan and international regulatory documents; periodical publications with expert materials on the Republic of Kazakhstan; open presentations at national and international energy conferences.

4. RESULTS

The aging infrastructure was derived from the USSR, as well as a fragmented energy system, which depended on the supply of electricity from Russia and Central Asia. During the years of independence, Kazakhstan has achieved significant success in energy security through investments in the construction of facilities and modernization of the infrastructure of the national energy sector.

During the period of 2000-2017, the available capacity of power plants has doubled, and their installed capacity has increased

by 22%. Despite the creation of new capacities and the renewal of assets of existing power plants, a significant share of fixed assets has a high level of wear and is based on the aging Soviet technology. 65% of the energy equipment is over 20 years old, 31% is more than 30 years old. The state of the power supply network facilities is no way better; their wear is 60-80%.

The manageability of the sector has increased, which allowed production to follow the trend of electricity consumption and even to carry out its export to neighboring countries in small volumes.

During 2000-2017, electricity production increased from 51.6 billion kWh to 103.1 billion kWh, i.e., by almost 2 times (Figure 1).

In 2017, Kazakhstan's power plants generated 103.1 billion kWh of electrical energy (Samruk Energy, 2018). About 77% of energy is produced in the North energy zone of Kazakhstan, which includes the Akmola, Aktobe, Kostanay, Pavlodar, North Kazakhstan, East Kazakhstan, and Karaganda Regions. Due to the proximity to the coal deposits, the main power stations are located in the territory of these regions. The regional leader in electricity generation is the Pavlodar Region: It accounts for more than 40% of total electricity production.

The western and southern zones import energy, while the consumption in the western zone slightly exceeds production; in the southern zone, about 80% more energy is consumed than produced.

During 2000-2017, a significant increase in power generation was in the Kyzylorda Region (an increase by 13.6 times), the Jambyl Region (an increase by 5 times) and the Almaty City (an increase by 5.7 times). The decline in production was observed in the South Kazakhstan Region.

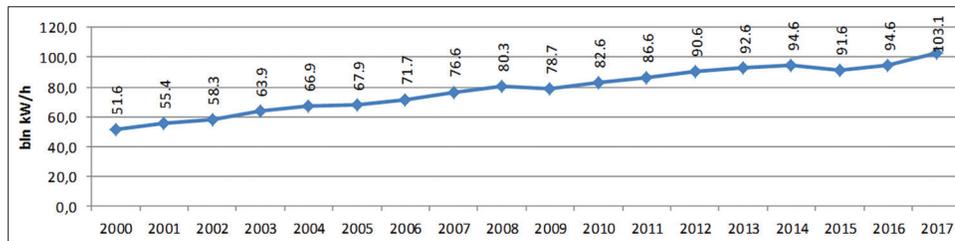
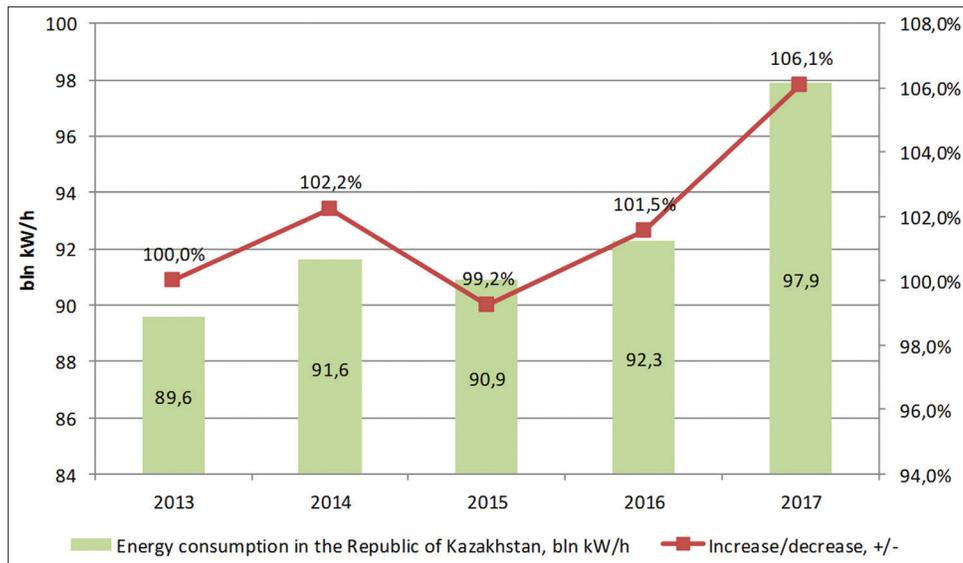
Since 2000, electricity production in Kazakhstan had grown by an average of 3.8% per year (which was slightly higher than the dynamics of consumption (3.4% per year) for the same period).

During 2000-2012, the average annual demand for energy was about 4.4% per year. However, from 2013 to 2016, the growth rate of electricity in the Republic of Kazakhstan slowed down due to global economic shocks and then stabilized at an average annual level of 2.3%.

In 2017, energy consumption in Kazakhstan showed an increase of 6.1% compared with the previous year, reaching 97.9 billion kWh, and this figure was a record in the history of independent Kazakhstan (Figure 2).

Due to the limited gas infrastructure, the dominant energy fuel in Kazakhstan is coal: it is used by about 66% of power plants. At the same time, the share of gas in the production of energy increased from 8.8% in 1996 to 15.6% in 2016.

A significant drawback of coal-fired power plants is the high level of emissions of harmful substances into the atmosphere (greenhouse and carbon monoxide gases, sulfur and nitrogen

Figure 1: Energy output trends in Kazakhstan in 2000-2017**Figure 2:** Energy output trends in Kazakhstan in 2013-2017

oxides, mercury compounds), which negatively affects the ecology and quality of life of the population. The advantage of coal-fired power plants is the low cost of electricity compared to gas power plants.

In addition to conventional sources in the energy sector of the Republic of Kazakhstan, a new paradigm related to the development of renewables becomes relevant.

In 2013, the mechanism of state support for the renewable energy sector was launched, which was based on a centralized guaranteed purchase of all electrical energy produced by renewable energy sources at fixed tariffs.

Nowadays, 58 renewable energy facilities have been commissioned, the gross installed capacity of which amounted to 352.5 MW. It should be noted that during the “fixed tariffs” mechanism, it was possible to achieve 1% of the gross installed capacity of renewable energy facilities in the country’s energy balance. The mechanism for applying fixed tariffs had functioned until February 2018.

Over five years (2013-2017), the volume of energy production from RES had increased by almost 1.5 times and reached 11.64 billion kWh. Their share in total output remained relatively stable and did not exceed 12.7% (Figure 3).

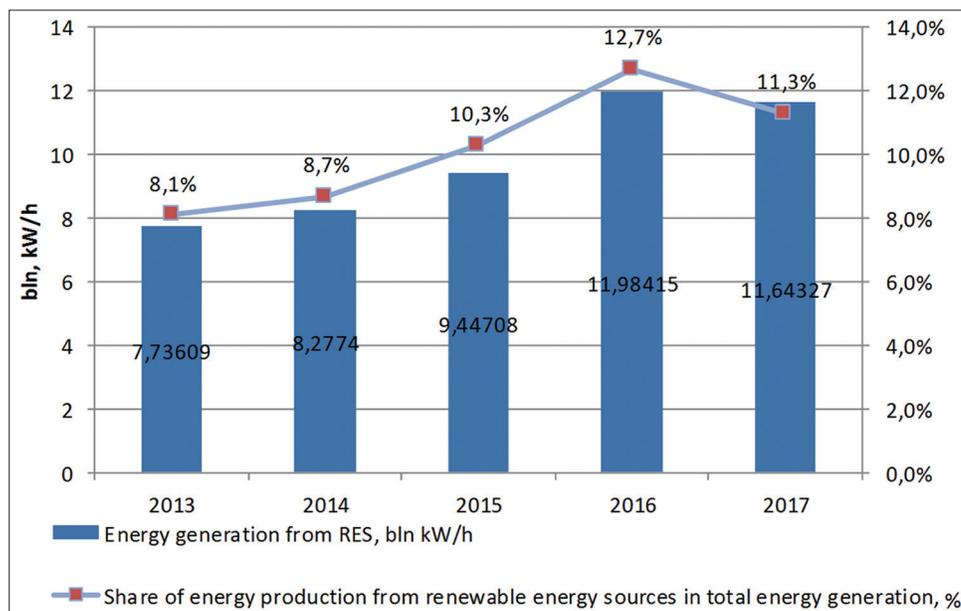
According to the Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan, in 2017, the price index

number for energy was 4.6% compared to 2016, which was the lowest figure over the past few years (Committee on Statistics of the Republic of Kazakhstan, 2017).

The current policy of the Kazakhstan regulator in the field of tariff setting provides for the inclusion of the investment component in energy prices in order to update fixed assets in the industry. The program of cap rates for power generation facilities remained in force in 2009-2015 and has been extended until January 1, 2019. Since 2016, the organizations of the electric energy sector in Kazakhstan have switched over to 5-year cap rates, which may be adjusted.

In general, it should be noted that a number of reforms scheduled for implementation since 2008, in particular, for optimizing the structure of the wholesale market, liberalizing price policies that stimulate tariff setting in the field of transmission, distribution, and sale of electricity, have either been suspended or replaced by tight control mechanisms over prices.

Despite significant progress in reforming the energy sector, the model of the energy market of the Republic of Kazakhstan currently demonstrates insufficient efficiency and effectiveness at both the wholesale and retail levels. Thus, the distributing mains of the Republic of Kazakhstan are characterized by a fairly high level of energy losses (about 13%) compared with developed countries, low levels of efficiency of power plants (33-34%), high levels of environmental impact of coal energy, etc.

Figure 3: Energy generation from RES in 2013-2017, billion kWh.

5. DISCUSSION

Experts of the Kazakhstan Association of oil-gas and energy sector organizations KAZENERGY note that, despite the number of statutory instruments relating to some modern concepts, such as supporting the production of renewable energy sources, increasing efficiency, reducing emissions, etc., the overall strategy for the development of the energy sector remains insufficiently coordinated, detailed and predictable in the long-term (Association of Legal Entities “Kazakhstan Association of Oil-Gas and Energy Sector Organizations “Kazenergy,” 2017).

The pattern of sector development should take into account the global energy landscape, which is characterized by the need to strengthen energy security and the widespread environmental problems at the national, regional and global levels. Ambitious goals and commitments of the Republic of Kazakhstan in the framework of global initiatives, as well as technological advances, will facilitate the transition to more sustainable development.

When implementing an energy strategy, Kazakhstan needs to combine the achievement of green economy goals with the use of market-based incentive regulation mechanisms. Global trends indicate a change in energy consumption worldwide, and Kazakhstan is no exception. The key factors driving this change will be the increase in the electrification of Kazakhstan’s economy, the increase in energy production from renewable energy sources.

One of the most significant commitments of the energy sector in Kazakhstan is the concept of a transition to a green economy. The opportunity to demonstrate the successful implementation of Kazakhstan’s green economic growth strategy has been enhanced by having a rich resource base for future energy, in particular, vast potential for generating electricity from renewable energy sources.

In international practice, renewable energy refers to solar, wind, hydropower (in the context of a green economy, small

hydropower plants), biofuels, geothermal and other forms of energy. In Kazakhstan, due to its natural and climatic features, not all renewable energy sources are relevant. The most promising sources are hydropower, solar and wind energy. According to estimates in the “Concept for the Development of the Fuel and Energy Complex until 2030,” the total potential of renewable energy sources for energy production is 1,885 billion kWh; the thermal potential is 4.3 GW (Government Decree of the Republic of Kazakhstan No. 724, 2014).

The lack of a strategy for the development of the power industry of Kazakhstan for a long-term period of 20-30 years is causing concern of market participants, as well as the fact that decisions are made on a project basis rather than systemically. Moreover, the degree of the readiness of Kazakhstan’s energy system for the integration of the planned amounts of renewable energy is unclear.

Existing economic development programs and industry documents provide for an increase in energy production from renewable sources. In particular, in the concept of Kazakhstan’s transition to a “green” economy, it is planned to achieve a share in the total energy production of wind and solar power plants in the amount of 3% by 2020, and 10% - by 2030. This is a very ambitious plan, given that the volume of energy production is 0.3% using these two sources. According to a chief research scientist of the Kazakhstan Institute of Strategic Studies under the President of Kazakhstan, such a dramatic breakthrough appears highly unlikely over the next two or three years; thus, it is advisable to pay more attention to the development of renewable energy at hydropower plants.

Both the government and independent monitors confirm that, in general, the prospects for the development of renewable energy in Kazakhstan remain favorable, considering a significant resource potential for wind and sun, as well as the factor of the continuous progress of green energy technologies while reducing the cost of equipment for them. This will lead to lower prices for generated

electricity and increase its competitiveness with conventional energy sources.

Since 2018, Kazakhstan has had record big investments in clean energy. The projects in the Akmola, Atyrau, Kostanay, and Jambyl Regions are flourishing. The priority is given to the construction of solar and wind power plants. It is expected to have a construction of several renewable energy facilities with the participation of investors from Russia, China, Turkey, Bulgaria, and the United Arab Emirates. The state government will be able to issue so-called green bonds through the AIX exchange. It will be possible to attract international investments with their help for the implementation of projects related to renewable energy.

At the same time, market participants point out the instability of the development of renewable energy. According to a representative of the project “Energy of the Future” by Tetra Tech company, A. Arzumanyan, most of all prospective investors in the “green” energy sector in Kazakhstan are concerned about the financial sustainability of the accounting and finance center (AFC) at KEGOC, which purchases electricity from renewable energy sources (in the medium term). Now the volumes are small, but there is a distrust of guaranteed purchases in the future (Serikov, 2018).

Director of the Banking and Finance department of GRATA International law company, Sh. Chikanaev agrees that investors voice a doubt that the AFC will be able to sustainably provide payments for electricity for renewable energy sources in the mid-term. Therefore, the expert proposes to consider KEGOC to be a single buyer, which will operate in the conventional power generation capacity market beginning from 2019. Then the projects of “green” energy will immediately become profitable.

The rapid development of technologies in the renewable energy sector, combined with the growing number of investors wishing to implement projects in the field of renewable energy in Kazakhstan, required a mechanism for ensuring a fair and competitive choice of the most efficient projects, projects with the best technological solutions and the lowest capital costs. Today, the global trend that meets these requirements is auction selling aimed at the selection of renewable energy projects.

The first successful auction selling took place in 2018. The implemented mechanism of auction selling is based on studying the best international experience while attracting recognized international experts in this field – IRENA, NREL, USAID, as well as some public organizations such as NPP Atameken, AO KAZAKH INVEST National Company, and KAZENERGY Association.

According to the Vice-Minister of Energy of Kazakhstan, A. Shkarupa, the introduction of auction selling mechanisms has led to a reduction in tariffs: for wind (wind-power stations) – by 12.2%, for small hydropower plants – by 12.12%, for the sun (solar power plants) – by 35.71% (Press Center of the Prime Minister’s Office of the Republic of Kazakhstan, 2018). Thus, the creation of a competitive framework made it possible to determine the market prices for electricity generated by renewable energy sources.

According to experts of the USAID project in the Republic of Kazakhstan, it is desirable to prepare an auction program for three to five years ahead so that global players can prepare for them. This is especially true of wind energy, where it is necessary to make detailed measurements in long periods, while solar volumes can be read from a satellite (Zhiltsov, 2018). One of the solutions could be the creation of a separate agency for renewable energy, which would catalyze the development of “green” energy for the medium term.

The Development Concept of the energy sector of the Republic of Kazakhstan should include the development of mechanisms for the implementation of Smart Grid projects. Over the past years, energy production networks have become much more complex, mainly due to the growth in the production of renewable energy and the growth in the number of small distributed electricity producers.

Nowadays, the vast majority of innovative technologies in the energy sector are developed abroad. Therefore, the majority of “smart” monitoring systems cannot be fully utilized in the Russian networks, since there are some technical differences between the energy infrastructure of Kazakhstan and Western countries. To that end, home-grown technologies in the Internet of Things, smart microgrids, analysis system, and power system control stand a good chance to secure a foothold in the market which has just begun to develop.

Kazakhstan may benefit from the Austrian experience in applying the smart grid mechanisms since Austria is the European leader in the practical use of renewable energy.

The Republic of Kazakhstan and Austria have similar problems, including the presence of abandoned power grids, unprofitability of regional energy transmission companies (RECs) and the need to strengthen them.

According to the director of the LIFE, Australian Research Center for Climate, Energy and Society, F. Pretenthaler, smart grid systems can be used in remote areas of Kazakhstan, which are distant from the infrastructure of the main power lines and where the maintenance of power lines is not always cost-effective (Serikov, 2017).

Knowing that Astana and Almaty use Ekibastuz high-ash coal in their Central Heating and Power Plant, Australia’s experience in creating “smart cities” may also be interesting. The concept of a smart city in Austria consists of three dimensions. The first is decarbonization, i.e. CO₂ emission reduction based on energy saving to maintain clean air in a city. The second dimension is digitalization of power grids, ensuring interconnectivity of various parts of the city’s infrastructure. The third condition is the attractiveness of the city for citizens, the improvement of their quality of life, for which it is necessary to create measures for participation in the life of the city.

In general, Austrian experts come to the conclusion that there is a market base for the implementation of smart grid in remote areas of Kazakhstan and recommend that Kazakhstan’s RECs

with experience in power management become partners of local communities in smart grid projects. This may have a positive effect on balancing the country's electricity market depending on the price parameters in the local segments of the power system.

6. CONCLUSION

This study made it possible to identify a number of characteristic features inherent in the modern development of the electric power industry of the Republic of Kazakhstan. The power system of Kazakhstan derived from the USSR is characterized by high deterioration of the infrastructure; now there is a need to modernize equipment and build new generation facilities.

The specific problems of the energy sector of Kazakhstan are similar to those faced by most countries – they are caused by the need for affordable, sustainable and reliable energy systems to support national, regional and global economic growth. The concept of the development of the energy sector should take into account the trends of the global energy market, including changes in the structure of demand, development of renewable energy sources, digitalization of the power industry, etc.

The development of energy using renewable energy sources, as well as the introduction of creative solutions, should be aimed primarily at solving the main tasks of the industry: improving the quality and reliability of energy supply, improving operational efficiency, improving the technical conditions of the energy infrastructure, and the energy efficiency of industry.

REFERENCES

- Aldayarov, M., Dobozi, I., Nikolakakis, T. (2017), *Stuck in Transition: Reform Experiences and Challenges Ahead in the Kazakhstan Power Sector*. Washington, DC: World Bank.
- Association of Legal Entities “Kazakhstan Association of Oil-Gas and Energy Sector Organizations “Kazenergy”. (2017), *Natsionalnyi Energeticheskii Doklad [National Energy Report]*. Available from: http://www.kazenergy.com/upload/document/energy-report/NationalReport17_ru.pdf. [Last accessed on 2019 Jan 12].
- BP. (2018), *BP Energy Outlook, 2018 edition*. Available from: <https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/energy-outlook/bp-energy-outlook-2018.pdf>. [Last accessed on 2019 Jan 12].
- Committee on Statistics of the Republic of Kazakhstan. (2017), *Toplivno-Energeticheskii Balans Respubliki Kazakhstan [Fuel and Energy Balance of the Republic of Kazakhstan]*. Available from: <http://www.stat.gov.kz/getImage?id=ESTAT271812>. [Last accessed on 2019 Jan 12].
- Deloitte Center for Energy Solutions. (2016), *Human Capital Trends in Alternative Energy. Focusing on People to Sustain Growth*. Available from: <https://www2.deloitte.com/us/en/pages/energy-and-resources/articles/alternative-energy-human-capital.html>. [Last accessed on 2019 Jan 12].
- International Energy Agency (IEA). (2014), *World Energy Outlook 2014 Executive Summary*. Paris: International Energy Agency.
- International Energy Agency (IEA). (2018a), *World Energy Outlook 2018*. Available from: <https://www.iea.org/weo2018>. [last accessed on 2019 Jan 12].
- International Energy Agency (IEA). (2018b), *World Energy Investment* 2018. Available from: <https://www.webstore.iea.org/download/summary/1242?fileName=Chinese-WEI-2018-ES.pdf>. [Last accessed on 2019 Jan 12].
- International Renewable Energy Agency (IRENA). (2015), *Renewable Energy and Jobs Annual Review; 2015*. p2. Available from: <http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=585>. [Last accessed on 2019 Jan 12].
- International Renewable Energy Agency (IRENA). (2016), *REMap: Roadmap for a Renewable Energy Future, 2016 edition*. Available from: http://www.irena.org/-/media/Files/IRENA/Agency/About-IRENA/Council/Eleventh-Council/C_11_DN_5_REMap.pdf. [Last accessed on 2019 Jan 12].
- Karakosta, C., Pappas, C., Marinakis, V., Psarras, J. (2013), *Renewable energy and nuclear power towards sustainable development: Characteristics and prospects*. *Renewable and Sustainable Energy Reviews*, 22, 187-197.
- KAZENERGY. (2017), *Natsionalnyi Energeticheskii Doklad [National Energy Report]*. Available from: http://www.kazenergy.com/upload/document/energy-report/NationalReport17_ru.pdf. [Last accessed on 2019 Jan 12].
- Larionov, A., Metechko, L., Davydov, A., Davydov, D. (2018), *Prospects for the Development of Green and Energy Efficient Technologies in Construction*. *MATEC Web of Conferences No. 193, 04027*.
- Makarov, A.A., Mitrova, T.A., Kulagin, V.A. (2012), *Dolgosrochnyi Prognoz Razvitiya Energetiki Mira I Rossii [Long-Term Forecast of Energy Development in the World and Russia]*. Russia: *Ekonomicheskii Zhurnal VShE*. p2.
- Moyer, J., Hughes, B. (2012), *ICTs: Do they contribute to increased carbon emissions? Technological Forecasting and Social Change*, 79(5), 919-931.
- Nielsen, H., Warde, P., Kander, A. (2018), *East versus west: Energy intensity in coal-rich Europe, 1800-2000*. *Energy Policy*, 122, 75-83.
- Panajotovic, B., Jankovic, M., Odadzic, B. (2011), *ICT and Smart Grid*. In 10th International Conference on Telecommunications in Modern Satellite, Cable and Broadcasting Services, TELSIKS 2011 Proceedings of Papers, Serbia, Niš, 5-8 October, 2011. Serbia: IEEE.
- Postanovlenie Pravitelstva Respubliki Kazakhstan ot 28 Iyunya 2014 Goda No. 724. “Ob Utverzhdenii Kontseptsii Razvitiya Toplivno-Energeticheskogo Kompleksa Respubliki Kazakhstan do 2030 Goda” [Government Decree of the Republic of Kazakhstan No. 724 “On Approval of the Concept of Development of the Fuel and Energy Complex of the Republic of Kazakhstan Until 2030]. Available from: <http://www.adilet.zan.kz/rus/docs/P1400000724/info>. [Last accessed on 2019 Jan 12].
- Press Center of the Prime Minister’s Office of the Republic of Kazakhstan. (2018), *Materialy Vystupleniya Vitse-Ministra Energetiki RK A. Shkarupa. “Ob Itogakh Pervykh Mezhdunarodnykh Auktsionnykh Torgov Po Otorbu Proektov Vozobnovlyаемых Istochnikov Energii (VIE)” [Contributions of the Vice-Minister of Energy of the Republic of Kazakhstan A. Shkarupa “On the Results of the First International Auction Selling for the Selection of Renewable Energy Projects (RES)”]*. Kazakhstan: Press Center of the Prime Minister’s Office of the Republic of Kazakhstan.
- Rodilla, P., Battle, C. (2010), *Security of Electricity Supply at the Generation Level: Problem Analysis*. Working Paper No. IIT-10-027A. Available from: <http://www.iit.upcomillas.es/battle/Publications.html>. [Last accessed on 2019 Jan 12].
- Ryabov, B. (2015), *Natsionalnaya Technologicheskaya Initsiativa: Dorozhnaya Karta Razvitiya Rynka Energy Net [National Technological Initiative: Roadmap of the Energy Net Market]*. Presentation at the Workshop “Global Trends and Uncertainties in the Energy Sector”, December 11, 2015 at HSE.
- Samruk Energy. (2018), *Analiz Rynka Elektroenergetiki Kazakhstana*

- [Analysis of the Energy Market in Kazakhstan]. Available from: <https://www.eenergy.media/wp-content/uploads/2018/02/netdeveloper-market-elektroenergii-kazakhstana-za-2017.pdf>. [Last accessed on 2019 Jan 12].
- Serikov, D. (2017), Avstriiskie Eksperty Rekomenduyut Kazakhstanskim Setyam Pournet [Austrian Experts Recommend Kazakhstan Networks to Become Smarter]. Kursiv Delovye Novosti Kazakhstana, No. 2525498. Available from: <https://www.kursiv.kz/news/kompanii-i-rynki/2017-07/avstriyskie-eksperty-rekomenduyut-kazakhstanskim-setyam-pournet>. [Last accessed on 2019 Jan 12].
- Serikov, D. (2018), Auktsiony VIE Prodavlivayut Tarifly [RES Auctions Push Prices]. Available from: <https://www.abctv.kz/ru/news/auktsiony-vie-prodavlivayut-tarifly>. [Last accessed on 2019 Jan 12].
- Statoil. (2014), Energy Perspectives 2014: Long-Term Macro and Market Outlook. Norway. Available from: <http://www.statoil.com/no/NewsAndMedia/News/2014/Downloads/Energy%20Perspectives%202014.pdf>. [Last accessed on 2019 Jan 12].
- Turk, D., Munuera, L., Cozzi, L., Kamiya, G. (2018), The digital transformation of energy: From energy silos to digitally interconnected systems. Digitalisation of the Energy Sector. SETIS Magazine, 17, 15-16.
- Wang, J., Zhao, J., Li, H. (2017), The electricity consumption and economic growth nexus in China: A bootstrap seemingly unrelated regression estimator approach. *Computational Economics*, 52(4), 1195-1211.
- Winkler, H., Somoos, A.F., La Rovere, E.L., Rahman, A., Mwakasond, S. (2011), Access and affordability of electricity in developing countries. *World Development*, 39(6), 1037-1050.
- Yang, S., Shi, X. (2018), Intangible capital and sectoral energy intensity: Evidence from 40 economies between 1995 and 2007. *Energy Policy*, 122, 118-128.
- Zhiltsov, V.G. (2018), Vetrovoi atlas Kazakhstana i Perspektivy Ispolzovaniya Vetrovoi Energetiki [Kazakhstan Wind Atlas and Perspective of Using of Wind Energy]. In: Materialy Nauchno-Prakticheskoi Konferentsii "Podkhody k Razvitiyu Elektroenergeticheskogo Sektora v Tsentralnoi azii v Usloviyakh Vysokoi Stepeni Integratsii VIE v Sistemu" [Proceedings of the Research-To-Practice Conference "Approaches to the Development of the Energy Sector in Central Asia in the Conditions of Integration of Renewable Energy Sources into the System"]. Available from: http://www.ptfcar.org/wp-content/uploads/2018/08/V.-Zhiltsov_August-11_RU_1.pdf. [Last accessed on 2019 Jan 12].
- Zhong, S. (2018), Structural decompositions of energy consumption between 1995 and 2009: evidence from WIOD. *Energy Policy*, 122, 655-667.