The Bulletin of Kazakh Academy of Transport and Communications named after M. Tynyshpayev, ISSN 1609-1817, DOI 10.52167/1609-1817, Vol. 118, No.3 (2021) pp.124-134

УДК 621.1/5 **DOI 10.52167/1609-1817-2021-118-3-124-134**

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ASSESSMENT OF THE PROSPECT FOR THE USE OF RENEWABLE ENERGY SOURCES IN THE WORLD AND KAZAKHSTAN

Annotation. The world energy industry today is at a new stage of development, which is characterized by the strengthening of integration processes, the development of new technologies in the field of extraction and production of energy resources. The energy sector of Kazakhstan was designed with the understanding that it was part of the energy sector of the Soviet Union. Today Kazakhstan follows international development trends in the field of energy. To make a reliable forecast of the Kazakhstani energy sector, it is necessary to look at the global processes in the development of the world energy industry. There are several organizations that have this information. These are the International Energy Agency (IEA), the UN, the World Bank, large-scale international companies, etc. In forecasting energy consumption in Kazakhstan, as part of the Eurasian Economic Union (EAEU), it is important to look at the forecasts for the EAEU member countries. This article provides basic information on forecasting the growth of electricity consumption in the world and in Kazakhstan, based on various sources. It also provides a comparative analysis of the use of various sources of electrical energy. A detailed analysis of the energy sector of Kazakhstan and the prospects for the use of renewable energy in Kazakhstan are considered.

Keywords: wind turbine, energy resources, electric energy, forecast of electricity use, Renewable sources, traditional sources

The key indicator for forecasting energy consumption is energy demand, which directly depends on the quantitative indicator of the population. However, there are other important factors that affect obtaining a reliable forecast. This is the economic situation in the country as a whole, and such indicators as energy consumption per capita, energy intensity, human factor, the qualitative composition of the population by professional preferences, occupation, etc. After all, as you know, all these details can also significantly affect the energy consumption of a particular category of the population. In addition, such an indicator as an increase in energy consumption per capita can be considered as a key indicator of improving the quality of life of people and their well-being. This is the case when the result of the country's economic development works to improve the living standards of consumers.

As for the intensity of electricity use per unit of GDP, it directly affects the progress of technological development. Thus, it can be seen that three key indicators should be taken into account. (According to the latest UN forecasts, in 2040 the world population will reach 9.1 billion people (Figure 1) [1].

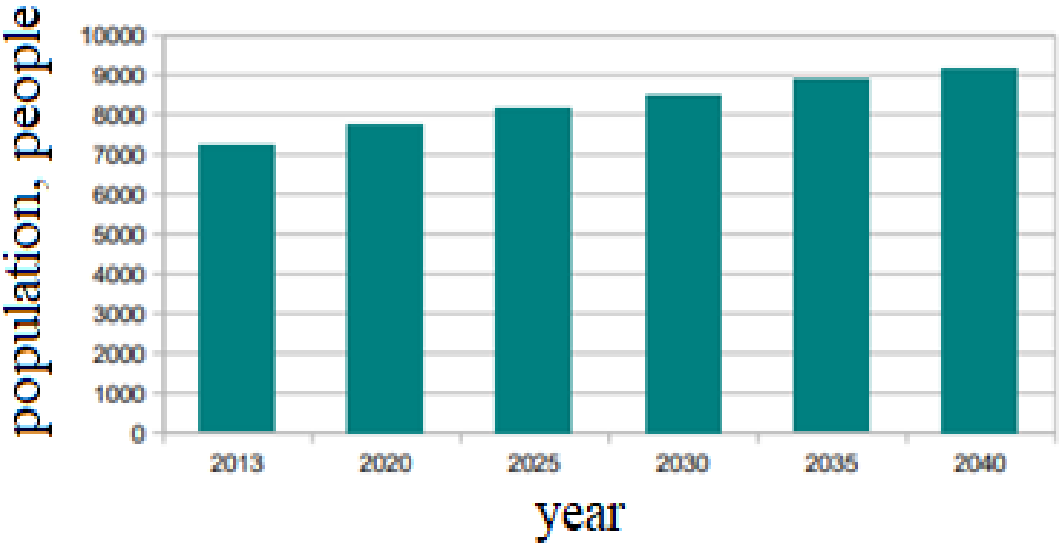

Figure 1 - Forecast of world population growth according to UN data

Africa, Asia and India will provide the most significant population growth (83% and 33%). So, Asian countries will be the most populous and therefore have the highest energy demand (Figure 2). Technological advances will undoubtedly have an impact on the energy sector.

The most urgent problem in the real energy sector is the problem of energy conservation. This problem has both economic and environmental components as the driving force for innovation. There are many predictions based on the assumption that there will be no technological revolution in the energy sector in the near future. The energy intensity of GDP per capita is expected to decrease by almost 1.5 times by 2040 (Figure 3). But due to population growth, total electricity consumption will grow (Figure 1.4). Energy consumption per capita is a key factor in the quality of life, and this figure will rise from 1.88 to 1.92 per person.

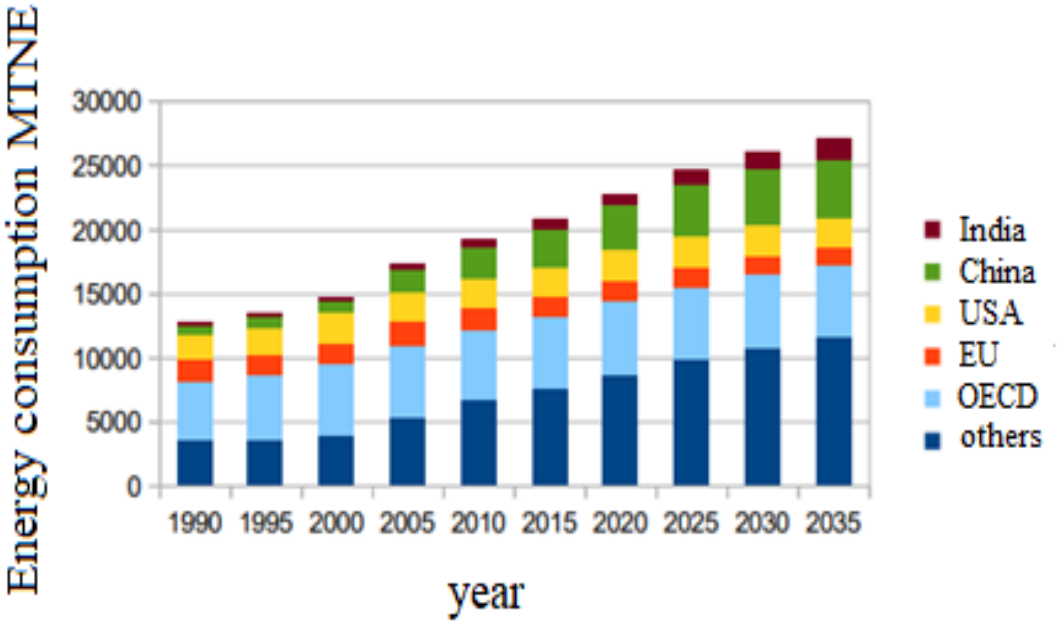

Figure 2 - Energy consumption by region [4]

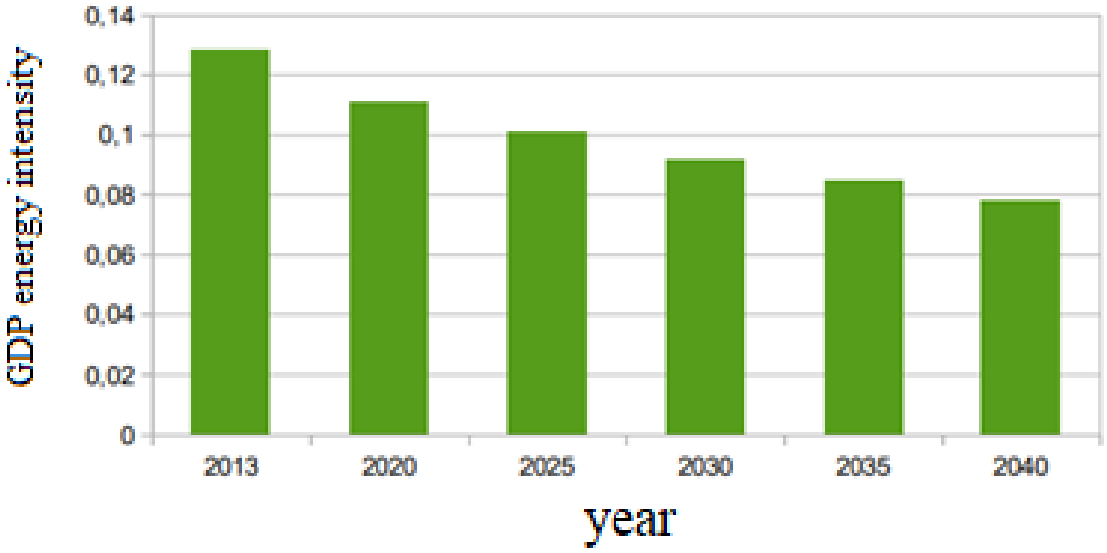

Figure 3 - Dynamics of energy intensity of GDP [3]

It is also important to consider the forecast of the structure of energy consumption in the world. Environmental, economic issues and technical breakthroughs in the industry of certain energy sources will change the pattern of energy consumption over several decades. The share of hydrocarbons will be reduced and a large increase in renewables and nuclear energy is expected (Figure 5).

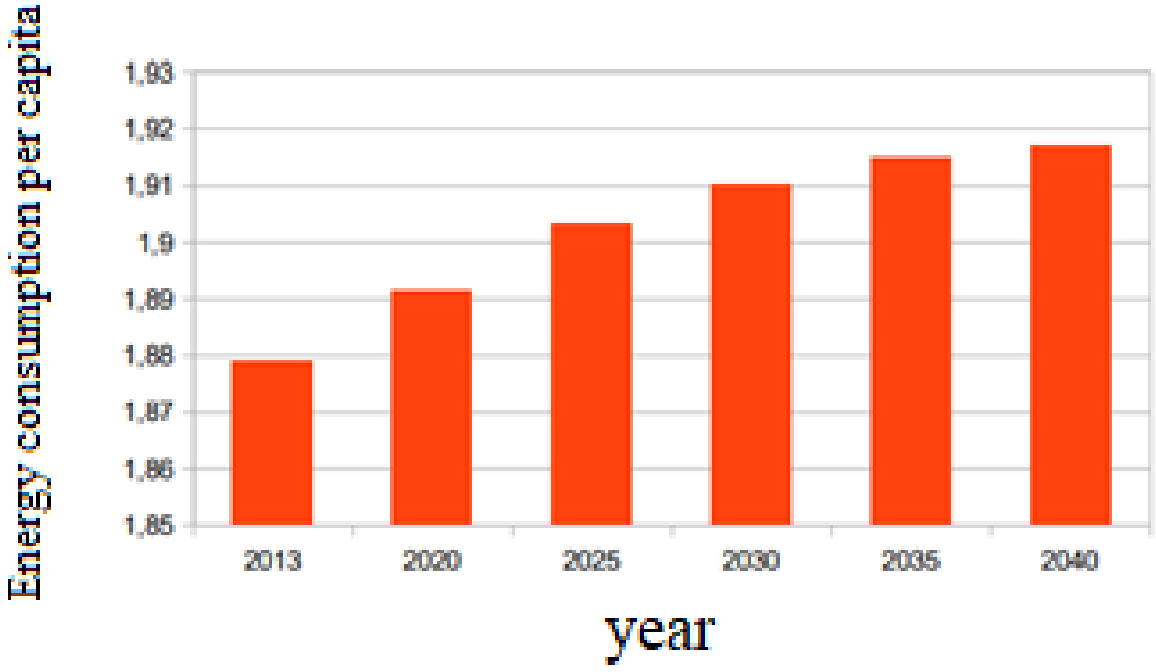

Figure 4 - Energy consumption per capita

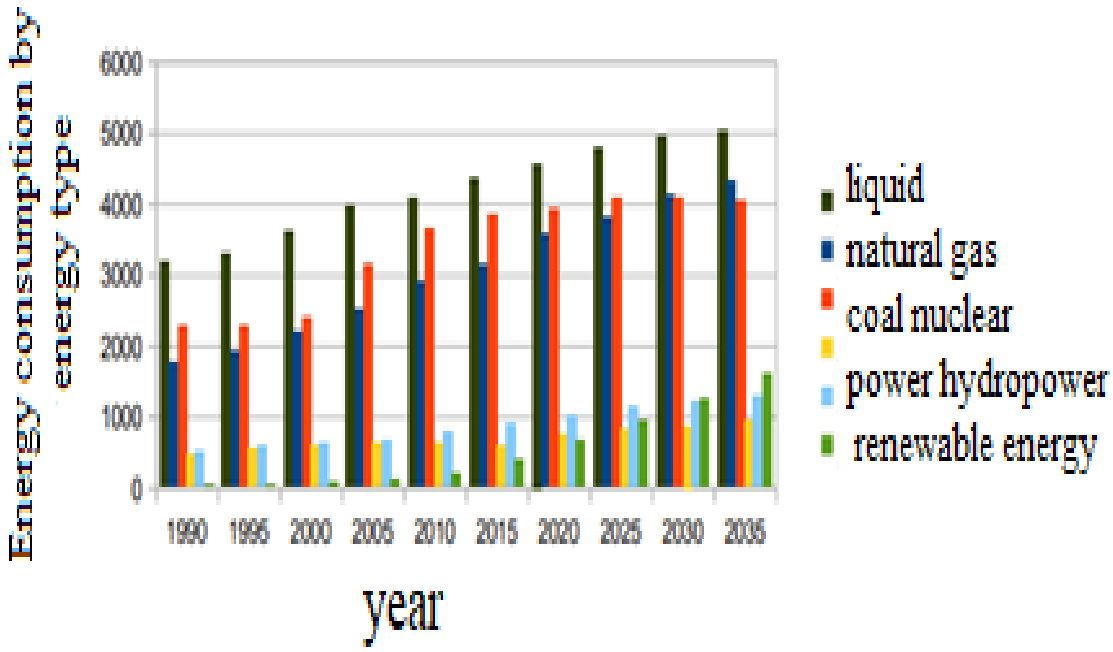

Figure 5 - Structure of energy sector consumption by fuel type. BP forecast [4]

Consider the forecast of the structure of energy production in the world. Due to the growing demand for energy consumption, it is necessary to install additional power plants (Figure 6).

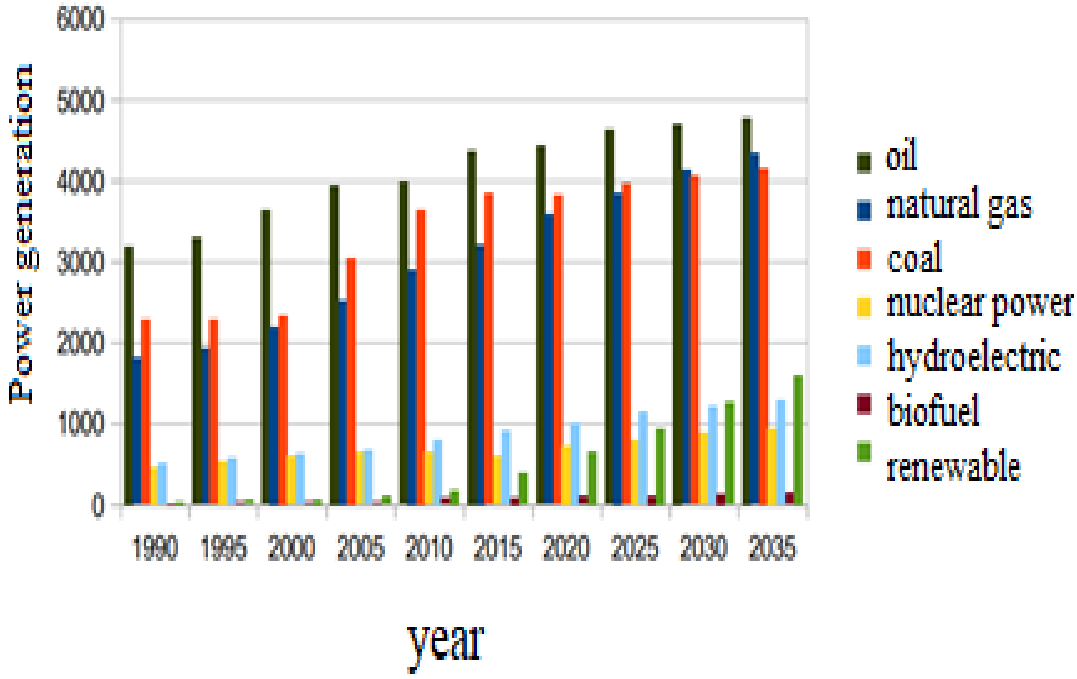

Figure 6 - The structure of production in the energy sector according to the BP forecast [4]

The share of renewable energy sources will also grow (Figure 7)

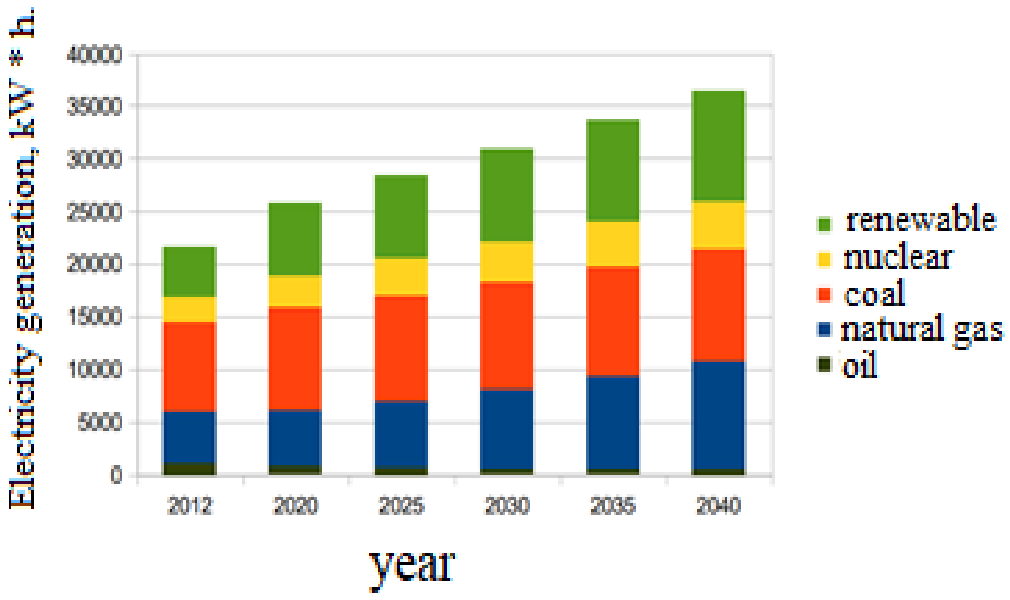

Figure 7 - Structure of production in the energy sector according to the US Energy Information Administration (EIA) [2]

Speaking about the forecast of energy production and consumption in the EAEU countries, we can say that Kazakhstan was one of the founders of the Eurasian Economic Union (EAEU), which was created in 2014 [5]. In contrast to the global demographic growth, population growth in the EAEU countries is expected to decrease in 2030–2040. (Figure 8). However, population decline does not affect the growth of energy consumption in the EAEU countries (Figure 9)

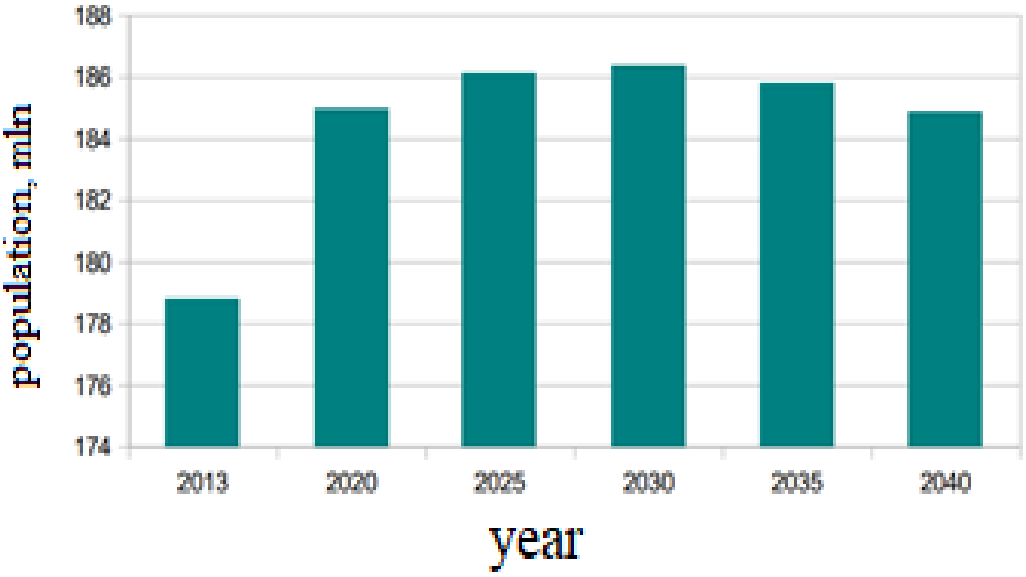

Figure 8 - Forecast of the EAEU population according to the data of the Research Institute of Energy of Russia [3]

Thus, the level of energy consumption per capita will reach 5.15 TOE per person (Figure 1.9). Which is much higher than in the world (1.92). Thus, an increase in the quality of life is expected in the region. The use of modern technologies and the implementation of energy efficient programs in the EAEU countries will lead to a decrease in the energy intensity of GDP (Figure 10).

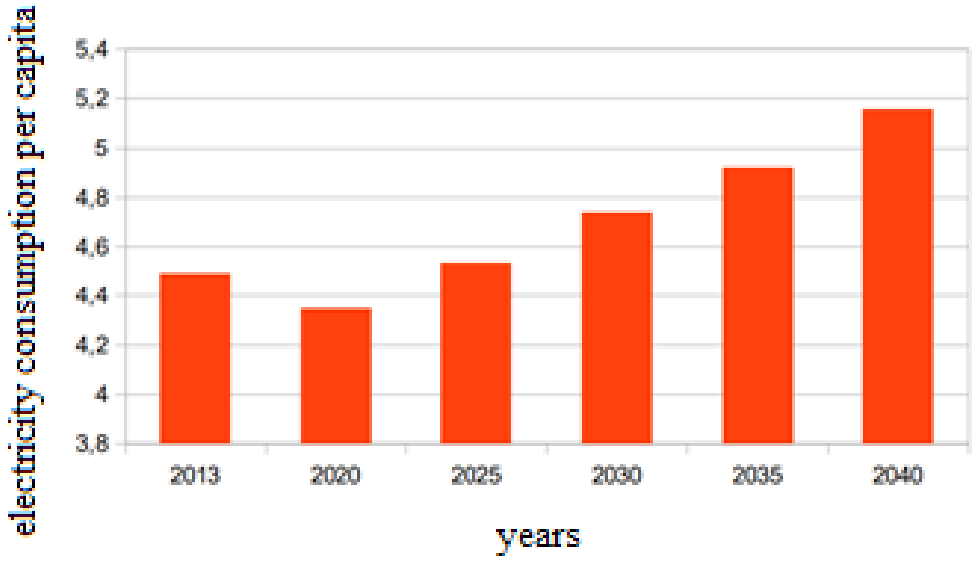

Figure 9 - Dynamics of energy consumption per capita in the EAEU [3]

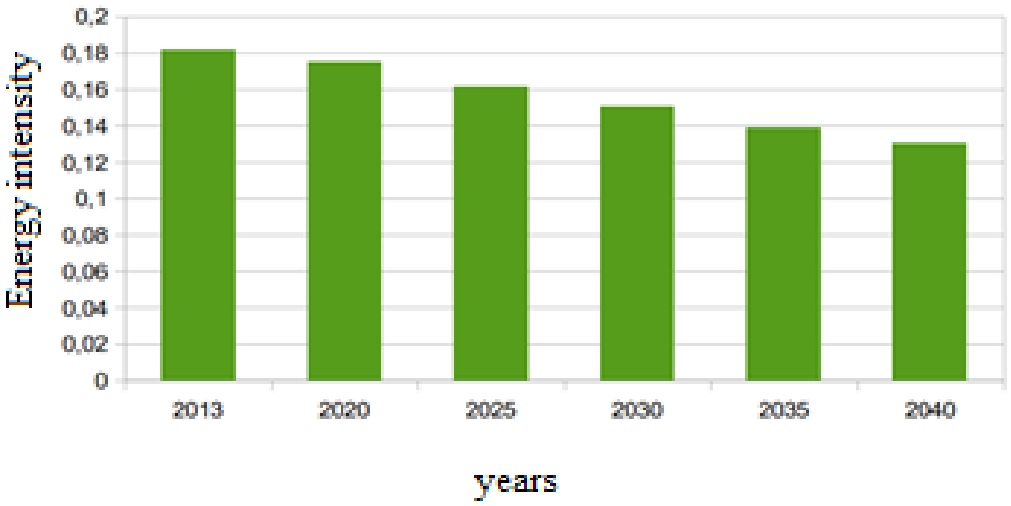

Figure 10 - Dynamics of energy intensity of GDP in the EAEU [3]

The availability of natural resources in the region will be reflected in the structure of primary energy consumption. Natural gas is the most demanded energy source in the EAEU (Figure 11).

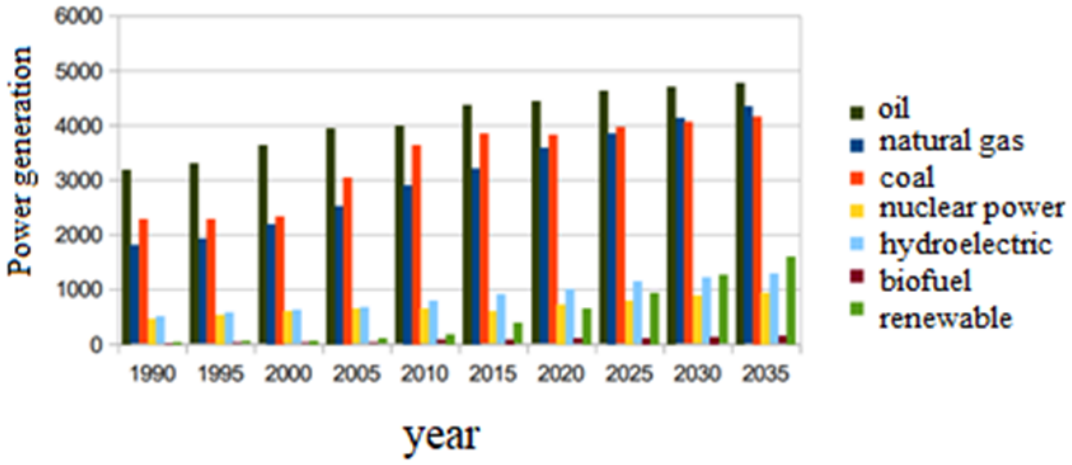

Figure 11 - Structure of consumption of the energy sector by fuel type in the EAEU according to the Institute of Energy Research of the Russian Academy of Sciences [3]

Energy sector of Kazakhstan

Figure 13 shows that both consumption and production of electricity are growing steadily. Objects of the energy sector of Kazakhstan in percentage terms are shown in Figure 14. In total, 63 power plants are in operation today. The basis of the electric power industry in Kazakhstan is made up of large coal-fired power plants (Ekibastuzskaya GRES (GRES) 1 - 4 million kW, Aksu GRES - 2.1 million UAH kW, Zhambyl GRES - 1.2 million kW, Ekibastuz GRES-2 - 1 million kW). The group of the largest hydroelectric power plants includes: on the Irtysh River Bukhtarminskaya HPP - 0.7 million kW, Ust-Kamenogorsk HPP - 0.3 million kW and Shulbinskaya HPP - 0.7 million kW, on the Ili River Kapchagayskaya HPP - 0.4 million kW. KW. The largest thermal power plants that provide heat and electricity to large industrial enterprises and nearby settlements include: Pavlodar thermal power plant (TPP), Shymkent TPP, Balkhash TPP, Rudnenskaya TPP and others

Figure 13 - Dynamics of production and consumption of electricity in the Republic of Kazakhstan during 1990–2020

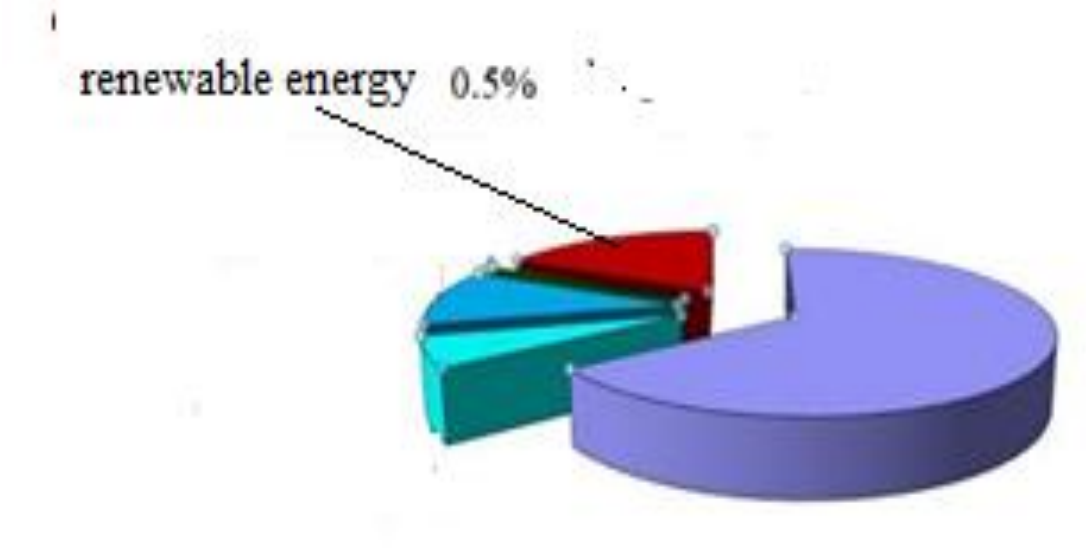

Figure 14 - Structure of the installed capacity of power plants in Kazakhstan

A fairly powerful energy system was created in the Soviet era, based on the maintenance of energy-intensive industry, mining and primary processing of raw materials (in particular, the production of aluminum, ferroalloys, copper). Despite the fact that consumption in the 1990s fell by half, the balance of electricity remained in deficit: the volume of imports amounted to 37% of the total consumption. Only since 2002 has the import of electricity ceased to exceed export for the first time. For example, in 2010 Kazakhstan imported 6.2 billion kWh of electricity (Table 1), Including 4.6 billion kWh from Russia and 1.6 billion kWh from Kyrgyzstan. Russian electricity is supplied to consumers in Western Kazakhstan, while Kyrgyz electricity is supplied to consumers in the southern regions of the country.

Table 1 - Export and import of electricity, billion kWh

year	2005	2006	2007	2008	2009	2010
import	3,5	4,0	3,4	2,8	1,7	6,2
Export	3,6	3,7	3,3	2,5	2,4	4,7

Renewable energy sources and their prospects in Kazakhstan

The concept of a "green" economy is in force in Kazakhstan, and a draft law has been created to date, where a plan for the development of renewable energy has been developed. In accordance with this concept, the share of renewable energy in the country by 2020 will be 3% of the total electricity production, and by 2030 it should be 10%, by 2050 - 50%. This forecast is based on the available potential of alternative energy sources. Thus, the potential of solar energy is 3000 hours of sunshine per year, the energy of the wind flow was estimated at 920 billion kWh per year, and the potential of hydropower is 62 billion kWh per year [1]. Also in 2009, the law “On Supporting the Use of Renewable Energy Sources” [2] was approved, this law is aimed at supporting the use of alternative energy sources in the generation of heat or electricity. There are 99 renewable sources in Kazakhstan as of May 2020, including:

- SES - 37;
- WPP - 21;
- BioES - 4;
- HPP - 37.

The total capacity is 1,361 MW, including:

- SPP - 797.6 MW;
- WPP - 335.9 MW;
- BioPP - 2.82 MW;
- HPP - 224.6 MW.

The total electricity generation from renewable energy sources in 2020 amounted to 2.4 billion kWh, which corresponds to 2.3% of the total electricity generation in the Republic of Kazakhstan. The Ministry of Energy of the Republic of Kazakhstan expects continued growth in the production and consumption of electricity in the country. Thus, in the next five years, the average growth rate of electricity consumption will be 2% and will increase from 110.1 billion kWh in 2020 to 120.9 billion kWh in 2025, According to the Ministry of Energy of the Republic of Kazakhstan, the average annual growth rate of electricity production in 2020-2025 will be 3%. As a result of lower consumption, the excess supply of electricity over this period will grow by 123%, or an average of 17.5% per year, to 14.1 billion kWh, compared with a surplus of 6.3 billion kWh in 2020 year. By 2025, 28% of all electricity production will come from plants commissioned between 2020 and 2025, which indicates the need for additional capital investments in this industry. At the same time, 19% of the stations planned for commissioning will be renewable energy sources. 12.7 billion tenge in dividends paid by KEGOC to its shareholders in June 12.7 billion tenge in dividends paid by KEGOC to its shareholders in June

The question of increasing their own savings for many is becoming more and more . The demand for maximum electrical load from 2020 will increase from 18,205 MW to 20,262 MW in 2025. The total installed capacity of the power plant in Kazakhstan over this period will grow by 13.2% from 23,867 MW in 2020 to 27,017 MW in 2025.

Conclusion.

Thus, two main opposite processes: population growth and GDP energy intensity affect future energy consumption and electricity production in the world and the EAEU, which includes Kazakhstan. As the charts discussed in this section show, the demand for energy will continue to grow. The challenge for the energy sector is to increase electricity production as required. According to forecasts of power engineers, most of the energy potential is still in hydrocarbons. However, unstable prices, an unclear political situation in the world [7], as well as the deterioration of the environmental situation, the acceleration of the involvement of other energy sources, the development of the nuclear industry insistently dictates that mankind is already today turning to renewable energy sources, which in the near future will at least partially contribute to the replacement of hydrocarbon energy sources. If we talk about the potential of Kazakhstan in this matter, then it is great. The republic has a real opportunity to use wind and solar energy, geothermal energy, the energy of small rivers (small hydroelectric power station), etc. The growing demand for energy resources and environmental restrictions lead to the need to

take measures to develop renewable energy sources, in particular, the construction of small hydropower plants, as well as wind farms. However, the issue of introducing renewable energy sources requires careful analysis both from the standpoint of the technical capabilities of the energy system implementation, and from the point of view of considering the economic aspects.

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ASSESSMENT OF THE PROSPECT FOR THE USE OF RENEWABLE ENERGY SOURCES IN THE WORLD AND KAZAKHSTAN

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ӘЛЕМДЕГІ ЖӘНЕ ҚАЗАҚСТАНДА ЖАҢА ҚУАТТЫ ЭНЕРГИЯ КӨЗДЕРІН ПАЙДАЛАНУ ПЕРСПЕКТИВАЛАРЫН БАҒАЛАУ

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Аннотация. Әлемдік энергетикалық индустрия бүгінде интеграциялық процестердің күшеюімен, жаңаның дамуымен сипатталатын дамудың жаңа сатысында тұр энергия ресурстарын өндіру мен өндіру саласындағы технологиялар. Қазақстанның энергетикалық секторы Кеңес Одағының энергетикалық секторының бір бөлігі екенін түсініп жасалған. Бүгінде Қазақстан энергетика саласындағы халықаралық даму тенденцияларын ұстанады. Қазақстандық энергетикалық секторға сенімді болжам жасау үшін әлемдік энергетикалық индустрияның дамуындағы жаһандық үдерістерді қарау қажет. Бұл ақпаратқа ие бірнеше ұйым бар. Бұл Халықаралық энергетикалық агенттік (ХЭА), БҰҰ, Дүниежүзілік банк, ірі халықаралық компаниялар және т. ЕАЭО -ға мүше елдерге арналған болжам. Бұл мақалада әр түрлі көздерге сүйене отырып, әлемде және Қазақстанда электр энергиясын тұтынудың өсуін болжау туралы негізгі ақпарат берілген.

Ол сонымен қатар электр энергиясының әр түрлі көздерін пайдаланудың салыстырмалы талдауын ұсынады. Қазақстанның энергетикалық секторының егжей -тегжейлі талдауы мен Қазақстанда жаңартылатын энергияны пайдаланудың болашағы қарастырылды.

Түйінді сөздер: жел турбинасы, энергия ресурстары, электр энергиясы, электр энергиясын пайдалану болжамы, жаңартылатын көздер, дәстүрлі көздер

ОЦЕНКА ПЕРСПЕКТИВЫ ИСПОЛЬЗОВАНИЯ ВОЗОБНОВЛЯЕМЫХ ИСТОЧНИКОВ ЭНЕРГИИ В МИРЕ И КАЗАХСТАНЕ

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Аннотация. Мировая энергетика сегодня находится на новом этапе развития, который характеризуется усилением интеграционных процессов, освоением новых

технологии в области добычи и производства энергоресурсов. Энергетический сектор Казахстана создавался с учетом того, что он был частью энергетического сектора Советского Союза. Сегодня Казахстан следует мировым тенденциям развития в сфере энергетики. Чтобы сделать достоверный прогноз развития казахстанской энергетики, необходимо взглянуть на глобальные процессы в развитии мировой энергетики. Есть несколько организаций, у которых есть эта информация. Это Международное энергетическое агентство (МЭА), ООН, Всемирный банк, крупные международные компании и др. При прогнозировании энергопотребления в Казахстане в рамках Евразийского экономического союза (ЕАЭС) важно учитывать прогнозы для стран-членов ЕАЭС. В данной статье представлена основная информация по прогнозированию роста потребления электроэнергии в мире и в Казахстане, основанная на различных источниках. Также дается сравнительный анализ использования различных источников электроэнергии. Рассмотрены подробный анализ энергетического сектора Казахстана и перспективы использования возобновляемых источников энергии в Казахстане.

Ключевые слова: ветряная турбина, энергоресурсы, электроэнергия, прогноз использования электроэнергии, возобновляемые источники, традиционные источники.

The Bulletin of Kazakh Academy of Transport and Communications named after M. Tynyshpayev, ISSN 1609-1817, DOI 10.52167/1609-1817, Vol. 118, No.3 (2021) pp.134-141

УДК 62-9 **DOI 10.52167/1609-1817-2021-118-3-134-141**

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CALCULATION OF THE PARAMETERS OF THE WIND TURBINE ROTOR EDDY CURRENT SENSOR

Annotation. Eddy current sensors are used to measure shaft clearance in wind turbines and to check that there is a thin film of oil in the clearance. In this case, the oil is usually applied under pressure. Because the eddy current sensors are resistant to oil, pressure and temperature, this allows them to operate reliably in these hostile environments. When the gap becomes too large, a maintenance warning is generated. Eddy current sensors help detect axial and radial deflection of the turbine shaft. Radial movement occurs when the shaft is off-center. Axial movement indicates that the shaft is tilted relative to the central axis. Both cannot be eliminated