

## The analysis and development of alternative energy sources in Kazakhstan

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**Abstract.** The purpose of the study - to assess the state of the energy industry and to identify the effectiveness of its functioning in the framework of the implementation of innovative alternative wind sources based on environmental sustainability of the economy of Kazakhstan. Anthropogenic activities have led to an increase in the burning of fossil fuels, which filled the atmosphere with "greenhouse" gases. Scientific contributions of the authors in the development of this theme is dictated by the fact that in Kazakhstan there is no system of economic research in renewable energy, particularly in view of ecological modernization. Relevance of writing is also associated with the improvement of state regulation in the electricity sector and the introduction of wind farms as an effective method of renewable energy sources on the basis of specific climatic conditions.

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### Introduction

According to estimates, by 2050 use inexhaustible sources of energy in the world economy should be at least 20% of all sources. In order to achieve economic growth in the advanced countries of the world, this stage is characterized by expanded electricity restructuring process. This is achieved through the introduction of new innovative technologies in the energy sector and the intensification of public-private partnership to create favorable conditions to ensure the competitiveness of the energy market.

Energy security, primarily due to the reform and the application of different types and advanced areas of alternative energy (Quaschnig, 2010), as well as promoting energy efficiency assigned to government [1]. All industrialized countries have energy to face the problem of environmental safety. Authors conducted the evaluation showed that the solution of environmental problems depends on the introduction of alternative methods of electricity. Despite certain positive aspects of economic growth, and the negative consequences occur. This increased pollution and environmental degradation, reduction of natural resources, increasing energy consumption and the imbalance of the biosphere, which generally leads to poor health. According to Fomichev A.N. (2009) the ecological problems connected through an active industrial and domestic consumption, with exploration work, including development fields, and natural gas emissions, radiation and impact on climate [2].

The use of traditional energy sources (Hermanovitch & Turilin, 2014) are excised stock,

for this reason they constitute a relatively expensive raw materials. The uncontrolled use of these raw materials may lead to global energy catastrophe. While the vastness of the mechanical force of the wind, biomass, water and the sun have unlimited natural resources, energy [3]. Thus, in Europe over recent years in the production of fast-growing electricity market paid attention on wind energy technology as a renewable natural source (Klessmann, Held, Rathman & Ragwitz, 2011). In this regard, the European policy aimed at creating incentives to attract investment in the industry [4]. In the post-crisis environment to achieve sustainability of the national economy, the Government of the Republic of Kazakhstan (RK) has directed efforts to support the development of priority sectors of industry. This in turn implies an increase in demand for energy resources consumption.

In Kazakhstan, the production of energy by type of power plant is classified as follows: TES (thermal electronic station), CES (condensation electronic station), GTES (gas turbine electronic station), HES (hydro electronic station) and TPP (thermal power plant). A large proportion of energy production accounts for TES, CES and TPP. No more than 15% of electricity and more than 70% is produced from coal at the GTES and HES, the rest of the sources used from hydropower, oil and gas.

According to estimates, the share of production of goods and services in GDP for 2010 to 2013 is up 45.1% to 40.4% and up 51.7% to 52.6% in accordance. Analysis of the structure of Kazakhstan's GDP over the last four years shows a decline in the production of goods by about 5% and increasing the

share of services by 1% (Table 1). Thus, in 2013 major share in GDP is industry - 29.6% [5].

**Table 1. Structure of Kazakhstan's GDP in 2010, 2013, % of total**

GDP by the method of production	2010	2011	2012	2013
Goods production:	45,1	43,2	41,4	40,4
Including - Electricity, gas and etc.	1,8	1,7	1,7	1,9
Production services	51,7	50,2	52,5	52,6
Gross value added	94,7	93,4	93,9	92,6
Net taxes on products and imports	3,2	6,6	6,1	7,4

Note - The compiled by the authors based on Agency on statistics of the RK. Date Views 10.03.2014 [www.stat.gov.kz/](http://www.stat.gov.kz/).

Intensification of economic development leads to increased consumption and production of electricity. In turn, this increases the consumption of fossil fuels and aggravates the environmental burden. Environmental indicators for monitoring and evaluation of Environmental Protection of Kazakhstan from 2005 to 2012 were identified by the authors of works (Table 2).

**Table 2. Total energy consumption in Kazakhstan**

Indicators	Unit	years							
		2005	2006	2007	2008	2009	2010	2011	2012
Energy productions	1000 toe	117 028,9	128 952,2	128 750,6	140 815,2	142 933,5	153 224,4	156 960,0	157 970,0
Energy imports	1000 toe	16 029,2	19 542,1	15 823,8	11 551,0	9 932,6	11 399,0	10 380,0	13 000,0
Energy exports	1000 toe	80 600,6	84 224,6	82 452,5	86 613,4	96 123,5	89 392,1	93 380,0	99 330,0
Inventory changes	1000 toe	299,7	3 513,3	1 082,6	533,6	1 477,1	2 039,3	2 770,0	1 560,0
Total energy consumption	1000 toe	52 157,8	60 756,3	61 039,3	65 219,2	55 265,5	73 192,0	71 190,0	70 080,0

Note - The compiled by the authors based on Agency on statistics of the RK. Date Views 01.03.2014 [www.stat.gov.kz/](http://www.stat.gov.kz/).  
toe - Thousands of tons of oil equivalent

The represented data show that the total energy consumption from traditional sources for 8 years increased by about 35%, and based on renewable sources - increased only by 0.11%. In 2009 there was noted a reduction of production and consumption of electricity due to the decline in industrial production due to the global financial crisis. In 2011 and 2012 in total usage of energy consumption was associated with a recession in industrialized countries, especially the United States of America and the European Union. The same trend is observed in 2013 and 2014.

Significant problem of the domestic energy sector is the high depreciation and obsolescence of equipment exceeding 70%. This situation leads to low efficiency of energy, emission and higher operating costs. If in 2009 in this sector raised about \$ 1 bln investment, already in 2013 - more than 1.5 bln USD, however, investment rates are still low, because general need of more than 20 bln USD.

It is interesting to note that the country is divided into three main energy regions - north, south and west. Priority natural resource for power generation - coal, which can be attributed to its huge reserves in the North and Central Kazakhstan, where the largest thermal power plant were built TES, CES and TPP of state. The vast amount of electricity

(70%) is produced in the northern part of the country. This situation is caused by the fact that the main electric power facilities are located in the northern region, the excess of which is exported to Russia. While the southern, western and central areas are experiencing their deficit. Especially South Zone does not have sufficient primary energy resources, its power generation based on imported coal and gas imports. As a result, it raises the cost of electricity for consumers.

### Methodology

Research Methodology is based on the application of scientific methods as - hypothetical synthesis, structural-functional, and logical approaches, systematic, comparative, factorial and SWOT-analysis.

### Main part

#### State regulation of the resource in Kazakhstan

In Kazakhstan the state regulation of the electricity sector based on the following laws and regulations. Kazakhstan ratified the Kyoto Protocol (2009), which provides financial incentives for the implementation of wind energy projects and programs RES. The Law of RK "On supporting the use of renewable energy sources" (2009) has created favorable conditions for the organization of programs "green" energy. So include investment preferences and public support for transportation of electricity and construction of renewable energy to the network [6]. Aspects of effective management of the electricity market and creating an attractive environment for the inflow of foreign and domestic investment is the Law of Kazakhstan "On amendments and additions to some legislative acts of Kazakhstan on electricity issues, investment activity of natural monopolies and regulated markets" (2012) [7].

In the "Strategic Development Plan of the RK until 2020" (2010) marked the position to reduce the energy intensity of GDP at least 20% and 25% by 2015 and 2020, respectively [8]. The Law "On energy saving and energy efficiency" measures have been developed to reduce the energy intensity of the industrial sector and the unnecessary loss of energy [9]. Under the Strategy "Kazakhstan - 2050" (2012) [10] and the State Program on Forced Industrial-Innovative Development [11] for the application of new technologies in the energy measures planned organizational and financial. In Kazakhstan, for the socio-economic welfare and environmental security is required to strengthen measures to improve the state of resource development policy. Thus, the concept has been adopted for the transition of the RK (RK) to the "Green Economy", which provides for

the application of innovative technologies and alternative energy sources, which by 2050 will be at least 50% of total energy consumption. These measures are aimed at economical consumption of non-renewable energy and resources, energy efficiency and energy saving, as well as to optimize the management of ecosystems, reduction of emissions and pollution [12].

In accordance with the provisions of the UN Environment Programme (UNEP), “green economy” - an economy that improves the standard of living within the risk reduction and emissions to the environment, including by attracting private and public investment. However provision for energy efficiency (wind, hydro, solar and other sources) and the rational allocation of scarce resources. Major prerequisite for the transition of Kazakhstan to the “green economy” is not optimal use of natural resources, leading to significant economic losses of at least 2.5 bln USD a year. Hence the introduction of industrial innovation, ecosystem services and “green clusters” will reduce disparities in regional development, effective management of water resources, reduce air emissions and waste disposal. This, together provide Kazakhstan into the 30 most competitive countries in the world.

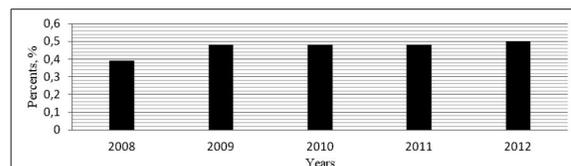
All these pieces of legislation need to characterize the modernization and diversification of the energy industry based on the use of alternative sources and resource-saving technologies under active government support in the form of energy-saving innovations - products accumulation, transfer and use of energy, new methods of energy generation, stimulating economic use at the nano-technology and special adaptive mechanisms, the use of wind farms and wind turbines, etc.

Prospects for the introduction of renewable energy sources (RES).

Analysis conducted by the economic and environmental condition says that it is necessary to strengthen the process of introduction of renewable energy sources as the main direction of development of energy sector. Thus the main source of funding for modernization and technological restructuring, except foreign and private investors in this area should address the state. Prerequisites influencing the development of renewable energy sources are achieving environmental and energy security, environmental protection, sustainable use of natural resources and biofuels, creating their own innovative model of the energy market, diversification and modernization of the material base of power, reducing process losses and wastes fuel. Using outdated energy technologies in the industry leads to negative results of electromagnetic radiation that has a detrimental effect on the atmosphere [13].

As one of the most effective source of renewable energy in the detail the application of wind power technology. In particular, for the application of energy wind potential of the Ministry of Energy and Mineral Resources in conjunction with the UN was made “Wind energy development program in Kazakhstan until 2015 with the prospect of further until 2030”. Thus, construction of a wind farm of 250-300 MW by 2015 was planned (investments of 500-600 million USD) and 2000MVt - by 2030 (investment 4000 million). According to the Ministry of Industry and Trade in 2020 Kazakhstan should build 34 objects given total production capacity of renewable energy in the volume of 1362 megawatts [14]. In accordance with international practices, for improving the innovative technologies for energy production from renewable energy sources, the cost of its production began to decline. For example, the cost of wind power generation in decreased from \$ 0.38 in the early 80's the last century to 0,03 - 0,035 USD per 1 kW/hour in the modern period. At the same time, if cost of electricity of 1 kW/hour considered, obtained from natural gas, it is increased up to \$ 0,055 and has a tendency to increase [15].

In Kazakhstan there are practically no alternative and environmentally friendly power plants (Picture 1). In general, the potential of water resources of the country is about 170 bln kWh per year. Plus in wind power and solar power generation can be realized in the potentials - 1.8 trillion kWh and 2.5 bln kWh per year, respectively. It is estimated that the use of these resources, reserves equal to about \$ 12 bln annually. Today reserves of non-renewable resources can be depleted within 60 to 75 years. Therefore, the government planned to increase renewable energy to 10% by 2024.



Picture 1 - Renewable energy consumption

Note - The compiled by the authors based on Agency on statistics of the RK. Date Views 06.03.2014 [www.stat.gov.kz/](http://www.stat.gov.kz/).

According to the analysis found that progressive wind energy potential is several times higher than the average energy consumption in the country. According to experts, the economic potential for wind energy present period involves more than 3 bln kilowatt-hours per year [16]. The evaluation revealed that the possible use of wind energy, the country seems leader per capita. Thus, in an area of one hectare of wind power can be produced in almost

twice larger than in other countries, with innovative wind energy. Therefore, one of the most promising directions in the field of renewable energy technologies is using wind turbines. 16 regions of Kazakhstan, more than half have wind potential with the average wind speed at the level of 7-10 m/s. Such a capability can provide a sufficiently high capacity factor of the wind farm (over 30%) while, for instance, France and Germany wind speed + wind generated by them is only 5.4 m/s [17]. For example, in the southern region in the foothills there are more than 5 unique unidirectional and counter wind corridors. As an example, the square of Djungar gate area is 15 km wide and 80 km long. You can build a wind farm capacity of at least \$ 1 trillion kWh per year, which will provide not only energy-requirement all Kazakhstan, but also allow selling electricity for export.

The density of the wind in some areas reaches up to 10 MW per square kilometer [18]. Estimated price for wind power generation stations would be approximately 3.5 cents/kWh that seems fairly competitive advantage. At the present stage of wind energy is used in almost 80 countries around the world. For example, in 2013 in Europe have initiated projects to build 21 wind power plants, of which 7 have been completed. Mainly used in wind energy wind power (70%), located in the North Sea [19]. Priority installation of wind farms in relation, for example, the construction of solar photovoltaic

modules is that they are less costly in 3-4 times, and require a small area to accommodate them. However, when the wind speed exceeds 7 m/s wind energy price may be lower than the cost of coal energy services, and at speeds above 8.5 m/s - in the gas. The country has its own experience of the local production of innovative wind turbines. For example, in 2010 Kazakhstan participated and received recognition project for the creation of such turbines for obtaining wind energy "Djungar gate" at the international competition "Red Herring".

Application of RES (renewable energy sources) will reduce the impact of carbon exhaustible energy, contribute to attracting investment in the sector and will stabilize greenhouse gas concentrations in the atmosphere. Renewable sources are "soft" energy sources and virtually no adverse effects on the atmosphere. The favorable factors for the implementation of the use of renewable energy in Kazakhstan include: the presence of a dynamic market solar and wind power, the competitive cost of electricity capacity, the ability to adapt to the necessary construction wind farm load; decentralized methods provide electricity in remote areas; stabilization of energy supply in the context of sustainable development, the lack of emissions and greenhouse gases. We emphasize that the use of resource-saving technologies in Kazakhstan may be used in the production and transmission of energy long-term and low level of innovation risk.

**Table 3. SWOT-analysis of the adoption of technology of wind energy in Kazakhstan**

	<b>Strong points</b>	<b>Weak points</b>
Internal environment	The presence of socio-economic target programs and the financial resources	Lack of opportunities for local budgets to create the infrastructure for wind farms
	Growth of total wind power installations	High operating costs for servicing wind farms
	Reduction of air pollutants	The risk of technological losses
	Increase the potential of wind turbines	Occurrence of accidents and technical failures
	Cost optimization of energy systems engineering device by improving technology	Lack of spare parts and units for prompt repair of equipment
	Development of information systems for monitoring environmental impacts	Non-condition of computer technology for monitoring mechanism
	Introduction of new equipment into the energy system of the country	Unplanned growth of prices for innovative equipment
	<b>Opportunities</b>	<b>Threatening</b>
External environment	Updating of electricity infrastructure	Destruction of energy networks
	Adoption of new equipment for the construction of wind farms	Power outages on individual objects
	Strengthening the potential power and reliability of the power system	Possibility of equipment failure due to non-compliance with the operating mode
	Providing energy consumers of the country in full	Technical and economic failures in forecasting energy demand
	Search for forms of attracting investment through public-private partnership	Reduction in budget funding and unfavorable investment climate
	Rational use of wind speed	Inconsistency capacity wind turbines
	Improving environmental and sanitary-epidemiological situation	Failure to clean technologies and filtering the air basin
Note - Compiled by authors		

In order to study the complex market environment, evaluation of phenomena on the implementation of wind energy projects, as well as

factors affecting the level of the ecological state of the authors was compiled SWOT-analysis (Table 3).

Implementation of innovative sources of risk in the power sector wind equipment RC are: inflation,

lack of funding, lack of qualified engineering personnel, the underestimation of the wind speed and the specific conditions of the area, natural disasters, etc. Obviously, the introduction of innovative wind energy capacity implies significant financial costs that private investors without government support cannot accomplish. It plays an important role may have measures of state incentives at the level of creating incentives and tax breaks. Business should be exempt from duty, importing “green” technology for the production of “clean” energy [20].

### Conclusions

So, in Kazakhstan there is a certain level of government regulation in terms of the adoption of laws and regulations, as well as the development of state programs in the energy and energy conservation.

The analysis revealed its energy state technical deterioration, high operating costs, the presence of harmful emissions into the atmosphere due to the use of outdated technologies. On this basis, we should implement and use alternative energy sources in Kazakhstan, which entail fundamental changes in the organizational structure of the energy department. State planned sufficiently revolutionary changes technological base. The authors propose the industrial energy sector focus on the construction of wind farms, wind farms and wind turbines based on the application of specific environmental conditions in Kazakhstan. These proposals are due to the identification of the best ways of rational use of resources and effective search directions of the development of innovative energy technologies, reduce production costs of electricity and achieve energy savings in industry.

### Findings

On the basis of research work produced the following conclusions:

–to development of alternative sources of energy industry Charged - insufficient to attract investments for the construction of wind farms , there is no clear interaction between the state and private businesses in matters of innovative electricity infrastructure; insufficiently elaborated provisions for the development of wind energy inventory; high proportion of pollution and emissions of greenhouse gases, long-term turnover of finance, high specific capital construction costs and the risk of uncertainty in the sphere of energy facilities, the high degree of worn-out equipment and technologies in the energy system of the country, the existence of monopoly market power is a barrier to the development of renewable energy sources;

–improvement of state regulation should be based on events: meeting deadlines and the plans adopted by the government resource programs, input tax holidays, financial and customs privileges and preferences for entrepreneurs importing and deploying into production of energy-saving technologies, modernization of the electrical and hydraulic power plants with the aim of restructuring of production facilities and reduce electricity transmission losses, strengthening the role of the state's participation in the wholesale energy market to create competitive advantages of all kinds of energy sources, the introduction of government guarantees to foreign manufacturers for purchase of new energy technologies in a timely manner;

–prospects for introducing alternative energy sources include: increasing energy efficiency and the share of renewable energy in industry, actively implement wind turbines in favorable spatial area with wind speeds of at least 7.6 m/s, the purchase of advanced power generating facilities and innovative technologies in the field of renewable energy, optimizing costs in energy consumption, the construction of wind farms and delivery of electricity in remote and remote villages, improve the quality and effectiveness of environmental management for the control and monitoring of rational use of wind resources, to ensure the growth of skill native technical personnel serving energy complex.

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