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Renewable Energy in Kazakhstan: Challenges and Prospects

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Abstract *– The current state of RE development in Kazakhstan based on SWOT-analysis is studied in the article. The research results are as follows. The driver of RE development is the strategic planning of indicators; established regulatory and legal framework and open energy policy; the potential of RES resources; national production of solar cells; grants for full financing of research and development and partial financing of technology and equipment transfer for RES; consultations of foreign and domestic experts and specialists. The prospects of RE development in Kazakhstan should be linked to: the creation of a new pricing model in the electric power industry of Kazakhstan, involvement of small and medium business entities in the RE sector, creation of new or re-profiling the existing production of electrical equipment for the needs of all types of RES, the development of individual power consumption from RES, the strengthening of control over the fulfillment of obligations on construction and commissioning of RES facilities by various entities, the use of funds from the state budget; and over the achievement of targets by RE entities.*

Keywords *– renewable energy, electricity, structure, production, consumption.*

1. INTRODUCTION

The importance of the RE development in Kazakhstan is due to the influence of various political, ecological, climatic, economic, and social factors. Political factors, first, include international obligations of Kazakhstan.

The political factor is that the country is a party to the Declaration “Agenda 21”, the UNFCCC, the Kyoto Protocol, the Paris Agreement, and complies with the resolutions of these programs. The main objectives of these documents are to solve global crises through reducing or eliminating the negative environmental impact of products of the processing of traditional energy resources, preserving or restoring the biosphere and ecosystems of the world, improving the quality of human life through the transition to a green economy and developing an alternative, including RE [1].

The environmental factor in the RE development is increasingly important for Kazakhstan. According to [2], the economy of the republic loses on average over 140 million US dollars (in 2005 prices) due to damage from dangerous hydro meteorological phenomena and adverse conditions. To solve environmental problems, according to the country's commitment to the UNFCCC, it is necessary to reduce CO_2 emissions by 2020 by 15% of the 1990 level, *i.e.* to 200.6 Mt. One of the ways to solve these problems is to increase the share of RE, the production of which is environmentally friendly.

The economic factors for the RE development in RK include the following: 1) a high degree of energy use from hydrocarbon energy sources by industry, which is characterized by a high level of energy intensity of industry (63.2-72.1% for 2013-2017) and an increase in the energy intensity of GDP in 2013-2018 from 0.177 to 0.206 toe (toe per 1 thousand dollars, at the price of $ in 2015), according to Enerdata. The latest figures lag far behind similar data from Enerdata in countries with former carbon-intensive economies: Germany - 0.072 toe and the UK - 0.062 toe (toe per 1 thousand dollars, at the price of $ in 2015) [3]; 2) the growing demand of the economy in heat and electricity (the amount of energy consumed in Kazakhstan in 2000-2018 has a positive trend from 39 to 103 TWh, which is determined by the growing population from 14,866 to 18,396 million people and an increase of GDP from 2 599.9 to 61820 billion KZT (from data of a SC of the MNE RK) [4]; 3) the volatility of world prices for primary energy resources (coal, oil, and gas) [5].

The social factors for the RE development in Kazakhstan include the deterioration in the quality of life of the population, accompanied by energy poverty in some regions.

However, despite the presence of all of the above factors and favorable natural and climatic conditions for the RE development, this sector is still in its infancy. Therefore, the purpose of this work is to study the current state, drivers, problems, and prospects for the RE development in Kazakhstan using a SWOT-analysis method.

2. LITERATURE REVIEW

The issues of stimulating the RE development are well developed in the academic literature. Countries that are currently leaders in the RES development have come a long way in supporting various types of RES, so their experience can be used to evaluation the prospects and effectiveness of various incentive measures.

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The most common economic measures for supporting RE in the world include FIT, tax preferences for RE producers, and manufactories of RE equipment. This category of support measures may also include taxes levied on producers of energy from hydrocarbon sources.

The effectiveness of economic measures to stimulate RE has been investigated by Li and Yi [6], Sarzynski and co-authors [7], Shrimali and Jenner [8], Krasko and Doris [9], Ratner and Khrustalev [10] and many others.

Another popular category of support measures is administrative measures, such as goals for achieving certain indicators of the RE development, RPS, and bans on the use of high-carbon technologies and equipment. The effectiveness of administrative incentive measures for RE has been studied by Carley [11], Zhu and co-authors [12], Choi and co-authors [13], Rountree [14], Rouhani and co-authors [15] and others.

Most scientists note in their research that neither financial nor administrative incentives cannot be effective enough on their own if they are not supported and combined. For example, Rouhani *et al.* [15] note that RPS create stable markets for investment in RE technologies and help reduce the cost of RES. Cory and Swezey [16] note that administrative support measures provide opportunities for the most economical use of resources and allow them to meet the needs of electricity. Also, many researchers point out that to achieve maximum efficiency, state economic and administrative measures to stimulate RE must also be supported by educational and awareness-raising activities. Zografakis *et al.* [17] analyze the impact of educational programs on the success of RE development. Noll *et al.* [18] emphasize that educated students can contribute to the formation of energetically harmless models of behavior in society and, thus, stimulate demand for RES. Ratner [19] investigates the issues of how insufficient awareness of consumers about the possibilities of new energy-saving and RES technologies may hinder the development of markets for such technologies.

As for studies on the development of the energy system of Kazakhstan, various challenges in the RE development are highlighted in the following papers [20]-[24].

In [20], the authors believe that the implemented auction mechanism to support RE projects in Kazakhstan allows selecting suppliers of RE with the best advanced technologies and low level of tariffs on a competitive basis, rather than administratively. As a result, the auctions reduce the financial burden of RE on the country's economy.

The paper [21] aims to address the issues of decarbonization: the authors propose the formation of a new socio-economic and technological system (model) of the economic development that stimulates the reduction of greenhouse gas emissions (compared to traditional economies). The authors propose to strengthen the monitoring and reporting on the implementation of each regulatory, policy, and program document, and not only to set limits that will become additional costs for producers but also to create economic incentives that would offset the inevitable costs of enterprises and would allow the launch of the ETS market for carbon trading.

In [22], the authors proposed to legislate on the following aspects of a RES development in RK: special instruments for granting credits (funds for RES; credit lines); financing by third parties; tax benefits for investment activities; comprehensive application of energy certification; information and educational programs. Some aspects of these proposals are currently in force in the current legal and regulatory framework.

In [23], the authors ranked and identified the main barriers hindering widespread usage of RES: policy and regulatory frameworks that support the use of fossil fuels; lack of awareness of alternative energy; a combination of social poverty and low levels of education in communities that can benefit from the widespread usage of renewable technologies; market conditions driven by current electricity tariffs; inefficient but effective power electricity generation technologies; and a high-risk business environment.

In [24], on the base of a broad review of all existing energy systems (including RE) in Kazakhstan, the following barriers to the development of the entire energy system have been identified: low electricity tariffs; electricity transmission losses and inefficient technologies; weak legal and regulatory frameworks for stimulation the use of RE; persistent governmental body reforms; inadequate level and quality of scientific support; information and educational barriers; and a high-risk business environment. The authors suggest that the problems of low tariffs for electricity in Kazakhstan, which harm the RE development, can be solved through a wide range of measures (FIT, RPS, mandatory market policy and "green" certificates), which have been successfully implemented in other countries, as well as through the use of specialized state funds and the creation of new state institutions for the RES development (following the example of Chinese energy policy); by ensuring guaranteed priority access to the grid in all aspects (grid connection, usage, and expansion of grids).

The Law of RK "About Support for Usage of RES", adopted back in 2009, already contained such energy policy mechanisms as guaranteed preferential access to grid in all aspects (connection, usage and expansion of the grid), so the conclusions of Karatayev and Clarke about the absence of these measures in this law are erroneous. It should also be noted that the scientific works of Karatayev *et al.* provide information for the period up to 2016. In recent years (after the publication of the paper of Karatayev and Clarke, *i.e.* from 2016) there have been major changes in the regulatory framework and production practice of the RE sector in Kazakhstan, which significantly contributed to overcoming some of the above-mentioned barriers. Therefore, this research examines the current state of the RES development in Kazakhstan, including in the light of recent changes in the regulatory framework since 2016.

Despite the different orientation, all the works of Kazakhstani researchers agree that the legislative (regulatory) framework adopted in Kazakhstan is imperfect and the state of RE development lags behind the strategic goals. In the authors' view, a comprehensive government program is needed to accelerate its development. To develop such a program, it is necessary first of all to analyze the current state of development of this sector, identify problems, and determine the prospects for its development. In this paper, the authors made this attempt for the first time taking into account the results of research in a literature review and studying the current state of RE in the country.

3. MATERIALS AND METHODS

The goals set in the paper provide for the application of methods of strategic analysis of the object. In the world practice, various methods are used which differ from each other by the purposes of objects analysis. For example, for analyzing the object's external environment the STEP/ PEST-analysis [25], Porter's Five Forces Model [26], Competitive Market Map [27], Consumer Cluster Analysis [28] are used; for analyzing the object's internal environment (product portfolio) the BCG Matrix, McKinsey/GE, Arthur D. Little [29] and others are used. All these methods are aimed at the study of either external or internal factors affecting the object of analysis.

The authors chose the SWOT-analysis method as it is a situational analysis of the RE sector in Kazakhstan (the object of analysis) based on the relationship of both external and internal factors, as well as the strengths and weaknesses of the object.

The methodology of SWOT-analysis is known, but it is used for the first time to study the state of RE sector development in Kazakhstan.

In the SWOT analysis process, the authors used a system approach [30], which is based on considering the RE sector as a system consisting of subsystems (sub-sectors - RES based on wind, solar, water, and biogas energy). The authors also used a well-known classical method - comparative analysis [30] of quantitative indicators of the share of RE in the total electricity production for 2011-2018, to determine the dynamics of the RES sector development in the context of sub-sectors (types of RES) and total electricity production in Kazakhstan.

The information base for research was Enerdata, the reports of USAID, World Bank, Transparency International, regulatory documents governing the domestic energy industry of Kazakhstan (laws of RK, messages and decrees of the President of RK, legislative and regulatory acts of the Government of RK, the Ministry of Energy of RK, and development strategies of the country). The authors also used the materials of the annual statistical information of various organizations of RK (data of the SC of the MNE RK, Samruk-Energy JSC, Settlement, and Financial Center for Support of RES LLP (SFC)).

4. RESULTS AND DISCUSSION

4.1 Strengths of the Current State of the RE Sector Development in Kazakhstan (S)

4.1.1 Implementation of the strategic planning system for the RE sector in Kazakhstan, taking into account international experience

Among the strengths of RE development in Kazakhstan, the authors first highlight the introduction of a strategic planning system in the government documents [31], the indicators of which are shown in Table 1.

Table 1. RE targets in state programs of Kazakhstan.

State Programs	Targets
Strategy "Kazakhstan 2050"	Share of non-hydrocarbon energy sources (including nuclear and RES) electricity production in total electricity production - 50% by 2050
Concept of the Transition of RK to a "Green economy"	Share of "clean" energy sources (including gas, nuclear and RES) in total electricity production: 3% by 2020, 30% by 2030, 50% by 2050, including share of wind and solar energy - 3% by 2020 and 10% share by 2030.
State Program of Industrial and Innovative Development RK for 2015-2019	Reduction of the energy intensity of the manufacturing industry by at least 15%
Strategic Development Plan of RK until 2025	RE share in the total electricity production - 6% by 2025, and 50% share by 2050.
Targets for RE sector 2020	RE share in total electricity production - 3%, total installed capacity up to 1700 MW.

Source: authors own from data [31].

The strategic priorities for the development of the RE sector in Kazakhstan are realized through the application of various measures of state support for the use of RE, which reflected in the laws of the country: "About Support for Usage of RES"; "About Electric Power Industry"; "About Natural Monopolies and Regulated Markets", "About investments", "About State Regulation of Biofuel Production and Turnover" and "About Permits and Notifications"; the Land and Water Codes of RK, as well as other sub-laws regulatory and legal documents (Rules: determination of fixed (feed-in) tariffs and limit auction prices; determination of the

tariff for RES support; centralized purchase and sale by the SFC of electric energy produced by RES facilities; provision of targeted assistance to individual consumers; purchase and sale of electric energy from net consumers; formation of Reserve Fund, *etc*.) [31]. This legal and regulatory framework has become a driver of RE development in Kazakhstan.

The basic Law (Law of RK "About Support for Usage of RES") provides for the following support measures: power transmission organization (ETO) must provide free access to electric or thermal grids, non-discriminatory determination of the nearest point of grids and connection of RES facilities to them; the RES entity has a priority right to transmit electric power through ETO grids during daily supplies, as well as in case of grid capacity limitation during all periods, except for the periods of liquidation of emergency situations; ETO itself pays for connection of RES facility to its grids; ETO (in particular, regional power grid companies) is obliged to buy electricity produced by RES facilities to compensate for regulatory losses of electricity in its grids in the amount not exceeding 50% of the total losses (since January 2011); SFC guarantees the RES entity the purchase of electricity at a fixed tariff or auction price for 15 years; the RES entity has the right to independently sell its electricity in two options: to SFC at a fixed tariff/auction price or to other consumers at agreed prices; approved fixed tariffs and auction prices are subject to annual indexation in accordance with the change in the exchange rate of KZT against foreign currencies in accordance with the procedure established by the Government of RK starting from the second year of electricity generation (70% for the second year); SFC generates costs (tariffs) for support of RES use from means of conditional electric power consumers (using fossil fuel), not RES subjects; energy supplying organization is obliged to buy all thermal energy from RES; costs for targeted assistance to individual consumers of RE make 50% of the cost of RES units with total capacity not exceeding 5 kW; coverage of cash gaps and debts of SFC to RES facilities is carried out with the help of Reserve Fund, which SFC generates from means of conditional consumers.

Based on this Law, until February 2018, the mechanism of competitive selection of RES projects at fixed tariffs was in force, after this date, auctioning is now in operation. Following the results of the auctions RES projects with low auction prices specified by the investor in the Application for participation in the auction are selected.

The winners of auctions apply to the SFC to conclude a Procurement purchase agreement within 60 calendar days after their inclusion in the List of Power Generating Companies using RE facilities. Entities of RES and ETO are also obliged to conclude a standard contract on connection of RES facilities by the procedure and terms determined by the Ministry of Energy of the RK. The obligations of the parties are fixed in these agreements. At the same time, all current changes under obligations, except for changes in the RES facility and sale of electricity from other RES facilities, may be determined by additional agreements.

Following the Code of RK "About Administrative Violations", the grid and heat supply companies are subject to fines in the amount of 100, 200, and 500 monthly calculation index set by the government of RK for small, medium, and large businesses, respectively, for non-fulfillment of obligations to purchase electricity and heat from RES, as well as for violation of the procedure and terms for determining the nearest point of connection to electric or thermal grids and connecting RES facilities to them. In the case of repeated violations, these amounts are increased to 150, 350, and 2000 monthly calculation indices, respectively, for small, medium, and large businesses.

Following the Resolution of the Government of RK "About some issues of implementation of state support for investments", "production, transmission, distribution, and sale of electricity from all types of energy sources (including RES)" is included in the List of Priority Activities for the Implementation of Investment Projects (including priority and special investment projects). On the basis of this Resolution and the Law of RK "About Investments" RES entities are granted the following investment preferences: exemption from customs duties on import of technological equipment, components and spare parts, raw materials and (or) materials for a period not exceeding 5 years from the date of commissioning of a fixed asset; exemption from value added tax on import of raw materials and (or) materials; state in-kind grants in the amount of no more than 30% of the volume of investments into fixed assets (land plots, buildings, structures, machinery and equipment, computing equipment, measuring and regulating devices and devices, vehicles (except for cars), production and economic inventory); tax preferences (reduction of corporate income tax on income of a new RES facility by 100% during 10 years, extended or renewed RES facility by 100% during 3 years; zero rate of land tax for the period of realization of the investment contract and property tax for 8 years after the first accounting of the asset; investment subsidy in the amount of up to 30% of the cost of construction and installation works and equipment purchases, excluding value added tax and excise duties.

Following the Land Code of RK, a RES entity has the right to an unpaid use of the land plot for up to 5 years and the possibility to extend the period of up to 49 years on a paid basis: after the expiration of 5 years, the land plot with the RES facility is put up for tender for lease; if a RES entity, who has built a RES facility on this land plot, applies for tender, he has a preferential right for long-term rent up to 49 years compared to other applicants. Land plots for construction of RES facilities are reserved by the Akimats (local executive authorities) based on plans of the location of RES facilities formed by the Ministry of Energy of RK.

Under the Law of RK "About Permits and Notifications" such types of work as "production, transmission, and distribution of electric and thermal energy, as well as operation of power plants, electric grids and substations and use of RES" are not subject to licensing. Only the purchase of electricity for energy supply purposes is licensed.

In accordance with the Resolution of the Government of RK "About approval of Rules for trading quotas and obligations to reduce emissions into the environment", a system of state regulation of greenhouse gas emissions has been operating in Kazakhstan since 2013, which also contributes to the RES development. Industrial enterprises and power plants receive a certain permitted amount of carbon dioxide emissions (quotas), the excess of which should be compensated by the purchase of additional quotas in the domestic carbon market. According to the Resolution of the Government of RK "About approval of Rules for limiting, suspending or reducing greenhouse gas emissions into the atmosphere", the country also introduced a mechanism of internal projects to reduce greenhouse gas emissions, which allows converting the results of energy-saving and energy efficiency projects into quotas available for sale on the domestic carbon market.

As a result of effective strategic planning and development of the regulatory and legal framework for RE development, there has been a positive dynamics of growth of RES indicators in Kazakhstan in recent years (Table 2).

Table 2. The dynamic of RE development in Kazakhstan (in million kWh).

	2011	2012	2013	2014	2015	2016	2017	2018
Wind	0.15	2.7	4.5	13.3	131.7	274.1	338.5	400.5
Solar	0	0.02	0.8	1.2	46.2	86.1	89.8	138.6
Bio	0	0	0	0	0	0	0.2	1.3
Hydro	7883.3	7637.3	7730.8	8262.8	9269.2	11605.9	11157.9	10343.0
large hydro	7883.3	7637.3	7730.8	8256.9	9238.2	11525.4	11014.1	10100.6
small hydro	0	0	0	5.9	31	80.5	143.8	242.4
Total RE	7883.45	7640.02	7736.1	8277.3	9447.1	11966.1	11586.4	10883.4
Total RE without large hydro	0.15	2.72	5.3	20.4	208.9	440.7	572.3	782.8
Total Energy	86585.5	90613.9	92615.7	94643.2	91645.1	94076.5	102383.6	106797.8
Total RE share (%)	9.1	8.4	8.4	8.7	10.3	12.7	11.3	10.2
RE share sans large hydro (%)	0	0	0.01	0.02	0.23	0.47	0.56	0.73

Source: authors own from data of a SC of MNE RK, Samruk-Energy JSC, SFC [32]-[34].

The annual growth rate of electricity from RES (without large hydro with a capacity of more than 25 MW) is high: in 2012 compared with 2011 the growth was 1713% (upon 2.57 million kWh), in 2013/2012 – 95% (upon 2.58 million kWh); in 2014/2013 – 285% (upon 15.1 million kWh) in 2015/2014 – 924% (upon 188.5 million kWh); in 2016/2015 – 111% (upon 231.8 million kWh); in 2017/2016 – 30% (upon 131.6 million kWh); in 2018/2017 – 37% (upon 210.5 million kWh). The highest growth rates of electricity from RES (without large hydro) were observed in 2011-2016.

The number of RE projects being implemented and their installed capacity are also increasing annually. So, by the end of 2017, 58 RE facilities with a total installed capacity of 342.3 MW were operating in Kazakhstan, and by the end of 2018 – 67 RE facilities with a total installed capacity of 531 MW, which represents an increase of 19% in number and 55% in capacity [32, p. 22].

As of July 1, 2019, 75 RE facilities have been introduced, of which 16 are wind farms (232 MW), 23 solar PV power plants (250 MW), 34 hydropower plants (200.3 MW), and 2 bioelectric power plants (1.3 MW) [32, p. 22; 33, p.10; 34]. The total installed capacity of 75 RE facilities is 683.6 MW (Figure 1).

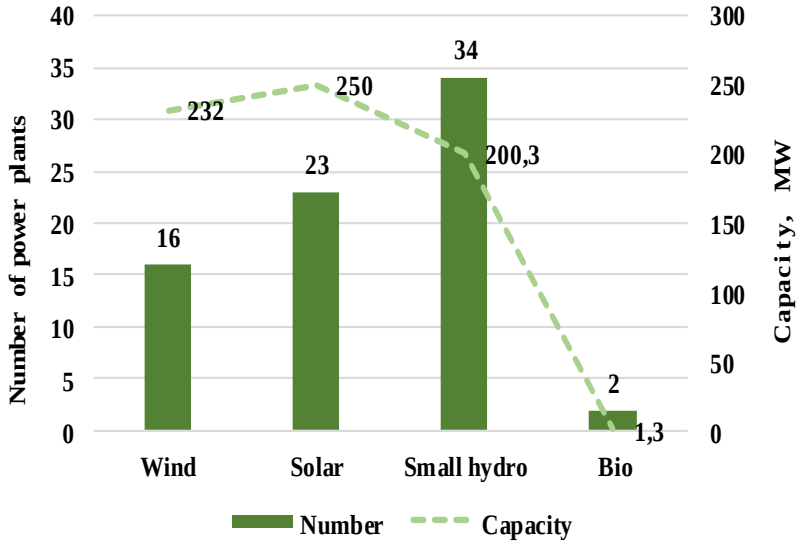

Fig. 1. The dynamic of RE development in Kazakhstan.
Source: authors own from data [32]-[34].

Table 3. Indicators of auction tenders in Kazakhstan for 2018-2019.

RES facility	Selected power of the RES facility	Number of selected projects	Start auction price, ten KZT / kWh	Minimum auction price for electricity, KZT / kWh	Deviation from starting prices, %
			2018		
WPP	500,85	16	22,68	17,39	-23,3
SPP	270,0	12	34,61	18,0	-48,0
HPP	82,08	7	16,71	12,8	-23,4
BPP	5,0	1	32,23	32,15	-1,0
Total	857,93	36	-	-	-
			2019		
WPP	108,99	5	22,66	19,27	-15,0
SPP	86,5	3	29,0	9,9	-66,0
HPP	7,0	2	15,48	15,43	-0,3
BPP	10,4	3	32,15	32,13	-0,1
Total	212,99	13	-	-	-

Notes: WPP – wind power plant, SPP – solar power plant, HPP hydroelectric power plant, HPP – hydroelectric power plant, BPP – BIO power plant.
Source: Authors own from data [35].

To July 1, 2019, the volume of electricity produced by RES amounts to 826.4 million kWh (compared to 2018 for 6 months of 2019, the growth of this indicator is 43.6 million kWh or 6%), to October 1, 2019 – 1650 million kWh (compared to 2018 for 9 months of 2019, the growth of this indicator is 867.2 million kWh or 110%).

4.1.2 Auction mechanism for implementing RES projects

Auction bidding rates in Kazakhstan for 2018 and 2019 are shown in Table 3.

Comparative analysis of the auction prices for 2018 and 2019 showed a decline in the price of electricity from RES, in particular, a significant decline in the price of electricity from SPP in 2018 and 2019 (in 2019, this price came close to the limiting tariff of carbon power plants - 6.64 KZT/kWh), high demand for capacity, and a large number of interested investors. The auctions of 2018 were attended by 113 Kazakh and foreign companies from 9 countries: Kazakhstan, Russia, China, Turkey, France, Bulgaria, UAE, Italy, Netherlands, and the total volume of bids from bidders was 3,422.35 MW. The auctions of 2019 were attended by 32 Kazakhstani and foreign companies from 8 countries: Kazakhstan, Russia, China, Germany, Malaysia, Italy, Spain, the Netherlands, the total volume of bids from auction participants was 818.99 MW. Demand for capacities averaged by all types of RES was 4 times higher than supply in 2018-2019.

4.1.3 Active development and introduction of RES in the Southern and Western regions of the country, where there is a shortage of electricity

The largest RE facilities (which an installed capacity of more than 25 MW) implemented after the country's transition to a green economy in the Southern and

Western zones are the following. In the *Southern zone*, there are wind farm Kordayskaya (53.75 MW) in the Kordaysky district of Zhambyl region (VetroInvest LLP), SPP with a capacity 100 MW near the city of Kapshagai, Almaty Region (Eneverse Kunkuat LLP), SPP Kapshagay (50 MW) near the city of Kapshagay, Almaty Region (Solar Power Kapshagay LLP), SPP "Burnoe Solar" (100 MW) in Zhualynsky district of Zhambyl region (Burnoye Solar-1 LLP, Burnoye Solar-2 LLP) and HPP Korinskaya (28.5 MW) in the Almaty region. In the *Western zone*, it is a 52.8 MW wind farm in Isatai district of Atyrau region (VetroEnergoTehnologii LLP) [32].

4.2 Weaknesses of the Current State of the RE Sector Development in Kazakhstan

4.2.1 Lagging of actual indicators of RE development from planned ones

In this part, the indicators are given without taking into account the auction results, as the selected projects are in the launch state. The share of RES electricity in the total electricity production in the country lags behind the target of 3% by 2020. In fact, as of October 1, 2019, it is 2.17% and may grow by no more than a 1% by the end of the year. The installed capacity of realized RES is also lagging behind the planned target. The plan is 1700 MW by 2020, but as of 1 October 2019, only 936.8 MW were installed in effect (Table 4).

Lagging behind the planned indicators of RE development and energy efficiency technologies also affects the dynamics of greenhouse gas emissions. Kazakhstan's commitment under the UNFCCC by 2020 is to reduce emissions by 15% (200.6 megatons) from the 1990 level (236 tones). In fact (Figure 2), by 2018 there was not a decrease, but a 5% increase in this indicator (to 247 Mt).

4.2.2 High share of RES consumption by electricity producers using fossil fuels

According to SFC [32, p. 26], the bulk of electricity from RES (87 %) is consumed by regional energy companies (including network companies and electricity producers based on coal and gas), as well as heat from RES - energy supplying organizations. Regional grid companies consume electricity from RES to compensate 50% of their losses in the grids, and coal and gas based power plants (conditional consumers - carbon power plants) to meet the missing demand for electricity.

4.2.3 Acquisition of equipment for construction of RES facilities mainly from foreign manufacturers

Currently, there are 912 electrical companies-manufacturers, and distributors-suppliers of electrical equipment of foreign production in Kazakhstan [36]. Among them, the largest is "Kainar-AKB" LLP, "Kazenergokabel" JSC, "ZHERSU Power" LLP, "Kentau transformer plant" JSC. The export of electrical equipment exceeds its import, while the income from exports is less than that from imports (Table 5).

Consequently, the construction of RES facilities mainly uses foreign-made electrical equipment, which is more expensive than similar products in Kazakhstan.

Table 4. Strategic targets of RE development and indicators achieved by October 1, 2019.

Type of RE power plant	Plan, MW	Fact (2019/10/01), MW
Wind	933	281.8
Solar PV	467	449.6
Small Hydro	290	203.0
Bio electric	10	2.4
Total	1,700	936.8

Source: Authors own from data [32]-[34].

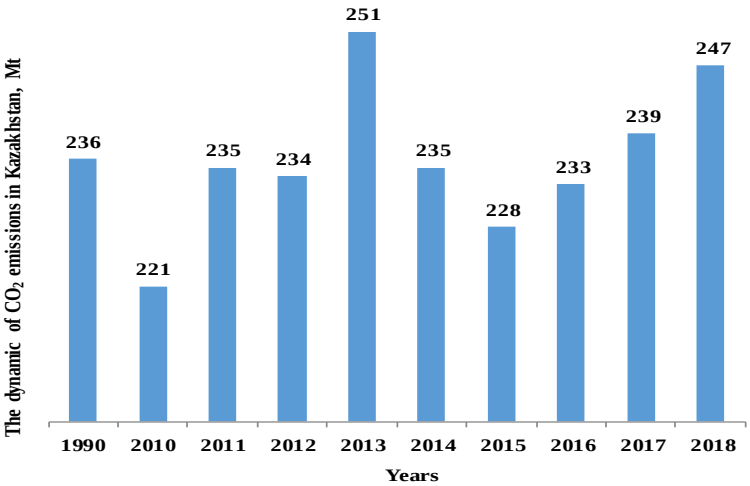

Fig. 2. The dynamic of CO_2 emissions in Kazakhstan.
Source: Authors own from Enerdata [3].

Table 5. Export-import of electrical equipment of Kazakhstan with the EAEU countries for 2018.

Code and Name of goods	Export		Import	
	Quantity, tons	Cost, thousand US dollars	Quantity, tons	Cost, thousand US dollars
8501, 8502, 8503, 8504 Electrical equipment	836.9	2 753.6	426.7	3657.1

Source: Authors own from data of a SC of the MNE RK.

4.3 Opportunities of Successful Development of the RE Sector in Kazakhstan (O)

4.3.1 Significant resource potential of Kazakhstan

In 2018 research by TetraTech (a Consulting and Engineering Company in the USA) under the framework of the Regional Program "Future Energy", commissioned by the Ministry of Energy of RK with funding from USAID identified the technically feasible resource potential of RE in Kazakhstan: a) wind energy - 920 TWh/ year; b) hydro potential - 62 TWh/year; solar energy - 2.5 TWh/year; thermal potential of geothermal waters - 4.3 GW/year [32], [33], [37]. The technically possible potential of non-traditional RE sources in Kazakhstan significantly exceeds the energy consumption.

4.3.2 The availability of a full cycle of national production of solar panels (Astana Solar)

Following the Agreement "About strategic partnership between the RK and the Republic of France" dated 11 June 2008, to develop technology transfer and implement the State program "Way to Europe" for 2009-2011 between the Ministry of Industry and Trade of RK and the Ministry of Economy, Industry and Employment of the Republic of France signed an Intergovernmental Agreement "About development of the real sector of the economy on an innovative basis". It was planned to build photovoltaic panel factories in Astana and Ust-Kamenogorsk based on Kazakhstani quartz from Sarykol deposit (near Ushtobe) [38].

On December 25, 2012, the country's first photovoltaic module production plant, Astana Solar, was launched. The capacity of the plant is 50 MW per year (more than 217,000 solar cells of two types - photovoltaic modules KZ PV M60 and KZ PV M72) [39]. KazSilicon Smelter LLP was the first plant in Kazakhstan to produce metallurgical silicon with a design capacity of 5 000 tons per year, which was launched in 2006 in Ushtobe before the KazPV project started. Kazakhstan Solar Silicon LLP is the main link in this project, responsible for the production of silicon wafers for photovoltaic cells. This plant was launched in early 2013 [40].

The result of the KazPV project was the creation of a complete cycle for the production of solar cells "Astana Solar".

4.3.3 Transparency of public organizations in the country

Governmental organizations (Ministries of Energy, Investment and Development, Agriculture) actively involved international experts and scientists from IFC (International Finance Corporation); EBRD (European Bank for Reconstruction and Development), ADB (Asian Development Bank); USAID (United States Agency for International Development); TetraTech; United Nations [32], [33], as well as domestic scientists and specialists from research institutes (the Kazak Research Institute of Energy named after academician Chyokin and the Centre for Energy Research of the Private Institute "NURIS" of Nazarbayev University), and professional communities (Association of Legal Entities "Kazakhstan Association of Oil and Gas and Energy Complex Organizations "KazEnergy" (KazEnergy), Association of RES of Kazakhstan, National Chamber of Entrepreneurs "Atameken", Kazakhstan Electric Power Association, Kazakhstan Solar Energy Association). The Ministry of Energy of RK and "KECMO" JSC also organize transparent auction procedures for investors to participate. This factor allows for continuous transformation of the regulatory framework for RES development taking into account international experience and local conditions (resource potential of RES, territorial unevenness of energy supply, etc.).

The indicator of the Corruption Perceptions Index in Kazakhstan in 2019 compared to 2018 improved: 34 points out of 100 and ranked 113th among 183 countries (11 positions higher than in 2018). Although the country is still in the last thirty points and in the second hundred countries in terms of position, this indicator shows a great deal of progress and commitment of the state authorities to procedural transparency [41].

Kazakhstan also has a good performance in the "Doing business" rating given in the World Bank report. According to 3 indicators from 4, RK is among the top 40 countries from 189: "Property Registration"-18th place, "Business Registration" - 35th place," Obtaining a construction permit" – 35th place. According to the 4th indicator "Connecting to electric grids", the country ranks 76th place [42].

4.3.4 State support for research and development and transfer of technologies and equipment for RES projects

Scientific research and commercialization of innovations as well as the transfer of technologies and equipment for RES projects are supported by state grants on a competitive basis. The implementation of scientific

research in 2018 was carried out by following the seven priorities for the development of science for 2018-2020, approved at the meeting of the Supreme Scientific and Technical Commission under the Government of RK. One of them is a priority – Energy and mechanical engineering. Kazakhstan's research in the field of RE is focused on the study of promising materials and technologies for solar, hydrogen, bio- and wind energy, as well as energy storage and hydroelectric systems [43].

4.4 Threats for Successful Development of the RE Sector in Kazakhstan (T)

There are only a few significant threats to the rapid RE development in RK.

4.4.1 Low limit tariffs for sale of electricity from carbon power plants

This indicator for 2019 is at the level of 6.64 KZT/kWh and still represents a threat to the competitiveness of electricity from RES, the average price of which is 19.18 KZT/kWh. Only the price of electricity from SPP in 2019 came close to the price of electricity from carbon power plants. This was mentioned earlier in the work of Karatayev and Clarke [24]. They offered support measures such as preferential tariffs, RPS, mandatory market share policy, and green certificates. In fact, all these measures, with the exception of green certificates, have been introduced into the RE policy. Moreover, the Ministry of Energy of RK is considering the introduction of green bonds. Obviously, these measures will still be insufficient, as green bonds are more focused on attracting finance for RE rather than on resolving price imbalances.

4.4.2 Lack of qualified engineers for RE

This factor poses a serious threat and is conditioned by the orientation of the country's leading higher education institutions towards the general training of bachelors and masters mainly in the field of "Electric Power Engineering". This is evidenced by the authors' review of educational programs of technical universities in the country.

Students of all three levels (Bachelor, Master, Doctor) study only on specialty "6B071800, 7M071800, 8D071800 - Electric Power Engineering" (Almaty University of Energy and Communication, Karaganda State Technical University, Kazakh National Research Technical University, Karaganda State Technical University, East Kazakhstan State Technical University, Taraz State Technical University). Educational programs on this specialty contain mainly obligatory components of basic disciplines for general training on power networks, systems, and stations. There is no separate specialty on RE in these universities. RE is reflected in the content of educational programs "6B071800, 7M071800 - Electric Power Engineering" at the bachelor's and master's level in the form of special disciplines only in some universities: Almaty University of Energy and Communication (Use of Renewable Energy Sources, 2015), Kazakh National Research Technical University (Renewable Energy Sources, 2018), Karaganda State Technical University (Non-traditional and renewable energy sources, 2018).

4.4.3 Lack of domestic facilities for accumulation and storage of RES in Kazakhstan

RES are unstable energy sources depending on environmental conditions. Therefore, the power supply to the national and regional grids of the country is uneven, which can lead to catastrophic consequences and failures in the energy system and related equipment. Besides, adverse weather conditions of the country's sharply continental climate can lead to rapid wear and tear and failure of relevant electrical equipment and long-distance export and transit lines (due to their territorial dispersion). Such a situation will lead to interruptions in the power supply of the Unified Energy System of Kazakhstan, hence, energy-intensive industrial enterprises, the population and all other consumers of electricity. These hazards can neutralize the RES facilities, which are currently not yet implemented in Kazakhstan [44].

4.4.4 Planned creation of a common electricity market in the Eurasian Economic Union

Despite the presence of large reserves of hydrocarbons (oil and gas), no power plants based on them have been established in the Western and Southern zones of the country. As before, the Kazakh government intends to replenish the main shortage of electricity in these regions from the resources of Russia (in Western Zone) and Kyrgyzstan and Uzbekistan (in Southern Zone) within the Eurasian Economic Union. Only a small demand for electricity is met from new RES facilities.

4.5 Situational Analysis of Mutual Influence of SWOT Analysis Factors

The authors estimate the development factors (S, W, O and T) of the RE sector based on the SWOT matrix (Figure 3).

Mutual influence S–W

Development of regulatory and legal measures (S) allowed to overcome earlier existing shortcomings of the RE sector (W): the guaranteed payment for electricity from RES due to the creation of reserve fund (4.1.1); organization of continuous construction of RES project due to definition of standard agreements, which clearly stipulate financial responsibility of the entities in the form of fines (4.1.1) in case of non-fulfillment of mutual obligations; connection of RES facilities to power transmission and heat supply organizations due to regulatory regulation in the form of fines (4.1.1), and lack of energy in the Southern and Western Zones due to launching large RES facilities in these regions (4.1.3).

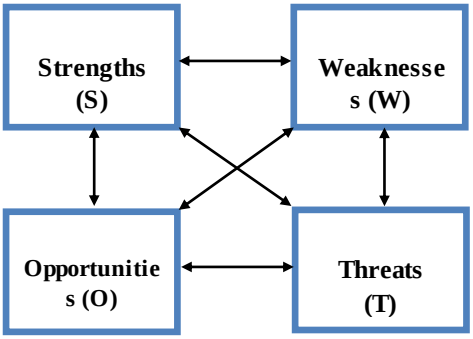

Fig. 3. SWOT matrix factors (S, W, O and T) in the development of the RE sector in Kazakhstan.
Source: Authors own.

It is expected that the introduction of the auctioning mechanism for the selection of RE projects (S, 4.1.2) will eliminate the lag in actual indicators of RE development from the planned ones (W, 4.2.1). The 2018-2019 auctions allowed for the selection of projects with better qualifying characteristics and reduced auction prices for electricity from RE, which reduces the financial burden to support preferential tariffs and increases the price competitiveness of electricity from RE. The auction mechanism in the world practice may not take place when different preferences for investors are not legally established. There are various favorable preferences in Kazakhstan (4.1.1). However, the conditions of auctions (financial support of an application for participation in auctions in the amount of 2000 (two thousand) KZT for 1 (one) kW of installed capacity) based on the "Rules of organization and conduct of the auctions" are financially unacceptable for the participation of small and medium businesses, which does not contribute to the development of national business.

Regulatory and legal regulation of the guaranteed sale of energy from RES commissioned before July 21, 2013 to regional power companies (after this date from RES to all consumers with whom SFC concludes a purchase and sale contract) and heat supply companies (S) has led to an increase in the share of conditional consumers among the RES consumers (W), which has a positive impact on the reduction of their greenhouse gas emissions (4.2.2). However, this may hinder their reconstruction and modernization to switch to energy saving or to use less harmful fuel - gas.

Import of expensive electric equipment of foreign production for the RES construction projects in Kazakhstan against the background of exceeding the export of similar Kazakhstani equipment (W) indicates the need to improve factor (S), in particular, the regulatory framework for the optimization of export and import of Kazakhstani electric equipment (4.2.3). The importance of these measures may be due to the rapid wear and tear of foreign electrical equipment not always suitable for the harsh climatic conditions of Kazakhstan; the need to avoid possible delays in the supply of imported equipment; hence, violations of the timing of commissioning of RES facilities, as well as to reduce the cost of RES projects, in which the purchase of equipment is a large share.

Mutual influence S–O

The discovery of a large RES potential in Kazakhstan by TetraTech, with funding from USAID (4.3.1) by order of the Ministry of Energy of RK, demonstrates the impact of strategic planning (S) measures on obtaining huge opportunities for RE development (O). A consequence of this was the impact of opportunities (O) on the strengths (S), namely the establishment of a "RES Facility Location Plan" with capacity corresponding to RE resources (4.1.1).

The creation of the full production cycle of solar cells "Astana Solar" (O, 4.3.2) opened up opportunities for accelerated development of solar energy, which is confirmed by the results of auctions (S, 4.1.2), in which the auction prices for electricity from the SPP were the lowest.

Transparent procedures on websites organized by the Ministry of Energy of RK, "KECMO" JSC, the Committee for the Regulation of Natural Monopolies, SFC, and other institutions, as well as the promotion of Kazakhstan in the ratings "Corruption Perception Index" and "Doing Business" on "Property Registration", "Registration of Enterprises", "Obtaining a Building Permit" (O, 4.3.3) indicates a positive impact of the regulatory framework (S, 4.1.1). To overcome the latter indicator "Connection to electricity networks", it is necessary not only to impose fines on network companies (4.1.1), but also to exercise strict control over them with the help of inspection bodies, which is advisable to establish regulatory documents. The negative effect (O) on (S) is that continuity of obligations is not always respected when changing ministers. For example, currently, under the leadership of the new Minister Nurlan Nogayev, who replaced former Minister Kanat Bozumbayev, there is no previously available information on the functional indicators of RE.

Although the country provides grant opportunities for research and commercialization of innovation in the field of RE (O, 4.3.4), demonstration projects implemented by domestic scientists are single (WPP of Bolotov). This fact calls for stricter control over the use of budgetary resources and the establishment of the responsibility of state officials and scientists in regulatory documents (the impact of O on S).

Mutual influence S–T

In the authors opinion, the impact of low limit tariffs on electricity from carbon power plants (T, 4.4.1) on their regulatory framework (S) in the country should be related to their revision and reflection of real costs, namely the costs of modernization of obsolete equipment, the introduction of green technologies for gas purification, the costs of the state to eliminate the consequences of environmental pollution and to rehabilitate the health of carbon power plant workers and the population living near these power plants. This will create a competitive market for electricity from renewable energy sources. But it is not enough, as in the conditions of a competitive free choice by consumers of electricity from RES it is also necessary to exclude in the legal field subsidized differentiated tariffs provided by large carbon power plants in the centralized market of electricity sales in the country.

The threat of poor training of qualified engineers for RE in Kazakhstan (T, 4.4.2) does not have significant obstacles in the legal field (S), as the existing technical universities based on the requirements of the current State Educational Standards have academic freedom and can independently create programs of RES disciplines and attract foreign personnel for their preparation and research.

The absence of domestic facilities for accumulation and storage of RES in Kazakhstan (T, 4.4.3) also has no obstacles in the legal field (S), as the transfer of promising RES technologies has legal grounds under the Entrepreneurial Code of RK. Moreover, the National Agency for Technological Development periodically holds contests for grant support of the transferred technologies.

Mutual influence W–O

The large resource potential of RE in Kazakhstan (O, 4.3.1) is a strategic basis for leveling the current state of RE development, characterized by lagging behind the targets (W, 4.2.1). The establishment of a full cycle of the national production of solar cells (O, 4.3.2) has provided great opportunities for the accelerated development of solar energy. For the production of electrical equipment designed for all types of RES, the country has existing production facilities of large and medium-sized businesses, which can be re-profiled per international standards. For this purpose, it is necessary to initiate special state programs partially financed from the state budget.

Transparency of state organizations in the country (O, 4.3.3) provides opportunities for RES electricity consumption not only for conditional consumers, but also for individual consumers. Therefore, the issues of lagging development of RE (W, 4.2.3) can be solved through the broad involvement of individual consumers in this sector. This will make it possible to level out the issues of price competitiveness of electricity from RES and solve social poverty and backwardness of the population in the areas located far from the national networks and organizations of centralized electricity and heat supply by excluding the cost of connection to them.

In Kazakhstan, the Entrepreneurship Code also provides state grants for enterprise and industry development (O, 4.3.4). This regulatory framework opens up great opportunities for investors to transfer the best foreign technologies and RES equipment (W, 4.2.3).

Mutual influence W–T

In this spectrum of influence, government agencies need to constantly monitor so that threats do not further exacerbate the weaknesses of the RE sector.

The biggest threat to the current backlog in the RE sector (W, 4.2.1) is the low limit tariffs for electricity sales from carbon power plants (T, 4.4.1). Above (S-T mutual influence) the authors have indicated what needs to be done to eliminate the negative impact of the factor (T, 4.4.1).

The problem of the shortage of highly qualified specialists in the RE sector is also solvable (T, 4.4.2). This was mentioned above (S-T mutual influence). In addition, in order not to exacerbate the impact of this factor on factor 4.2.1, it is necessary to organize continuous professional development abroad at the expense of Samruk-Energy national companies (similar activities are conducted in the oil sector).

Mutual influence O–T

It is important here that opportunities do not become threats, but threats become opportunities. In this aspect, the authors do not consider only the RES resource factor (O, 4.3.1).

The probability that the national production of solar cells "Astana Solar" (O, 4.3.2) may become a threat to the development of RES is very low, as this production has a full cycle (own resources - the cycle of production of intermediate products - production of final products).

The transparency of government organizations in a country (O, 4.3.3) should be continuously checked by internal and external procedures so as not to become an administrative barrier to the development of the RE sector. The internal procedures include legal (administrative and criminal) responsibility of all state officials for corruption, as well as continuous reporting by the Minister of Energy of RK to the Government, RE entities, experts, associations for types of RE, and other communities on various RES issues. External requirements include the rating requirements "Corruption Perception Index" and "Doing Business".

State support for research and development as well as the transfer of technologies and equipment for RES projects is not urgent. It is carried out so there is no chance to become a threat.

Factors T, 4.4.2, and T, 4.4.3 can be overcome and enabled from threats.

To turn the threat (T, 4.4.1) into an opportunity, it is necessary to work out the issues of cheapening the RES projects (in addition to the measures mentioned above) through re-profiling of domestic production of electrical equipment for other types of RES, except for SPP; development of national demonstration projects based on RES technologies by RK scientists, as well as

the transfer of technologies and equipment for RES of foreign production through partial replacement of their cost within the framework of grant programs of Kazakhstan.

Factor T, 4.4.4 poses a risk to RE development, despite the availability of large resources and prospects for RES development in the Western and Southern Zones of the country. With the development of a common electricity market within the Eurasian Economic Union, it can be expected that the processes of electricity export and import with neighboring countries rich in energy resources will only increase, and economic incentives for the development of RE will decrease. In case of political turmoil between the countries, there may be interruptions in the electricity supply in the West and gas supply in the South of the country. Therefore, Kazakhstan's energy security through the development of RES in these regions is equal to its political independence. The solution to this issue is in the field of renewable energy, as well as in the political sphere of the country.

5. CONCLUSIONS

The results of this study using the methodology of SWOT-analysis showed that Kazakhstan has launched the RE sector by transforming the experience of development of the sector in such countries as Denmark, Germany, France, Canada, Brazil, India, etc., using tender and auction mechanisms and systems of preferential tariffs.

The *driver* for the development of RE in Kazakhstan is the strategic planning of indicators; the established legal and regulatory framework (including investment preferences, etc.) and open energy policy of the state, accompanied by transparent procedures of state and other bodies; identified potential for RES; creation of a full cycle of production of solar cells "Astana Solar"; providing grants from the state budget for the full financing of research and development and partial financing of the transfer of energy from the state budget to the state.

Despite the active development of the RES sector in Kazakhstan, there are still *problems* in the country. The problems that can be solved within the existing regulatory framework include the lack of qualified engineering personnel for the RES sector; insufficient development of domestic capacities for technologies and energy storage facilities.

The prospects for the RE sector should be aimed at solving complex problems that require improvement of existing laws and regulations or initiation of state programs with the involvement of budget funds from National Companies (Samruk Energy, Kazenergy). For example, to address the competitive advantage of the hydrocarbon sector over the RE sector due to the low limit tariffs for electricity from carbon power plants, it is necessary to create a new pricing model in the power industry of Kazakhstan, which allows the creation of a competitive electricity market for all types of power plants. For the wide involvement of small and medium business entities, it is reasonable to review all investment preferences. For the creation of new or re-profiling of existing production of electric equipment for the needs of all types of RES, as well as for the development of individual power consumption from RES, state financial support is required. To strengthen control over the fulfillment of obligations of various entities on construction and commissioning of RES objects; on use of finances from the state budget; as well as to control over the achievement of target indicators by RES subjects, it is necessary to revise the regulatory and legal framework.

The authors' researches have preliminary character, further the authors plan to study questions of efficiency of economic and financial mechanisms of development of the sector of RE in Kazakhstan taking into account international experience.

NOMENCLATURE

RE	renewable energy
RES	renewable energy sources
UNFCCC	United Nations Framework Convention on Climate Change
RK	Republic of Kazakhstan
GDP	Gross Domestic Product
toe	ton of oil equivalent
SC of MNE RK	Statistics Committee of the Ministry of National Economy of the Republic of Kazakhstan
FIT	feed-in tariff
RPS	energy portfolio standards
LLP	Limited Liability Partnership
SFC	Settlement and Financial Center for Support of RES LLP
ETO	Energy transmission organization
"KECMO" JSC	"Kazakhstan Electricity and Capacity Market Operator" Joint Stock Company

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