



Current trends and development problems of renewable energy sources in the Republic of Sakha (Yakutia)

Tendencias actuales y problemas de desarrollo de las fuentes de energía renovables en la República de Sakha (Yakutia)

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ABSTRACT:

The main development problems of renewable energy sources and its development prospects are considered in this article as a result of the conducted research. It was revealed, based on the analysis, that the use of power plants working on renewable energy sources in the districts of the Republic of Sakha (Yakutia) has the high cost of imported fuel and a sufficiently high potential of certain types of renewable energy resources. The introduction of power plants, working on renewable energy sources, will not only reduce the consumption of expensive imported diesel fuel, but also have a positive impact on the environment. The study has revealed the problems and prospects of development of renewable energy sources in the Republic of Sakha (Yakutia).

Keywords: : renewable energy sources, electric power industry, electric power, production, consumption, the Republic of Sakha (Yakutia).

RESUMEN:

Los principales problemas de desarrollo de las fuentes de energía renovables y sus perspectivas de desarrollo se consideran en este artículo como resultado de la investigación realizada. Se reveló, según el análisis, que el uso de centrales eléctricas que funcionan con fuentes de energía renovables en los distritos de la República de Sakha (Yakutia) tiene el alto costo del combustible importado y un potencial suficientemente alto de ciertos tipos de recursos de energía renovable. La introducción de plantas de energía, que trabajan con fuentes de energía renovables, no solo reducirá el consumo de combustible diesel importado caro, sino que también tendrá un impacto positivo en el medio ambiente. El estudio ha revelado los problemas y las perspectivas de desarrollo de fuentes de energía renovables en la República de Sakha (Yakutia).

Palabras clave: fuentes de energía renovables, industria de la energía eléctrica, energía eléctrica, producción, consumo, República de Sakha (Yakutia).

1. Introduction

The prolonged consumer attitude of a human to nature has led to the depletion of natural resources. Irrational use of oil, coal and gas can lead to an energy crisis. The transition to renewable energy sources (RES) can radically solve the problems of energy security and save the climate. Consequently, the RES can be considered as a way to save a part of the traditional fossil fuel. In addition, the use of the RES is economically justified for those regions and facilities where

there are no other opportunities to connect to the power grid, and these include many decentralized regions of the Republic of Sakha (Yakutia).

Currently, the share of renewable energy resources in the energy balances in the most countries is increasing rapidly. In the Russian Federation, the objectives of an effective use and development of the RES are reflected in the Federal Law of 26.03.2003 №35-FL "On Electricity" (FL "On Electricity", 2003), in the "Strategy for the development of the Arctic zone of the Russian Federation and national security for the period up to 2020" of 08.02.13 Ord. No. - 232 (Strategy for the development of the Arctic zone of the Russian Federation, 2013). Expenses on R & D in the field of renewable energy can increase the innovative activity of Russian companies, thus Russia can accelerate its economic transition from an extensive type of development to an intensive one (Barinova, Lanshina 2016). The aim of the research is to study the current situation and identify the development problems of renewable energy sources in the Republic of Sakha (Yakutia).

In accordance with the stated goal, the following tasks were set and solved:

- to assess the current trends in the development of renewable energy sources in the Russian Federation and the Republic of Sakha (Yakutia);
- to identify the development problems of renewable energy sources in the Republic of Sakha (Yakutia).

2. Methods

The presented study focuses on the economic and statistical analysis of the financing features as a crowdfunding for the development of renewable energy sources in individual countries of the world. The study calculated the financing of projects for the construction of solar power plants using the financing mechanism of these investment projects for the development of renewable energy in the Republic of Sakha (Yakutia), such as crowdfunding, which is a mechanism to attract financial resources from the masses for the implementation of various kinds of projects. This mechanism is implemented on Internet sites where recipients post information about their project (G. Khotinskaya, 2017). Crowdfunding will attract the necessary funds without the participation of financial market structures, which greatly simplifies this procedure (Evdokimova S.S., 2015).

Of the presented methods for regulating this mechanism, the most optimal option for Russia seems to be to control the crowdfunding market in the UK. In accordance with the draft Central Bank of the Russian Federation "On alternative methods of attracting investments (crowdfunding)," the Bank of Russia will exercise control over crowdfunding in the country (Federal Law dated 02.08.2019 N 259-Φ3, 2019). The control of crowdfunding sites can be transferred to the Central Bank, but here the control should not be as tightened as in the bill: it can only be reduced to a more demanding procedure for registering the platforms being created, which, in strict order, will be required to ensure the security of payments using bank cards using secure connection technologies.

3. Results and discussion

Russia inherited the structure of the energy complex from the Soviet Union, when the USSR began to develop since the 60s of the XX century as an energy power nation, that focused on production and export of traditional energy resources (Barinova, Lanshina, 2016). Popel O.S. believes that on the basis of the previous development there was a stable belief that Russia had inexhaustible reserves of energy resources (Popel, 2008). According to Bezrukikh, the illusion that the energy crisis in Russia is impossible on the basis of high availability of fossil fuels was formed in the country (Bezrukikh, 2014). The belief that traditional energy is always relevant and paramount was formed.

In addition to the obstacle which is the meaning that prioritize oil and gas as key energy resources in domestic consumption, the low level of renewable energy development in Russia is associated with the following factors:

- There are no special programs that subsidize projects based on renewable energy sources;
- Low prices for traditional energy resources and produced electricity;
- High cost of the equipment;
- Relatively small number of qualified personnel;
- There is no environmental impact claim on the state government from society in the country.

Moreover, the disadvantages of alternative sources include low efficiency, which is usually characteristic to solar panels, volatility (depending on weather conditions and time of day), expensive repairs and maintenance (wind turbines).

It is important to note that most of the regions of the Russian Federation are energy deficient; they need to import fuel and supply energy. 10 per cent of the population does not have access to centralized electricity and heat. In addition, Russia, being a gas nation, gasified the population only by 67.2%.

One of the main problems hampering the rapid development of renewable energy is considered to be the high cost of electricity production. Nevertheless, the results of calculations carried out by Barinova and Lanshina showed that renewable energy sources are quite competitive in terms of costs in areas isolated from the unified energy system, where diesel power plants are mainly used, in particular in the Republic of Sakha (Yakutia). In remote areas, the complex logistics of diesel fuel supplies forms an extremely high cost of electricity, which can reach 100-200 rubles per kWh, and in some settlements of Yakutia it is 383 rubles for 1 kWh. The cost of generation from renewable energy sources ranges from 1.2 rubles per kWh (small HPPs) to 24.85 rubles per kW (solar power plants) [3]. Moreover, it is predicted that renewable energy sources will become cheaper than all other energy resources by 2020. It is worth noting that over the past two years, solar panels have fallen in price twice.

Therefore, the above identified problems in relation to renewable energy sources have prospects to be solved, taking into account the risk factors in the design and operation of power facilities. A SWOT analysis of renewable energy development in Russia was performed by Nefedova, Soloviev, Shilova and Soloviev (table 1).

Table 1
SWOT analysis of renewable energy
development in Russia (Nefedova, 2016)

	Positive factor	Negative factor
Internal factor	Strength: * significant RES potential; * ability to create power plants of different capacities	Weakness: <ul style="list-style-type: none"> • the volatility of energy; * weak development of domestic technologies at the industrial level; * the need for infrastructure; * complex incentive mechanism
External factor	Scope: * additional production of electricity in the required volumes in the areas of centralized power supply; * significant reduction of environmental pollution; * ample opportunities for foreign investment; * availability of extensive free space	Threats: <ul style="list-style-type: none"> • technical obstacle; • * non-fixed electricity tariff; * adverse financing conditions; * imperfect legislative framework

From the presented data of table 1 it follows that negative factors cause a variety of risks in obtaining energy from renewable energy facilities (Degtyarev, 2015).

It follows from the above that projects based on renewable energy sources involve significant risks. However, these risks are inherent to innovative technologies that are now successfully implemented in our life. Moreover, it is possible to reduce the probability of occurrence of the identified risks, for this it is necessary to control those aspects that can lead to their occurrence.

Since there is currently a mass production of renewable energy installations around the world, their cost naturally decreases over time. So, the problem of high cost of the RES installations is gradually disappearing. But apart from this factor which is identified as an obstacle to the introduction of energy facilities based on renewable resources, the main obstacle - financing the development of alternative energy remains traditional.

Russian energy Minister Alexander Novak believes that Russia should not lose these advantages due to the fact that until 2040 hydrocarbons will be the key energy sources in the world. Renewable energy should not be relegated to the background. Besides, we are not talking about total transformation of energy balance in Russia. We are talking about the development of these

technologies in isolated territories that are in decentralized energy systems by combined use of diesel power plants of small capacity along with the power plants based on renewable natural resources because the latter cannot completely replace the exploited energy sources.

Renewable energy sources have significant environmental and social advantages over primary energy sources. The need to use renewable energy sources not only in Yakutia, but also throughout the world, is primarily associated with their relative environmental cleanliness. Alternative energy replaces traditional energy based on oil, gas and coal, where the latter ones emit carbon dioxide during combustion, which contributes to the growth of the greenhouse effect. According to the experts, the projected doubling of greenhouse gas emissions will lead to an increase in the Earth's temperature by 6°C, which, in turn, will lead to irreversible consequences (Ozhgikhin, 2012).

A clear example of the negative impact of extraction, processing, burning of natural resources is the extremely unfavorable situation in Beijing. Poisonous smog does not dissipate over the metropolis; the content of harmful substances exceeds the norm by an average of eight times. It was recorded for the first time an extremely dangerous level of pollution (900 micrograms of harmful particles per 1 cubic meter, while the permissible limit is 50 micrograms) in some areas of the city. The reasons for the dangerous fog are harmful emissions from industrial enterprises in Beijing, coal mining in neighboring provinces, as well as its use for heating homes.

There is a tendency to reduce harmful emissions into the air in the Republic of Sakha (Yakutia) in recent years (table 2).

According to the state report on the condition and environmental protection of the Republic of Sakha (Yakutia), emissions of pollutants into the atmosphere from 15,298 stationary sources amounted to 256,584 thousand tons, which is 10.46% less than in 2015.

Table 2
Emissions of the most common pollutants from stationary sources for 2014-2016, thousand tons

Pollutants	2014	2015	2016
Total emissions, including	307,394	286,557	256,584
Solid	57,962	54,970	53,214
Liquid and gaseous, of which:	249,432	231,587	203,370
Sulphur dioxide	10,373	11,469	13,057
Carbon oxide	186,075	162,238	126,123
Nitrogen oxide	29,152	29,979	34,113
Hydrocarbons (without VOC)	18,056	20,871	16,537
Volatile organic matter	5,776	7,030	13,540

Annual reports of the Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia), 2017

More than half of the gross emissions of pollutants come from mining – 54.4%, and 33.5% of all emissions come from the production and distribution of electricity, gas and water.

Due to the fact that air pollutants depart from stationary sources belonging to enterprises of these economic activity types, the data on harmful emissions of the oil and gas and electric power industries will be analyzed.

Emissions of pollutants into the atmosphere from the largest enterprises of the oil and gas industry are shown in table 3.

Table 3
Data on pollutant emissions into the air from stationary sources of large enterprises of the oil and gas industry in the Republic for 2014-2016, thousand tons

Title of enterprise	2014	2015	2016
OJSC «Surgutneftegaz»	9,4	14,2	19,9
JSC «Sakhatransneftegaz»	0,286	0,144	0,158
JSC «YATEC»	1,284	1,307	1,365
LLC «Transneft'-Vostok»	1,039	1,392	1,446
LLC «Taas-Yuryakh Neftegazodobycha»	163,622	130,611	78,958

Annual reports of the Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia), 2017

Table 3 shows that the largest amounts of pollutant emissions into the air are observed at the enterprises of OJSC "Surgutneftegas" and LLC "Taas-Yuryakh Neftegazodobycha".

In 2016, the volume of harmful emissions into the atmosphere from the sources increased from 14.2 thousand tons to 19.9 thousand tons (+40%).

While in LLC "Taas-Yuryakh Neftegazodobycha" there has been a decrease in the gross emissions of harmful substances by 652,386 51 tons, which was achieved by decreasing the production of natural and associated gas and reduce flaring of associated petroleum gas by 176 330,214 thousand cubic meters.

Pollutant emissions into the atmosphere from the largest enterprises of the electric power industry are shown in table 4.

Table 4

Data on pollutant emissions into the air from stationary sources of large electric power enterprises in the Republic for 2014-2016, thousand tons.

Title of enterprise	2014	2015	2016
PJSC «Yakutskenergo»	9,140	9,262	8,826
JSC «Sakhaenergo»	5,468	6,686	6,387
JSC «Vilyuiskaya HPP-3»	0,006	0,006	0,022
JSC "DGK"(GBC) branch Neryungrinskaya GRES	17,584	19,044	19,905

Annual reports of the Ministry of Ecology, Nature Management and Forestry of the Republic of Sakha (Yakutia), 2017

Table 4 shows that the largest amount of harmful emissions is from stationary sources of the enterprises of PJSC "Yakutskenergo" and the "Neryungrinskaya GRES" branch of JSC GBC. But it is worth noting that the company "Yakutskenergo" decreased pollutant emissions by 436,708 tons in 2016 compared to the previous year. Neryungrinskaya SDPP increased its electricity production in 2016 consequently harmful air emissions have been increased compared to 2015 by 861,095 tons.

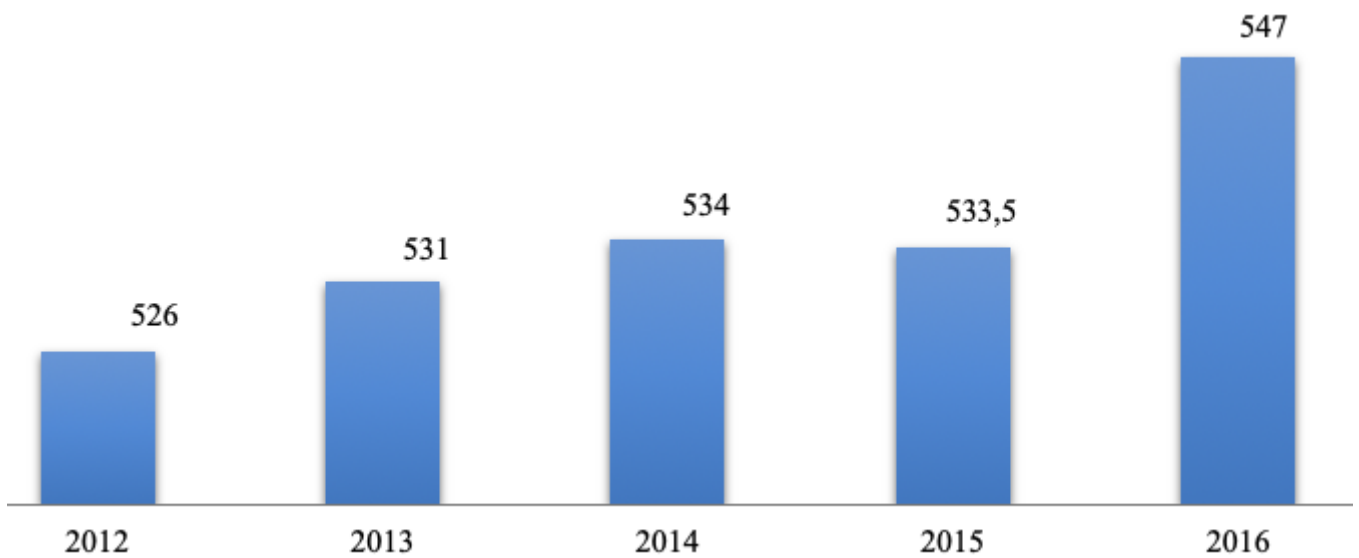
The UN Framework Convention on climate change (UNFCCC) was adopted in 1992, where a climate change problem was acknowledged which is largely the result of anthropogenic activities, and, as it is known, the use of renewable energy sources can reduce the impact of this factor by replacing the fossil fuel used in the industrial sphere, which emits pollutants. The reduction of harmful emissions into the atmosphere in the territory of the Republic by increasing the number of renewable energy facilities in operation becomes obvious.

This trend is advisable to continue, as the number of economic entities and other activities engaged in emissions of pollutants into the atmosphere, according to 2016 is 585 in the region.

One of the main advantages of renewable energy is also inexhaustibility. The demand for energy is steadily increasing with the population growth, and the supply of traditional energy resources is not infinite. According to the average forecast scenario of the UN, the world population will grow from 6.2 billion people (at the beginning of the XXI century) to 8 billion by 2030 and to 10 billion people by 2050, with 80% of the population will live in developing countries. At the same time, energy consumption by 2020 is projected to increase to 18-20 billion tons per year.

According to analytical forecasts, geological reserves of oil and gas, as the main types of fuel resources, will last for another 40-50 years. However, on the whole, the situation is such that the main oil reserves on Earth will run out in 50-75 years. According to some forecasts, traditional fuel and energy resources will disappear in the next 100-150 years, while maintaining the actual rate of production. Oil, the world's main fuel, will run out in 53 years. However, considering the dynamics of oil production in Russia, it should be noted that the state does not reduce the production of this exhaustible resource. On the contrary, every year the active growth of oil production is noticeable (figure 1).

Figure 1
Oil production in Russia, millions tons.



Source: Official materials of the Federal State Statistics Service, 2017

Oil production amounted to 10.1 million tons in 2016 in the Republic of Sakha (Yakutia), that means the plan was fulfilled by 104.7%. The task to ensure oil production at the level of the same 10.1 million tons for 2017 was set. Consequently, there is no question of reducing the rate of oil production.

The scarcity of fossil fuels is only a part of the problem. Another aspect of the problem is the depletion of proven deposits and the constant increase in the costs of exploration and development of new, most likely, hard-to-reach (oil can be found in the sands, rocks or in the depths of the Arctic seas), it evidently affects the price of hydrocarbons, as well as the mentioned global warming (Ozhgikhin, 2012).

The role of renewable energy sources in solving the food problems of mankind deserves special consideration. The possibilities of different renewable resources and installations based on them in solving global problems are presented in table 5, where: "+" means a positive impact, "-" - a negative impact, "0" - no impact on the solution of the problem (Korobova, 2009).

Table 5
The role of renewable energy sources in solving the energy, environmental and food problems of mankind.

Type of resources or installations	Constraint			
	Energy	Environmental	Food	
Wind turbine	+	+	+	Water-lifting installations on pastures and in remote settlements

Small and micro Hydroelectric Power Stations	+	+	+	Irrigation of lands on the basis of small reservoirs; water lifting devices of RAM type
Solar thermal installations	+	+	+	Plants for drying hay, grain, agricultural products, fruits
Solar photovoltaic installations	+	+	+	Water-lifting systems, power supply of security devices on pastures
Geothermal power plants	+	+/-	0	
Geothermal heat installation	+	+/-	+	Greenhouse heating with geothermal water
Biomass. Municipal solid waste incineration	+	+/-	0	
Biomass. Incineration of agricultural, logging and processing waste	+	+/-	+	Use of ash as fertilizer
Biomass. Bioenergy waste recycling	+	+	+	Production of environmentally friendly fertilizers as a result of waste fermentation
Biomass. Gasification	+	+	0	
Biomass. Obtaining liquid fuel	+	+	+	Obtaining diesel fuel from rapeseed
Low-grade heat recovery plants	+	+	0	

Source: Korobova, 2009

Notes:

- 1) Water-lifting installations on pastures and in remote settlements.
- 2) Irrigation of lands on the basis of small reservoirs, water lifting devices of RAM type.
- 3) Installations for drying hay, grain, agricultural products, fruit.
- 4) Water-lifting systems, power supply of security devices on pastures.
- 5) Heating of greenhouses by geothermal waters.
- 6) Use of ash as fertilizer.
- 7) Production of environmentally friendly fertilizers as a result of waste fermentation.
- 8) Production of diesel fuel from rape seeds - self-sufficiency of agriculture with diesel fuel.

It follows from table 5 that the use of renewable energy sources in the Republic of Sakha (Yakutia) is capable of establishing agricultural production in the future, namely field cultivation. The development of crop production can reduce the outflow of population from rural areas; it can also improve living conditions in general and reduce unemployment, if the problem is present. Moreover, the cultivation of potatoes and cereals, forage crops will create additional sources of income. Therefore, it can be concluded that the boundaries of opportunities will expand in Yakutia if the introduction of renewable energy sources into the energy balance of the Republic is accelerated.

A significant basis for the development of renewable energy sources in the Republic of Sakha (Yakutia) is also the huge amounts of cross-subsidization of diesel energy (table 6).

Table 6
Data on the volume of cross-subsidization of diesel energy in the Republic of Sakha (Yakutia) for 2014-2016.

Indicator	The value of the indicator, billion rubles.			Change of indicator in 2016 as compare to 2014 r.	
	2014	2015	2016	In billion rubles	%
Amount of cross-subsidization	5,5	6,0	6,8	1,3	23,63

Source: Annual reports of PJSC "Sakhaenergo" for 2013-2016.

The 6.8 billion rubles indicated in the table are a significant additional price burden on industrial consumers, which can be reduced by increasing the share of renewable energy sources in the energy balance of the Republic. In addition, it is also worth noting that each kilowatt-hour consumed by industrial facilities carries 2.48 rubles of cross-subsidization of diesel energy.

4. Conclusions

The study revealed the problems and prospects for the development of renewable energy sources. Based on the above, we can say, according to the data, that the impact of renewable energy on the environment is already noticeable. Despite this, there is something to work on: oil production is not reduced either in the Republic of Sakha (Yakutia), or in the whole country. But renewable energy is based on a variety of renewable natural resources, which allows you to protect traditional energy sources. It is worth thinking about, because the use of fossil fuels at a steady pace can lead to such devastating, irreversible harmful consequences.

The results of the study can be applied by ministries and departments, state organizations, other organizations and companies involved in the formation of policy in the energy sector, including JSC "Sakhaenergo".

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