The development of the logistics system of the electric power complex

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Abstract. The article is devoted to the development of the logistics system of the electric power complex of the Russian Federation. The study analyzed the electric power potential, namely, the estimated capacity utilization, the availability of interstate power lines and the level of competitiveness of Russian electricity. As a result of the analysis, it was revealed that about 80 GW of production capacity is not used, interstate power lines allow transmitting tens of thousands of billions of kilowatt-hours, and the cost of electrical energy is much lower than in other states. Further, the work presented the development mechanisms of the logistics system of the electric power complex, which consist in the need to break down territories by the level of capacity utilization, determine the pace of development of territories, plan consumption and production of electric energy and determine the possibility of using existing electrical networks or building new intergovernmental transmission lines. At the end of the article, the main conclusions of the study are made.

1. Introduction

The electric power industry of Russia is a branch of the national economy that provides for the vital activity of society and the development of the national economy, within the framework of which a multitude of technically complex facilities producing, transmitting, distributing and consuming electric energy are combined. The electric power industry, as a sector of the national economy, independently brings a positive economic effect and creates added value of the gross domestic product of the country [1; 2; 3].

Since the transition of the Russian Federation to market relations, various kinds of changes have been taking place in the power industry [4; 5], for example, in the industry a competitive electricity market was formed, some companies were transferred to private management, and large companies remained under state management. In addition, there is a decline in the technical development of the industry, financial stability, reduction in the volume of intersystem and interstate flows, etc. [6; 7].
Despite the problems that emerged, about a third of the production capacity of the electric power complex is not involved, and interstate power lines are not used, while electric power companies are forced to bear the costs of maintaining them in working condition, conducting annual maintenance and repairs of power equipment.

2. Materials and methods
The purpose of this study is to develop the logistics systems of the electric power complex of the Russian Federation in the context of reducing the use of the potential of the electric power complex and increasing the sales of electric power on the world market. To achieve this goal, the following tasks have been proposed:
- analyze the existing electric power potential of the Russian Federation;
- propose mechanisms for the development of logistics systems of the electric power complex.

Further, based on the use of the system analysis method, expert assessment methods, statistical, factor, historical, comparative and logical analysis methods, we will conduct a study and present recommendations for the development of logistic systems of the electric power complex of the Russian Federation.

3. Results
The transfer of electric power in the territory of foreign countries in recent years has been updated, since a special need for the purchase of foreign electric power arises in the countries of the Commonwealth of Independent States for a number of reasons. First, in the CIS countries, the stability and reliability of the electric power complex is reduced, due to the use of obsolete and morally worn industrial complexes. Secondly, the Russian electricity is cheaper compared to the own energy of these countries. Thirdly, the purchase of electric energy provides a reduction of socio-economic tensions in the states, due to the reduction of costs for the maintenance of the national electric power industry. Fourth, the preservation and development of national electrical networks, intersystem and interstate power lines, through which the transportation of electrical energy to the final consumer is ensured, is ensured [8].

Today, the volume of export of electric energy depends not only on the ability of the state to sell electric energy on the territory of other states, but also on its competitiveness, availability of reserve capacity and corresponding intergovernmental power lines. According to the Ministry of Energy of the Russian Federation, the share of electricity exports in the Russian Federation does not exceed 1% annually of the total electricity generation, for example, in 2015 it amounted to 16 billion kWh, and in 2016 and 2017 about 9 billion kWh*h, respectively [9; 10].

The possibility of transferring Russian electric power to the territory of other states can be carried out only if there is free and unused production capacity [11]. Consider the potential of the electric power industry of the Russian Federation to determine the possibility of intergovernmental power flows from the territory of the Russian Federation to the territory of other states. In our opinion, for the purpose of objective analysis, it is necessary to consider indicators reflecting the real and possible volume of electric energy production, or the level of capacity utilization and installed capacity. The following indicators are the volumes of export and import of electric energy, the presence of intersystem power lines and their capacity, and the last indicator is advisable to consider the competitiveness of Russian electric energy in comparison with the prices of other states. Let us analyze the dynamics of each indicator separately.

Let us consider an indicator reflecting the ability of the electricity industry to produce a greater amount of electrical energy than is consumed within the state. A similar indicator is the maximum level of capacity utilization (figure 1).
From the presented figure it is clear that the maximum capacity utilization in recent years did not exceed 160 GW, while the installed capacity of power plants is 245 GW. Thus, about 80 GW of installed capacity is not used, despite the fact that the power industry enterprises have to bear the costs of their maintenance, maintenance and annual periodic inspections or repairs.

Next, we present information reflecting the competitiveness of the Russian electric power industry, which should be considered through the tariff for electrical energy (figure 2).

The figure shows that electricity tariffs in the Republic of Kazakhstan and the Russian Federation are minimal, and, consequently, Russian electricity can compete in the market of Eurasian countries and the Common Electricity Market of the European Union.

At the final stage of the study, it is advisable to analyze the logistics systems of the Unified Energy System of the Russian Federation, as well as the possible export volumes of electric energy. It is worth noting that the Unified Energy System of the Russian Federation was separated from the Unified Energy System of the Soviet Union, which not only united the general power lines of the republic, which are part of the USSR, but also carried out the flow of electrical energy from the energy surplus to the energy-deficient regions each republic. Considering the list of interstate power lines, it is clear that the Russian Federation can transmit electrical energy to the following states - Azerbaijan, Abkhazia, Belarus, Georgia, Kazakhstan, China, Latvia, Lithuania, Mongolia, Ukraine, South Ossetia, Finland, Estonia and Norway. At the same time, only 69 interstate TLs of the Russian Federation with
the Republic of Kazakhstan, which, in turn, borders on almost all countries located in the south of the Eurasian continent. There are 11 joint power lines with the Republic of Belarus and the Republic of Mongolia, the first of which borders almost the entire eastern part of the European Union, and the Republic of Mongolia with the states in the south of Eurasia. In addition, joint power lines are available with the Republic of Ukraine and the Republic of Finland at 27 and 13 power lines, respectively, which opens up new ways of supplying electric power to the common market of the European Union. The maximum volume of electric power flows only to the Republic of Belarus, the Republic of Kazakhstan and Ukraine can reach 40 billion kWh, while the total volume of power flows is only 16.1 billion kWh\(^*\)h. At the same time, there are interstate lines that are not operated, but are on the balance sheet of electric power companies and their potential is not used [12; 13].

Thus, the analyzed indicators indicate that the electric power industry of the Russian Federation has the necessary production potential, interstate power lines and has a competitive advantage over other countries. In this regard, we present the mechanisms for the development of logistics systems of the electric power complex.

4. Discussion

In recent years, there has been an increase in the consumption of electric energy, in this regard, the issues of increasing the production or purchase of electric energy are even more actualized, especially in the republics of the former Soviet Union, in which equipment from the 50s and 60s are operated, and the costs of production are more than the level of the real tariff for electrical energy. During this period, the Russian Federation, which possesses not only generating potential, but also network capabilities, should develop a program at the national level for entering the industry to the markets of other countries.

In our opinion, the development of the logistics systems of the electric power complex of the Russian Federation should be developed together with potential states and consumers of electrical energy. One of the directions of development of the logistics systems of the electric power complex should be the loading of existing power transmission lines and the construction of new electrical networks, taking into account the needs of states consuming electrical energy. Within this direction, it is proposed to introduce the following mechanism at the national level, with the participation of the Ministry of Energy of the Russian Federation and the System Operator of the Unified Energy System of the Russian Federation (figure 3).

As part of this mechanism, it is proposed to start developing the logistics systems of the electric power complex with a breakdown of the territory of the Russian Federation both in terms of capacity utilization, and equipment condition, type of fuel used, energy efficiency and cost of electricity produced. At the second stage, it is advisable to assess the reserve of production capacity and the possibility of producing additional volumes, both in terms of technical feasibility and economic efficiency. Next, it is necessary to assess the pace of development of the territories of the Russian Federation and the border areas that are not part of the Russian Federation, this is the most important stage, where it is advisable not only to assess the possibilities of supplying electric energy, but also to present the competitive qualities of Russian electricity to potential consumers. At the next stage, the volumes of generation and consumption of electric energy are planned, and the possibilities of its delivery without the construction of additional production capacities are assessed. Otherwise, it is advisable to develop projects and programs for the construction of new interstate power lines, in order to provide electricity to end users. In this case, the Russian electricity can be sold to passing consumers, who are located along the newly constructed interstate power line.
Figure 3. The mechanism of development of the logistics system of electric power complex of the Russian Federation.

Of course, the proposed mechanism cannot be implemented without interaction with other countries or large consumers located in the territory of neighboring states. Thus, the issues of electric power flows to other energy systems were relevant both during the USSR’s existence and now, when most of the generating capacities created in the last century run out of useful life, there is a drop in the energy efficiency of production and the negative impact of the electric power complex on environment.

5. Conclusion
The study showed that the Russian Federation has an untapped potential of the electric power complex, the underutilization of which is about 80 GW, and some interstate power lines are currently not used, while the cost of Russian electric energy is lower than in European countries. The work proposed a mechanism for the development of logistics systems of the electric power complex, which consists in planning consumption volumes, taking into account the pace of development of territories, and using existing power lines, or designing new interstate transmission lines.

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