

Ensuring a balance of production and consumption of electric energy in order to preserve the environment

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Abstract. The presented study is devoted to ensuring the balance of production and consumption of electric energy in order to preserve the environment for future generations and ensure environmental safety. The work analyzed statistical data reflecting indicators of production and consumption of electric energy, volumes of commissioned capacities and balances of the flow of electric energy. Based on the data analyzed, it was concluded that the electric power industry is able to satisfy its own needs, however, solely by ensuring the flow of electric energy from surplus areas to scarce areas. The commissioned volumes of capacities will make it possible to ensure exclusively an increase in the consumption of electric energy; however, this does not make it possible to solve the problems associated with wear and tear of capacities. At the end of the study, a model was proposed to ensure the balance of production and consumption of electric energy, which contains a set of mechanisms ensuring the stability of the energy system.

1 Introduction

The modern structure of consumption and production is being transformed under new conditions for the existence of activities, the functioning of industrial complexes, the needs of the population and state needs [1]. However, the functioning of technically complex complexes has been developing for a rather long time, and changes in their conditions and principles of functioning do not always ensure the stability and stability of a particular type of activity [2-3]. Ensuring the balance of production and consumption of different types of goods and services is a priority for the state, large corporations, industrial enterprises and other organizations. Such conditions ensure the stability of the state system, social and economic stability, and maintain the efficiency of enterprises and industrial complexes. Of course, this situation requires many industries to adapt to the new requirements and needs of consumers, as well as adapt their own production to new conditions and principles of operation [4-5].

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Modern industrial complexes have moved to a new path of development, when the consumer, and not the manufacturer, plays the decisive role, therefore, issues related to ensuring the balance of production and consumption come to the fore [6]. The electric power complex of Russia has been forming for a rather long period of time, and the specificity of production is to maintain a continuous process of production - transmission - distribution - sale of electric energy [7-8]. Maintaining such a functioning environment, especially for the electric power industry in Russia, is a necessary and priority task for all areas of activity [9]. To date, problems in the electric power industry have been revealed related to equipment wear, the use of outdated technologies, reduced production efficiency, increased resource consumption, increased environmental load, etc., which affect the sustainability, reliability and safety of the electric power industry. In this regard, we will consider the issues of ensuring the balance of production and consumption of electric energy; we will form mechanisms that will further maintain the reliability, stability and safety of the industry.

2 Materials and methods

The goal was set in the work related to ensuring the balance of production and consumption of electric energy. Based on the stated goal, the following tasks were proposed:

- Analyze indicators reflecting the balance of production and consumption of electric energy in the energy system;
- To propose a model to ensure the balance of production and consumption of electric energy.

The study used statistics published in open sources. The work was based on the use of scientific approaches and methods, which made it possible to reveal the goal of the study.

3 Results

The formation of the energy system consisted in the need to provide electric energy to all consumers, regardless of the available capacities and volumes of energy consumption. A similar balance was the creation of the Unified Energy System, the formation of which consisted in the construction of intersystem power lines, the construction of switchgears and substations, which helped to ensure the flow of electric energy from one energy system to another. Ensuring the flow of electric energy allows you to supply energy to energy-insulated areas from energy-surplus territories, which allows you to optimally distribute production loads to power plants, reduce the use of the most wasteful capacities, produce cheaper electric energy, etc [10-11].

In modern conditions, new requirements are being formed to ensure the balance of production and consumption of electric energy; this is due to a multitude of both internal and external factors, which, ultimately, can affect the stability and safety of the entire electric power complex [12]. In the electric power industry, it is possible to assess the balance between production and consumption by analyzing the volumes of production and consumption of electric energy (figure 1) [13-15].

From the presented figure it is seen that the volume of production for the entire period under review exceeds the volume of consumption. The graph shows that the Russian Federation can fully provide electric energy to its own consumers, moreover, if necessary, supply electric energy to the world energy market. At the same time, we see that the volumes of production and consumption of electric energy, on average, annually increase production by 1.5%. An increase in the volume of production and consumption of electric

energy requires an increase in installed capacity, as well as a policy to modernize and upgrade production capacities in order to maintain reliable and uninterrupted power supply to consumers [16-17].

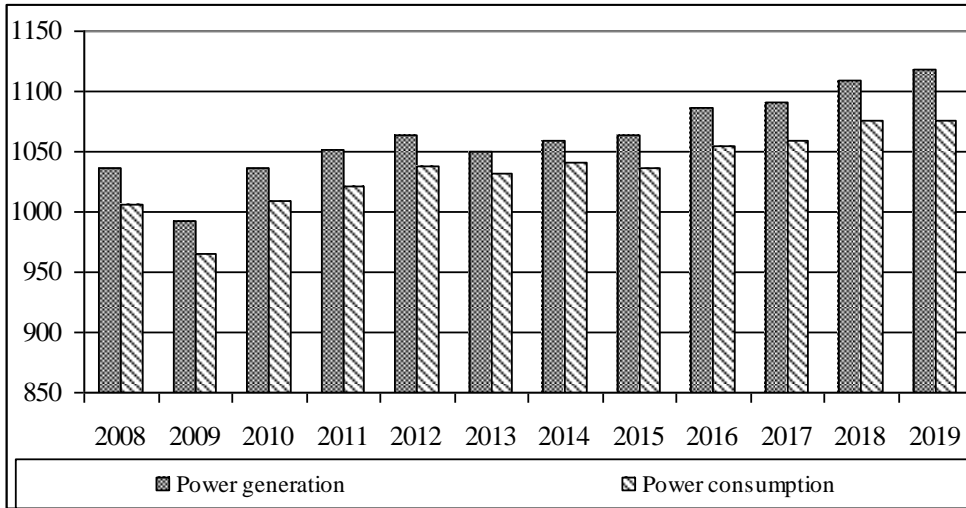


Fig. 1. Volumes of production and consumption of electric energy in the Russian Federation, billion kW * h.

Consider the volumes of capacity commissioned in the energy system of the Russian Federation (figure 2) [13-15].

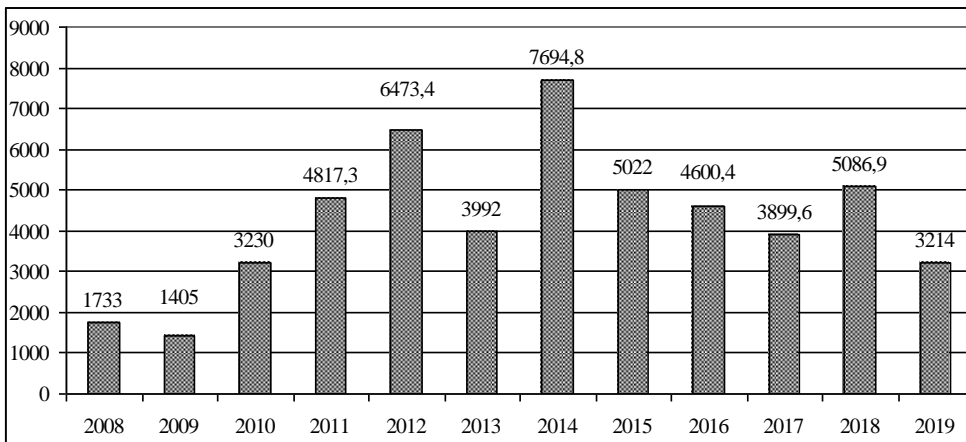


Fig. 2. Input of generating capacity of power plants of UES of Russia, MW.

The presented figure indicates that, on average, 1.5% of generating capacities of the installed capacity are commissioned annually, which will provide coverage for the increase in electricity consumption. At the same time, there is a need associated with the need to upgrade capacities, since the volumes of commissioned capacities cannot ensure the updating of operating equipment.

Of course, the use of installed capacity in the regions occurs with different daily and annual loads, which, in fact, ensures the flow of electric energy between the regions and allows achieving stability in the short term. Consider the volumes of electric energy flows within the framework of the Unified Energy System (figure 3) [13-15].

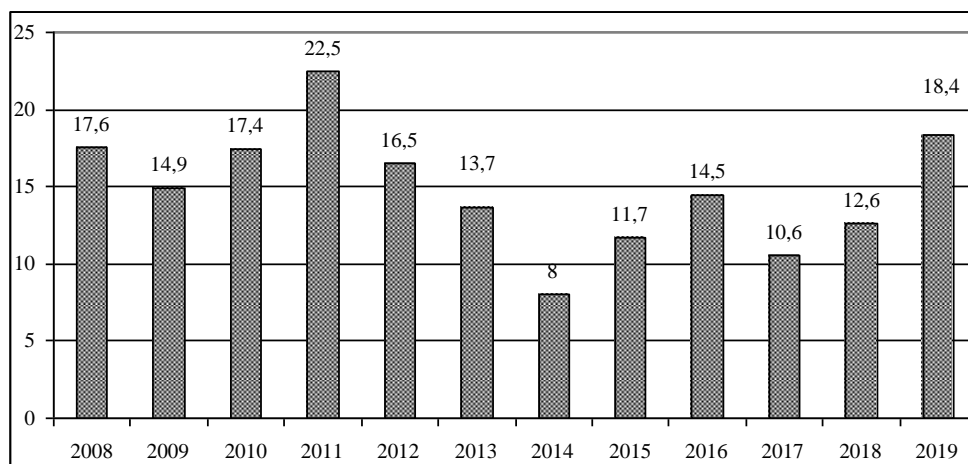


Fig. 3. The balance of electricity flows in the UES of Russia, billion kW * h.

From the presented figure it is seen that the balance of the flows of electric energy in the Unified Energy System of Russia changes annually. A similar indicator indicates that individual energy systems or regions cannot satisfy their own needs, and are forced to receive electric energy from other territories [18].

4 Discussions

It is possible to achieve a balance in the production and consumption of electric energy of the entire energy system through the flow of electricity within the system, the purchase of electric energy on the world energy market, as well as through the development of autonomous energy supply to industrial enterprises, residential buildings and households. However, if we consider the electric power industry as a system-forming industry, which provides not only the electric energy of consumers, but also the stability of the national economy, it is necessary to implement measures aimed at improving the quality characteristics of the electric power complex [19].

In this regard, it is advisable to propose a model aimed at achieving a balance of electricity production and consumption (figure 4) [13; 20-24].

Thus, the presented model will ensure a balance of electricity production and consumption due to the phased implementation of the following measures [13; 15; 19-24]:

- Forecast consumption and the formation of a plan to meet the stated needs;
- Assessment of the technical and technological state of equipment and facilities and ensuring the decommissioning of potentially emergency or hazardous facilities;
- Analysis of the volume of available capacities, the formation of plans for commissioning capacities in areas of high demand or in areas of priority development;
- Assessment of the capacity of power lines in order to ensure the flow of electric energy to energy-deficient regions and the construction of new power lines to achieve a balance of production and consumption throughout the national state;
- Analysis of the global energy market and the development of mechanisms to increase the competitiveness of the industry in order to enter new markets for electric energy.

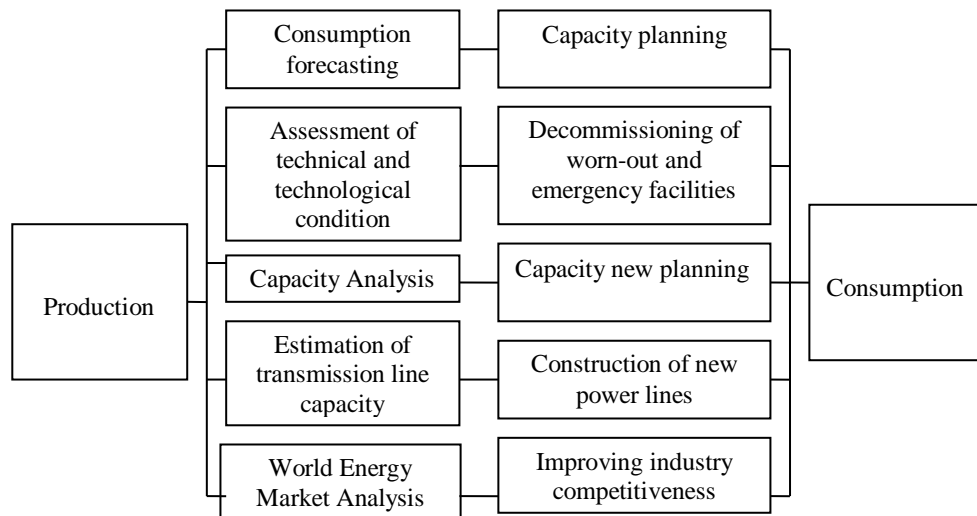


Fig. 4. Model for ensuring the balance of production and consumption of electric energy in the framework of the Unified Energy System.

5 Conclusion

Thus, the study allowed us to assess the balance of production and consumption of electric energy and identify due to what factors this balance is ensured. The work analyzed the indicators of the electric power industry, which indicate that Russia can satisfy the demand for electric energy on its own, while it is necessary to constantly transfer electric energy from one region to another, from one energy system to another energy system. The work revealed that the capacity commissioning volumes can satisfy only the growing demand for energy, but at the same time, the needs for updating and replacing capacities are not satisfied. In the work, a model was proposed that will ensure a balance of production and consumption of electric energy, which contains mechanisms to ensure the stability of the energy system.

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