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Development of mechanisms of active-adaptive management of reactive power on the basis of intellectual electric networks

Currently, in the power grid complex of the Russian Federation there are more than 3,000 power grid companies [1]. At the same time, a significant part of power grid companies is characterized by low energy efficiency indicators. First of all, this is due to a significant level of power losses in their distribution electric networks, as well as to high wear of power supply equipment.

It was established that the technical power losses in the distribution electric networks of power grid companies are largely determined by the high load of the network elements with reactive power due to its significant consumption from the networks. So, in the enlarged structure of technological power losses, their share is about 47% [2].

There are different approaches to improving the energy efficiency of distribution networks of power grid companies. The most algorithmically worked and software tested is the reduced gradient apparatus [3] with stochastic accounting for the variety of modes [4]. In this case, an algorithm has been proposed to reduce the power losses from reactive power transmission, based on the theory of multi-level systems [5]. In the algorithm, the process of controlling reactive power flows is implemented on the basis of a combination of complexly organized and interdependent subsystems. The presented algorithm allows to achieve the optimal value of reactive power in the distribution networks of power grid companies and provides a significant reduction of power losses. In addition, using this algorithm, it is possible to implement reactive power control based on compensating devices taking into account the load of installed transformers. This allows you to optimize the operation of distribution networks of power grid companies.

Nowadays an important role is given to actively adaptive control of the parameters of various technological processes. In this regard, the development of mechanisms for actively adaptive control of reactive power, based on a change in its value with a change in voltage, load, structure, and other parameters of distribution networks, is certainly an urgent task.

This also corresponds to the general policy of the transition of the Russian Federation to the digital economy. In [6], key priorities were identified for digital transformations of the state economy, including in the energy complex. The essence of digital energy as a part of the digital economy, in addition to technological equipment, is the formation of new mechanisms of economic interaction, which gives its subjects increased potential for increasing efficiency. And the greatest effect of digitalization can be achieved where the scale and nature of such interaction is qualitatively changing.

An active-adaptive network in a general way involves the development of elements aimed at improving the efficiency of managing the processes of production, transmission and distribution of power. In this regard, the concept (technology) of intelligent electric networks (Smart Grid) has become widespread in the world electric power industry [7, 8].

Power networks formed using intelligent control systems based on digital technologies are a multi-level system that includes measuring systems, automation and voltage and load control devices. It should be noted that the construction of an actively adaptive network involves the implementation of a number of innovative solutions. At the same time, the integration of digital technologies in the power grid complex provides the possibility of their further use to increase the efficiency of implemented innovative processes. Using actively adaptive technologies, the main trends in the innovative development of power grid companies can be determined. Also studies of the effectiveness of implemented innovations to make decisions about the possibility of their further dissemination can be carried out [9]. Thus, the use of intelligent control systems based on digital technologies allows not only to increase the energy efficiency of power grid companies, but also to significantly optimize their activities.

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