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ANALYSIS OF METHODS FOR OPTIMIZING THE ELECTRIC POWER SUPPLY SYSTEM

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Abstract
This study analyzes methods for optimizing the electrical power supply system in various regions. Genetic algorithms, evolutionary programming, and other modern optimization methods and techniques are examined with the aim of increasing energy efficiency and ensuring economic effectiveness. The research applies integrated management approaches to address complex problems in electricity generation and transmission systems. It is demonstrated that the use of econometric models for optimizing the electrical power supply system serves to enhance the stability of electricity provision.

Keywords: Electrical power system, optimization methods, distribution networks, genetic algorithms, energy efficiency, economic efficiency

Introduction

At the current stage of development of the electric power system, great attention is paid to increasing its efficiency and ensuring its stable operation. In this process, an important role is played by improving the energy transmission and distribution system, implementing technological innovations, and solving territorial and economic problems. In addition, to solve these problems, it is necessary to analyze methods for optimizing the electric power supply system.

Literature Analysis

The processes of optimizing electricity supply are carried out on the basis of certain principles. Based on these principles, economists have expressed their scientific views on the development and optimization of electricity supply systems with innovative approaches. In particular, the work of D.P. Kothari [1]

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analyzed the technical and economic problems of optimizing electricity systems. Similarly, the work of Varganova, A.V. [2] and others analyzed optimization techniques for increasing the efficiency of electricity systems and networks. The study emphasizes the importance of applying mathematical optimization approaches to reduce costs in the face of rising prices for resources used in the production of electricity and heat, such as natural gas, solar, wind, and other energy sources[3,4,5].

Research Methodology

The main objective of this study is to analyze methods for optimizing the electricity supply system in the regions, increase its efficiency and ensure economic efficiency. The study aims to perform the following tasks: Analyze methods for optimizing the electricity supply system; Develop recommendations for improving energy efficiency.

Analysis and Results Discussion

To improve the efficiency of the power supply system, approaches to overcome constraints and solve complexities in power transmission are discussed. Modern methods such as genetic algorithms, evolutionary programming, differential evolution are successfully used to solve problems. There are various methods for optimizing power supply, which are based on interrelated principles.

Integrated control approaches help develop multi-objective optimization strategies for the power system, taking into account constraints. Table 1 shows the division of energy optimization methods into groups and classes as follows.

Table 1. Energy optimization methods

Energy optimization methods		
Methods of reduction	**Calculus of variations**	**Mathematical programming methods**
-Variable metric method	-Lagrange multiplier method	-Linear optimization
-Coordinate reduction method		-Dynamic optimization
-Parallel tangens usuli		-Stochastic optimization
•	•	-Integer optimization

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The integrated application of these optimization methods allows to increase the economic and technical efficiency of power systems. Similarly, in a study conducted by Yamille del Valle[4] et al., the effectiveness of the Particle swarm optimization (PSO) technique for solving complex optimization problems in power systems was analyzed. The principles of PSO technique such as proximity, diversification, quality, stability and adaptability are applied in the stochastic search process, ensuring that the system reaches the optimal solution. Power system optimization problems are diverse and can be classified according to the characteristics of the objective function and/or the type of constraints. These problems are usually referred to as linear, nonlinear, integer, and/or mixed integer constrained optimization problems. The main goal of power system optimization problems is to reduce costs. Economic efficiency is important for getting the most out of the money spent on the power system. Tariffs set by regulatory authorities and the importance of fuel savings (in production and network losses) are forcing stakeholders in the power supply system to achieve the highest possible efficiency. Examples of applications of power system optimization are described below (Table 2).

Table 2. Examples of applications of optimization of electrical power systems

Energy system planning	Planning the electrical network to ensure stable and efficient operation of the system.
Maintenance planning	Organize operational and maintenance activities to ensure equipment efficiency and minimize downtime.
Economical load distribution/optimal power flow	Ensuring an economically efficient balance between electricity production and consumption.
Devices Obligation	Efficient management and optimization of electricity generation devices.
Reconfiguring networks	Reorganizing networks to reduce energy transmission losses.
Environmental load distribution of power plants	Load sharing to reduce environmental damage in energy production.

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In optimization problems, objectives need to be minimized (e.g., costs, energy losses, errors) or maximized (e.g., profit, quality, efficiency) under some constraints. If only one objective function is optimized, the problem is said to be single-objective. A number of scientific publications have skillfully described and analyzed various aspects of the power system planning problem, in particular the planning of transmission networks[5,6,7], distribution networks, and generation units. Grond and colleagues review general power system planning and provide a representative overview of various coherent planning approaches. These studies show that power system planning (expansion) is inherently a very complex optimization problem. However, recent developments in the power industry have further increased the complexity of power system planning. In the process of optimizing power systems, different stakeholders often pursue multiple, sometimes conflicting, goals. Technically, a power system includes generation, consumption, and distribution elements. The joint and efficient optimization of these elements, taking into account the goals of the different participants, is of great technical and economic importance.

Conclusions and Suggestions

In conclusion, problems in power supply systems are usually too complex and large for conventional optimization methods. Therefore, it is necessary to use advanced approaches to ensure efficiency and develop methods aimed at simplifying problems. Through the successful application of econometric models for optimizing power supply systems, it is possible to ensure uninterrupted power supply, effectively use resources, and reduce operating costs.

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