

Studies in Systems, Decision and Control

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Power Systems Research and Operation

Selected Problems II

 Springer

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Introduction

Improving the efficiency and reliability of the functioning of electric power facilities is one of the most important problems of the unified energy system of Ukraine. This problem is multifaceted, because the correct functioning of generation, transmission and distribution systems depends on many technical, economic, social and natural factors that change the integral properties of the system. At the same time, it should take into account that for each life cycle, it is necessary to develop correct measures to compensate for disturbing influences that lead to the inoperability of the energy system or its individual components. As world practice has shown, an effective way to improve the reliability of the energy system is the improvement and construction of electric power networks and systems according to the smart grid concept. The implementation of the concept involves the modernization of the existing energy system, through the development of a fully integrated, self-regulating and self-healing electric power system, which has a network topology and includes all generating sources, main and distribution networks and all types of consumers of electrical energy, controlled by a single network of information and control devices and systems in real time. In this case, there is a need to develop new and improved existing models and methods that allow optimizing the operating modes of electrical networks, ensuring the sustainable development of the share of RES in energy production and the reliability of the operation of existing electrical equipment of power plants and networks. The research results presented in the monograph allow finding solutions to some of the problems that arise during the functioning of the integrated energy system of Ukraine in modern market conditions in the following areas:

- implementation of some problems of electrical networks operational control solving in the operational information incompleteness conditions;
- study of actual trends of electrical distribution systems automation;
- development of power systems model for various types of analysis;
- study of main methods of forecasting and optimization of energy processes by various factors for electrical networks with solar power plants, hydropower plants and other plants;

- development methods and means of diagnosing power converter technology for smart grid;
- development solutions for improving the reliability of electricity supply based on use fault indicators for smart monitoring systems of distribution networks;
- development specialized tools for mathematical and computer modeling, information technology support for automation of the preparation and decision-making process by appropriate organizational management systems of competitive electricity market participants operating in complex relationships and potential risks.

Developing these areas, the monograph covers new technologies and methods related to the management of large interconnected power systems, solving a stable and reliable problem of electricity generation, sources of electricity from renewable sources and classical energy sources. Increasingly widespread use of local sources of generation and energy storage in distribution electric networks sharply reduces the effectiveness of traditionally used methods and technical means for controlling their operating modes. The monograph considers the possibility, expediency and efficiency of the selective use of remotely controlled switching devices in distribution networks with an open loop topology. In addition, when dispersed generation sources are connected to the energy system separately, as active consumers, as part of local microgrid power systems and as separate generating facilities, a number of issues arise related to ensuring proper synchronization of the parameters of these systems, their electromagnetic compatibility, quality of electric energy, occurrence of additional losses and reliability of their work. Development of measures to ensure the quality of electricity is possible only after assessing the actual state of quality of electricity in all nodes of the electricity network. Therefore, the electricity quality assurance system should be based on a model that takes into account the load curve of the system, regulation of production, storage system, as well as the operation of renewable energy sources in the area, as well as other factors affecting the power system. These models are the basis for energy systems management and monitoring systems. Management of energy systems is not possible without optimizing the structure of the energy balance of the state, based on the requirements of energy security and ensuring the share of renewable energy, among which a significant place is occupied by solar and hydropower. Shown that, as facts, with the existing structure of production capacities in the united energy systems of Ukraine, only hydroelectric power plants and pumped storage power plants are able to balance the rapidly changing load schedule of renewable energy sources due to their high maneuverability, which requires the development of solar and wind energy storage systems. A component that allows connecting the producer and consumer of electricity is overhead and cable lines. To identify overloaded overhead lines in the power system, the use of the “H-1 principle” is proposed. The application of the method makes it possible to determine the influencing and “weak” elements of the network in order to determine measures to reduce the overload of overhead lines. To take into account damage to overhead and cable lines associated with external operating conditions, it is necessary to apply methods for detecting and locating short-term damage and limiting

them. To determine short-term damage, the use of additional damage indicators for existing monitoring systems of distribution networks is proposed.

The presented research results in monograph allow increasing the reliability and efficiency of operation of energy facilities and ensuring the stability of power systems, the introduction of effective methods and tools for forecasting electricity supply, optimize power systems and suggest road map to integrate electricity markets taking into account network constraints in modern conditions of electricity markets.

The authors of the monograph are author's team from the Institute of Electrodynamics of the National Academy of Sciences of Ukraine, Institute of Energy Saving and Energy Management of National Technical University of Ukraine «Igor Sikorsky Kyiv Polytechnic Institute» and Institute of General Energy of the National Academy of Sciences of Ukraine.

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