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INCREASING THE EFFICIENCY OF FUNCTIONING OF EMERGENCY AUTOMATICS IN THE REGION

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Abstract

An improved procedure for controlling the region's emergency automation was developed. The algorithm for solving the problem of unstable power supply has been perfected. A computer simulation was developed for testing the complex of anti-emergency automation. The main directions and ways of improving the current electrical energy management system in the region are determined.

The proposed method can be used to increase the level of efficiency of emergency automation in a region with a significant share of alternative energy sources.

Key words: method, efficiency, emergency automation, power supply, alternative energy sources, network, power hub, power systems, electric networks, voltage, energy, sustainability, solar power stations.

Анотація

Отримано удосконалену процедуру керування протиаварійною автоматикою регіону. Удосконалено алгоритм розв'язання задачі нестабільного електропостачання. Розроблено комп'ютерне моделювання для тестування комплексу протиаварійної автоматики. Визначено основні напрямки та шляхи вдосконалення діючої системи управління електричною енергією в регіоні

Запропонований метод може бути використаний для підвищення рівня ефективності протиаварійної автоматики в регіоні зі значною часткою альтернативних джерел енергії.

Ключові слова: метод, ефективність, протиаварійна автоматика, електропостачання, альтернативні джерела енергії, мережа, енерговузол, енергосистеми, електричні мережі, напруга, енергія, стійкість, сонячні електростанції.

Introduction

The energy strategy of Ukraine clearly outlined the priority directions for the development of alternative and renewable energy sources (RES). These include Bioenergy, the use of biomass (wood, agricultural crops, organic waste) for the production of heat and electricity. Extraction and utilization of mine methane, the transformation of this by-product of coal mining into ecologically clean energy. Use of secondary energy resources, recycling and processing of waste to obtain energy. Solar and wind energy active implementation of solar and wind power plants. Geothermal energy is the extraction of heat from the Earth's interior for heating and electricity generation. Hydropower of small rivers, construction of small hydropower plants on Ukrainian rivers.

The introduction of RES into the energy system of Ukraine entails certain challenges associated with differences in generation technologies compared to traditional power plants. One of the key challenges is to ensure the stability and reliability of the RES power system. Minor voltage fluctuations, which occur more often in emergency modes, can lead to the disconnection of RES stations from the network. This, in turn, can lead to power flows and destabilization of the entire energy system. Improvement of emergency control systems: development of adaptive automation systems that would take into account the peculiarities of RES operation and minimize the risks of outages. Development of new emergency management methods: research and implementation of innovative technologies to ensure the stability and reliability of the RES power system. Modernization of existing methods: improvement and adaptation of traditional anti-emergency control methods to the specifics of RES operation.

The development of RES in Ukraine is not only a strategic direction of diversification of the energy sector, but also an important step towards the ecological and socio-economic development of the country. Perfection of the emergency management systems of renewable energy systems is a key task to ensure their stable and reliable operation, as well as to realize all the advantages that the integration of alternative energy sources entails.

The purpose of the work: to increase the effectiveness of emergency automation in the region with a significant share of alternative sources.

The object of the research is the equipment of anti-emergency automation, means of analysis, means of increasing the efficiency of the functioning of anti-emergency automation in the region with a significant share of alternative energy sources.

The subject of the study is the functioning of emergency automation in the region with a significant share of alternative energy sources.

Research results

Purpose and functions.

The PA complex of the region's power system networks is created to ensure reliable energy supply to responsible consumers in the region.

In the case of disconnection of power connections and emergency shortage of active and reactive power caused by emergency disconnection of the overhead line (PL).

When the generation by renewable energy sources (RES) is reduced in the repair regimes of power plants.

PA is performed at the expense of managing sources of active and reactive power and metered disconnection of less responsible consumers at facilities in the region.

The impact of RES on the sustainability of the power system.

The reliability of electrical networks and power supply to consumers is determined by the stability of the energy system. One of the main causes of accidents in the power system is incomplete or incorrect management. Therefore, one of the urgent tasks is PA stability of power system operation modes.

Currently, to ensure the regulatory safety reserves of crossings, the automatic system for preventing violations of stability (AZPS) is used. Therefore, one of the factors that must be taken into account in the calculations of the stability of the power system operation modes is the nature of RES operation. With the growth of the installed capacity of RES in networks, the task of modelling and evaluating the efficiency of PA of intersections of electrical systems taking into account the operation of RES, in particular SES, is relevant.

Modelling and research of PA taking into account RES.

The subject of the research is the PA model in the North-Western Centre of the United Energy System of Ukraine (PZCHOO) and its settings, and the purpose of the work is to form an approach and evaluate the efficiency of the PA intersections with the projected SES.

The PA complex being developed controls the degree of difficulty of the current mode with the help of the CPR settings. At this stage, the flow of active power through the only feeder PL-330 kV in the region is determined as a CPR.

In order to increase the reliability and simplify the PA structure, the volume of SAVN is divided into three sub-orders.

In order to automate the calculations of the simulation of the work of the designed PA, an algorithm was developed and, based on it, using the Python programming language, a computer program that, based on the Monte Carlo (M-K) method, performs simulations of a large number of modes of PZCHOO with stochastic generation of SES (from 0 to P_{max}.) and network load (0.8...1.2P current, cos f = 0.94...1.0) in case of emergency shutdown of the 330 kV substation.

At this stage of the research, simulations of 5,000 modes were performed, and an analysis of the sufficiency of SAVN discharge, violation of voltage stability was carried out.

The impact of stochastic RES generation on PA operation:

Operation of renewable energy sources, in particular wind turbines/SPPs, is characterized by a certain periodicity of the operating mode (seasonal and daily) and a significant level of output power fluctuations. Fluctuations in RES capacity depend on both global and local factors, which can significantly affect the stability of power system operating modes.

Therefore, one of the factors that must be taken into account when calculating the stability of power system operation modes and designing PA is the nature of RES operation.

However, such calculations of stability and settings of AZPS are significantly complicated due to stochasticity of RES generation. Therefore, with the growth of the installed capacity of RES, the task of modelling and testing the effectiveness of PA of intersections of electrical systems, taking into account the peculiarities of RES work, is becoming increasingly important.

Results of PA research and adjustment.

To do this, with the help of the created calculation model of the network and models of five SES, formed power balances and simulation scenarios of characteristic modes, the simulation of emergency modes was performed taking into account the action of the PA complex.

The main indicator of the successful operation of the PA is the maintenance of voltage stability, the identifier of which is the provision of voltage levels above the emergency permissible limits (0.9 U_{nom}).

For example, in the normal scheme of the power grid, taking into account the operation of the SES, when disconnecting the PL-330 kV with a pre-emergency flow of active power on it of 150 MW, the PA should disconnect the load of 37 MW, and the voltage at all points of the investigated network should be higher than 0.9 U_{nom}.

Additional complications and ways to solve them.

At the same time, an additional complicating factor is that during the generation of the SES, when the voltage drops below 0.9 U, the SES are turned off by the action of their own automation, which can lead to a worsening of the operational situation, i.e., even with the successful operation of the PA, the SES is turned off due to a decrease in voltage on its own tires below 0.9 U_{nom} can lead to a violation of stability.

When evaluating the efficiency of the designed PA, it is quite difficult to accurately predict the level of load at each substation in the studied region, just as it is difficult to predict the generation level of each of the five SES.

In order to automate calculations for modelling the work of the designed PA, an algorithm was developed and based on it, using the Python programming language, a computer program that, based on the Monte Carlo (M-K) method, performs simulations of a large number of modes with stochastic generation of SES (from 0 to P_{max}.) and the network load (0.8 – 1.2 $P_{current}$, cosf = 0.94 – 1.0) during emergency shutdown of the 330 kV substation.

At this stage of the research, 5,000 modes were simulated and an analysis of the adequacy of SAVN unloading was carried out. As a result of the analysis, it was found that for these PA settings, in approximately 20% of cases, the amount of unloading is not enough to maintain voltage stability, namely, the voltage level in the network under study is higher than 0.9 U_{nom}.

The obtained results were later used to adjust the settings of PA operation.

Conclusions

Implementation of intelligent accounting: This will allow receiving accurate data on electricity consumption and identifying areas with the greatest losses. Based on this data, networks can be optimized and the quality of power supply can be improved. Installation of devices for recording power quality indicators: This will allow detecting violations of power quality standards and taking measures to eliminate them.

Modernization of anti-emergency automation systems. Limiting the load of consumers in case of emergency shutdown of overhead lines (PL) 330 kV. Increasing the reliability of the power system and preventing accidents. Simulation of the work of emergency automation in the region showed that its implementation is expedient.

To improve the quality of electricity supply in Ukraine, it is necessary to update worn-out equipment, implement intelligent accounting, install devices for recording power quality indicators, and modernize emergency automation systems. These measures will increase the reliability of the power system, reduce electricity losses and improve the quality of electricity for consumers.

Thus, the proposed approach made it possible, based on stochastic modeling, to determine the effectiveness of the current settings of the AZPS and carry out their appropriate adjustment. The computer program includes a module containing all the necessary information to control the evaluation of efficiency and the setting of emergency automation.

In the future, a promising direction of research is the development of methods for taking into account the impact of more complex scenarios of changes in SPP generation and network load, as well as research into the possibility of coordinating the operation of the PA with control systems of SPP operation modes.

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