Power Systems Protection With AI-Based Stability Enhancement in Emergency Situations

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Due to natural disasters or wars, the power system suffers, resulting in power outages, economic shutdown and losses of millions of dollars. To minimize the impact of external factors on the power system operation, a comprehensive solution is proposed, including underground placement of power transformers and a neural network system for power grid stabilization. The first module is aimed at protection of high-voltage transformers from external influences and includes thermodynamic modelling with the help of which the capacity of necessary ventilation is determined, allowing to maintain the winding temperature below the critical level (110 °C). The analysis of thermal processes has shown that at the given parameters of ventilation and placement of the transformer underground, its service life is not significantly reduced (1-2%), and the discrepancy with the method of finite elements does not exceed 5%. The second module is a neural network system capable of promptly eliminating overloads of power lines that lead to increased resistance and higher energy losses. Based on the Gauss-Seidel algorithm, a dataset of 50,000 scenarios of power grids during emergency situations based on IEEE standards was generated to train the neural network. Testing 5,000 new examples confirmed the accuracy of the neural network solutions at 96.8%. The tests on the mock-up were just as successful. At the same time, the computational efficiency of the proposed approach is higher than traditional stabilization methods. Thus, the combination of underground transformer protection and intelligent power system stabilization ensures reliable power supply even under extreme conditions, minimizing economic losses and increasing the resilience of critical infrastructure.

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