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Optimal Operation of Wind Power Plants with Doubly-fed Induction Generators under Considerations to Network Operator Regulations

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Dresden, 1st July 2016

Rahmat Suryana

Abtract

The goal of this research is to develop control methods of wind power plants with doubly-fed induction generators in contribution to the network frequency and voltage stabilities. Beside of that, the wind power generator have to be controlled in the optimal operation point by implementing the maximum power point tracking (MPPT) method, distributing reactive power generation for getting the minimum power losses, and exploiting the kinetic energy.

Two power system models for frequency analysis based on an isolated and an interconnected power system were developed. The network operator regulations were summarized. The wind power plants are not allowed to be disconnected from the power system immediately during network frequency and voltage disturbances. Then, they have to contribute to the network frequency and voltage control.

A frequency control method of wind power plant combining two control methods based on pitch control and kinetic energy was developed, simulated, and investigated experimentally. This method is able to act very fast and support the frequency control in long period. Wind power plants are able to control the network frequency without supporting from conventional power plants. All wind power plants are coordinated by a wind farm supervisory control. They are divided into two groups. The first group will discharge kinetic energy and the second group will deliver their reserve power to the network if the frequency disturbance happens.

A power system model for voltage analysis was developed. A voltage control method of wind power plant was developed, simulated, and investigated experimentally. All wind power plants deliver additional reactive power for controlling the network voltage.

Simulations using Matlab/Simulink Power Systems were done. Experiments using a wind power plant simulator were completed. A 15 kW induction motor represented an emulator of wind turbine. A 4 kW doubly-fed induction generator was controlled interactively in PC using dSPACE controller board 1103. Simulation and experimental investigation results proved the effectiveness of frequency and voltage control methods of wind power plant with doubly-fed induction generator.

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