DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Frequency Control Strategies of Power System with Renewable Generation Integration

Location: Pontoppidanstræde 111, auditorium

Time: Monday 26 August at 13.00

PhD defendant: Pengfei Li

Supervisor: Associate Professor Weihao Hu

Moderator: Associate Professor Jiakun Fang

Opponents: Associate Professor Jayakrishnan Pillai, Dept. of Energy Technology, Aalborg University (Chairman)
Associate Professor Pierluigi Siano, University of Salerno, Italy
Associate Professor Qiuwei Wu, DTUTamas Kerekes, Dept. of Energy Technology,

All are welcome. The defence will be in English.

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Abstract:

Although the renewable energies integrate into power grid will relieve the energy crisis and environmental pollution problems, its strong fluctuation may seriously affect the power quality and the stable operation of power systems. Especially, the generators of renewable energy plants do not have such inertia response features as conventional generators do. When an impact load disturbance occurs in a power system with large-scale wind power or a microgrid with electric vehicles, their outputs are volatile and uncertain. Thus, those generators may not have fast response to meet frequency regulation requirements of the power grid. Furthermore, to ease the bottleneck of integrating intermittent power sources and improve frequency indices, it is necessary to introduce new supplementary means of the frequency by its rapid response feature.

This PhD project proposes the novel frequency regulation methods and advanced control strategies for renewable energies integrated into power grid and microgrid in different operating conditions. The capability of wind power plant and electric vehicles could be taken full advantages by these strategies, it could also enhance the stability of power system, reduce the pressure of traditional power plant and ensure the reliability of power grid.

Wind power plants participate into frequency regulation in a large wind speed range under the power constraints. A novel de-loading operation strategy is designed that combines with over-speed control and pitch control to achieve the de-loading strategies for different types of VSWTs. The WPP is allowed not only to store reserved power to meet the restricted requirements from power grid, but also contribute to PFR. The designed control strategy uses the operating characteristics to calculate the reserved capacity for de-loading strategy, achieve the controllable inertia response by virtual inertia control and analyze the droop value for modifying the pitch angle and static characteristics of power-frequency. EVs with V2G (vehicle to grid) control strategy to participate into frequency regulation of the microgrid. Electric vehicle as a mobile energy storage device, after it is accessed to the microgrid, it could provide reserve capacity of frequency regulation for the microgrid when the microgrid works in the independent mode. EV could reduce the demand for frequency regulation resources of microgrid and brings the obvious economic benefits.

Finally, all the proposed control strategies and methodologies are compared with traditional control methods. Meanwhile, the simulation results are verified and show the effectiveness of these proposed strategies.