DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: High Bandwidth Frequency and Voltage Control in a VSC based AC Microgrid

Location: Pontoppidanstræde 111, auditorium

Time: Tuesday 17 December at 13.00

PhD defendant: Rasool Heydari

Supervisor: Associate Professor Tomislav Dragicevic

Moderator: Associate Professor Amjad Anvari-Moghaddam

Opponents: Professor Remus Teodorescu, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Jose Rodriguez, University Andres Bello, Chile
Professor Ramon Costa Castello, Universitat Politecnica de Catalunya, Spain

All are welcome. The defence will be in English.

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Abstract:

With the increasing penetration of renewable energy resources (e.g., wind and solar), the conventional bulky power system operation faces significant challenges. Intelligent micro-grid (MG) as an intermediate aggregation entity between the overall smart grid and individual units is introduced to maximize the power system flexibility and coordination. The adoption of MG for integration of renewable energy resources, energy storage systems (ESSs), and non-synchronous generators (NSGs) will reduce the need for complex centralized management. However, high penetration of the NSGs complicates the MG operation and control, substantially. Due to the inherent low inertia characteristic of NSGs, voltage and frequency control become a major challenge in the MG operation and control.

From the technical perspective, lower inertia in the grid yields a larger impact of disturbances on the system frequency. Compared to the synchronous machine based bulky grids, the NSGs do not provide any inertial response toward the grid; hence, the conventional primary controllers do not have time to react to load/generation imbalance and the grid disturbance. Consequently, a large perturbation or generation/load imbalance in the system may lead to significant frequency and voltage deviations.

To address these challenges, this Ph.D. project discusses proper solutions to enhance the control functionality and reliability of the autonomous MG. Throughout this project, high bandwidth frequency and voltage control strategies have been developed. A fully distributed control architecture has been proposed to enhance the MG reliability. A systematic communication non-ideality compensation algorithm is also proposed to compensate for the communication network impairments. Then, a communication-free control structure has been developed to realize MG stability. The performance of the proposed control structure has been verified experimentally under several operation scenarios.