



DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title:	Protection and Stability Analysis in Microgrids
Location:	Pontoppidanstræde 111, auditorium
Time:	Tuesday 27 June 2017 at 13.00
PhD defendant:	Hengwei Lin
Supervisor:	Professor Josep Guerrero
Moderator:	Associate Professor Laszlo Mathe
Opponents:	Associate Professor Dezso Sera, Dept. of Energy Technology, Aalborg University (Chairman) Professor Manuela Sechilariu, Université de Technologie de Compiègne, France Associate Professor Jose Matas, BarcelonaTech UPC, Spain

All are welcome. The defence will be in English.

**After the defence there will be an informal reception
in Pontoppidanstræde 111 (coffee room).**



Abstract:

Due to the high penetration of renewable energy integration and the liberalization of electricity market, lots of distributed generation units (DGs) have been integrated into the transmission and distribution systems. On the other hand, the entire electrical system has been evolving towards to an intelligent entity with more flexible ancillary services for consumers and utilities. The “smart grid” empowers the utilities and the consumers to realize new ways of operation and participation in power industry.

In extensive distribution systems, microgrid is regarded as an effective solution to manage/organize the downstream on-filed devices such as DGs, reactive compensation devices, storage units and loads. In this project, the author mainly focuses on the stability analysis for power electronic converters and the automatic protection and control system for microgrids in distribution automation. In industrial electrical systems, the system stability is often related with various disturbances while the faults behave as significant influences. In case of a fault or serious disturbance, protection must response quickly and correctly to ensure the power system operated safely. Therefore, it is meaningful to analyze the stability from a system level, instead of only focusing on the control subsystem for power electronic system which is already addressed in the previous literatures. This is also the motivation that this project focuses on the stability analysis and protection for microgrids.

However, there are some difficulties to analyze the stability for a real power system due to the severe complexity and nonlinearity. It means some new methodologies, perspectives, and proper simplifications should be considered to deal with the challenges. This project addresses mainly two practical problems: 1. from a time scale decomposition perspective, the angle instability mechanism for voltage-controlled converters is illustrated with both theoretical analysis and experiment verification. It means the power-electronics-based electrical system has the ability to maintain stable and efficient operation depending on cautious planning and design, which requires both advanced hardware and software in modern power system and future smart grid. 2. A new rule-based adaptive protection approach combined with machine learning is proposed for microgrids that can be flexibly integrated into the distribution automation system. A statistic method is also adopted in this protection scheme to analyze the influence of uncertain elements. Moreover, a discussion section is proposed for microgrids to perform reconfiguration automatically and intelligently as additional ancillary services with the extended concept of modular power architectures. Since there are still uncertainties for the evolution of the microgrid and the smart grid over time, the project presents an attempt and preparation for power industry toward an efficient framework for the future.