DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Harmonic Modelling, Propagation and Mitigation for Large Wind Power Plants Connected via Extra Long HVAC Cables

Location: Pontoppidanstræde 105, room 4.127

Time: Monday 10 September at 13.00

PhD defendant: Mohammadkazem Dowlatabadi

Supervisor: Professor Frede Blaabjerg

Moderator: Associate Professor Xiongfei Wang

Opponents: Associate Professor Florin Iov, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Tim Green, Imperial College, UK
Dr. Zia Emin, Technical Director, Power Systems Planning & Analysis PSC, UK

All are welcome. The defence will be in English.

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Abstract:

The wind power industry is rapidly growing and is gradually replacing conventional power plants. Therefore, the effects of wind power plants cannot be neglected any longer and the grid codes and requirements are becoming more complex and challenging. Power electronic devices such as STATCOMs and wind turbines can help the wind power plant developers to meet some of the requirements; however, it also brings some new challenges in terms of power quality and stability.

Larger offshore wind power plants are being placed farther from shore. Longer and longer cables, bigger and bigger transformers as well as other passive components within the wind power plant electrical infrastructure (e.g. shunt reactors, harmonic filters, capacitor banks, etc.) can potentially create phenomena not seen before such as resonances within the lower frequency range. This PhD project is focused on investigating and addressing the system/level harmonic analysis in offshore wind power plants taking into consideration the interaction between active components (e.g. wind turbines and STATCOMs), external resonant plants, offshore electrical infrastructure as well as HVAC transmission assets. The specific aim is to improve existing and to develop new analysis methods as well as implement state-of-the-art models to ensure reliability, availability and robustness of offshore wind power plants as large power generation units in the electrical power system.

This project is an industrial PhD project; therefore, the challenges that are considered have more industry-oriented perspective. For instance, a big portion of the thesis is about processing, analysis and interpretation of numerical data delivered by the suppliers of different components such as wind turbines, STATCOMs and cables. How can these data be used for the harmonic studies? and what should additionally be delivered for future projects to ensure stable operation of the wind power plant? These are the questions answered by this research project.

An analysis tool has also been developed during this project, which loads all the necessary data from the models already developed in the power system analysis software, and evaluates the stability of the entire system. The tool has also some useful add-ons for the sensitivity analysis of large systems and the participation factor analysis. The participation factor analysis is an important tool to quantify the contribution of different components (i.e. active and passive) to a potential stability problem, since there are usually different parties involved in an offshore wind power plant, such as different wind turbines and STATCOM suppliers. Furthermore, the sensitivity analysis enables the user to see how a change in the system can improve or worsen the stability.