DEPARTMENT OF ENERGY TECHNOLOGY
AALBORG UNIVERSITY

PhD Public Defence

Title: Modelling and Control of DC Microgrids for Efficient Energy Distribution Systems

Location: Pontoppidanstræde 111, auditorium

Time: Thursday 15 Februar at 13.00

PhD defendant: Enrique Rodriguez Diaz

Supervisor: Professor Josep M. Guerrero

Moderator: Associate Professor Sanjay K. Chaudhary

Opponents: Associate Professor Erik Schaltz, Dept. of Energy Technology, Aalborg University (Chairman)
Professor Pavol Bauer, Delft University of Technology, the Netherlands
Professor Javier Uceda Antolín, Electrical and Electronic Engineering Department at UPM, Spain

All are welcome. The defence will be in English.

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Abstract:

The integration of renewable energy sources in the low-voltage distribution grid, especially photovoltaic (PV) panels in residential and commercial buildings, has been growing in the past years, in an attempt on reducing the dependency of the energy generation from fossil fuels, and achieve a more sustainable electrical energy system. The concept of a microgrid aims to ease the integration of RES, together with ESS at consumption level, in order to reduce the dependency of the system from the main electrical grid. Microgrids and dc distribution systems applied to residential or commercial buildings bring a potentially higher efficiency improvement, especially on the presence of dc-based loads. A dc distribution system is a more natural interface between mostly dc devices (i.e. PV panels, batteries..) since avoids non necessary conversion stages in the power converters. The first part of this work focuses on a feasibility study of the integration of dc distribution systems for residential applications. The main objective is to give a thorough analysis about the achievable efficiency improvement by using dc voltage for distribution, since this feature is seen as the most attractive. A Danish household has been used as study case, which is based on the Intelligent DC Demonstration Home, developed at Aalborg University during this 3 year period of the project. The second part of the work has focused on modelling and the control challenges for dc-based distributions systems. The impedance/admittance based modelling has been found to be a powerful method for system level analyses, where there is little knowledge of the physical environment. The main effort has been focused on the input admittance passivity compliance for power converters. The input admittance stability criterion is seen as a robust condition for the stability of the power systems, therefore the compliance with this criterion by a given power converter is highly desirable. As a result of this work, guidelines for input admittance passivity compliance have been developed. Furthermore, an approach has been proposed to actively emulate different grid admittances. This approach enables the emulation of virtually any grid, with a single power converter unit. A bi-directional buck and boost converters have been modelled an analysed for this application. Two different study cases, based on widely proposed dc-based distribution systems, have been used to assess the emulation capability of the proposed approach. The experimental tests have shown the feasibility of the emulation method.