Keynote

Renewable Energy Source Integration by Multi Terminal High Voltage Direct Current (MT-HVDC) Networks

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Abstract

New technologies in control, computers and communications have allowed the possibility of a future power grid quite different from the present one. These so called Smart-Grids have, as one of their main goals, to better facilitate the connection and operation of renewable energy sources (renewables) to significantly reduce the environmental impact of the whole electricity supply system; as well as to deliver enhanced levels of reliability and security of supply.

During the last few years, global warming and pollution has pushed governments to reduce the impact of human activities. One of the main challenges Smart-Grids will have to cope with is a direct consequence of the European Union 20-20-20 Energy policy signed in January 2007: By the year 2020 - to cut 20% of CO2 emissions; to make 20% energy savings; and to use 20% of energy production from renewable sources.

This is a very important problem, because these sources are, in general, time varying in a fast and, to some extent, unpredictable manner: wind force variation, cloud cover and sunshine... Some sources are available in low consumption hours (wind during the night for example) and in geographic places far from consumption centers. These characteristics of renewables make the development of new techniques necessary so as to better integrate them into the power grid.

One of the possibilities for dealing with this problem is to use High Voltage Direct Current connections. This very challenging topic is at the center of many international projects like Winpower, Twenties, Super-Grid and Transgreen/Desertec. But most HVDC links are bi-terminal (one sending and one receiving). Moving forward in this way will economically and technically lead to an unsustainable scheme, therefore leading to migration toward Multi-Terminal HVDC networks. However, the scientific and technical literature has not yet solved voltage and power quality control on multi-terminal DC networks.

Solving such problems requires a complete re-thinking of a new system, in particular at the control level. Classical control schemes are not able to cope with the large variability and complexity of such systems. It is then necessary to develop a wide-ranging control strategy to manage large scale MT-HVDC networks that will interconnect renewables to the main power network. This new strategy needs to deal with large scale networked power system issues like delayed remote information, uncertainties, interconnected nonlinear dynamics and mixed time scales. It is then necessary to use a multi-layered strategy coming from slow scale top layers dealing with weather forecasts and real-time energy markets, through discrete time predictive layers dealing with physical constraints, to finally arrive at the fast real-time non-linear control of the converters that make up the terminals.
Biography


His research interests concern nonlinear and adaptive control and observers applied to power systems (SmartGrids). His main applications are in the field of large scale renewable energy integration - Multi-Terminal HVDC systems; Variable Speed Pumped Storage Plants; control of power generators (transient stabilization, frequency and voltage stability); synchronization of power networks; solar panels’ control.

He is Work-Package Leader of the European Network of Excellence on Highly Complex and Networked Control Systems - HYCON2. He has an important activity in the Knowledge and Innovation Community (KIC) ICT LABS from the European Institute of Innovation and Technology – EIT, where he is leader of the Smart Energy Summer School, and partner of the European Virtual Smart Grid Laboratory. He is also the coordinator of the project WINPOWER from the French national research agency (ANR) about the integration of wind and solar based electrical power by a High Voltage Direct Current (HVDC) multipoint network. In the same way, he is co-leader of the national research forum on SmartGrids from the French national research center CNRS. He has received the French research excellence grant (Prime d’Excellence Scientifique) since 2008.

Gilney Damm has been Associated Editor of the European Journal of Control since 2010.