PhD SCHOLARSHIP APPLICATION FORM 2016

ORGANISATION Business Division Business Area	**TECNALIA RESEARCH & INNOVATION** ENERGY AND ENVIRONMENT Smart grids
Scholarship location Province/Building	BIZKAIA, Parque Tecnológico de Bizkaia. Edificio 700-Derio
Tutor	Maider Santos / Salvador Ceballos

SCHOLARSHIP DESCRIPTION

Title: Grid integration of large amounts of renewable energy by means of High Voltage Direct Current (HVDC) transmission systems.

Brief Description of Scholarship:

The aim of this thesis is to analyze the interactions between the AC grid and an overlaid wide area meshed HVDC grid with high penetration of renewable energy resources. The HVDC grid will mainly rely on the use of voltage source converters. Different aspects such as power quality studies, contribution of the HVDC grid to the voltage and frequency regulation of the AC grid, analysis of resonances/oscillations between the AC and DC grids, etc. will be analyzed in detail. Control strategies to mitigate adverse interactions between the AC and DC grids and to improve the operation of the whole electrical system will be proposed.

The main activities to be carried out under the frame of this thesis are related to the following highly industry demanded research topics:

- HVDC transmission systems.
- Grid integration of an overlaid HVDC meshed grid.
- Development of protections and DC circuit breakers for meshed HVDC grids.

Scholarship description:

There is an increasing interest in Europe on the development of a wide area HVDC grid to interconnect load centers with large amounts of renewable energy resources located at remote areas. Such a “supergrid” will be overlaid to the existing AC grid and will be very likely rely on the use of voltage source converters as a key enabling technology.

In fact, offshore wind farms located at remote areas far from the shore are already under development in Northern Europe. These wind farms are already being connected to the HVAC grid using HVDC links. Fig. 1 shows a picture of an offshore wind farm and an offshore HVDC substation used to collect and transmit the power of the wind farm.

(a) (b)

Fig. 1. (a) Offshore wind farm; (b) offshore HVDC substation.

Today point-to-point HVDC links are used to connect offshore wind farms with the onshore HVAC grid. However, these systems will be very likely evolve towards the use of multi-terminal links first and meshed grids later on, to conform in the long term what it is call the overlaid HVDC supergrid.

There are still a lot of research areas where additional considerations should be carried out to guarantee the proper integration of the overlaid HVDC grid with the existing HVAC grids. The final goal is to achieve a level of interoperability of HVDC systems in such a way that HVDC substations are controlled to provide the same services and grid support than today electrical plants based on synchronous generators.

The research activities that will be carried out in this thesis will be developed under this frame. The aim of the thesis is to analyze the interactions between the AC grid and the future overlaid meshed HVDC grid that will have a high penetration of renewable energy resources. Different aspects such as power quality studies, contribution of the HVDC grid to the voltage and frequency regulation of the AC grid, analysis of resonances/oscillations between the AC and DC grids, etc. will be analyzed in detail. Control strategies to mitigate adverse interactions between the AC and DC grids and to improve the operation of the whole electrical system will be proposed

The main research topics that will be developed under the frame of this thesis include, but are not limited to:

- Grid integration of an overlaid HVDC meshed grid with high penetration of renewables.
    - Development of a set of configurable models to study different phenomena between the AC and the overlaid DC grid.
    - Interoperability of HVDC meshed grids.

  - System stability analysis of HVDC meshed grids and analysis of interactions with the AC grid.
  - Analysis of sub-synchronous torsional interactions between HVDC converters and nearby generators.
  - Development of control algorithms to damp sub-synchronous oscillations.
  - Analysis of local and inter-area frequency oscillations and development of HVDC converter's control algorithms to damp these oscillations.
  - Characterization of the network harmonic impedance.
  - Power quality studies: analysis on how the low and high frequency current harmonics generated by HVDC converters influence the AC grid voltage, characterization of inter-harmonics and their effect on the AC grid, flicker, etc.

- HVDC protections and DC circuit breakers:
  - Development of fast protection algorithms for HVDC meshed grids.
  - Analysis of different solutions to block DC fault currents.

These are all hot research topics today. It is expected that the PhD. student will acquire strong technical skills and competences in these topics which are highly demanded by the industry as a way to improve her/his professional perspectives.

The PhD will be developed between UPV/EHU and TECNALIA. There might be the possibility of working several months at the Australian Energy Research Institute (AERI), University of New South Wales, Sydney, Australia.

Requirements:

The PhD candidate shall meet the following requirements:

- Qualifications and Speciality: Control/Electrical Engineer or similar degree on a related field
- Languages: Very fluent English
- IT skills: Matlab-Simulink (standard)
- The following will be a plus:

  - Knowledge of grid integration of renewable energy, power electronics, AC and DC grids and related topics.

  - Knowledge of DigSilent, PSIM or related simulation packages.