PhD SCHOLARSHIP APPLICATION DATA

Business Division Business Area	DEMA/Smart Grids and Storage
Scholarship location Province/Building	Bizkaia, Edif. 700

SCHOLARSHIP DESCRIPTION

Title: Control and management methods of AC/DC hybrid networks

Brief description of scholarship:

The doctorate thesis focuses on the study of AC/DC hybrid networks. More specifically, the following dual objective is considered:

i) Develop a set of analytical techniques that enables the underlying interactions between the power converters and the remaining elements that form part of the AC/DC hybrid networks to be characterised and their local and global stability to be analysed.

ii) In addition, the following is also considered: the development of a set of control solutions that allow for the primary regulation of the network and an optimum performance from the point of view of local and global stability and the attenuation of sub-synchronous resonances and stationary and dynamic harmonics.

The study will be validated through simulations with high signal models and experimentally via an AC/DC hybrid network in the laboratory.

Today, the characterisation of the power converters integrated in the network and their impact on the stability of the electrical system is an issue that concerns industry in the sector, mainly network operators and developers/operators of renewable energies. Countries like Spain, Germany and the Nordic countries, which are strongly committed to the mass integration of renewable energies in their systems, and the Medium Term connection of offshore wind farms in DC, are already being analysed to decide on how to approach and address this problem.

The final objective is that the doctorate student obtains strong skills and abilities in this field in order to reinforce this line of research.

Scholarship description:

Since their development at the end of the 19th century, the structure of electric grids has not undergone significant changes. Energy is produced at large generation centres which are connected to a high voltage AC transmission network. This transmission network extends from the generation centres to the vicinity of the consumption centres. Here, the voltage level is

reduced through the use of transformers, and the energy is distributed in medium voltage via a distribution network to the end users. Figure 1 shows an outline of this structure. All of this is based on the predominant use of alternating current due to the possibility of modifying the voltage levels efficiently and robustly through the use of transformers.

However, nowadays, electric grids face a revolution which will require their structure and operating modes to be modified. This change derives essentially from the use of renewable distributed energy sources and more extensive use of power converters to integrate energy storage systems, install FACTs, develop transmission systems in direct current, and a long etc. This change, which has already begun and will be gradually developed, is giving rise to AC networks with a high penetration of renewable energies and heavily supported by power electronics systems (See Figure 2). Furthermore, in a not too distant future, there is talk of the development of integrated DC sub-networks operating in coordination with the AC network, which is known as AC/DC hybrid networks (See Figure 3). The common denominator in all these changes is the network integration of a large number of power converters.

The use of power converters provides the network with greater levels of control and flexibility, but also considers important challenges from the point of view of the stability of the electrical system and the power quality. Furthermore, the classic analysis and control methods that have been used to date are no longer valid in hybrid networks and they must be modified. The thesis falls into the framework of this context. More specifically, the following main operation objectives are considered:

- Development of mathematical methods that allow the behaviour of AC/DC hybrid networks to be studied, using techniques to analyse the local and global stability, attenuation of sub-synchronous oscillation modes and stationary and dynamic harmonic components.

- AC/DC hybrid network control and management solutions to guarantee the primary regulation, the inertial response and some quality power parameters equivalent to those of traditional networks.

- Development of adaptive control tools to dynamically adjust the control parameters of the converters, improving the response of the system in terms of stability, dynamic response, cushioning, etc.

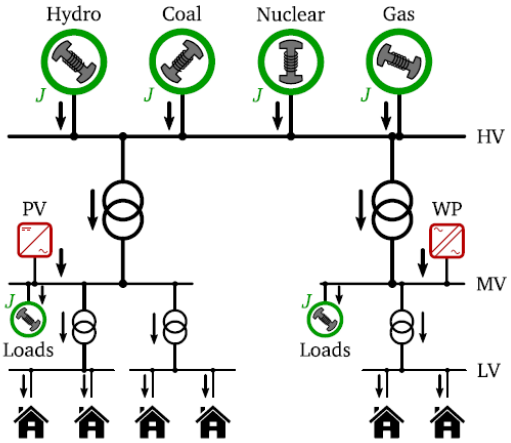

Fig. 1. Traditional structure of the electrical system.

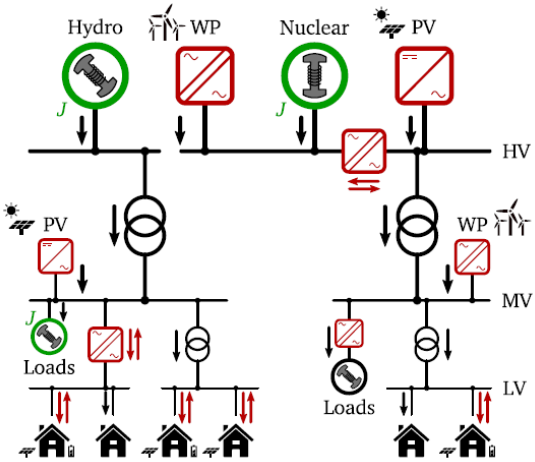

Fig. 2. Electric grid with distributed generation and strong participation of electronic power systems.

- Degree and specialisation: Master's or equivalent degree in Engineering required to enter the PhD programme. Electrics, electronics, automation and control or similar specialisation.
- Languages: Fluent English
- IT: command of Matlab-Simulink, DigSilent or similar tools.

The following will be a plus:

- Knowledge of renewable energy network integration, power electronics, electric grids and related topics.
- Teamworking skills.
- Autonomy and initiative to put forward new ideas and implement them.

Further information and applications: http://bit.ly/2HE4Y0N