

RESEARCH TOPIC FOR THE PARISTECH/CSC PHD PROGRAM

Field: Energy, Processes

Subfield: Electrical Engineering

Title: Dynamic simulation of large transmission grid incorporating modular Multilevel converters with internal storage system

ParisTech School: Arts et Métiers Sciences et Technologies

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Research group/Lab: Laboratory of Electrical Engineering and Power electronics (L2EP)

Lab location: ENSAM, 8 Boulevard Louis XIV, 59046 Lille, France

(Lab/Advisor website): <http://l2ep.univ-lille.fr/?lang=en>

Short description of possible research topics for a PhD:

The Future transmission system leads to the increase of power electronic devices in the power system due to more and more renewable energy production systems and High Voltage Direct Current (HVDC) grids.

With the possible integration of marine renewable energy like offshore wind turbine, the concept of HVDC begins to emerge. The L2EP has worked on this subject for 10 years. A **demonstrator of Multi-terminal DC grid** has been developed during the European project Twenties. To connect These DC grids to the AC transmission grid, High voltage and power converters are required. A structure, called Modular Multilevel Converter (MMC), has emerged one decade. One **small scale HVDC/HVAC converter** has been developed in the L2ep in 2016. Based on the MMC topology, the ESS can be dispatched into MMC sub modules and can decouple the dependence between the AC system and the DC system.

To provide **ancillaries services** to the **transmission grid** like frequency regulation or supporting, flattening renewable sources production or propose an energy reserved for the realization of grid forming converter function an **Energy Storage System** (ESS) are required.

This project aims to study the capability of MMC with internal ESS to dynamically support large transmission systems of the future.

Required background of the student:

Beside a good level of English and communication, the recruited student must have:

- A Master or equivalent on Power System or Power Electronics
- Autonomy and capability to work with a team

A list of 5 (max.) representative publications of the group:

1. S. Samimi, *Modélisation et Commande des Convertisseurs MMC en vue de leur intégration dans le Réseau Electrique*. PhD dissertation, in English, Ecole Centrale de Lille, 2016.
2. COSSART Quentin, COLAS Frédéric, KESTELYN Xavier, A Novel Event and Non-Projection-Based Approximation Technique by State Residualization for the Model Order Reduction of Power Systems with a High Renewable Energies Penetration IEEE Transactions on Power Systems, 07/2020
3. Q. Cossart, "Tools and Methods for the Analysis and Simulation of Large Transmission Systems Using 100% Power Electronics," PhD dissertation, Arts et Metier Institute of Technology 09 2019.
4. H. Zhang, M. M. Belhaouane, F. Colas, R. Kadri, F. Gruson and X. Guillaud, "On Comprehensive Description and Analysis of MMC Control Design: Simulation and Experimental Study," in IEEE Transactions on Power Delivery, 2020, doi: 10.1109/TPWRD.2020.2977470.