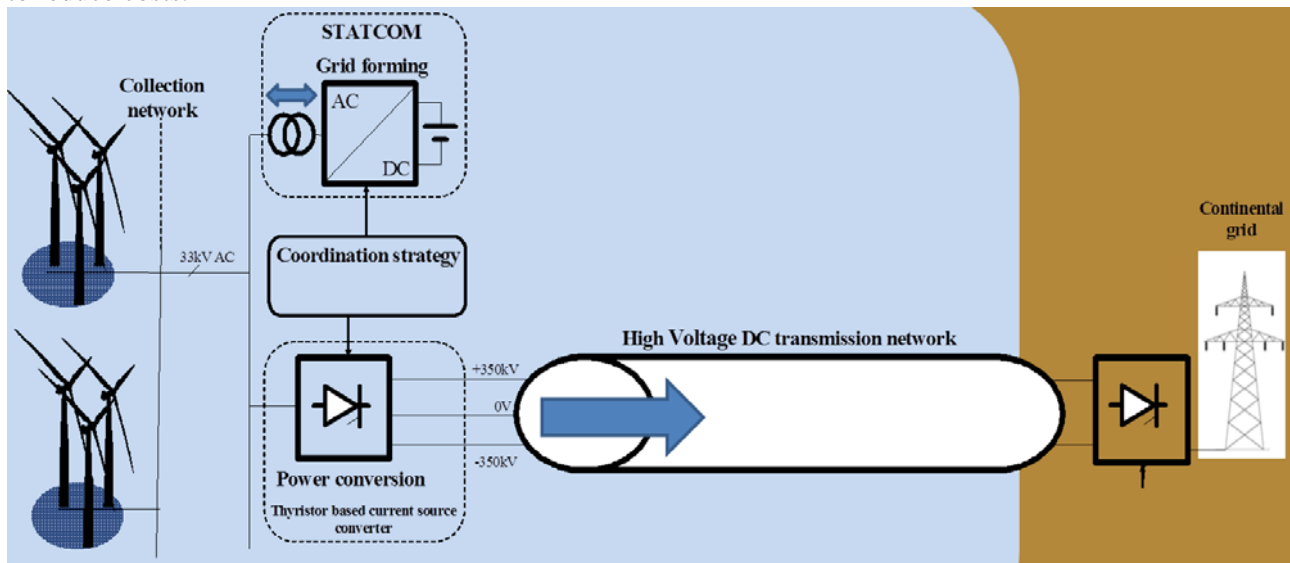

Master Thesis, 2017-2018

— *Energetic coordination and management of an isolated offshore network
for grid forming operation* —

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Context

A 2.92GW development of off-shore industrial wind turbines is planned on the west French coast sea. Such a development requires new network architectures for the distribution and transmission of electricity from this new offshore production to on-shore consumption [1],[2],[3]. New solutions must be imagined to solve all challenges offered by this evolution of electricity networks. Basic functions of an electrical network must be thank and designed: undersea transportation of electricity, building of an offshore AC electrical network to connect offshore wind generators, energy management of intermittent renewable energy, ... First industrial realizations use available high power hardware power converter systems as thyristors based Line Commutated Converters or transistors based Voltage Source Converters (VSC). Unfortunately, these power structures integrate many operational functions in a single device and so are huge and have high costs. The general task of the proposed internship is to consider new possible power conversion systems that are specifically designed and optimized in order to maximize the efficiency of required operational functions and to reduce costs.



Objective

The research activity will be focused on the operating design of the offshore power station. New applications of storage systems ([4]) will be considered in order to generate the sine waveform of the collection network voltage with a transistor based multilevel statcom and regulate it [5] [6]. The collected power in the AC collection network will be converted into DC by a thyristor based LCC [7].

Then, the goal of the research internship is to propose and design the coordination and the management of both power electronic converters in order to control the offshore AC voltage with the statcom and to control the power conversion from AC to DC by the LCC.

Dynamic responses will be tested under power variations and also the regulation of the DC voltage.

Work steps

- a) Bibliographic work : Operating of LCC and STATCOM and applications in power networks
- b) Scientific project: modelling and simulation under Matlab Simulink, assessment of static operating points with basic control laws and assumptions
- c) Internship :
 - Design of both local dynamic control systems
 - Coordination strategy through a dynamic decoupling of power conversions
 - Implementation under Matlab Simulink
 - Technical analysis of the entire system (stability, sizing of the storage, power quality, ...)

Key words

Wind farms, HVDC, active filtering, LCC, Thyristor

References of past works

- [1] Electricity Production from Renewables Energies, B. Robyns, A. DAVIGNY, B. FRANCOIS, A. HENNETON, J. SPROOTEN, *Wiley*, 2012, ISBN 978-1-84821-390-6
- [2] Practical determination of HVAC - HVDC Hybridization ratio for Offshore Transmission network Architectures through technico-economic considerations, A. P. Roses, B. Francois, *IFAC Workshop on Control of Transmission and Distribution Smart Grids: CTDSG'16*, 11 – 13 october 2016, Prague, Czech republic
- [3] Architecture optimization of offshore wind farm grids for cost reduction under operational and reliability constraints, Adria PIBERNAT ROSES, *Master Thesis*, 2015, E2SD, Univ. of Lille
- [4] Energy Storage in Electric Power Grids, Benoît Robyns, Bruno François, Gauthier Delille, Christophe Saudemont, *Wiley*, 2015, ISBN : 978-1-84821-611-2
- [5] AC OFFSHORE GRID OF A COLLECTION NETWORK FOR WIND PARKS BY CONSIDERING STORAGE AND HYBRID POWER ELECTRONIC SYSTEMS, N'Guessan KOUASSI, *Master Thesis*, 2016, E2SD, Univ. of Lille
- [6] AC Offshore Grid Forming of a Collector Network for Wind Park by Considering Storage and Hybrid Power Electronic Systems, N'Guessan KOUASSI, B. FRANCOIS, *CISTEM conference*, November 2016, Marrakech, Marroco
- [7] Interest of storage based STATCOM systems to the power quality enhancement of thyristors based LCC HVDC links for offshore wind farm, Heythem HAMLAOUI, *Master Thesis*, 2017, E2SD, Univ. of Lille