Investigation of the transient fault behavior of offshore AC power hubs interconnecting mass-scale wind power farms via point-to-point HVDC links to onshore AC grids

Master or Bachelor Thesis

For the integration of offshore wind farms into the existing onshore AC systems, voltage source converter based high voltage direct current systems (VSC-HVDC systems) have become a promising solution. While nowadays offshore transmission systems are mostly built and operated as independent point-to-point systems (P2P), the trend to mass-scale offshore power generation being far distant from shore requires a more flexible and economical approach in the future. One promising grid concept is based on AC hubs, which are, seen from the electrical perspective, AC nodes pooling energy and offering the infrastructure for transmitting it to the load centers onshore. A single AC hub could be designed for collecting offshore wind power in the gigawatt scale and enable power exchange between numerous linked P2P-HVDC systems that can each interconnect either further AC hubs or onshore AC grids. In that way, an expandable HVDC grid structure originates (see Figure 1) that has the advantage of requiring only high voltage components, which are already available on today’s markets.

Therefore, the focus of the research is located in the field of protection and control to allow safe and reliable operation of this grid connection topology. To overcome potential issues during operation, the overall system behavior of the concept must be well understood and extensive studies have to be done. Within this thesis, the steady-state and transient fault behavior of a single AC power hub shall be investigated by means of simulation tools and suitable measures for an appropriate operation of the proposed topology for both states are to be identified and assessed.

Figure 1: AC power hub concept (figure adapted from [PRO17])

[PRO17] EU project PROMOTioN (http://www.promotion-offshore.net/)
**Goals and focus of the thesis:**

Your focus and core tasks will be:

- Literature research regarding the AC power hub topology and identification of realistic parameter sets (e.g. converter configurations, AC/HVDC voltage level, rated power)
- Familiarization with PSCAD/EMTDC (Electromagnetic Transient Program)
- Modelling and simulation of a single AC hub connected to wind farms and several HVDC links in PSCAD/EMTDC
- Identification of suitable protection schemes with regard to existing grid codes (onshore/offshore, AC/HVDC)
- Comprehensive analysis of the system’s behavior in steady-state and during system faults on both the AC and the DC side
- Appropriate discussion of the results and documentation

**Your profile:**

- Interest in HVDC control and protection studies
- Basic skills in Matlab/Simulink™ and PSCAD/EMTDC™ advantageous

**Other:**

- The thesis can be written in either English or German.

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**Contact**

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**Focus**

- HVDC converter
- Control
- Protection