Interoperability of different converter and protection technologies within a multi-terminal HVDC grid

Master or Bachelor thesis

High-voltage direct current (HVDC) transmission is increasingly being used in the European electricity supply network. Especially for the integration of renewable energies, as well as the stabilisation of the AC grid in the context of conventional power plants being decommissioned, HVDC systems play a key role. Depending on the systems’ requirements, Modular Multilevel Converters (MMC), which are considered state of the art, can utilise different power electronic circuits and control schemes. To ensure the security of supply even for large offshore generation capacities planned for the future, the development of reliable protection systems for HVDC grids is necessary. Different DC fault handling strategies being in discussion not only differ regarding the required switching equipment, but also depend on the applied MMC technology. Previous investigations regarding multi-terminal HVDC networks concentrate on systems comprising only converters using the same technology and hence employing the same protection concepts. To assess the extensibility of existing systems, it is interesting to investigate the interoperability of these different protection concepts and their related converter topologies, identify challenges and point out possible solutions.

The subject of possible theses is the development of protection strategies for HVDC systems comprising different converter and/or protection technologies. Existing concepts have to be analysed regarding their interoperability within the same DC network, taking into account several influencing factors. For the investigations, the models of converters and DC systems have to be understood and adapted.

Goals and focus of the thesis:
Your focus and core tasks will include:

- Familiarisation with the following topics and tools:
  - HVDC grids and Modular Multilevel Converters (MMCs)
  - DC Fault handling concepts for Multiterminal HVDC systems
  - Electromagnetic Transient (EMT) Simulation in PSCAD™/EMTDC™
- Interoperability investigations, focusing on DC fault handling and post-fault recovery
- Development of an EMT simulation model to investigate phenomena related to DC faults in multi-terminal HVDC systems comprising different protection concepts
- Identify challenges, critical scenarios and influencing parameters
- Analysis of requirements for the interoperability of different protection concepts based on the (simulations’) results
Your profile:

- Interest in component-related and/or systemic issues in HVDC systems
- Study in “Electrical Engineering” or “Business Administration and Engineering” focusing on Electrical Power Engineering or similar
- Basic skills in PSCAD™/EMTDC™ and/or MATLAB® advantageous

Research areas and methods covered:

**Innovative HVDC systems for the integration of renewable energy**
- Interactions between HVDC systems, offshore wind parks and the AC transmission grid
- Control and protection concepts for existing and novel HVDC grid topologies
- Software-aided modelling & Hardware-in-the-Loop based lab-scale replication of HVDC systems
- Analysis of Converter technologies, DC switchgear and cable stresses

**Contact Person**

Patrick Düllmann, M. Sc.
+49 241 80 - 93033
p.duellmann@iaew.rwth-aachen.de

**Focus**

- HVDC systems
- Simulation
- Control & Protection