PhD Offer: Grid-Interface Power Converter with MVAC and MVDC

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1. Context

To attain climate neutrality, a massive expansion of renewable energy (RE) is necessary. An increasingly attractive trend is emerging to establish intermediate collecting medium voltage DC (MVDC) distribution networks that integrate the output from various renewables, such as PV and wind farms and storage systems such as battery and H2.
In this context, the **Grid-Interface Power Converter with MVAC and MVDC** (GI-PC) based on multi-terminal MVDC topologies can be further expanded to integrate seamlessly electric vehicles, storage (battery, hydrogen), and other RE, e.g., wind energy. So, on the one hand GI-PC contributes to a climate neutral European future by integrating significant new shares of energy supply. On the other hand, such a GI-PC can play an important role as a **firewall** to enhance reliability and resilience of the overall interconnection system. To fully enable GI-PC's potential, there is a need to address challenges including, e.g., architecture design, hybrid AC-DC planning, control and operation coordination, and asset management.

2. Objective and works

In this thesis subject, we propose **Grid-Interface Power Converter with MVAC and MVDC**. GI-PC control strategies to provide system services and facilitate network management and protection will be studied (eg support for the voltage plan, study of resonances, MVRT etc...). A digital prototype of GI-PC at the MV level will be proposed implementing the control algorithms. The validation of the prototype will include regulation of the MVDC bus according to different scenarios.
The GI-PC can contribute for:

- Providing a grid-connected interface for various MVAC systems such as power router (providing grid ancillary services such as bidirectional power flow, congestion management, islanding detection, grid isolation, on-grid operation)
- Providing distribution interface for different levels of DC systems
- Improving power quality of MVAC distribution systems (voltage control, suppress harmonics, and compensate reactive power …)
- Providing a grid-connected interface for high-power DC sources such as electric vehicle charging stations, battery energy storage systems, H2, and PV and wind farms
- Other functionalities: fault support (firewall), imbalance reducing, auto reconfiguration (redundancy), grounding adapting, galvanic isolation …

This thesis aims to mature the GI-PC with the following aspects:

- Develop a new topology of SiC-based power converter (GI-PC)
- Develop new control of GI-PC as shown about
- Demonstrate functionalities of GI-PC like continuity of service or power quality capability with dedicated simulations, HIL and lab tests with the MV DC laboratory.