

**Master project, 2020-2021**

— Modular Multilevel Converters with internal storage system—

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**Context**

With the possible integration of marine renewable energy like offshore wind turbine or hydro-turbine, the concept of High Voltage Direct Current (HVDC) grids begin to emerge. The L2EP has worked on this subject for 10 years in close cooperation with RTE and EDF for instance. 6 PhD thesis has been defended; 3 PhD students, 2 post-doctorates are in progress on this topic. The interest of this work has allowed the emergence of this theme as transversal axes of L2EP. A demonstrator of Multi-terminal DC grid has been developed. This demonstrator has been presented as part of a European project name Twenties (<http://www.twenties-project.eu/node/148>). To connect the DC grid to the AC transmission grid, High voltage AC to DC converter are required. A structure has been proposed by SIEMENS in 2007 and has emerged as a reference. This AC/DC converter is called Modular Multilevel Converter (MMC) and it is shown in fig. 1. One small scales HVDC/HVAC converter has been developed in the L2ep in 2016.

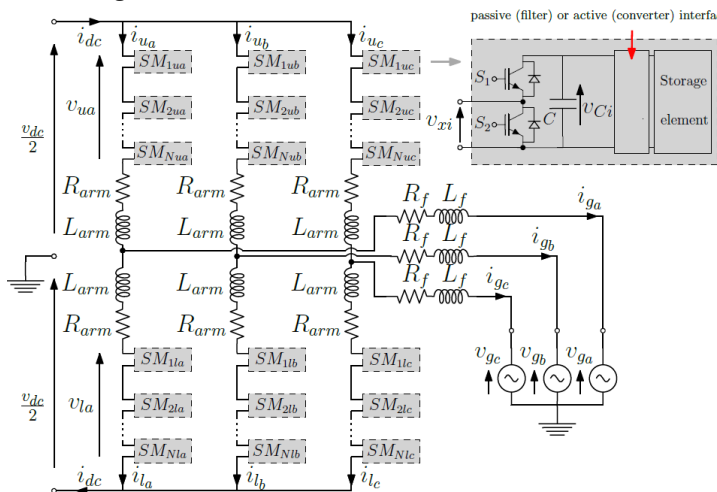


Figure 1: MMC Scheme with Storage elements

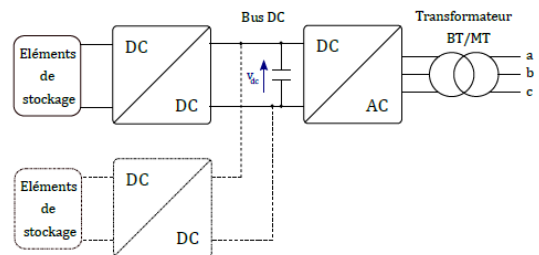


Figure 1: Storage element interfaced to the system with a single power converter

To provide ancillaries services like flattening the production of renewable sources or consumption, VE load/charging, inertial effect for frequency control, energy reserved for the realization of grid forming converter function, decouple the dependence of the AC system and the DC system on each other, an Energy Storage System (ESS) could be required. This ESS could be series/parallels connections of multiple storage element interfaced to the system with a single power converter (Fig. 2.). The ESS could be splitted into MMC sub modules.

**Objective**

The objectives of this Master Thesis are to understand and to develop the model and control of the MMC with ESS integrated into sub-modules.

## Work steps

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The proposed work consists of:

- Bibliography study on the subject
- Model and control of the average arm MMC : Scientific project
- Produce the Low level model , control
- Perform a preliminary study on the storage aging/Losses

## Key Words

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modular multilevel converter; MMC; HVDC; High Voltage Direct current; HVDC link; HVDC converter; energy storage

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