LABORATOIRE D'ELECTROTECHNIQUE ET D'ELECTRONIQUE DE PUISSANCE DE LILLE

Master project, 2021-2022

— Operating V2X with Grid-Forming control —

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Context

Due to CO2 saving energy policies [1], the electricity production system has been moving towards a decentralized scheme, with more and more low-power production means distributed on the territory (wind or solar power plants). Among the technical challenges, there is that of ensuring stable power transfers between the new systems of production and the rest of power-grid. In particular, it must be considered for the modern power system that the stability problem is no longer the exclusive responsibility of a limited number of large power plants using high power synchronous rotating machines as generators. Now, any active-source or -load, connected to the grid with help of a Power-Electronics (PE) converter, has the ability to improve or damage overall stability of the grid [2]. In this context, H2020 European project MIGRATE [3] assessed the operating rules of an hypothetical 100% Power-Electronics grid. In this project, L2EP laboratory developed solutions (methods and tools) to manage the control of PE converters [4] along with respect of classical and new types of high-level control. Since MIGRATE project, L2EP Power-System team has been recognized as an international expert in Grid-Forming control theory, i.e. when PE converter is not only used to manage active or reactive power transfers but also to take part in the generation of the frequency-controlled-voltage [4]-[5]. More recently, Grid-Forming control theory has been transposed at L2EP from the high voltage transmission grid context to the context of lower voltage distribution grid. Indeed, the operating conditions of the converter integrated to a transmission or a distribution grid are not the same: Typically, the grid lines impedances are different, or the connection inductive impedance between the converter and the grid can be drastically reduced in case of distribution applications. This reflection was carried out as part of the study of a reversible automobile charger, which has led to adaptations in grid-forming control techniques [6]. Now, it is targeted to experimentally validate the proposed solutions.

Objective

The objective of this master project is to support the work of a post-doctoral engineer who takes up the work described in [6] to validate it experimentally. First, additional analysis must be carried out in simulation by the master's student, in particular when the grid model is not perfect: case of an unbalanced grid, or with the presence of voltage harmonics, or in islanded conditions. The master's student will also be able to take part in the development of embedded models in order to participate in the campaign of experimental tests.

Work steps

- Literature consolidation on grid-forming control using Automotive reversible chargers
- Simulation model consolidation of a disturbed distribution grid
- Grid-Forming robustness study and improvement solutions development
- Embedded model development and participation to experimental validation tests

Keywords

Power-System, Power-Grid, Power-Electronics, Grid-Forming, Control-Design, Model-Based-Design, Matlab-Simulink

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