Summary

The technological advancements and the decarbonization requirements have pushed towards generating more electricity from renewable energy sources and the transportation electrification. This guarantees a more sustainable energy sector, but it also has a heavy impact on the grid infrastructures. In fact, the shift from a synchronous generator (SG) based electricity production towards static converters is impairing the stability of the grid.

For this reason, it is important to find out new control strategies for power converters, which can guarantee a seamless substitution of the traditional SG-based generation. A promising technology is the emulation of SGs using virtual synchronous machine (VSM) algorithms. This would enable static converters provide the so-called ancillary services (frequency regulation, reactive support...), which are necessary to the correct operation of the electric power system.

The goal of this thesis is, therefore, to propose a VSM model called Simplified Virtual Synchronous Compensator (S-VSC), which can provide each of these ancillary services. This dissertation first presents an overview of the existing VSM strategies and then describes and experimentally validates the S-VSC. Finally, a state-space modeling technique, called component connection method, is extended and applied to the S-VSC model, in order to obtain a simulation model that can be used to analyze larger power systems with an high penetration of power converters.