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Power Systems Laboratory

Providing Virtual Inertia as an Ancillary Service on the Transmission Grid Level

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Type: SA or MA (Modeling/Design/Simulation)

Description

Large-scale deployment of Renewable Energy Sources (RES) has led to significant generation shares of variable RES in power systems worldwide. RES units, notably inverter-connected wind turbines and photovoltaics (PV) that as such do not provide rotational inertia, are effectively displacing conventional generators and their rotating machinery. The traditional assumption that grid inertia is sufficiently high with only small variations over time is thus not valid for power systems with high RES shares. This has implications for frequency dynamics and power system stability and operation. Frequency dynamics are faster in power systems with low rotational inertia, making frequency control and power system operation more challenging. Therefore, the concept of Virtual Synchronous Machines (VSMs) is emerging as a general framework for controlling Power Electronic (PE) converters in power system applications to emulate the behavior of traditional synchronous machines. Converters with VSM-based control systems can be used to provide virtual inertia and additional damping, as well as other ancillary services to the power system from any distributed generation or load with energy storage capability.

This project aims to analyze the potential for providing virtual inertia as an ancillary service on the transmission grid level. The dynamic performance of Voltage Source Converter (VSC) control schemes integrated into the large-scale power systems with low rotational inertia will be evaluated. Furthermore, the cost-effective aspects of such ancillary services should also be investigated in detail.

Goals and Objectives

Study different control schemes for emulating virtual inertia through VSCs. Develop adequate models and incorporate them into the existing one- and two-area power system models in Simulink. Investigate the frequency response and dynamic characteristics of the system under proposed regulatory frameworks.

Tasks

1. Do a literature review on inertia emulation techniques through VSC control.
2. Develop adequate models and incorporate them into the existing one- and two-area power system models in Simulink.
3. Analyse system response, frequency control and stability margins.
4. Investigate the market side of the problem in a cost-effective manner.
5. Determine a regulatory framework for providing virtual inertia as an ancillary service.

Notes

Interested students should have a basic understanding of power systems and control. Experience with MATLAB/Simulink, as well as good mathematical background are an advantage.

Since the research field of low- and no-inertia power systems is quite new, there is a high potential and encouragement from my side for incorporating the ongoing student project into a potentially published paper. The students who are capable and willing to go the extra mile and get their work published (with the help of the supervisor) are favored.

This thesis will be done within the framework of the MIGRATE project (https://www.h2020-migrate.eu/).