Universität Stuttgart
Institute of Combustion and Power Plant Technology

Announcement

Master/Bachelor Thesis

Stability analysis of grid-following, grid forming, and limited grid forming converter control for various scenarios in an IEEE 39-bus system

Background

Renewable energy sources have been added to the electrical power systems through conventional grid-following (GFL) converters. However, the increasing penetration of these converters and the phasing out of fossil fuel-based large synchronous machines have resulted in different issues, including the inertia reduction of power systems, among others. To solve these issues, grid-forming (GFM) converters have been introduced to provide artificial inertia and other ancillary services by emulating synchronous machine (SM) behavior.
However, the question of finding an optimum mix of synchronous machines, GFL converters, and GFM converters is still of prime interest in this area of research. Moreover, the present state of the art on GFM control mostly provides applications of GFM control assuming an unlimited primary energy source, implying that it is capable of providing grid-forming services at all times. However, in reality, these sources have their capacity constraints. Therefore, a question arises about the performance of GFM control when the primary energy source runs into certain limitations. Therefore, a necessity for a limited grid-forming (LGF) mode arises which can handle such scenarios. Moreover, finding the impact of LGF control in an optimum mix of synchronous machines, GFL converters, and GFM converters is also worth investigating.

Objectives

Within the scope of this work, power system stability under different mixes of synchronous machines, and GFL and GFM converters has to be evaluated in the IEEE 39-bus benchmark system. Secondly, the impact of LGF control in these scenarios is also required to be investigated to find the feasibility of this scheme in such a network. For these purposes, simulations on a PowerFactory model will have to be carried out to perform stability analysis of the system.

Approach and tasks

1. Literature review and understanding of the concepts of GFL, GFM, and LGF control
2. Proposing different mixes of sources and events for system stability analysis
3. Simulation work for the said purpose in different test scenarios
4. Evaluation and reporting of the simulation results

Requirements

- Ability to work independently
- Understanding of electrical power systems and their controls
- Knowledge of Python programming and the DIGSILENT PowerFactory tool is preferable (not mandatory)

Start date: possible immediately

Examiner: Prof. Dr.-Ing. Hendrik Lens

Interested students please contact

M.Sc. Syed Muhammad Sami ur Rehman
Dept. Power Generation and Automatic Control
sami.rehman@ifk.uni-stuttgart.de
Tel. 0711/685 63392, Room 0.58

IFK, Pfaffenwaldring 23, 70569 Stuttgart
www.ifk.uni-stuttgart.de/lehre/Studentische_Arbeiten/