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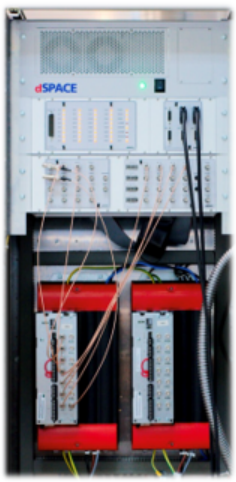
Master Thesis, Hauptseminar, Forschungspraxis

Modeling and emulation of grid dynamics for stability analysis of renewable energy control systems

Due to the high penetration of inverter-based resources (IBRs) in future grids, the focus of current research is on grid-forming control methods for IBRs to stabilize the grid voltage and frequency. In contrast to (conventional) grid-following control, the grid-forming control enables inertia emulation. This is key to compensate for the decreasing grid inertia due to less grid-connected synchronous generators (less rotating masses). However, grid-forming control comes along with new challenges for IBRs, such as ensuring current limitation and grid synchronization at the same time. For the analysis of grid-forming control methods, the modeling and emulation of the grid dynamics is required. Existing simplified reduced-order grid models derived for conventional power generation may not be sufficient since the fast switching and the nonlinear characteristics of IBRs are often neglected.
Possible work packages with either focus on theory (modeling) or practice (emulation at the lab):

- Literature research and derivation of the system dynamics (starting with synchronous machines)
- Implementation of the grid model (e. g. IEEE 9-bus in Matlab Simulink)
- Definition and evaluation of test cases for stability analysis
- Identification of potential grid emulation methods for our lab-hardware (e.g. for two-level inverters or voltage amplifiers)
- Hardware design (if necessary)
- Implementation and validation of the emulation (in dSPACE at our laboratory)



Please send your application with CV and transcript to Andre Thommessen andre.thommessen@hm.edu