Probing-based data driven modelling of grid inverter dynamics on PHIL emulators in CoSES Laboratory

Project background

The transition of power grids to inverter dominated behaviour has led to questions regarding grid inertia, weak grid operation and stability margins under intermittent renewable generation. Therefore, deriving an accurate dynamics model for a collection of grid inverters is important. Data driven modelling approaches can be used for efficient and robust modelling of inverter dynamics. Such methods generally involve perturbing the grid with specifically designed "probe" signals, and performing a state estimation on the current and voltage response. These signals can be purely simulation (using a Real time simulator as the power grid) or can be power amplifiers injecting real power into the grid.

Project expectations

- Review the current data driven modelling approaches for inverter dynamics
- Build a MATLAB/Simulink model for the inverters, the state estimator block and the probing signals
- Deploy these models on the CoSES PXIe embedded controllers and verify real time operation.
- Deploy the inverter models with the probing signals as setpoints for the CoSES Egston Emulators.
- Analyse the results to make an estimated model and compare with the analytical / measured results.
- Prepare a high quality manuscript to publish at an international conference.

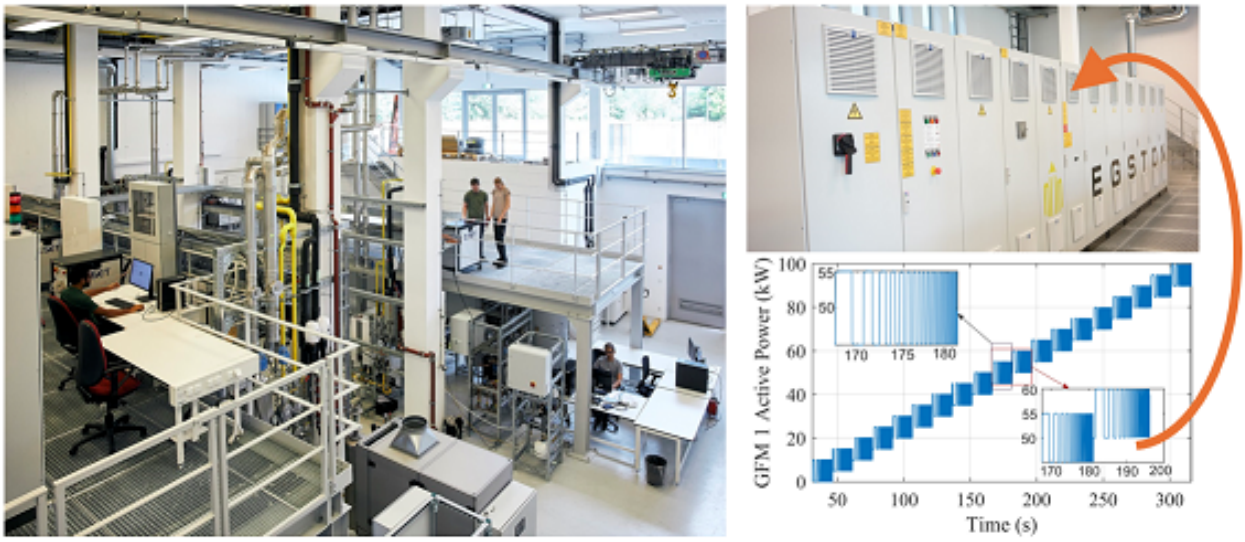

Figure 1: CoSES Laboratory in Garching (left), Egston PHIL emulators (top right), typical inverter model (bottom right)

Requirements

- Electrical engineering background with knowledge of dynamic modeling of electric grid, inverters and state estimation methods.
- A good understanding of MATLAB/Simulink.
- Previous experience with real time simulators is preferrable.
- Affinity to programming and structural thinking.
- Good team-player and an attitude to learn and explore new approaches.

References

- Guruwacharya, N. et al., 'Data-driven modeling of grid-forming inverter dynamics using power hardware-in-the-loop experimentation', 2024, IEEE Access, 12, pp. 52267–52281. doi:10.1109/access.2024.3383323.
- A. Mohapatra, T. Hamacher and V. S. Perić, 'PHIL Infrastructure in CoSES Microgrid Laboratory', 2022 IEEE PES Innovative Smart Grid Technologies Conference Europe (ISGT-Europe), Novi Sad, Serbia, 2022, pp. 1-6, doi: 10.1109/ISGT-Europe54678.2022.9960295.

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Note - The thesis will be co-supervised by the Chair of Renewable and Sustainable Energy Systems and the Chair of Electric Power Transmission and Distribution.