Bachelor / Master Thesis

Investigation of Stability Indicators for Assessing the Damping Characteristics of Power-Electronics-Dominated Grids

With the increasing integration of power-electronic-based units into modern power grids, new challenges are emerging with regards to system stability. In particular, the growing occurrence of sub-, super synchronous, and harmonic phenomena necessitates the (further) development of suitable stability metrics. A key element in this context is knowledge of the system's poles, as they provide insight into the damping behavior and thus the system's response to disturbance events.

In practice, system stability is often assessed using simplified, linearized grid models. However, only limited data – such as impedance measurements of the grid and connected generation units – are typically available for model development. Based on this constrained data situation, there are currently no established methods to indicatively assess grid stability. The aim of this thesis is therefore to investigate the extent to which transient system characteristics can be reconstructed from steady-state measurement data, as a basis for future stability metrics.

To this end, a Python tool is to be developed, which first computes the poles from a known time-domain model and consequently compares them with poles reconstructed from frequency-dependent measurement data. The focus is on analysis of the agreement between both sets of poles and identification of the limits of pole reconstruction based on steady-state, frequency-domain measurements. The work contributes to the advancement of quantitative stability metrics, which are essential for analyzing future power-electronics-dominated grids.

Core tasks and objectives of the thesis:

- Literature research on dynamic grid modeling and frequency-dependent impedance measurements
- Development of a time-domain method for analysis of grid dynamics in Python
- Comparison of the developed method with analysis approaches in the frequency-domain

Your profile:

- Study of engineering or industrial engineering (electrical engineering, mechanical engineering, energy technology) or computer science
- Basic knowledge of Python is advantageous

We offer:

- Intensive and reliable support during your thesis
- Flexible time management and your own air-conditioned workplace with good IT equipment
- A great atmosphere with lots of activities for students and research assistants
- Lots of industry contacts and help with finding internships
- The possibility of a subsequent doctorate or employment if you perform very well

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Focus

- Stability analysis
- Grid modeling
- Programming in Python