Titel: **A Non-Intrusive Uncertainty Quantification System for Modular Smart Grid Co-Simulation**

Abstract:

Smart grids are complex multidisciplinary systems that touch scientiﬁc domains from power engineering to ICT and even meteorology and economics, just to name a few. Holistic analysis and development of such systems are only possible via the collaboration of various domain experts. A promising approach for collaboration is co-simulation since it implies the reuse and combination of already existing simulation models. The integration of diﬀerent domain models into one environment allows large-scale testing of smart grid components and prediction of system behavior. However, simulation results can only be trusted to serve test-based development and prediction if their accuracy is known. Model internal and data uncertainties decrease the overall simulation accuracy, especially if models from diﬀerent sources are combined. Therefore, an uncertainty quantiﬁcation (UQ) process has to be applied to any given simulation setup that should serve for the prediction of reality. So far UQ has been mostly disregarded in smart grid co-simulation due to the complexity of the domain. Co-simulation in general and smart grid research in particular typically incorporate black box models with heterogeneous structures, which impedes adoption of UQ approaches from other domains.

The presented thesis suggests a modular UQ concept that may be applied to common co-simulation frameworks. A prototypical implementation of the concept is provided as an extension to the framework mosaik, and evaluated in comparison to a Monte-Carlo approach. Results of the evaluation reveal complementing capabilities of the two approaches. Furthermore, a number of design requirements are considered in the new approach which cannot be included into a Monte-Carlo setup. As a consequence, the suggested concept has some crucial advantages in terms of applicability. Due to its modularity, compatibility with existing UQ and co-simulation software is easily achieved. Thus, the thesis can be understood as a starting point for UQ development in the smart grid co-simulation domain.