Toward Modular Modeling and Simulations of Microgrid Dynamics

Rupamathi Jaddivada (rjaddiva@mit.edu), Aidan Dowdle (ai24004@mit.edu)
& Xia Miao (xmiao@mit.edu)

The microgrid concept refers to a smaller-scale power system equipped with local energy resources that can operate either connected to the bulk power system (BPS) or autonomously. Although this definition excludes the BPS, microgrids may still range in size from a single household to as large as an entire city. Microgrids offer improved reliability and efficiency for future urban energy grids, but preliminary studies show that they pose additional operational complexities from the conventional BPS. The performance objectives may not be well-defined and there can be dynamic interactions between components over a wide time scale range that lead to blackouts or other issues.

Due the complex nature of microgrid systems, simulation software can provide insight into their operation and serve as a preliminary to hardware testing. The Centralized Automated Modeling of Power Systems (CAMPS) software is designed for this purpose, using a modular modeling approach to produce ODEs in standard state-space form in a systematic, automated manner. The resultant dynamics exhibit a spatial and temporal structure that provides the basis for multi-layer hierarchical simulation and parallel computing. However, when using detailed component models, the resultant microgrid system models tend to contain a large number of states and be numerically stiff, thus even small-scale microgrids can be challenging to simulate to high fidelity. This poster presents some of the numerical and modeling issues encountered in microgrid simulation and describes ongoing research to address them. Longer-term ongoing research concerns Distributed Automated Modeling of Power Systems (DAMPS) which naturally lends itself to scalable parallel simulations of complex multi-layered electric power systems.