What are the key challenges in modeling the Smart Grid?

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Key Challenges of Distribution System Analysis for Modeling the Smart Grid

- **Merging Planning and Real-Time Analysis**: EPRI's vision of the Smart Grid future includes merging off-line distribution planning and on-line distribution operations. The key enabler is the assumed existence of sufficient data thoughout the system to precisely know the state and loading of each element in the system.
- **Very Large System Models**: We have assisted the IEEE in releasing the 8500-Node Test Feeder. One purpose of this circuit is to screen out proposed algorithms that do not scale well to large systems. 10 000 bus system models are fairly common. There is talk of going to 100 000 bus systems and even million-bus systems to be able to coordinate all the available resources.
- **Systems Communications Simulations**: Communications latency may make planned Smart Grid functions impractical. Currently simulation tools do either communications networks or power distribution networks. These tools need to be merged. Also, short term response of such things as PV arrays and batteries for storage need to be modeled to complement the communications network simulation.
- **Large Volume of AMI Data**: AMI data is both a blessing and curse. It provides more up-to-date information on loading to help with distribution state estimation. However, the sheer volume of data is difficult to keep up with. Handling bad and missing data is also a major headache.
- **AMI-based Decision Making**: Processing AMI data to make better planning decisions and operating decisions.
- **Time Series Simulations**: With disruptive technologies such as renewable generation and electric vehicles, the load profile is no longer as predictable. Studying only the peak loading case can give the wrong answer.
- **Distribution State Estimation**: This is an important need for distribution management systems (DMS). It is a particularly difficult problem on North American style 4-wire multi-grounded neutral MV systems with a plethora of switched capacitor banks, voltage regulators, etc.
- **Detailed LV Modeling**: Distribution analysis is moving from the MV system into the LV system. This is perhaps more important for the European-style system, but also important for large urban networks throughout the world.
- **Including multiple feeders, transmission**: Some distribution system analysis tools focus only on one feeder at a time. However there are more issues arising with the Smart Grid that require simultaneous modeling of multiple feeders and even part of the transmission network.
- **DG Integration and Protection**: More tools are needed to support the analysis of DG once it is interconnected with the system.
- **Generator and Inverter Models**: There is a continuing need to develop inverter models in particular as new functionality is implemented.
- **Meshed (Looped) Network Systems**: Most DSA programs can take advantage of the radial nature of a distibution system for computational efficiency. Multi-phase models of Networked (meshed) systems is now becoming important as users investigate ways to better utilize the power delivery components.

- **Regulatory Time Pressures**: Tools are needed to allow distribution planners to rapidly assess the impact of such things as proposals to interconnect DG.

--Rdugan 17:27, 7 October 2010 (UTC)
