Microgrid System Design and Economic Analysis Tools

DOE Microgrid Workshop

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Jason Stamp, Ph.D. (Sandia National Laboratories)

Michael Clark (Encorp)

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Session Outline

- First 20 minutes (or less): short introductory presentation by Jason and Mike
  - Introduction of technical issues
  - Case study (systems integration in practice)
  - Example discussion topics
- Next 75 minutes: group discussion
- Last 10 minutes: summary and wrap-up

Example Design Stages

1. Conceptualizing the microgrid:
   a. Analyzing load and site requirements (including environmental)
   b. Sizing, selection, and location of energy sources (including RE and storage), distribution and low voltage analysis
   c. Building controls and passive efficiency options
   d. Grid interactions: economic behavior and ancillary services
2. Microgrid economic analysis and reliability / performance
3. Electrical network analysis: power flow and stability
4. Controls, dynamic performance, and cyber security
5. Analysis rollup and final decision making

Microgrid Conceptualization Tools

	Spatial Layout	Component Location	Component Sizing
Energy Surety Microgrid ESM	Yes	Yes	Yes
Lockheed Martin tool	Yes	Yes	Yes
RETScreen	Yes?	Yes?	Yes
HOMER	No	No	Yes
ES-Select	No?	No?	Yes
DER-CAM	No	No	Yes

Economic and Performance Analysis

	Total System Cost	Component Cost	Performance Analysis
ESM	Yes	Yes	Yes
HOMER	Yes	Yes	Yes
RETScreen	Yes	Yes	Yes
DER-CAM	No	No	Yes

Tools for Electrical Network Analysis

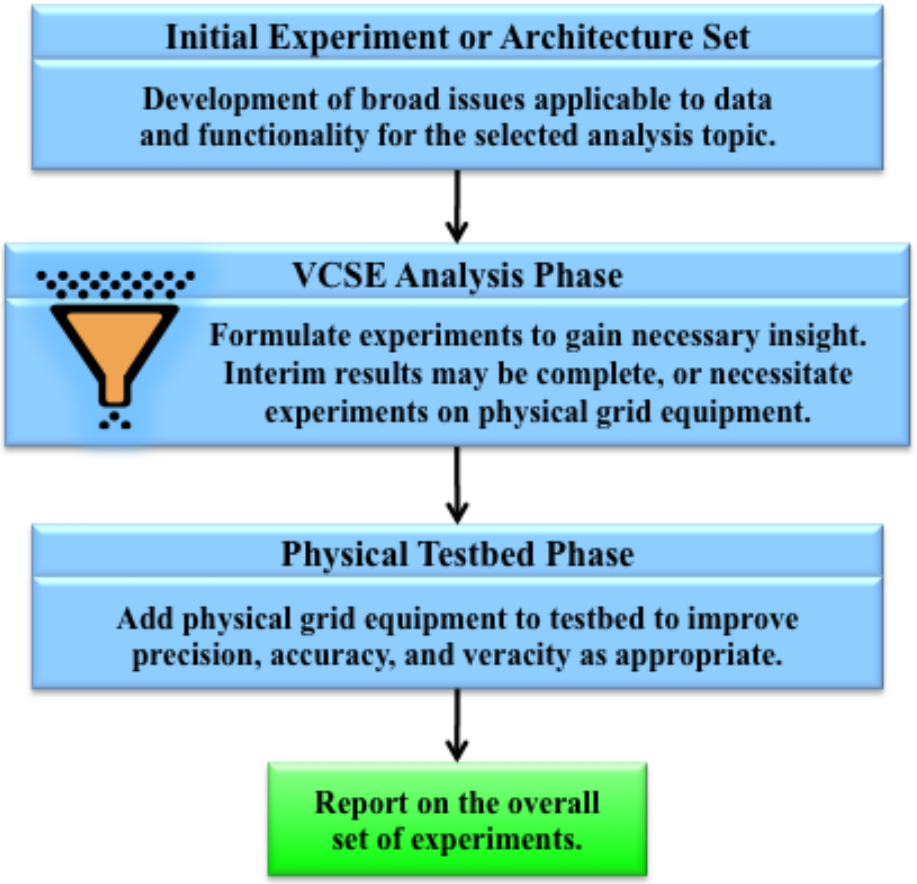
	Load Flow	Stability	SC Analysis
PSS/E	Yes	Yes	Yes
PSLF	Yes	Yes	Yes
PSCAD	Yes	Yes	Yes
OpenDSS	Yes	Yes	Yes

Controls Systems Design

- **Controls use cases:**
  - **Automated grid management and control – frequency, voltage, load management, etc (anything automated, second-to-second requirements)**
  - **Supervisory control – human-in-the-loop grid management (i.e. base command decides to energize priority load)**
  - **Protective relaying – specific channels dedicated to coordination between relays (also automated, time sensitivity on the order of cycles)**
  - **Microgrid configuration management – remote device (re)configuration, downloading fault data, engineering configuration and management, etc.**
  - **Connections to other systems: with utility systems for ancillary services, and with building systems for efficiency / load management**
- **Controls design must ensure expected microgrid performance meets standards for power quality, voltage, frequency, protection, etc.**

Cyber Security Design

- Test cases for cyber
  - Usability: how difficult is it to install, maintain, and use the cyber security architecture? Does it function reasonably (i.e. it can't take 20 minutes to log into a system)?
  - Functionality: how well does the cyber security architecture function against possible attacks?
  - Transparency: does the cyber security architecture interfere with normal operations (i.e. it can't introduce latency on a protective relaying channel)?
- Design is supported by testbed environments (perhaps of the simulated-emulated-physical sort) over microgrid design domains of controls, communications / networking, and the electrical energy system
- Test system assets can be retained to support red team/auditing practice



Sample Discussion Topics

- **An R&D topic must lend itself to:**
  - **Understanding baseline (including costs for managing systems integration challenge)**
  - **Developing target for improvements**
  - **Describing impactful R&D activities to achieve the target**
- **Examples R&D topic areas from the lead-off presentation (these are just examples - we need your input!):**
  - **Consistent, quantitative metrics for microgrid design analysis**
  - **Optimization models that include performance tradeoff options for system operational alternatives**
  - **Concise framework for initial conceptualization efforts, including environmental/ancillary service options**
  - **Tools for modeling post-project completion annuities (i.e. microgrid maintenance contracts)**

Topic Area Example Analysis

- Costs for current applications
  - Not having standardized performance metrics adds costs during design
  - Incomplete modeling of microgrid operational character can negatively impact microgrid economic performance
- Performance targets and R&D
  - Set of metrics that are easily selected depending on previously defined microgrid application scenarios
  - Framework that allows for optimizing microgrid operational character and facilitates backward integration with existing tools

Session Reporting

- **Show table listing all R&D activities**
- **Determine the relative priority of all R&D activities**
- **Elect spokesperson(s)**

Contact Information

Jason Stamp, Ph.D.
Principal Member of the Technical Staff
Sandia National Laboratories
PO Box 5800, Albuquerque, New Mexico 87185-1108
505-284-6797, jestamp@sandia.gov

Mike Clark
Senior Vice President
Encorp
1825 Sharp Point, Fort Collins, CO 80525
970-674-5300, michael.clark@encorp.com