



# Microgrid System Design and Economic Analysis Tools

**DOE Microgrid Workshop  
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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         |

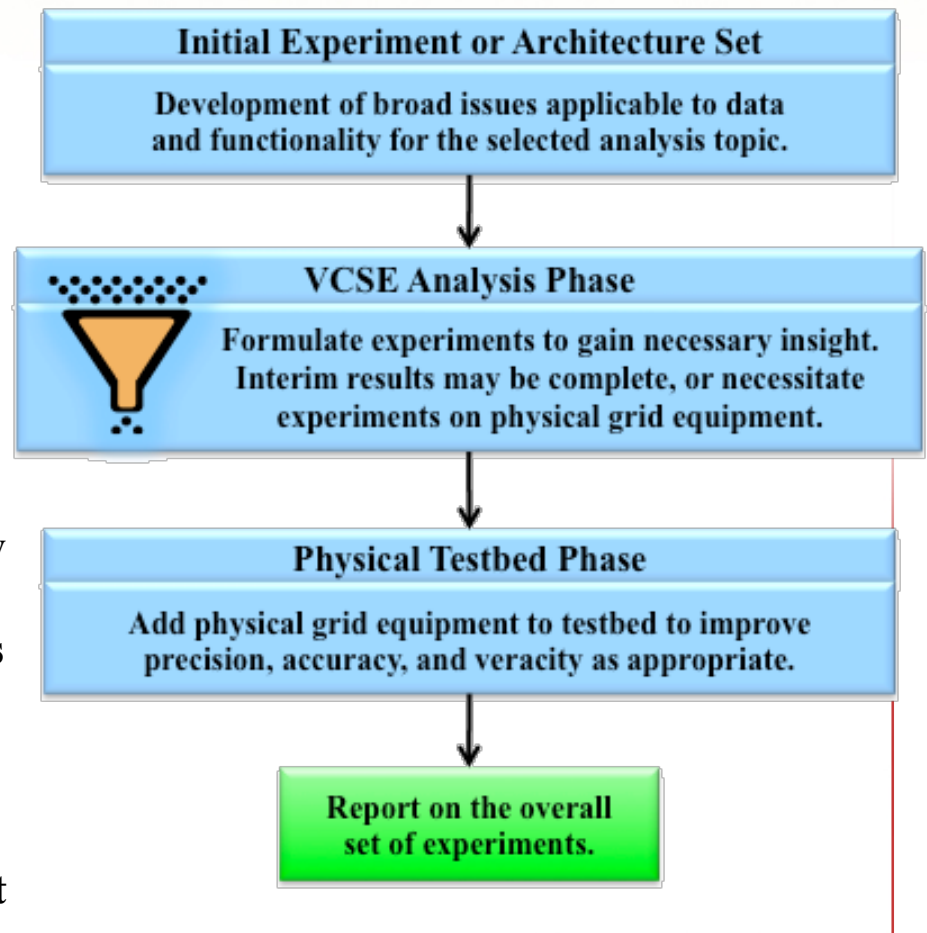
# Controls Systems Design

- **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**



# 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

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