



2014 Smart Grid R&D Program Peer Review

Project Summary

Project Title: Modeling and Control Technologies for Near-Term and Long-Term Networked Microgrids

Organization: Michigan Technological University

Presenters: Eddy Trinklein

FY 2014 Funding (\$K): \$250K

Project Objectives, Significance, and Impact

A network of Advanced Microgrids provides enhanced resiliency through self-healing, aggregated ancillary services, and real-time mesh communication allowing optimal topology reconfiguration and control whether grid-connected or in networked islander mode while enabling a high penetration of renewable energy resources. They offer attractive options for enhancing energy surety, facilitating renewable integration and providing new revenue streams across the electricity market including consumers, utilities, transmission operators, and producers. The **objectives** of this study were to identify (1) the potential benefits of networked micro grids, and (2) the technology and infrastructure gaps for realizing them. Understanding these two attributes is **significant in the short term** for realizing the promise of inexpensive Combined Heat and Power based micro grids that when connected can provide enchanted energy surety and reduced costs to both the consumer and the utility. The **longer term significance** is to be prepared with scalable control and communication strategies that permit massive influx of inexpensive distributed generation and energy storage that may result from the large federal R&D investment into these areas. The **impact** of this study will be to help guide future DOE R&D investments to help realize a more secure and efficient power grid. The specific tasks are:

- 1. Coalition Formation.** Collaborate and form a coalition with national labs and other microgrid stakeholders to identify key R&D topics in networked microgrids.
- 2. Near Term Solutions.** Look at near term solutions that can be quickly and easily integrated into existing microgrids.
- 3. Design Strategies.** Determine best practices and optimized control strategies for the ground-up design of future networked microgrids.
- 4. Advanced Microgrid Whitepaper.** Work within the DOE and national lab partnerships to produce an FOA whitepaper on single microgrid systems.

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5. **Scoping Study.** Perform a scoping study on value streams from coordinated, networked microgrid operations based on varying ownership models.

Technical Approach

1. **Coalition Formation.** Meet with DOE laboratory researchers focused on single microgrids to understand technology extensions/challenges to networked micro grids. Participate in the DOE OE quarterly micro grid meetings. Participate in the Sandia-led networked microgrid “core team” for identifying future high-value R&D thrusts.
2. **Near Term Solutions.** Perform a case study to determine the cost and benefit of restructuring an existing micro grid into a networked micro grid.
3. **Design Strategies.** Develop microgrid simulation tools that permit optimal control of the power flow throughout the network.
4. **Advanced Microgrid Whitepaper.** Conduct an extensive literature survey to define micro grid state of the art to motivate the definition and attributes of the Advanced Microgrid as an enabler to the networked microgrid concept.

Scoping Study. Determine the trade-offs in resiliency and value for networked microgrids under a variety of ownership scenarios.

Technical Progress and Results

1. **Coalition Formation.** Built a coalition with micro grid researchers from ANL, PNNL, ORNL, LBNL, SNL. Ongoing.
2. **Near Term Solutions.** We used an existing campus micro grid to determine the costs and benefits (to both the campus and the surrounding community) of deploying a network of micro grids instead of current monolithic design. Complete.
3. **Design Strategies.** A MATLAB/Simulink simulation was developed that allows any arbitrary topology of transmission and distribution between networked microgrids. Closed form optimal solutions were sought, without success, but numerical optimization is feasible. Complete.
4. **Advanced Microgrid Whitepaper.** The Advanced Microgrid definition was developed and a whitepaper was developed around this concept to elucidate the key R&D gaps and opportunities. Complete.

Scoping Study. Information from previous studies and published literature was accumulated to identify the value

Project Collaborations and Technology Transfer

1. Onsite visits with micro grid researchers at ANL, SNL, PNNL, ORNL, and LBNL
2. Used results from the recent concluded Sandia Grand Challenge LDRD in DC micro grid control and networking for optimization studies.
3. Worked with researchers at LBL and SNL to investigate micro grid and networked micro grid comparisons using LBL's DER-CAM analysis software.
4. Weekly participation in the SNL-lead networked micro grid "core team" to identify high value networked micro grid R&D thrusts.