[MRD] Resilient Operations of Networked Microgrids

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Timeline: FY2020 – FY2022

Challenge:

The Nation's distribution utilities have access to engineering tools for system planning and operation; however, these tools have some notable limitations: they do not offer the ability to model extreme event damage, they cannot accurately model microgrid capabilities and control options, and they cannot provide optimization-based design solutions. While past work at DOE has led to capable microgrid design tools, optimal resilient design tools, and recovery tools, separately these capabilities do not comprehensively consider the abilities of networked microgrids to dynamically interconnect and share load. In particular, existing microgrid design tools are unable to model the potential value of supporting loads outside the boundaries of the microgrid, the resilient design tools do not model reconfigurations that combine and expand microgrids to form powered islands, nor do they provide detailed generation mixes and feasible control methods, and the recovery tools do not account for changes to the distribution system that would improve recovery activity performance.

Technical Approach:

RONM's multi-lab technical approach includes three capability development activities and one outreach and deployment activity: 1) Formulation and Methodology which develops the formulation for resilient reconfiguration algorithms and restoration algorithms and adds first-of-kind advanced engineering objectives and constraints on system stability, device protection, regulatory restrictions, and economic considerations; 2) Software Implementation, which develops and implements a scalable algorithm for solving the problem formulated in previous activity; 3) Evaluation and Demonstration, which uses distribution system models – adapted from a test system provided by the National Rural Electric Co-op Association (NRECA) and from a system model provided by IOU partner San Diego Gas & Electric – to evaluate RONM solutions for reconfiguration and restoration of distribution systems after extreme events, during which solutions are first verified using software simulation and second validated on a sophisticated HIL evaluation platform; and 4) Deployment and Outreach, which deploys the RONM software on NRECA's Open Modeling Framework platform for use and delivery to the Nation's distribution utilities.

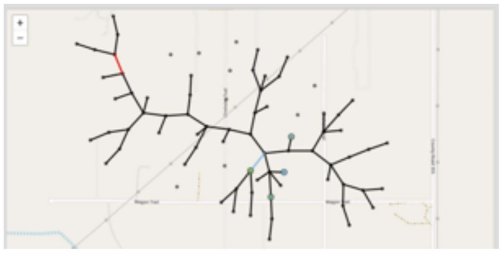

Figure 5-9: RONM map interface that gives a visual representation of the feeder system with microgrids. The interface shows the faulted line (an input) as red and items on the recovery timeline. Items are color-coded based on the time at which they occur (bluer is earlier and greener is later).

Impact:

As extreme event damage to the electric grid continues to grow, it is clear that there is a critical need for an advanced resilience tool such as RONM. Recovery is becoming increasingly more challenging, therefore, utilities must learn how to adapt their approaches to incorporate advanced technologies like inverter-based generation and storage and provide support to defense-critical infrastructure for longer term supply and resilience. Deployment of microgrids can address these challenges by providing backup power and controllable resources for black start restoration.