Dynamic Microgrid Research at BNL
Dynamic Microgrids & Utility Restoration

Brookhaven National Laboratory
Sustainable Energy Technologies Department
December 4, 2013
Smart Grid Research Initiatives at BNL
Key Considerations for Microgrids

- Degree of Isolation
- Nature of the Local Power Grid
- Operating Margin
- Load Capacity Factor
- Size of the Control Area
- “Permanence” of the Boundaries
- Regulatory Complexity “Seams”
7 Core Microgrid Configurations

A core set of seven configurations of differing functional intent can be used to characterize microgrids as we move forward:

- Classic separable microgrid
- Defensive microgrid
- Demand response microgrid
- Controlled separation Island
- Recovery island
- Real Islands
- Dynamic Microgrids
Evolving to the Dynamic Microgrid
A Roadmap

1. Formation and identification of natural microgrids
2. Evolution of localized microgrid support infrastructure
3. Formation of more and more microgrids leads to distributed distribution grid
4. Movement toward aggregated dynamic microgrids
Key Characteristics of the Dynamic Microgrid

- Accommodate different sources of energy
- Self-sustaining—for short times up to extended periods of operation
- Advanced self-healing capabilities
- Optimal management of energy demand and supply
Long Island is an ideal location to test the dynamic microgrid concepts

- **Microgrids on Long Island**
  - Rather than an interconnected hierarchical grid, creation of a dynamic and flexible grid with islands for defense

- **Microgrid strategy**
  - Extend SBU example to Long Island system; building around the existing peaking plants on Long Island as well as renewable energy resources including storage systems.

**Stony Brook University Example**

- Main university and health campus disconnected themselves from LIPA system
- Utilized co-generation power plant on campus
- 37 minutes outage for transfer
- Campus operated in islanded mode throughout Hurricane Sandy
- Supported thousands of students and community in academic and health campus
Applying Dynamic Microgrid Concepts
Long Island is an ideal test location

- Geographical island with minimal external interconnection
- Regularly exposed to widespread outages from hurricanes, blizzards, nor’easters, ice storms
- NYISO locational capacity requirements (105% of peak) resulted in a network of distributed generation to anchor multiple dynamic microgrids
BNL’s electrical distribution system: R&D test bed for Microgrid

- Design and demonstration of a grid-wide, high-speed measurement and control platform for microgrids using innovative smart grid sensor instrumentation
- Modeling & analysis of BNL electrical system using Distribution Engineering Workstation (DEW) Integrated System Model (ISM) distribution system management software
- Operate the NSERC facility as a microgrid with renewable sources and energy storage (including PHEV) supplying power to BNL distribution system
- Demonstrate load shedding and islanding capability for all or part of NSERC microgrid
- Integration of microgrid controls and building energy management systems
BNL working with LIPA:
Modeling of NY Route 110 Corridor Load Area to study Technologies & Microgrid Formation Possibilities

- Modeling NY Rt 110 corridor load area in LIPA’s distribution system using DEW / ISM software tools.
- Leverage smart grid improvements installed via the ongoing ARRA Rt 110 smart grid development project.
- Cost savings realized from reduced outage response efforts, delayed capital expenditure for new generation, and reduced O&M costs are being studied.
- Evaluation of cost benefits from DER, energy storage, and renewable generation can also be addressed.
Microgrids & Evolution of the Electrical System

- After more than a century of slow and steady development, the utility power grid in place at the end of the 20th Century was a highly centralized, largely passive, electricity delivery network.

- Today, we are participating in the rapid evolution of that utility power grid into a more active, decentralized, bi-directional power system driven by the incorporation of high speed digital analysis, measurement, and control technologies of the smart grid.

- Microgrids represent the key building blocks to realizing the full potential of the smart grid as utilities and system operators move into the future.
Dynamic Microgrids – A pathway to Distribution System Evolution

• Distribution system of the future will continue to evolve toward an integrated network of microgrids, each with its own characteristics
• Some will be capable of balancing load and supply to achieve stable operation isolated from the main grid, others will not
• Application of dynamic microgrid concepts together with emerging smart grid technologies will enable utilities to redefine the way future distribution systems will be designed and operated
  - More efficient operation
  - Minimize number and extent of outages
  - Faster system restoration
Brookhaven National Laboratory
Smart Grid & Renewable Energy Research Programs

Questions
&
Discussion
Identifying and Predicting Weather Impacts on Utility Systems

to be held at Brookhaven National Laboratory
Upton, Long Island, NY – December 3 and 4, 2013

Severe weather events are one of the greatest threats to electrical grid infrastructure and operations. Many utilities use simple models, coupled with a few weather observations, to predict the impacts of storms. In this workshop sponsored by Brookhaven National Laboratory on December 3-4, 2013, we will discuss the current techniques used for determining potential weather impacts and identify untapped data and modeling resources that may be brought to bear on the problem.

One underutilized source of storm observations is weather radar. Electric utilities can use weather radar measurements to achieve a number of advantages, including: 1-Accurate, more rapid, real-time detection of storm activity, including severe thunder storms; 2-Pinpointing the location of intense storm activity; 3-Accurate estimates of the extent of storm activity; and 4-Historical radar data can be used to develop more accurate storm outage prediction models. These advantages provide the coordination between storm pathway and utility equipment needed for targeted real-time response decisions.

Finally, we will discuss possible paths forward for improving real-time identification and prediction of these important weather impacts.