Enhancing Microgrid Deployment across the States:
A NARUC-NASEO Microgrids State Working Group Roundtable

Summary

First Day, Wednesday, February 12, 2020

Webinar recording: https://youtu.be/L9imbLloWyE

Introductions

During introductions, states and participants explored challenges they face as well as questions around the issue of microgrid deployment:

State	Challenge	Question
Kentucky	- Finding optimal locations	- How to identify the best location for resilience benefits through microgrids
Pennsylvania	- Where to start and how to unite and coordinate disparate efforts across the state	- See other states' success stories and understand what success would look like
Wisconsin	- Don't allow third party ownership of generation (some movement)	- How to create partnerships with utilities to get data to understand proper location for resilience for grid and communities
Iowa	- How to work with the diversity of players in this space and determine State Energy Office Role	
California	- 1. Reducing challenge of interconnection, easier and more streamlined for developers - 2. Finding and incentivizing market to deploy simplified packages instead of unique design for each facility	- How to expand market and drive innovation across the country
Massachusetts	- Utilities resistant to microgrid because of ownership structure and management structure issues - Cost effectiveness - Microgrid vs. solar plus storage definition - Third party participation	
Hawaii	- Third party participation prohibition	- Resistance of utility to microgrids significant, big hurdle and like to hear about

		other entities and states have dealt with this issue
Wyoming	- Not a lot of interest in this subject yet, opportunity to get ahead of the issue - Issue of third party also would apply in states -	- How would microgrids apply to rural areas?
DC	- Grid modernization proceedings include microgrids in the discussion, challenge is how to treat microgrids in the regulatory proceeding	- How to regulate microgrids especially in light of DC government agencies moving forward with microgrids - Understanding other states' efforts (especially when multiple customers are involved, questions how cost is allocated) - How to get regulatory roadmap to encourage third party multi party customers and how are other states doing
Rhode Island	- States have limited funds for program design - how to best deploy limited funds	
Illinois	- Understanding regulatory issues surrounding microgrids	
New Jersey	- Historic regulation inhibiting microgrids - Issue of right of way challenge in particular	

Other participants' challenges and questions:

- Valuation of microgrids (especially resilience aspect – no metric available to define resilience in an economic way) and quantifying benefits
- Needs of states (especially once past feasibility studies)
- Understanding where states are in microgrid deployment and commercial viability without state and federal support, if support is needed and how to move forward
- What regulatory barriers impede microgrid development?
- How can microgrids be integrated into evolving grid and communities (built environment and infrastructure)
- How can DOE bring in knowledge base, tools, methods (labs) and assistance
- How states can achieve goals (climate and resilience) through microgrids

Where Are We? A Summary of State Needs on Microgrids

Common Questions:

- What is a microgrid?
- What are the components of a microgrid?
- Who can own a microgrid?

State Technical Assistance Needs:

- Developing methods to quantify resilience
- Understanding regulatory regimes needed to smooth microgrid development
- Understanding the kinds of financing structures that can be utilized to finance microgrids and make them economically self-sufficient
- Identifying ownership structures for microgrids that make sense for all parties
- Delineating the role(s) of utilities in owning/operating parts of all of microgrid systems

State Actions to Incentivize Microgrid Development

- Illinois: ComEd Bronzeville microgrid project
  - Docket filed 7/28/2017 on implementation of demonstration microgrid project
  - Goals: learn about value of microgrids, grid security and reliability; best practices for siting microgrids; best practices for integrating DERs; microgrid operation and coordination among microgrids (with Illinois Institute of Technology microgrid); emerging technologies and standards; third-party asset ownership; impact of increased resilience on economic development
  - Ten-year study period with report at the end
  - Two phases to rollout: $8M first phase covering 24 city blocks and 490 customers; $17M second phase adding 16 blocks and 570 customers
  - Area included critical public service customers: nursing homes, schools, Chicago police HQ
  - DOE supported project with a $1.2M grant to research, develop, and test a microgrid controller to integrate with neighboring IIT microgrid; $4M additional grant from DOE Sustainable and Holistic INtegration of Energy Storage and Solar (SHINES) to deploy PV + storage
  - Integrating smart inverter, PV, storage required reconfiguration of an existing feeder to serve 2.5 MW load
  - ComEd was required to file certifications to get from phase 1 to phase 2 – 1/3/19 certification that microgrid master controller was operating satisfactorily and within design parameters; 5/6/19 certification that project meets specifications to receive SHINES funding; proceed to phase 2 (adding 4.5 MW load and 7 MW controllable generation resources)
  - ComEd would own battery storage, which would function as part of distribution grid; ComEd would not own the remainder of the project DER
  - Expenditures would be recorded as distribution costs; revenues from DERs recorded as a reduction of unaccounted for energy
  - Retail electric customers within the footprint would be able to choose alternative suppliers but would be billed for delivery services by ComEd, islanding would not affect customer choice
  - Annual reports filed each February
  - Conclusion of ten-year period will deliver another longer summary report
- California: EPIC program

- In response to public safety power shutoffs (PSPS) to avoid wildfires – lasting up to 8 days – Electric Program Investment Charge (EPIC) program started
- CPUC oversees three large R&D programs to drive investment in emerging technologies, one of which is EPIC – goals to increase reliability, safety, and drive down costs
- CPUC gives direction to program administrators, IOUs, California Energy Commission
- In 2015, approved CEC program on microgrid R&D
- PEER program preceded EPIC – started CEC work on challenges to interconnecting DERs
- 2015: started investigation of a fully functional resilience solution – funded 4 microgrids focused on critical facilities, 3 on integrating a large number of DERs (wrapped up last year)
- New funding for 9 microgrids to create commercially replicable microgrid solutions
- Maturity of controllers is improving, substantial savings on a day-to-day basis for 7 existing projects – several companies started microgrid offerings as a result
- Variety of microgrids tested: 40 different microgrids having been funded or currently receiving funding (many non-microgrid EE and DER programs added microgrid controls) across state
- Variety of applications: critical facilities, major ports, military installations, communities, industrial facilities that are all potential customers
- Small microgrid package available for small customers like fire stations, financed with PPA; cloud-based control software to manage multiple microgrids
- Airport seeking multi-customer microgrid: CCA owns everything behind the meter, PG&E owns everything in front – working on tariff to clarify power and money flows
- Blue Lake Rancheria: casino and Red Cross community shelter, able to island during recent PSPS and provide services to community (shelter, phone charging, hotel rooms for medically vulnerable customers, power to gas station) – estimate the microgrid saved 4 lives, tribe is doubling the size
- SDG&E-owned microgrid that can power community for 4 – 6 hours; at end of transmission line vulnerable to storms; has received DOE funding
- CEC workstream on energy storage: diversifying types available beyond lithium ion
- CA legislature can get very technical on issues – CPUC opened rulemaking in September 2019
- CPUC allowed utilities to de-energize T&D lines to avoid wildfires (PSPS) under dangerous circumstances
- Demand for microgrids is particularly high in communities susceptible to PSPS
- Microgrids and resilience order instituting rulemaking (OIR) looks for achievements on three tracks: near-term actions in early 2020 (Q2) to issue proposed decision, long-term evaluation of standards, rates, and tariffs to support more microgrids and comply with GHG reduction targets in CA

- Rhode Island
    - Identified energy and resilience as a lifeline sector by Emergency Management Association
    - 2014 Resilient Rhode Island Act established Executive Climate Change Coordinating Council, set GHG reduction targets and adaptation strategies for cities and towns
    - 2017 Celtic Energy report on resilient microgrids for critical services, with policy goals ranging from easy (set goals, create demonstration projects on state property) to medium (design and run microgrid incentive program) to hard (identify and fix right of way issues, create interconnection standards for large multi-user microgrids)

  - Energy office ran out of resources in 2017, delayed further action until 2018 hire of director of stormwater and resilience in governor's office
  - Resilient Rhody (July 2018) contains priority actions for statewide resilience, need for OER to work collaboratively with municipalities
  - Resilient Rhody also created Municipal Resilience Program at RI Infrastructure Bank to support cities and towns in identifying hazards, challenges, and strengths; funding to help projects move forward
  - Executive order for 100% renewables by 2030, OER wants to include storage and microgrids given limited land availability and interconnection challenges
  - Microgrid incentive program design: workshop hosted by NASEO in August 2019
  - Working group is providing feedback for incentive program design for $1.5M in Regional Greenhouse Gas Initiative funding
- New Jersey: Key constraint right of way challenge
  - Superstorm Sandy spurred internal and external reports, key turning point in 2015 with delivery of energy master plan, which had microgrids baked in (first time in master plan)
  - In 2017, established town center DER microgrid program, solicited applications statewide for feasibility studies, received 13 applications from cities, municipalities, counties, funded $2.2M for studies
  - Now, preparing application for detailed design phase with $4M budgeted for 12 participants (1 of 13 dropped out)
  - Solicitation will encourage reduced GHGs, integrating storage, and cost sharing
  - Design applications will be competitive
  - Feasibility studies included options and future plans – need to finalize
  - No construction funding yet
  - DERCAM has helped to maximize storage and clean energy
  - Interested in increasing use of EV charging and reducing peak demand via microgrids
  - Cat 3 and 4 FEMA critical facilities are of interest (i.e. hospitals, fire stations), as well as public shelter locations
  - Want applicants to submit in conjunction with distribution company, discuss ratepayer impacts and who pays for and benefits from the microgrid – what about those beyond the core of the microgrid?
  - Not mandating undergrounding or any specific resilience measures – looking at effectiveness in keeping electricity service during a storm
  - Overall effect of microgrids on distribution system and avoiding T&D costs
  - Financing advanced microgrids: NJ received DOE grant of $300,000, hired NJ Institute of Technology and Rutgers in developing financing options
  - Two stakeholder meetings with municipalities, consultants, electric utilities, NARUC, NASEO, and DOE
  - Benchmarking programs around the country
  - Using a variety of funding streams: FEMA, HUD, EE savings, green bank
  - NJ Energy Resilience Bank runs on HUD money
  - DBOOM: design, build, own, operate, and maintain
  - Key constraint is right of way on privately owned wires
  - Should a microgrid save ratepayers money? Should utilities be involved? Is rate basing an appropriate financing mechanism? Should new microgrid-specific tariff be established?
  - Report in mid 2021

Breakout Sessions

The Utility Role in Microgrid Development, Maintenance, and Cost Recovery

- Compensation levels for resilience:
    - FEMA metric for resilience developed, used for funding: $150 per person per day
    - Florida statewide outage: $1 billion a day $50 per person per day
- How to get to conversation going with utilities, innovative proposals without NWA legislation – how can we talk to utilities? Without IRP-levers?
- Traditional solutions usually proposed first by utilities, because familiar concepts
- MISO plan for really big needs give state some information
- Grid mod and microgrid connection – when do you need microgrids?
- What is definition of a microgrid – when is it just a small grid?
- How do you not duplicate what utilities are doing
- Regulation as a benefit to consumers – utilities know where vulnerable customers are located

Microgrid Ownership Structures, Business Cases, and Financing Option

- Number of cases in which utilities and private parties work together. Where do they come together if they have already made plans without each other?
- What does the utility existing system need? What should private parties provide?
- Elements common to microgrid:
    - Combination of load generation and/or storage under the control of a microgrid controllers within a boundary
- Community microgrids
    - Sweeping in multiple customers (could be town hall, fire station, senior center, etc)
- NYSERDA: community microgrids build on existing resources and equipment, connecting multiple facilities
- Can be multiple players in microgrid development
- Beneficiaries:
    - Customers who are connected to microgrid get a set of benefits (resiliency, cost savings, peak shaving, DER integration)
    - Benefits to system: voltage support, etc that supports wider grid.
    - Public: may benefit from having services available, power to access critical needs
- Revenue streams:
    - Demand response, REC sales, etc.
- Marcus Garvey Housing project (part of BQDM)
- Moco microgrid: Microgrid-as-a-service. We provide the asset, you pay us over time.
- Utility-owned microgrid:
    - Borrego Springs (demo project in CA)
    - Duke Energy
        - Do microgrid for transmission tower? Due to reliability issues. Keeps cell tower going. Usually cell tower resilience is also propane generator. Duke project in NC: Mt. Sterling.

        - Hot Springs microgrid ($30 million total cost): frequency and voltage regulation, ramping support, lessons from deployment of utility-scale battery storage. Commission has approved this microgrid to be rate-based. Using in place of new transmission line due to reliability issues. Treating it as a distribution system investment. But utility convinced commission that benefits would be to entire system, so could pass cost to all ratepayers and use as a learning experience on how to allocate costs of future projects.
- Microgrids that can improve the grid system overall will fare batter with Commissions
- What types of markets can microgrids reach? Who can they sell their benefits to?
- CA resource adequacy program: load-serving entities allowed to participate, microgrids do not fall into that category, so can't receive capacity payments for being on standby capacity, can't participate in RTO.
- What is the correlation between who the beneficiaries are and how the value stack is being activated?
- Access DRRA funds for microgrids? That's tricky to meet all criteria.
- DC: one idea that keeps coming to us from microgrid developers – the regulatory regime needs to allow them to sell power, aggregate services. That would help them pay for themselves.
- BRIC funding for microgrids
- CA: utilities want to rate base microgrids
    - Would potentially want to see energy-as-a-service model be used for microgrids to reduce risk for ratepayers
- How to give utilities an economic model that makes them a "plug-and-play" platform instead of the role they play now?

Quantifying Resilience and Other Economic Benefits of Microgrids

- NARUC/Converge paper cited three examples of IOUs bringing resilience investments before commissions (2 in MD, 1 in IL)
    - Resilience was not fully quantified, although one used DOE's Interruption Cost Estimate calculator
    - Two investments were denied in MD, one was allowed in IL
- Four examples of valuation methodologies for resilience outside of commissions
    - Stated preference: contingent valuation (ICE Calculator)
      NREL integrated a value of resilience into its economic analysis of the three sites. NREL used the Interruption Cost Estimate (ICE) Calculator tool, developed by LBNL. The ICE Calculator estimates the avoided cost of power interruptions for specific customer types in different parts of the country and for different durations (i.e., the "customer damage function" or CDF). The CDF values are developed from a meta-analysis of 34 different survey datasets collected by 10 utilities across the country from 1989-2012. The surveys employed a contingent valuation approach to assess customer willingness-to-pay for avoiding power interruptions as it relates to grid reliability.
    - Revealed preference: damage cost (Industrial Economics Inc. model, FEMA BCA tool)
      The IEc model includes an estimate of the benefits for avoiding major power interruptions, which it breaks into two categories: the benefits of maintaining

commercial and industrial (C&I) services and the benefits of maintaining critical services. The IEc model uses the ICE Calculator to quantify the C&I services component of the benefit calculation. To determine the benefit of maintaining critical services, the model uses the Federal Emergency Management Agency (FEMA) Benefit–Cost Analysis (BCA) approach, which incorporates a damage cost methodology. FEMA developed this methodology in order to conduct cost-benefit analyses for its Hazard Mitigation Grant Program. The methodology uses location-specific information—such as the size of the population served and the power interruption duration at that location—as well as some standardized equations to estimate the costs of degraded fire, police, and emergency services. The costs associated with critical services are based on assumptions about the value of lives saved and injuries prevented.

    - Input-output analysis (IMPLAN)
      Input-output analyses are economy-wide models that show how processes binding the regional economy are affected by a shock, policy, or change of economic circumstances. An input-output model can quantify (often disproportionate) changes that one economic sector can have on the entire regional economy. The model does so by translating changes in productivity in one sector to changes in demand in the regional economy. An input-output analysis can represent all inter-industry relationships or flows in an economy; namely, how outputs of some industries are used as inputs to others. IEc used IMPLAN—a commercially available input-output tool with historical datasets that allows users to model economic impacts.
    - Revealed preference: defensive behavior (generator cost calculation for DOD)
      The Pew study analyzes scenarios in which small-scale diesel generators connected to individual buildings at military bases in different parts of the country are replaced by large-scale diesel generators installed as part of a microgrid. The Pew study argues that attempts to identify a value for resilience are "misguided." Since DoD requires the installation of a standalone diesel generator at every building that houses a critical load, the study argues, the cost of a standalone diesel generator (including up-front capital, O&M, and incremental fuel costs) should "represent the value (price) that DoD…places on energy security." The study further argues that "the value of energy security should be determined by the least-cost method of providing that security"—i.e., of avoiding damage from the power interruption in the first place. "Currently, standalone generators represent that least cost method." This approach to valuation can be viewed as a form of defensive behavior methodology. The defensive behavior method assumes that electricity users act rationally and insure themselves against damages caused by power interruptions when it is economical to do so. Customers purchase back-up generators until the expected marginal cost of additional back-up power equals the expected marginal cost of a power interruption.
- No one method is perfect, but all have strengths and weaknesses and can be adopted/adapted at commission level
- Community resilience: ability of residents to access energy services
    - Focus on human impacts of an outage, which escalate over time

Planning for Working Group Success

- Potential webinar with SEPA – microgrid resilience for natural disaster (wildfires, natural disaster)
- DC grid mod initiative – regulatory treatments of microgrids
- Reports/Information
    - Power Path DC Commission Report
    - CA – inverter standards, interconnection barriers, tariff modification – staff proposal
    - PR microgrid tariff
    - NJ procurement models – with DOE support
- Compiling resources on NASEO and NARUC's website

Second Day, Thursday, February 13, 2020

Webinar recording: https://youtu.be/aI_feDFHni0

During the second day, DOE, the national labs and EPA provided an overview of different tools available to assist deployment of microgrids. There is no single tool that can truly optimize the design, so a suite of tools is needed.

Sandia: Designing Resilient Communities	
Goal	To develop an approach for identifying and prioritizing grid investments targeted at improving community resilience
Method	Guiding questions for communities and accompanying modeling tool (mathematical framework to calculate, project, and improve resilience) to develop metrics of consequence (community and economic measures)
Use Cases	Sandia has worked with Norfolk (VA), New Orleans (LA), and Puerto Rico to propose measurement units for resilience metrics that work within current planning paradigms and convey the goals and benefits of resilience-enhancing investments
Availability	Not publicly available – Sandia provides tool with technical assistance (with DOE funding)

Discussion and Q&A	- Cities have not yet implemented the design
	- How is extended power measured and defined?
	    ○ New Orleans used multiple days
	- What data and tools would a city need to provide?
	    ○ Historical data key – system performance over historical parameters
	    ○ SAIDI and SAIFI scores
	    ○ Sandia to provide regional data, complimentary data (i.e. coastal area data from other coastal area)
	- Tool can be downsized
	- How were the initial cities selected?
	    ○ Number of demonstration projects in PR
	    ○ New Orleans approached Sandia

	○ DOE addresses resilience – DOE prioritizes cities and locations based on the impact and scale and then leverage resources from labs (GMLC process) ○ Norfolk DOD facility – one of the locations to support critical infrastructure

NREL: REopt Energy Integration and Optimization Model (ReOpt and ReOpt Lite)	
Goal	To model optimal economic & resilience benefits of DERs
Method	Capacity expansion model for behind the meter to find value proposition of DER for facility owners for site (primary users are facility owners and operators). ReOpt Lite has two modes: financial and resilience: • **Financial mode** optimizes PV, wind, and battery system sizes and battery dispatch strategy to minimize life cycle cost of energy • **Resilience mode** optimizes PV, wind, and battery systems, along with back-up generators, to sustain critical load during grid outages and to minimize life cycle cost of energy
Recent Updates	**October 2019:** Resilience Modeling, Diesel Generator Sizing, Load Profile Dashboard, Utility Rate Help, International Guidelines, and Updated Cost Assumptions **February 2020:** Release of Open Source version of REopt Lite
Availability	Free web tool
URL	https://reopt.nrel.gov/tool

EPA: CHP Energy and Emissions Estimator Tool	
Goal	To provide education and overview of the role of CHP in microgrids, resilience, and grid integration
Method	• The CHP Emissions Calculator calculates the difference between the anticipated CO_2, methane (CH_4), nitrous oxide (N_2O), SO_2, and NO_x emissions from a CHP system to those of a separate heat and power system. • The Calculator uses fuel specific CO_2, CH_4 and N_2O emissions factors from the EPA's GHG Reporting Program, region specific Transmission & Distribution (T&D) loss values, and data from eGRID 2012.
Case Study	Microgrid in Milford, CT with solar PV and CHP under CT DEEP • 2x 146 kW natural gas CHP systems; 120 kW PV array with battery storage

	• Estimator tool provides amount and percent reductions in NO_x, SO_2, CO_2, CH_4, N_2O, total GHGs, fuel consumption, and passenger vehicle/electricity generation GHG equivalents
Updates	• Current tool to be updated to include key renewables for which CHP is a grid-balancing, dispatch-flexibility resource. • DOE models provide more depth; EPA estimator is a simple educational tool
Availability	Free web tool
URL	https://www.epa.gov/chp/chp-energy-and-emissions-savings-calculator

EPA: Regional Resilience Toolkit	
Goals	• Emphasize the need for action, not process, to move the needle on resilience-building (including a whole step on funding). • Integrate various plan requirements or efforts into a single process to bring partners to the same table and create a common action plan. • Coordinates local action to amplify disaster resilience within a regional context.
Method	• Sets up coordination of activities between EPA's community technical assistance programs and FEMA's disaster recovery planning and hazard mitigation programs. • Seeks to provide lessons learned for EPA, FEMA, and other federal agencies that can be used to build a stronger federal framework for mitigation planning as well as post-disaster recovery planning and operations. • **Engage:** build trust between stakeholders, map partners, define common terms • **Assess:** set goals, describe and prioritize hazards, summarize assets and vulnerabilities • **Act:** develop and prioritize strategies, write implementation plans • **Fund:** build network of funders, consider range of funding sources • **Measure:** outputs and outcomes, self-evaluation, measure and refine • Seeks to provide a collaborative framework for policy work related to both hazard mitigation planning and climate change adaptation to create more resilient communities.
Availability	Free web report
URL	https://www.epa.gov/smartgrowth/regional-resilience-toolkit

LBNL: Distributed Energy Resources Customer Adoption Model (DER-CAM)	
Goal	Finding optimal distributed energy resource (DER) investments in the context of either buildings or multi-energy microgrid
Method	In the process of finding optimal DER solutions for microgrids through mathematical modeling, several important questions are answered by DER-CAM: • What is the optimal portfolio of DER that meet the specific needs of this microgrid? • What is the ideal installed capacity of these technologies to minimize costs? • How should the installed capacity be operated so as to minimize the total customer energy bill? • Where in the microgrid should distributed energy resources be installed and how should they be operated to ensure voltage stability? • What is the optimal DER solution that minimizes costs while ensuring resiliency targets?

Discussion and Q&A	• Additional case studies available (NC, OR, FL)
	• Are costs for interconnections factored into the model?
	  ○ Not taken directly into account
	• What are the differences between ReOpt, DER-CAM, and HOMER? Which one should be used when?
	  ○ Homer simulation vs. optimization tool (case studies have table outlining this)
	  ○ DER-CAM looks deeper into distribution system

Availability	Free web tool
URL	dercam.lbl.gov

Action Items:

- NASEO and NARUC to share a summary of workshops, slides, and recording.
- Sandia to share report on framework use in Puerto Rico and New Orleans
- NASEO and NARUC to develop a working group call and webinar schedule and topics for webinars
- NASEO and NARUC to develop a resource website and incorporate resources from workshop and working group engagement