Regulating for Resilience Workshop

Dr. Robert Jeffers and Dr. Mercy DeMenno
Agenda & Introductions
Agenda

1:00 – 2:00 Introductions and Opening Discussion (60 minutes)

2:00 – 3:15 Stakeholder Presentations (75 minutes)
  ◦ Sandia National Laboratories
  ◦ National Association of Regulatory Utility Commissioners
  ◦ Critical Consumer Issues Forum
  ◦ U.S. Department of Energy, Office of Electricity
  ◦ U.S. Department of Defense, Army Office of Energy Initiatives

3:15 – 3:30 Break (15 minutes)

3:30 – 4:15 Breakout Discussions (45 minutes)
  ◦ Defining and Measuring Resilience
  ◦ Valuing Resilience
  ◦ Regulatory Approaches for Resilience
  ◦ Resilience Mitigations and Investments

4:15 – 4:45 Breakout Discussions Report Out (30 minutes)

4:45 – 5:00 Closeout (15 minutes)
Introduction Topics

• Name, role, and organization
• Are you now or are you expecting to be in a proceeding or other process involving grid resilience?
• What keeps you up at night (i.e., the threats to which you want to be resilient and how those threats could drive negative consequences of concern)?
Regulating for Resilience Workshop
Electric Grid Resilience Analysis

PRESENTED BY
Dr. Robert Jeffers and Dr. Mercy DeMenno
We’ve been working hard

A considerable body of recent DOE research has focused on quantification and valuation of grid resilience. This is an incomplete list:

GMLC 1.1: Foundational Metrics
GMLC 1.2.4: Grid Services Valuation Framework
GMLC 1.3.04: Industrial Microgrid Analysis and Design
GMLC 1.3.11: Analysis and Design for Resilience in New Orleans
GMLC 1.4.17: Extreme Event Modeling
GMLC 1.4.29: Future Electric Utility Regulation
GMLC 1.5.06: Designing Resilient Communities
GMLC 1.5.07: Lab Value Analysis Team
+ New GMLC projects awarded in FY20

The North American Energy Resilience Model
Several projects supporting resilience and recovery in Puerto Rico
Programs: Institutional Support, Advanced Grid Modeling R&D, Storage R&D, Microgrid R&D, Systems Integration, etc.

https://gmlc.doe.gov/projects
Defining resilience as it pertains to the grid

“The term ‘resilience’ means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.” – PPD 21

1. Resilience is contextual – defined in terms of a threat or hazard
   - A system resilient to hurricanes may not be resilient to earthquakes

2. Includes hazards with low probability but potential for high consequence
Three distinct goals for grid performance can be categorized by these dimensions:

- Features/attributes of the grid can enable performance along these dimensions.
  - A non-exhaustive list is illustrated here.
  - Performance in one dimension can improve or hinder performance in another.

Goals may be pursued independently or collectively through regulatory processes.

Comparing Resilient, Sustainable, and Efficient Systems
Resilience vs. reliability

The tail is not only long – it can change drastically year-over-year

This highlights the challenge of relying on historic measurement to predict future grid performance

Extending grid performance to consequence includes additional challenges
Analytical processes

Analytical processes for resilience quantification must tackle these four dimensions:

THREATS ➔ IMPACTS ➔ PERFORMANCE ➔ CONSEQUENCE

Hurricane ➔ High Winds ➔ Power Served ➔ Gross Municipal Product
Flooding ➔ Inundation ➔ Commute Time ➔ People Without Services
Heatwave ➔ Overloading ➔ Water Served ➔ Total Population
Consequence-focused metrics

Consequence can be further decomposed into three categories:

<table>
<thead>
<tr>
<th>Measure Classification</th>
<th>Example Metrics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Measures</td>
<td></td>
</tr>
<tr>
<td>Number of People Without Necessary Services</td>
<td></td>
</tr>
<tr>
<td>Quality-Adjusted Life Years</td>
<td></td>
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<tr>
<td>Societal Burden to Acquire Services</td>
<td></td>
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<tr>
<td>Economic Measures</td>
<td></td>
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<tr>
<td>Repair and Recovery Costs</td>
<td></td>
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<tr>
<td>Business Interruption Costs</td>
<td></td>
</tr>
<tr>
<td>Gross Municipal Product Losses</td>
<td></td>
</tr>
<tr>
<td>National Security Measures</td>
<td></td>
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<tr>
<td>Ability to serve mission essential functions</td>
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</tbody>
</table>
Example: Societal Burden to Acquire Services

Advancing social metric quantification for grid investment portfolio evaluation

Bringing it together – a process for integrated resilience planning

Resilient Community Design Framework:
- Additional process that can be integrated with existing planning frameworks

1) Resilience Drivers Determination
- Multi-stakeholder definition of:
  - System
  - Threats
  - Goals
  - Metrics

2) Baseline Resilience Analysis
- Baseline Impact Analysis
- Baseline Resilience Metrics

3) Resilience Alternatives Specification
- Policy, Market, and Technology Screening
- Resilience Mitigations Identification

4) Resilience Alternatives Evaluation
- Resilience Metrics Improvement Analysis
- Multi-Stakeholder Decision-Making

Phase 1: Technology Investments
- Resilient, Sustainable, Efficient, Affordable Communities

Phase 2: Regulatory Frameworks

Phase 3: Utility Business Models
NARUC/Converge/PJM Team
SOLAR PV FOR ADVANCED SYSTEM RESILIENCE AND RESTORATION
AGENDA

- Project team and context
- What’s being done today?
- What’s needed next?
PROJECT OBJECTIVES
(MARCH 2018 – NOVEMBER 2019)

- Understand how DERs can contribute to system resilience
- Develop a quantifiable value of resilience and performance metrics to measure success
- Improve the cost-effectiveness of DERs
- Increase DER deployment and improve system resilience
TEAM MEMBERS

- National Association of Regulatory Utility Commissioners
- Converge Strategies
- PJM Interconnection
- Convened advisory committee of state regulators and commission staff to provide input and feedback on scope and work products
- Hosted three facilitated workshops with PJM and NARUC stakeholders
- Produced two white papers on state commission approaches to resilient DERs (NARUC) and valuation methodologies for resilience (Converge)
- Produced a list of questions and resources for regulators to tackle resilience related to DERs (NARUC)
- Connected with local, state, and national organizations engaged with energy resilience
SOLAR ENERGY INNOVATION NETWORK (SEIN) PROCESS

NARUC Meeting
- August 14, 2018
- Scottsdale, AZ

PJM Meeting
- September 27, 2018
- Audubon, PA

NARUC-PJM Meeting
- November 14, 2018
- Orlando, FL

- Facilitated by RMI
- Attended by NARUC advisory committee of commissioners and staff, PJM stakeholders, other stakeholders
- Selected technical presentations from team members, NREL, project developers
State regulators want to have this conversation and are interested in state-level actions
Resilience is not a direct focus but is a critical element of commission work
Regulators are interested in learning from and replicating successful approaches in other states
Lack of applicable valuation methodologies for resilience is a major barrier
RELIABILITY VS. RESILIENCE

Routine, common disruptions - local, and smaller in scale and scope

VS.

High impact, large-area, long-duration outages
WHERE ARE WE ON THE RESILIENCE MAP?

You are here
Project team and context
What’s being done today?
What’s needed next?
What definitions and valuation methods for resilience currently exist?
What are the characteristics of resilient DERs?
What state-level policies are in use to encourage DER deployment? Do these policies encourage resilient DERs?
Can regulators make incremental changes to enable DERs to deliver resilience benefits?
What else is needed to move forward?
Characteristics of resilient DER

- Dispatchability
- Island capability
- Critical loads/locations
- Fuel security
- Quick ramping
- Grid services
- Decentralization
- Flexibility
Looked at popular state-level policies to encourage DERs such as Renewable Portfolio Standards, advanced rate structures, resource planning.

Mapped each policy to resilient DER characteristics.

Found that existing policies encourage some but not all characteristics.

With incremental changes, state policies can incentivize full range of characteristics and stimulate resilient DER growth.

### Table 4.1 Key Resilient DER Characteristics that Can Be Encouraged by Types of Regulatory Processes and Policies

<table>
<thead>
<tr>
<th>Key Resilient DER Traits</th>
<th>REGULATORY PROCESSES AND POLICIES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Integrated Resource Planning</td>
</tr>
<tr>
<td>Dispatchability</td>
<td>•</td>
</tr>
<tr>
<td>Islanding Capability</td>
<td>•</td>
</tr>
<tr>
<td>Siting at Critical Loads / Locations</td>
<td>•</td>
</tr>
<tr>
<td>Fuel Security</td>
<td>•</td>
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<tr>
<td>Quick Ramping</td>
<td>•</td>
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<tr>
<td>Grid Services</td>
<td>•</td>
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<tr>
<td>Decentralization</td>
<td>•</td>
</tr>
<tr>
<td>Flexibility</td>
<td>•</td>
</tr>
</tbody>
</table>
HAVE REGULATORS IDENTIFIED A VALUE OF RESILIENCE FOR DER?
<table>
<thead>
<tr>
<th>Utility</th>
<th>Baltimore Gas &amp; Electric</th>
<th>Commonwealth Edison</th>
<th>Pepco</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proposed Microgrid</td>
<td>Columbia, MD (Kings Contrivance)</td>
<td>Chicago, IL (Bronzeville)</td>
<td>Largo, MD Rockville, MD</td>
</tr>
<tr>
<td>Location</td>
<td>Baltimore, MD (Edmonson Village)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Cost</td>
<td>$16.2 million</td>
<td>$12.6 million</td>
<td>$63.7 million</td>
</tr>
<tr>
<td>Technologies</td>
<td><strong>Columbia, MD:</strong> Natural gas (2 MW)</td>
<td><strong>Phase 1:</strong> Solar PV (0.75 MW) Battery storage (0.5 MW) Diesel (3 MW)</td>
<td><strong>Largo, MD:</strong> Natural gas (5.6 MW) Solar PV (1.18 MW) Battery storage (1.85 MW) <strong>Rockville, MD:</strong> Natural gas (6.6 MW) Solar PV (0.86 MW) Battery storage (0.25 MW)</td>
</tr>
<tr>
<td>Included:</td>
<td><strong>Baltimore, MD:</strong> Natural gas (3 MW)</td>
<td><strong>Phase 2:</strong> Controllable generation (7 MW) (most likely natural gas)</td>
<td></td>
</tr>
<tr>
<td>Resilience Analysis</td>
<td>Resilience acknowledged as a distinct benefit, but not quantified or valued.</td>
<td>Resilience acknowledged as a distinct benefit, but not quantified or valued.</td>
<td>Pepco calculated “resiliency savings” for microgrid participants using the Interruption Cost Estimate (ICE) tool. The PSC determined that a value for community resilience could not be quantified.</td>
</tr>
<tr>
<td>Approved by</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Regulators?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasons for Decision</td>
<td>- Reliance on single fuel</td>
<td>- Community learning benefits justified socialization of costs across ratepayers</td>
<td>- Resilience benefits not quantified - Grants and other funding mechanisms to support project not pursued - Unequal distribution of benefits to ratepayers.</td>
</tr>
<tr>
<td></td>
<td>- Renewables/storage not incorporated</td>
<td></td>
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<tr>
<td></td>
<td>- Unequal distribution of benefits to ratepayers.</td>
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<tr>
<td></td>
<td>- The concept of a “major event” was not defined</td>
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</table>
AGENDA

- Project team and context
- What’s being done today?
- What’s needed next?
REMAINING QUESTIONS FOR STATE REGULATORS

- Demonstrations of DERs delivering resilience
- System operators have difficulty factoring customer-owned DERs into system visualization
- Tension between simplicity for ratepayers and economic efficiency for the system
- Choosing which projects can get cost recovery through rate base: allocating costs and benefits of resilience investments, defining utilities’ share of revenue from resilient DERs, getting ownership structures right
AVENUES FOR CONTINUING THE RESILIENCE CONVERSATION

- State regulators continue discussion of what resilience means
  - Fuel security and diversity
  - Distributed generation
  - Transmission and distribution planning
  - Critical infrastructure coordination
- NARUC CPI is facilitating a state working group on microgrids and system resilience to keep focus on distribution-level resilience
National Council on Electricity Policy
Mini Guide: “State Agency Coordination During Energy-Related Emergencies”

https://pubs.naruc.org/pub/41DF9BEF-DEFF-B995-4865-37AB2367FA84
Resilience Decision Framework

November 20, 2019

NARUC 2019 Annual Meeting

Johanna Zetterberg
Investor utility distribution spending has risen from ~$14b in 1999 to ~$39b in 2019 – resilience planning should inform investments in most categories (blue categories)

Source: EEI (October 2019)
What is the Need?

- A larger number of states are concerned with distribution resiliency recognizing the need from several dimensions
  - Increasing severity of resilience events
  - Increasing exposure to multiple threats
  - Need to optimize growing distribution investment to address multiple objectives including customer affordability

- Challenge is that distribution planning has grown in complexity given the multiple objectives, uncertainty and technological advancements in solutions

- Distribution resilience planning has largely been about hardening, response and recovery, but given the digitalization and increasing adoption and utilization of DER - resilience challenges significantly expanded

- Unlike Bulk Power System, the resilience planning methods and tools are largely immature or non-existent - robust decision making methods and models are needed to support regulators and utilities
State Integrated Distribution Planning Activity

Regulatory Commissions Pursuing Integrated Distribution & Resilience Planning Initiatives
The fundamental difference is the scale, scope and complexity of an event’s impact and subsequent outage duration

Distribution resiliency events involve similar types of infrastructure failures (e.g., wire down, poles broken, transformer failure, fuses blown, etc.) involved with reliability events but at a greater scale which creates significant complexity to address. Additionally, adversarial threats pose an increasing level of risk to distributed power networks.

**Resilience Events:** Larger geographic impact on distribution and/or bulk power system with long duration outage (typically greater than 24 hours & classified as “Major Events” following IEEE Std. 1366)

**Reliability Events:** Local impact with short duration outage (generally less than 24 hours & not classified as “Major Events” following IEEE Std. 1366)
Roles and Responsibilities

Scale of potential impact shapes who will be involved in process

How should roles, responsibility and coordination be considered in this or other contextual approach?

Note: Diagram is simplified - cities, communities, emergency services, DOD and other key stakeholders are all part of the process
Coherence Across Policy Making and Implementation Domains

### State Policy Makers

- **Legislatures and Governors**
  - Develop policy goals
  - Required plans and objectives
  - Fund improvements
  - Require utility coordination and oversight (ex: coordination & data-sharing among state agencies, eg, sharing cybersecurity information and practices, and conducting independent evaluations)
  - Facilitate specific risk mitigation strategies

- **Public Utility Commissions**
  - Set substantive and procedural requirements for plans, including
    - Setting objectives, based on state policy goals and customer expectations
    - Establishing scope and timing requirements based on priorities
    - Establishing metrics to measure performance
    - Determining cost recovery mechanisms
  - Approve or accept plans
  - Fund improvements (cost recovery approval through and/or outside General Rate Case)

- **System Owners & Operators**
  - Utilities
    - Develop plans
      - Align objectives
      - Develop long-term strategy and short-term implementation plans integrated with current planning processes
      - Prioritize short-term vs long-term needs through risk assessments
      - Coordinate planning and operations
      - Re-design business practices
      - Establish staged, technology deployment plans and cost estimates
    - Implement approved plans

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Stakeholder Input Processes
Resilience Solutions – Societal Benefits

- Policymakers, regulators, utilities and customers are considering and implementing various point & community solutions
  - Community: Hybrid Microgrids, Mini-grids, Cyber-Physical Grid, etc.
  - Point Solutions: Back-up generation, energy storage, customer microgrid, etc.

- Specific solutions don’t necessarily solve all the needs – a portfolio is needed
  - Solutions usually address specific functional resilience needs
  - Solutions have different potential societal benefits based on type of event and severity
  - How to determine an effective portfolio?

- Benefits analysis has significant gaps
  - ICE reliability data focused only on short duration events and sources are dated
  - Regional GDP impact analysis methods haven’t transitioned from academia into practice
  - Social impact analysis for critical and essential facilities immature and not in practice

- Given uncertainty - resilience investments are 20-40 year bets on the future - What techniques can be applied to identify least regrets decisions?
Planning for Distribution Resilience

No single set of distribution resilience planning criteria for any single utility

- Distribution Resilience is a largely ill defined landscape – can we develop organizing frameworks to facilitate decision making now?

  - For example,
    - Distribution resilience events involve various potential scales and scopes based on different events
      - Scale and scope of potential events inform structural considerations and functional requirements
      - Scale and scope shape the economic impact and related value of solutions
    - Suggests that there are no single set of distribution resilience planning criteria for any single utility

- Need to unpack distribution resilience to gain insights for planning approaches and decision making practices
Resilience & Reliability Planning-Operational Lifecycle

Overall lifecycle elements are the same, difference is in addressing the variation, scale and complexity of major events.

**Distribution resiliency planning requires a different set of methods and capabilities to address the variation and complexity.**
Distribution Resilience Planning Process Maturity

Lifecycle elements for **reliability planning are well understood and mature** including related processes, methods, solutions, metrics and valuation.

Lifecycle elements for **resiliency planning are not mature** including processes, methods, solutions, metrics and valuation have **significant knowledge gaps**

- What are the critical issues that practitioners are running into or grappling with?
- What are the critical gaps in resources, tools and methods within the resilience planning workflow?
Principles:

• Logical consistency across policy, regulatory & utility domains (with clarity of objectives in planning processes)

• Whole grid view to understand structural implications and coordination requirements

• Enable effective resilience investment decisions
Potential Needs to Address

- Investor- and consumer-owned electric utilities responsible for distribution of power
- State policy makers and implementers: NARUC, NASEO, NGA, NCSL, NASUCA
- Federal partners with an interest in distribution system resilience: Subject matter experts
Objectives & Criteria

Developing a Common Understanding of Threats & Risks

• Developing a common language to discuss resilience to enable productive discussions among utilities, regulators, stakeholders
• Understanding the potential threat/hazard/risk profiles of a specific geographic location (e.g., utility territory, state, or multi-state region) and specific distribution system in order to determine the related resilience needs

Identifying Roles & Responsibilities

• Need for and examples of coordination/logical consistency across federal and state policymaking, utility regulation, utility planning and other relevant state/local gov't resilience planning
• What are issues regarding the roles and responsibilities for resilience at the grid edge between utility and customer?

What are the planning criteria?

• What resilience metrics are available today for practical use?
• How do/do not existing metrics address resilience?
Identify Solutions

• How can the resilience of operational information, control, and communication systems be addressed structurally? We might consider that utilities and third party providers (DER, SaaS, PaaS, communications, etc.) play important roles in the continuity of power delivery.

• How can regular, ongoing grid component improvements (replacements/upgrades) support resilience? Can the grid be “built back better?”

• How do existing codes, standards, and utility equipment inventory [based on standard design practices] help or hinder resilience?

• Options to improve resilience through tech functions (software & hardware) and operational functions (processes & protocols) as a function of utility size and ability to (or inability) to invest in advanced distribution system technologies.

• How to support resilience of critical facilities/critical loads?
Solution Prioritization

Technical Efficacy of Solutions

- *How do utilities currently prioritize resilience related investments when selecting among options?*
- *What are the low-hanging fruit or no-regrets solutions?*

Risk-Based Cost-Effectiveness Analysis

- *What methods to evaluate costs/benefits of solutions are available today for practical use?*
- *How to quantify or estimate ratepayer benefit?*

Distribution Investment Portfolio Evaluation

- *What are the ‘big-bang-for-the-buck’ solutions – those that are impactful against a multitude of hazards?*
- *Methods for prioritizing alternatives that include ancillary benefits?*

Existing Practice & Knowledge

- *State or utility distribution system resilience activity, pilots, compendiums of resources available?*
Integrated Planning

Integration of Distribution Planning Processes
• How are states and utilities integrating resilience considerations into plans and planning practices (e.g., grid modernization, asset management plans, CapEx plans, distribution system plans, rate cases, integrated system plans)?
• How do distribution grid vulnerabilities (and efforts to make the distribution grid more resilient) interplay with bulk electric grid vulnerabilities and critical energy infrastructure (heightened concern for physical and cyber security)?
• How to address the challenge of resiliency along with DERs, NWAs and other tech being integrated with the grid?

Distribution Structure/Architecture
• What are the implications of treating resilience in planning as an “overlay” vs “built in from the ground up”?
• How can current reliability requirements and programs be leveraged to also promote resilience?
• How circuit or substation level distribution infrastructure can be structured for resilience – including role of microgrids (campus and community types), T-D interface considerations, and other distribution system structural considerations?
• What are the resilience limitations, risks and opportunities specific to different utility load density designs/grid configurations under common vs. extreme stresses (e.g., urban secondary networks, sub-urban preferred/alternate loops, and rural radial)?

Planning Methods & Tools
• What planning methods, practices, and tools exist for assessing how distribution infrastructure vulnerabilities interplay with other critical infrastructure (e.g., telecom, water/wastewater/storm water, etc.)?
Thank You

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Regulating for Resilience Workshop

Mr. Michael McGhee, P.E.
Executive Director
U.S. Army Office of Energy Initiatives

20 November 2019
The Office of Energy Initiatives seeks to ensure energy resilience for installation infrastructure supporting critical Army missions

- Central program management office for Army's development, implementation and oversight of large-scale alternative energy projects that leverage private investment and financing

- Secures Army installations with energy that is resilient, affordable and sustainable

- Many efforts focused on creating a longer-duration “islandable” capability for days-to-weeks – energy security projects include onsite generation, storage, and controls

Hurricane Michael Left 1.2 Million Without Power

America’s Electric Grid Has a Vulnerable Back Door—and Russia Walked Through It
10 USC 2911 Energy Policy of the Department of Defense

(a) The Secretary of Defense shall ensure the readiness of the armed forces for their military missions by pursuing energy security and energy resilience.

Anticipate and prepare;
Adapt to changing conditions;
Withstand;
Respond to;
Recover rapidly from disruptions

5 Phases of resilient energy operations

5 “Musts”

Power capabilities must match the threat
Personnel must be trained
Facilities and equipment must be maintained
Fuel and supplies must be available
Personnel and resources must be reliable
An effective energy resilience program requires resourcing, maintenance, and sustainment

- Not Enough Time
- Not Enough People
- Not Enough Money
The “OEI Way” to Acquire Resilient Infrastructure

Assemble Comprehensive Solutions in a “Building Blocks” Approach
OEI identifies and develops energy resilience project opportunities by:

- Supporting assessments
- Conducting financial and technical analysis
- Identifying financing strategies
- Developing courses of action
- Facilitating solutions
- Coordinating project from development to execution

OEI can assist in the technical and financial evaluation of energy resilience project opportunities at installations in order to provide recommendations to best meet installation energy resilience needs.
50 MW Multi-fuel Plant / 30-Day Microgrid

- Hawaiian Electric constructed, owns and operates the generation plant to provide three installations with 100% of energy requirements during a grid outage.
- Located above the tsunami inundation zone, the plant is equipped with “blackstart” capability; 5 days of fuel storage onsite and 30 days of fuel storage on the island.
- Enhances Oahu grid resilience and provides power to the community during an outage.
Breakout Topics
Breakout Topic 1: Defining and Measuring Resilience

- How are existing definitions of resilience operationalized?
- Is resilience threat-agnostic or threat-informed? Are threats acute or chronic?
- Are metrics attribute- or performance-based? Do metrics measure performance and consequence?
Breakout Topic 2: Valuing Resilience

• How is resilience prioritized relative to other goals/mandates (e.g., reliability, sustainability)?
• How are different resilience metrics/consequences prioritized?
• What are the methodological/implementation challenges associated with valuing resilience?
Breakout Topic 3: Regulatory Approaches for Resilience

- How are commissions currently incorporating resilience into regulatory processes? Given existing authorities and resources, what are some (potentially unrealized) options?
- How does the regulatory process in which resilience is embedded affect how it is measured (e.g., cost-benefit analysis requirements)?
- Which aspects of resilience involve entities outside the commission? Who are the key stakeholders and what are the mechanisms (existing or needed) of coordination?
Breakout Topic 4: Resilience Mitigations and Investments

• What potential resilience mitigations exist (e.g., physical, policy, procedure)?
• How should potential investments be evaluated? What would we need to feel confident that they could be applied?
• Are there no-regrets, high bang-for-buck investments?
Breakout Discussion and Report Out Topics

**Breakout**
- Defining and measuring resilience
- Valuing resilience
- Regulatory approaches for resilience
- Resilience mitigations and investments

**Report out**
- Breakout topic summary
- Innovative practices or lessons learned
- Key challenges or needs identified