Performance-Based Regulation for Resilience

Connecticut Public Utilities Regulatory Authority (PURPA)
Technical Meeting in Docket No. 17-12-03RE08
PURPA Investigation into Distribution System Planning of the Electric Distribution Companies – Resilience and Reliability Standards and Programs

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Overview

- Performance-based regulation background
- Need to define what goal is, only then to performance criteria, and only then how to measure in metrics
  - What do we mean by resilience?
  - Set goal and performance criteria (expectation)
  - Metrics follow to measure progress to goal(s)
  - Performance incentives come later when targets are clear
- PBR for Resilience: State examples that represent some leading thinking
Performance-Based Regulation Basics
Performance-based regulation (PBR) is...

- A regulatory framework to connect achievement of specified objectives to utility performance and executive compensation

- A PBR plan may include goals, criteria, metrics, a scorecard, benchmarks, and/or a collection of performance incentive mechanisms (PIMs), namely, formulas that determine measures and, if any, levels of financial rewards or penalties (i.e., adjustments to allowed revenues) for achievement of specified objectives
States’ progress in grappling with PBR is uneven

Various combinations of drivers are advancing PBR in 19 states and D.C.

- **Early Exploration**: Initial inquiries often marked by a report examining PBR options
- **Initial Stakeholder Engagement**: Soliciting comments and/or conducting workshops assessing PBR options
- **Advanced Stakeholder Engagement**: Soliciting comments and/or conducting workshops in discussing specifics of PBR options
- **Implementation**: Decisions have been made or are close to being made to deploy PBR options
- **Conclusion of Inquiry**: Decisions have been made not to consider the PBR framework

Source: EnerKnol and Wood Mackenzie Power & Renewables; Tracking of the proceedings available on the EnerKnol Platform
U.S. DOD metrics and standards for resilience at military installations

MEMORANDUM FOR ASSISTANT SECRETARY OF THE ARMY (INSTALLATIONS, ENERGY, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE NAVY (ENERGY, INSTALLATIONS, AND ENVIRONMENT)
ASSISTANT SECRETARY OF THE AIR FORCE (INSTALLATIONS, ENVIRONMENT, AND ENERGY)
DIRECTORS OF THE DEFENSE AGENCIES
DIRECTORS OF THE DOD FIELD ACTIVITIES

SUBJECT: Metrics and Standards for Energy Resilience at Military Installations

This memorandum implements the requirements of title 10, United States Code, section 2911(a), by establishing metrics and standards for the assessment of energy resilience pursuant to section 2911(b)(1). The purpose of these metrics and standards is to ensure the energy resilience of Department of Defense (DoD) military installations. It fulfills, in part, the responsibility of the Secretary under section 2911.

As discussed in the 2018 National Defense Strategy, the variety and velocity of global threats continues to rapidly evolve. The homeland is no longer a sanctuary, and we must anticipate potential attacks and mitigate risks to our critical defense, government, and economic infrastructure. In this environment, maintaining secure access to energy resources is critical to the Department’s execution of its mission, and ensuring energy resilience at our installations is a top priority.

DoD Instruction 4170.11, “Installation Energy Management,” requires DoD Components to take necessary steps to plan and have the capability to ensure available, reliable, and quality power to continuously accomplish critical DoD missions from our installations. To that end, the attachment to this memorandum provides metrics, standards, supporting policy and guidance, and identifies associated reporting requirements. This memorandum and its attachment apply to all permanent and enduring installations worldwide.

The provisions of this memorandum and its attachment will be incorporated into the relevant DoD issuances at their next revision. The DoD Components shall take immediate action to implement this memorandum and its attachment. My point of contact is Mr. Walter Ludwig, Office of the Deputy Assistant Secretary of Defense for Energy, at (571) 372-6859.

Ellen M. Lord

Attachment:
As stated
Set guiding goals
From the goals consider performance criteria (directional targets)

Guiding goal: improve distribution system reliability

Directional target: 5% improvement in SAIFI from baseline value
Expressing targets with measurable performance criteria, expressed in standard metrics is a best practice.
Metrics

- Quantifiable measure of a specified performance
- Typically expressed as standard power system measures or consumer impact measures
Performance criteria to metrics

• Quantifiable measure of a specified performance
• Typically expressed as standard power system measures or consumer impact measures
• Examples:
  • Customer minutes with electricity during outage
  • Time to restore x% of customers following outage
  • Critical services without power or alternatively with power during an outage
What form of performance-based regulation is right for the situation? Where to start?

- **Public Metrics Only**
  - Metrics are publicized on a publically available "dashboard."

- **Public Metrics with Ranking**
  - Metrics are publicized and ranked
  - Examples: Denmark DSO efficiency ranking, RIIO

- **Public Metrics with Financial Incentives**
  - Metrics are publically available, and utilities receive financial awards or penalties depending on achievement of the metrics.
  - Examples: NY REV
2 What is “Resilience”?  

Regulators cannot set the goals, performance expectations, and metrics if the resilience we seek is only vaguely understood.
Resilience

The ability of energy systems & operations to minimize service interruptions during extraordinary events and threats

- Robustness against threats and disruptions
- Ability to recover from disruptions
- Ability to continue operations during extraordinary events, threats and disruptions
- Ability to adapt operations and modify the system to continue service
Resilience definitions – Scale matters: Whose resilience? Whose perspective?

<table>
<thead>
<tr>
<th>Customer Resilience</th>
<th>Grid Recovery</th>
<th>Grid Ability to Withstand Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer ability to operate and maintain essential functions when grid is down</td>
<td>Ability to recover from major event:</td>
<td>Reliability metrics in a major event, e.g., resilience through an event</td>
</tr>
<tr>
<td>- Residential</td>
<td>- Black Start</td>
<td>- Measure without major event exclusions</td>
</tr>
<tr>
<td>- Commercial</td>
<td>- Storm</td>
<td>- Measure “all-in”</td>
</tr>
<tr>
<td>- Industrial</td>
<td>- Cyber event</td>
<td>- Measure just during major events</td>
</tr>
<tr>
<td>- Essential services: Hospitals, police, military</td>
<td>- Failure</td>
<td>- Physical attack</td>
</tr>
</tbody>
</table>
### Resilience definitions: Scale(s) of focus & measurement: Goals, criteria, metrics

<table>
<thead>
<tr>
<th>Customer</th>
<th>Grid</th>
<th>Microgrids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residence</td>
<td>Transmission Distribution Both?</td>
<td>Microgrids fully grid connected</td>
</tr>
<tr>
<td>• House with battery and switch</td>
<td>Generation • (EFORd)</td>
<td>Microgrids that can island</td>
</tr>
<tr>
<td>Businesses</td>
<td>Whole grid, which grid(s)?</td>
<td>• Campuses</td>
</tr>
<tr>
<td>• Buildings</td>
<td></td>
<td>Operationally independent</td>
</tr>
<tr>
<td>Industrial/military facility</td>
<td></td>
<td>• Backup/standby</td>
</tr>
</tbody>
</table>

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Performance-Based Regulation for Resilience (and Reliability):

Maryland
Minnesota
North Carolina
U.S. DOE Lawrence Berkeley National Lab
Minnesota Reliability and Resilience Metrics

- System Average Interruption Duration Index (SAIDI)
- System Average Interruption Frequency Index (SAIFI)
- Customer Average Interruption Duration Index (CAIDI)
- Customers Experiencing Long Interruption Duration (CELID)
- Customers Experiencing Multiple Interruptions (CEMI)
- Average Service Availability Index (ASAI)
- Equity – Reliability by geography, income, or other relevant benchmarks
- Momentary Average Interruption Frequency Index (MAIFI)
- Power Quality

Maryland Reliability and Resilience Metrics for Battery Pilots* pending @ MD PSC

• **Customer resiliency**: Utilities will report minutes of energy provided while grid power is unavailable (islanding) by energy storage assets. This quantification could lead to calculating the value to customers of having use of such necessities as lighting and refrigeration during major outage events.

• **Grid resiliency**: To help quantify value of energy storage assets to grid resilience, utilities will report amount of time (hours or days) for restoration of feeders/circuits and entire grid after a major outage event.

Source: MD PSC, PC 44 (Case No. 9619), Submission of the PC44 Energy Storage Working Group, Maillog No. 234481 (March 31, 2021).
For traditional reliability metrics, the workgroup also recommended that Maryland utilities report on battery pilot metrics:

- System Average Interruption Duration Index (SAIDI) - no event exclusions
- System Average Interruption Frequency Index (SAIFI) - no event exclusions
- Momentary Average Interruption Frequency Index (MAIFI) – no exclusions
  - MAIFI_E is the ratio of total number of customer momentary interruption events divided by total number of customers served, where E is equal to number of interruption events

All “should be computed on the feeder(s) that are affected by the energy storage installation”

Source: MD PSC, PC 44 (Case No. 9619), Submission of the PC44 Energy Storage Working Group, pages 14-15, Maillog No. 234481 (March 31, 2021).
### North Carolina DEQ Stakeholder Group

#### Outcome: Resilience

**Preferred metrics:**
- Number of critical assets (see note below) without power for more than N hours in a given region (# of assets), N may be set as 0 hours or greater than the number of hours backup fuel is available
- Critical asset energy demand not served (cumulative kW)
- Critical asset time to recovery (average hrs)

**Alternative metric:**
- Cumulative critical customer hours of outages (hrs)

**Notes:**
- Recommended metrics revolve around impacts on critical community assets since that is the framework used in the PARSG (Planning an Affordable, Resilient and Sustainable Grid) project and in the state Resilience Plan. This approach is also being integrated into the NARUC-NASEO comprehensive system action plan that the NC delegation is considering.
- Critical assets may include hospitals, fire stations, police stations, evacuation shelters, community food supply distribution centers, production facilities, military sites, etc.
- Since resilience study is very much a work in progress in North Carolina, it is recommended that these initially be tracked metrics, with no incentive attached.
- Efforts to develop resilience metrics are currently underway across organizations such as the DOE, FERC, EPRI and multiple state public utility commissions. The industry is lacking agreed-upon performance criteria for measuring resilience, as well as a formal industry or government initiative to develop consensus agreement. As such, there are currently no standardized metrics to measure resilience efforts or to quantify the extent or likelihood of damage created by a catastrophic event. Resilience is addressed state-by-state, and oftentimes event-by-event. If different metrics, benchmarks, rewards or incentives are identified and developed for reliability and resilience, there is a need to properly distinguish each, take into account the benefits for each, and differentiate how to separately determine the benefits, rewards and penalties for each.
- The metrics identified above are based on community impact driven resilience needs for critical infrastructure. It is based on current North Carolina state and local government led application of energy vulnerability and risk analysis framework that uses the Resilience Analysis Process (RAP) developed by the Sandia National Lab, which includes prioritization of grid-modernization...
### DOE Grid Modernization Lab Consortium metrics: Resilience

<table>
<thead>
<tr>
<th>GMLC Resilience Metrics</th>
<th>Data Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative customer-hours of outages</td>
<td>customer interruption duration (hours)</td>
</tr>
<tr>
<td>Cumulative customer energy demand not served</td>
<td>total kVA of load interrupted</td>
</tr>
<tr>
<td>Avg (or %) customers experiencing an outage during a specified time period</td>
<td>total kVA of load served</td>
</tr>
<tr>
<td>Cumulative critical customer-hours of outages</td>
<td>critical customer interruption duration</td>
</tr>
<tr>
<td>Critical customer energy demand not served</td>
<td>total kVA of load interrupted for critical customers</td>
</tr>
<tr>
<td>Avg (or %) of critical loads that experience an outage</td>
<td>total kVA of load severed to critical customers</td>
</tr>
<tr>
<td>Time to recovery</td>
<td></td>
</tr>
<tr>
<td>Cost of recovery</td>
<td></td>
</tr>
<tr>
<td>Loss of utility revenue</td>
<td>outage cost for utility ($)</td>
</tr>
<tr>
<td>Cost of grid damages (e.g., repair or replace lines, transformers)</td>
<td>total cost of equipment repair</td>
</tr>
<tr>
<td>Avoided outage cost</td>
<td>total kVA of interrupted load avoided</td>
</tr>
<tr>
<td>Critical services without power</td>
<td>$ / kVA</td>
</tr>
<tr>
<td>Critical services without power after backup fails</td>
<td>number of critical services without power</td>
</tr>
<tr>
<td></td>
<td>total number of critical services</td>
</tr>
<tr>
<td>Loss of assets and perishables</td>
<td></td>
</tr>
<tr>
<td>Business interruption costs</td>
<td>avg business losses per day (other than utility)</td>
</tr>
<tr>
<td>Impact on GMP or GRP</td>
<td></td>
</tr>
<tr>
<td>Key production facilities w/o power</td>
<td>total number of key production facilities w/o power (how is this different from total kVA interrupted for critical customers?)</td>
</tr>
<tr>
<td>Key military facilities w/o power</td>
<td>total number of military facilities w/o power (same comment as above)</td>
</tr>
</tbody>
</table>
About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org
Resources

- Next-Generation Performance-Based Regulation: Volume 1 (Introduction—Global Lessons for Success)
- Next-Generation Performance-Based Regulation: Volume 2 (Primer—Essential Elements of Design and Implementation)
- Next-Generation Performance-Based Regulation: Volume 3 (Innovative Examples from Around the World)
- Performance Incentives for Cost-Effective Distribution System Investments
- Protecting Customers from Utility Information System and Technology Failures
- Metrics to Measure the Effectiveness of Electric Vehicle Grid Integration
- Sharing the Good Stuff: Best Practices From Three Minnesota Initiatives
- raponline.org