Economic Approaches to Understanding and Addressing Resilience in the Bulk Power System: A Workshop Summary

Karen Palmer, Devin Hartman, Paul Picciano, and Daniel Shawhan

Introduction

Resilience of the electric power system has become an increasingly relevant issue as a consequence of increased frequency and severity of weather events, natural disasters, and other threats to the grid that raise the specter of potential large and long duration outages, such as that experienced in Puerto Rico in the wake of Hurricane Maria. Resilience has also become a lens through which some policymakers are viewing the evolution of the electricity sector in the face of low cost natural gas and renewables combined with state level policies to promote clean energy and the associated effects on electricity markets. In an effort to understand the nature and severity of challenges to resilience, the Federal Energy Regulatory Commission (FERC) initiated a rulemaking on Grid Resilience in Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs)[1] in January of 2018 seeking comments from the RTOs and ISOs on a series of questions related to resilience and subsequent reply comments from the broader community.

Given the limited application of economic principles and methods in most US discussions of resilience, Resources for the Future (RFF) and the R Street Institute organized an economics-oriented expert workshop to aid FERC, RTO/ISO stakeholders, energy policymakers, state utility commissions, and others in interpreting the filed comments and making upcoming decisions. The event emphasized the bulk power system because of proposed new resilience-motivated interventions there, but insight gathered from the event also applies to state- and distribution-level decisions, which are extremely important for resilience. The workshop, held at RFF's offices in Washington, DC, on May 30, had 40 participants with four panels of experts and lively discussion. A copy of the agenda and a list of attendees are included at the end of this document, and presentation slides from the event are available on the RFF website.

1 Docket No. AD18-7-000

Herein we present a summary of some of the take-away points from this day-long event. To facilitate open and honest discussions, we applied Chatham House rules. This summary document will honor those rules by summarizing what was said without attribution. We will begin by summarizing what the workshop organizers heard as the important high level observations and then present several associated recommendations for policymakers.

Definitions

In the recent study of electric system resilience organized by the National Academies of Sciences, Engineering and Medicine, the definition of reliability emphasizes the avoidance of outages.[2] In the same study, resilience is about limiting the size, duration, and impact of outages and learning from adverse events to reduce the probability, size, duration, and impact of future outages. These same elements are featured in the definition offered by FERC in its recent rulemaking proposal. Other definitions of reliability are broader than the one above, and partly or entirely include resilience. Regardless of definition, actions taken to enhance reliability also commonly affect resilience, and vice versa. Given limited data about new threats that could lead to large, long duration outages, metrics of resilience are yet to be fully developed and more efforts to create a well formulated and widely accepted definition of resilience would be helpful to policy development—FERC's definition serves as a good starting point for that discussion.

Important Observations

The existing level of generation resilience is already quite high. The organized markets have recently taken steps to make it even higher. After factoring

2 National Academies of Sciences, Engineering, and Medicine. 2017. *Enhancing the Resilience of the Nation's Electricity System.* Washington, DC: The National Academies Press. https://doi.org/10.17226/24836

in penalties for failing to meet reserve requirements and capacity performance payments, high prices to be earned for delivering energy in hours of shortage range from roughly $3500 to $10,000 per megawatt hour (MWh) and provide a strong incentive to generators to be able to deliver energy during those hours and one that is in the neighborhood of estimates of the value of lost load (VOLL), or estimates of the value to society of avoiding power outages.

Resilience of electricity supply should be evaluated from the consumer perspective as the system exists to serve customers. While the recent resilience discussions surrounding the NOPR and other policy proposals have largely been from the perspective of centralized supply-side resources and fuel security, an extremely small fraction of both the number of total customer outages and total minutes of service lost to outages is due to generation disruptions. Rather, the majority of such exposure to customer outages results from transmission and distribution (T&D) grid failures caused by weather, falling trees, etc. as was the case in Puerto Rico after Hurricane Maria. Adopting a "consumer-centric" perspective has implications for the types of resilience enhancing investments or actions that should be prioritized, and suggests resilience is generally not a basis for more administrative constraints on wholesale energy or capacity markets.

Estimates of the VOLL play a role in constructing administrative demand curves for reserves and should also be used in benefit-cost comparisons to choose economically efficient reliability and resilience investments and standards. Bringing the value of lost load more explicitly into the standard setting process could help to uncover a way to move from resource adequacy to resource optimality. There is a need for research to improve estimates of the value of lost load and the ability to estimate how different actions will affect the probability and duration of outages. With the present state of research, it is already clear that there is not economic justification for the highly stringent one-in-10-years outage probability standards that are applied to generation. Additionally, greater use of real-time electricity prices could allow customer behavior to directly reveal the VOLL, in addition to having other reliability and resilience benefits.

Today's electricity markets and reliability institutions already address to some extent the kinds of threats emphasized in recent discussions of electric service resilience, but there is room for improvement. One example is that decisions about preparing for threats with highly uncertain probabilities (cyber attacks, solar flares, terrorism) or highly correlated outages can especially benefit from improved benefit-cost analysis and incentive-setting methods. Most of these threats are likely in the area of transmission and distribution, and not generation. The nuclear outages in Japan after the 2011 tsunami, and a possible cyberattack on just generators, rather than the transmission or distribution grid, are exceptions. However, the Japanese nuclear outages illustrate that even an exceptionally large outage of just generators can likely be managed through demand-side management and, if necessary, short, rolling blackouts. Another example of room for improvement is that optimally managing the risk of concurrent outages (likely from a common mode failure, i.e. a failure of two related but independent systems attributable to a single cause) may require some special sophistication in market design. If the current market mechanisms prove insufficient for this, one possible solution would be to accredit and procure capacity that is robust to the most important common mode failures.

Addressing resilience generally involves actions that fall outside of generation markets, and most responses may be best derived at the state and local levels. As highlighted in the National Academies study, identifying risks, having well-chosen spare equipment, and coordinating between sectors—in particular electricity and gas pipelines—will be important, as will the improvement of restoration processes, protocols, ways to evaluate system resilience, and ways to set standards to support it. Increasing resilience of central station generators would, in some events, not prevent or shorten customer outages, given the long recovery periods associated with T&D outages that are likely to coincide with generation outages. Other approaches, such as investments in measures to harden/maintain the distribution grid, and more distributed energy resources, could be more effective and cost-effective for enhancing resilience.

Additional Advice to Policymakers

Many pieces of advice to policymakers and market operators can be gleaned from the presentations and discussions at our workshop. The following list includes parenthetical references to the most relevant audiences for each item:

- Avoid ad hoc, impulsive interventions in electricity markets. As one participant said, "Doing the wrong thing in a panic may make us more vulnerable rather than less…and cost us a bundle." (Everyone)

- Use economic criteria to prioritize resilience enhancing measures (e.g., use of cost-efficient scenario planning for T&D hardening). These processes should adopt the customer perspective and focus on restoration of service in event of an outage, which is the main element of resilience not well captured in traditional reliability planning. (FERC, NERC, state PUCs, Local Governments)
- Establish performance expectations for delivery of energy and other services, including contingency definitions for T&D and generation markets that include the important threats to reliable service, and then set up the right incentives to achieve those expectations. (RTOs/ISOs, RRCs, NERC, FERC)
- Incorporate better representations of VOLL in administrative demand curves used in scarcity pricing, and support efforts by researchers to develop better estimates of VOLL (RTOs/ISOs, DOE)
- Find ways to promote more direct demand participation (demand response programs and real-time or critical-peak pricing) in electricity markets. (RTOs/ISOs, State PUCs, utilities)
- Consider creating a more robust version of resource adequacy (for conventional reliability purposes as well as resilience) but beware of unintended consequences of differentiated capacity products. (FERC, NERC, RTOs/ISOs)
- Consider tweaks to existing instruments, such as capacity accreditation (see above) and the definition of contingencies used in system planning, but avoid creating unnecessary new products in the name of resilience. (RTOs/ISOs, RRCs, NERC, FERC)
- New resilience-motivated interventions in T&D planning, bulk power markets, and RTO/ISO market design processes can have a hard time "getting it right" given high levels of uncertainty and overconfidence in estimating the probabilities of events. Market failures can sometimes justify such interventions, but the possibility that government failure could outweigh market failure suggests exercising caution in such interventions. (Everyone)
- Focus on T&D policy as T&D systems are by far the most vulnerable parts of the integrated supply system from a resilience perspective, and we know that the average component of the T&D system "loses load" for an amount of time that is approximately 200 times greater than the loss of load expectation standard for generation. (State PUCs, FERC, DOE)

Conclusion

Four important economics insights emerged from the diverse presentations and discussion comments at the workshop. First, economic principles, customer valuation of outage avoidance, and benefit-cost analysis should guide decisions about resilience. Second, enhancing resilience happens through the provision of services such as real power and voltage support, rather than attributes such as inertia or a particular fuel type. They are the same services that are currently needed and procured, and they should be procured from whoever can provide them at lowest cost, through the use of market mechanisms when feasible. Regulations, planning, and central command or control have important roles, but only when justified by factors ("market failures") that would otherwise prevent the market from producing the outcomes that are best for society. Third, heightened concerns about resilience and low-probability events can probably be addressed relatively well by incremental improvements to current markets, incentives, and processes, and not on an emergency basis. Generators in the RTO/ISO regions already face incentives to be able to generate during extreme scarcity events, and those incentives are similar to the very high value that customers place on avoiding outages. Fourth, customers and regulators are not willing to pay boundless amounts for resilience, so resources should be allocated to where they can benefit society the most. Those opportunities are largely related to enhancing the reliability and resilience of the electric distribution and transmission systems, and in better natural gas-electric coordination, planning, incentives, and rules. As part of this better targeting of resources, resilience would be improved by shifting some expenditures away from today's excessive generation reserves to more cost-effective uses.

Economic Approaches to Understanding and Addressing Resilience in the Bulk Power System

May 30, 2018, 9:00 a.m. –3:30 p.m.
Resources for the Future, 1616 P Street, NW, Washington, DC

AGENDA

Background

The motivating factor for this workshop is the high level of regulatory and political interest in grid resilience, a concept still emerging from intellectual infancy. In an effort to understand the nature and severity of challenges to resilience, FERC initiated a proceeding in January. Given the limited application of economic principles and methods in the recent discussions of resilience, we hope that an economics-oriented workshop can aid FERC, RTO/ISO stakeholders, energy policymakers, Hill staffers and others in making upcoming decisions. The goals of the event are to learn from each other and to develop advice about addressing resilience in wholesale electricity market design and system planning.

Light Breakfast (8:30–9:00 a.m.)

Introduction and Opening Remarks (9:00–9:15 a.m.)

- Richard Newell, Resources for the Future
- Conference organizers on ground rules and objectives

Defining and Measuring Resilience (9:15–10:15 a.m.)

- How should we define, identify and measure bulk power system resilience and how does it differ from reliability?
- How should resilience be valued?

Moderator: Karen Palmer, Resources for the Future

Speakers:

- Granger Morgan, Carnegie Mellon University
- Dan Shawhan, Resources for the Future
- Alison Silverstein, Independent Consultant

Coffee Break (10:15–10:30 a.m.)

Identifying Resilience Market Failures and Services (10:30 a.m.–12:00 p.m.)

- What are the market failures that can cause the under-provision (or over-provision) of bulk power supply resilience?
- What are the services that are important for electric system resilience?

- To procure services of the kinds that support power supply resilience, what factors make organized markets better, and what factors make planning and other non-market methods better?

Moderator: Devin Hartman, The R Street Institute

Speakers:

- Ben Hobbs, Johns Hopkins University
- John Moura, North American Electric Reliability Corporation
- Rob Gramlich, Grid Strategies LLC
- Sue Tierney, Analysis Group

Lunch (12:00–12:30 p.m.)

Reconciling Resilience Services with Current Market Design (12:30–1:45 p.m.)

- How should we determine what threats to bulk electricity supply resilience are not adequately addressed in current market design, electric and gas system planning, and industry practices?
- How should we assess what potential changes should be in the ways that the specific services are procured, and what changes do you recommend?
- To what extent should economic objectives rather than standards be used in choosing resilience measures and in choosing the rules, incentives, and market designs used to induce resilience measures?

Moderator: Daniel Shawhan, Resources for the Future

Speakers:

- Jim Bushnell, University of California, Davis
- Erik Ela, Electric Power Research Institute
- Sam Newell, The Brattle Group

Afternoon Break (1:45–2:00 p.m.)

Identifying Next Steps (2:00–3:15 p.m.)

- What should next steps be to address resilience concerns in wholesale market design, operating procedures, transmission planning, DER integration or other mechanisms?
- How urgent and region-specific are these issues?

Moderator: Karen Palmer, Resources for the Future

Panelists:

- Mike Hogan, Regulatory Assistance Project
- Joe Bowring, Monitoring Analytics
- David Patton, Potomac Economics
- Devin Hartman, R Street Institute

Closing Session: Review of take away points from today (3:15–3:30 p.m.)

- Sue Tierney, Analysis Group

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