



Assembling a Grid Resiliency Toolbox: The Tools That Make it Possible

By: Josh Schellenberg, Vice President



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Multi-disciplinary team at the forefront of rethinking regulatory structures, the role of the utility and the relationship that utilities have with their customers

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In 2017, the U.S. experienced 16 extreme weather events with damages exceeding \$1 billion, which is expected to cost a record total of \$300 billion



This map denotes the approximate location for each of the **16 billion-dollar weather and climate disasters** that impacted the United States **during 2017**.

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In 2018, total weather-related damages were lower (\$91 million), but electric utilities were disproportionately impacted



This map denotes the approximate location for each of the 14 separate billion-dollar weather and climate disasters that impacted the United States during 2018.

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Joint press release with Lawrence Berkeley National Laboratory and U.S. Department of Energy on July 31, 2018

"I am pleased to announce the release of two OE-sponsored research products that provide timely assistance for this electric utility planning challenge. These research products, which were developed in a public-private partnership (Lawrence Berkeley National Lab and Nexant), are the <u>Estimating Power</u> <u>System Interruption Costs: A Guidebook for</u> <u>Electric Utilities</u> and the <u>Interruption Cost</u> <u>Estimate (ICE) Calculator 2.0</u>."



Bruce J. Walker

Assistant Secretary, Office of Electricity U.S. Department of Energy <u>energy.gov</u>



Estimating Power System Interruption Costs

A Guidebook for Electric Utilities

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ICE Calculator Microgrid Example: How much do customers benefit from avoiding a 16-hour power outage? (Step 1)

1. Go to icecalculator.com and click "Estimate Interruption Costs"



The Interruption Cost Estimate (ICE) Calculator is a tool designed for electric reliability planners at utilities, government organizations or other entities that are interested in estimating interruption costs and/or the benefits associated with reliability improvements.

Estimate Interruption Costs

Estimate Value of Reliability Improvement



ICE Calculator Microgrid Example: How much do customers benefit from avoiding a 16-hour power outage? (Step 2)

2. Provide inputs on customers, reliability and state (Illinois in this example)





ICE Calculator Microgrid Example: How much do customers benefit from avoiding a 16-hour power outage? (Step 3)

3. Review and incorporate results into benefit-cost analyses







Assessing risk over the lifetime of a 20- to 50-year resilience investment is an especially challenging planning problem

- Variety of challenges at each step in the risk assessment process
 - Identifying relevant power interruption scenarios
 - Forecasting probability of each scenario
 - Estimating economic impact of each scenario (beyond 16 hours)
- Challenges arise from nature of long duration power interruptions
 - Infrequent (few data points)
 - Potentially catastrophic impacts across multiple sectors of the economy
 - Critical infrastructure
 - Significant indirect costs that extend to areas not directly affected by the outage



Academics, think tanks, consultants and government institutions are working together to address these resilience planning challenges



Frontiers in the Economics of Widespread, Long-Duration Power Interruptions

Proceedings from an Expert Workshop

January 2019



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1. Mitigation and Resilience Trade-offs In Electricity Outages by Jonathan Eyer and Adam Rose (USC)

2. Estimating Residential Customers' Costs of Large, Long-Duration Blackouts by Sunhee Baik, Selin Sirinterlikci, Jun Woo Park, Alex Davis and M. Granger Morgan, (Carnegie Mellon University)

3. Economic Consequence Analysis of Electric Power Infrastructure Disruptions: An Analytical General Equilibrium Approach by Ian Sue Wing (Boston University) and Adam Rose (University of Southern California)

4. Using Stated Preferences to Estimate the Value of Avoiding Power Outages: A Commentary with Input from Six Continents by Daniel Shawhan (Resources For the Future)

5. Evaluating Methods of Estimating the Cost of Long-Duration Power Outages by Jeffrey Roark (EPRI)

6. Data Landscape: Challenges and Opportunities by Josh Schellenberg, Myles Collins, Michael Sullivan, Shannon Hees, Stephanie Bieler (Nexant, Inc.)



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