Environment Sector Resiliency Research Initiatives

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Overview

- Key message
- Background and motivation
  - Resiliency at EPRI
  - Federal and state climate policy drivers
  - Climate vulnerabilities for the electric system
- Environment resiliency research initiatives
  1. Survey of resiliency metrics
  2. Climate impacts and resiliency case studies
- Facilitated discussion
EPRI and member-identified research need for objective assessment of ongoing activities around resiliency metrics

- National Academy (2012): “without some *numerical basis* for assessing resilience, it would be impossible to monitor changes or show that resilience has improved. At present, *no consistent basis for such measurement exists*...”

- Nevertheless, many players are proposing metrics and frameworks in an uncoordinated fashion
  - e.g., environmental groups, regulators, NGOs, consultants, shareholder resolutions

New ENV research will assess landscape of resiliency metrics and proposals to inform members in response to climate-driven stakeholder and regulatory efforts
Background and Motivation
Resiliency White Paper showcases EPRI’s longstanding research portfolio on resiliency measures

Resilience

“The ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions” (US Gov 2013)

“Damage prevention, system recovery, and survivability” (EPRI 2016)

Generation
- Hardening
- Power adequacy
- Fuel security
- Distributed generation

Power Delivery & Utilization
- T&D undergrounding
- Hardening
- Vegetation management
- Cyber security
- Reliability
- Spares strategies
- Outage management
- Damage assessment
- Microgrids
- Value of lost load / interruption costs

Environment
- Evaluate metrics (e.g., sustainability)
- Climate impact policy assessment
- Electric system analysis (e.g., US-REGEN scenarios)
- Cost-benefit frameworks
- Water resource planning

www.epri.com/Pages/Power-System-Transformation-White-Papers.aspx
Federal and state climate policies expanding from GHG mitigation to focus on impacts and adaptation

- US Climate Action Plan
- Executive Order 13653 “Preparing for Climate Impacts”
- Social Cost of Carbon (SCC) use in federal & state regulation
- EPA’s Climate Change Impacts and Risks Analysis (CIRA)
- DOE Partnership for Energy Sector Climate Resilience
- Climate Resilience Toolkit
- Many DOE reports: *US Energy Sector Vulnerabilities to Climate Change and Extreme Weather, Quadrennial Energy Review*

Research and activities will continue to shape policy / regulatory environment
DOE Partnership for Energy Sector Climate Resilience engages electric companies around climate vulnerabilities

In 2015, 18 utilities joined to develop and pursue strategies to reduce climate and weather-related vulnerabilities

www.energy.gov/epsa/partnership-energy-sector-climate-resilience

Austin Energy (joined June 2016)
AVANGRID (Iberdrola USA)
Consolidated Edison of New York
Dominion Virginia Power
Entergy Corporation
Exelon Corporation
Great River Energy
Hoosier Energy
National Grid
New York Power Authority
Pacific Gas and Electric
Pepco Holdings, Inc.
Public Service Electric and Gas
Sacramento Municipal Utility District
San Diego Gas and Electric
Seattle City Light
Southern California Edison
Tennessee Valley Authority
Xcel Energy
### Energy sector is vulnerable to extreme weather and climate via multiple pathways

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Rising trend of extreme events places climate resiliency in the spotlight among a diverse group of stakeholders.
Mounting pressure around climate risk in the finance and insurance communities

- Many calls for SEC to standardize disclosure of climate risk for investors and taxpayers
- Uptick in shareholder resolutions
- Insurance and re-insurance industry
- Risky Business study

“...the SEC has already taken important steps to make clear that today’s climate risks can be financially material, which is necessary to trigger mandatory disclosure requirements. But shareholders are increasingly pushing management to be more attentive to climate risk.”

– WSJ op-ed Aug 18
Environment Resiliency Research Initiative:

Survey of Resiliency Metrics
Many drivers for ENV supplemental project “Technical Assessment of Resiliency Metrics and Analytical Frameworks”

Key Drivers
- Research needs identified in EPRI Resiliency White Paper
- Rising trend of local storm events
- Regulatory risk and pressure from external stakeholders
- Lack of cost-recovery methodology for resiliency investments

Objectives
1. Comprehensive survey of metrics and cost-benefit approaches for electric power resiliency
2. Objective review of the technical and economical soundness of resiliency metrics proposals
3. Collaboratively advance understanding of climate resiliency issues among project participants

Project Participants (as of Aug 31 kick-off)
- American Electric Power
- Pacific Gas & Electric
- Southern Company
- Tennessee Valley Authority
- WEC Energy Group

Project Approach
*What it is:*
- Literature review of metrics and practices being discussed by regulators, insurers, investors, and public groups
- Technical evaluation of merits and limitations

*What it is not:*
- Not proposing or endorsing metrics
- Not considering standards or policies
- Not defining an EPRI perspective on resiliency

Scientific and technical objectivity paramount
Resilience Analysis Process

1. Set objective
   - Initiate dialogue – internal or external?
   - Evaluate investments/improvements?
   - Request cost recovery?

2. Set scope and identify approach

3. Catalog physical/system-level threats and likelihood

4. For a given threat, what are possible outcomes?

5 & 6. Set scope and identify approach
   - (e.g., cost-benefit, break even)

7. Catalog options to enhance resiliency and quantify benefits;
   prioritize among options given limited resources

Francis and Bekera (2014), from Sandia National Lab report
Research gaps: Standardized resiliency metrics do not exist

- National Academy (2012): “without some numerical basis for assessing resilience, it would be impossible to monitor changes or show that community resilience has improved. At present, *no consistent basis for such measurement exists*...”

- Established Reliability metrics already in use...
  - Average Interruption Indices (e.g., CAIDI, SAIFI, SAIDI) deal with routine operations and conditions
  - Value of lost load (VOLL) for up to 16 hour outage

- ...but, Resiliency deals with extreme conditions
  - Deeply uncertain (e.g., high impact, low frequency)
  - Resiliency is characterized with respect to a specific threat/event
  - Additional costs beyond the local system – e.g., community and social impacts, structural damage, increased operational costs, emergency services, critical public infrastructure
Resiliency metrics can be categorized by their purpose:

Assess risk and vulnerabilities

- Communication with external stakeholders (e.g., shareholders, local planners)
- Identify vulnerabilities
  
  e.g., Entergy’s Gulf Coast Assessment

Evaluate resiliency investments

- Prioritize investments given a fixed budget
- Conduct cost-benefit analysis
- Cost recovery / rate case use
  
  e.g., PSE&G’s Energy Strong request to NJ BUP to harden system

“spider diagram” of resiliency scores

Total VOLL Dollar Value vs. Customer Minutes of Interruption
Conceptual challenge: Resiliency engages a broad audience on varied issues

- Resiliency issues are heterogeneous
  - Threat-specific, varies by region and sector
  - Many constituents: e.g., people, infrastructure, services
  - Temporal dimension: both proactive and reactive

- Resiliency spans a cross-functional audience
  - Transmission, distribution, risk management, operations, regulatory affairs, environment, sustainability managers, emergency response
  - Each group deals with the topic differently & definitions may vary

- Resilience extends beyond corporate boundaries and engages communities, local governments, etc.
  - Mandatory compliance vs. voluntary

- No "one-size fits all" framework
Environment Resiliency Research Initiative:
Climate Impacts and Resiliency Case Studies
EPRI Energy & Environmental Analysis Group, Environment Sector

**Energy and Climate Analysis (P102)**
- *Economy-wide, integrated perspective*
  - Economy-wide Analyses of U.S. Energy and Climate Policy Objectives
  - National Impacts of International Climate Policies
  - Climate Impacts Valuation & Risk Management Analysis

**Analysis of Environmental Policy Design, Implementation and Company Strategy (P103)**
- *Power sector perspective*
  - Analyze U.S. Energy and Environmental Policies, and Regulations
  - Near-term focus on analysis of the EPA’s Clean Power Plan under CAA 111(d)
  - Inform Company Strategies

**Technology Assessment, Market Analysis and Integrated Portfolio Planning (P178)**
- *Utility planning perspective*
  - Technology Cost and Performance (TAG)
  - Fuel and Power Market Analysis
  - Integrated Generation, Transmission and Distribution Planning

**Supplements**
- Resiliency Metrics
- Social Cost of Carbon - Phase 2

- State CPP Analyses

- Natural Gas Interest Group
- TAG Web
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Many quantified in EPA’s climate damage study and US Gov’s social cost of carbon
EPRI modeling can inform climate resiliency research questions

- How might electric system operations change over time in response to a changing climate?
- What is the potential magnitude of impacts on costs and reliability if these changes are not accounted for?

**Costs**

**Benefits**

- How might investments and operation evolve differently if changes are anticipated? → climate adaptation and resiliency in system planning
Planning for Climate Resiliency
Case Studies of electric system resilience to heat and drought

Climate Scenario
temperature, precipitation, hydrology

Electric Supply & Demand
impacts on resources, efficiency, loads

Electric System Analysis
EPRI US-REGEN capacity expansion & dispatch model

Resiliency Planning
generation capacity, transmission, cooling technology decisions

Costs and Benefits of Resilience Adaptation

Apply EPRI expertise & EEA tools to evaluate system impacts from extremes for select case study regions
Impact pathways under development in US-REGEN

Illustrative drivers from Cumberland Basin study (ORNL 2016)

- Increased frequency/intensity of heat events
- Increased water temperature
- Decreased water availability (hydrology model)
- Drought Indicator

Temperature Extremes
Stream Temperature
Drought Indicator

Cooling technology choice

- Increased cooling / decreased heating
- Transmission impacts
- Decreased thermal efficiency / increased cooling cost (EPRI SOAPP model)
- Decreased availability of hydro generators

End-use technology choice
Add inter-region transmission capacity
Generation capacity addition and dispatch decisions

Other policy, resource, customer drivers

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Facilitated Discussion
Open discussion: P180 member perspectives on resiliency challenges

1. What are the top drivers of resiliency at your company? (e.g., regulators, financial disclosure, infrastructure)

2. What is the difference in your company's approach to resiliency vs reliability? (e.g., planning, investment, operations)

3. What are the key research gaps and emerging issues related to resiliency metrics and analytical frameworks?
Open discussion: What are additional research needs?

- Resiliency basics: improve understanding and credibility of definitions and metrics
- Analytical tools or inputs
  - Frameworks to evaluate / prioritize investment options
  - Outage costs for resiliency? e.g., Interruption Cost Estimate (ICE) calculator
  - Costs and benefits of system-level resiliency planning
  - Actionable climate projections for analysis
- Process and policy guidance
  - Sharing best practices across companies: e.g., learning by doing, structured interviews, case studies
  - Guidance on collaborative processes including stakeholder involvement
  - Identify barriers to implementation of resiliency solutions (e.g., funding, policy / legal impediments, scientific understanding)
Together...Shaping the Future of Electricity

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Supplemental project summary
“Technical Assessment of Resiliency Metrics and Analytical Frameworks”

Objectives
- Identify and evaluate current practices around electric power resiliency
  – metrics, risk management, and cost-benefit approaches being requested/applied by regulators, insurers, investors, and public groups
- Examine the technical and economical soundness of resiliency metrics
- Collaboratively advance industry understanding of climate resiliency issues

Benefits/Products
- Comprehensive survey of resiliency metrics and practices for measuring climate resiliency and resiliency investments
  – e.g., vulnerability, exposure, impacts, likelihood, costs and benefits
- Technical evaluation of the purpose and technical validity of resiliency frameworks and applications
- Assessment of analytical approaches to resiliency measures and risk management strategies
- Outreach and communication of analyses and insights to project participants, stakeholders, and the public

Evaluating Resiliency Approaches in the Electric Power Sector

NOAA (2015)

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