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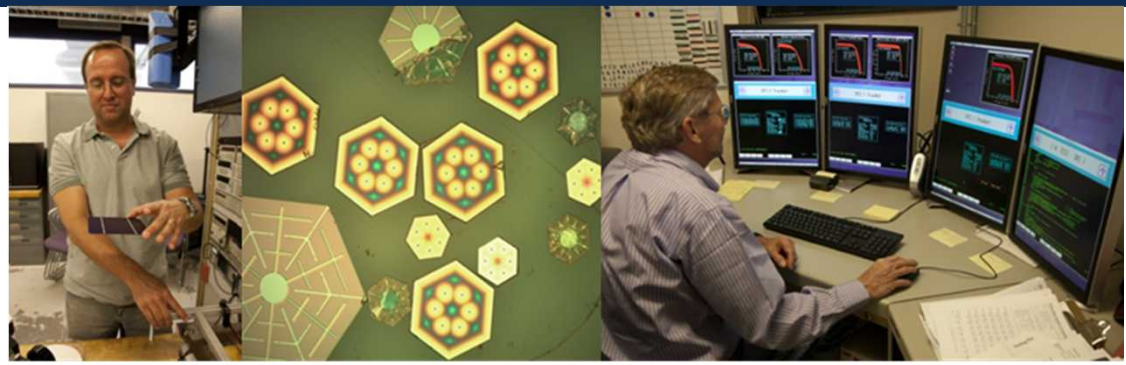
Microgrids and Resilience Framework

IRED Workshop on Microgrids
Niagara Falls, CA
October 24, 2016



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U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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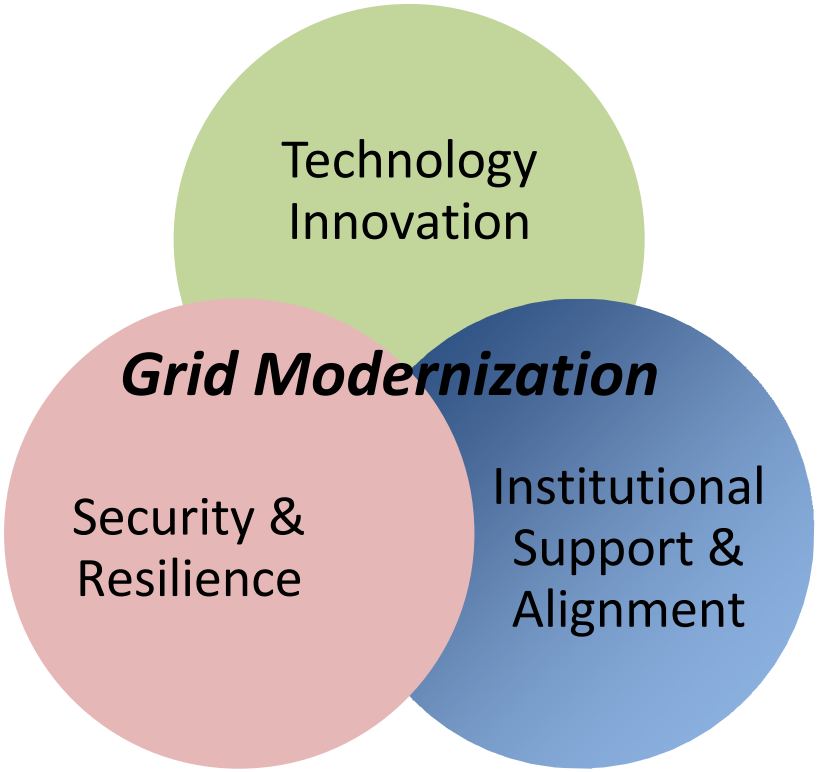
Outline

- DOE and Electric Power System Resilience
- What is Resilience?
- Resilience Metrics
- Resilience Frameworks
- Q&A

US Department of Energy (DOE)
Office of Electricity (OE)

MISSION: The Office of Electricity Delivery and Energy Reliability (OE) drives electric grid modernization and resiliency in the energy infrastructure.

- OE leads the Department of Energy's efforts to ensure a resilient, reliable, and flexible electricity system.
- OE serves as the Energy Sector Specific lead for the Federal emergency response when activated by DHS/FEMA.



US DOE Grid Modernization Vision

*The future grid provides a critical platform for U.S. prosperity, competitiveness, and innovation in a global clean energy economy. It must deliver **reliable, affordable,** and **clean electricity** to consumers where they want it, when they want it, how they want it.*

Achieve Public Policy Objectives

- 80% clean electricity by 2035
- State RPS and EEPS mandates
- Access to reliable, affordable electricity
- Climate adaptation and resilience

Sustain Economic Growth and Innovation

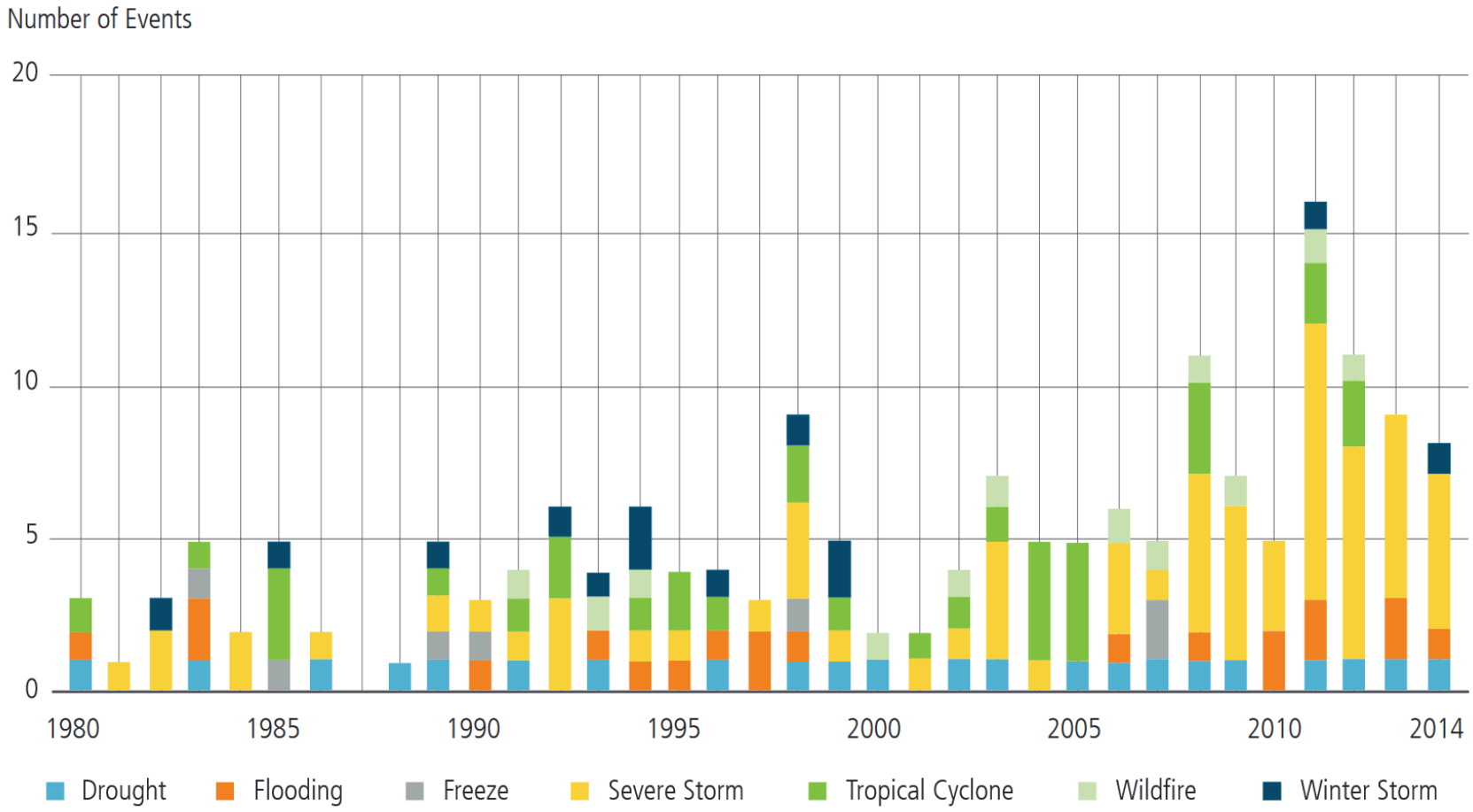
- New energy products and services
- Efficient markets
- Reduce barriers for new technologies
- Clean energy jobs

Mitigate Risks and Secure the Nation

- Extreme weather
- Cyber threats
- Physical attacks
- Natural disasters
- Fuel and supply diversity
- Aging infrastructure

Increasing Weather-Related Disasters

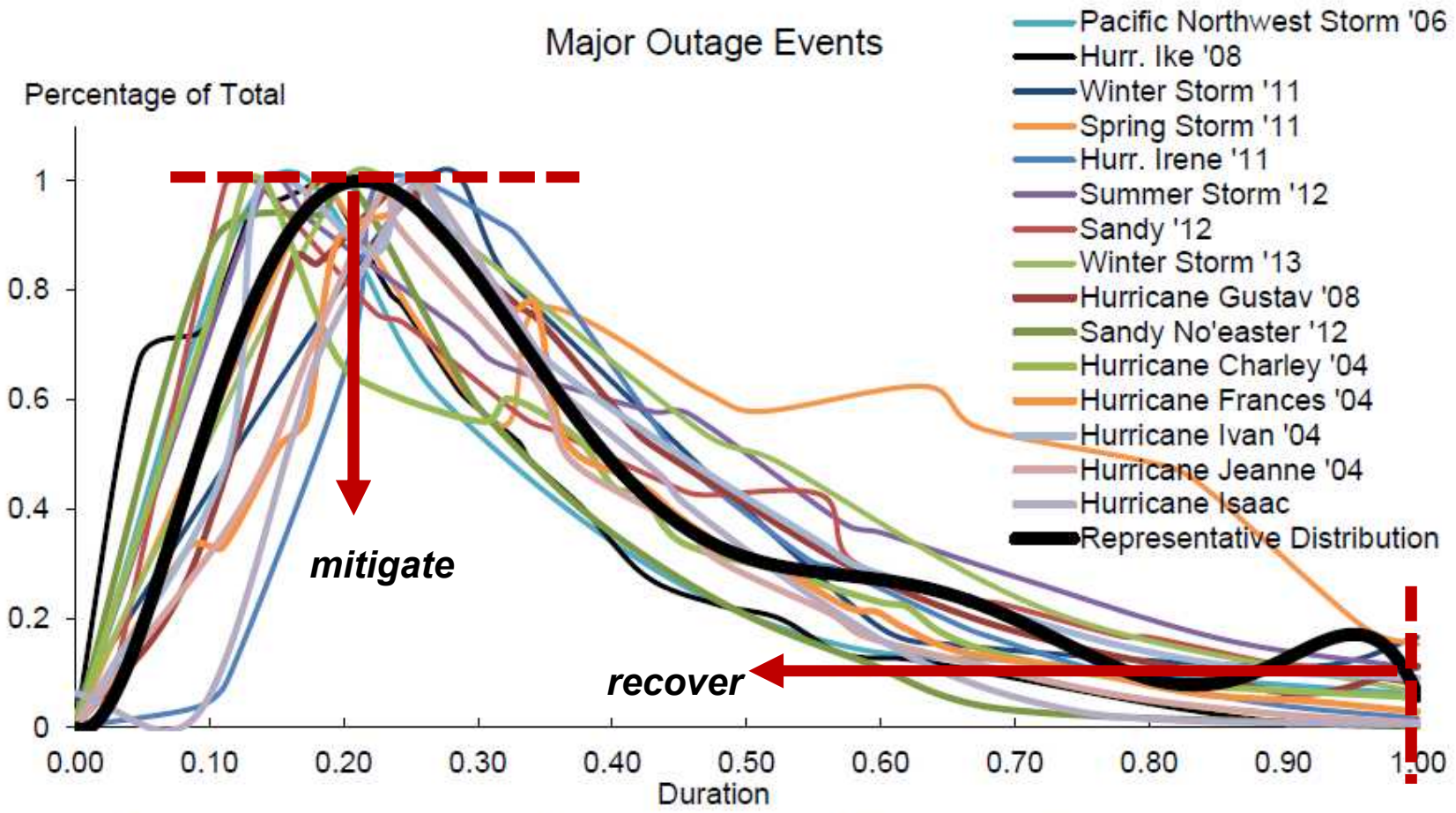
Figure 2-2. Billion-Dollar Disaster Event Types by Year[10, c]



Costly weather-related disasters have been increasing in frequency over the past decade.

http://energy.gov/sites/prod/files/2015/08/f25/QERChapter II Resilience April 2015.pdf

DOE/OE and Power System Resilience R&D



Source: Department of Energy, Office of Electrcity Delivery and Energy Reliability

DOE/OE and Power System Resilience R&D

Initial work elements developed with input from the 2014 stakeholder workshop and later aligned with activities identified in the DOE Grid Modernization MYPP technical focus area, Security and Resilience

Resilience Metrics	System Design	Preparedness and Mitigation Measures	System Response and Recovery
• Quantitative, risk-based metrics to assess and measure capabilities for resilience against weather disasters	• Design tools to prioritize upgrades and rebuilding • Hardening (new materials and designs, higher construction standards)	• Simulation tools w. environmental forecasting and damage prediction models • Predictive failure modes of equipment • New tools for resilience assessments	• Improved situational awareness • Resilient communications infrastructure • Metrics-based optimization tools for restoration prioritization

Refinement of the work elements and associated R&D priorities is being made, based on findings from the 2016 MYPP Workshop on Resilient Electric Distribution Grids (July 2016)

Microgrid Value Proposition

Microgrid Applications

- Enabling integration of distributed energy resources
- Smoothing of intermittent and variable resources
- Peak-shaving and provision of other grid services (i.e., ancillary services, demand response)
- Intentional islanding for safety and reliability
- Enhance local reliability and power quality
- Energy surety during outages and emergency conditions
- Arbitrage of energy price differentials

Multiple Objectives

Environmental	Maximizes electricity produced and consumed from renewable resources to reduce overall emissions
Economic	Responds to real-time changes in electricity prices to minimize total energy and operational costs
Reliability	Serves as a grid resource in grid-connected mode and switches to island mode upon detecting a contingency
Resilience & Security	Ensures that critical loads can be served for sustained periods of time during and after catastrophic events

Definitions of Resilience

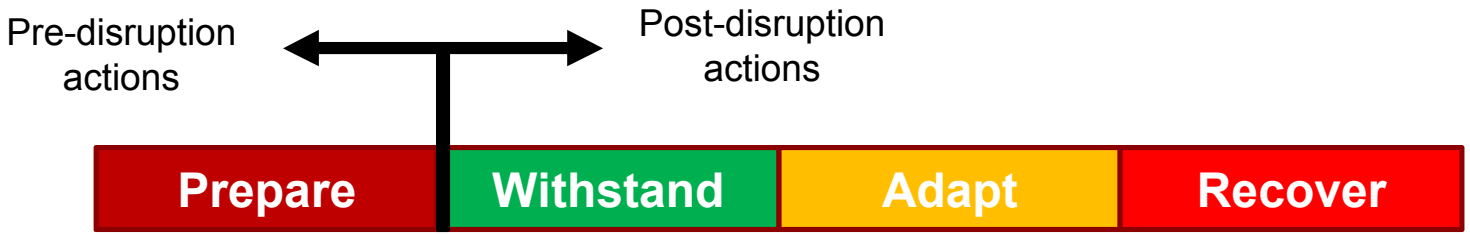
- Critical Infrastructure Security and Resilience:

  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.

  Presidential Polity Directive 21 (PPD-21)

- Energy Infrastructure Resilience

  Resilient energy infrastructure prepare for, withstand, adapt to, and/or recover from potentially high consequence, low frequency disruptions in rapid and efficient manners.



Resilience from a Utility Point of View

Hardening Measures

- Higher design & construction standards within Microgrid

Recovery Measures

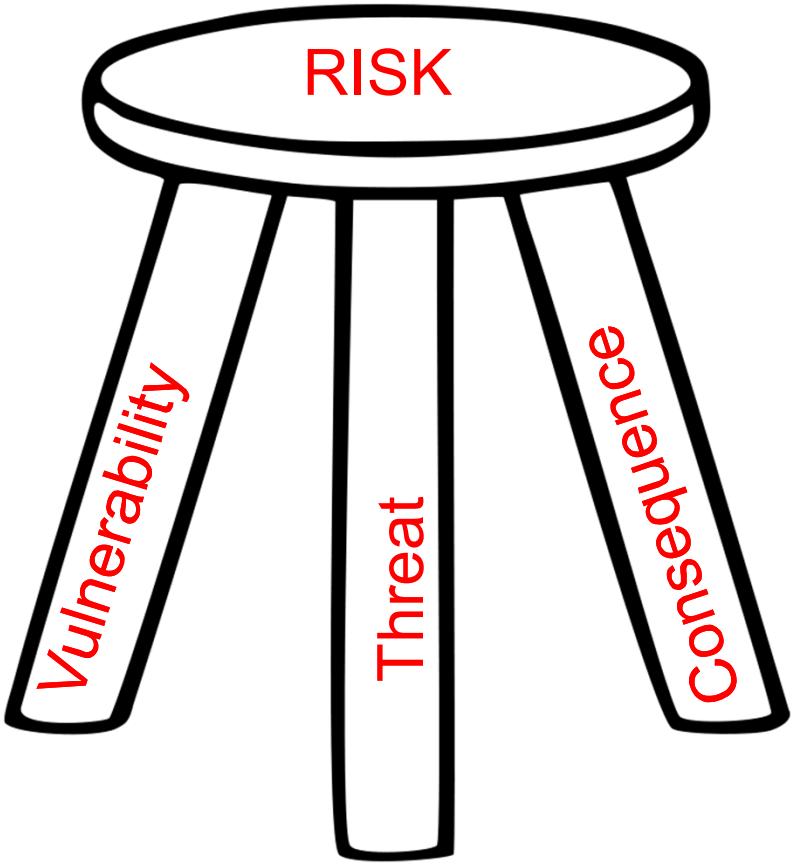
- Microgrid will enable
  - Faster Restoration management
  - Damage Assessment
    - OMS
    - GIS

Survivability Measures

- Resilient technologies within microgrid
  - Standby equipment
    - PEV, PV
    - Community energy storage

Resilience: A Risk-Based Approach

- $Probability_{consequences} = f(vulnerability, threat)$



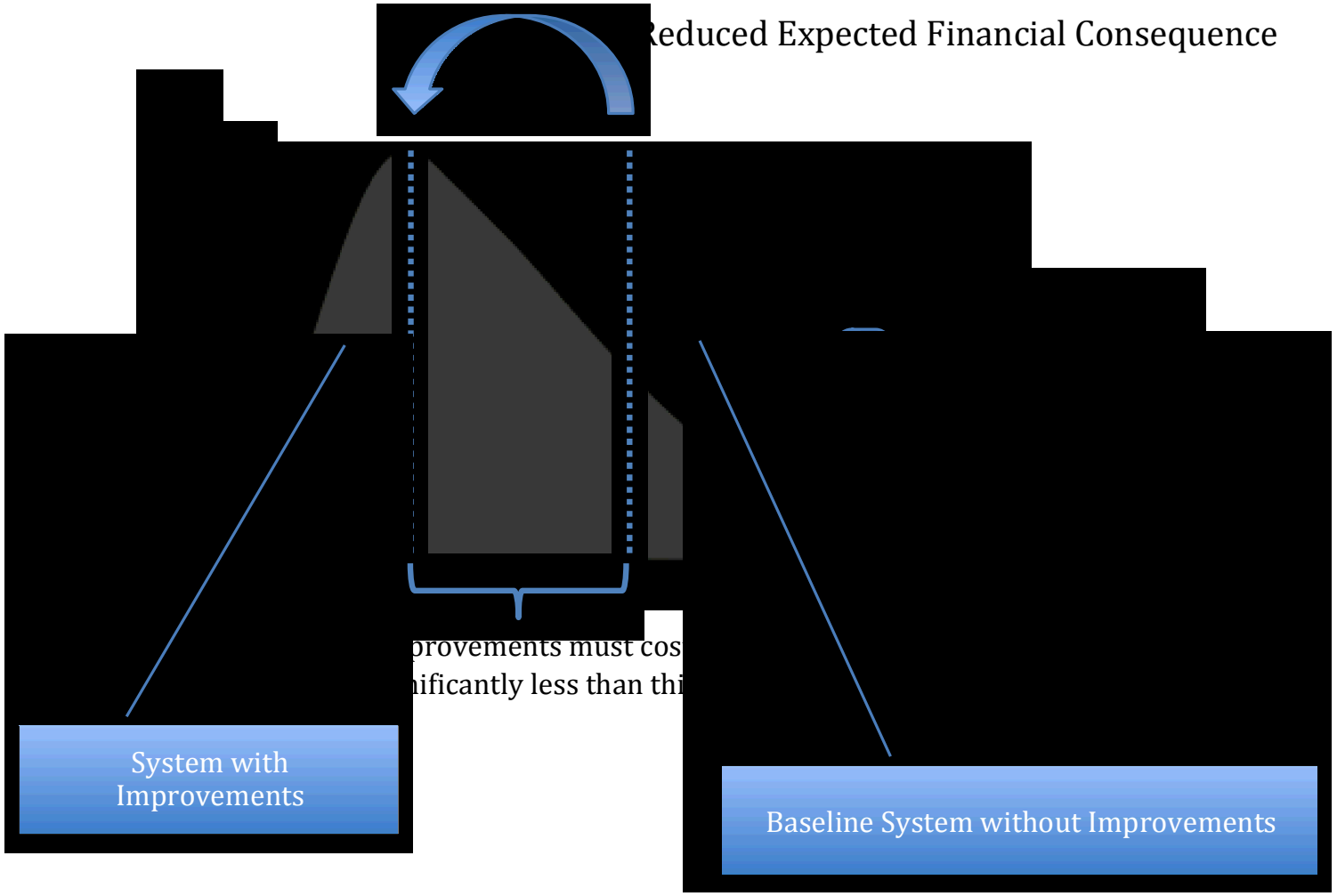
Resilience Versus Reliability

- Differentiating reliability and resilience is important

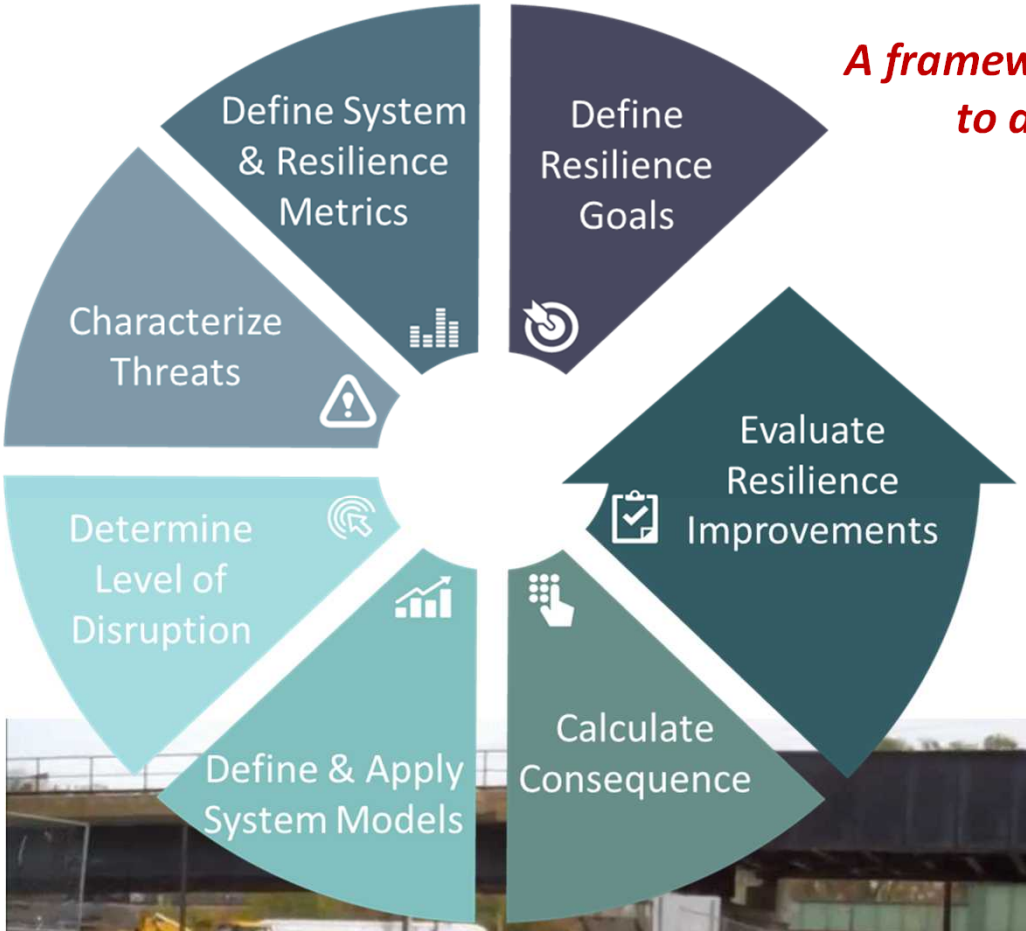
Reliability	Resilience
Focus on high probability, low consequence events (SAIDI/SAIFI; exclude storm)	Focus on low probability, high consequence events (Storms, GMD, cyber/physical threats)
Not usually risk-based • N-1 criteria (assume components will fail) • Evaluate all "credible" possibilities and make decisions accordingly	Risk-based, includes: • Threat (you are resilient to something) • System vulnerability (things that can cause system disruptions) • Consequence (beyond the system)
Operationally, You are reliable, or you are not [0 1]. Confidence is unspecified	Resilience is a continuum, confidence is specified
Focus is on measuring impacts to the system (load not served, components out of service, etc.)	Focus is on measuring impact of the consequences (life, cost, security, etc.)

Evaluating Resilience Improvements

- How do we know resilience is improving?



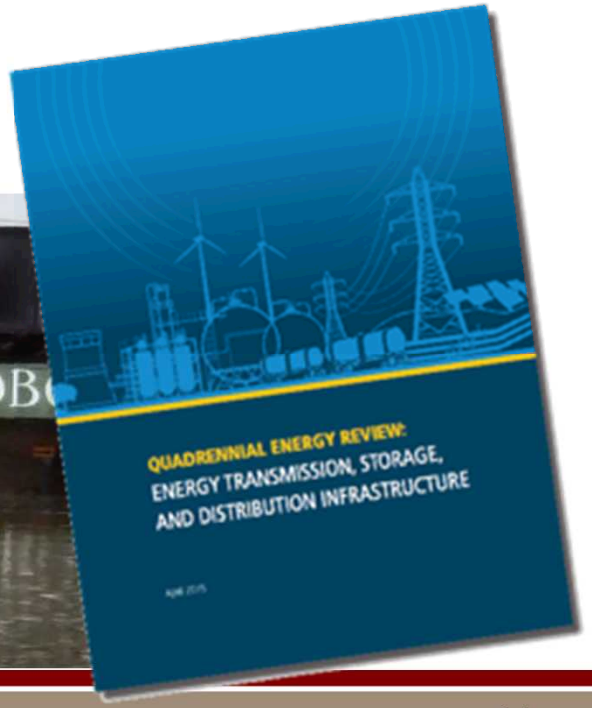
Sandia Resilience Framework



A framework for deploying metrics that can be used to assess energy infrastructure planning, operations, and policy changes

- Documented in 2015 US/DOE Quadrennial Energy Review (QER)

http://energy.gov/epsa/quadrennial-energy-review-qer



Questions? Comments?

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