



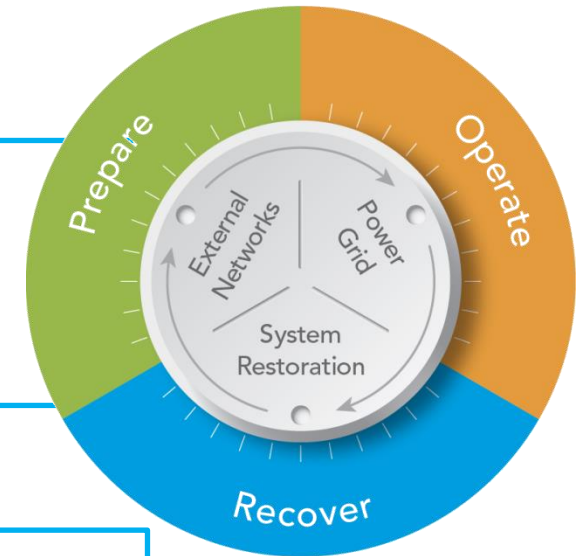
# Grid Reliability Resilience and Efficiency

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**FERC's Proposed Definition:** The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.

**PJM's Working Definition:** The ability to withstand or quickly recover from events that pose operational risks.

**Prepare + Operate + Recover**

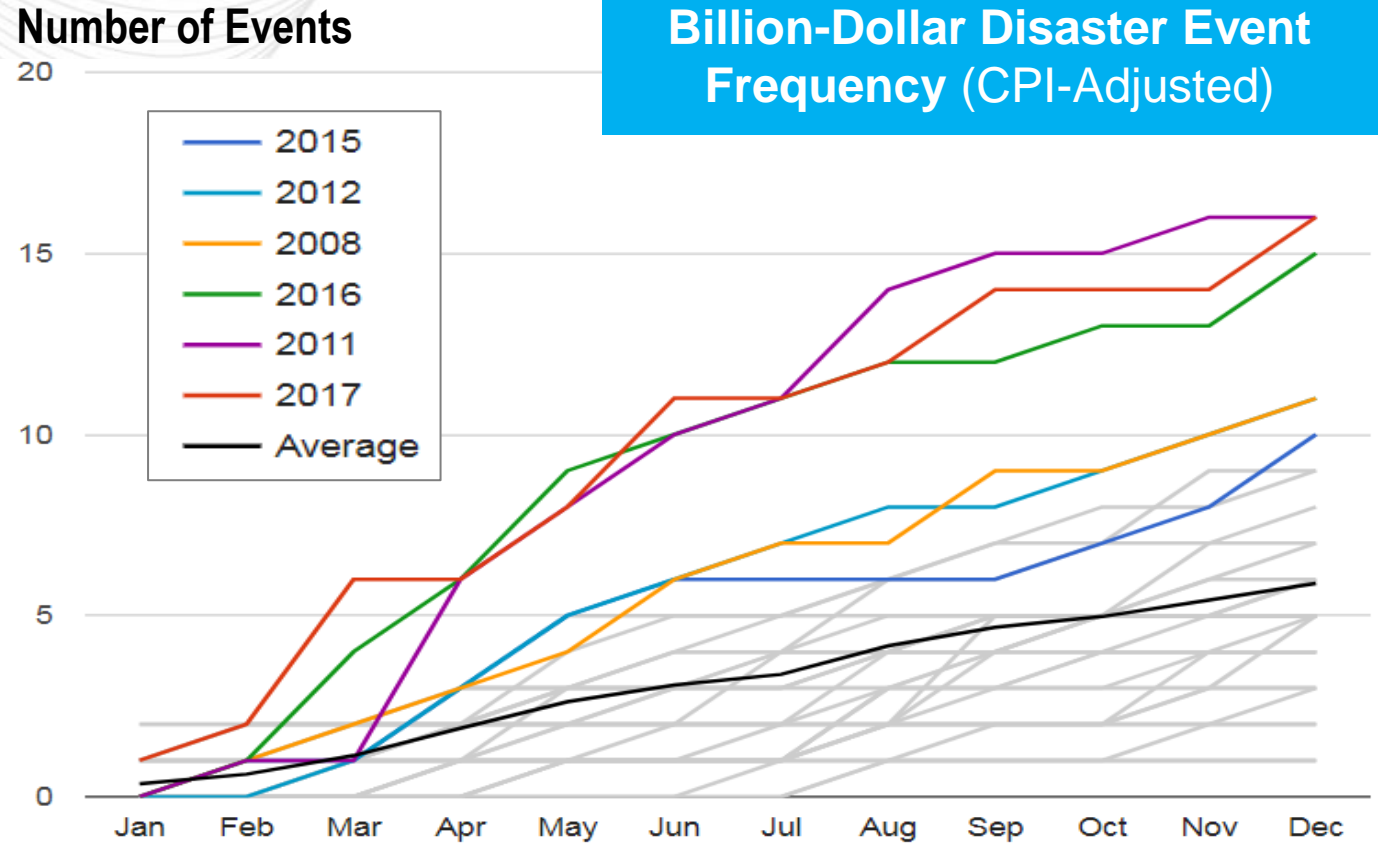


**Reliability:** Delivering electricity consistently and uninterrupted

**Resilience:** Grid survivability during extreme events, even if that means outages

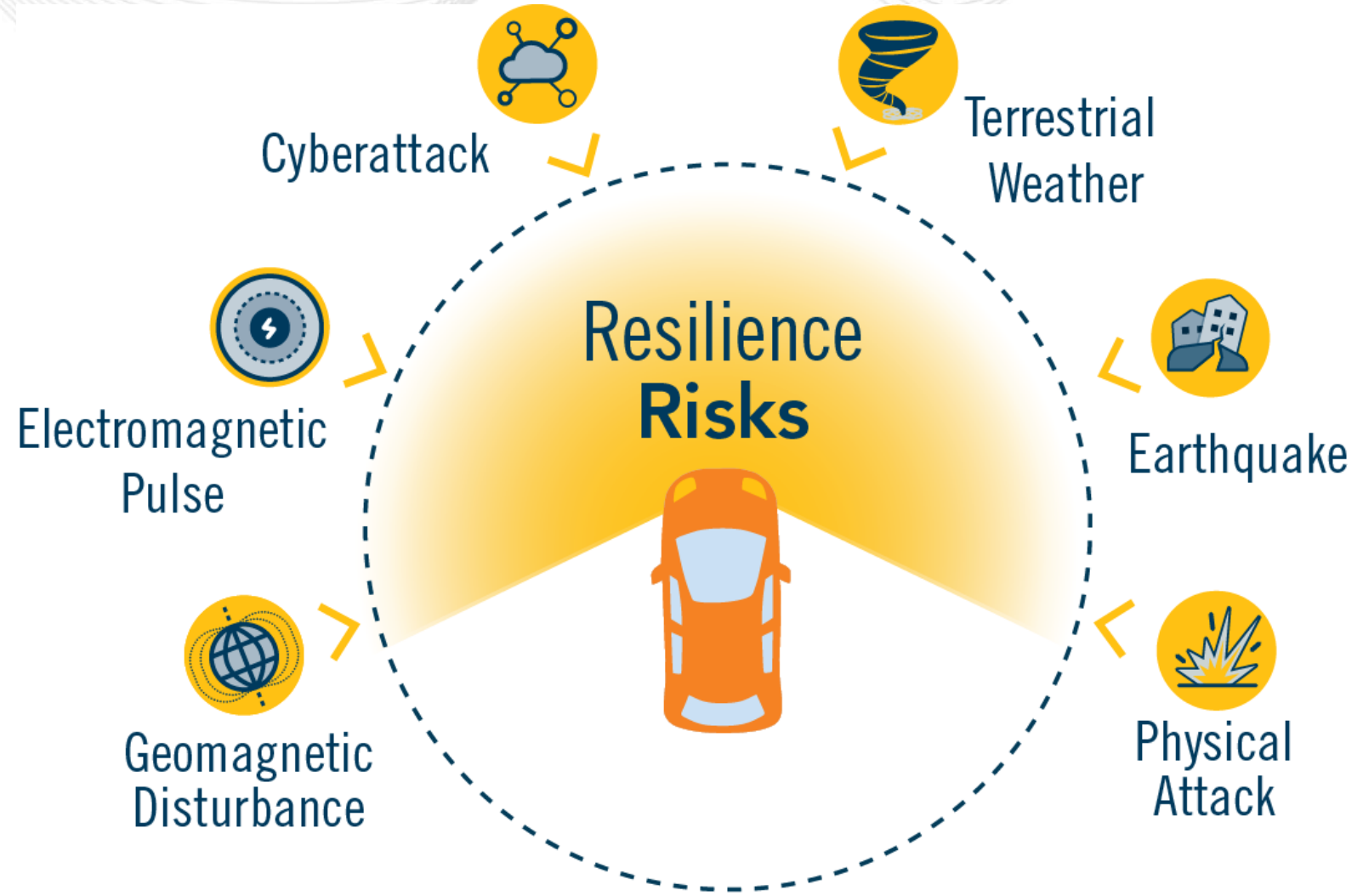
- 1 It can't happen to us.
- 2 The systems we need will be available.
- 3 Our system is stronger than others.

**1980-2017 YTD United States Billion-Dollar Disaster Event Frequency (CPI-Adjusted)**



## Risk Assessment

- 1 Determine risks we will protect against
- 2 Identify steps to mitigate
- 3 Must consider Interdependencies





**Risks / Dependencies:**  
 Extreme Weather | Physical/Cyber Attacks | Fuel Source/Security

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### Prepare

- Assess Risks**  
Targeted risk management
- Strengthen Infrastructure**  
Make critical assets less vulnerable
- Increase Coordination**  
Cross-sector & public/private partnerships

### Operate

- Strengthen Operations**  
Expand coordination and communications
- Enhance Continuity**  
Planned response exercises
- Apply Innovative Approaches**  
Microgrids & distributed energy resources

### Recover

- Stabilize the System**  
Prioritize interdependent infrastructures for system survivability
- Regain System-Critical Functions**  
Balance industry and societal priorities
- Make Enhancements Based on Lessons Learned**

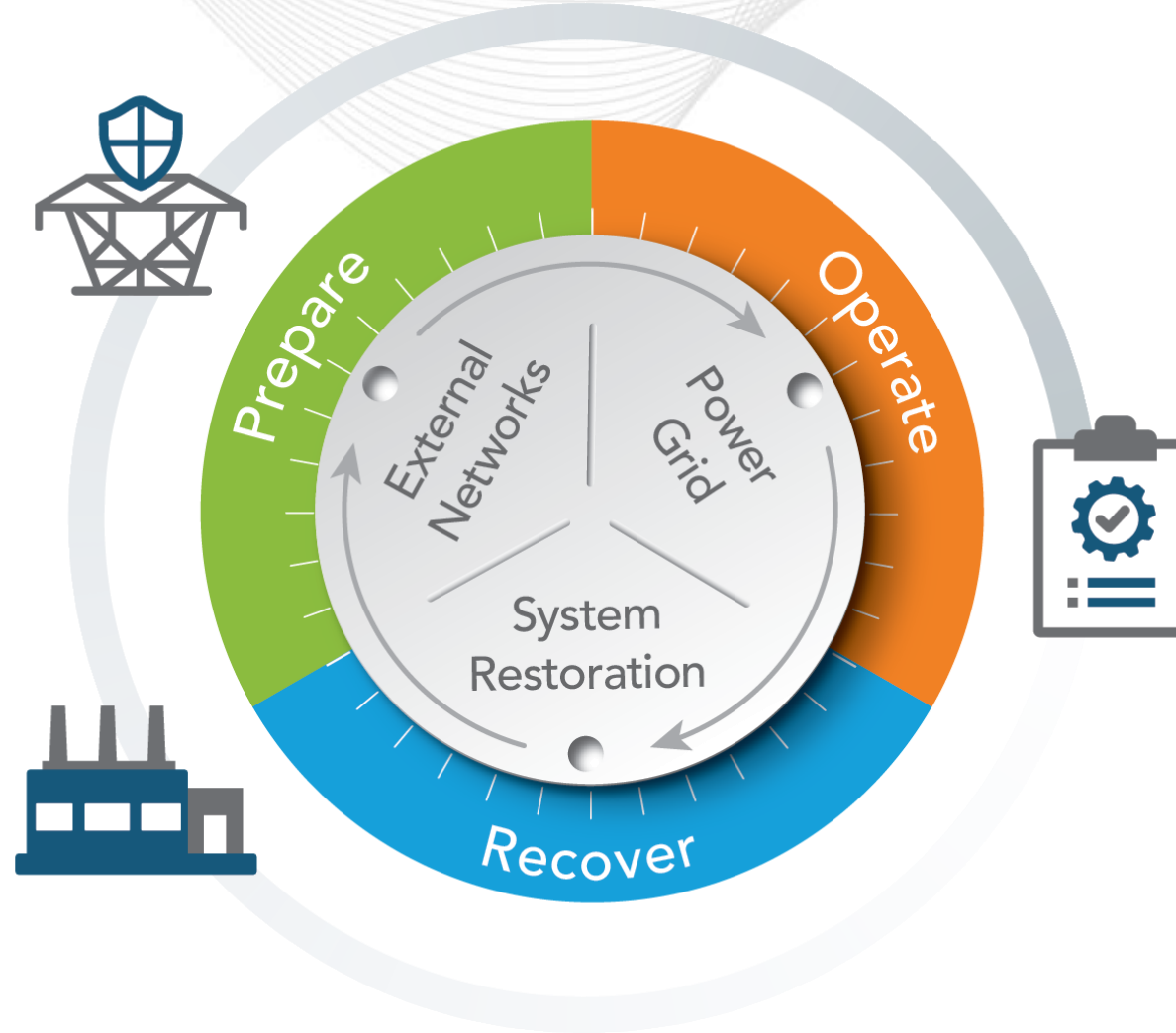
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## Infrastructure

- ① Enhanced Models & Analysis
- ② Planning Criteria
- ③ Reduce Criticality

## Supply

- ① Attributes for Wholesale Supply
- ② Fuel Security Analysis
- ③ Black Start Requirements



## Operations Criteria

- ① Load Loss Limits
- ② Locational Limits
- ③ Interdependent Systems



- 1 Fuel Security
- 2 Fuel Diversity
- 3 Co-location with critical loads
- 4 Flexible and Adaptable



- 1 Transmission planning criteria
- 2 Prioritized, all-hazard hardening
- 3 Targeted redundancy





- 1 “Do No Harm” – never make a system less resilient
- 2 Opportunistic Resilience – lifecycle replacements
- 3 Resilience as a Driver – Targeted Projects

**You can't stop all outages all the time;  
the goal should be to avoid  
catastrophic impacts**

**Consider effects to interdependent,  
life-support systems**

**Define the limits of failure in order to  
develop design targets and models**





- 1 Real-time visibility of interdependent systems
- 2 Enhanced system flexibility during events
- 3 Reduced dependencies and increased reserves