

**NERC**

NORTH AMERICAN ELECTRIC  
RELIABILITY CORPORATION

# Severe Risks Affecting the Power Grid

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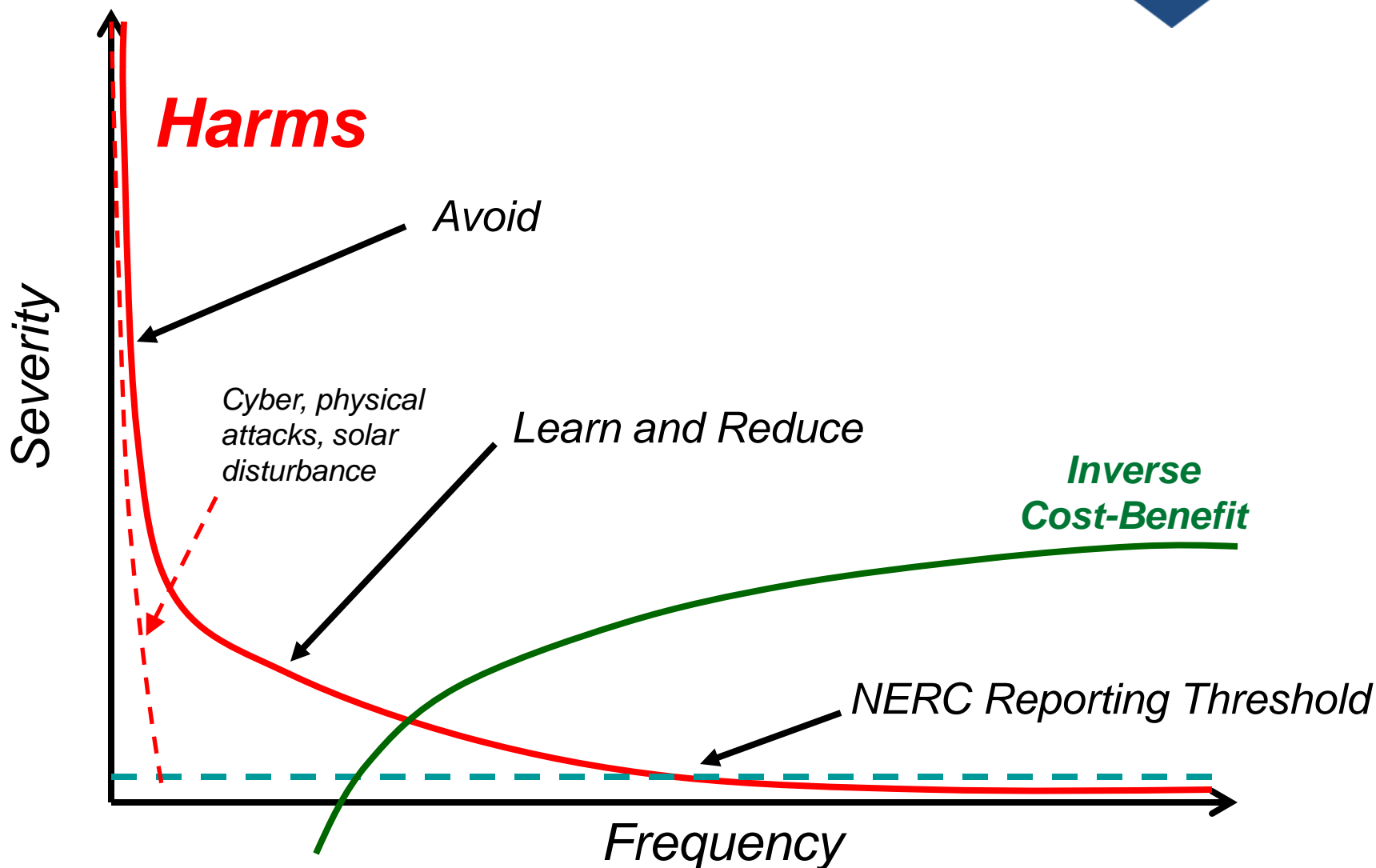
*CAMPUT 2016 Panel 9: Ensuring the Resiliency of the Grid*

May 17, 2016

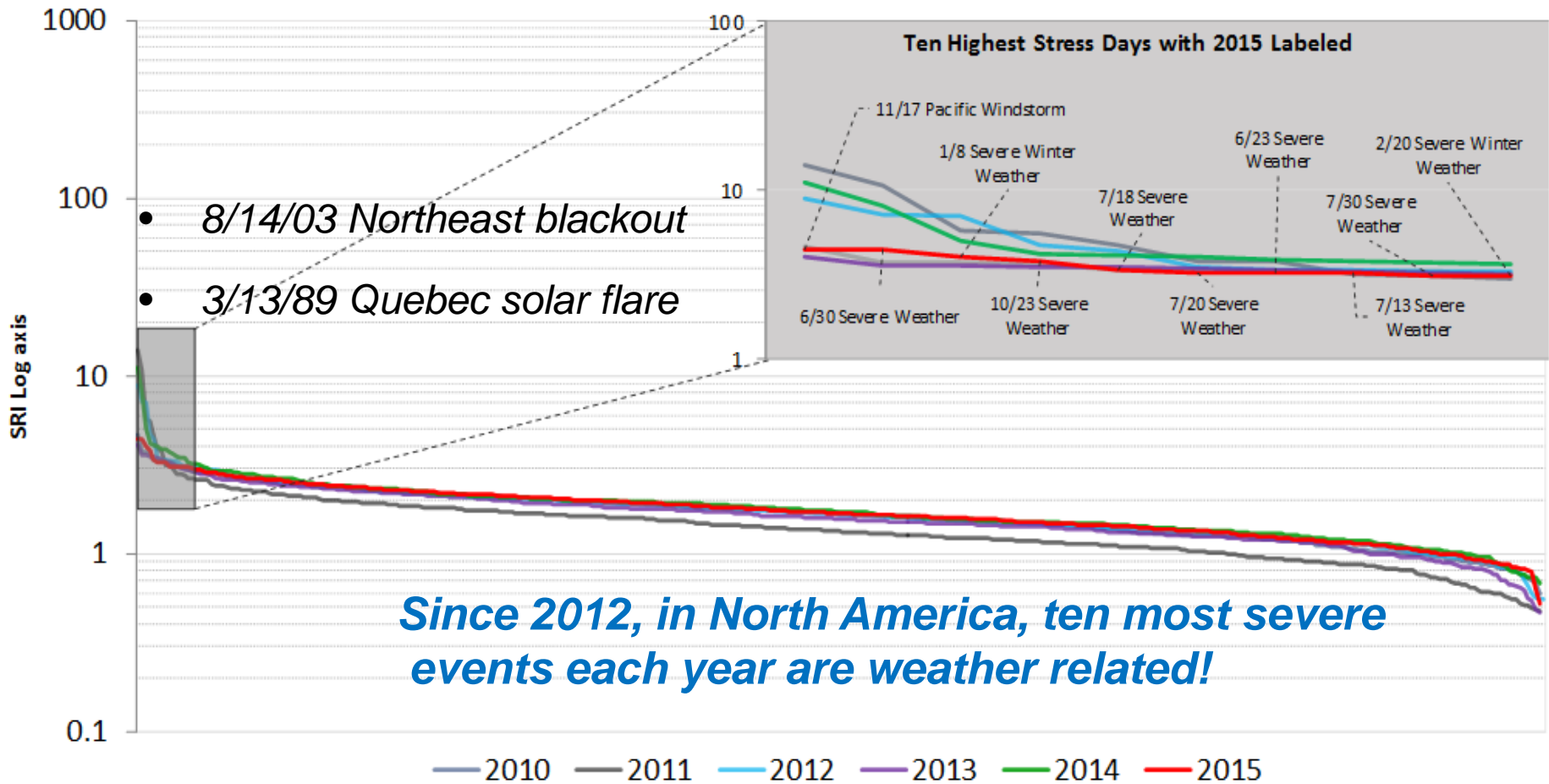
**RELIABILITY | ACCOUNTABILITY**



# Character of Risks in Interconnected Power Systems



# Severe Event Trends 2010-2015



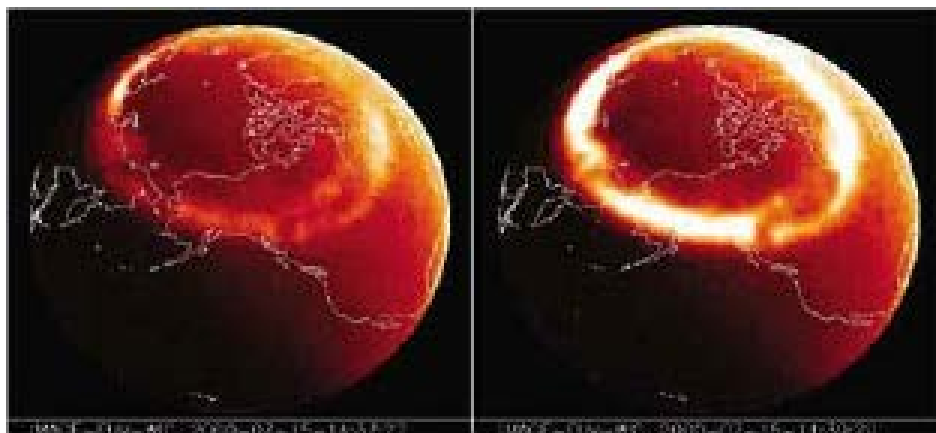
- Hurricane
- Tornado
- Wind (derecho)
- Severe snow/ice
- Earthquake
- Fire/explosion
- Extreme drought
- Extreme heat/cold



- Geomagnetic (solar) disturbance
- Intentional attack on grid
  - Physical (kinetic) attack
  - Cyber attack
  - EMP attack



Surveillance video screenshot  
Metcalf Substation April 16, 2013



NASA satellite image pre- and post-shock  
July 14, 2000 "Bastille Day" GMD Event

- Preparation and hardening to minimize consequences
  - Robustness or system hardening
  - Redundancy and autonomy
  - Preparation: plans, procedures, resources, exercises
- Response (during event)
- Restoration and recovery (post event)



- Preparedness
  - Severe event plans, training and exercises
  - Restoration procedures, training and exercises
  - Coordination with law enforcement and first responders
  - Coordination with local, provincial, and federal emergency response agencies
  - Black start and restoration resources
  - Government regulations and policies needed during emergencies
  - Facilities and backup power for crisis management
- Robustness
  - Select, cost-effective hardening
  - Cyber security protection of critical assets
  - Physical security protection of critical assets
  - Shielding and other GMD/EMP protections of critical assets
- Redundancy and autonomy
  - Structural or configuration changes to reduce facility criticality

- Situational awareness
- Advanced warning systems (e.g. space and weather services)
- Command and control, emergency response coordination
- Communications – internal and external systems and protocols
- Media and public relations
- Government-industry coordination



- Spare equipment inventories and deployment readiness
- Critical long lead time equipment reserves (e.g. transformers)
- Qualified personnel for various recovery scenarios (e.g. **storm** versus **cyber** versus **physical attack**)
- Logistics, transportation support for restoration/recovery crews
- Backup power supplies and communications
- Alternative system configurations
- Public safety and essential services
- Government emergency response resources