# Facing Extreme Weather –

## An Update of IEEE WG on Natural Disaster Mitigation Methods and Operation Technologies

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October 2nd , 2023



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# History

- The TF/WG was set forced by IEEE PES TC after the hurricane Big Sandy in 2012, and is currently under PES PSOPE.
- Best practices survey on natural disaster mitigation with utilities around the world
  - Supersessions and panel sessions at the IEEE PES General Meetings 2013 – 2022
  - Trending technologies
- Investigation on power grid infrastructure design guide enhancement to adapt to climate changes
- Operation methods and theories are proposed
- Collaboration with other WGs/TFs on resilience


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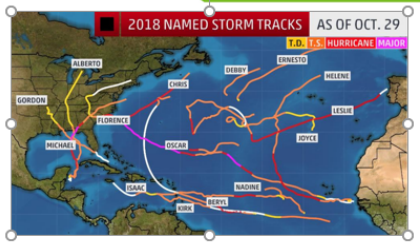
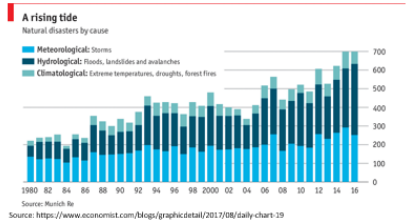
# Key elements of Natural Disaster mitigation


## Background: Increasing Extreme Weather Events

- Increasing extreme weather events
  - The number has risen dramatically in the past two decades
  - Extended power outages, especially in distribution systems
- Electricity supply is essential for surviving
  - Communication, lighting, air conditioning, cooking, …
  - Interdependent with other critical infrastructures (gas, water, transportation, …)
- Goal of electric utilities: Restore the power as soon as possible




Source: https://weather.com/storms/hurricane/news/2018-10-29-2018-atlantic-hurricane-season-unusual/




Source: https://www.economist.com/blogs/graphicdetail/2017/08/daily-chart-19

Krishnamurthy, Vaidyanathan, Alexis Kwasinski, and Leonardo Dueñas-Osorio. "Comparison of power and telecommunications dependencies and interdependencies in the 2011 Tohoku and 2010 Maule earthquakes." *Journal of Infrastructure Systems* 22.3 (2016): 04016013.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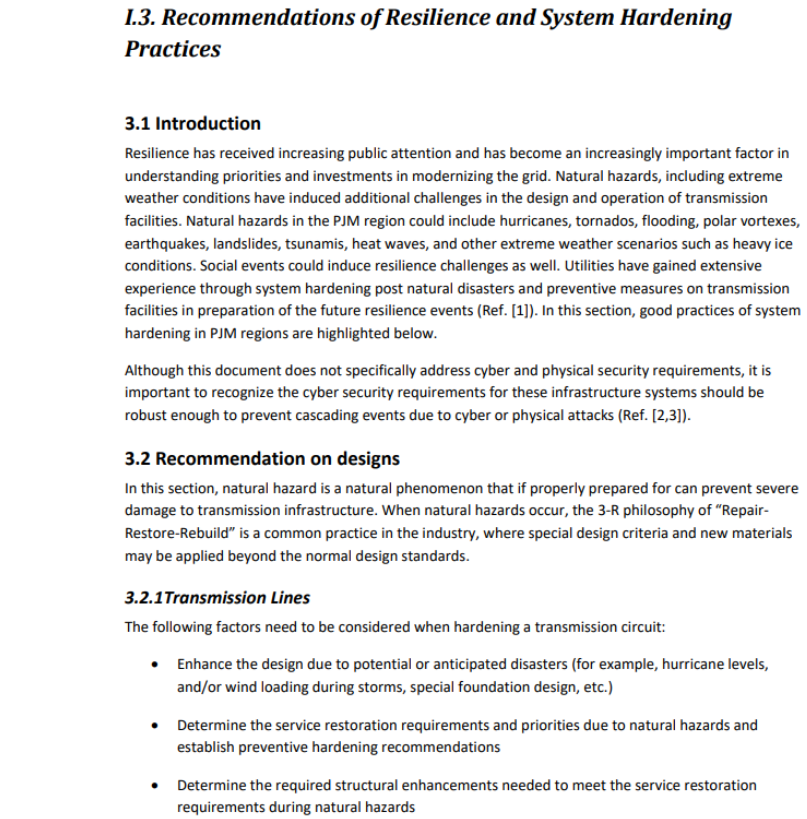
# Next Steps

- Operation methods on situational awareness and preventive actions
- Critical load response strategies
- Wild fire
- Applicable response method with collaboration in the energy market
- Resilience enhancement through infrastructure planning and design
- New technologies



***I.3. Recommendations of Resilience and System Hardening Practices***

**3.1 Introduction**

Resilience has received increasing public attention and has become an increasingly important factor in understanding priorities and investments in modernizing the grid. Natural hazards, including extreme weather conditions have induced additional challenges in the design and operation of transmission facilities. Natural hazards in the PJM region could include hurricanes, tornados, flooding, polar vortexes, earthquakes, landslides, tsunamis, heat waves, and other extreme weather scenarios such as heavy ice conditions. Social events could induce resilience challenges as well. Utilities have gained extensive experience through system hardening post natural disasters and preventive measures on transmission facilities in preparation of the future resilience events (Ref. [1]). In this section, good practices of system hardening in PJM regions are highlighted below.

Although this document does not specifically address cyber and physical security requirements, it is important to recognize the cyber security requirements for these infrastructure systems should be robust enough to prevent cascading events due to cyber or physical attacks (Ref. [2,3]).

**3.2 Recommendation on designs**

In this section, natural hazard is a natural phenomenon that if properly prepared for can prevent severe damage to transmission infrastructure. When natural hazards occur, the 3-R philosophy of "Repair-Restore-Rebuild" is a common practice in the industry, where special design criteria and new materials may be applied beyond the normal design standards.

***3.2.1Transmission Lines***

The following factors need to be considered when hardening a transmission circuit:

- Enhance the design due to potential or anticipated disasters (for example, hurricane levels, and/or wind loading during storms, special foundation design, etc.)
- Determine the service restoration requirements and priorities due to natural hazards and establish preventive hardening recommendations
- Determine the required structural enhancements needed to meet the service restoration requirements during natural hazards

PJMs recommendations of resilience and system hardening practices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