What Should Grid Resilience Plans Include?

Planning Requirements, Emerging Best Practices, and Template

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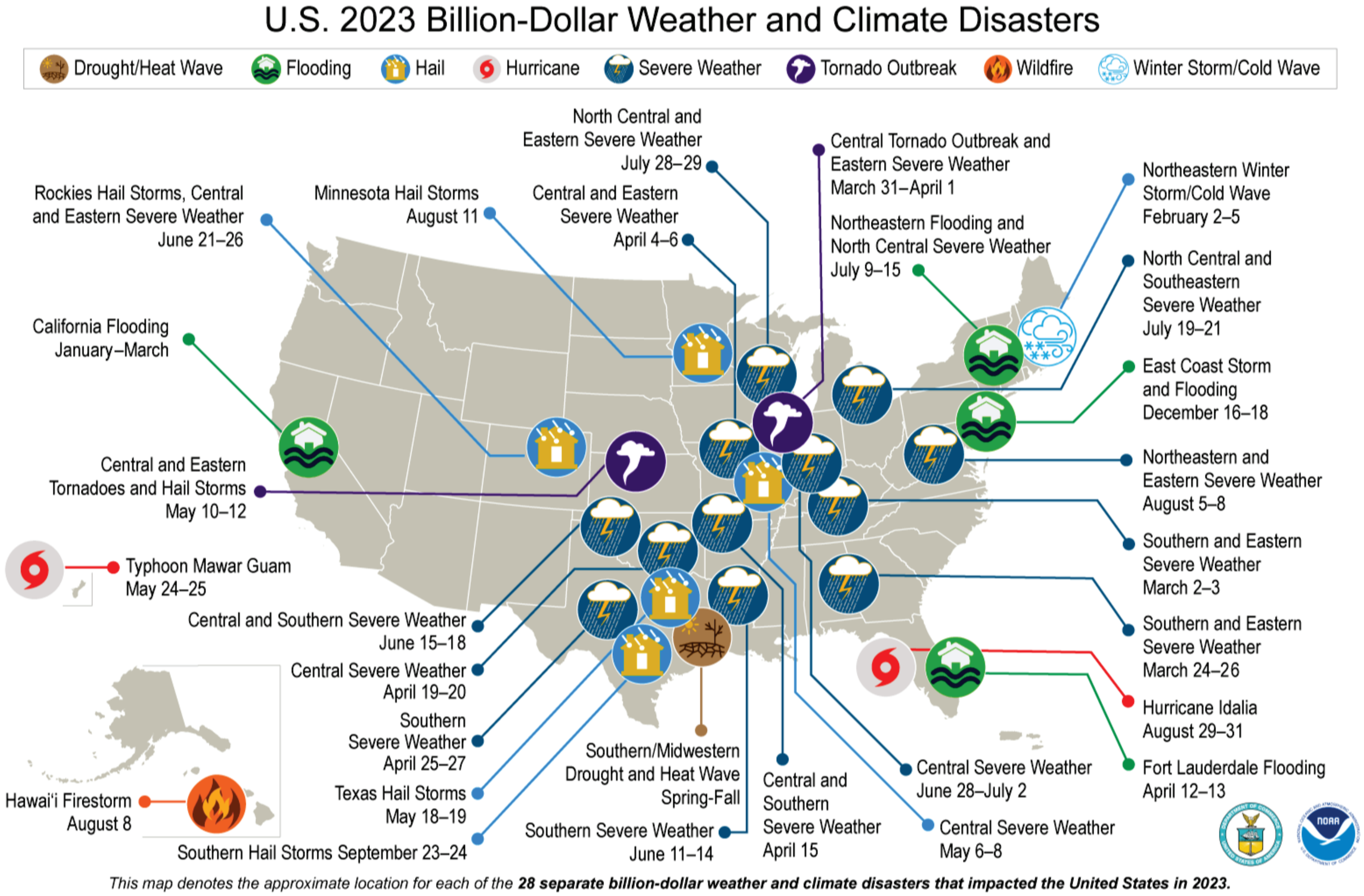
2023 had more billion-dollar weather and climate disasters than any year on record (inflation-adjusted)



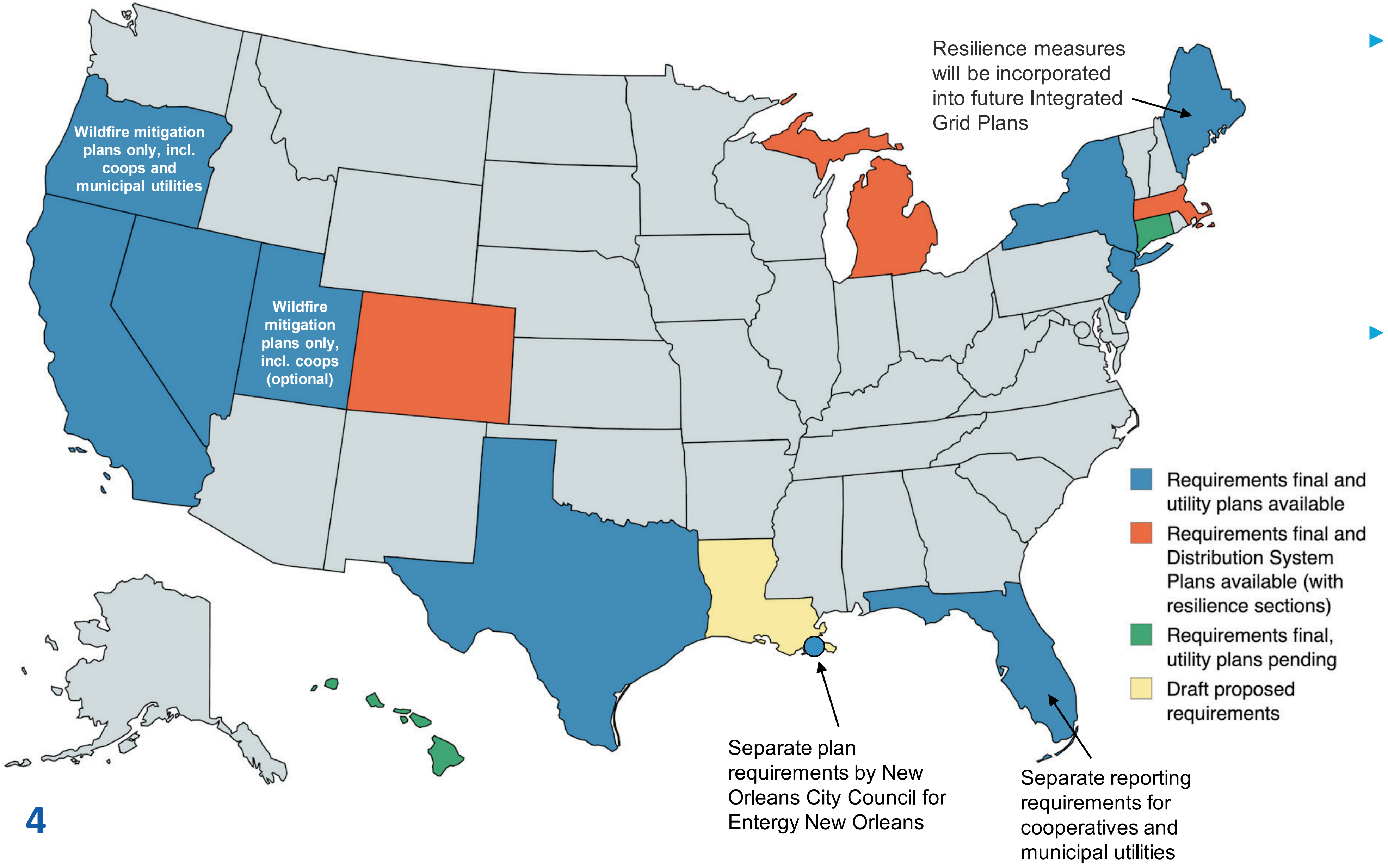
- **All 50 states** have been impacted by at least one of these billion-dollar disasters in the past 10 years
- Hawaii did not have any disasters of this magnitude for over 30 years until the August 2023 firestorm that destroyed the historic town of Lahaina on Maui Island
- 2023 was also the hottest year on record worldwide

Source: National Oceanic and Atmospheric Administration (NOAA)

Poll

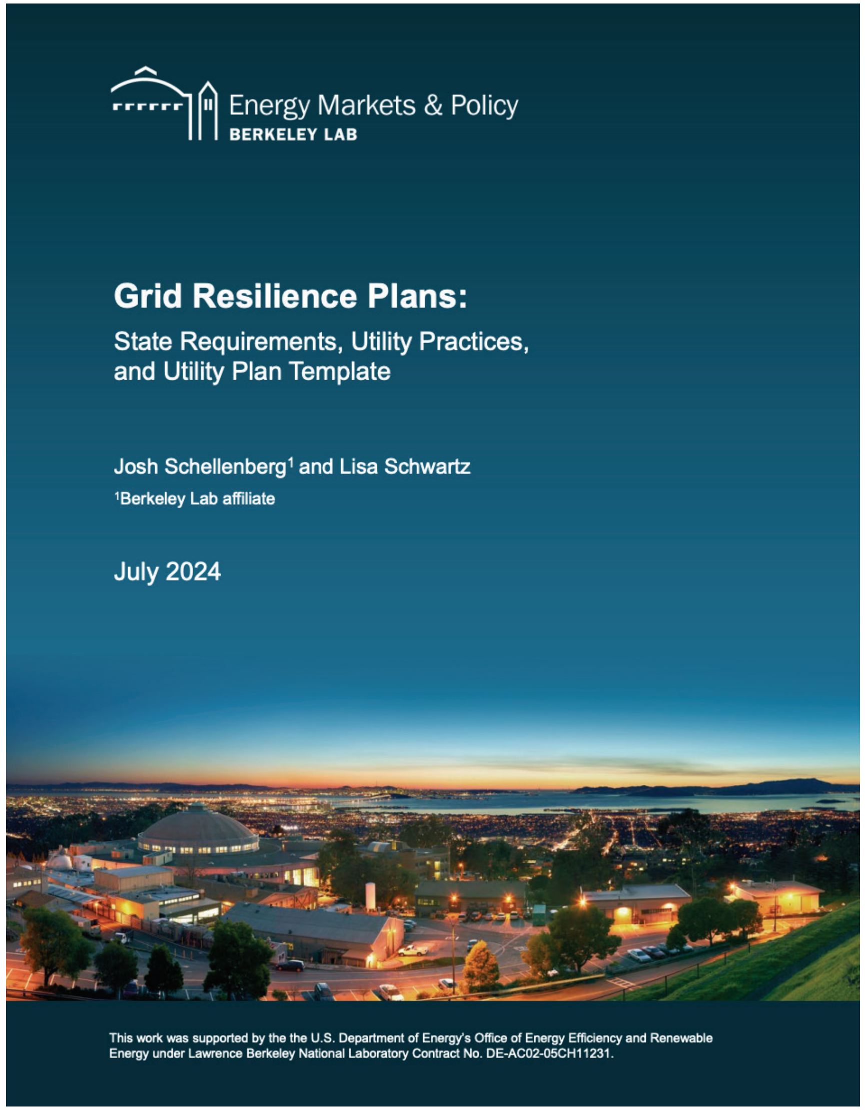
Which U.S. state was the first to require that utilities file standalone plans to improve grid resilience in response to extreme weather?

States are responding with resilience planning requirements for regulated utilities



- The four largest states – California, Texas, Florida and New York, accounting for a third of the U.S. population – have adopted resilience plan requirements, as well as nine other states.
- These requirements and associated utility plans point toward emerging best practices.

Berkeley Lab's new report, *Grid Resilience Plans: State Requirements, Utility Practices, and Utility Plan Template*



Resilience Plan Template

States and utilities can adapt this template to account for jurisdiction-specific considerations. A Word document version is available on Berkeley Lab's website for this purpose.

Section 1. Executive Summary

- Resilience plan objectives and motivation
  - Legislative and regulatory requirements
  - Extreme weather events, increasing restoration costs, availability of government funding support, data sources and solutions, technological changes, and other jurisdiction-specific items
- Definition of resilience, resilience event, and reliability – for example:
  - *Resilience* – "[A]bility 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."[1]
  - *Resilience event* – "[A]n event involving extreme weather conditions, wildfires, cybersecurity threats, or physical security threats that poses a material risk to the safe and reliable operation of an electric utility's transmission and distribution systems. A resiliency event is not primarily associated with resource adequacy or an electric utility's ability to deliver power to load under normal operating conditions."[2]
  - *Reliability* – "The ability to maintain the delivery of electric power to customers in the face of routine uncertainty in operating conditions."[3]
- Definitions of other key terms,[4] including those that define what the plan does (and does not) cover in terms of the service territory, infrastructure areas, etc.
- Hazards in scope
  - Summary of all hazards considered and ultimately selected during plan development
  - Brief rationale for any hazards that were not included in the vulnerability assessment

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- Utilities can adapt the template to meet their own needs, using the editable Word document version
- Report and template available at: https://emp.lbl.gov/publications/grid-resilience-plans-state

Emerging Best Practices

Emerging best practices for resilience plans (1)

1. **Hazards in Scope:** Resilience plans can provide a summary of all hazards analyzed and the resulting vulnerability assessment
   - Publicly available utility resilience plans have not focused on cyber/physical security threats, even if those hazards are included as an option in the requirements (Colorado and New Jersey)
   - Texas' resilience planning law and proposed Louisiana requirements include cyber and physical security measures as options to include in a resilience plan

2. **Planning Horizon and Frequency:** Given the long-term nature of most resilience investments, resilience plans can have a planning horizon of at least 10 years, with more detail provided in the first 3 to 5 years and updates every 3 to 5 years
   - Wildfire Mitigation Plans have a shorter planning horizon (3 years) and are updated more frequently (1 to 3 years) reflecting the urgency of the wildfire threat in Western states in recent years

Emerging best practices for resilience plans (2)

3. **Measures in Scope:** Consider most viable resilience measures, *including changes to planning/operational processes*, and include analysis of those measures
   - Undergrounding (California, New York, Michigan and Texas requirements)
   - Vegetation management (most plan requirements)
   - Lineworker staffing and storm severity forecasting (Connecticut requirements)
   - Measures that mitigate gas-electric dependencies during winter storms (Louisiana requirements)
   - De-energization events, including protocols and emergency communications (Wildfire Mitigation Plans)

4. **Vulnerability Assessment:** Emerging best practice includes providing a matrix that summarizes all hazards relative to assets and processes analyzed with a clearly defined vulnerability rating that applies to each asset-hazard and process-hazard pair
   - Emerging best practice from utility vulnerability assessment and plans (examples provided in next section of this presentation)
   - Resilience solutions are then identified and prioritized for each asset-hazard and process-hazard pair that the assessment identifies as highly vulnerable

Emerging best practices for resilience plans (3)

5. **Climate Scenarios and Data:** For extreme weather hazards, states can specify climate scenarios for the vulnerability assessment and provide source for downscaled climate data based on expert input
   - In California and New York, State Energy Offices worked with climate experts at universities in their states to develop extreme weather forecasts for a variety of climate hazards, downscaled for their state
   - This provides consistency of data sources and scenarios for utilities, including municipal utilities and rural electric cooperatives
   - With the general warming trend and increasing frequency and severity of extreme weather events, using long histories of weather data may lead to misguided resilience investment decisions

Argonne National Laboratory's Climate Risk and Resilience Portal (ClimRR): tool for developing local climate projections

- Can upload a GIS shapefile of the utility's service territory to ClimRR and receive a summary of projections

Emerging best practices for resilience plans (4)

6. **Performance Reporting:** Consider quarterly or annual reporting of specific, impact-oriented metrics (relative to key benchmarks if applicable)
   - "Metrics should focus on the success of mitigation at lowering the risk of catastrophic wildfires and not simply program targets such as the number of trees removed or wires replaced" (California requirements)
   - Utilities file forecasted reliability metrics and benchmarks, with and without major storm events, and map planned system investments against metrics to better understand expected impacts (Michigan requirements)
   - Major storm data on outages, blocked roads, critical facility impacts, and life-threatening emergency response events by storm intensity and level of resilience investment (Connecticut requirements)

7. **Funding Support:** Consider seeking funding support (if applicable for a given measure), including IIJA Formula Grants, and report progress
   - Connecticut and Louisiana requirements include almost identical language: "Every effort must be made, both now and in the future, to identify non-ratepayer funds to offset the costs associated with implementing [resilience plans] required herein. Specifically, it is incumbent on each [utility] to continuously review the [plans] for alignment with and potential leveraging of existing and future federal or state funding opportunities, particularly those included in the Federal Infrastructure Investment and Jobs Act (IIJA)."

Examples from Utility Plans

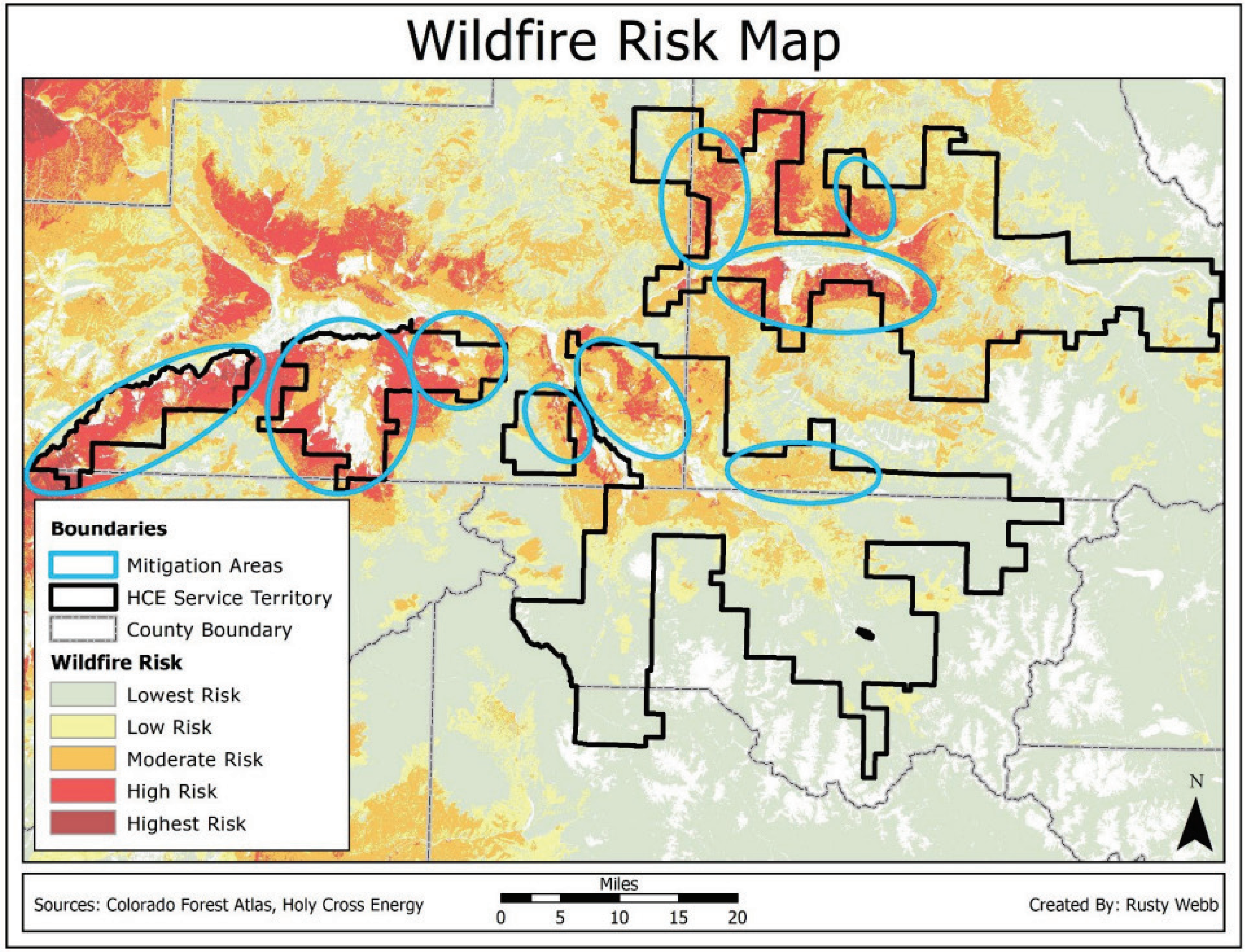
Eversource Summary of Storm Costs for Historical Events (in thousands)

	Storms				
	October 2017	March 2, 2018	March 7, 2018	May 15, 2018	Tropical Storm Isaias
Event Level	Level 4	Level 5	Level 4	Level 5	Level 2
Labor – Internal	$4,028.5	$3,947.8	$4,652.8	$6,799.1	$13,618.9
Labor - Affiliate	$1,299.1	$1,145.1	$1,983.7	$6,311.0	$16,342.0
Payroll-Related Overheads	$795.6	$415.8	$802.4	$3,830.7	$7,160.2
Mutual Aid and External Contractors	$26,979.1	$17,864.6	$26,247.6	$48,346.2	$206,256.8
Vehicles	$129.6	$73.6	$107.0	$241.8	$1,293.6
Material	$366.1	$694.1	$873.3	$2,887.3	$6,292.2
Food and Lodging	$1,246.3	$1,021.7	$1,662.7	$4,031.9	$13,275.4
Employee Expenses/Other	$196.9	$180.1	$243.0	$446.6	$880.1
Total Incremental Storm Restoration Costs	**$35,041.2**	**$25,342.8**	**$36,572.6**	**$72,894.7**	**$265,875.0**

Source: Connecticut Public Utilities Regulatory Authority (2022)

- Precipitous increase in costs for mutual aid and external contractors for Tropical Storm Isaias in 2020
- Highlighting such trends in extreme weather events and impacts, including solutions previously implemented that have proven effective (or ineffective), helps identify high priority issues that the plan can address

Holy Cross Energy Wildfire Mitigation Plan (2023)



Source: Holy Cross Energy (2023)

Con Edison Climate Change Vulnerability Study (2023): Summary of Vulnerabilities

	Temperature and Temperature Variable (TV)	Flooding	Wind and Ice
Area and Unit Substations	Primary	Primary	Low
Transmission Substations	Primary	Primary	Low
Overhead Transmission	Primary	Low	Secondary
Overhead Distribution	Secondary	Low	Primary
Underground Transmission	Secondary	Secondary	Low
Underground Distribution	Primary	Secondary	Low
Key Company Facilities	Secondary	Secondary	Low

Source: Con Edison (2023a)

Con Edison Climate Change Vulnerability Study (2023): Vulnerability Scoring Rubric

Low	• Asset/system has low vulnerability to the given climate hazard. – There are minimal or no negative outcomes or effects associated with asset/system exposure to this climate hazard.
Secondary	• Asset/system is moderately vulnerable to the given climate hazard. • Vulnerability is influenced by one or more of the following factors: – Asset is expected to experience increased degradation over time. – Asset is moderately sensitive but expected to experience a limited increase in magnitude for the given climate hazard within the evaluated time horizon. – Asset has limited sensitivity, but the increase in magnitude for the given climate hazard is moderate.
Primary	• Asset/system is highly vulnerable to the given climate hazard. • Vulnerability is influenced by one or more of the following factors: – Asset is highly sensitive, and the increase in magnitude for the given climate hazard is high, resulting in a high risk of major individual failure or severe degradation of service. – Asset is only moderately sensitive to the given climate hazard but is expected to experience a large magnitude of change in the given climate hazard. – Asset is highly sensitive to the given hazard but will experience only moderate changes in the magnitude of the given hazard.

Source: Con Edison (2023a)

Duke Energy Climate Risk and Resilience Study (2022): Vulnerability Ratings by Process Area

Table 2. 2050 projected vulnerability priority ratings for asset and operations planning groups, agnostic of scenario.

Process Area	Risk Score
Asset Management	High
Load Forecasting	Medium
Capacity Planning	Medium
Reliability Planning	Medium
Emergency Response	Low
Workforce Safety	Low
Vegetation Management	Low

Source: Duke Carolinas (2022)

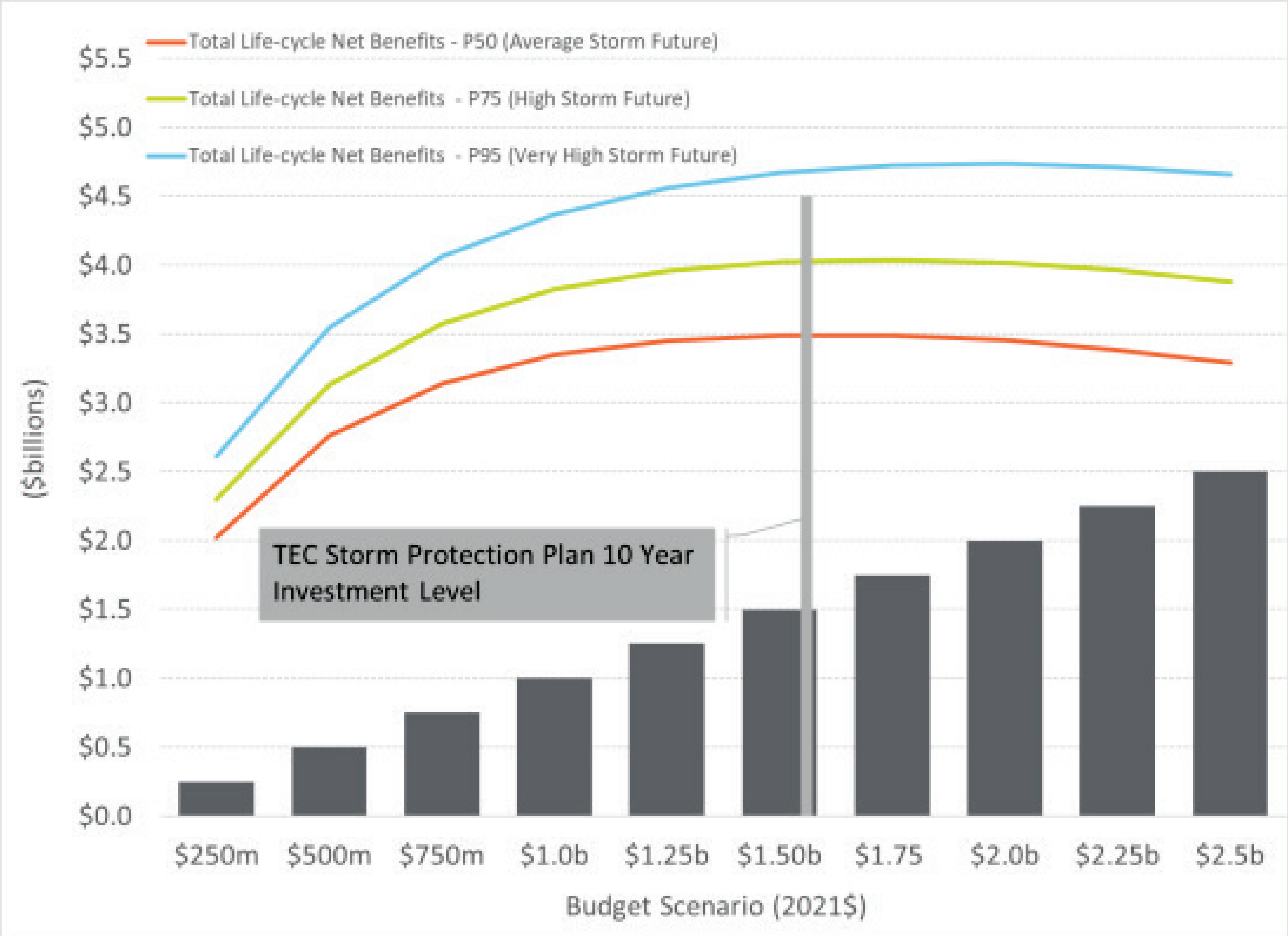
"Risks to Duke Energy's asset management include accelerated equipment aging; a potential need to adjust design criteria to address the risk of changing precipitation, flooding and heat patterns; an incomplete understanding of the pole fleet's weather readiness; and limited insight into failure data and impact of climate on failure rates."

Duke Energy Climate Risk and Resilience Study (2022): Vulnerability Priority Category Rating Scale

	Vulnerability Category	
	Assets	Planning & Operational
Low	Limited sensitivity to projected levels of change in exposure, accounting for existing risk mitigations.	No process vulnerabilities to climate change are identified.
Medium	Potential for increased impacts that could result in reliability, cost, or other consequences. Moderated by existing adaptive capacity or risk mitigations, concentration of risks in high-end climate scenarios only, or other factors.	Vulnerabilities to climate change are identified in one or two process components.
High	High sensitivity/consequence associated with potential change in exposure. Could result in increased potential for highly significant outages, risks, and/or costs.	Vulnerabilities to climate change are identified in several process components.

Source: Duke Carolinas (2022)

Tampa Electric Storm Protection Plan (2022)



Source: Tampa Electric (2022)

Next steps

- **Public Utility Commissions:** Consider template for utility resilience plans — in close alignment with integrated distribution system plans — to:
  - Facilitate development of plan requirements
  - Facilitate Commission review of filed plans
  - Reduce the burden of review by using a standard format across regulated utilities
- **State Energy Offices:** Consider working with climate experts at leading universities in your state to develop extreme weather forecasts for a variety of climate hazards, downscaled for your state
  - Critical step to ensure consistency of data sources and scenarios for all types of utilities in your state, including municipal utilities, rural electric cooperatives, and investor-owned utilities
- **Industry Professionals:** Get started and grow capabilities
  - Support a vulnerability assessment for one or two high priority hazards
  - Learn from the process and continue iterating as planning practices evolve
  - Incorporate stakeholder input and state and local objectives with each iteration

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