What Should Grid Resilience Plans Include?

Planning Requirements, Emerging Best Practices, and Template

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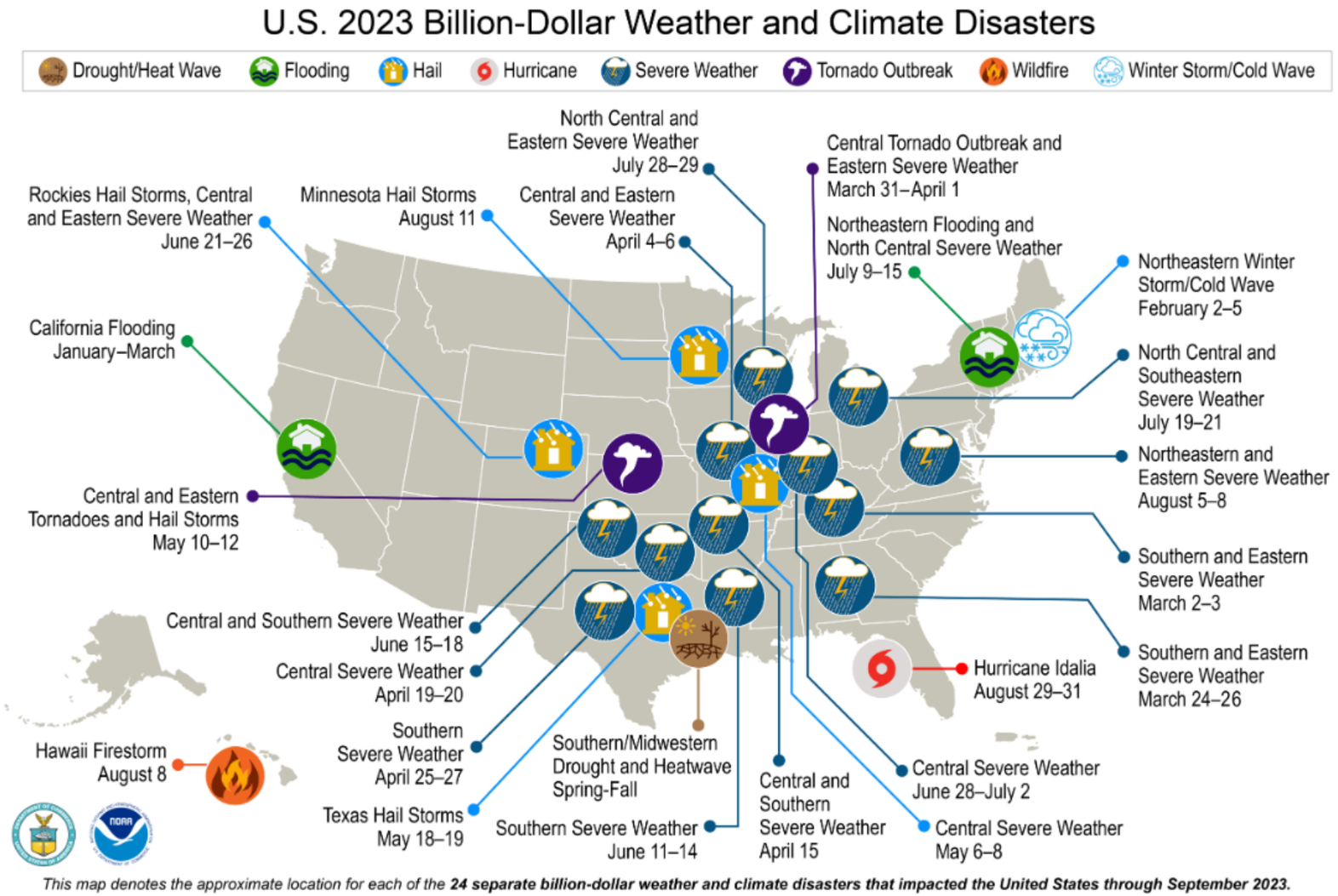
Resilience Training for States – Western Region

January 25, 2024

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

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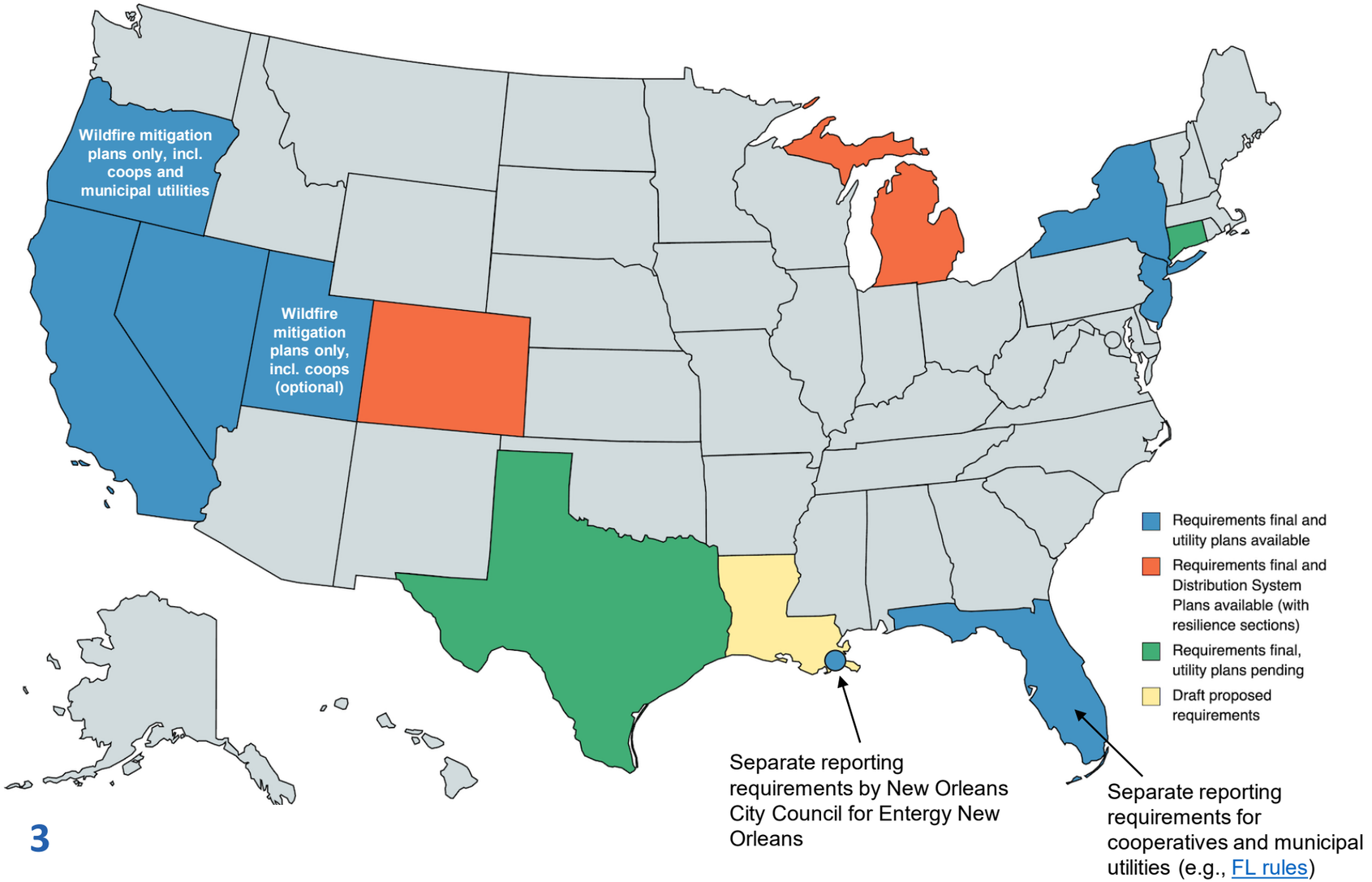
States are responding with resilience planning requirements for regulated utilities



- The four largest states – California, Texas, Florida and New York, which account for a third of the U.S. population – set resilience plan requirements, by law or rule, as well as eight other states.
- Existing requirements and utility plans have begun to establish best practices, which serve as guidance to states that have not created resilience plan requirements and regulatory processes.

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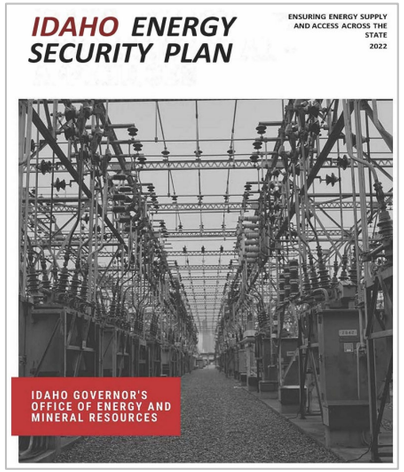
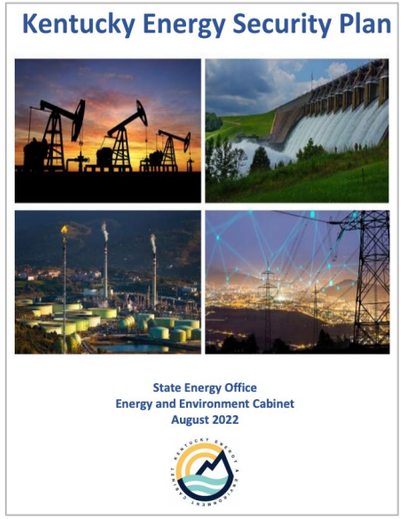
States are also developing Energy Security Plans

- Under IIJA, State Energy Security Plans must assess existing circumstances in the state and propose methods to strengthen its ability to:
  - Secure energy infrastructure against all physical and cybersecurity threats
  - Mitigate the risk of energy supply disruptions
  - Enhance the response to, and recovery from, energy disruptions
  - Ensure that the state has reliable, secure, and resilient energy infrastructure

- Specific resilience-related requirements include:
  - Addressing physical and cybersecurity threats and vulnerabilities
  - Providing a risk assessment of energy infrastructure and cross-sector interdependencies
  - Developing a risk mitigation approach to enhance reliability and end-use resilience

- The security plans are the **foundation of grid investment resilience planning** under the IIJA. They highlight resilience risks, discuss investment priorities for enhancing the grid, and provide insights into potential priority investments by utilities.
  - Utility resilience plans should align with methods, data sources and priorities in the state's Energy Security Plan





Source: NASEO and Berkeley Lab (2023). *State Energy Offices' Engagement in Electric Distribution Planning to Meet State Policy Goals*

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Berkeley Lab plans to publish a resilience planning framework and standardized template for utility plans in early 2024

Resilience Plan Template

Section 1. Executive Summary

- Resilience plan objectives and motivation (e.g., legislation, PUC rulemaking, extreme weather events, increasing restoration costs, new funding, data sources and solutions, etc.)
- Definition of resilience and how it differs from reliability
- Types of measures considered as part of plan development to enhance the resilience of the utility's infrastructure and practices, including the following options:
  - Hardening electrical T&D facilities
  - Modernizing electrical T&D facilities
  - Undergrounding certain electrical distribution lines
  - Lightning mitigation measures
  - Flood mitigation measures
  - Information technology (IT)
  - Cybersecurity measures
  - Physical security measures
  - Vegetation management
  - Wildfire mitigation and response
  - Other eligible resilience measures
- Proposed resilience programs in plan
  - Name of each resilience program
  - Category of resilience measure (from list of measure types above)
  - Specific types of hazards mitigated by program, including high winds, lightning, flooding, freezes, earthquakes, cybersecurity threats, physical security threats and other hazards
- Summary of overall costs and benefits by resilience program, including:
  - Cost summary
  - Rate impacts
  - Expected benefit streams (such as reduced restoration costs, shorter outage duration, avoided outage events, lower unserved energy, avoided customer interruption costs and increased safety)
  - How the program prioritizes areas of lower expected performance

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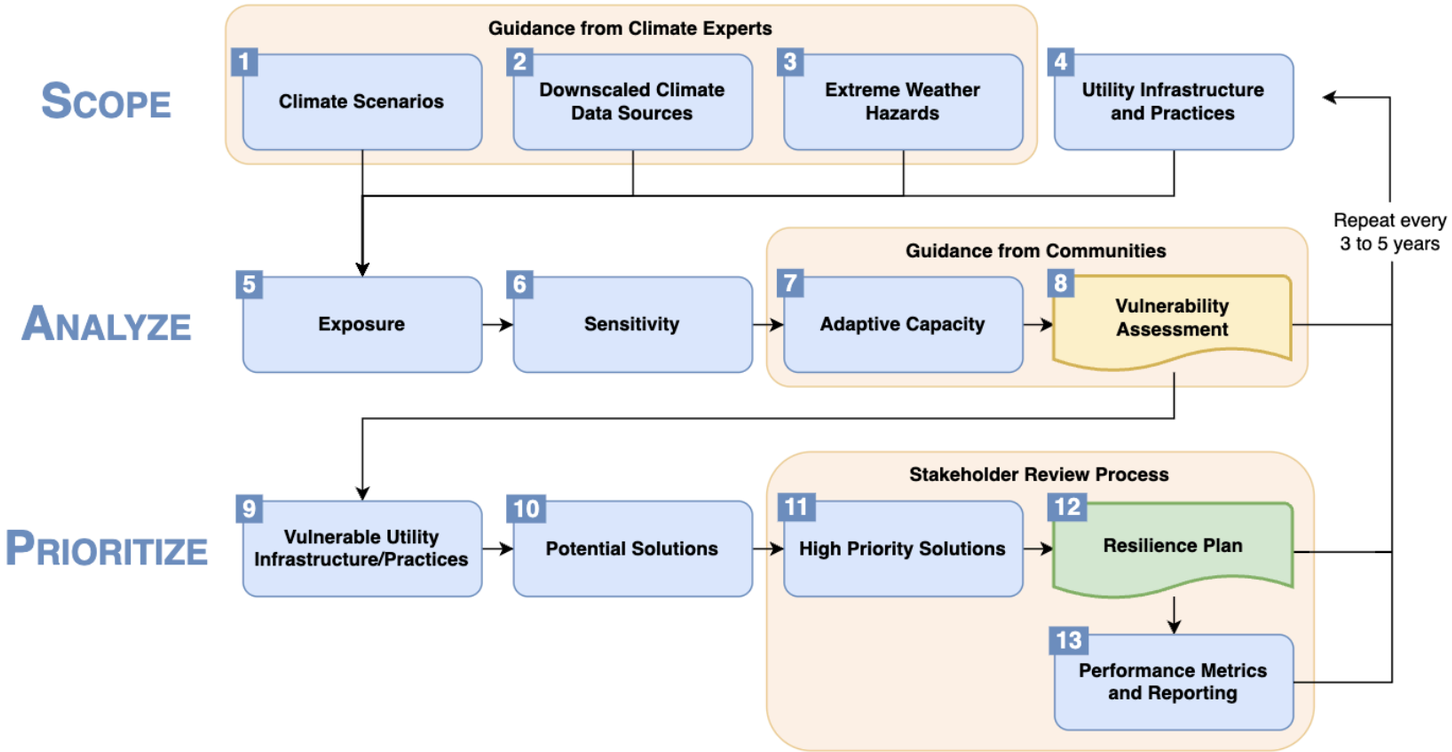
Resilience Planning Framework for Extreme Weather



Objectives:

- Facilitate development of plan requirements
- Assist with review of prepared plans
- Offer a standard format states can adapt (standardizing across utilities reduces burden of review)

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Resilience Planning Requirements and Emerging Best Practices

Resilience planning requirements

Wildfire is the primary focus in Western states

State	Plan Name	Hazards in Scope	Plan Frequency	Planning Horizon
California	Climate Change Vulnerability Assessment	**Wildfires**, extreme heat, extreme storms, drought, subsidence, sea level rise and other climate change hazards	4 years (part of general rate case)	10 to 50 years
California	Wildfire Mitigation Plan (required in Senate Bill 901)	**Wildfires**	Annual	3 years
Colorado	Distribution System Plan	Natural disasters and *cyber/physical security threats*	2 years	10 years
Nevada	Natural Disaster Protection Plan	**Wildfires** are primary focus, but state requirements cover other natural disasters	3 years	3 years*
Oregon	Wildfire Mitigation Plan	**Wildfires**	Annual	3 years*
Utah	Wildland Fire Protection Plan (required in House Bill 66)	**Wildfires**	3 years	3 years*

* These state requirements do not specify a planning horizon, but utilities have filed 3-year plans in practice

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Extreme weather is the primary focus in Northern states

State	Plan Name	Hazards in Scope	Plan Frequency	Planning Horizon
Connecticut	Resilience Plan	**Extreme weather**	4 years (part of GRC cycle)	10 years
Michigan	Distribution System Plan	**Extreme weather**	2 years	5 years
New Jersey	Infrastructure Investment Program	**Extreme weather** and *cybersecurity*	Voluntary	5 years
New York	Climate Change Vulnerability Study and Resilience Plan (required in legislation signed by governor)	Increase in **severe weather** expected from climate change, including stronger storms and more flooding	5 years	10 to 20 years

Storms are impetus for requirements in Southern states, but proposed rules in LA and TX take an ”All-Hazards” approach

State	Plan Name	Hazards in Scope	Plan Frequency	Planning Horizon
Florida	Storm Protection Plan	**Extreme weather**	3 years	10 years
Louisiana (excluding NOLA)*	Grid Resilience Plan	Any low-probability/high-consequence events, including *cyber/physical security threats*	5 years	10 years
New Orleans	System Resiliency and Storm Hardening Plan	**Extreme weather**	TBD	5 years
Texas*	T&D System Resiliency Plan	Any low frequency, high impact event that poses a material risk to the safe and reliable operation of an electric utility’s T&D systems, including *cyber/physical security threats*	3 years (voluntary)	3 years (minimum)

* Per HB 2555 (2023) for Texas requirements

Emerging best practices for resilience plan requirements

1. **Hazards in Scope:** If policymakers prefer an All-Hazards approach, requirements should specify that utilities provide a summary of all hazards analyzed and the resulting vulnerability assessment
   - Utility resilience plans to date 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, requirements should specify 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), most likely due to the urgency of the wildfire threat in Western states in recent years

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Emerging best practices for resilience plan requirements (continued)

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

4. **Vulnerability Assessment:** Require a matrix that summarizes all hazards relative to assets and practices analyzed with a clearly defined vulnerability rating that applies to each asset-hazard and practice-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/practice-hazard pair that the assessment identifies as highly vulnerable

Emerging best practices for resilience plan requirements (continued)

5. **Performance Reporting:** Require quarterly to 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" (in 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 (in 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 (in Connecticut requirements)

6. **Funding Support:** Include requirement to seek funding support (if applicable for a given measure), particularly IIJA, 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)."
   - Connecticut requirements include detailed quarterly funding status updates

Emerging best practices for resilience plan requirements (continued)

7. **Climate Scenarios and Data:** For extreme weather hazards, specify climate scenarios for 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 leading universities in their states to develop extreme weather forecasts for a variety of climate hazards, downscaled for their state
   - This is a critical step to ensure 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, long histories of weather data may lead to misguided resilience investment decisions

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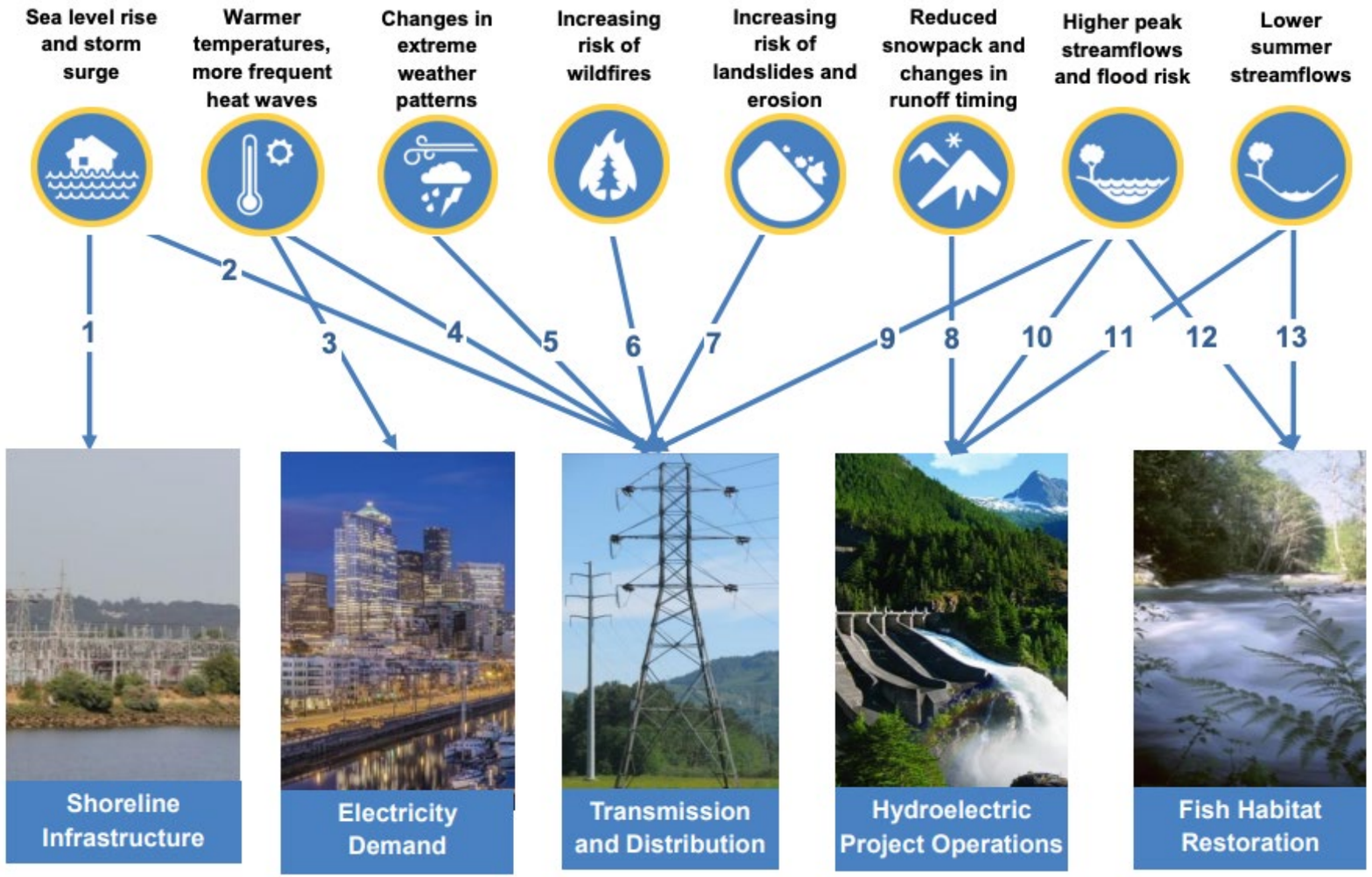
Example Utility Plans and Best Practices

Seattle City Light Climate Change Vulnerability Assessment and Adaptation Plan (2015)



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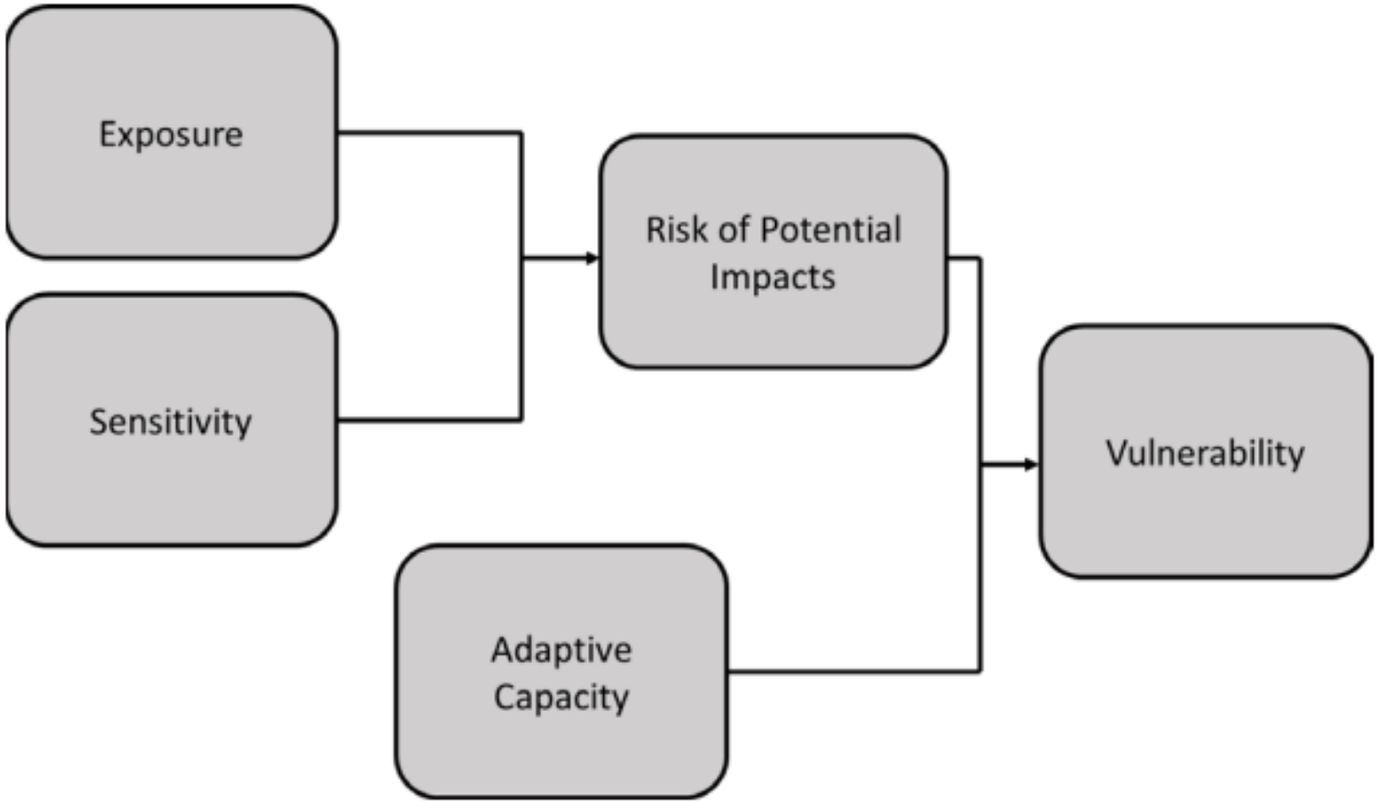
California Department of Water Resources Climate Change Vulnerability Assessment (2019)



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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

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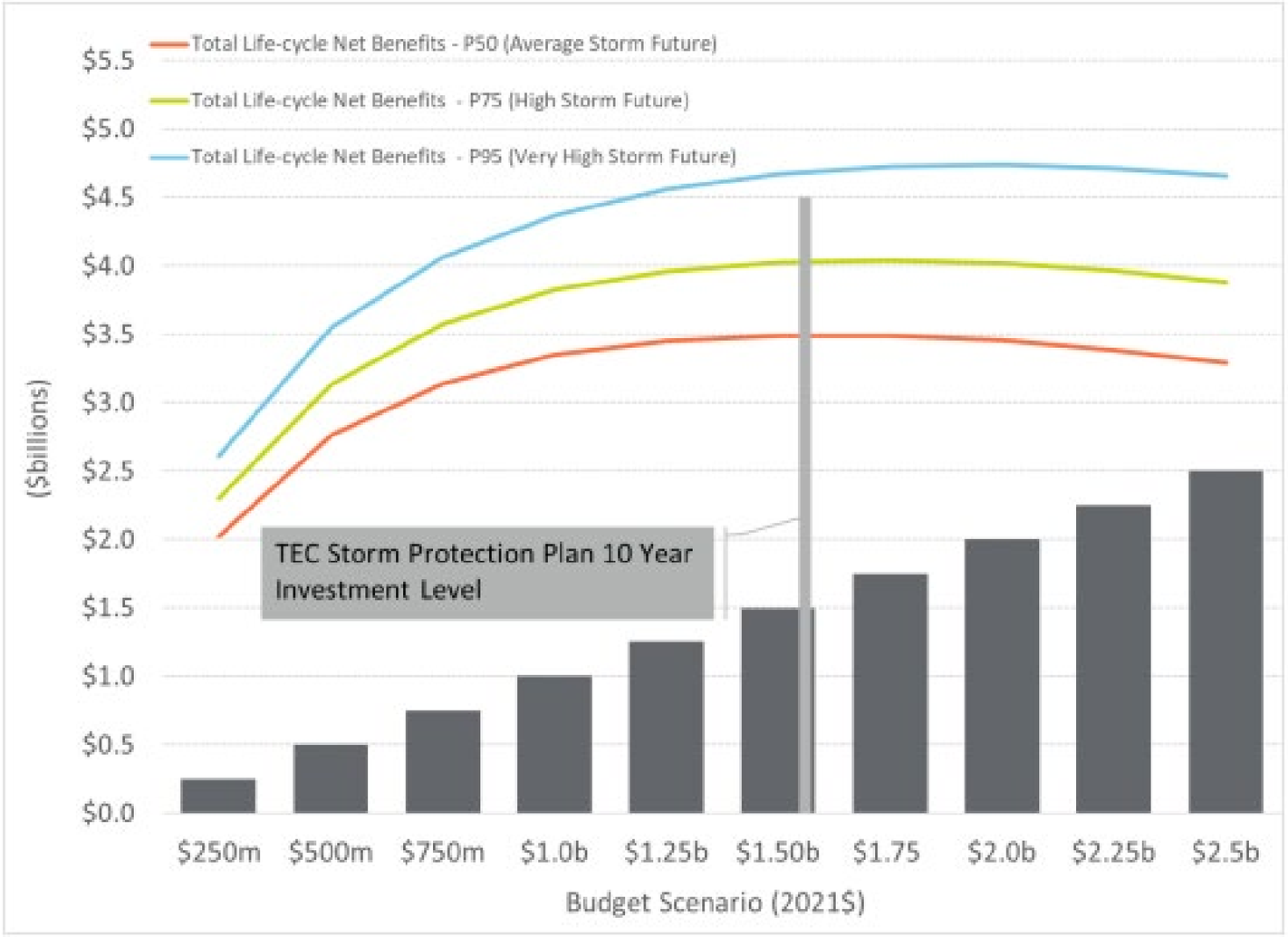
Duke Energy Climate Risk and Resilience Study (2022)

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

"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."

Tampa Electric Storm Protection Plan (2022)



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Draft Resilience Plan Template

Overview of Draft Resilience Plan Template

- Section 1. Executive Summary
  - Resilience plan objectives and motivation
  - Definitions of key terms
  - Measures considered in plan development
  - Proposed resilience programs
  - Summary of overall costs and benefits by resilience program
  - Summary of metrics the utility will use to evaluate the plan’s performance
  - Describe how the utility's resilience plan aligns with the State's Energy Security Plan
  - Status of state and federal resilience funding support
  - How the overall resilience plan is in the public interest

- Section 2. Vulnerability Assessment and Prioritization Approach
  - Description of service area
  - History of extreme weather events in service territory
  - Summary of approach for forecasting frequency and severity of extreme weather events
  - Practices and infrastructure prioritized for enhancement, including a matrix that summarizes all hazards relative to assets and practices, analyzed with a clearly defined vulnerability rating
  - Summary of third-party review/engagement

Overview of Draft Resilience Plan Template (continued)

- Section 3. Description of each proposed resilience program
  - Time period (actual or estimated start and completion dates)
  - Expected improvement to utility's existing infrastructure and practices
  - Estimate of the resulting benefits
  - How resilience program impacts prevention of, response to, and recovery from major outage events
  - Program performance metrics
  - Cost estimate including capital and operating and maintenance expenses
  - Comparison of costs and benefits for the proposed resilience program
  - Description of criteria used to select and prioritize the proposed program

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Overview of Draft Resilience Plan Template (continued)

- Section 4. Projected rate impacts
  - Estimated number and costs of projects under each program
  - Relevant cost drivers for each program
  - Estimated annual revenue requirements for each year of the plan (see example table below)
  - Estimated rate impacts for each year of the plan
  - For each of the first three years of the plan, estimated rate impacts by customer class (see tables below)
  - Description of implementation alternatives that the utility considered to mitigate the resulting rate impact

EXAMPLE TABLES

Year	Resilience Plan Annual Revenue Requirement ($ millions)
2024	
2025	
2026	
2027	
2028	
2029	
…	

Customer Class	Resilience Plan Estimated 3-year Rate Impacts		
	2024	2025	2026
Residential ($/kWh)			
Commercial ($/kW or $/kWh)			
Industrial ($/kW or $/kWh)			

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Guide for Applying Resilience Plan Template

- Policymakers can adapt the template to their state's needs based on:
  - State objectives
  - Definitions for key terms
  - Hazards, assets and practices in scope for a given utility service territory
  - Availability of downscaled climate data for specific hazards
  - Most viable resilience measures, including changes to planning and operational practices
  - Specific, impact-oriented performance metrics and benchmarks
  - Equity considerations and third-party review and engagement processes
  - Alignment with other applicable plans for state energy security, transmission and distribution systems, emergency response, etc.

Next steps

- **Berkeley Lab:** Complete draft report, including resilience planning framework and standardized plan template based on emerging best practices, and request external review
- **Public Utility Commissions:** Consider framework and 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

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Questions to ask

- Should the regulated utilities in my state develop resilience plans that follow a standardized format, frequency and planning horizon?
- What hazards and resilience measures should be in scope for the plans?
- How can we align resilience plan development with other processes such as integrated distribution planning and State Energy Security Plans?
- How can we support the development of similar resilience plans for municipal utilities and co-operatives?
- How can we ensure consistency of climate scenarios and data sources across the state for these planning processes?

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Thank You

References

- California Department of Water Resources (2019). Climate Change Vulnerability Assessment. https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/All-Programs/Climate-Change-Program/Climate-Action-Plan/Files/CAP-III-Vulnerability-Assessment.pdf
- ConEd (2023). Con Edison Climate Change Vulnerability Study. https://www.coned.com/-/media/files/coned/documents/our-energy-future/our-energy-projects/climate-change-resiliency-plan/climate-change-vulnerability-study.pdf
- Duke Energy Carolinas (2022). Climate Risk and Resilience Study. https://www.duke-energy.com/-/media/pdfs/our-company/carolinasresiliencetransmissiondistributionstudy.pdf?rev=0c58199ed32d466d89795a3bf2dc353b
- LLNL (2023). Cyber and Physical Threats to the Grid. https://eta-publications.lbl.gov/sites/default/files/gdo_se_resilience_training_klauberllnl_final.pdf
- NARUC (2023). Critical Infrastructure, Cybersecurity and Resilience. https://www.naruc.org/cpi-1/critical-infrastructure-cybersecurity-and-resilience/cybersecurity/
- NOAA (2023). Billion-Dollar Weather and Climate Disasters (as of September 30, 2023). https://www.ncei.noaa.gov/access/billions/state-summary/US
- South Central Climate Adaptation Science Center at the University of Oklahoma (2019). Managing for a Changing Climate (2.2.1 Statistical Downscaling). https://www.youtube.com/playlist?list=PLeQQSAEHE5PoblZ-Kfqt9FJDVX77SYBqX
- SCL (2015). Seattle City Light Climate Change Vulnerability Assessment and Adaptation Plan. https://www.seattle.gov/documents/Departments/CityLight/ClimateChangeAdaptationPlan.pdf
- Tampa Electric (2022). Storm Protection Plan. https://www.floridapsc.com/library/filings/2022/11038-2022/11038-2022.pdf

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