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State of the Grid Report

UTAH

Energy & Resources | Networks
May 2025

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Executive Summary

Windstorms are a key driver of severe outages in Utah, especially among rural counties in the SE portion of the state (including COOP-4's service territory) that experience reliability issues

PROGRAM OBJECTIVE

Help state energy offices and select utilities assess how to use **40101(d) funding** to best strengthen the power grid against extreme weather, by:

- **Assessing** the unique **needs** of each state energy office
- **Analyzing future exposure to extreme weather** in the state, its coincidence with energy assets, and potential impacts
- **Attributing outages to weather events** and commenting on the alignment of utility capital spending with historical exposure
- Outlining a **benefit-cost methodology** to improve asset planning

DELIVERABLE OBJECTIVE

This deliverable seeks to:

- Attribute historical outages in the state to specific weather events and **comment on which events are driving the most customer interruptions in the state**
- Analyze a select utility's capital plan and **assess the alignment between their resilience spending and the weather events driving outages in their service territory**

KEY FINDINGS

Hazard Analysis:

Winter storms and windstorms are key weather events driving severe outages* on the Utah grid

- Winter storms account for 40% of customer interruptions from severe outages, while wind-related outages (including winter storm) account for 75%
- Variable climate exposure throughout the state could justify asset-level vulnerability assessments to effectively prioritize investments
- Rural counties throughout the state experience a high volume of interruptions per customer, especially a pocket of counties in the southwest that are particularly exposed to wind

Capital Planning Insights:

- COOP-4 could consider increasing spend to improve reliability given it experienced the highest number of SAIDI minutes among the WECC utilities considered in this analysis
- Over 60% of customer interruptions from severe outages in COOP-4's service territory are attributable to windstorms, indicating this could be an area for expanded investment

*A severe outage is defined as one in which >50% of customers in a county are out simultaneously, or at least 30,0000 customers in a county experience an outage simultaneously, whichever is less

Sources: Found in slide notes

High Cost | Moderate Cost | Low Cost

Despite the importance of wind and wildfire in the West, utilities could bolster their capital alignment with historical & future risk by conducting asset-level vulnerability assessments

STATE OF THE GRID REPORT | FINAL INVESTMENT CONSIDERATIONS

Invest against windstorms: Windstorms are the most widespread and severe cause of extreme outages across WECC in the past 5 years. While utilities are investing some capital against wind risk, the universal elevated exposure requires an increased volume of capital towards mitigations. Given its homogenous exposure, wind upgrades could be pursued as updates to design standards rather than targeted, ad hoc investments like substation upgrades.

Continue existing wildfire mitigations: While wildfire exposure of the past 5 years varies by geography, the cost of ignition remains inordinately high in comparison to other hazards. Therefore, even though ignition probability may be low, the high expected cost, coupled with the expected increase in exposure due to changes in climate, substantiates increased investment in mitigation. Utilities can better justify expensive investments like undergrounding by ensuring upgrades are done on feeders that are exposed to multiple hazards, having a double dividend effect on the investment.

Quantify extreme weather risk in dollars: In order to optimally allocate capital expenditures to buy down the most extreme weather risk for the least amount of dollars, utilities must quantify the cost and benefits of the risk and subsequent investment. The utilities that are most effectively optimizing their plans are implementing asset-level vulnerability assessments, using down downscaled climate projections to predict impacts out to mid-century. Baringa will be expanding on how to conduct such analysis in phase 4 of this project.

ASSET	INVESTMENT	COST	HAZARDS
POLES & STRUCTURES	Pole Reinforcement	M	3
	Pole Upgrades	M	3
	Dead-End Structures	M	2
	Decreased Span	M	2
	Pole Wrapping	L	1
CONDUCTORS	Undergrounding	H	4
	Reconductoring	M	4
	Covered Conductors	M	4
	Hardening/Rebuilds	L	1
SUBSTATIONS	Substation Elevation	H	1
	Control House Remediation	H	1
	Enclosures	H	3
	Reclosers/Switchgear	M	2
	Flood Walls	M	1
	Cooling Mechanisms	M	1
PLANNING TOOLS	Vegetation Management	H	3
	Dynamic Line Rating (DLR)	L	1
	Wildfire Planning Tools	M	1

Project Approach

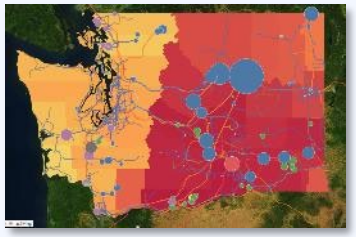
Project Overview

The State of the Grid Report will provide recommendations and insights into most effective **resilience projects**, **highest risk locations**, and strategies for **improving capital spend efficiency**

1 STATE OF THE GRID REPORT | **BENEFITS**

Improved understanding of **how extreme weather impacts outage and ignition rates** in your service territory

DELIVERABLE | **EXTREME WEATHER ANALYSIS**



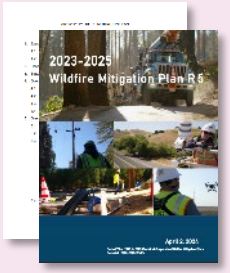
Analyze 5 years of publicly available extreme weather and outage data to **determine which type of events cause the largest outages and ignitions**.

Comment on expected change in outages and ignitions as a function of climate projections.

2 STATE OF THE GRID REPORT | **BENEFITS**

Actionable insights to **improve capital effectiveness** that addresses extreme weather risk

DELIVERABLE | **INVESTMENT PLAN REVIEW**



Review most recent investment plan to determine **effectiveness of normalized capital spend** in mitigating outages and ignitions from extreme weather.

Results will be anonymously compared with other participants to help outline resilience best practices and most effective mitigations.

Baringa is conscious of data privacy and sensitivities and is more than willing to work with your team to address concerns.

Extreme Weather Outage Analysis

Project Overview

Severe outages were mapped to corresponding weather events to better understand which forms of extreme weather are driving customer interruptions and how utilities can respond

DEFINE EXTREME WEATHER EVENTS

Purpose: Begin with a definition of extreme weather to focus on the most impactful events.

Definition: weather events are considered extreme if they are above the 90th percentile of severity for that state.

Data: Western Regional Climate Center (WRCC)

Time: 2018 - 2022

FILTER EXTREME OUTAGE EVENTS

Purpose: Define extreme outage events to highlight highest cost outages

Definition: outage events are considered extreme if:

At least 50% OR >30,000 of customers are out in a single county

*modified from Oak Ridge National Labs definition

Data: EAGLE-I

Time: 2018 - 2022

ANALYZE EVENT COINCIDENCE

Purpose: Identify the extreme outages that occur at the same time as extreme weather events.

Analysis Areas:

- WECC Overview
- Most Impactful Hazard Analysis
- Hazard by Total Interruptions (Pareto Chart)
- Spatial Analysis
- Historical Ignition Analysis
- Hazard Deep Dives

DETERMINE ASSET PLANNING INSIGHTS

Purpose: Provide implications for asset planning and funding priorities

Example Insights

- Historical severe outage locations
- Historical extreme ignitions
- Historical primary drivers of outages
- Distribution of outages across hazards
- Design standard implications

KEY WEATHER EVENTS

WILDFIRE | WINTER STORMS | SUMMER STORMS | WINDSTORM | EXTREME PRECIPITATION | RAINSTORM | EXTREME HEAT | EXTREME COLD | FLOOD

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Weather events were mapped to raw data to capture both single hazard and multi-hazard events. Events are considered extreme if the raw data is above the 90th percentile for the state

WEATHER EVENT	PRESENT WEATHER METRICS (Above 90th percentile)
EXTREME COLD	Min Temperature
EXTREME HEAT	Max Temperature
WILDFIRE*	Fire Weather Index (FWI)
EXTREME PRECIPITATION	Precipitation

WEATHER EVENT	PRESENT WEATHER METRICS (Above 90th percentile)
WIND STORM	Wind
RAIN STORM	Wind + Precipitation
SUMMER STORM	Wind + Precipitation + Max Temperature
WINTER STORM	Wind + Precipitation + Min Temperature
FLOODING	Surface Runoff

*Outages occurring within two days of a documented wildfire ignition in the county of origin were also attributed to wildfire, overriding other hazard combinations

Mapping outages to weather events more accurately captures the impact of coincident hazards, avoids double counting outages, and allows for flexible event definitions

Coincident Hazards

- **EXPLANATION:** Mapping to events captures unique threats posed to assets from coincident hazards
- **BENEFIT:** Multiple hazards occurring simultaneously can have different impacts on assets than considering each individually (e.g. coincident wind and snow/ice contributes to line galloping, wind and extreme heat could increase probability of vegetation contact given line sag due to heat).

No Double Counting

- **EXPLANATION:** Variable combinations are mapped to specific events
- **BENEFIT:** Ensuring that other hazards are below the 90th percentile isolates the most important hazards. Just looking at one hazards could capture outages that are actually attributable to other hazards.

Flexible Event Definitions

- **EXPLANATION:** Multiple different hazard combinations can be mapped to the same weather event given similar impacts to assets
- **BENEFIT:** Mapping to events allows for historical ignitions and extreme fire weather to be mapped to the same category, as both reflect ignition potential and can be addressed by similar upgrades.

Outages were classified as “severe” if more than 50% of customers OR more 30,000 customers in a given county are out at a single point in time

1 OUTAGE EVENT HANDLING

Define outage events to analyze coincidence with weather events and avoid double counting

METHODOLOGY

1. In a new column, assign “y” if “Customers Out” entry >0 in the data row, “n” if “Customers Out” = 0
2. Assign a unique event number to each string of consecutive “y” entries, separated by at least one “n” entry
3. For each unique event, keep the row with the maximum “Customers Out” value

DATASET | **EAGLE-I**

U.S. DEPARTMENT OF ENERGY

Comprehensive outage dataset from 2014-2022 created through a partnership between Oak Ridge National Lab and the U.S. DOE

OAK RIDGE National Laboratory

Data is collected from utility’s public outage maps and provides 92% coverage of US and Territories

2 SEVERE OUTAGE CLASSIFICATION

Define “severe” outages in order to determine which weather events are coincident with the costliest outages in the state

DEFINITION

At least 50% of customers out in a given county

OR

At least 30,000 customers out in a given county

*whichever is less

SEVERE OUTAGES | **JUSTIFICATION**

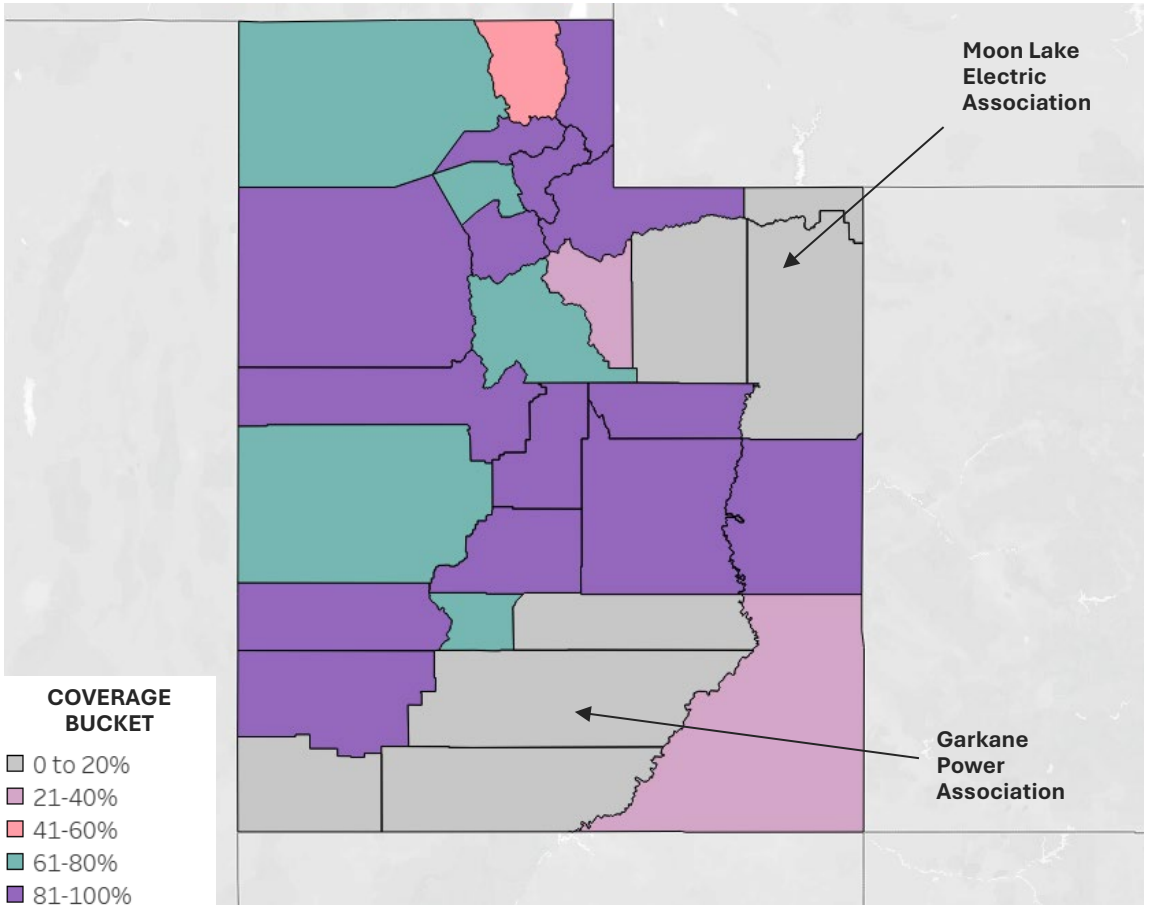
Draws on ORNL’s “Analysis of Historical Power Outages in the United States and the National Risk Index,” in which the researchers determined the 30,000 customer metric as a conservative threshold to isolate extreme, weather-cause events

While ORNL uses a 15% customer outage threshold, we have increased it to 50% for this analysis to focus our insights on how to address the costliest and most severe outages in the state

Baringa

The EAGLE-I dataset provides coverage for 80% of WA customers, but is missing data from various electric cooperatives throughout the state

EAGLE-I CUSTOMER COVERAGE (%) (UT, 2018-2022)



INSIGHTS

Outage data generally has better fidelity in the northern region of the state than the southern region

- Outage data is best the highly-populated counties in the northern portion of the state that are served by large public power entities or IOUs
- Rural cooperatives throughout the state generally have the worst outage coverage in the EAGLE-I dataset

Counties with sparse outage coverage only account for 20% of customers within the state

- Over 80% of customers in the state are covered in the EAGLE-I dataset
- Insights surrounding the volume of customer interruptions in the state will be aligned with real world exposure

Additional consideration could be given to the hazards faced by counties without outage data

- The weather events driving outages in counties without data will be underrepresented in this analysis
- While this may not have a large impact on the distribution of the volume of customer interruptions, it could significantly change the distribution of the count of outages associate with different hazards
- Wildfire and extreme heat in particular might be underrepresented in this analysis given their concentration in southern counties

WECC Summary

Windstorms are often the primary driver of customer interruptions in WECC, especially among smaller counties, but heat, wildfire, and rainstorms drive many interruptions along the coast

INSIGHTS

Windstorms are the most common primary driver of customer interruptions across WECC

- This is especially true among states in the eastern portion of the region such as Montana, Wyoming, and Colorado
- Wind is frequently the primary driver for counties with relatively fewer customer interruptions, indicating that it has an outsize impact on rural communities with radial networks and more overhead line mileage

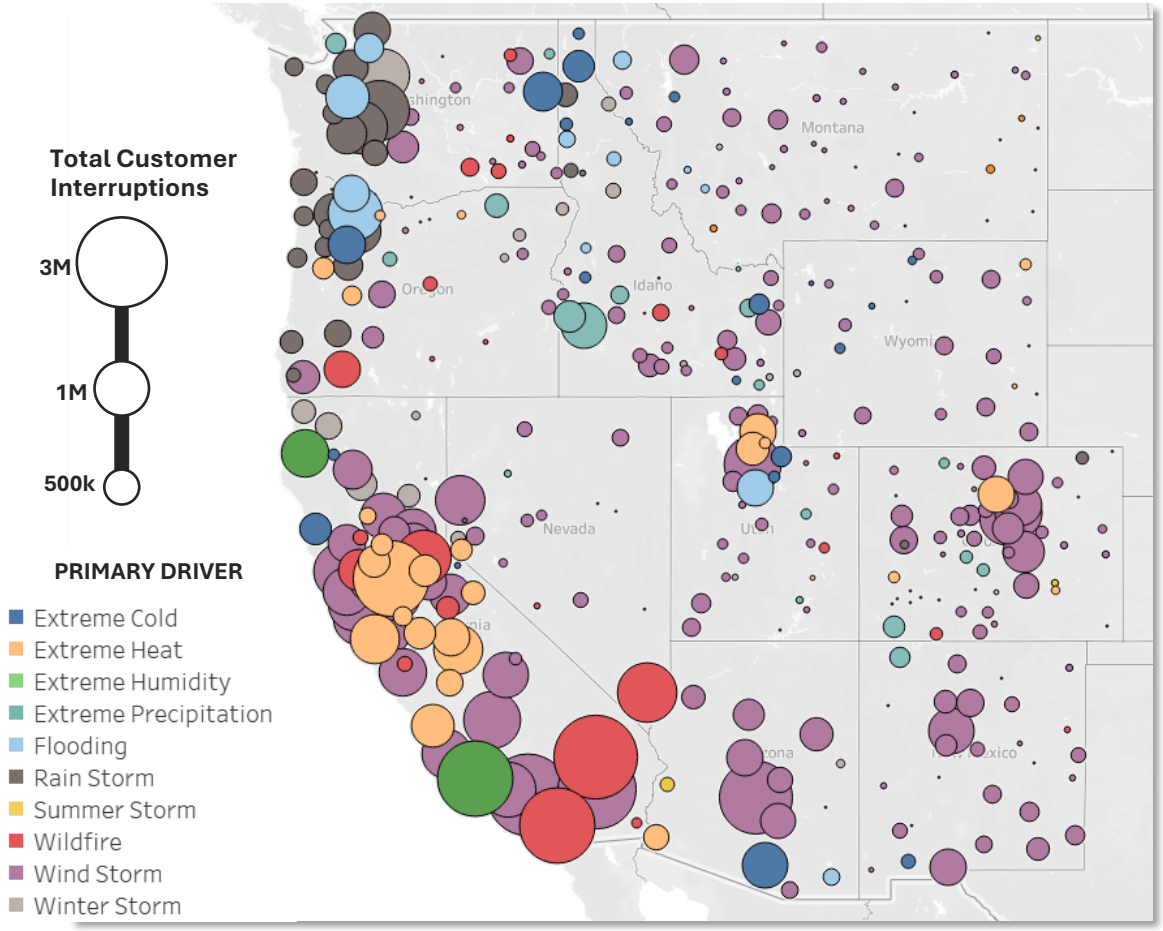
A higher volume of total customer interruptions is generally concentrated along the coast

- More populous counties in CA, WA, and OR drive a higher volume of customer interruptions
- Costal states demonstrate a wider range of primary driving hazards, including wildfire, extreme heat, flooding, and rainstorms

Extreme heat and wildfire are primary drivers of customer interruptions even in northern counties of the state

- While the northern portions of the state generally face less heat and wildfire exposure, these hazards are still driving customer interruptions because grid infrastructure could be less prepared for these events
- Per Baringa's Grid Resilience Reports, heat and wildfire exposure is projected to increase across the region out to mid- and end-century, potentially justifying hardening in historically less-exposed regions where this change will be most dramatic

PRIMARY DRIVER OF CUSTOMER INTERRUPTIONS BY COUNTY
(WECC, 2018-2022)



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State Summary

Utah

Legend: Most Impactful Hazard | Tertiary Hazard | No Extreme Hazard

High wind speeds are the key driver of severe outages in the state, especially when they coincide with precipitation and cold temperatures

HAZARD INSIGHTS

Winter storms drive a substantial portion of customer interruptions on the Utah grid

- Winter storms account for over 40% of total customer interruptions resulting from severe outages from 2018-2022
- In addition to driving a significant number of customer interruptions, winter storms are also the most common driver of severe outages in the state

Wildfire events drive some of the most severe outages in the state

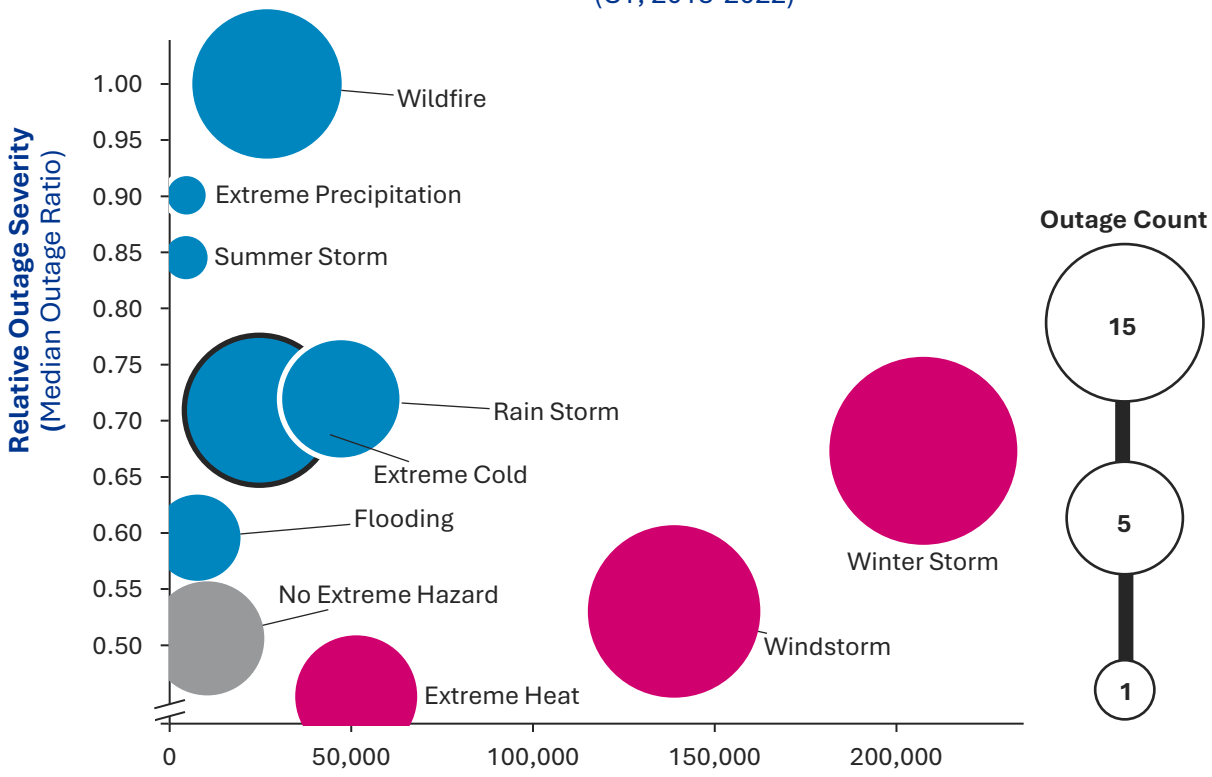
- While fewer customer interruptions are attributable to wildfire, its high median outage ratio indicates that these events tend to result in outages knocking out a high percentage of customers within a county (either through PSPS or asset failure)
- Baringa's GRR indicates escalating wildfire and extreme heat exposure in the future, substantiating additional investment to address these hazards

High wind speeds are a key underlying hazard for Utah to address

- 3 of the top 4 hazards include high wind speeds, indicating that it could be a key driver of severe outages
- Winter storms, windstorms, and rainstorms combine for about 75% of interruptions resulting from severe outages

MOST IMPACTFUL HAZARDS	FUTURE OUTLOOK**	EVENT COUNT	MED. OUTAGE RATIO	TOTAL CUST. INTS.	AVG. CUST. INTS. / EVENT
Winter Storm	→	19	.67	207,397	10,916
Windstorm	FURTHER RESEARCH NEEDED	16	.53	138,805	8,675
Extreme Heat	↑	8	.45	51,334	6,417

SEVERITY & FREQUENCY OF EXTREME OUTAGES* DURING EXTREME WEATHER
(UT, 2018-2022)



*A severe outage is defined as one in which >50% of customers in a county are out simultaneously, or at least 30,0000 customers in a county experience an outage simultaneously, whichever is less
**Future outlook for the hazard severity based on Baringa's Grid Resilience Report, completed as part of phase 2 of this analysis (Insert link to the GRR here)

Source: EAGLE-I, WRCC

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The majority of customer interruptions are concentrated among a few key weather events, including winter storms, windstorms, extreme heat, and rainstorms

OUTAGE INSIGHTS

Customer interruptions resulting from severe outages are highly concentrated among a few key weather events

- The top 4 weather events (winter storms, windstorms, extreme heat, and rainstorms) account for about 85% of all customer interruptions, exhibiting a slightly tighter concentration than other states in WECC
- UT could consider prioritizing allocating grid resilience funding to projects that address these key weather events, especially since they are driven by similar underlying hazards (wind, precipitation)

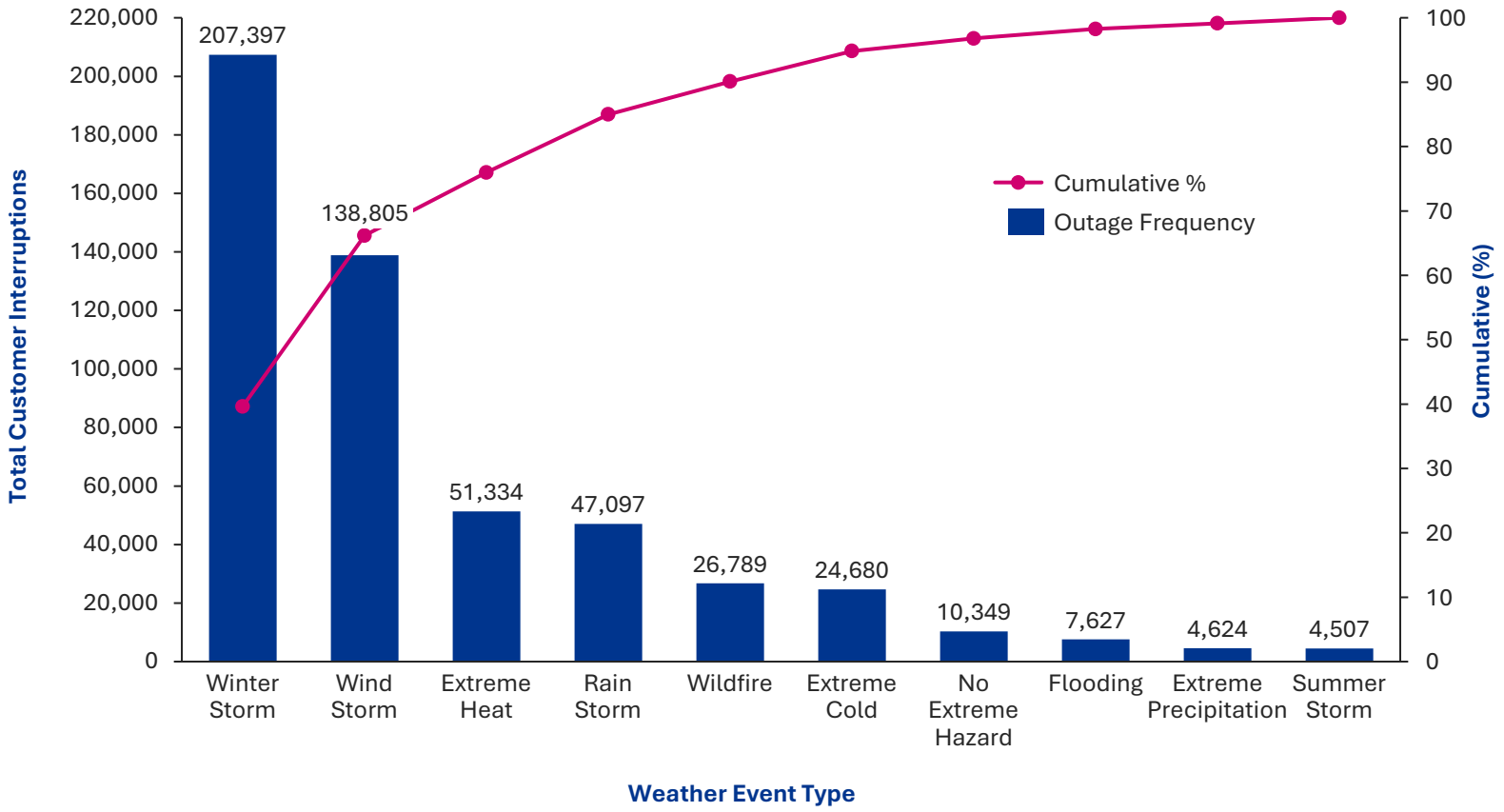
Wildfire and extreme cold are still key hazards in UT

- While they account for a smaller portion of customer interruptions, wildfire and extreme cold are two of the most frequent drivers of severe outages in the state
- High frequency and median outage ratio compared to a lower volume of interruptions indicates that these hazards are typically concentrated in less populated counties

Utilities could consider which events impact their climate zone

- Variable climate across the state indicates that local analysis is needed to determine the highest priority events at the utility level

OUTAGES BY HAZARD & TOTAL CUSTOMER INTERRUPTIONS
(UT, 2018-2022)



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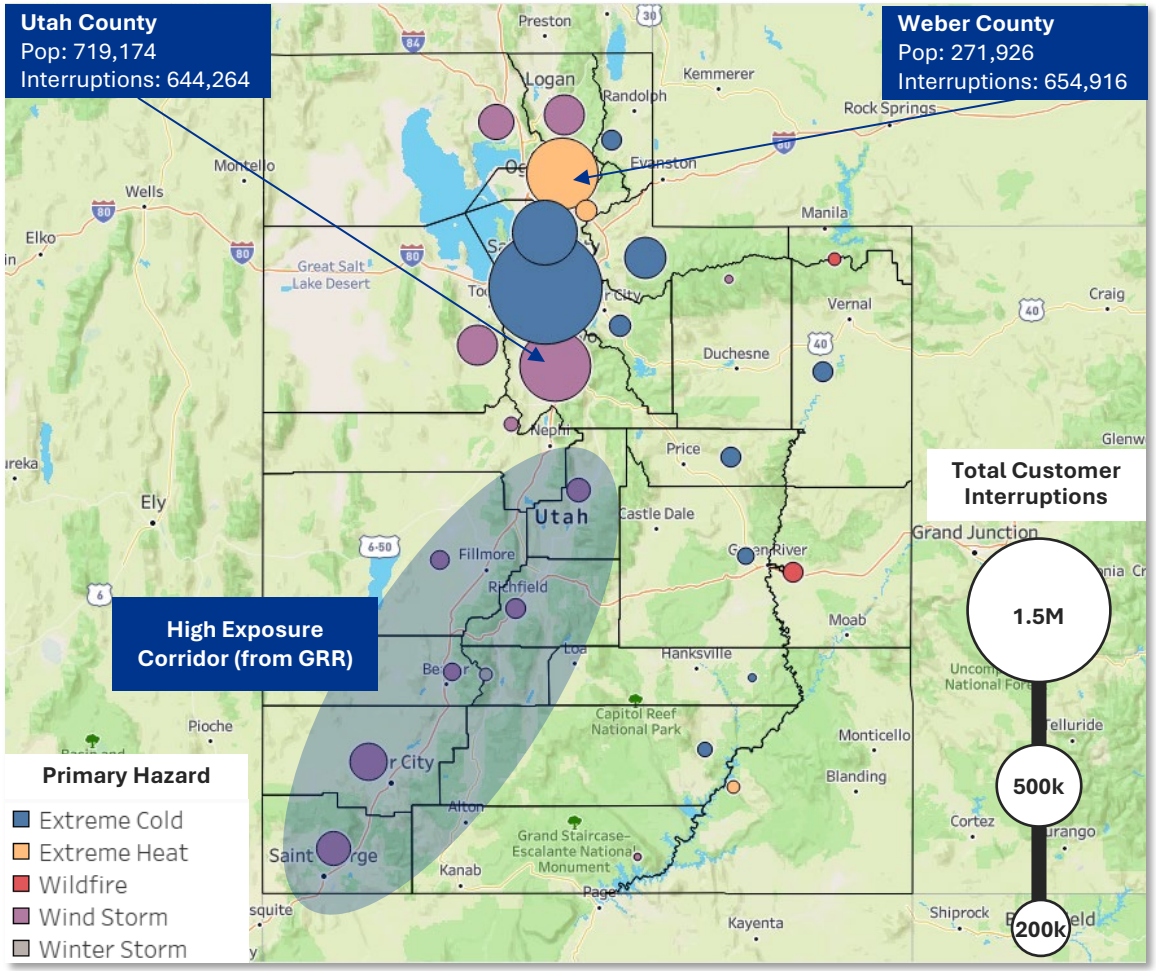
While wind is the primary driver of customer interruptions in the state, extreme temperatures drive a high volume of interruptions in highly-populated north-central counties

PRIMARY DRIVER OF CUSTOMER INTERRUPTIONS BY COUNTY (UT, 2018-2022)



INSIGHTS

The highest volume of customer interruptions is concentrated in north-central counties

- Highly populated northern counties account for the largest number of customer interruptions, and experience a wide variety of hazards (extreme temperatures, precipitation, wind) given proximity to the Wasatch Mountain Range

Wind is the most common primary driver of customer interruptions across the state

- Wind is a key driver of outages in southwestern counties, corroborating a high exposure corridor along the Rocky Mountains that was identified in the GRR

Winter storms are more likely to be coincident with severe outages

- Despite driving the highest volume of customer interruptions from severe outages, the lack of winter storm on this map indicates that it less common driver of non-severe outages

Morgan and Weber Counties experienced a high volume of customer interruptions compared to their populations

- The high number of interruptions per customer indicates that this is portion of the grid is less reliable either due to aging infrastructure or more extreme climate exposure

PRIMARY DRIVER METHODOLOGY

1. Map weather variable combinations to event definitions (see slide 15)
2. Count the number of total customer interruptions at the county level (> 0 customers out) coincident with 90th percentile or greater weather variables for each of the combinations associated with a weather event
3. Deem the event with the most coincident interruptions as the “primary driver”

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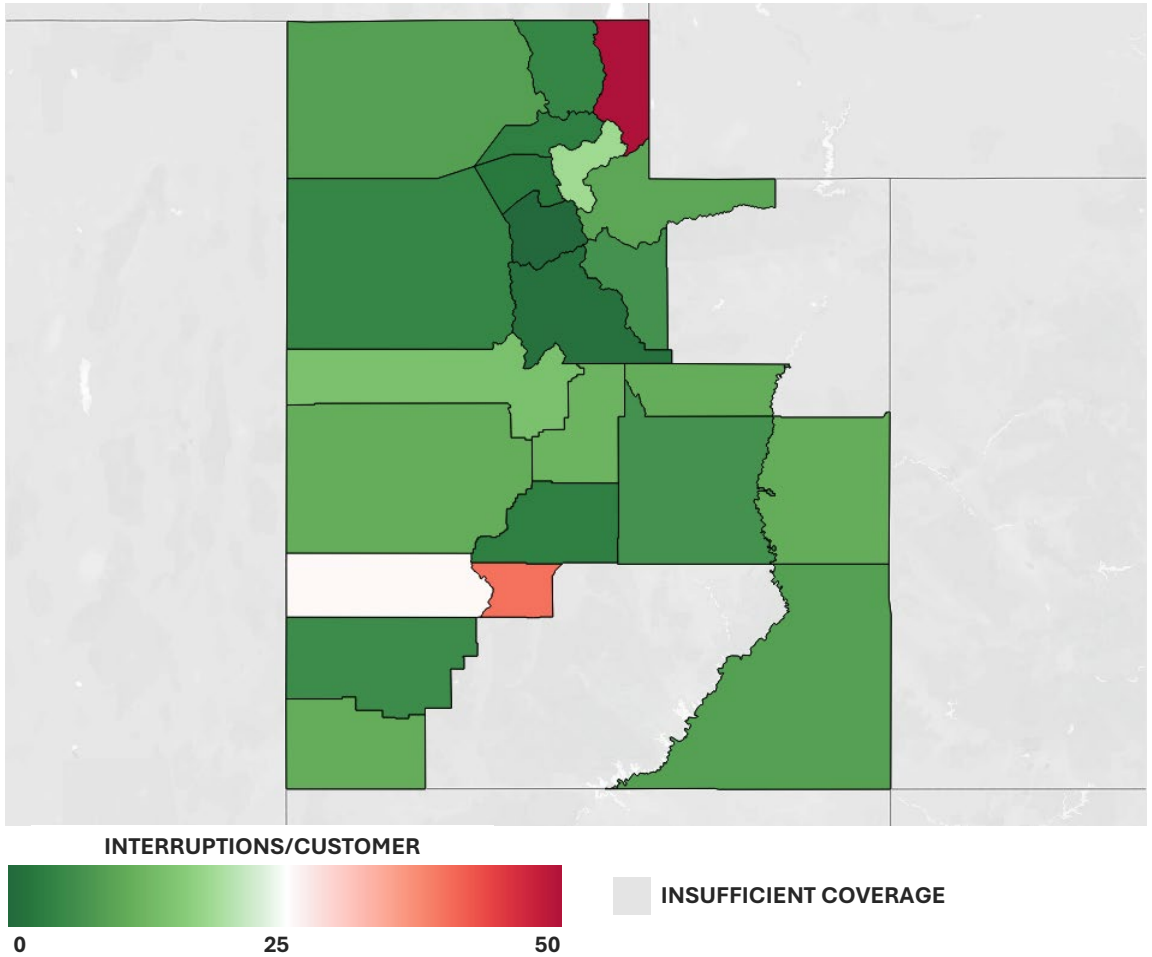
Counties with the highest volume of interruptions per customer are concentrated along a high wind corridor in the southwest and mountainous terrain in the northeast

TOTAL CUSTOMER INTERRUPTIONS PER COVERED CUSTOMER BY COUNTY (UT, 2018-2022)



INSIGHTS

Counties experiencing the greatest number of customer interruptions per capita are spread throughout the state and generally have small populations

- Counties with the most severe reliability issues in Utah are among the least populated in the state
- These rural counties likely have a high volume of radial, overhead distribution infrastructure that is susceptible to faults

High winds and extreme temperatures generally drive outages across the least reliable sections of the Utah grid

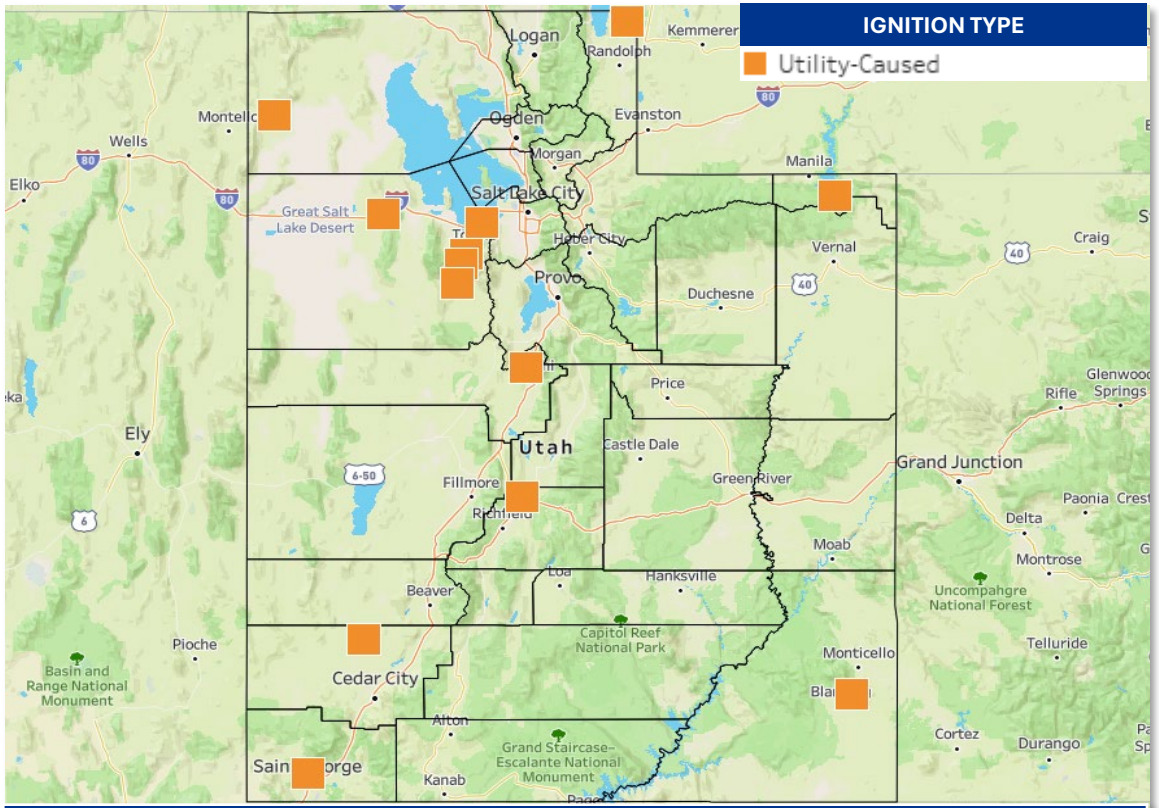
- Beaver and Piute Counties are located in a high wind exposure corridor along I-15, likely contributing to the high volume of outages in this area
- Extreme heat drives the majority of interruptions in Rich County while extreme cold drives outages in Morgan County, indicating that upgrades simultaneously addressing both temperature extremes (i.e. monitoring, switches, undergrounding, etc.) could be prioritized in this region

METHODOLOGY

1. Calculate the total number of customer interruptions that occur in a particular county, ensuring outage events are not double counted
2. Divide this number by EAGLE-I's "covered customers" metric for the county

Utility-caused ignitions are relatively evenly distributed throughout the state, but generally fall within Rocky Mountain Power's service territory

UTILITY-CAUSED, TOP 10% IGNITIONS BY ACRES BURNED (UT, 2018-2022)



IGNITION STATS (2018-2022)			
Ignitions in WECC Top 10%:	698	**Average Fire Size (acres burned)**	350
Total Ignitions	4,749	**Utility-caused extreme ignitions**	13

INSIGHTS

Utility-caused ignitions are relatively evenly distributed throughout the state

- This aligns with the findings of Baringa's Grid Resilience Report, demonstrating relatively similar levels of wildfire exposure across the state
- A cluster of ignitions in Tooele County coincides with a group of transmission assets, indicating that these may have been transmission-caused ignitions

Utility-caused ignitions are generally consolidated in PacifiCorp's service territory, but a handful may have been started by municipal power systems

- Most utility-caused ignitions occurred within Rocky Mountain Power's service territory given it covers a substantial portion of the state
- Stakeholders could consider whether Rocky Mountain Power's updated Wildfire Mitigation Plan contains investments that adequately mitigate ignition risk
- Evaluate whether the significant gap between RMP's requested vs. authorized rate increase cut wildfire mitigation spending in the state
- A few ignitions that occur in specific towns (i.e. Saint George, Blanding), may be attributable to municipal power systems

IGNTIONS METHODOLOGY

- Historical ignition data was collected from the FPA-FOD and the WFIGS Interagency Fire Perimeter Database
- We filtered out the **top 10% of ignitions by fire size across states in WECC**
- The map at left depicts these top 10% ignitions that also **listed "Power generation/transmission/distribution" as their NWCG cause code**
- The red boxes denote top 10% utility-caused ignitions that were also coincident with a severe outage in the ignition county within 2 days of the discovery date

The relative alignment of the outage severity curves and a high coincidence of outages with low wind speeds indicates vegetation contact could be driving many outages in the state

UNDERSTANDING THE DATA

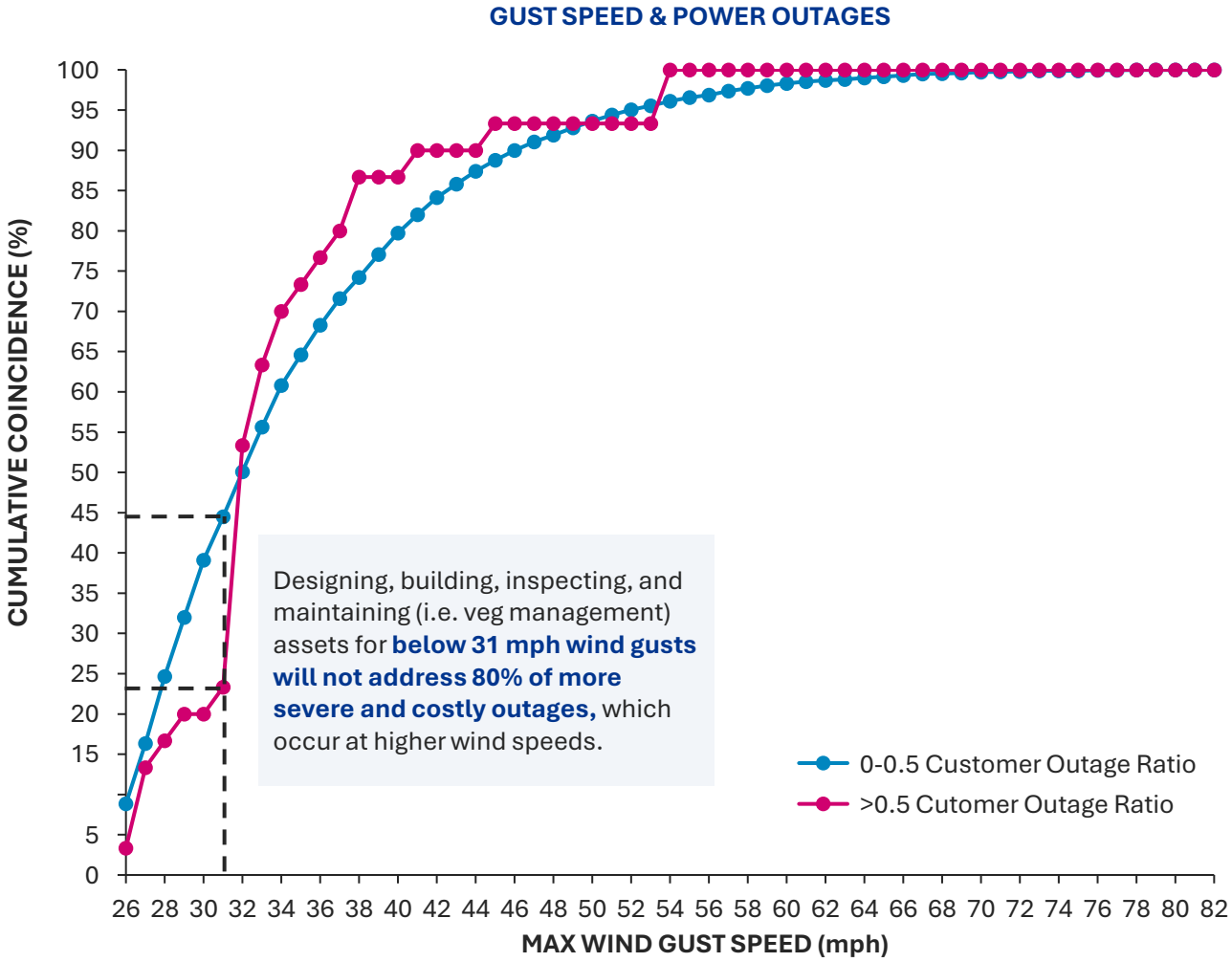
Extreme outages (>50% of customers out) are more likely to be coincident with wind gusts over 31 mph than non-extreme outages

- About 80% of extreme outages are attributable to wind speeds above 31 mph, compared to just 50% of non-extreme outages
- Above 31 mph the curves largely converge, indicating that outage severity is more responsive to vegetation density and asset condition than wind speed above this threshold

ASSET PLANNING INSIGHTS

Prioritizing vegetation management and active inspection could address a significant portion of wind-driven outages

- Almost 80% of all wind-related outages occur below 40 mph wind speeds, indicating that they are likely caused by vegetation contact or aging assets
- Pole reinforcement and upgrade may be necessary to address the last 15% of extreme outages, which occur above 53 mph and could be the result of direct asset failure
- **Low-Cost:** Pole Reinforcement (Trussing, Guy Cables, Concrete Base, etc.), Pole Material Upgrades, Decreased Spans, Vegetation Management
- **High-Cost:** Undergrounding



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Wind and snowfall both contribute to increasingly severe outages resulting from increasingly severe winter storms

UNDERSTANDING THE DATA

Extreme outages (>50% of customers out) are more likely to be coincident with more severe winter storms

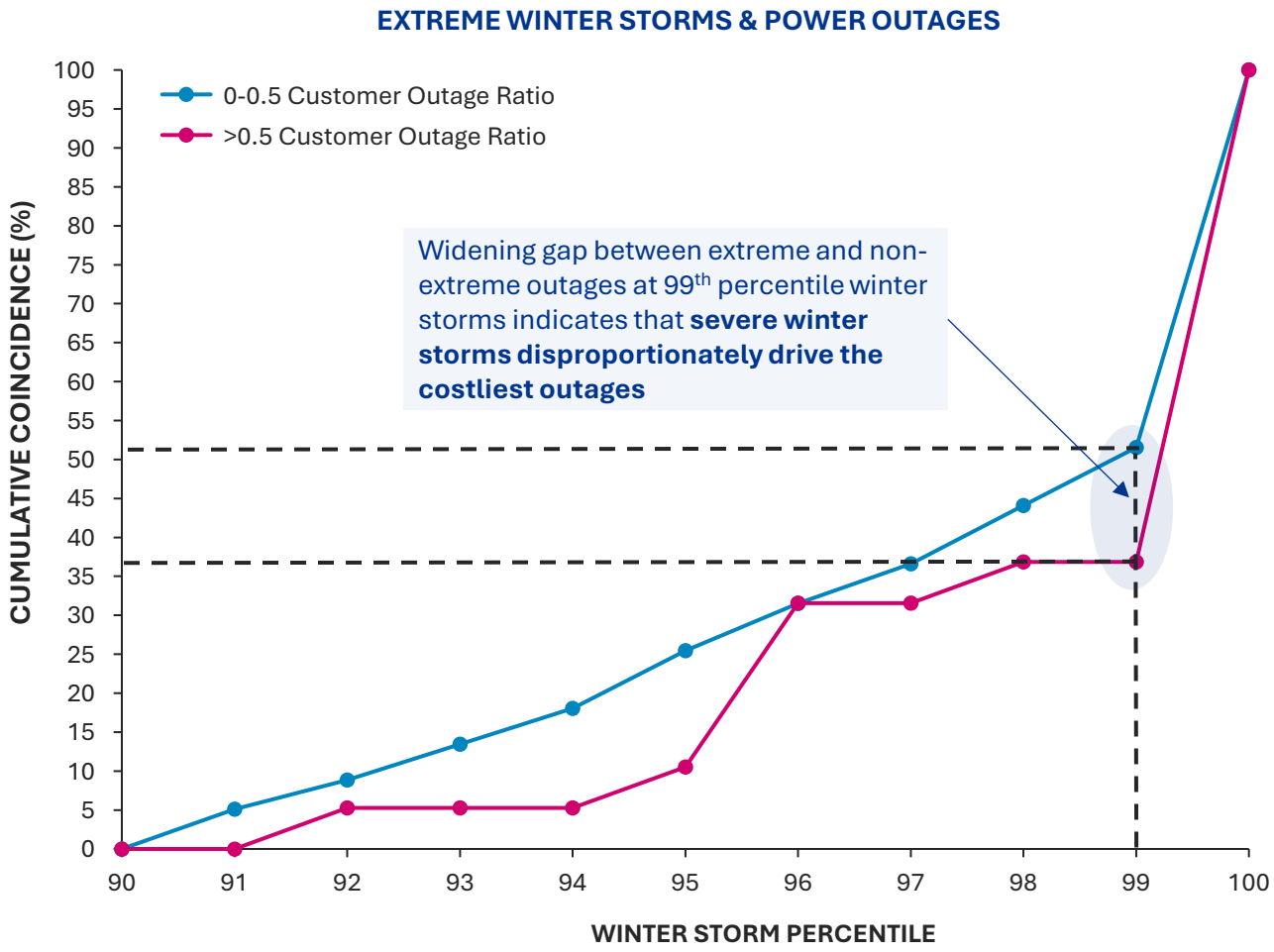
- Almost 65% of extreme outages are coincident with winter storms in the 99th percentile or greater, compared to about 50% of non-extreme outages
- Wind and precipitation are the key drivers of the percentile mapping, but the gap between severe and non-severe outages remains for both variables, indicating that neither is the sole climate hazard driving severe outages

ASSET PLANNING INSIGHTS

Utilities could consider pole reinforcement or undergrounding to address snow loading, which disproportionately drives the most severe and costliest outages in the state

- **Low-Cost:** Pole Reinforcement (Trussing, Guy Cables, Concrete Base, etc.), Pole Material Upgrades, Decreased Spans, Vegetation Management, Covered Conductors
- **High-Cost:** Undergrounding

HAZARD	PRECIP	GUST SPEED	MIN TEMP
99TH PERCENTILE	0.04 (in.)	45(mph)	10 °F



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Extreme outages are generally concentrated at higher temperatures, but these outages are likely driven by capacity violations and vegetation contact rather than direct asset failure

UNDERSTANDING THE DATA

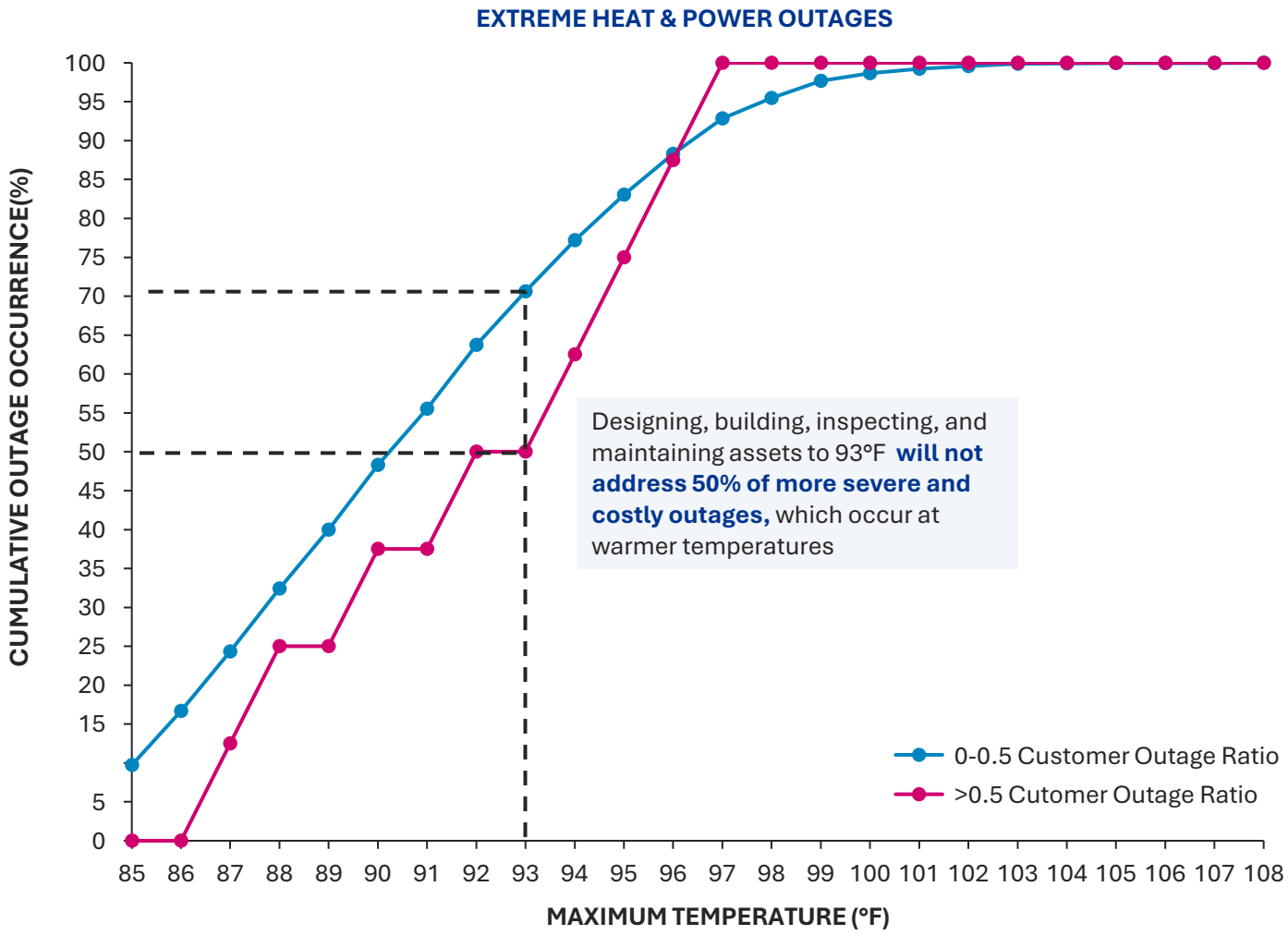
Extreme outages (>50% of customers out) are more likely to be coincident with maximum temperatures above 93 °F than non-extreme outages

- About 50% of extreme outages are attributable to minimum temperatures above 93 °F, compared to under 30% of non-extreme outages
- Outages were recorded at temperatures up to 107 °F, indicating a potentially important threshold for asset design and contingency planning

ASSET PLANNING INSIGHTS

Utilities could consider upgrading transformers and system capacity to address significant exposure to temperatures over 93 °F

- In addition to driving equipment failure, extreme heat can contribute to capacity violations due to increased load and heat-related line sag can cause vegetation contact
- The majority of outages shown here likely result from capacity violations and vegetation contact, as direct asset failure is concentrated above 104 °F[1]
- **Low-Cost:** Monitoring and sensors, demand response, vegetation management
- **High-Cost:** Undergrounding, backup power systems, capacity and transformer upgrades



1 SCE Climate Adaptation Vulnerability Assessment

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Utility Capital Plan Review

Project Overview

Background & Approach

Public Power Cooperative IOU

We have a total of 12 utilities across WECC participating in this analysis, 5 public power, 5 cooperatives, 2 investor-owned utilities

STATE	UQID
California	PUBLIC-1
Arizona	PUBLIC-2
Washington	PUBLIC-3
Nevada	PUBLIC-4
Washington	PUBLIC-5

STATE	UQID
Colorado	COOP-1
New Mexico	COOP-2
Oregon	COOP-3
Utah	COOP-4
Wyoming	COOP-5

STATE	UQID
Montana	IOU-1
New Mexico	IOU-2

Severe outages were mapped to corresponding weather events to better understand which forms of extreme weather are driving customer interruptions and how utilities can respond

ANALYZE 2024 UTILITY CAPITAL PLANS

Purpose: Review projects listed in capital plans and categorize into standardized buckets of utility spending

CAPITAL PLAN	
Project	**$(k)**
Undergrounding	900
Reconductoring	75
Substation Upgrade	500

TECHNOLOGY, PREDICTION, IMAGING
ASSESSMENT & REPAIR
VEGETATION MANAGEMENT
... additional spend categories in slide 34

Individual projects in utility capital plans are **mapped to standardized buckets in order to compare spend between utilities**

MAP RESILIENCE INVESTMENTS TO HAZARDS

Purpose: Determine which types of investments mitigate or adapt the utility network to certain extreme weather events

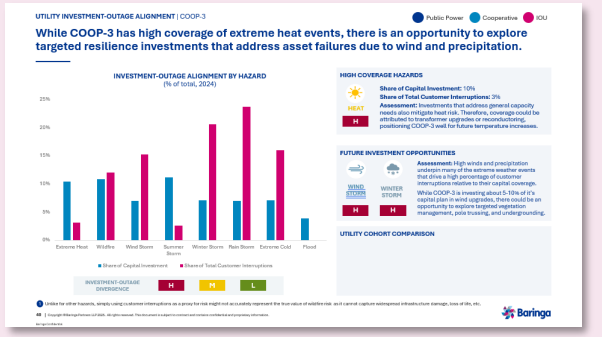
TECHNOLOGY, PREDICTION, IMAGING
ASSESSMENT & REPAIR
VEGETATION MANAGEMENT
... additional spend categories in slide 34

WILDFIRE
EXTREME HEAT
MAPPED TO 9 SEPARATE EVENTS

Project categories are ascribed a value as to generally how effective they are at **addressing each extreme weather variable**.

ASSESS INVESTMENTS-EXPOSURE ALIGNMENT

Purpose: Normalize spend across relevant utility metrics and determine the degree to which capital allocation aligns with historical extreme weather exposure



INVESTMENT-OUTAGE DIVERGENCE: L | M | H

The level of capital spend addressing each **weather event is compared to the share of customer interruptions it drives**

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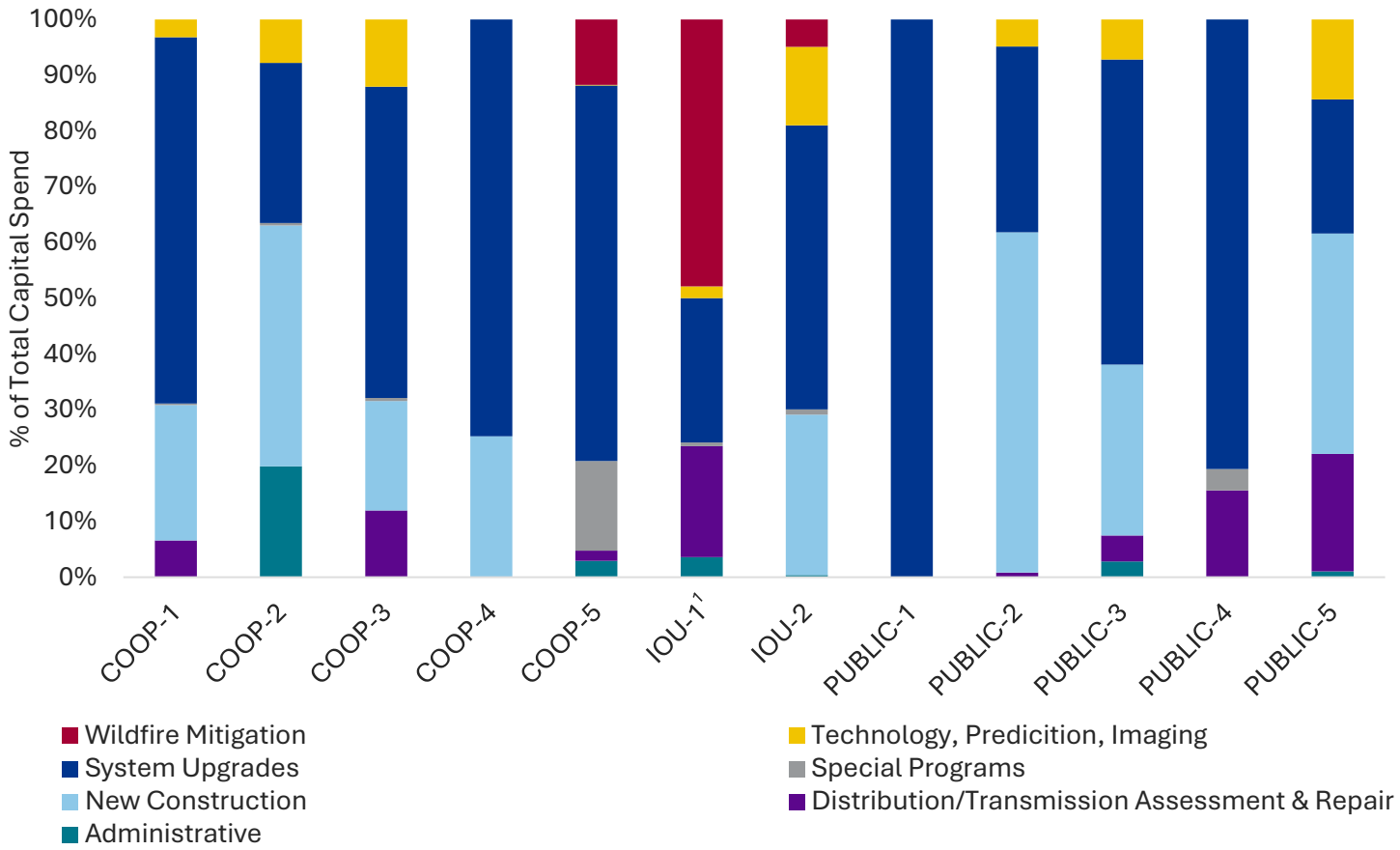
Individual projects and line items within the capital plans were mapped to larger buckets to allow for standardized comparison across utilities

	CATEGORY	DEFINITION	SUBCATEGORIES
	TECHNOLOGY, PREDICTION, IMAGING	Investments in analysis and tools that improve asset management, asset planning, and operational efficiencies.	Modeling, Remote Sensing, Mapping
	ASSESSMENT & REPAIR	Investments needed to repair or replace damaged or end-of-life distribution equipment like-for-like.	Like-for-like equipment replacement
	SPECIAL PROGRAMS	Investments needed for non-traditional capital and other unique projects.	Demand Response/VPP, Wildfire Training Environmental/Ecological Protection
	SYSTEM UPGRADES	Investments in existing assets that improve the capacity, reliability, resilience, etc. of the system.	Transformer Capacity Upgrades, Pole Replacement/Reinforcement, Reconductoring Undergrounding, Voltage/Phase Upgrades
	NEW CONSTRUCTION	Investments in brand new assets and equipment.	New Lines, New Substations, New Customer Interconnection
	ADMINISTRATIVE	Investments in supporting infrastructure and processes for capital planning and operations.	Fleet, Building Remodeling, Travel, Education, Salaries
	VEGETATION MANAGEMENT	Investments in vegetation management activities and equipment.	Software & Technology, Tools & Equipment, Specialized Vehicles, ROW Clearing, Hazard Tree Removal, Tower Raises
	WILDFIRE MITIGATION	Investments in system upgrades, adaptations, mitigations, that lower the likelihood of wildfire ignition and prevent damage to assets.	Investments specifically earmarked for wildfire mitigation

Capital Plan Review

Cooperatives' and public power entities' highest categories include system upgrades and new construction, while IOUs generally spend more on wildfire mitigation

UTILITY CAPITAL SPEND BREAKDOWN ($, 2024/25)



ALL UTILITIES

- System upgrades make up a significant portion of capital spending across all utility types, indicating that resilience is a key focus area
- Many utilities are also spending substantially on new construction, increasing capacity to serve new customers and large loads
    - This corroborates recent data showing new transmission and distribution expenditures driving the bulk of utility spending increases in recent rate cases

COOPS

- Cooperatives typically prioritize system upgrades in their capital allocation, demonstrating a prevalence of aging equipment and focus on resilience

PUBLIC POWER

- Public power entities spend significant sums on both system upgrades and new construction and often have extensive undergrounding programs

IOUs

- Generally spend more on wildfire mitigation given the commonplace requirement to file Wildfire Mitigation Plans (WMPs) with the PUCs

1 IOU-1 provided their Wildfire Mitigation Plan rather than their exhaustive capital plan, resulting in a high percentage of wildfire mitigation spending

U.S. EIA, FERC

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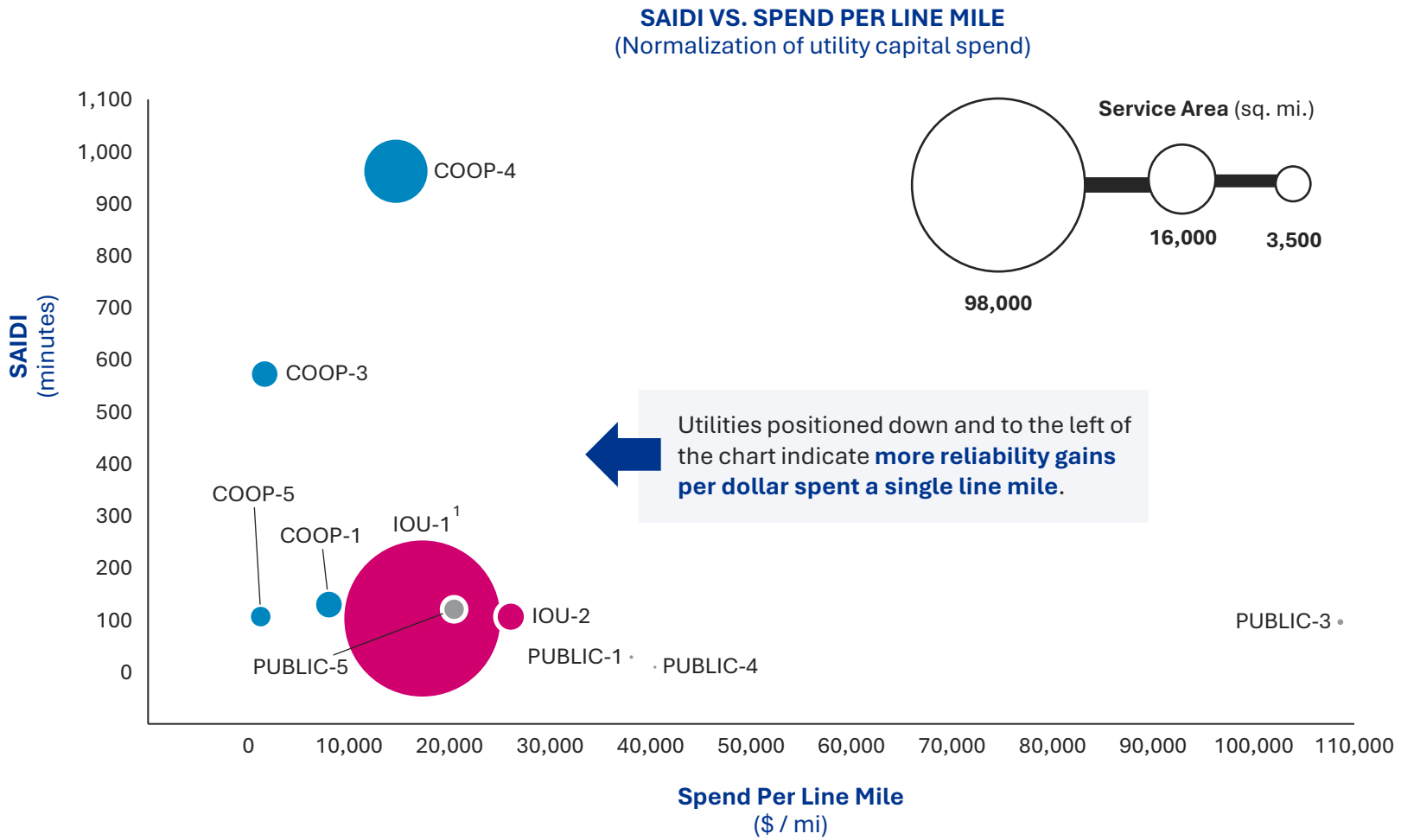
Public Power Cooperative IOU

Cooperatives spend less per line mile, while public power entities are generally more reliable; IOUs fall somewhere in between these two utility types on the spend vs. reliability matrix



INSIGHTS

COOPS

- Cooperatives typically spend less per line mile, indicating lower overall spend given their medium-sized service territories
- Wide range of reliability could be driven by different levels of spend effectiveness or extreme weather exposure

PUBLIC POWER

- Public power entities have higher reliability given their smaller territories and higher percentage of underground equipment
- Less area and more expensive upgrades indicate high spend per line mile, though entities that are outliers could be spending less effectively

IOUs

- IOUs see both high reliability and relatively low spend per mile
- Being subject to strict oversight from a state regulator could improve IOUs' reliability and spend effectiveness
- Given their larger service territories and customer counts, IOUs could benefit from economies of scale that increase spend effectiveness (i.e. admin, procurement, etc.)

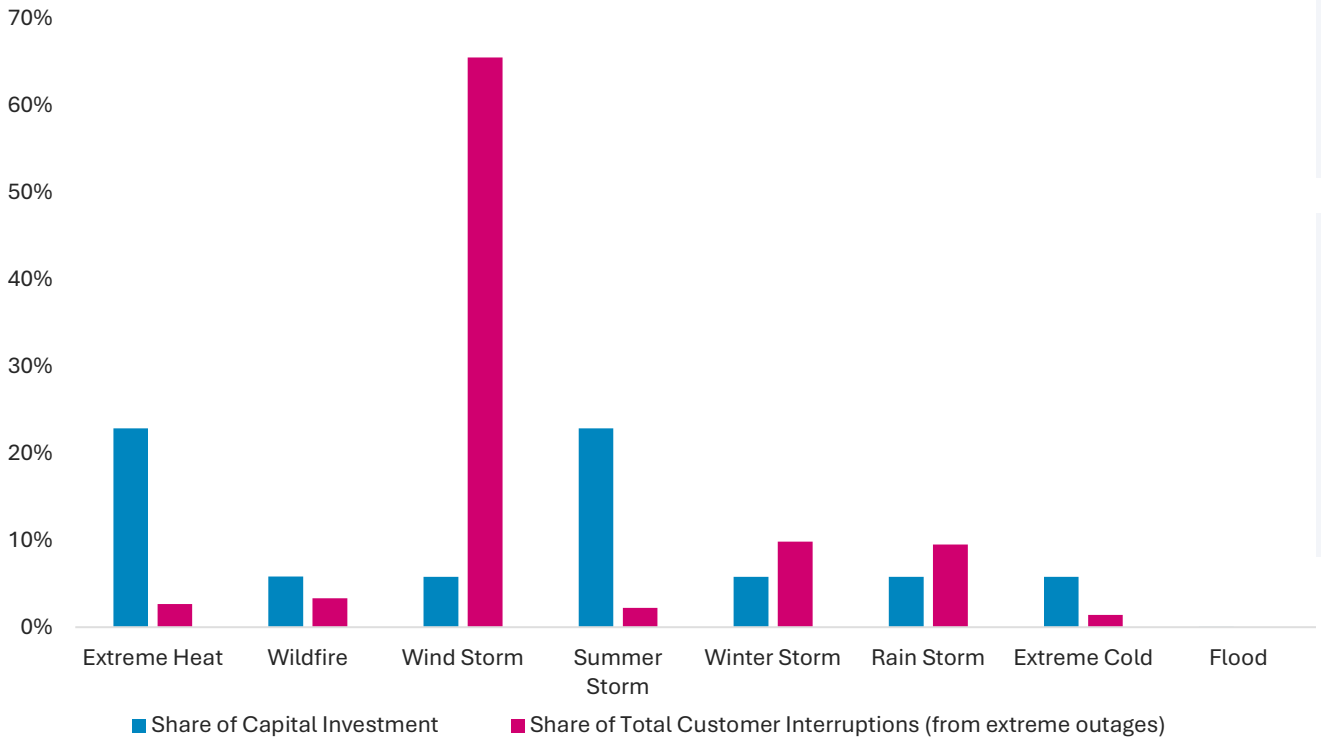
1 An estimate of IOU-1's total capital spend was considered in this view, not just Wildfire Mitigation Plan spending

Utility Investment-Outage Alignment

Public Power Cooperative IOU

While COOP-4 is well-positioned to weather future extreme heat and summer storm events, there is an opportunity to expand investment addressing high winds

INVESTMENT-OUTAGE ALIGNMENT BY HAZARD
(% of total, 2024)



INVESTMENT-OUTAGE DIVERGENCE: H M L

HIGH COVERAGE HAZARDS

HEAT: M

SUMMER STORM: M

Assessment: Investments that address general capacity needs also mitigate heat risk. Coverage can be attributed to transmission line rebuilds and substation transformer upgrades, positioning COOP-4 well for future temperature increases.

COOP-4 could consider expanded monitoring and grid analytics to ensure heat-related investment is targeting the most at-risk equipment.

FUTURE INVESTMENT OPPORTUNITIES

WIND STORM: H

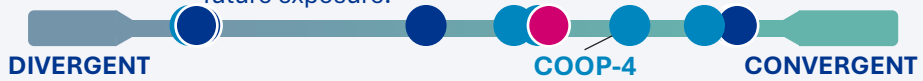
Assessment: Windstorms account for 66% of customer interruptions that occur during extreme outages, making them a priority hazard to address.

The large coverage gap for windstorms can be explained by a low percentage of COOP-4's capital spending going towards the distribution system. COOP-4 could consider targeted vegetation management, pole trussing, and undergrounding to better address wind exposure.

UTILITY COHORT COMPARISON

INVESTMENT EXPANSION

Assessment: COOP-4's capital expenditures exhibit above average alignment with climate exposure compared to other utilities in WECC. The utility could consider expanding distribution hardening investment and conducting an asset-level risk assessment using future weather data to clarify future exposure.



1 Unlike for other hazards, simply using customer interruptions as a proxy for risk might not accurately represent the true value of wildfire risk as it cannot capture widespread infrastructure damage, loss of life, etc.

Utility Benchmark Analysis

Public Power Cooperative IOU

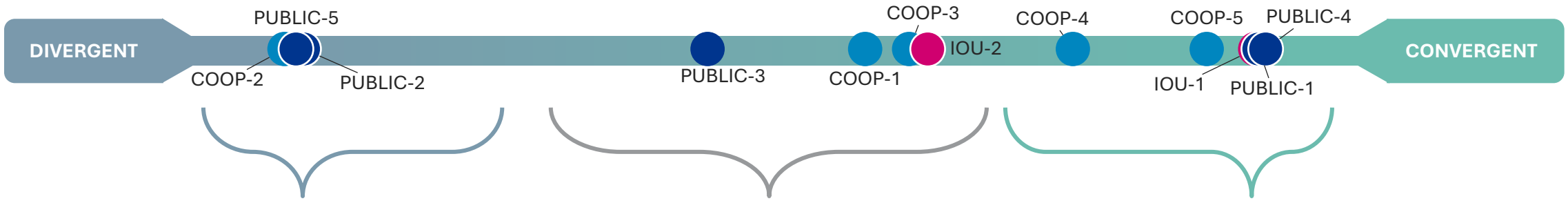
Utilities with convergent coverage are investing in upgrades that address hazards that have been historically responsible for the most severe outages in their service territory

RANKING OVERALL UTILITY COVERAGE OF EXTREME WEATHER EXPOSURE GIVEN CAPITAL INVESTMENTS

Utility Comparison Chart

Utilities that are **DIVERGENT** see a lower proportion of their capital plan cover the hazards that historically drive outages

Utilities that are **CONVERGENT** see a higher proportion of their capital plan cover the hazards that historically drive outages



REALLOCATION OPPORTUNITIES

Planning Considerations:

- Consider tradeoffs between resilience upgrades and other investments like new construction replacements
- Explore targeted investments to address hazards that historically drive outages
- Conduct asset-level risk assessment using future extreme weather data

UNCERTAIN COVERAGE

Planning Considerations:

- Investigate whether the share of customer interruptions from non-severe outages is better aligned with investment
- Conduct asset-level risk assessment using future extreme weather data to help clarify future exposure and prioritize resilience investments

INVESTMENT EXPANSION

Planning Considerations:

- Continue investment strategy to address the most pertinent hazards and prioritize resilience investments
- Pursue asset-level risk assessment to determine if current investments will continue to mitigate potential changes in most concerning hazards

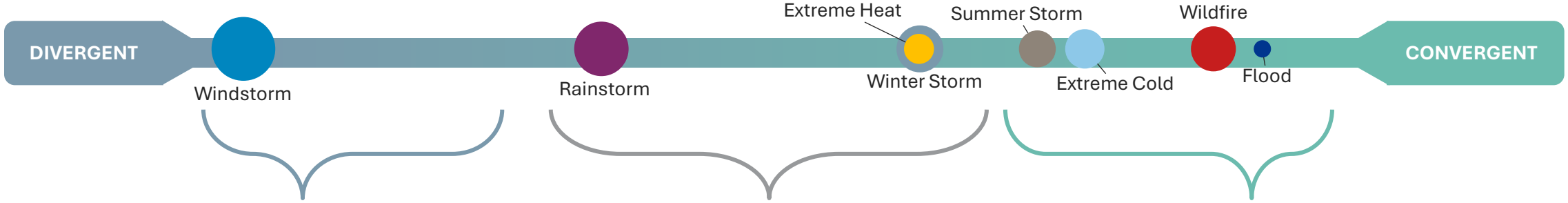
Utilities in WECC generally underinvest in windstorms given their widespread severity over utility service territories. Wildfire remains a highlight hazard for continued investment.

RANKING OVERALL UTILITY COVERAGE OF EXTREME WEATHER EXPOSURE GIVEN CAPITAL INVESTMENTS

Hazard Comparison Chart

Hazards that are **DIVERGENT** see a lower proportion of utility capital investments allocated towards them relative to exposure

Hazards that are **CONVERGENT** see a higher proportion of utility capital investments allocated towards them relative to exposure



REALLOCATION OPPORTUNITIES

Planning Considerations:

- Across WECC, windstorms are the primary driver of extreme outages
- While a large portion of capital spend is focused on wildfire and capacity upgrades, utilities could focus on targeted investments like vegetation management and pole reinforcements

UNCERTAIN COVERAGE

Planning Considerations:

- WECC sees high exposure to extreme heat. This is an opportunity for utilities to solve for both resilience and load growth challenges through capacity investments
- Rainstorms and winter storms include extreme wind, reinforcing the need for increased investment in things like pole reinforcement, vegetation management.

INVESTMENT EXPANSION

Planning Considerations:

- Continue investing in wildfire mitigations given high exposure and high cost of ignitions historically
- Unlike wind, extreme cold and summer storms are only issues in particular climate zones, meaning that overall investment sufficiently covers the limited exposure across WECC

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