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State of the Grid Report

NEVADA

Nevada Governor's Office of Energy

Energy & Resources | Utilities

May 2025

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Executive Summary

Nevada faces a tradeoff between addressing hazards that drive a high volume of customer interruptions (extreme heat) versus ones driving more severe outages (wind, wildfire, snow)

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:

Nevada faces a **tradeoff** between addressing the weather events that cause the **highest volume of interruptions** versus the ones that **most frequently drive severe outages***

- Extreme heat accounts for 32% of customer interruptions from severe outages, but this is driven a few severe events in Clark County
- Windstorm, wildfire, and winter storms drive more frequent severe outages in rural areas that knock out a higher percentage of the county
- The highest volume of interruptions per customer is typically concentrated in less-populated northern and western counties

Capital Planning Insights:

- PUBLIC-4 exhibits above average reliability in WECC but has a relatively high spend per line mile, prompting further evaluation is spend efficiency
- PUBLIC-4 could consider expanding investment to address extreme heat exposure, especially if demand growth if expected in their service territory

*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

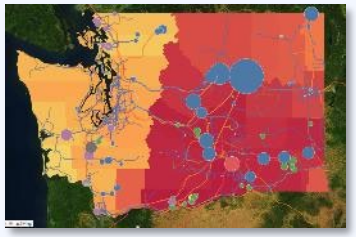
Project Overview

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**



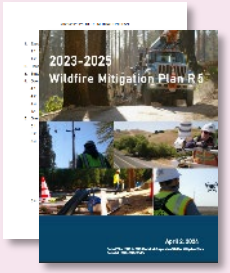
Analyze 5 years of publicly available extreme weather and outage data to **determine which type of events cause the largest outages and ignitions**.

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

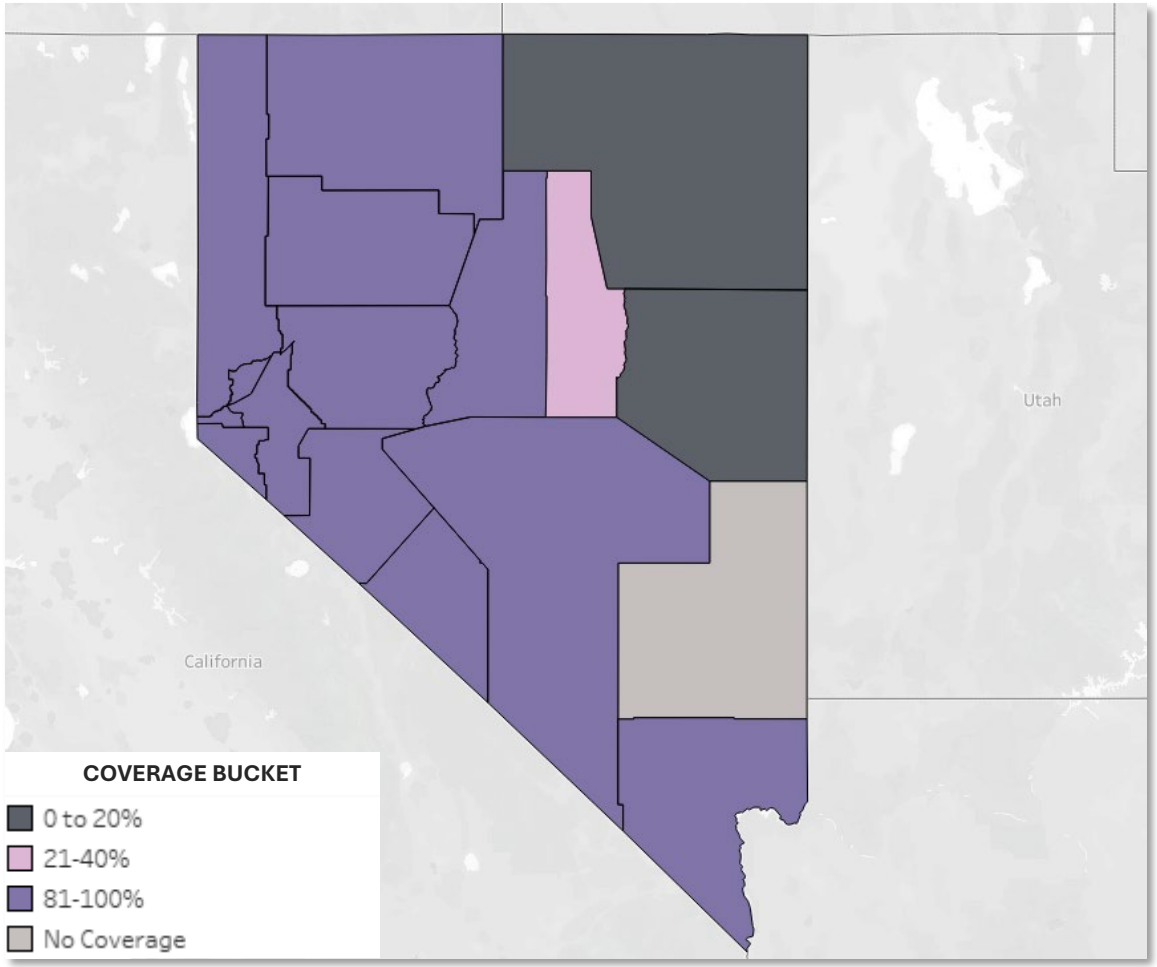
- **EXPLANATION:** Variable combinations are mapped to specific events
- **BENEFIT:** Ensuring that other hazards are below the 90th percentile isolates the most important hazards. Just looking at one hazards could capture outages that are actually attributable to other hazards.

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.

EAGLE-I generally provides sufficient coverage across the state of Nevada except for a pocket of sparsely-populated eastern counties served by smaller cooperatives

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



INSIGHTS

Lincoln County is the only county in the state with no EAGLE-I coverage

- General outage trends can still be assessed in White Pine and Elko Counties given the inclusion of at least some outage data

Counties with sparse outage coverage only account for 3% of customers within the state

- Over 97% 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, but there could be additional consideration given to the hazards facing eastern counties in funding allocation decisions
- Low customer coverage falls in the territories of Wells Rural Electric Company, Mt. Wheeler Power and Lincoln County Power District No.1

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

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

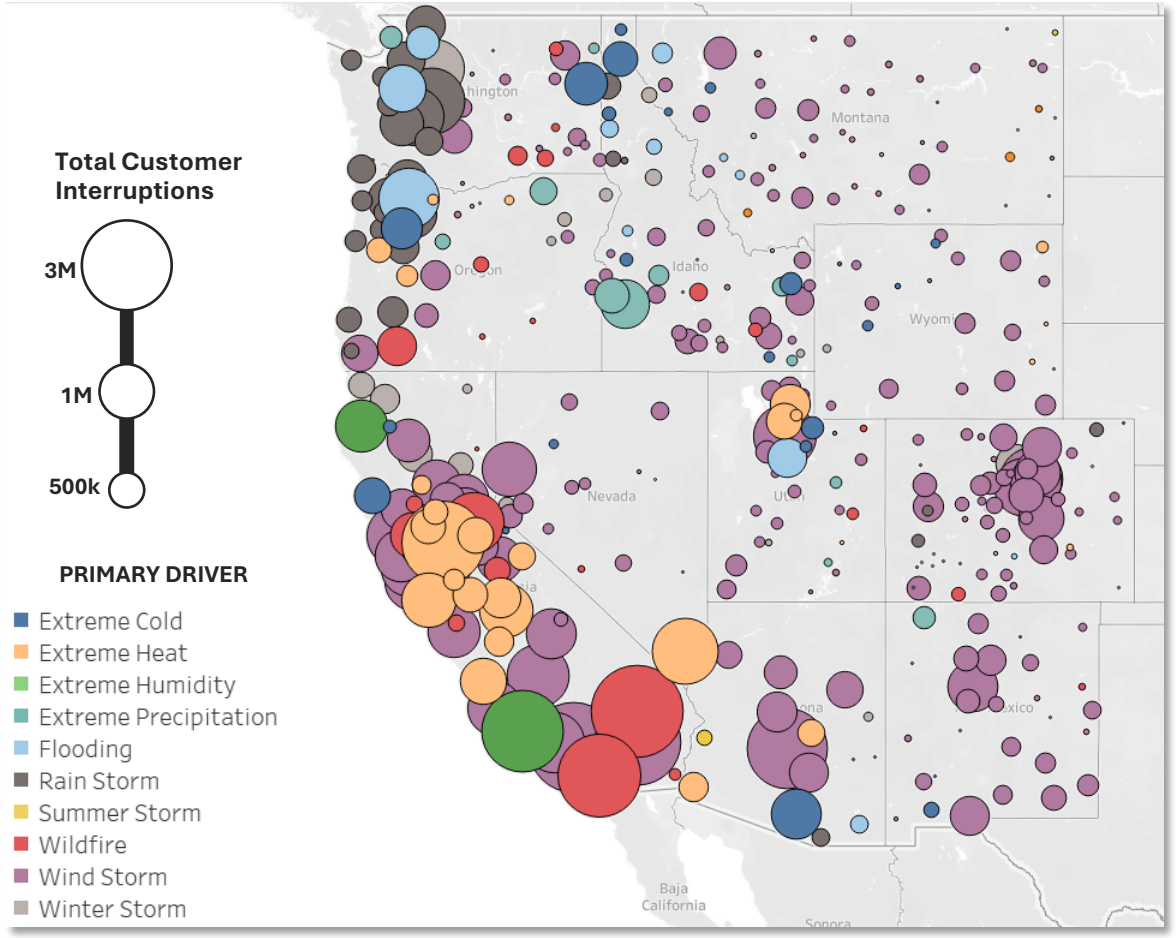
A higher volume of total customer interruptions is generally concentrated along the coast

- 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

Nevada

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

While extreme heat drives the highest volume of customer interruptions from extreme outages, high wind and wildfire drive the most frequent and severe outages

HAZARD INSIGHTS

Extreme heat drives a high volume of customer interruptions in Nevada

- Extreme heat accounts for over 100,000 customer interruptions associated with extreme outages in the state
- Despite the high volume of interruptions, these events are relatively infrequent and less severe given their concentration in the highly populated Clark County

Windstorms and wildfire are the most common drivers of extreme outages

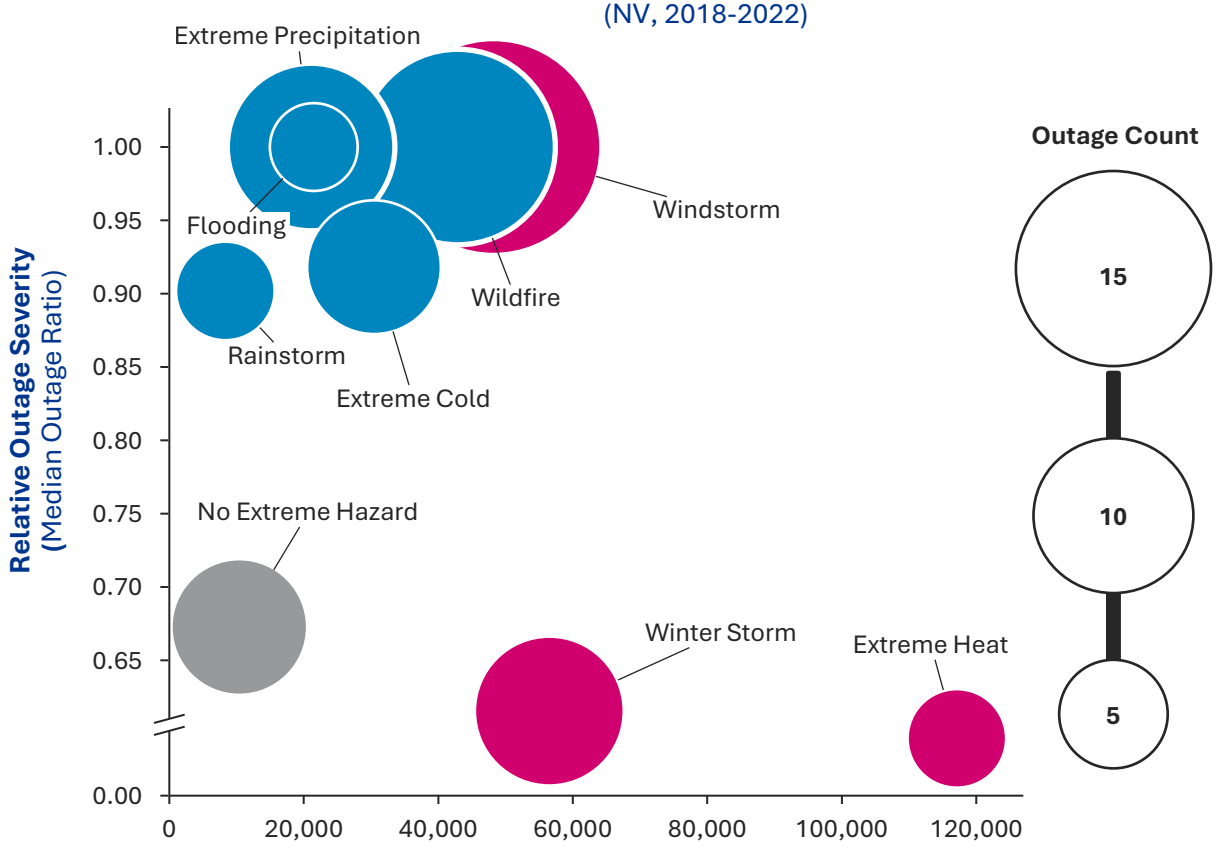
- These two events drove 42% of extreme outages in the state from 2018-2022
- Both events exhibited a mean outage ratio close to 1, indicating that they often caused county-wide outages
- Despite high frequency and severity, their lower volume of customer interruptions indicates that they were concentrated in less populous counties

Wildfire and extreme heat exposure are projected to intensify

- Baringa's GRR demonstrated escalating wildfire and heat exposure across the state, indicating that these hazards may drive more outages in the future

MOST IMPACTFUL HAZARDS	FUTURE OUTLOOK**	EVENT COUNT	MED. OUTAGE RATIO	TOTAL CUST. INTS.	AVG. CUST. INTS. / EVENT
Extreme Heat	↑	4	.04	117,115	29,279
Winter Storm	→	9	.61	56,510	6,279
Windstorm	FURTHER RESEARCH NEEDED	18	.96	48,206	2,678

SEVERITY & FREQUENCY OF EXTREME OUTAGES* DURING EXTREME WEATHER
(NV, 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

While the majority of customer interruptions are concentrated among a few key hazards, this is skewed by the uneven distribution of population throughout the state

OUTAGE INSIGHTS

A handful of hazards drive the majority of severe customer interruptions across the state

- The top 4 events (extreme heat, winter storm, windstorm, and wildfire) account for about 75% of all customer interruptions resulting from severe outages

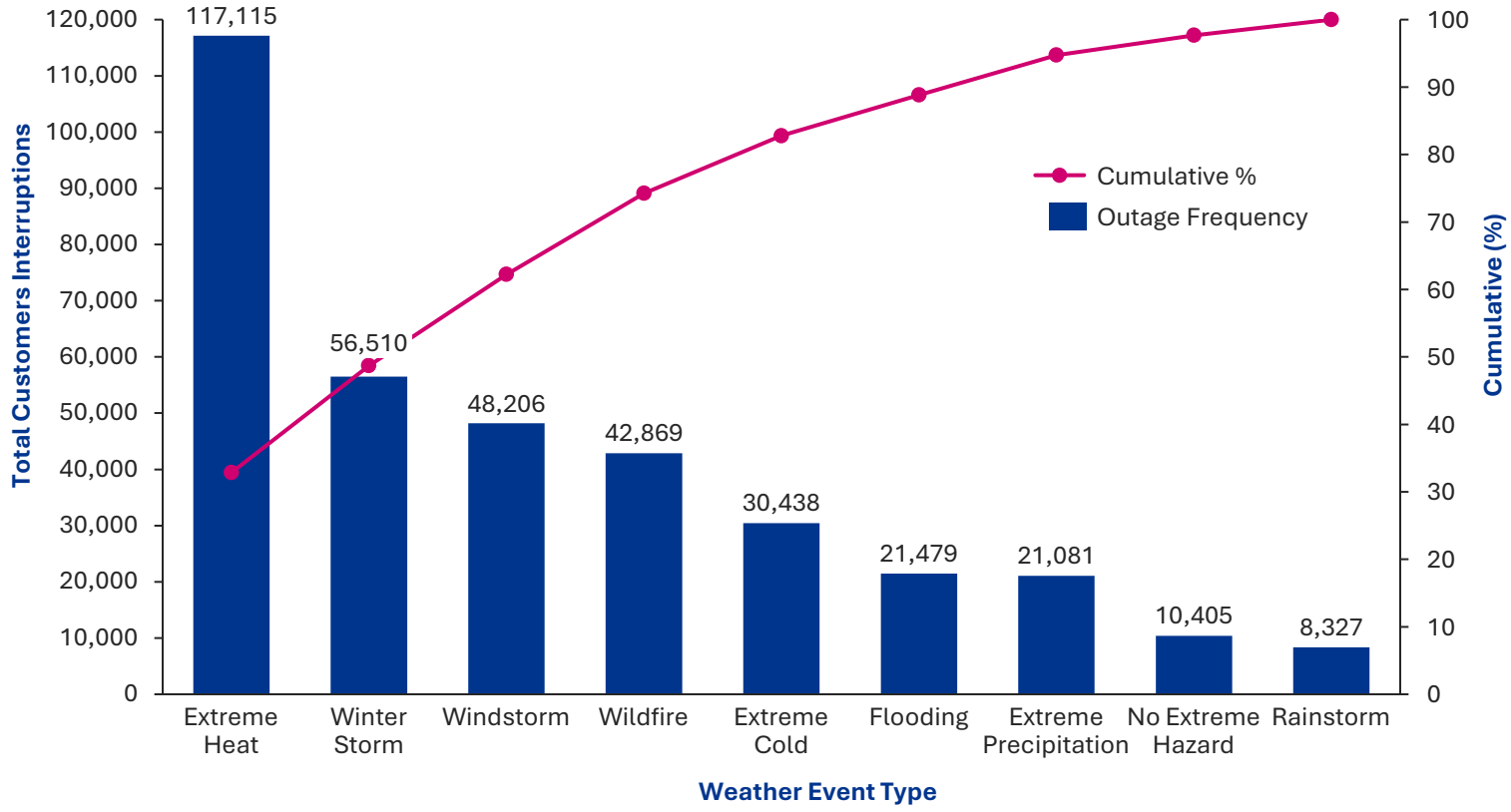
A tradeoff exists between addressing outage count vs. customer interruption volume

- While the Pareto chart indicates that extreme outages risk is concentrated among a few key hazards, Clark County's large population is having an outsized effect
- The distribution of outage frequency is much more even across the hazards, indicating that investment should not just be concentrated on these top hazards
- Stakeholders could also consider that on a percent of customers out basis at the county level, other hazards such as windstorm and wildfire are much more impactful than extreme heat

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
- While Clark County experiences a high volume of customer interruptions due to extreme heat, this is not necessarily representative of the hazards faced by the rest of the state

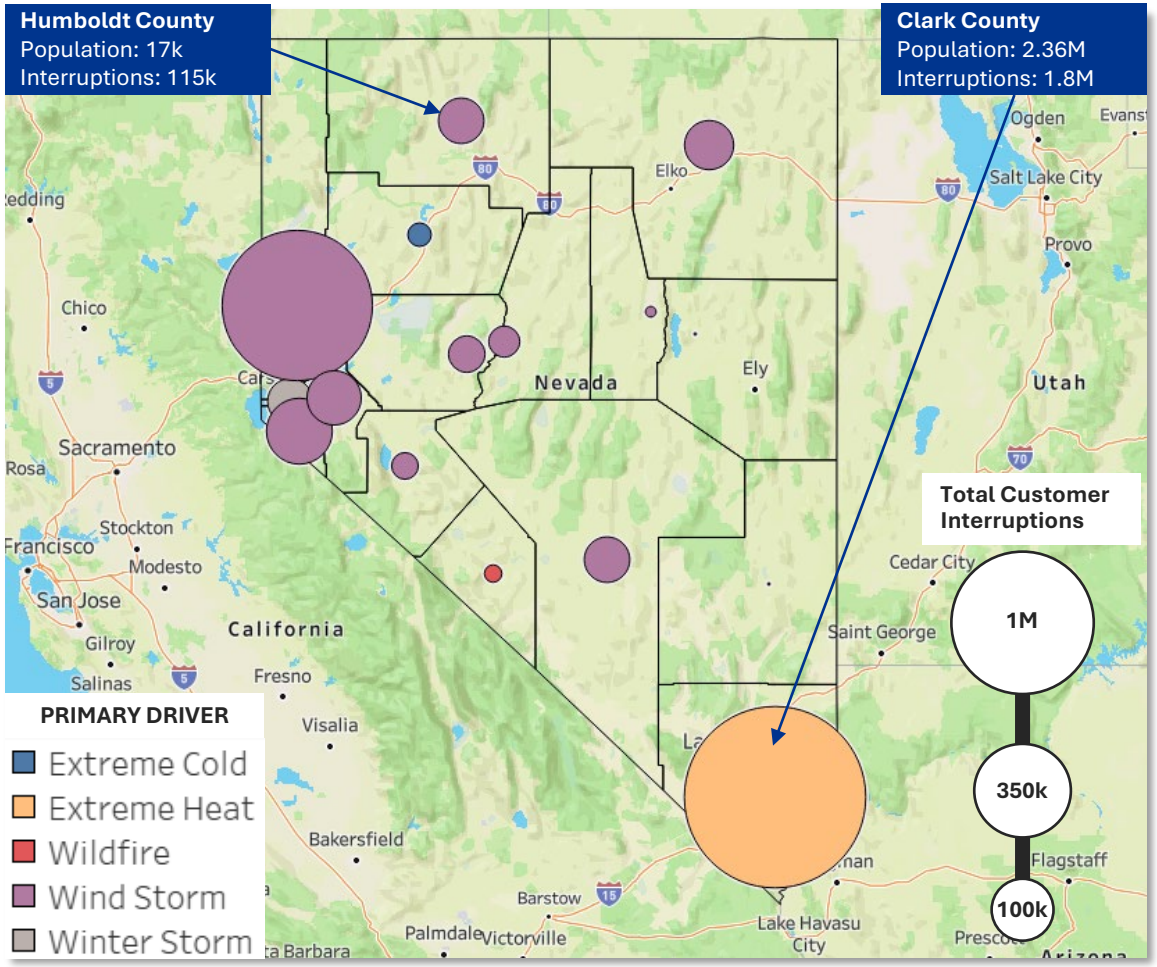
SEVERE OUTAGES* BY WEATHER EVENT & TOTAL CUSTOMER INTERRUPTIONS
(NV, 2018-2022)



*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

Wind is the primary driver of customer interruptions across the majority of Nevada, although there is a pocket of extreme heat and wildfire exposure in the southern portion of the state

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



INSIGHTS

The highest volume of customer interruptions is concentrated around population centers in Clark and Washoe Counties

- The unequal distribution of population throughout the state contributes to a concentration of customer interruptions in these counties

High winds are the primary driver of customer interruptions across the state

- The distribution of mountain ranges throughout the state results in most counties experiencing pockets of high wind exposure

Extreme heat exposure is primarily concentrated in the three southernmost counties and is projected to intensify by end-century

- Extreme heat exposure is most acute in Clark, Nye, and Lincoln Counties, which could experience over 60 days above 105 °F by end-century

Northwestern counties generally experience more customer interruptions relative to population

- Washoe, Douglas, and Humboldt counties experience a relatively high number of interruptions per customer
    - Indicates that this portion of the grid is relatively less reliable, or is more heavily exposed to severe weather than the rest of the state

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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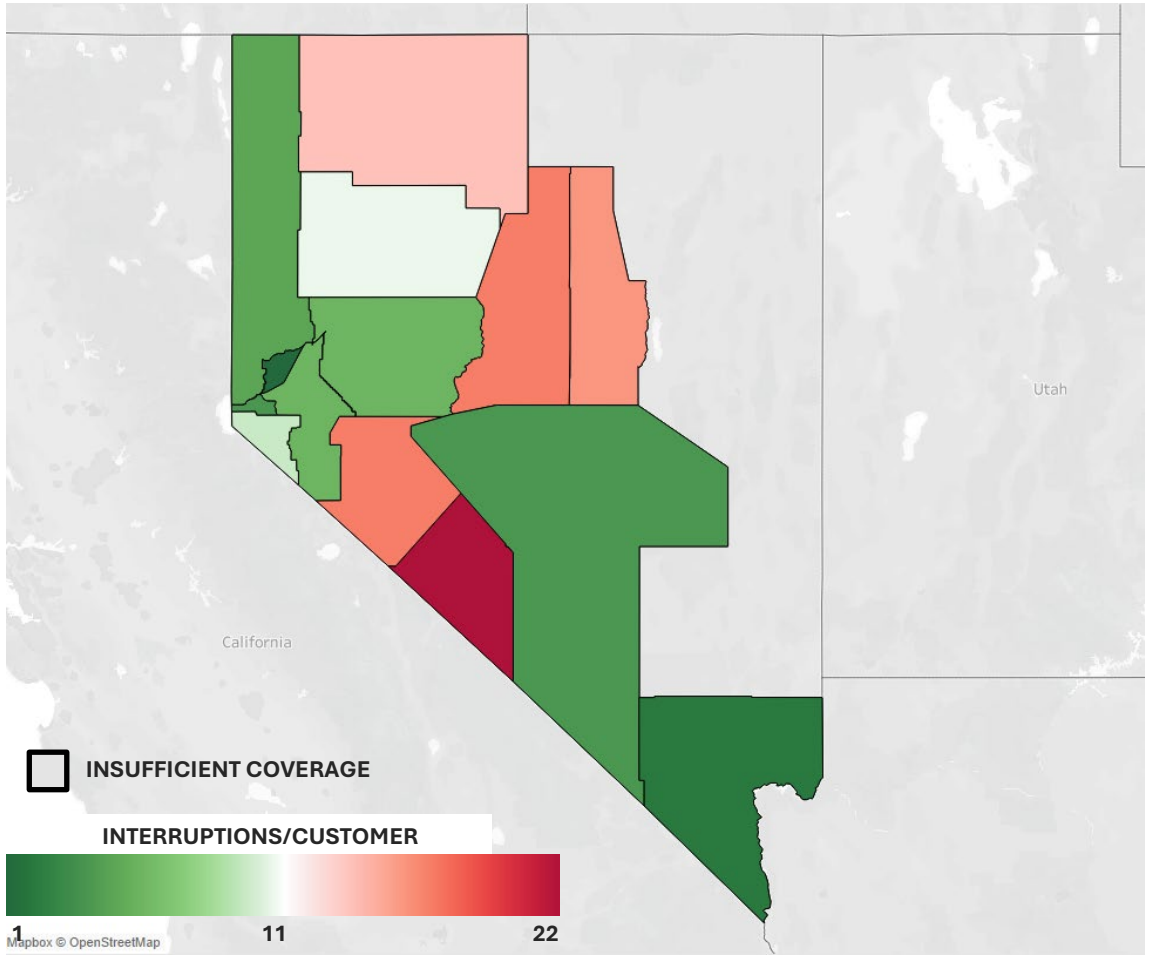
Rural counties in the northern and western portions of the state experience the highest volume of interruptions per customer given high wind exposure and mountainous terrain

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



INSIGHTS

Sparsely-populated counties throughout the state tend to experience the greatest number of customer interruptions per capita

- Counties with more customer interruptions per customer tend to be among the least populated in the state, as they likely have a large volume of overhead, radial distribution infrastructure that is particularly vulnerable and may not be well maintained

High winds and wildfire generally drive outages in the least reliable sections of the NV grid

- The mountainous terrain in northern and western counties contributes to significant wind exposure
- Radial infrastructure combined with access issues posed by the mountainous terrain can result in prolonged outages in this region

The least reliable counties are served by a variety of utility types

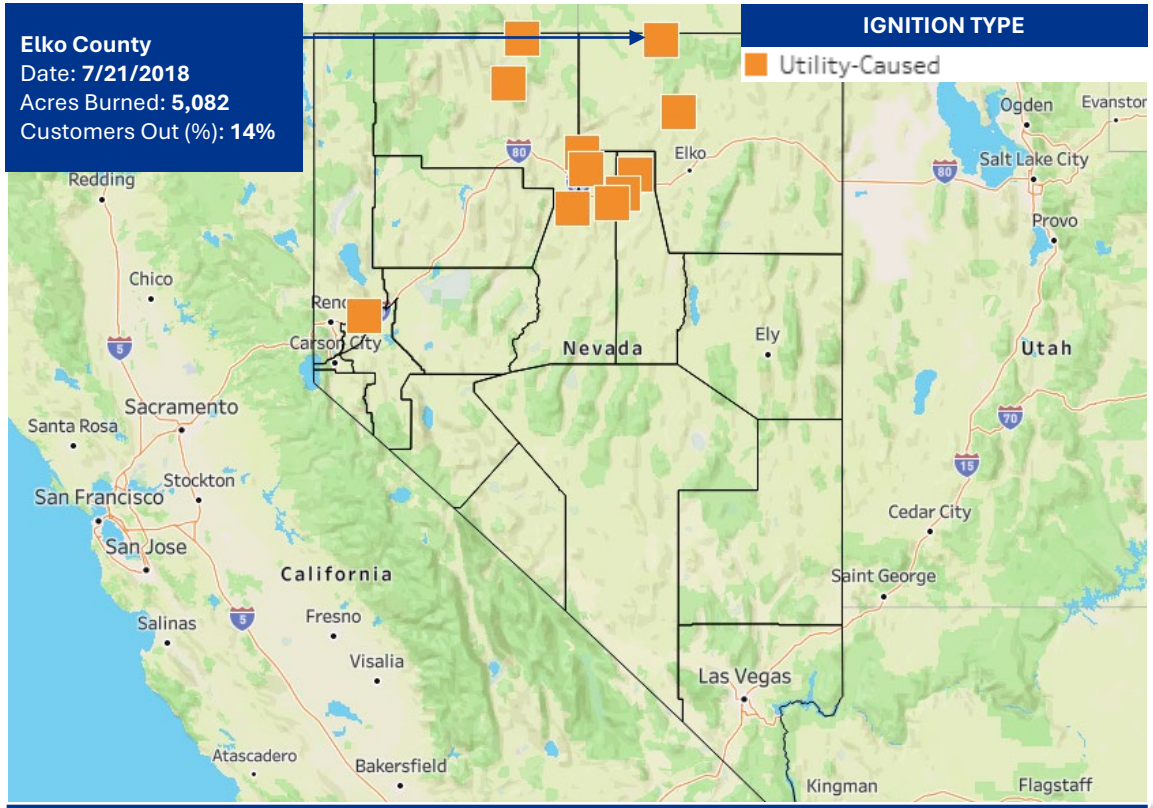
- Eureka and Humboldt Counties served by cooperatives while Mineral, Lander, and Esmeralda Counties are primarily served by NV Energy
- It is possible that cooperatives and municipal power providers generally exhibit lower reliability than IOUs, but this is difficult to confirm given their lack of outage data in EAGLE-I
- The presence of reliability concerns across utility types indicates that population density and climate exposure may serve as better indicators for where additional investment is needed

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 concentrated in the sparsely populated north-central portion of the state and are spread across both IOUs and cooperatives

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



IGNITION STATS (2018-2024)			
Ignitions in WECC Top 10%:	564	**Average Fire Size (acres burned)**	462
Total Ignitions	3,030	**Utility-caused extreme ignitions**	11

INSIGHTS

Utility-caused ignitions are concentrated in the north-central portion of the state, which faces increasing wildfire exposure

- Utility-caused ignitions are likely concentrated in this region as it is sparsely populated, indicating there could be a high volume of aging, overhead distribution infrastructure that is inspected/maintained infrequently
- North-central and northeast counties are projected to face the largest increases in wildfire exposure out to end-century (15-20%), which combined with a high volume of historical, utility-caused ignitions makes a compelling case for additional wildfire mitigation investment in this region

Utility-caused ignitions are spread across the service territories of IOUs and coops

- Ignitions are primarily concentrated in a dense north-central cluster
- The spread of ignitions across different utility types indicates that this region could be prioritized for investment (rather than a certain utility/utility type)

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

Extreme outages are generally attributable to higher wind speeds, but a high coincidence of outages with low wind speeds indicates vegetation contact could be a key driver

UNDERSTANDING THE DATA

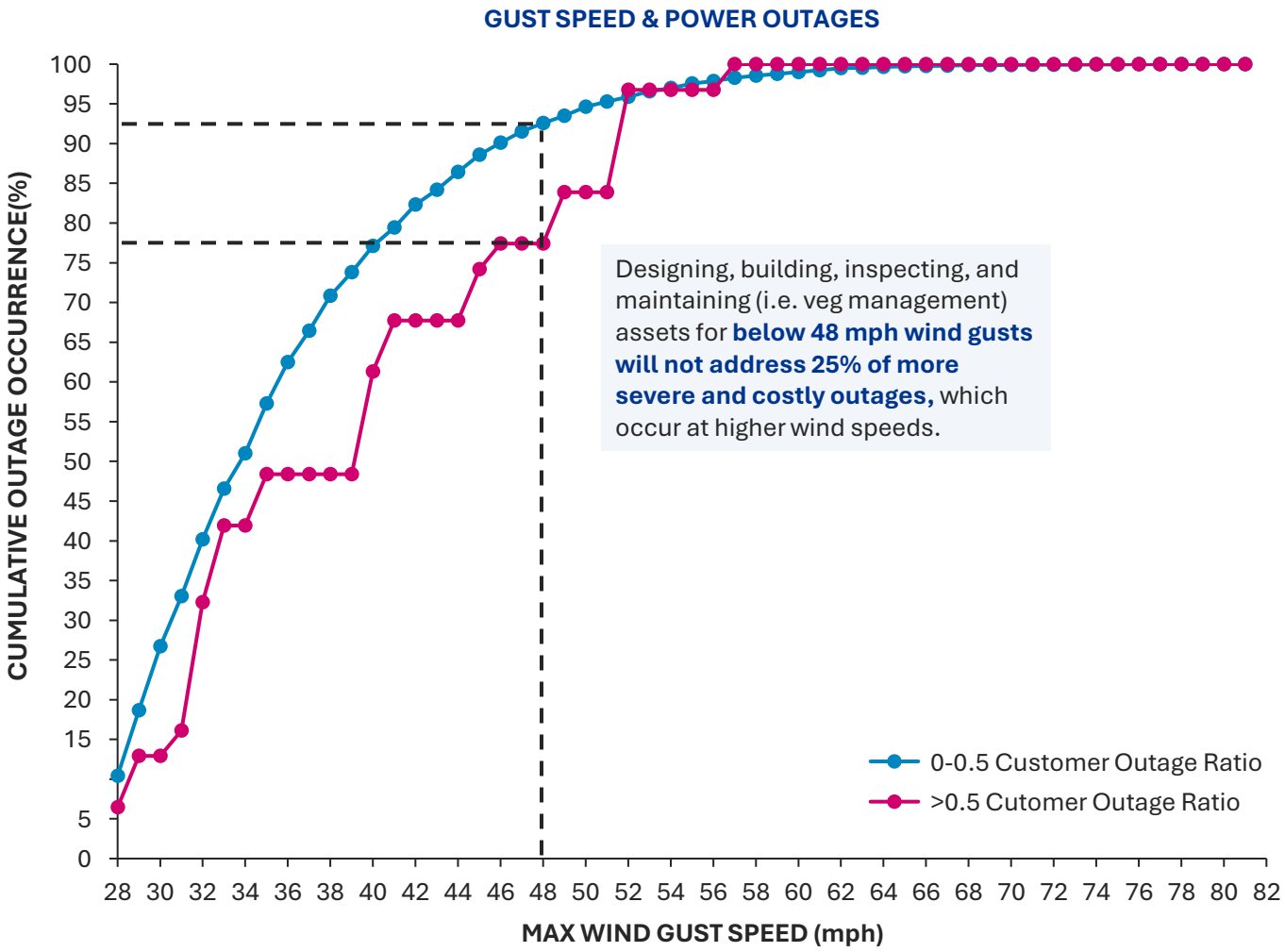
Extreme outages are more likely to be coincident with > 48 mph wind speeds than non-extreme outages

- About 23% of extreme outages are attributable to wind speeds above 48 mph, compared to 8% of non-extreme outages
- 14% of extreme outages occur at exactly 52 mph wind speeds, indicating that there may be a common failure mode that occurs at this threshold

ASSET PLANNING INSIGHTS

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

- About 95% of non-extreme outages and 80% of extreme outages occur at wind speeds < 50 mph, which are more likely attributable to vegetation contact or aging equipment rather than direct failure
- Outages are coincident with wind speeds up to 80 mph, which could serve as an important threshold for planning and design
- **Low-Cost:** Pole Reinforcement (Trussing, Guy Cables, Concrete Base, etc.), Pole Material Upgrades, Decreased Spans, Vegetation Management
- **High-Cost:** Undergrounding



Designing, building, inspecting, and maintaining (i.e. veg management) assets for **below 48 mph wind gusts will not address 25% of more severe and costly outages,** which occur at higher wind speeds.

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Extreme outages are heavily concentrated at the highest temperatures, as the probability of direct equipment failure increases as maximum temperatures increase

UNDERSTANDING THE DATA

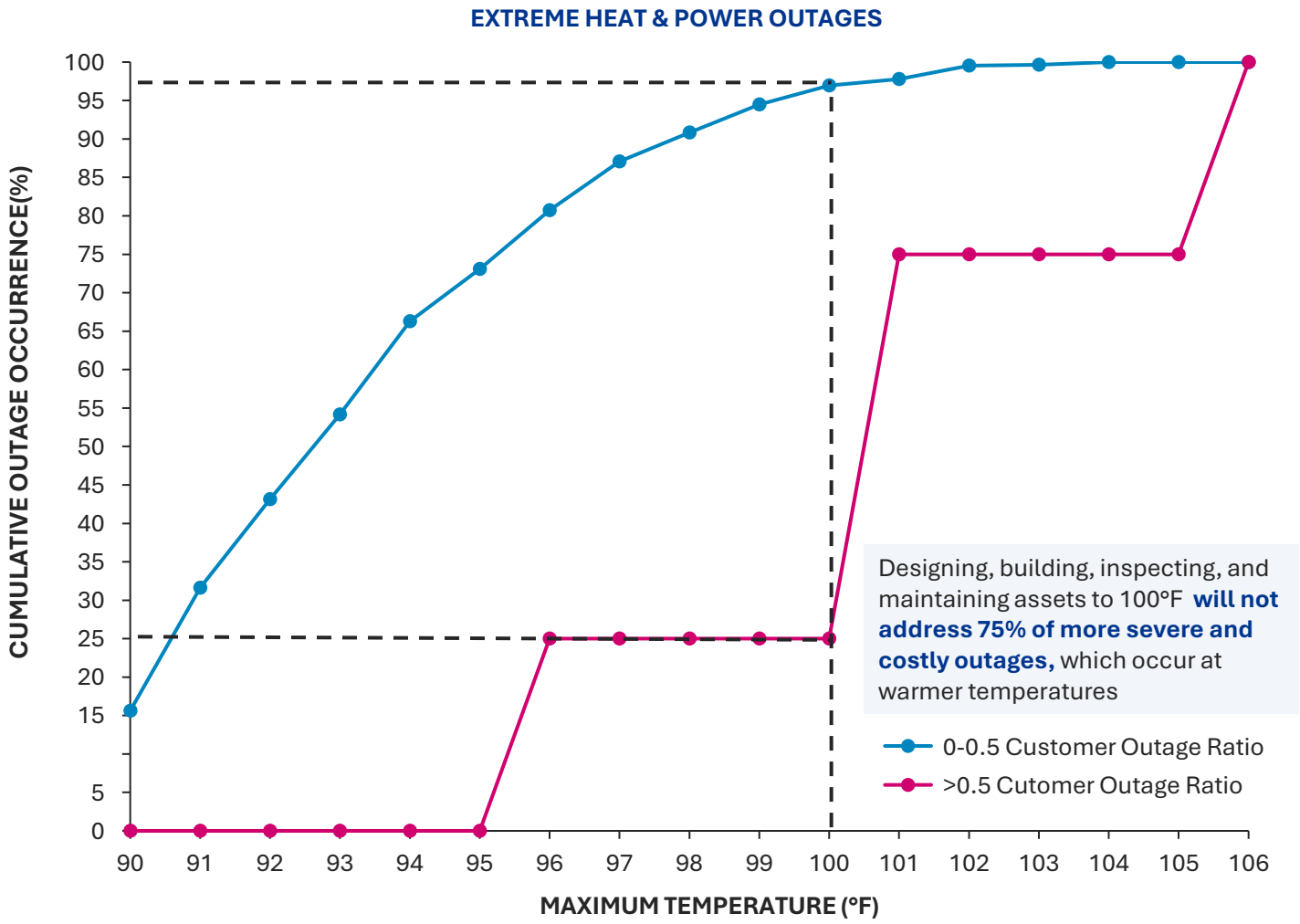
Extreme outages (>50% of customers out) are more likely to be coincident with maximum temperatures above 100 °F than non-extreme outages

- About 75% of extreme outages are attributable to minimum temperatures above 100 °F, compared to under 5% of non-extreme outages
- One severe outage in Clark County was coincident with 106 °F maximum temperatures, which likely contributed to direct asset failure

ASSET PLANNING INSIGHTS

Utilities could consider upgrading transformers and system capacity to address significant exposure to temperatures over 100 °F

- Substation transformers and other critical equipment can fail when exposed to two consecutive days above 104 °F, making this an important design standard for the system[1]
- 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
- **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

Extreme outages are concentrated above the 98th percentile weather hazards, particularly wind, necessitating additional investment to avoid the costliest outage events

UNDERSTANDING THE DATA

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

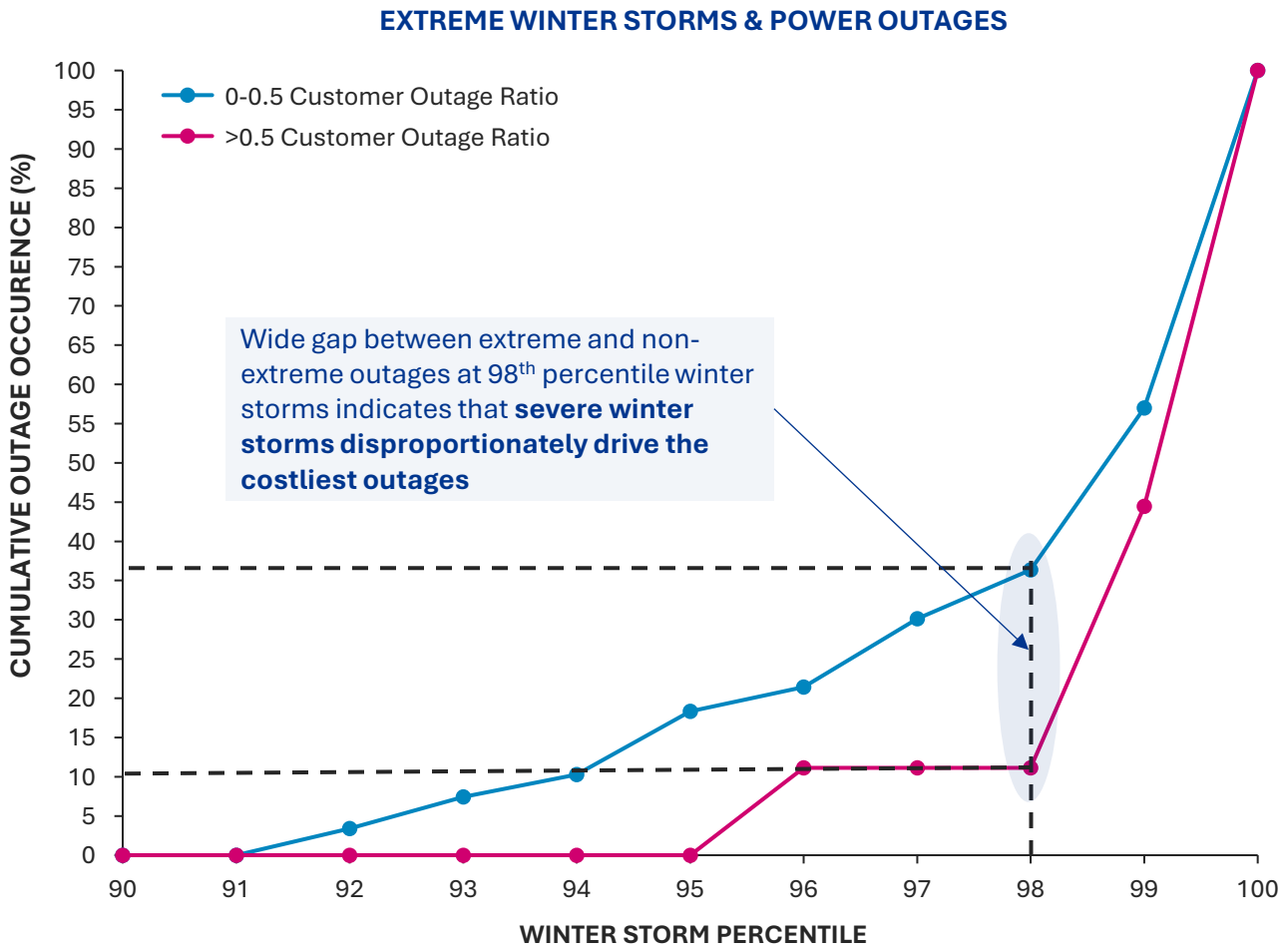
- About 90% of extreme outages are coincident with winter storms in the 98th percentile or greater, compared to less than 66% of non-extreme outages
- The curves converge at the 98th percentile when wind is excluded from the percentile mapping, indicating that it is the key drivers of extreme outages among the components of winter storms

ASSET PLANNING INSIGHTS

Utilities could consider pole reinforcement or undergrounding to address snow and ice loading, line galloping, and high wind speeds associated with winter storms

- **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
98TH PERCENTILE	0.01 (in.)	40 (mph)	17°F



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Utility Capital Plan Analysis

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

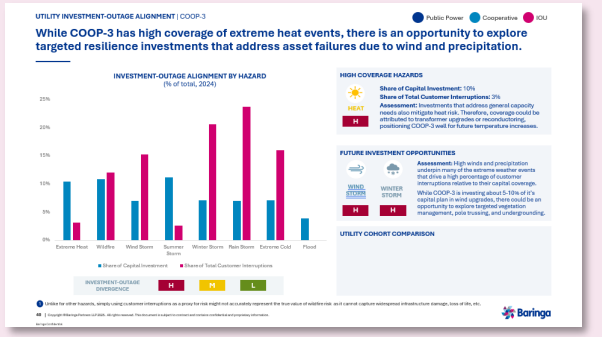
TECHNOLOGY, PREDICTION, IMAGING
ASSESSMENT & REPAIR
VEGETATION MANAGEMENT
... additional spend categories in slide 34

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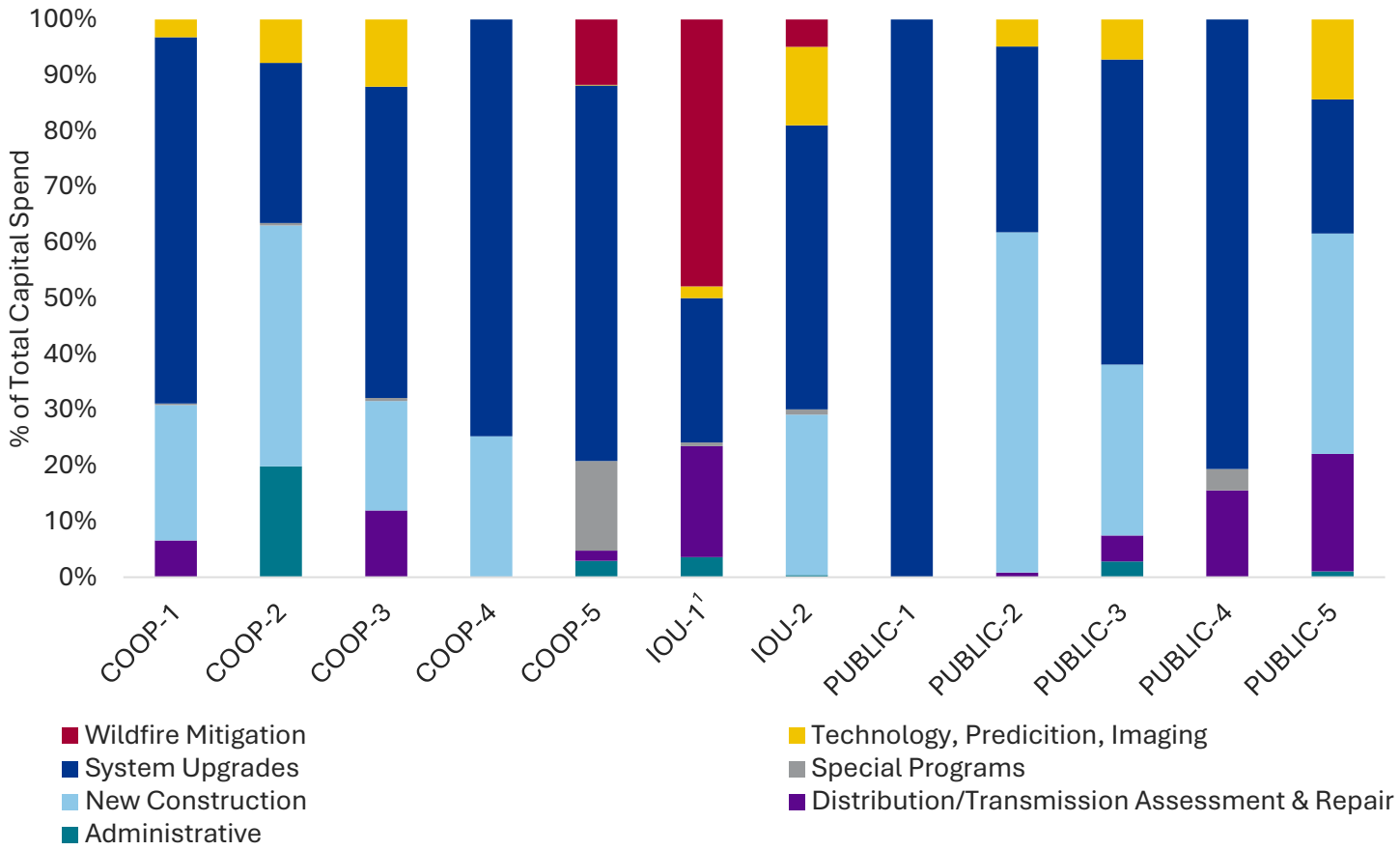
Individual projects and line items within the capital plans were mapped to larger buckets to allow for standardized comparison across utilities

	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
	**WILDFIRE MITIGATION**	Investments in system upgrades, adaptations, mitigations, that lower the likelihood of wildfire ignition and prevent damage to assets.	

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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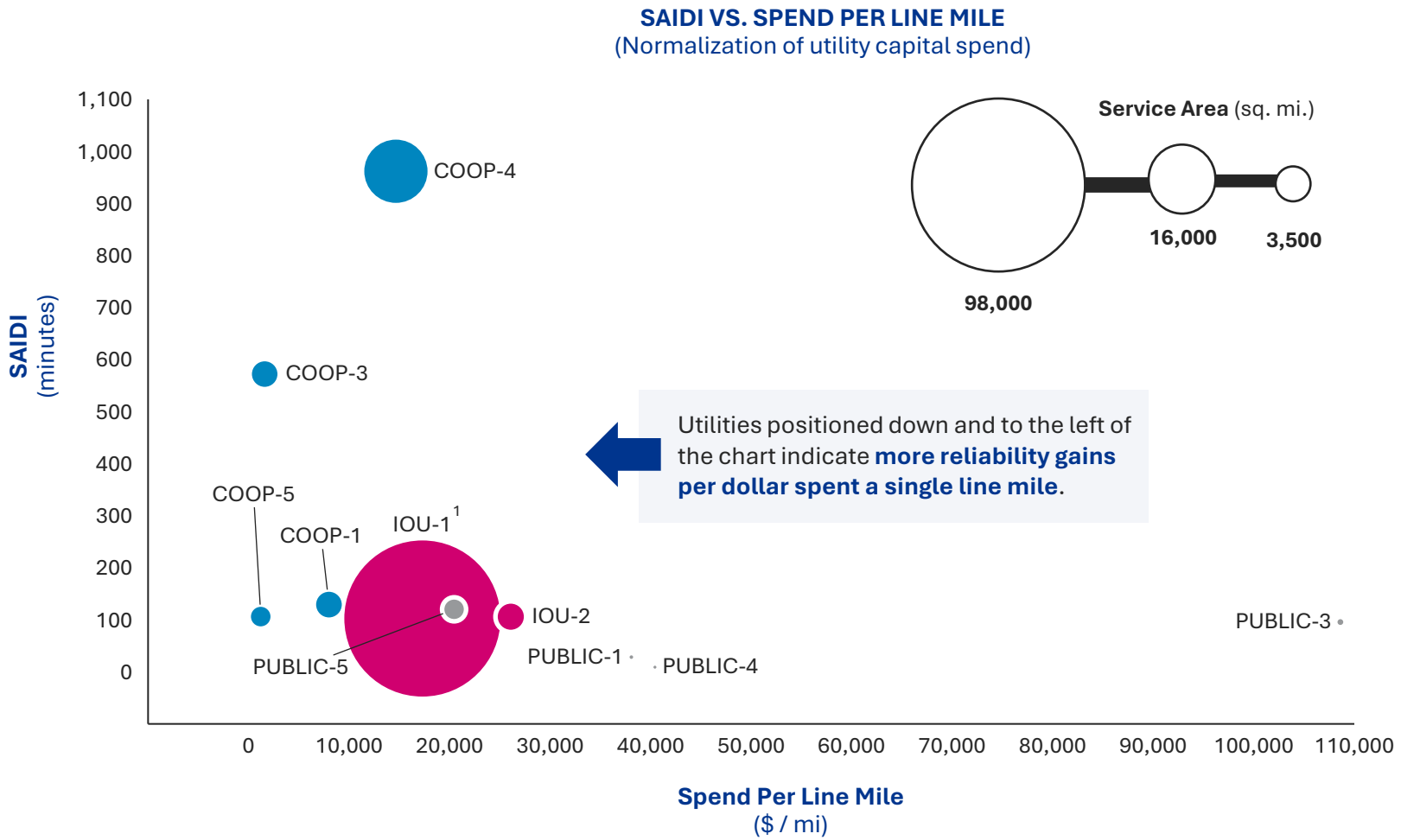
Public Power Cooperative IOU

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.)

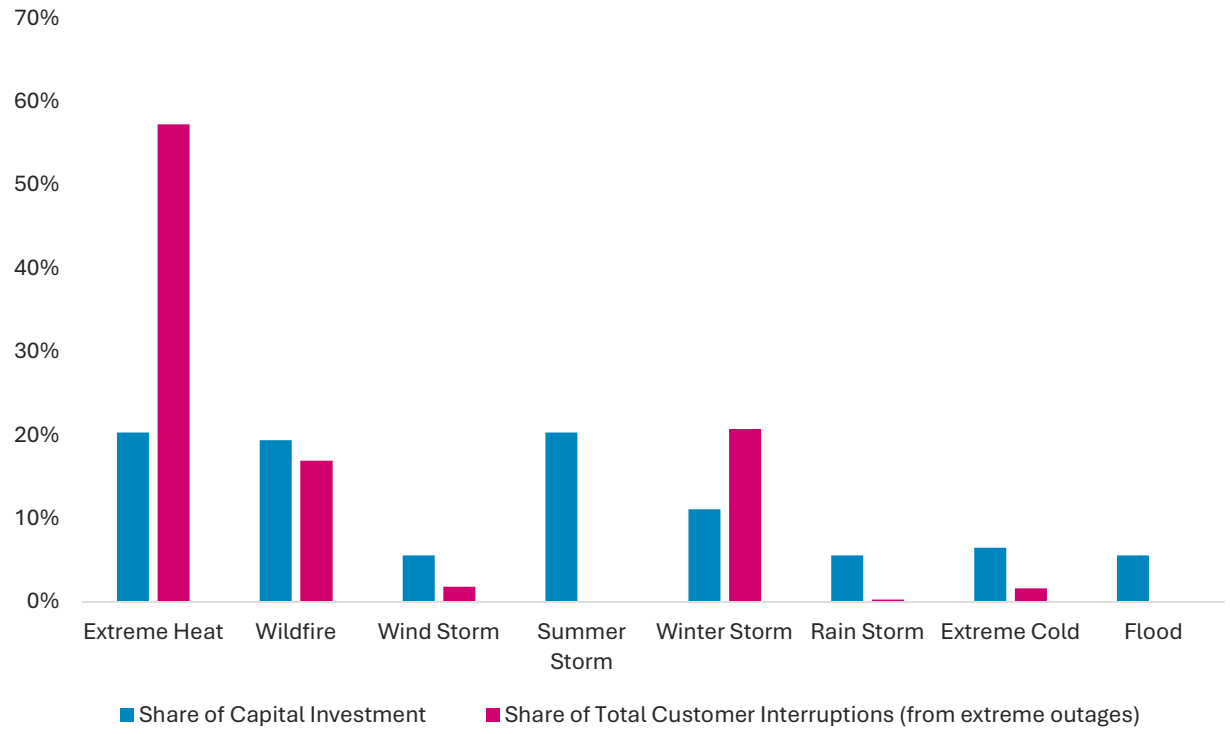
1 An estimate of IOU-1's total capital spend was considered in this view, not just Wildfire Mitigation Plan spending

Utility Investment-Outage Alignment

Public Power Cooperative IOU

PUBLIC-4's capital spending is generally well-aligned with its historical weather exposure, but it could consider expanding investment to address extreme heat

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



INVESTMENT-OUTAGE DIVERGENCE **H** **M** **L**

HIGH COVERAGE HAZARDS

SUMMER STORM **M**

Assessment: PUBLIC-4's apparent overinvestment in summer storm is a result of aligned investment with extreme heat, which addresses a component of summer storm. Thus, reallocation is likely not necessary.

The wind component of summer storm is generally less concerning for PUBLIC-4 given limited wind exposure and a lack of vegetation in its service territory.

FUTURE INVESTMENT OPPORTUNITIES

EXTREME HEAT **M**

Assessment: The high volume of customer interruptions attributable to extreme heat (57%) make it a priority hazard for additional investment. Investing to address extreme heat often increases system capacity, further justifying increased spending on the hazard.

While PUBLIC-4's investment in cable upgrades and substation rebuilds addresses extreme heat exposure, they could also consider transformer upgrades as well as improved monitoring and switches to react quickly to faults.

UTILITY COHORT COMPARISON

INVESTMENT EXPANSION

Assessment: PUBLIC-4 exhibits better capital spend alignment with historical climate exposure than other utilities in WECC, but could consider additional investments to address extreme heat, especially if it is projecting significant load growth.

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

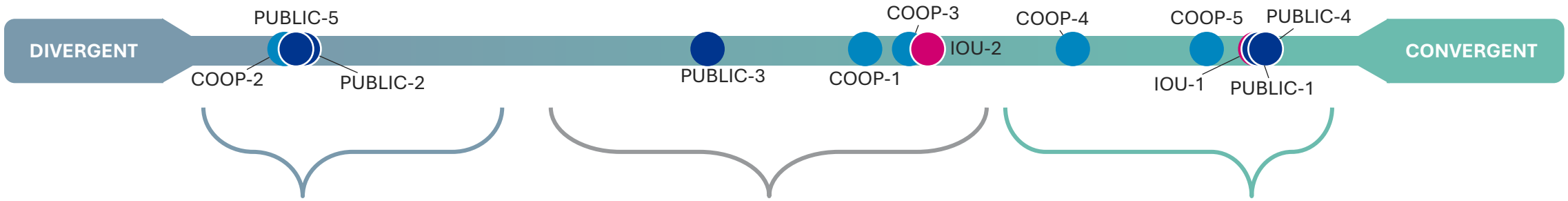
Utilities with convergent coverage are investing in upgrades that address hazards that have been historically responsible for the most severe outages in their service territory

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

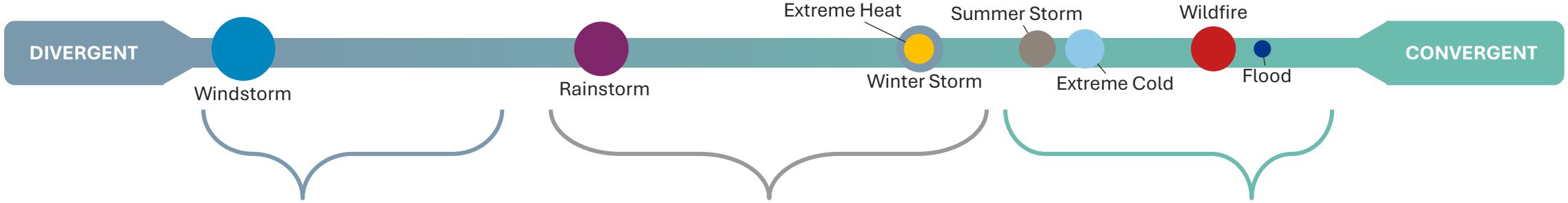
Utilities in WECC generally underinvest in windstorms given their widespread severity over utility service territories. Wildfire remains a highlight hazard for continued investment.

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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