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State of the Grid Report

WYOMING

WYOMING ENERGY AUTHORITY

Energy & Resources | Utilities

May 2025

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Executive Summary

Wyoming faces a variety of impactful climate hazards, substantiating asset-level analysis; COOP-5's capital spending is largely efficient and aligned to historical climate exposure

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:

High wind speeds, wildfire, and extreme temperatures are **the key drivers of severe outages*** on the Wyoming grid

- 50% of all customer interruptions from severe outages during 2018-22 are coincident with high wind speeds or wildfire
- Wyoming is subject to a wider range of climate hazards than other states in WECC, substantiating the need for regional and asset-level analysis
- The highest volume of interruptions per customer is typically concentrated in the northeast portion of the state

Capital Planning Insights:

COOP-5 is investing heavily to mitigate wildfire risk, but could **consider whether investments addressing wind and extreme cold should be expanded**

- Despite this minor misalignment, COOP-5 spends the least per line mile among the utilities considered in this analysis while experiencing below average SAIDI minutes, indicating it is generally spending effectively

*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

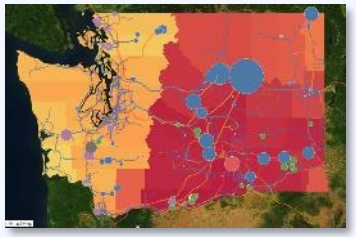
Project Overview

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**



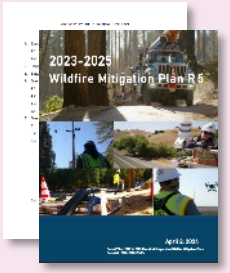
Analyze 5 years of publicly available extreme weather and outage data to **determine which type of events cause the largest outages and ignitions**.

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

SEVER OUTAGES | **JUSTIFICATION**

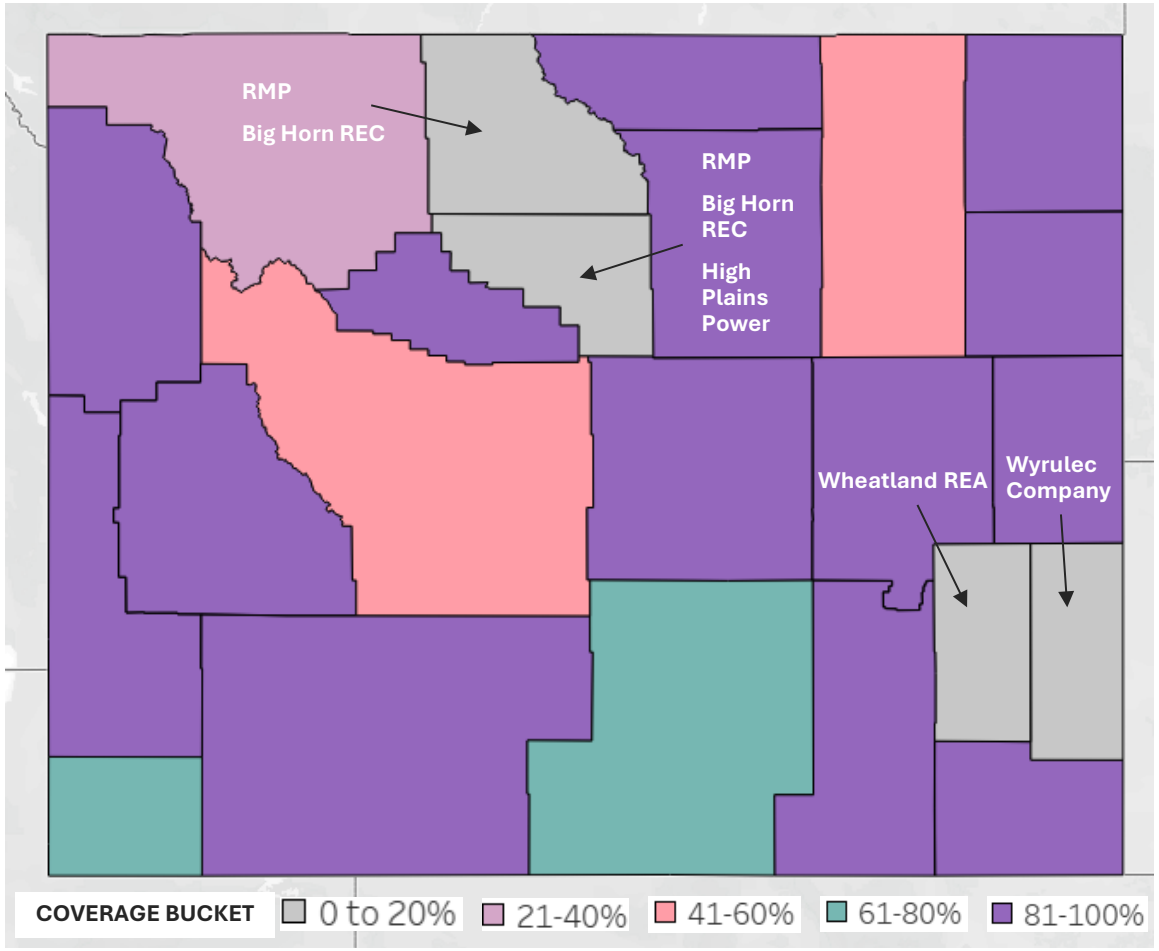
Draws on ORNL’s “Analysis of Historical Power Outages in the United States and the National Risk Index,” in which the researchers determined the 30,000 customer metric as a conservative threshold to isolate extreme, weather-cause events

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 WY customers, but is missing data from a handful of rural electric cooperatives scattered throughout the state

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



INSIGHTS

Outage data coverage issues are concentrated in a few pockets of the state largely served by rural electric cooperatives

- Outage data is generally best in the highly-populated counties across the state served by IOUs
- Data gaps exist in the service territories of Wyrulec Company, Wheatland REA, Big Horn REA, Garland L&P, and a small portion of Rocky Mountain Power's ("RMP") service territory in the northwest

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
    - **Platte and Goshe Counties:** Extreme heat and wind
    - **Big Horn and Washakie Counties:** Extreme cold and wildfire

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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

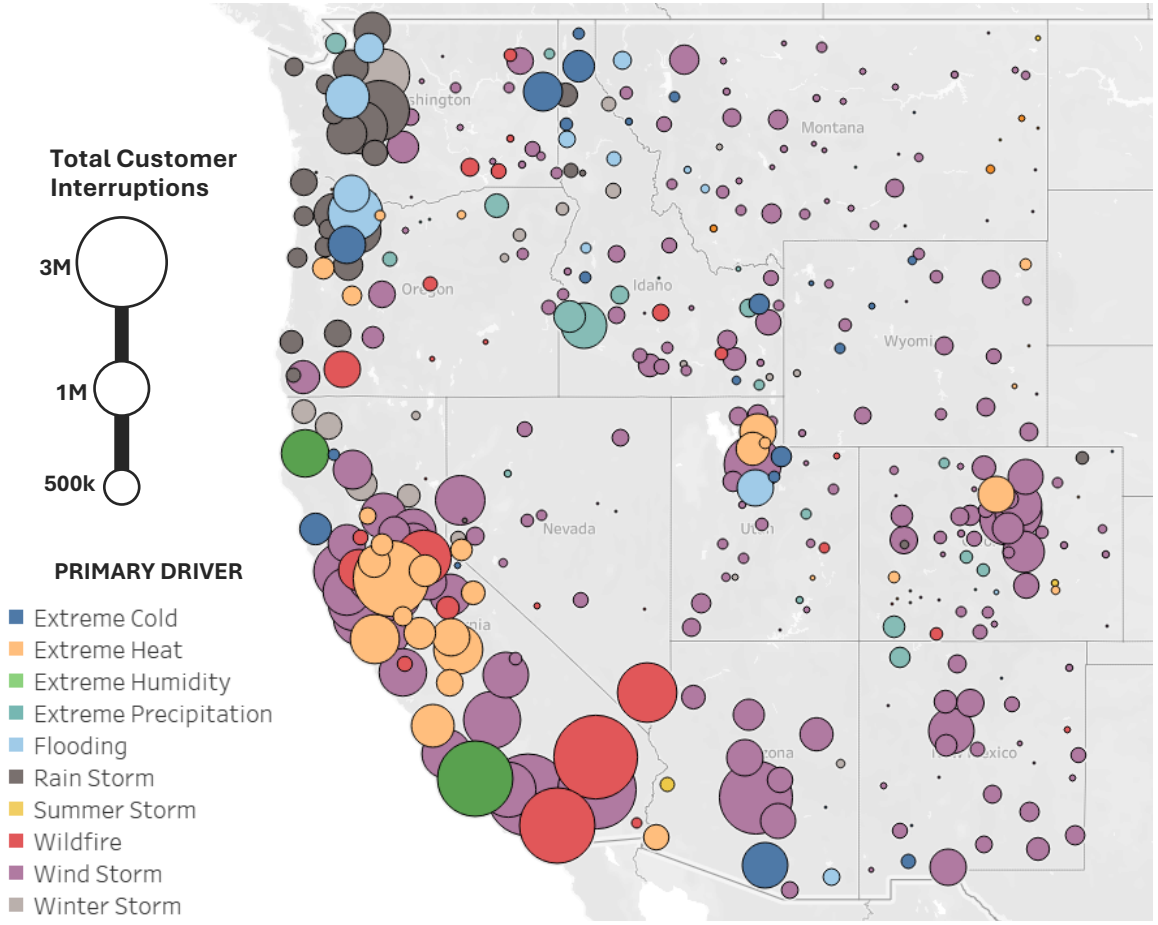
A higher volume of total customer interruptions is generally concentrated along the coast

- 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

Wyoming

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

Wildfire and high winds drive the most customer interruptions from extreme outages in Wyoming, with wildfire typically impacting more populous counties than windstorms

HAZARD INSIGHTS

High winds frequently drive severe outages on the Wyoming grid

- High wind gust speeds are an underlying driver behind windstorms and extreme fire weather, two of the most impactful weather events on the Wyoming grid

Winter weather poses a significant threat to energy assets in Wyoming

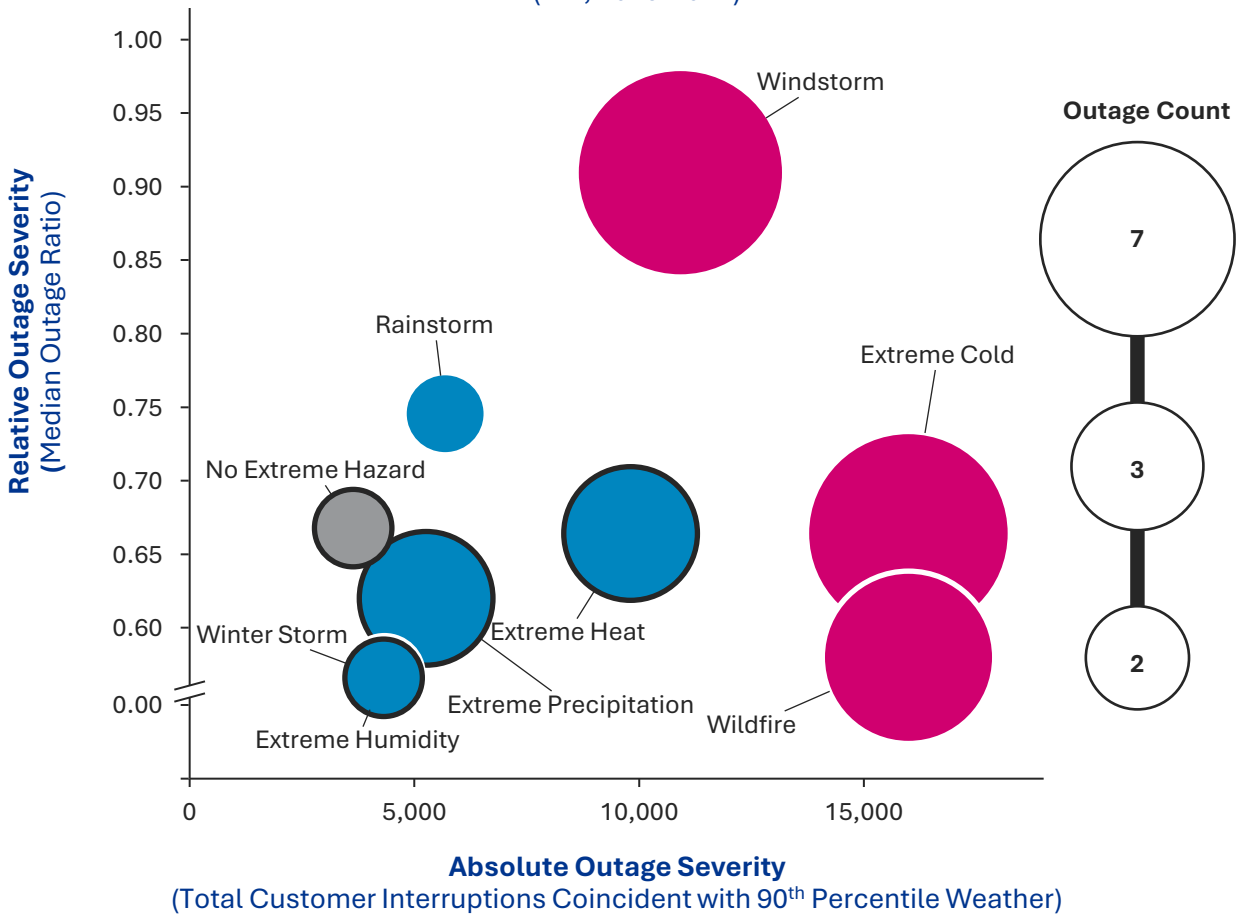
- Extreme cold can cause generator failures while associated snowfall can drive outages on the T&D system through physical line loading or vegetation contact

Wildfire typically impacts more populous counties than windstorms

- Wildfire drives the most customer interruptions from severe outages despite having fewer events and a lower median outage ratio than windstorms, indicating that these events are occurring in relatively more populous counties
- Rural Wyoming counties with a lot of overhead, radial distribution infrastructure are particularly susceptible to wind-related failures, yielding a lower number of customer interruptions despite being a more common driver of severe outages

MOST IMPACTFUL HAZARDS	FUTURE OUTLOOK**	EVENT COUNT	MED. OUTAGE RATIO	TOTAL CUST. INTS.	AVG. CUST. INTS. / EVENT
Wildfire	↑	5	.58	15,993	3,199
Extreme Cold	→	7	.66	15,991	2,284
Windstorm	FURTHER RESEARCH NEEDED	7	.91	10,918	1,560

SEVERITY & FREQUENCY OF EXTREME OUTAGES* DURING EXTREME WEATHER
(WY, 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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A significant concentration of customer interruptions from severe outages are concentrated among a few key weather events, including wildfire, extreme cold, and windstorms

OUTAGE INSIGHTS

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

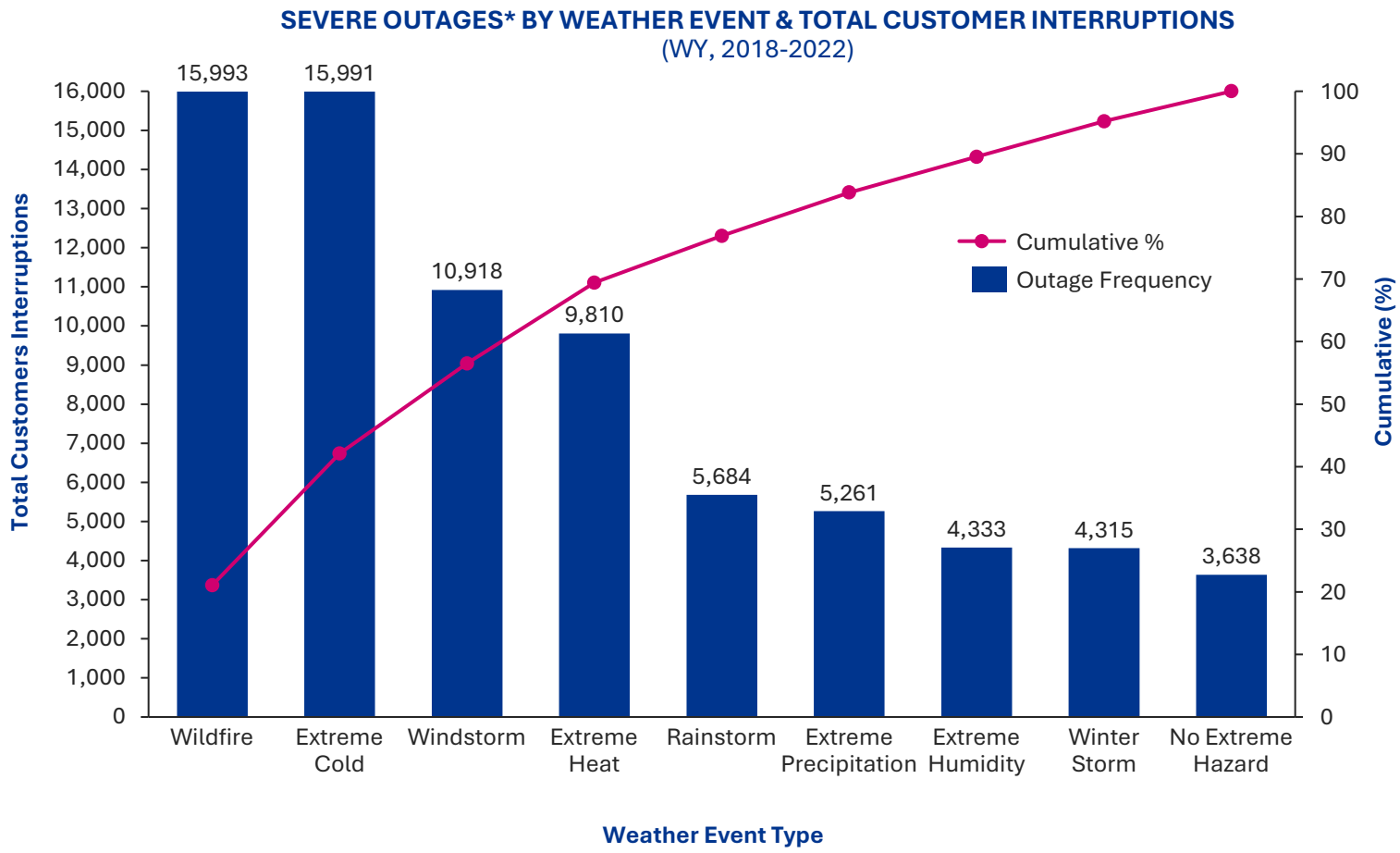
- The top 3 events (wildfire, extreme cold, and windstorms) account for about 56% of all customer interruptions resulting from severe outages
- Undergrounding addresses all 3 of these hazards, but may be prohibitively expensive

Wyoming experiences a wider range of climate hazards than other parts of WECC

- The concentration of interruptions across the top 3 events is less drastic than other states in WECC, indicating that WY faces a wide range of climate hazards
- Asset planners should ensure that they are quantifying all potential benefits from a proposed investment to accurate capture the value of upgrades that address multiple hazards simultaneously

Utilities could consider which events impact their climate zone

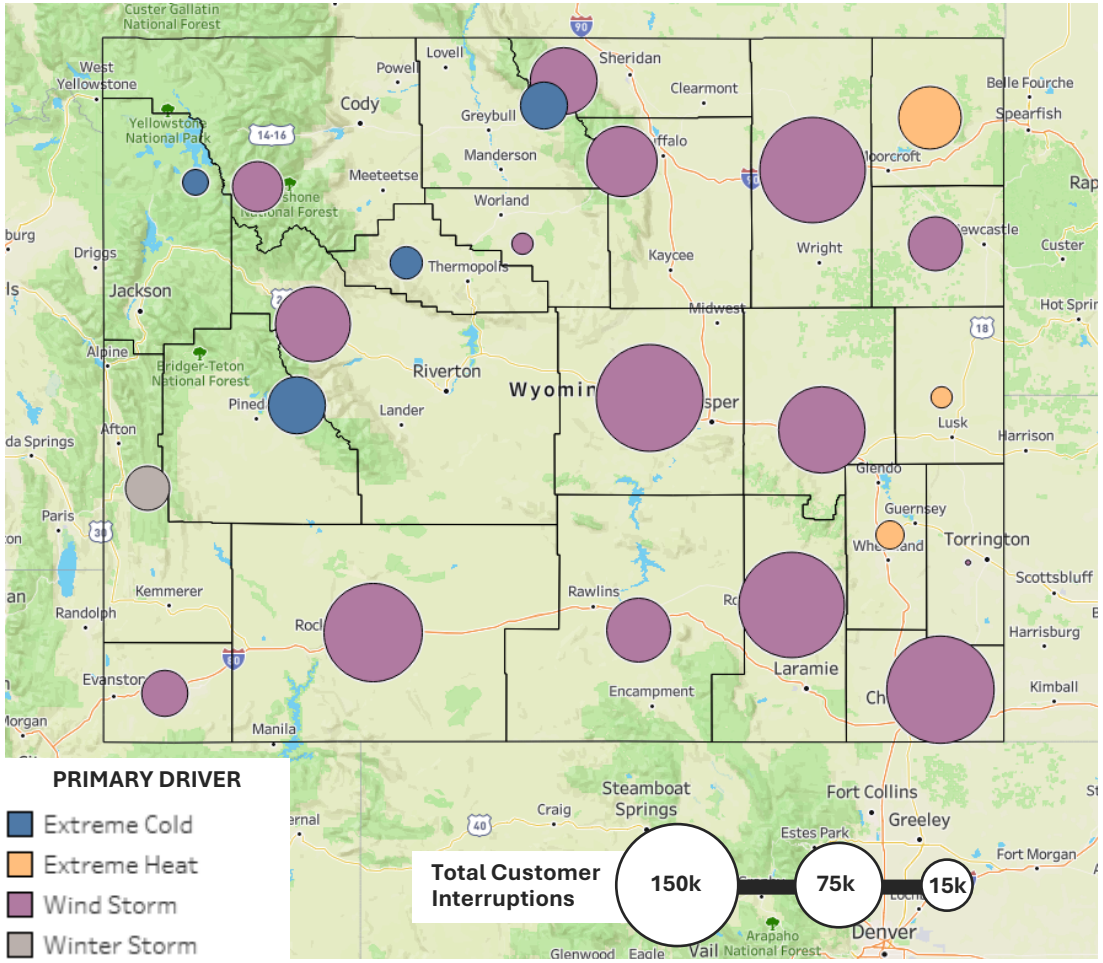
- Variable climate across the state indicates that local analysis is needed to determine the highest priority events
- Wind displays the most consistent level of exposure throughout the state and could be considered by all utilities



*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 far and away the primary driver of customer interruptions across Wyoming, while a pocket of extreme heat exposure in the NE could be addressed given projected intensification

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



INSIGHTS

Wind is the most common primary driver of customer interruptions across all outage severity levels

- While wildfire accounts for the largest volume of customer interruptions resulting from extreme outages, its absence from the primary driver map indicates that it is much less frequent outside of those severe events
- Wind is the primary driver of customer interruptions for the majority of counties in the state, demonstrating that it causes outages of varying severities

A handful of eastern/northeastern counties experience extreme heat as a primary driver of customer interruptions

- This lines up exactly with Baringa's findings in the WY GRR, where Crook and Niobrara Counties were exposed to peak statewide extreme heat
- Heat exposure is projected to intensity in this region, resulting in up to 4 days/year above 105 °F , further justifying heat-related upgrades in the NE

Albany County experiences a higher volume of customer interruptions than expected

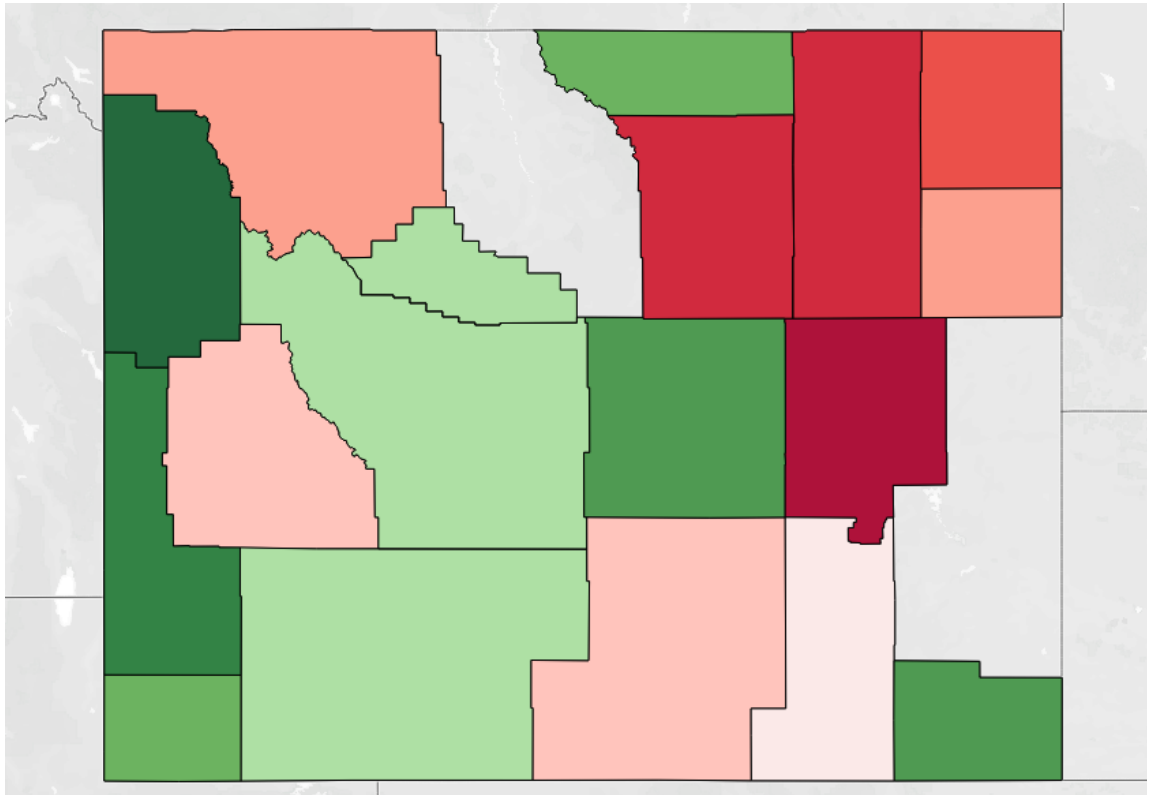
- Relatively high density of vegetation and reliance on a heavily constrained transmission line results in a larger volume of customer interruptions, accounting for population

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"

Northeastern counties in Wyoming generally experience the highest volume of interruptions per customer and could be prioritized for additional resilience investments

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



INSIGHTS

The most acute reliability issues in Wyoming are generally concentrated in the northeastern portion of the state

- While the volume of customer interruptions per capita is slightly higher in the NE, the reliability levels are much more convergent across the state than they are in other states in WECC
- This region is among the least-populated areas in the state, meaning there is likely a high volume of radial, overhead distribution lines that are more susceptible to failure
- Interestingly, the NE region does not face particularly severe climate exposure relative to the face of the state, per Baringa's Grid Resilience Report

High winds and wildfire contribute to the majority of reliability issues in NE Wyoming

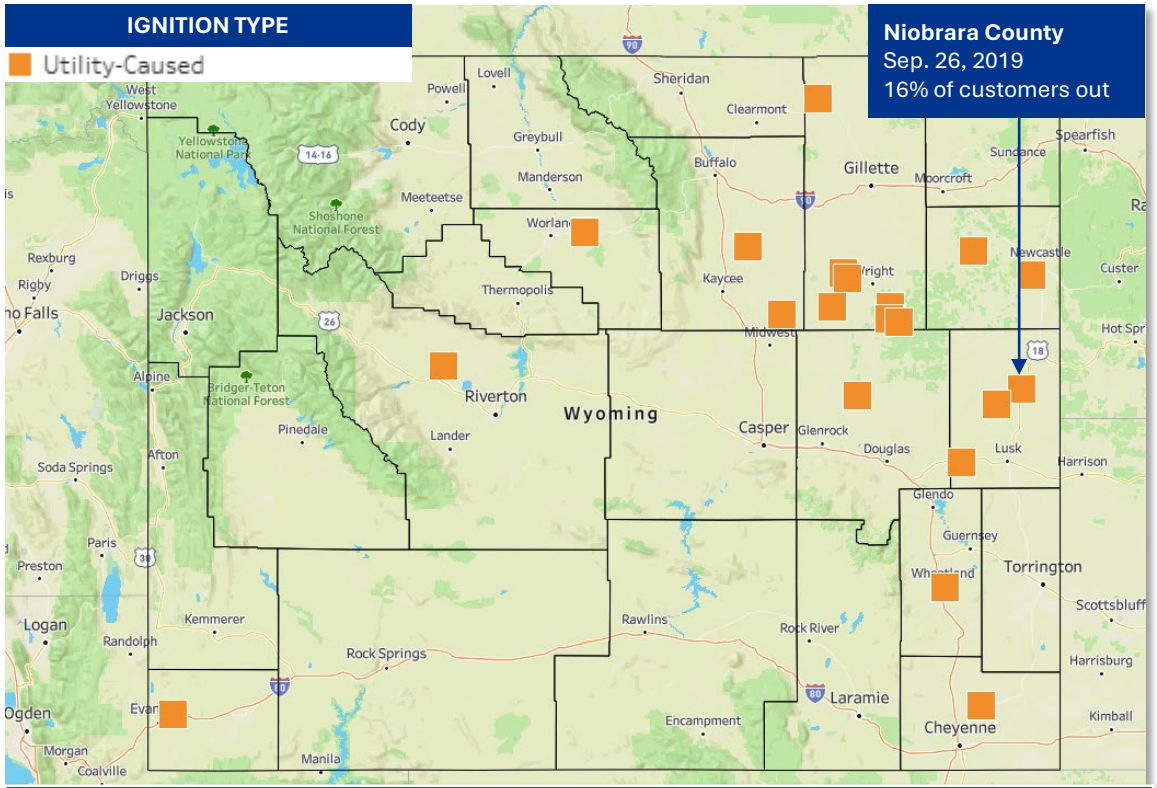
- Windstorms were identified as the primary driver of customer interruptions for the majority of the last reliable counties (see slide 24)
- A high volume of utility-caused ignitions in this region (see slide 25) reinforces the presence of high winds and indicates that the utility infrastructure in this region may bee aging or located close to vegetation

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

Extreme, utility-caused outages are concentrated in eastern counties despite lower exposure, indicating the cooperatives in the region could increase investment in wildfire mitigation

UTILITY-CAUSED, TOP 10% IGNITIONS BY ACRES BURNED (WY, 2018-2024)



IGNITION STATS (2018-2024)			
Ignitions in WECC Top 10%:	703	**Average Fire Size (acres burned)**	406
Total Ignitions	4,707	**Utility-caused extreme ignitions**	21

INSIGHTS

Utility-caused ignitions are generally concentrated in the eastern portion of the state, particularly in Campbell County

- This differs from the GRR, which generally displayed more severe wildfire exposure in western counties, indicating that:
  - Eastern utilities have less comprehensive wildfire mitigation strategies, and their infrastructure is more prone to ignition **AND/OR**
  - Western counties will see significant drought increase over the course of the century, shifting risk to the western portion of the state

Cooperatives in the NE portion of the state could prioritize investments to address ignition risk

- The concentration of utility-caused ignitions in the territories of Powder River Energy and Niobrara Electric indicates that these utilities could be allocate more capital for adaptations to decrease the probability of ignition
- Entities owning transmission infrastructure in the region, such as WAPA and Black Hills, could investigate whether their assets contributed to these ignitions

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 attributable to higher wind speeds up to 46 mph, but a high coincidence of outages with low wind speeds indicates vegetation contact could be a key driver

UNDERSTANDING THE DATA

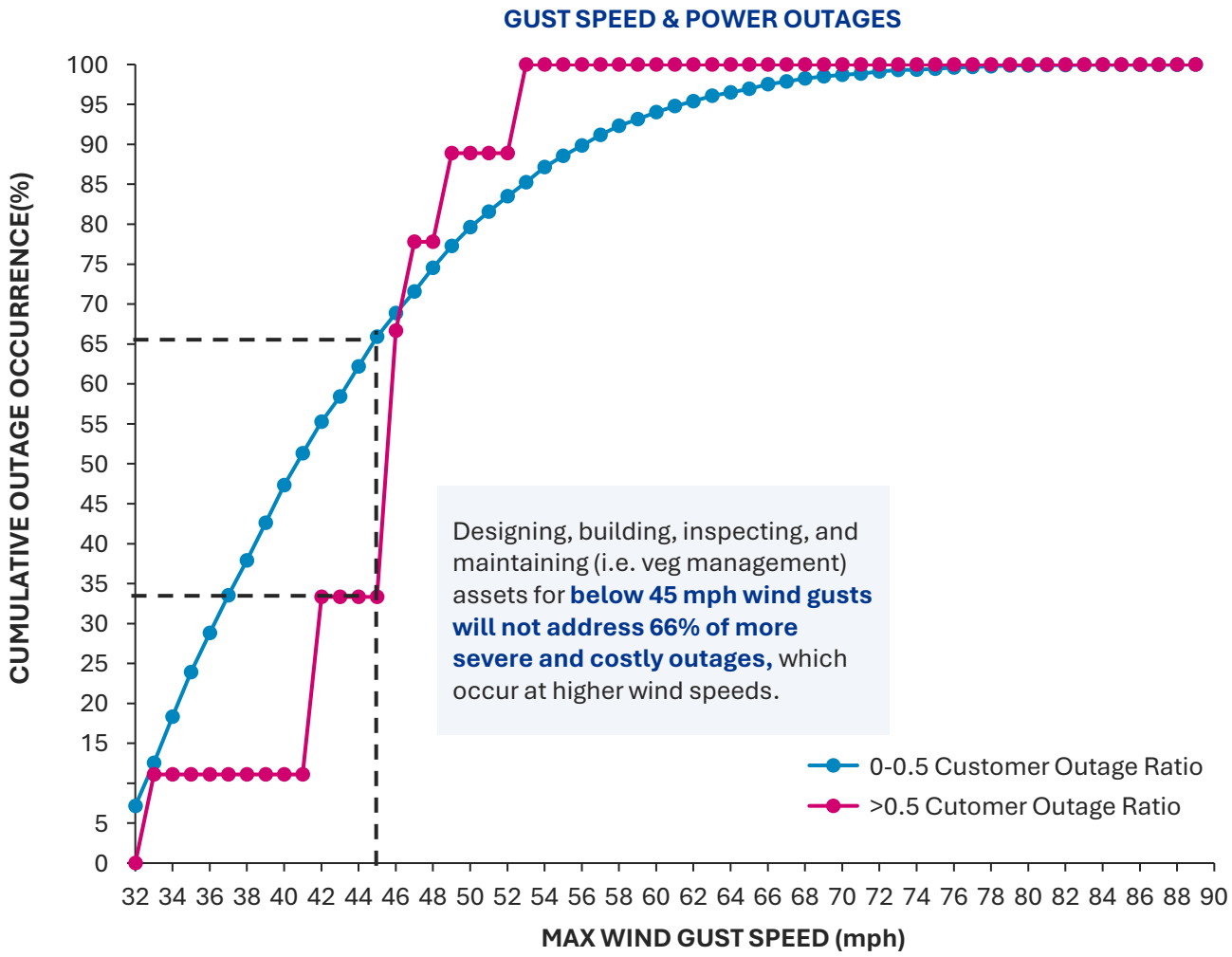
Extreme outages (>50% of customers out) are more likely to be coincident with >45 mph wind speeds than non-extreme outages

- About 66% of extreme outages are attributable to wind speeds above 45 mph, compared to just 35% of non-extreme outages
- This gap shrinks above 46 mph, indicating that above this threshold, outage severity is equally sensitive to wind speeds
- The low volume of extreme outages contributes to the steep slope of the curve

ASSET PLANNING INSIGHTS

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

- Almost 90% of extreme outages and 80% of non-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 83 mph, representing an important design threshold
- **Low-Cost:** Pole Reinforcement (Trussing, Guy Cables, Concrete Base, etc.), Pole Material Upgrades, Decreased Spans, Vegetation Management
- **High-Cost:** Undergrounding



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While extreme cold generally drives generator rather than network outages, many severe outages are concentrated between 2-6 °F, indicating an important threshold for planning

UNDERSTANDING THE DATA

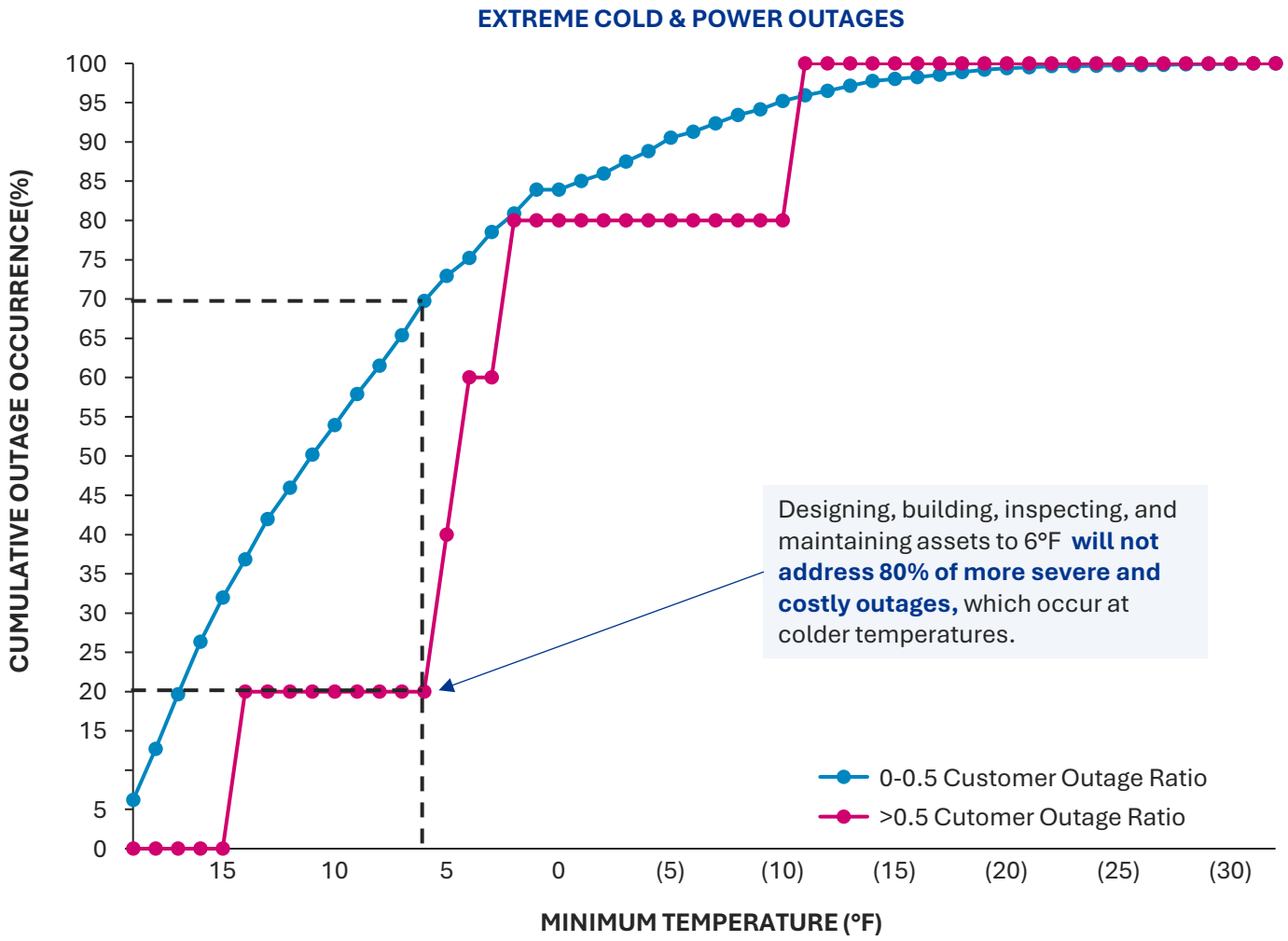
Extreme outages (>50% of customers out) are more likely to be coincident with minimum temperatures below 6°F than non-extreme outages

- About 80% of extreme outages are attributable to minimum temperatures below 6°F, compared to just 30% of non-extreme outages
- The low count of extreme outages contributes to the steep slope, but the shape generally indicates that severe outages are more sensitive to wind speed than less severe outages

ASSET PLANNING INSIGHTS

Extreme cold without accompanying wind or precipitation is more likely to cause power plant failure than distribution and transmission issues

- Smaller utilities could coordinate with generation owners and update emergency plans to prepare in advance for potential cold-related outages
- Any transmission and distribution system upgrades could target events below 2°F to address a significant portion of extreme outages
- **Low-Cost:** Contingency planning, monitoring and sensors, demand response, switches and reclosers
- **High-Cost:** Undergrounding, backup power systems, upgrade transformers



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Extreme outages demonstrate increasing sensitivity to fire severity, potentially justifying expanded wildfire mitigation expenditures to avoid costly outages and ignition damage

UNDERSTANDING THE DATA

Extreme outages (>50% of customers out) are more likely to be coincident with the most severe wildfires

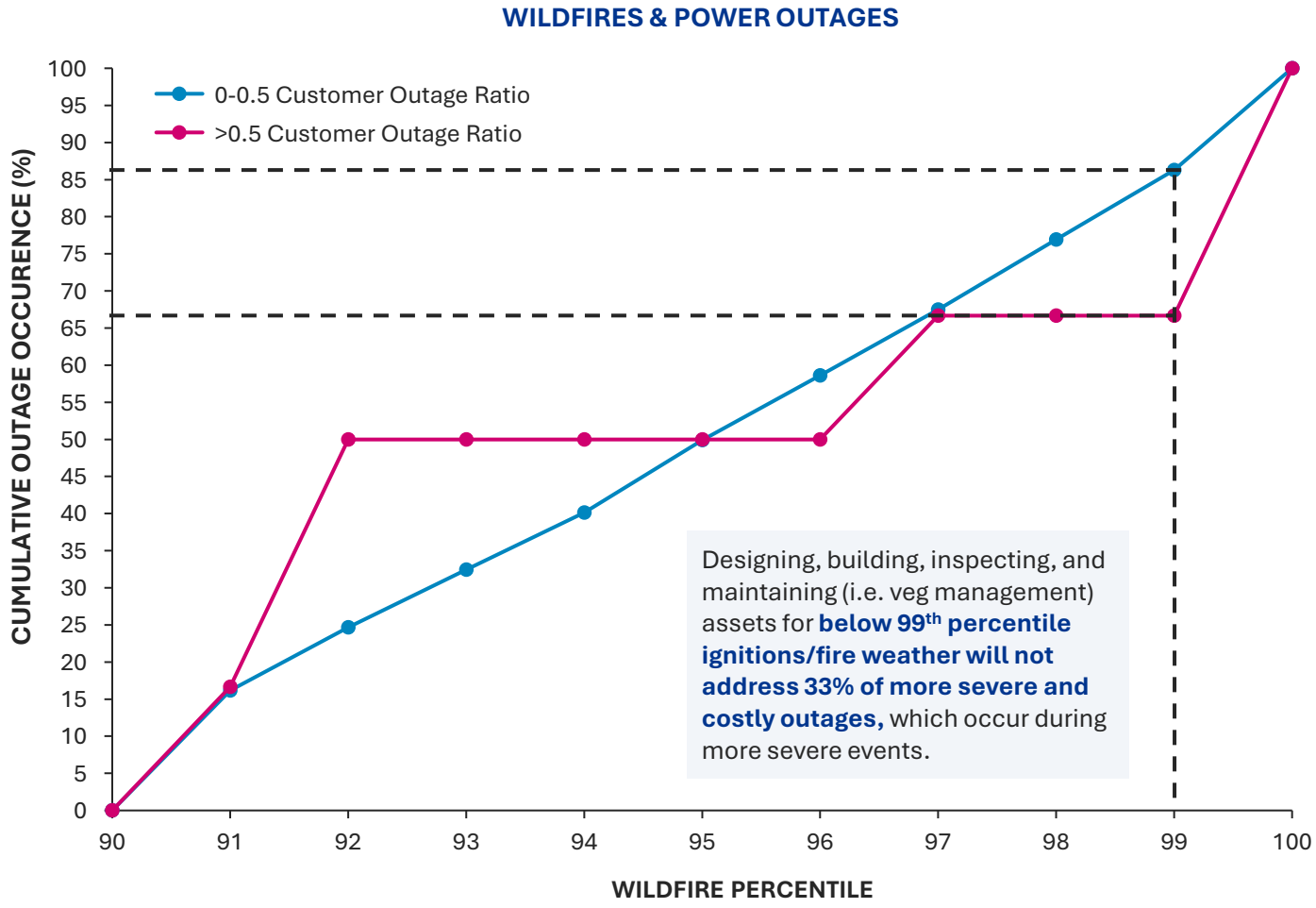
- 33% of extreme outages are coincident with wildfires in the 99th percentile or greater, compared to about 15% of non-extreme outages
- The widening gap between the curves above the 97th indicates that the most severe ignitions and fire weather are more likely to cause widespread PSPS events or asset failure contributing to extreme outages

ASSET PLANNING INSIGHTS

Asset planners could consider the high cost of ignition in addition to the cost of outages when determining the appropriate capital allocation level for wildfire

- **Low-Cost:** Pole upgrades, pole wrapping, vegetation management, switches/reclosers
- **High-Cost:** Undergrounding, reconductoring, covered conductors

HAZARD	FIRE SIZE	FWI
99TH PERCENTILE	3,488 Acres	86.72



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Utility Capital Plan Analysis

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
SYSTEM UPGRADES
... 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

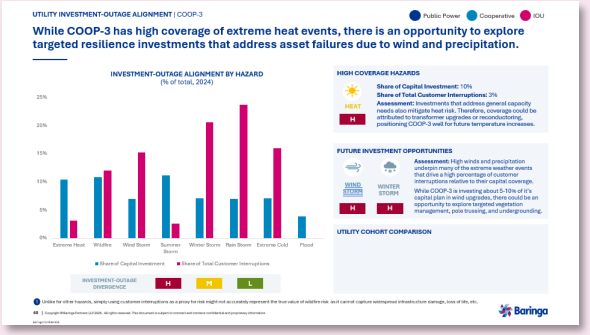
TECHNOLOGY, PREDICTION, IMAGING
ASSESSMENT & REPAIR
SYSTEM UPGRADES
... additional spend categories in slide 34

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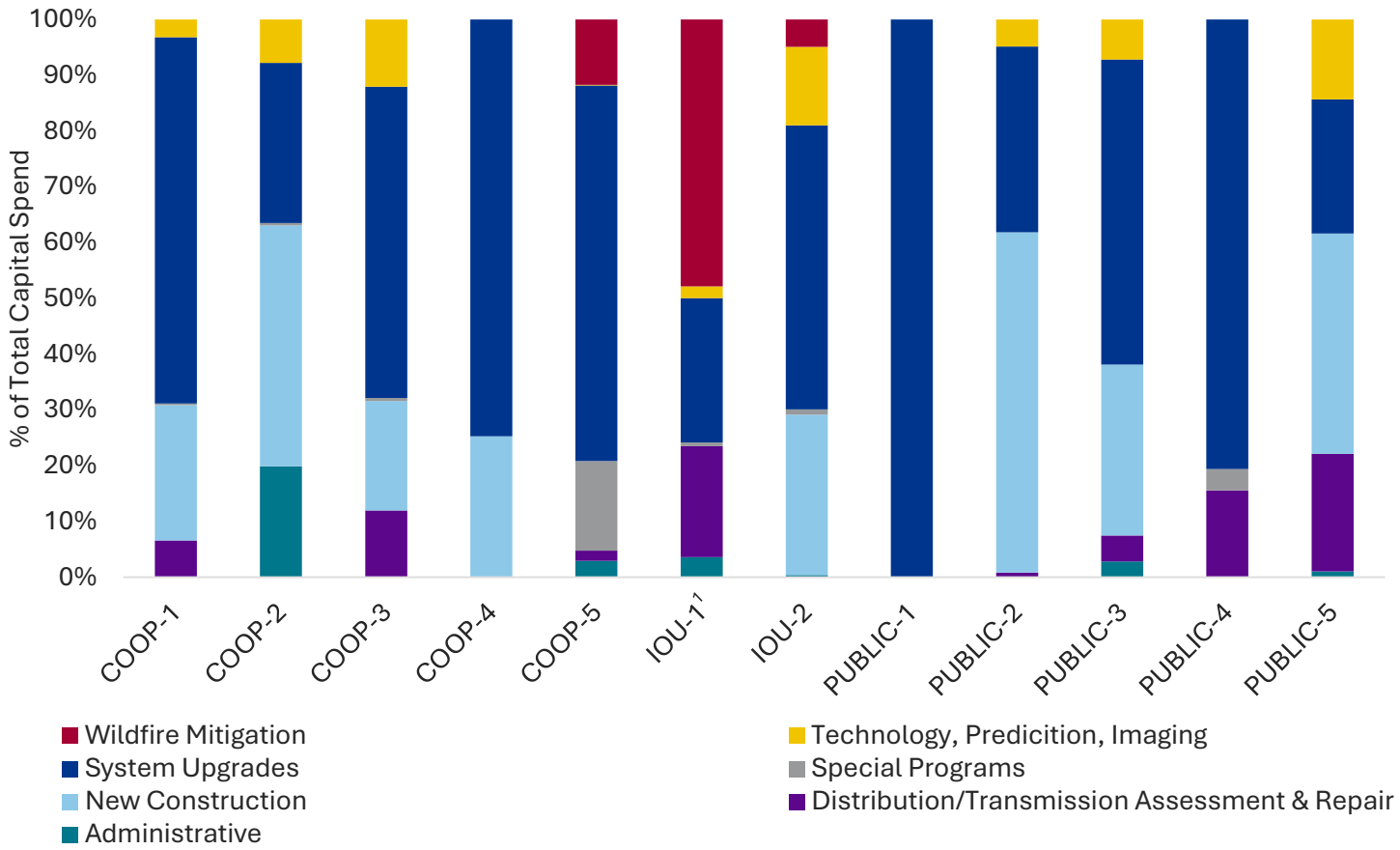
Individual projects and line items within the capital plans were mapped to larger buckets to allow for standardized comparison across utilities

	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.	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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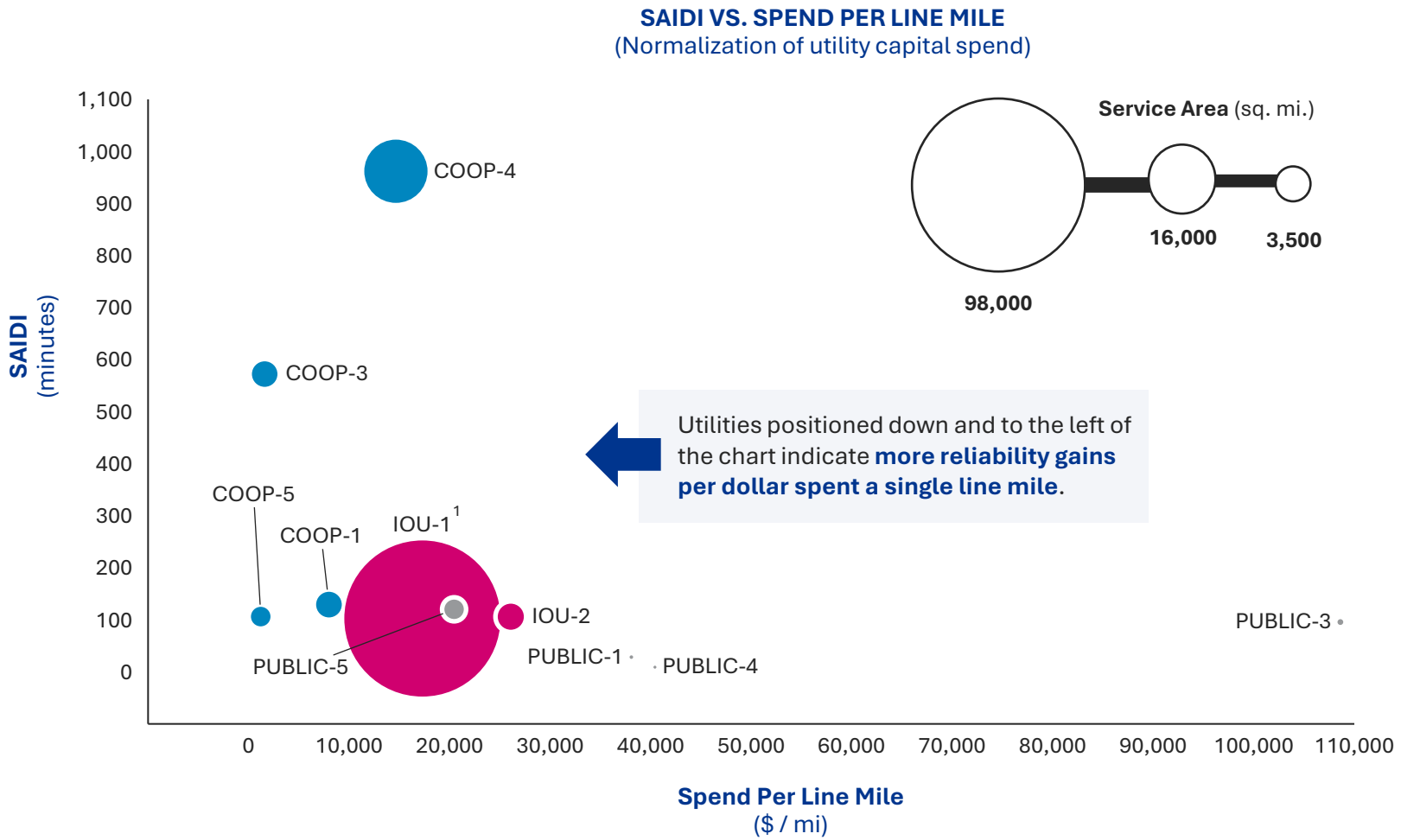
Public Power Cooperative IOU

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.)

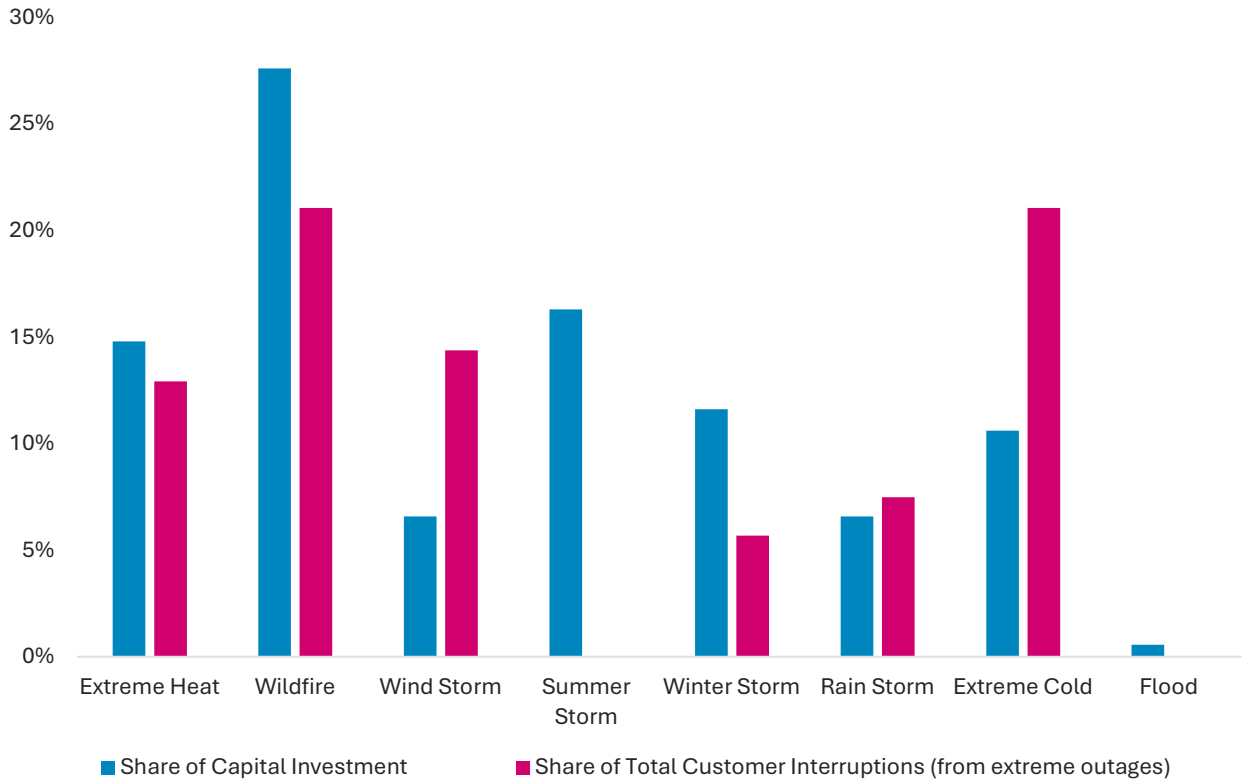
1 An estimate of IOU-1's total capital spend was considered in this view, not just Wildfire Mitigation Plan spending

Utility Investment-Outage Alignment

Public Power Cooperative IOU

While COOP-5 has high coverage of wildfire events, there is an opportunity to explore targeted resilience investments that address asset failures due to wind and extreme cold

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



INVESTMENT-OUTAGE DIVERGENCE: H M L

HIGH COVERAGE HAZARDS

WILDFIRE: M

SUMMER STORM: M

Assessment: The high cost of utility-caused ignition could justify a larger share of capital investment in wildfire mitigation relative to the amount of customer interruptions it causes.

Future summer storm investment could be geared more towards wind rather than heat to better align with relevant climate exposure.

FUTURE INVESTMENT OPPORTUNITIES

WIND STORM: M

EXTREME COLD: M

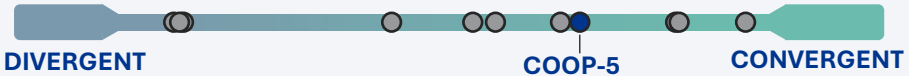
Assessment: According to the Grid Resilience Report, COOP-5's service territory faces peak statewide wind and cold exposure, which could be driving a high volume of customer interruptions.

While COOP-5 is investing about 5-10% of it's capital plan in wind upgrades, there could be an opportunity to explore targeted vegetation management, pole trussing, and undergrounding.

UTILITY COHORT COMPARISON

UNCERTAIN COVERAGE

Assessment: COOP-5's capital expenditures are generally better aligned with historical climate exposure compared to other utilities in the region, but opportunities for improvement remain. The utility could consider 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.

Baringa

Utility Benchmark Analysis

Public Power Cooperative IOU

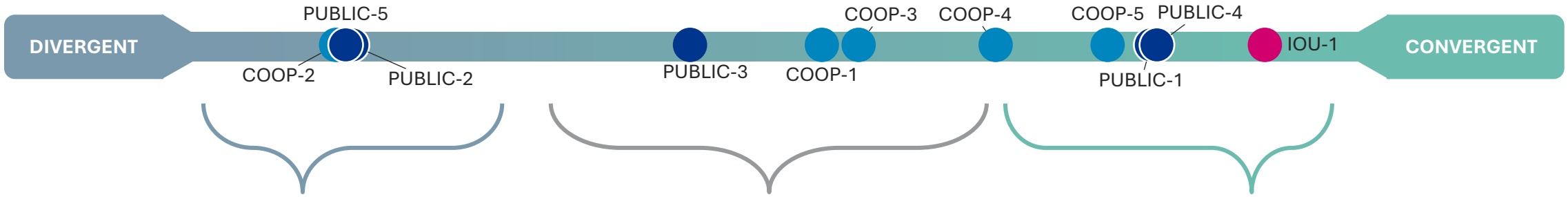
Utilities with convergent coverage are investing in upgrades that address hazards that have been historically responsible for the most severe outages in their service territory

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

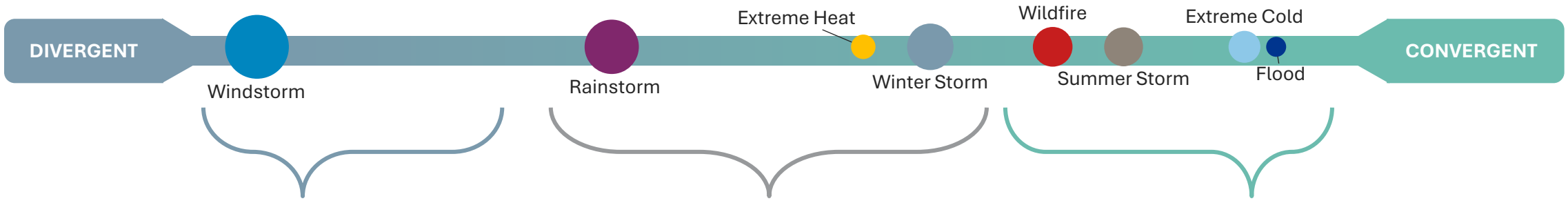
Utilities in WECC generally underinvest in windstorms given their widespread severity over utility service territories. Wildfire remains a highlight hazard for continued investment.

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

