Wildfire Risk Mitigation Current Best Practices

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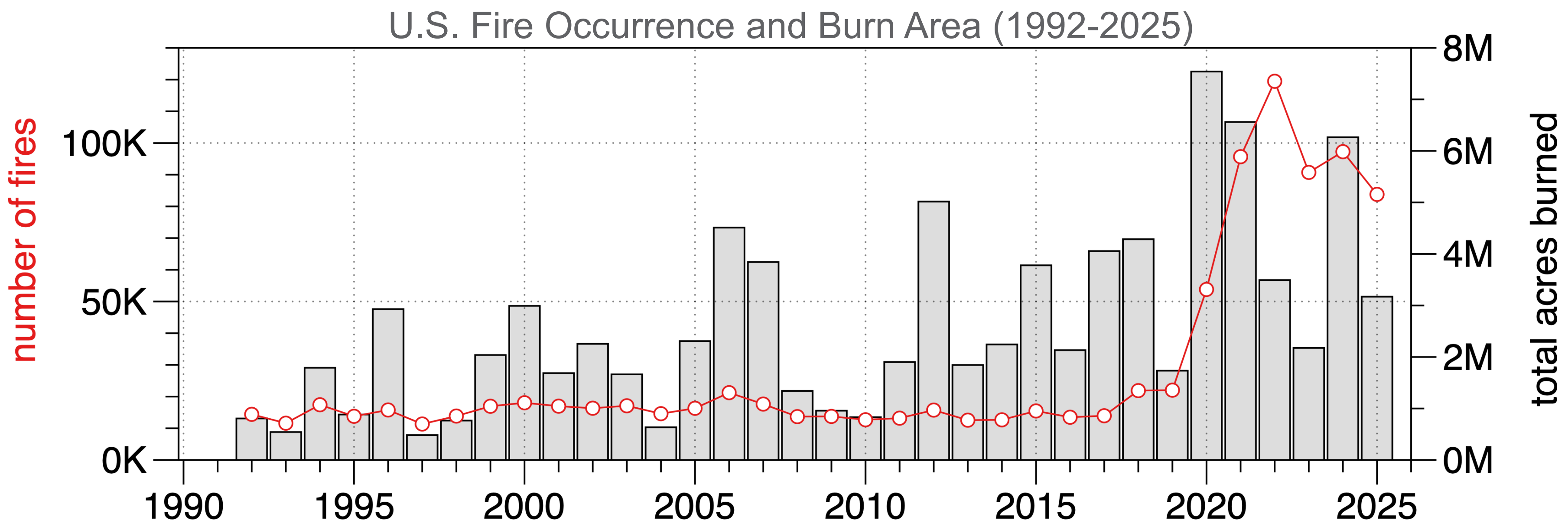
Piedmont States Wildfire Workshop
August 12-13, 2026

PNNL-SA-224379

WILDFIRE RISK & RESILIENCE @PNNL

wildfire.pnnl.gov

Wildfire Threat From/To Transmission

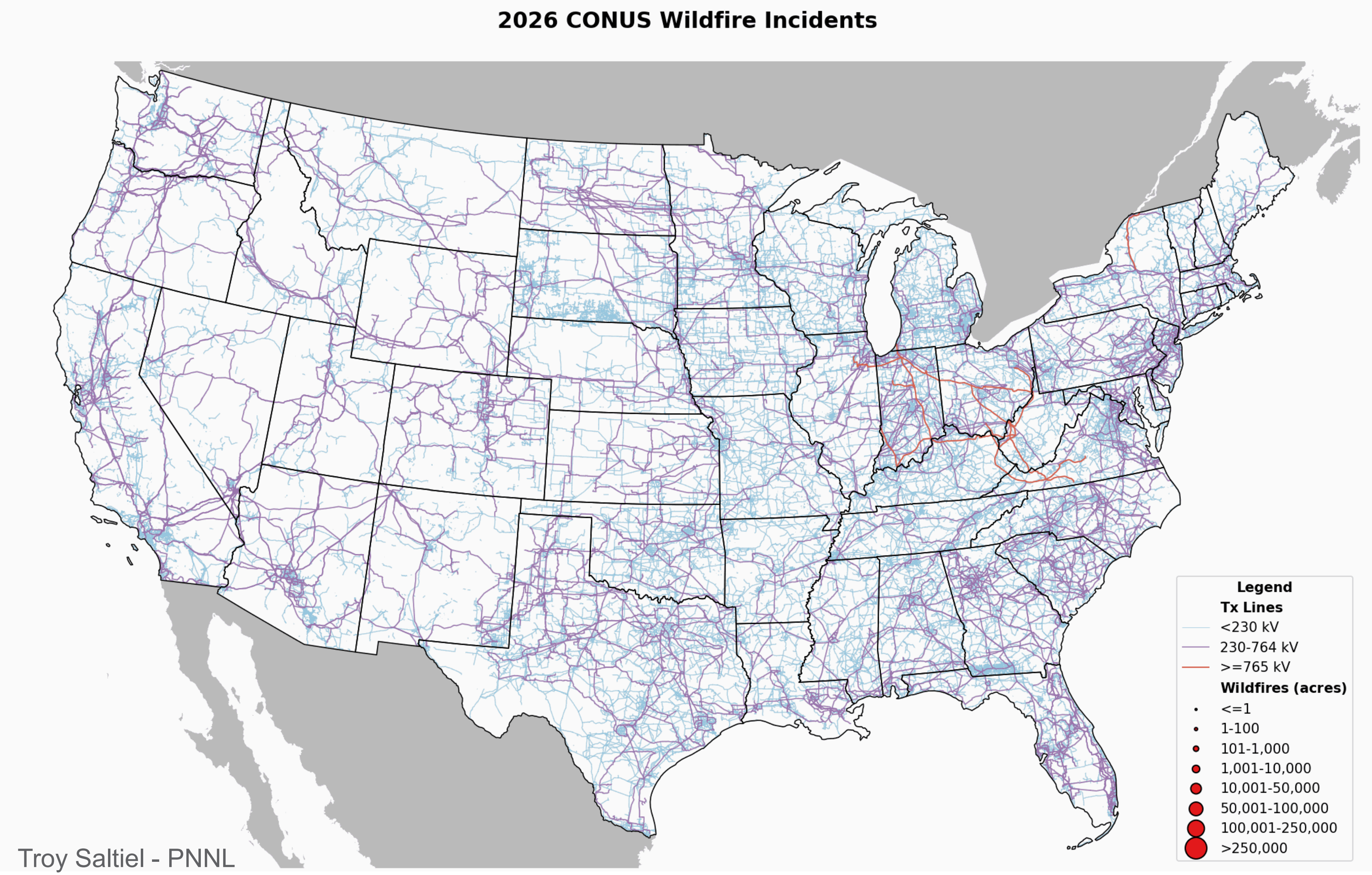


The exposure of wildfire to the bulk power system has increased by 143% over the past decade (2015-2024) compared to the decade prior (2005-2014).

On average over the past decade, 83% of all national wildfire ignitions occurred within 10-miles of a transmission line (impact to and from).

U.S. electric utilities are spending $126–$150 billion/year on wildfire-related activities.

2026 Fire Occurrence & Burn Area (CONUS)

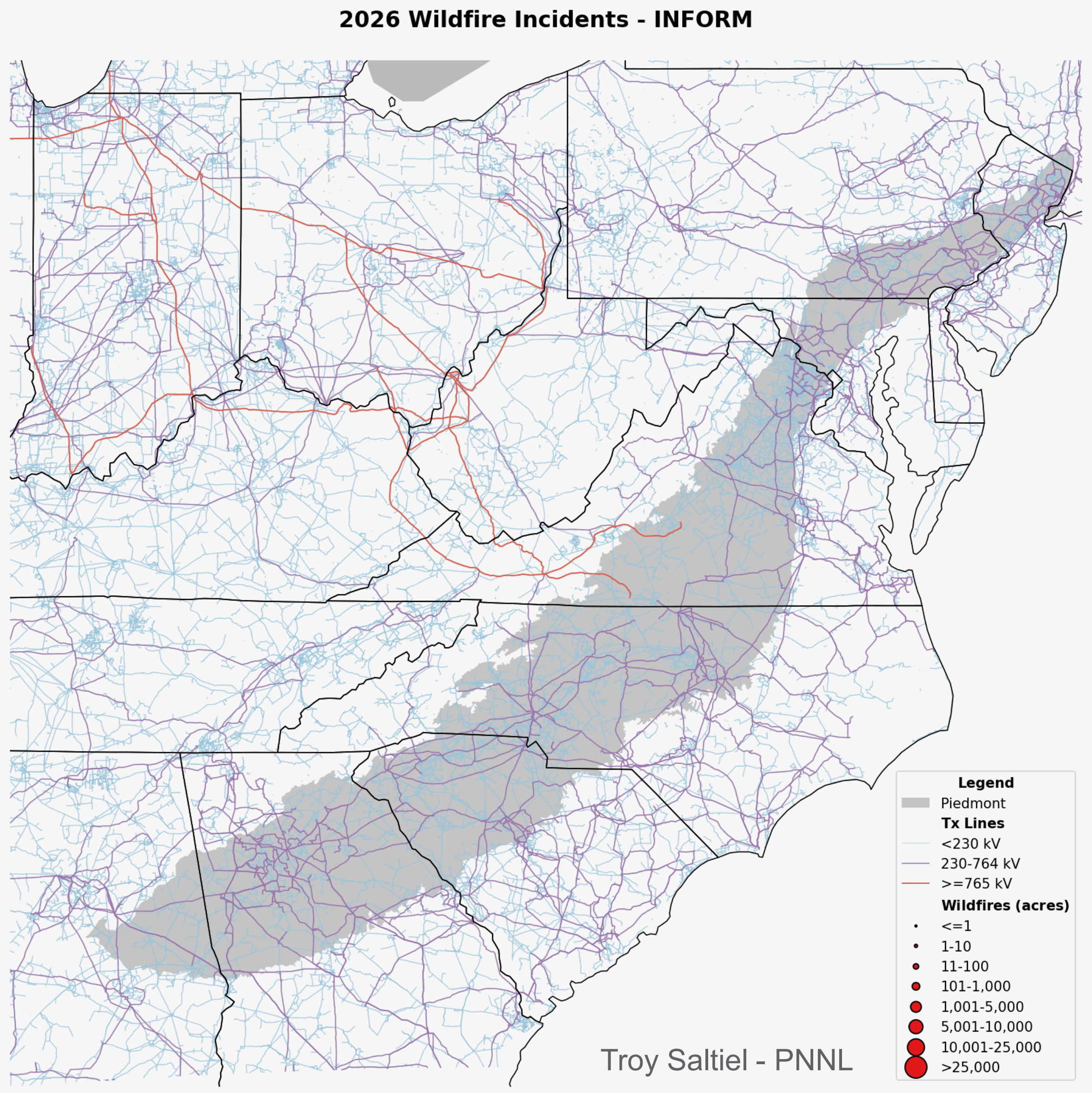


2026 (Jan. 1 – Aug. 11)	
# Fires	38,775
Burn Acres	7,621,569
Ignitions within 10 miles of Tx	93.8%
Proportion of total acres burned within 10 mi of Tx	60.6%

NOTE: Prescribed burns excluded from this analysis

Troy Saltiel - PNNL

2026 Fire Occurrence & Burn Area

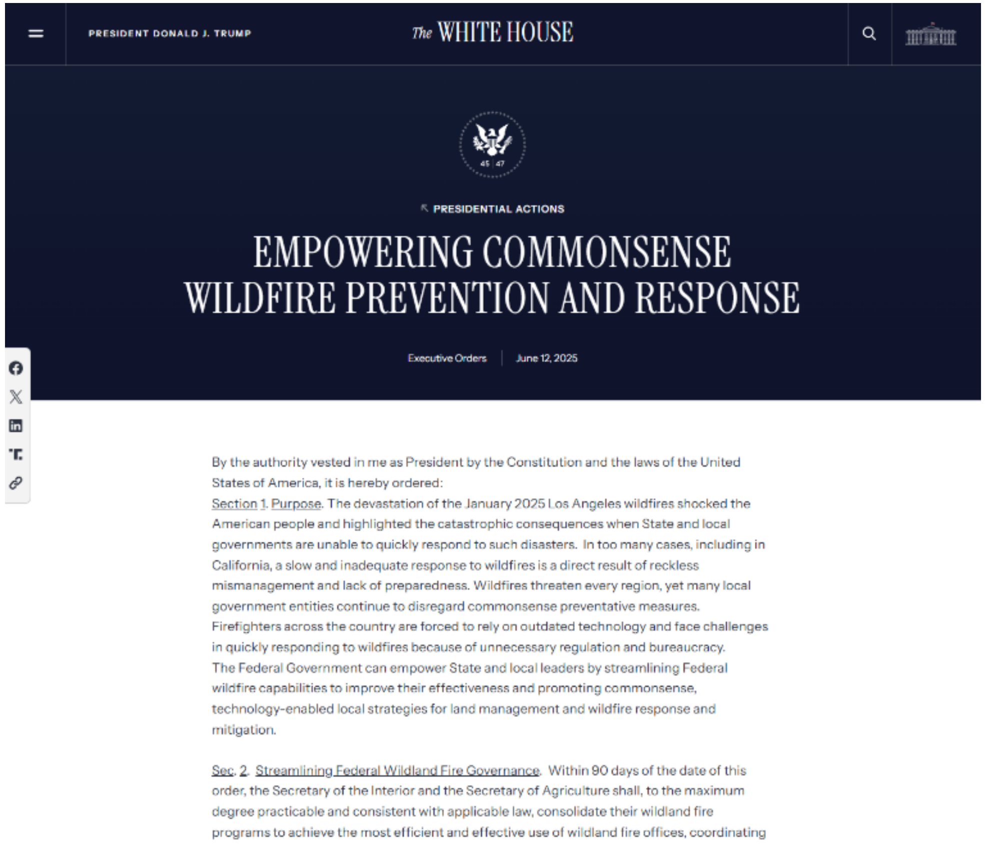


2026 (Jan. 1 – Aug. 11)	
# Fires	10,444
Burn Acres	15,089
Ignitions within 10 miles of Tx	99.8%
Proportion of total acres burned within 10 mi of Tx	95.5%

NOTE: Prescribed burns excluded from this analysis

Best Practices on Wildfire Risk Reduction

- Responses to a wildfire-focused [Executive Order]



PRESIDENT DONALD J. TRUMP

The WHITE HOUSE

PRESIDENTIAL ACTIONS

EMPOWERING COMMONSENSE WILDFIRE PREVENTION AND RESPONSE

Executive Orders | June 12, 2025

By the authority vested in me as President by the Constitution and the laws of the United States of America, it is hereby ordered:

Section 1. Purpose. The devastation of the January 2025 Los Angeles wildfires shocked the American people and highlighted the catastrophic consequences when State and local governments are unable to quickly respond to such disasters. In too many cases, including in California, a slow and inadequate response to wildfires is a direct result of reckless mismanagement and lack of preparedness. Wildfires threaten every region, yet many local government entities continue to disregard commonsense preventative measures. Firefighters across the country are forced to rely on outdated technology and face challenges in quickly responding to wildfires because of unnecessary regulation and bureaucracy. The Federal Government can empower State and local leaders by streamlining Federal wildfire capabilities to improve their effectiveness and promoting commonsense, technology-enabled local strategies for land management and wildfire response and mitigation.

Sec. 2. Streamlining Federal Wildland Fire Governance. Within 90 days of the date of this order, the Secretary of the Interior and the Secretary of Agriculture shall, to the maximum degree practicable and consistent with applicable law, consolidate their wildland fire programs to achieve the most efficient and effective use of wildland fire offices, coordinating

Sec. 4. Strengthening Wildfire Mitigation (90-days)

(a) EPA to modify or rescind Federal rules/policies that impede use of appropriate, preventative prescribed fire

(b) USDA, EPA, and USDOI to modify or rescind Federal rules/policies hindering the appropriate use of fire retardant to fight wildfires

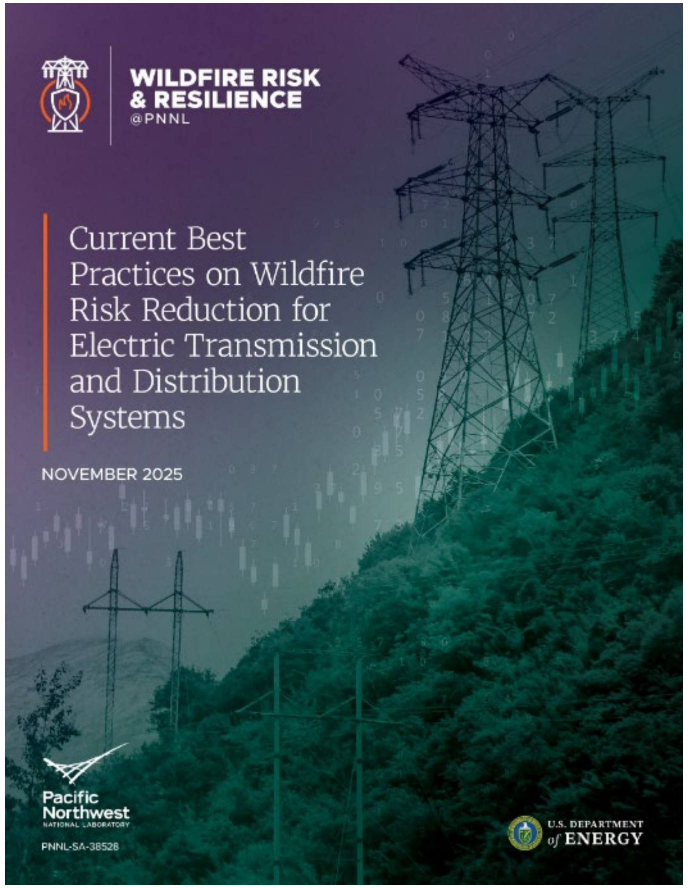
(c) USDA and USDOI to promote, assist, facilitate innovative uses of woody biomass and forest products to reduce fuel loads

(d) USDOI, USDA, USDOE, Federal Energy Regulatory Commission, shall consider initiating rulemaking proceedings to establish, as consistent with applicable law, best practices to reduce the risk of wildfire ignition from the bulk-power system without increasing costs for electric-power end users, including through methods such as *vegetation management*, the *removal of forest-hazardous fuels* along transmission lines, improved engineering approaches, and safer operational practices.

(e) Attorney General, USDA, and USDOI to review pending and proposed wildfire-related litigation involving electrical utilities

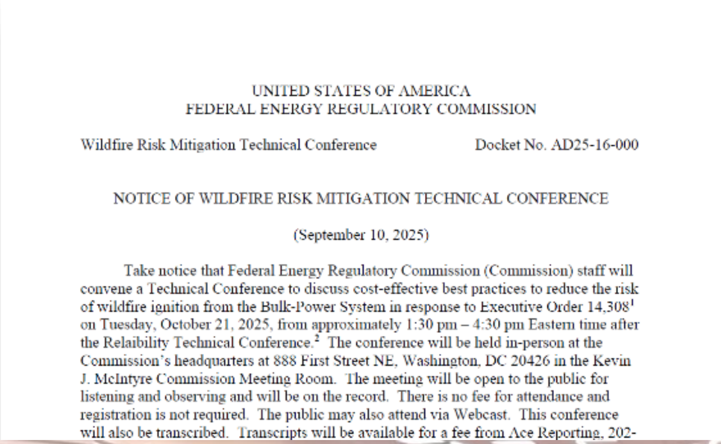
Best Practices on Wildfire Risk Reduction -Section 4(d) of Wildfire Executive Order

PNNL Technical Report



https://www.pnnl.gov/projects/wildfire-risk-resilience/best-practices

Federal Energy Regulatory Commission (FERC) Commissioner-led Technical Conference



UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

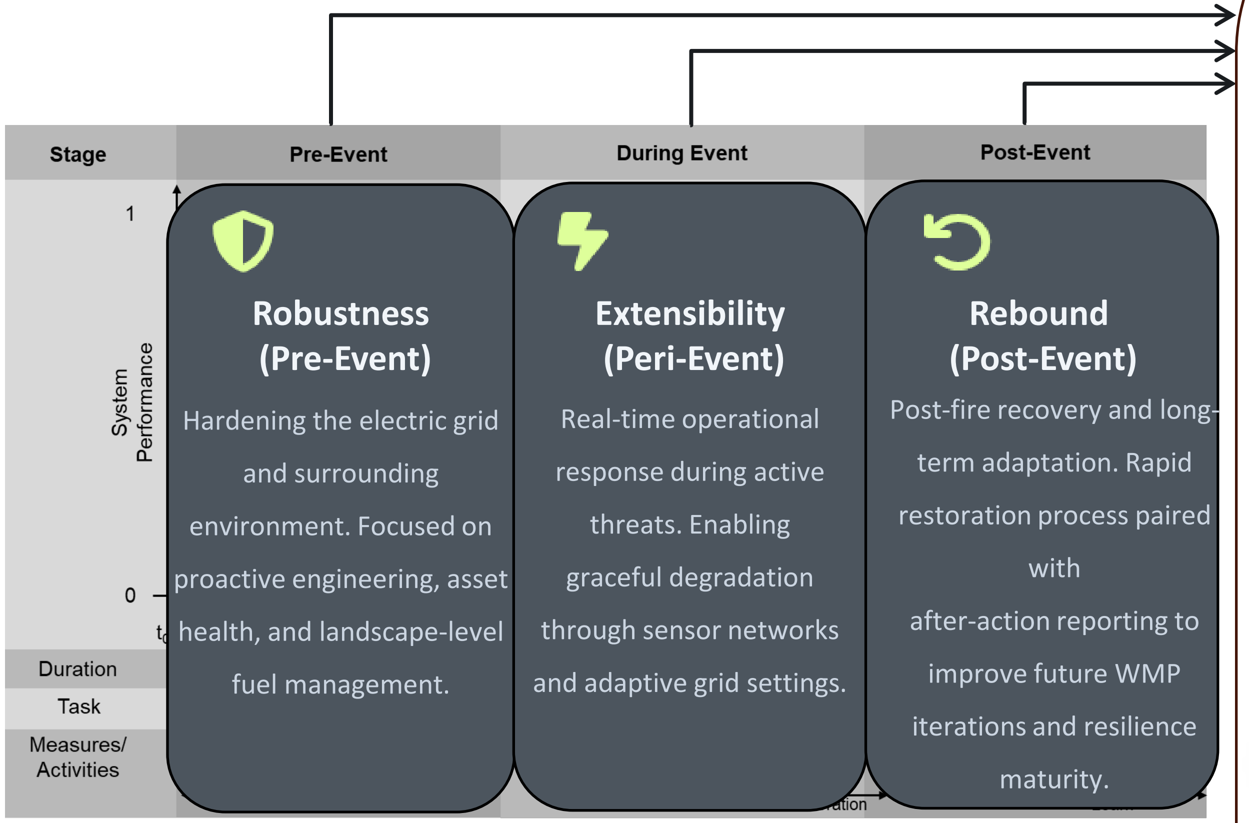
Wildfire Risk Mitigation Technical Conference Docket No. AD25-16-000

NOTICE OF WILDFIRE RISK MITIGATION TECHNICAL CONFERENCE

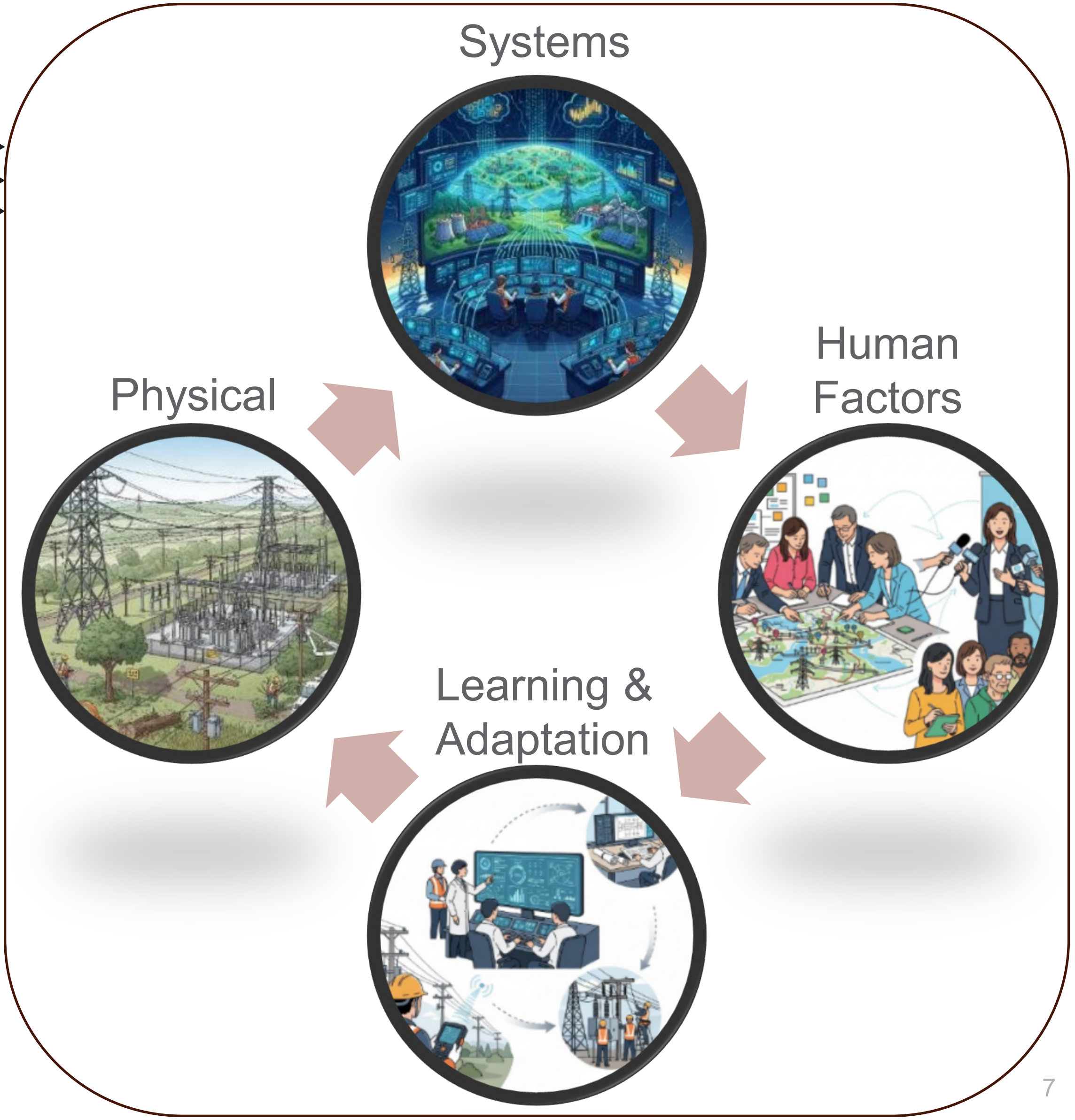
(September 10, 2025)

Take notice that Federal Energy Regulatory Commission (Commission) staff will convene a Technical Conference to discuss cost-effective best practices to reduce the risk of wildfire ignition from the Bulk-Power System in response to Executive Order 14,308[1] on Tuesday, October 21, 2025, from approximately 1:30 pm – 4:30 pm Eastern time after the Relaibility Technical Conference.[2] The conference will be held in-person at the Commission's headquarters at 888 First Street NE, Washington, DC 20426 in the Kevin J. McIntyre Commission Meeting Room. The meeting will be open to the public for listening and observing and will be on the record. There is no fee for attendance and registration is not required. The public may also attend via Webcast. This conference will also be transcribed. Transcripts will be available for a fee from Ace Reporting, 202-

Three-Phase Framework for Mitigating Wildfire Risk for Utilities



Impact event timeline for risk and resilience mitigation (adapted from Stankovic et al. 2023)

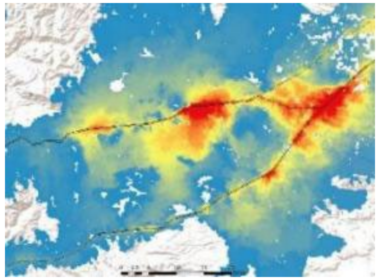


Multi-Temporal Consideration of Wildfire Risk

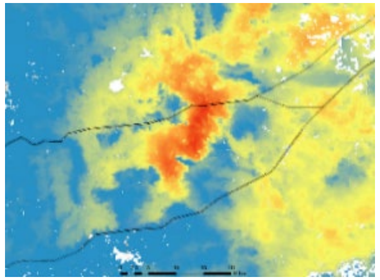
Mitigation Actions

- Vegetation Management
- Community Resiliency
- Infrastructure Hardening
- EPSS/PSPS Planning
- Consequence Analysis

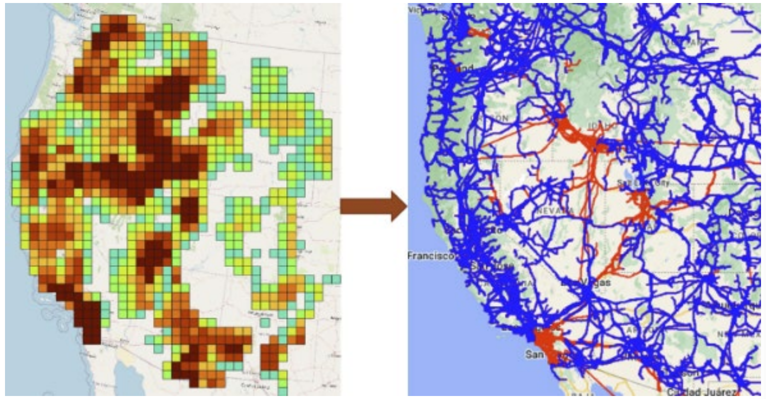
Annual Baseline Fire Risk



Corridor-Only Ignitions



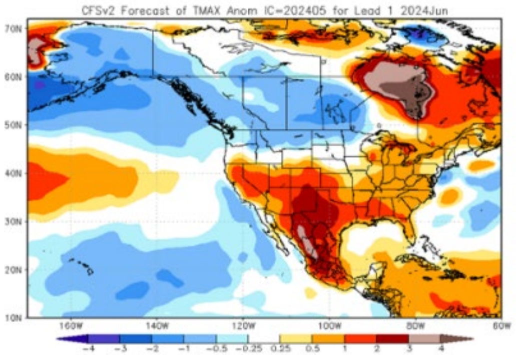
Landscape-Wide Ignitions



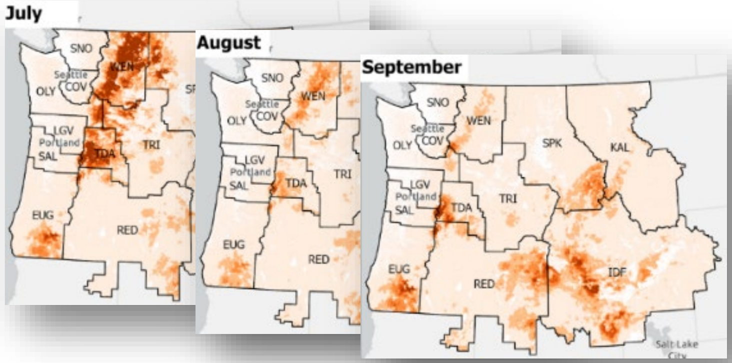
Infrastructure Fragilities - Wildfire Risk Evaluation of the System (WREST)

Monthly Forecast Wildfire Risk

Medium-Range Ensemble Meteorological Forecasts

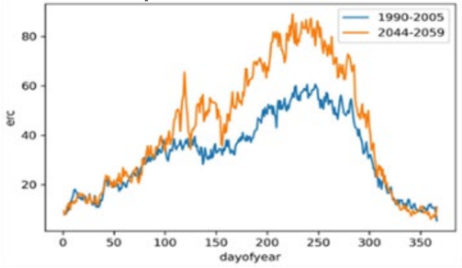


Monthly Wildfire Risk Forecasts (1-7 months)

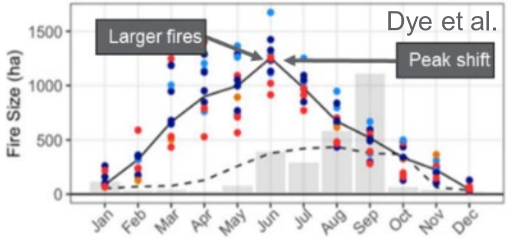


Long-Term Future Wildfire Risk

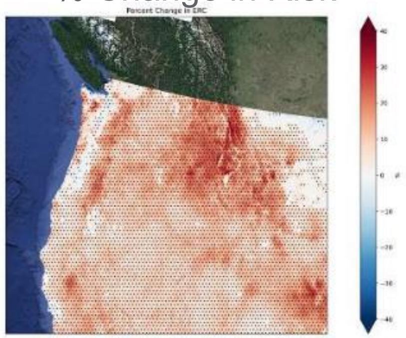
CMIP-5 & CMIP-6 Multiple RCPs / SSPs



Shifts in Fire Size and Timing



% Change in Risk



Example Best Practice

implementation will depend on the system's size and complexity. Implementing processes that span and integrate staff across utility departments—such as engineering, planning, operations, and field crews—is essential. Line crews that perform repairs or installations are key to updating asset inventories in near real time via mobile devices and intuitive software workflows.

3.2.2 Evaluation of Asset Health and Risk

Description of Practice: Asset health and risk assessment is a data-driven process for understanding the condition, performance, and reliability of utility equipment and components. These assessments are a foundational component of asset management strategies, synthesizing diagnostic and prognostic information to estimate failure likelihood and determine maintenance requirements, thereby avoiding asset failures that could potentially lead to wildfire ignition. Evaluation of asset health provides critical inputs for the risk modeling methodologies that utilities employ to inform preventive maintenance, equipment upgrade prioritization, asset conditioning forecasting, and failure likelihood assessment, thereby avoiding faults. Records of asset health are often integrated into asset inventories, and where SCADA systems exist, they can also provide a time-series record of asset operation. Asset health evaluations draw from inspection results, sensor data, and maintenance records.

Asset health is evaluated to identify any physical damage, asset degradation, or compromised integrity of supporting equipment. Asset health may also encompass asset design life, external exposure, or the likelihood of failure or fault due to vegetation encroachment, clearance violations with other non-utility objects, or the risk of intentional or unintentional physical damage resulting from surrounding land use and access. Utilities with smart grid capabilities may implement asset management and condition-monitoring systems to automatically issue alerts when components operate outside normal ranges. Utilities with smart grid capabilities may implement asset management and condition-monitoring systems to automatically issue alerts when components operate outside normal ranges. Utilities implement different asset health evaluation strategies based on asset type, size, resource access, and grid configuration. However, ISO 55000 and 55001 provide processes, standards, and a framework for asset health and performance management (ISO, 2024a; ISO, 2024b).

Asset inventories, health, and risk evaluations should also explicitly factor in de-energized and decommissioned facilities, which have been evidenced to ignite fires from static charge buildup on parallel energized circuits or through lightning strikes. Verification and possibly action are needed to properly ground lines that are 1) de-energized during PSPS outages, which adds another task and delay to line restoration, and 2) decommissioned systems whose equipment poses risks of attracting lightning and causing ignition to potentially unmaintained vegetation around these inactive systems.

System Application: Applicable to transmission systems as well as distribution systems.

Risk Mitigation Benefits: Data-informed replacement and maintenance strategies improve system resilience. By quantifying asset condition and proactively replacing failing components, utilities can minimize the risk of failure. Continual data collection and analysis provide insights that can inform future adjustments and enhancements to wildfire mitigation strategies, fostering a cycle of improvement.

Challenges of Implementation: Collecting and maintaining health assessment data for a geographically distributed system with different components is both cost- and time-prohibitive. While returns can be substantial in the medium and long term, developing, calibrating, and

applying methodologies to calculate risk across various asset types is also labor-intensive. Utilities must balance competing priorities with many assets in need of repair, and using asset health data to develop risk-based approaches for prioritization can be challenging.

Examples: Black Hills Energy explicitly supports its wildfire risk mitigation strategies with asset-based risk assessments. PacifiCorp uses an asset health indexing program to prioritize the replacement of high-risk assets. Similarly, United Power bases its efforts for risk analysis on an asset management approach.

Future Direction: Extend beyond ISO 55000 and 55001 to develop and standardize an asset health index to build a more robust and systematic framework. There is a need for an asset health index that combines multimodal observation data, models, and probabilistic risk assessment to support the prioritization of mitigation strategies across assets, encompassing both electrical flow components and supporting infrastructure. As a standard, there should be reasonable or multiple methods for obtaining the required information to support the variety of utility types and operations. The adoption of a range of technologies can complement existing inspection processes to help identify health anomalies.

3.2.3 Proactive Inspections

Description of Practice: Proactive inspections are field-based assessment and diagnostic activities designed to ensure that utility assets and surrounding conditions meet operationally defined minimum clearance specifications and safety standards. Unlike asset health evaluations, which analyze data trends and performance metrics, proactive inspections visually identify physical defects, safety hazards, and vegetation encroachment. Common types of proactive inspections include the following:

- Patrol inspections: Routine visual surveys of overhead systems to identify visual defects, violations, or safety concerns.
- Detailed inspections: Careful visual and diagnostic examinations of individual equipment pieces, where inspectors record visual findings and rate the condition of equipment to identify existing defects, including minor ones.
- Intrusive inspections: Physical testing or sampling, such as wood pole intrusive inspections, to assess structural integrity and decay mechanisms below groundline.

System Application: Applicable to transmission systems as well as distribution systems.

Risk Mitigation Benefits: Proactive inspections are an important component of the asset management process and have been demonstrated to reduce overall operating costs through informed decision-making and investment prioritization. They reduce wildfire risk by enabling utilities to visually identify and address potential issues, such as failing or deteriorating infrastructure, vegetation encroachment, or other anomalies. Inspections ensure the safety of both the public and workers while maintaining service reliability. Information gathered from visual inspections enhances overall understanding of environmental and operational conditions, thereby strengthening other components of the WMP, such as operational practices and response strategies.

Challenges of Implementation: The implementation of proactive inspection programs can face challenges, including limitations on capital and human resources to set up and perform regular inspections, problems with data quality and integration owing to human bias, complexities in

PHASE I

RESILIENCE AS ROBUSTNESS

Strategic grid hardening and proactive environment management

Advanced Asset Health & Protection

Dynamic Inventories

Moving from "run-to-failure" to "risk-informed" management. Utilizing GIS and SCADA systems to map location, install date, field inspections, and health of every single component.

Intrusive Inspections

Prescribe schedule of physical testing of wood pole structural integrity below groundline. Essential for detecting decay mechanisms that lead to catastrophic failure during high winds.

UAS & LiDAR Inspections

Uncrewed Aerial Systems can provide detail on asset health and identify potential issues. AI/ML models can detect corrosion, broken cross-arms, hot spots, etc. LiDAR allows for vegetation mapping & clearances.

Grid Hardening

Consideration of undergrounding in high fire threat districts, implementing next-gen conductors, installing non-expulsion fuses, sectionalizing, and more.

PHASE II

Graceful Extensibility

Real-time operational response and situational awareness

Situational Awareness & Operational Protections

Multi-Modal Control Room Feeds

Integration of weather station data, forecasted weather, active wildfires, forecasted fire spread, in-situ camera networks, satellite remote sensing, load, generation, faults, system readiness for power loss.

Enhanced Powerline Safety Settings (EPSS)

Enable and monitor protective equipment (relays and reclosers) with higher-sensitivity fault settings that may put reclosers in a non-reclose mode.

Fast-Trip Settings

Enable and monitor protective relays for instantaneous tripping, prioritizing immediate line de-energization over service continuity to prevent ground ignitions.

Public Safety Power Shutoff (PSPS)

Execute on preemptive de-energization given forecasted conditions of ignition risk; draw on table-top trainings and notify public through multiple mediums.

PHASE III

RECOVERY & ADAPTATION

Restoring power safely and integrating lessons learned.

Post-Event Recovery

Post-Fire Vegetation Management

Vegetation and hillslope inspections; identified hazard tree removal; hillslope engineering & stabilization to manage erosion and avoid failure with precipitation events.

Inspection & Restoration

Comprehensive foot, UAS, and/or helicopter patrols to determine asset damage; forensics/documentation; plan and begin restoration process.

Performance Metrics & AAR

Measure and analyze data to evaluate effectiveness of mitigation efforts, response, and recovery actions. Assess program effectiveness, improve processes, inform future mitigation strategies.

Hazard Clear
Verification that Red Flag Warnings or active fire threats have passed.

Patrol
Ground and UAS crews inspect every foot of the de-energized line

Repair
Replacement of fire-damaged poles, conductors, or insulators

Step-Energize
Incremental restoration of power to avoid system instability

Report
Filing SAIDI/SAIFI reports, after-action reports, and PSPS outcome analysis

Pacific Northwest NATIONAL LABORATORY

NERC Wildfire Risk Mitigation Report Recommendations

Maturity Rankings

Develop standard maturity rankings for all Utility Wildfire Mitigation Plans (WMPs) to ensure continuous improvement and decision-making. Adopt **maturity ranking criteria** to PNNL's Wildfire Mitigation Plans Database.

Comprehensive Review

Address gaps in prevention, planning, and detection/response standards to bolster mitigation. FERC and the DOE establish minimum requirements on collaboration and communication for PSPS during high fire risk conditions to ensure grid stability.

Outreach

Engage regional entities to educate stakeholders on current practices and recommended additional mitigation actions to enhance understanding of wildfire risks, operational practices, and shared responsibilities.

Single-Source DB

Establish a central database for ignition causes and near-misses to determine fault locations and analysis, including pattern recognition and other technologies, to identify equipment issues.

Risk Mapping

Collaborate with federal agencies to identify HFRAs for the creation of a unified, single-source wildfire risk tool resulting in focused action plans for PSPS, vegetation management, equipment maintenance, grid hardening, and protection.

Reference Frameworks

Utilize NARUC's Wildfire Workbook and PNNL's Best Practices report for evaluating risk reduction and spend efficiency or other valuation methods, cost mitigation, and beneficial practices for utilities.

DOE-Led Committee

Form a cross-functional federal committee to provide consistent interstate guidance and remove regulations that impede industry's ability to address wildfire prediction and mitigation (e.g., state-of-the-art technologies, access to federal lands).

Regional Consortiums

Form regional consortiums to promote excellence in wildfire risk reduction, collection of data for near misses, technology adoption, infrastructure updates, maturity model development, peer-review, and audits under confidential sharing.

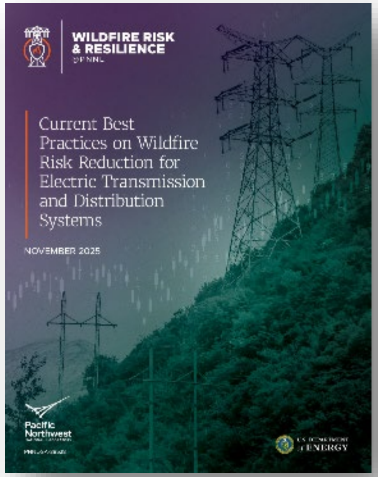
https://www.nerc.com/newsroom/nerc-outlines-recommendations-to-mitigate-wildfire-risk-ensure-grid-reliability

Pacific Northwest
NATIONAL LABORATORY

Best Practices on Wildfire Risk Reduction

- The intent of the report is to capture what electric utilities are currently practicing in wildfire mitigation
  - The individual best practices noted in the document are not going to be relevant to all utilities, but highlight opportunities that *could* be pursued to increase resilience to wildfire threats.

- The individual best practices are structured in the following manner under pre-event, peri-event, post-event/recovery:
  - *Description of the practice*
  - *System application (transmission, distribution, both)*
  - *Risk mitigation benefits*
  - *Challenges of implementation*
  - *Examples*
  - *Future direction*



Wildfire Mitigation Plan

- The intent of a wildfire mitigation plan is to minimize the risk of catastrophic wildfires being ignited by or associated with electrical infrastructure, while also ensuring the resilience and reliability of the power grid during extreme weather events → shift from reactive to proactive

- Objectives
  - Risk Reduction
  - Grid Resilience and Reliability
  - Public Safety
  - Accountability

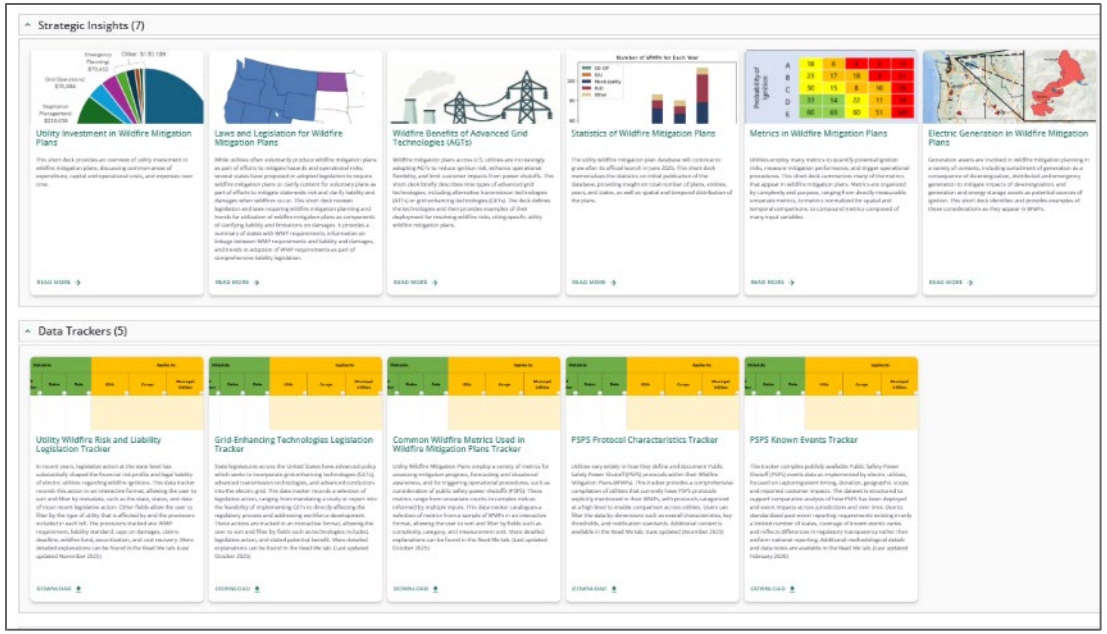
Alignment with IEEE Standard 1366-2022 ("IEEE Guide for Electric Power Distribution Reliability Indices")

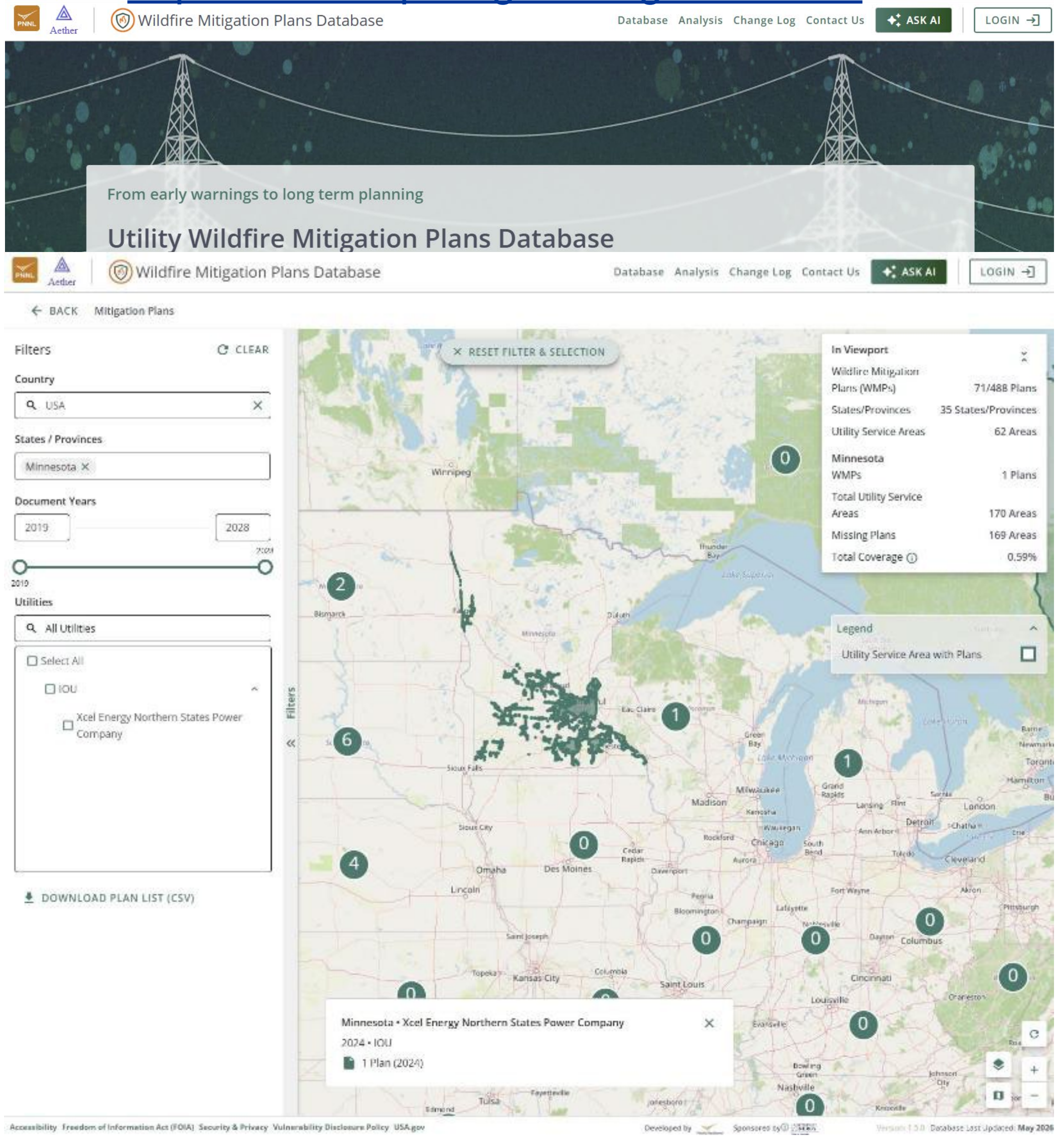
Utility Wildfire Mitigation Plan Database

https://wildfire.pnnl.gov/mitigationPlans

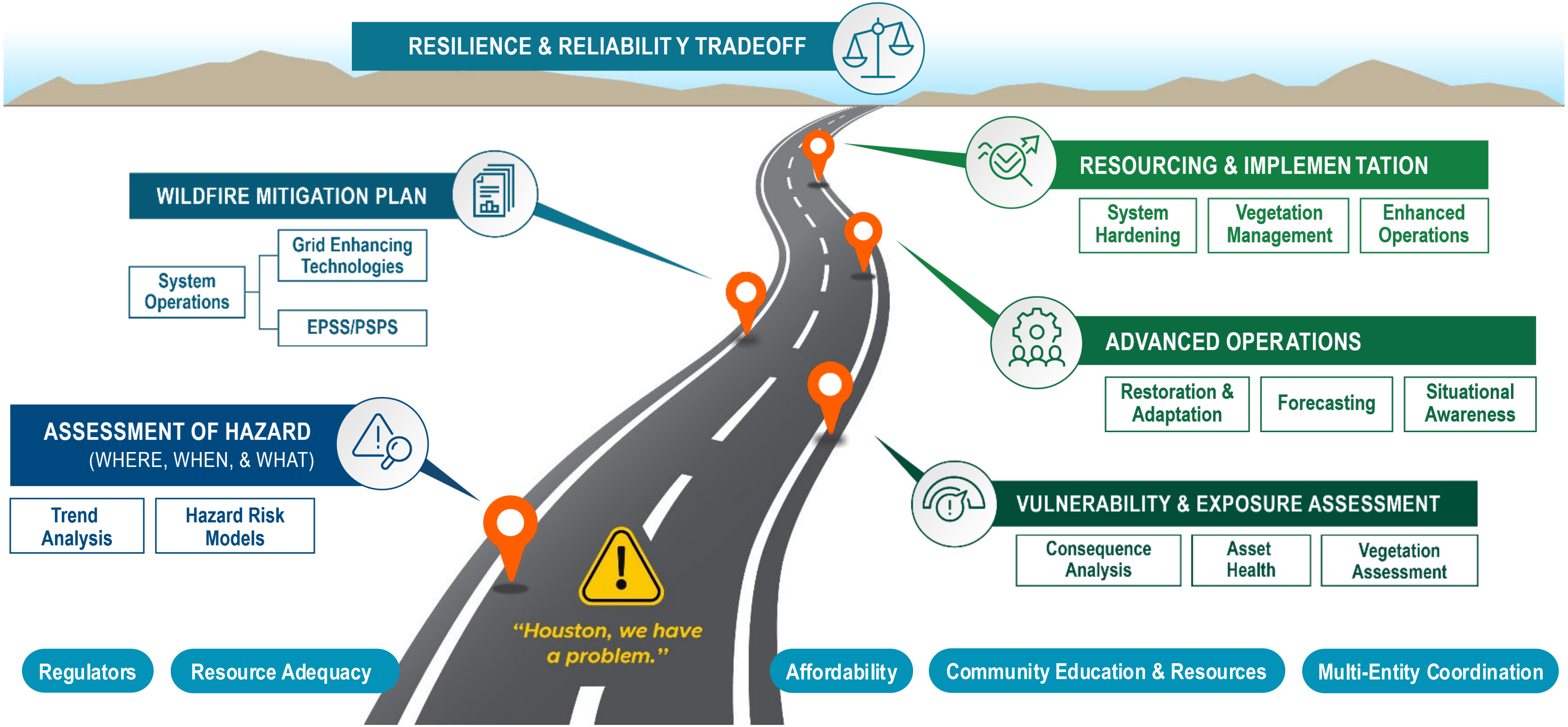
Spread adoption of effective Wildfire Mitigation Plans (WMPs) by providing access to <u>all</u> publicly available utility WMPs

- **Geospatial Plan Explorer**
  to visualize WMPs across landscapes and service territories
- **AI-Powered Research Assistant**
  to instantly generate actionable intelligence
- **Citable Insights**
  to track statistical analysis and emerging trends





Wildfire Risk Mitigation is a Journey



Vegetation Management Practices

Integrated Vegetation Management

Shifting from reactive trimming to establishing fire-resilient, low-growing plant communities. Consideration of scheduled management to dynamic management.

Cooperative Management

Establish formal MoUs with Federal, State, and other landowners/stewards to holistically manage fuels beyond the right-of-way corridor.

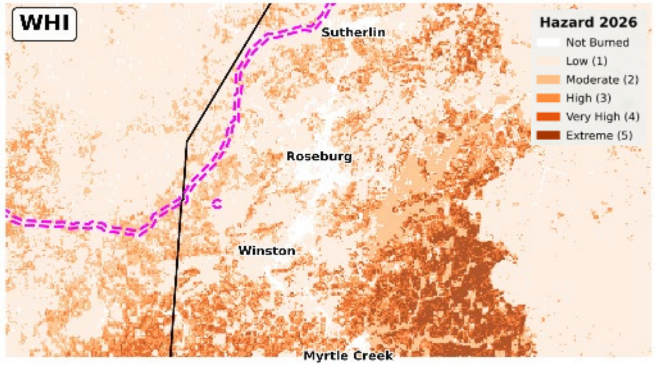
Accreditation

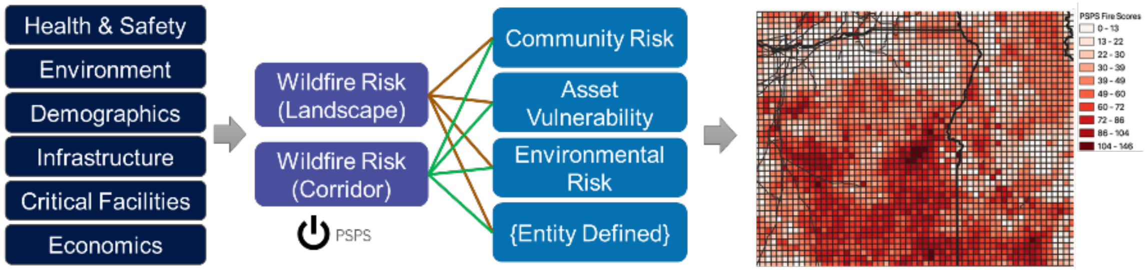
Adherence to ROW Stewardship Council standards to ensure sustainable, data-driven management across all service territories.

Modeling & Simulation

Implement predictive tools to establish hazard and consequence

- Probabilistic wildfire risk models → planning
- Wildfire spread models → near-term and *what-if* scenario planning
- Consequence analysis → prioritize mitigation actions based on what could be impacted on the landscape
- Fragility functions → establish probability of failure given specific hazard conditions
- High Wildfire Threat Areas → planning



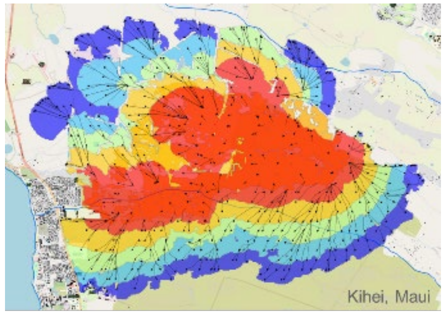


User-Defined Weights / Priorities

Fire Modeling Scenarios

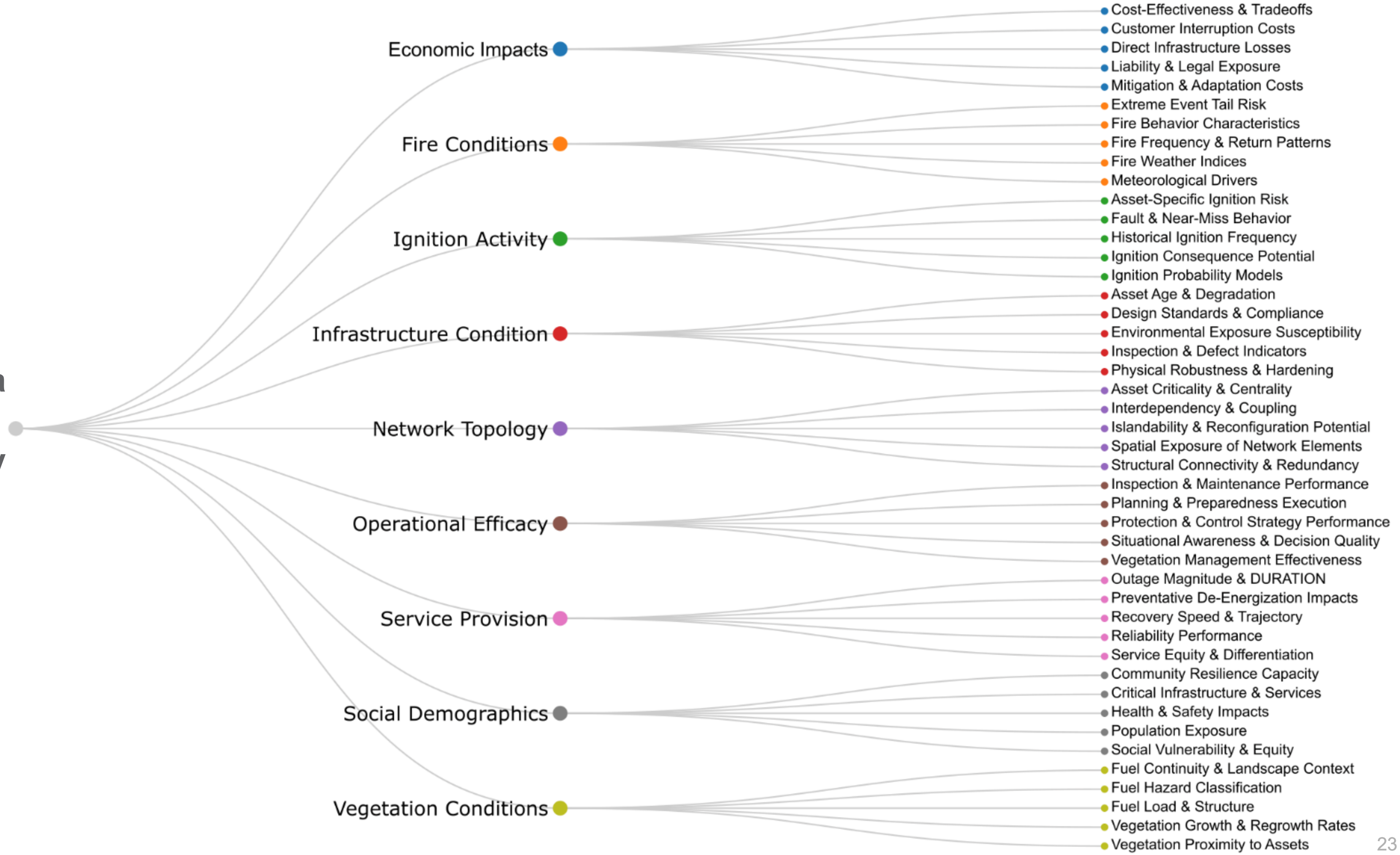
Topic-Level Consequence Risk

Compound Consequence Risk Score



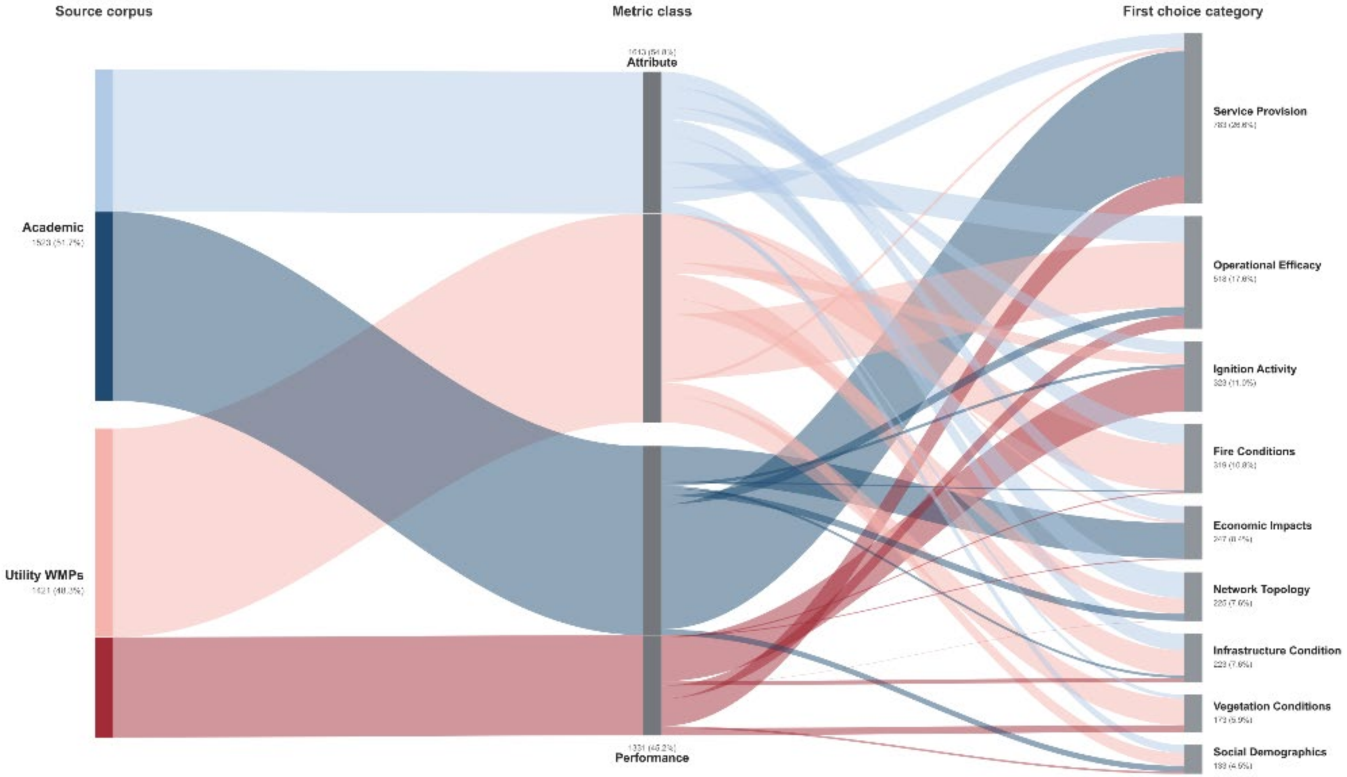
Towards Standard Wildfire Resilience Metrics

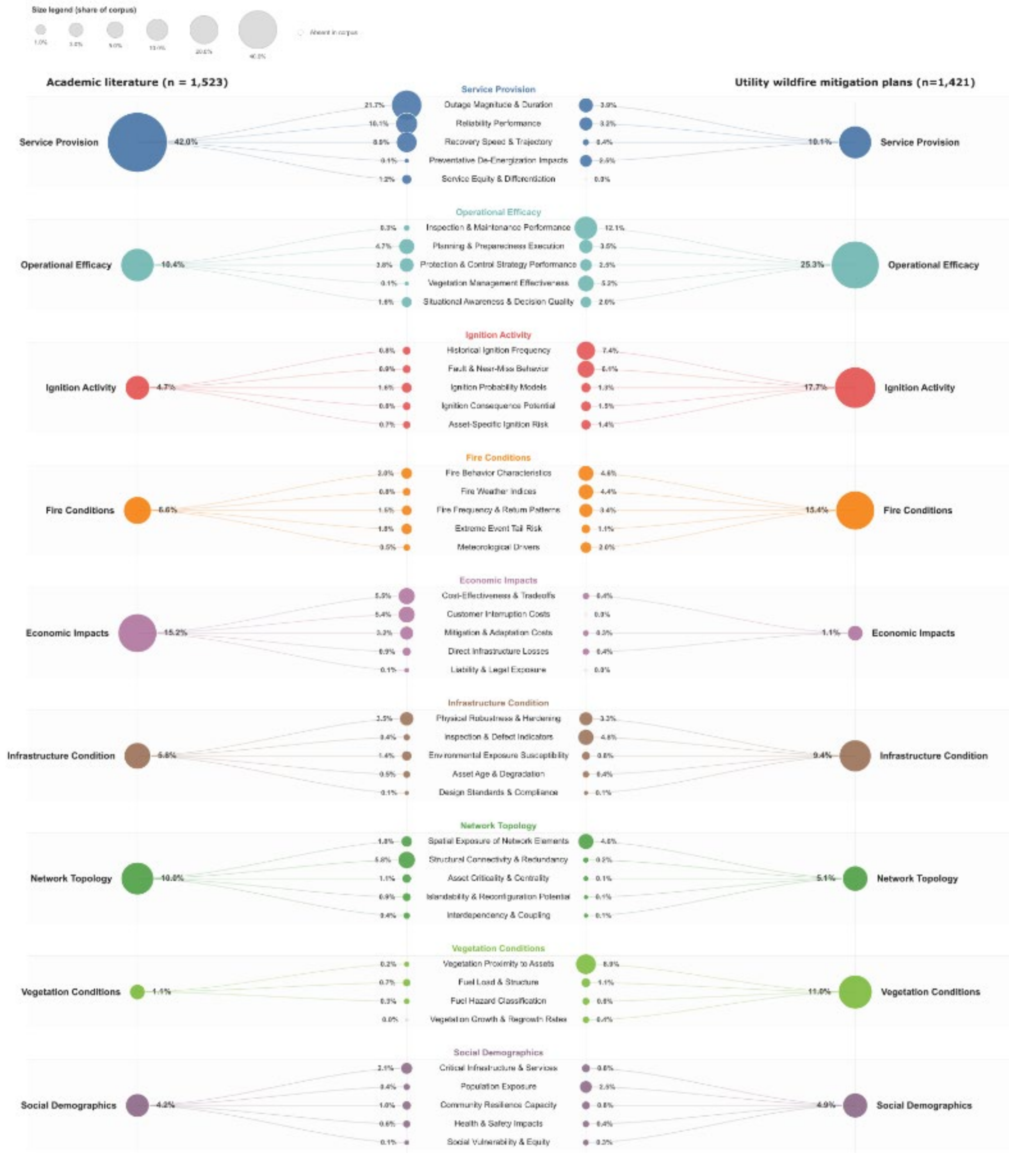
All Metrics Assigned to a Category / Sub-Category



Towards Standardized Utility Wildfire Metrics

- Addressing the industry need for standardized metrics (a well-communicated pain point for risk mitigation spending, decision-making, and maturity evaluation)





Thank you

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WILDFIRE RISK & RESILIENCE @PNNL

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