Photo Credit: Mike Blake (Reuters)

Wildfire Mitigation Data System (WMDS)

Policy Proposal

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THE BILL LANE CENTER FOR THE AMERICAN WEST

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1. Introduction

Wildfires have been increasing in size and severity due to human activities and climate change. The expansion of human settlement into the wildland-urban interface (WUI) has placed more property and lives at risk and has increased the likelihood of anthropogenic fires. Climate change, in the form of increased temperatures and prolonged droughts throughout Western North America, has greatly exacerbated this risk. Furthermore, decades of poor forest management have resulted in an enormous build-up of flammable material on public lands[1]. These trends have resulted in extreme wildfires that can both destroy and be caused by electric power infrastructure. This wildfire risk thus threatens grid reliability, which is only increasing in importance as more end-uses, such as transportation, become electrified to meet greenhouse gas (GHG) reduction targets.

To combat the ignition risks involved with electric infrastructure, a strategy called a Public Safety Power Shutoff (PSPS) is sometimes used. These are preemptive de-energizations of specific power lines that run through high-fire risk areas, and the goal is to reduce the chance that ignition will occur during conditions of low humidity, dry vegetation, and high wind speeds. An example of an event that could spark a catastrophic fire is a branch falling on a power line or a conductor dislodging. The three largest utilities in California – Pacific Gas & Electric (PG&E), Southern California Edison (SCE), and San Diego Gas & Electric (SDG&E) – all have PSPS procedures. In 2019, over 2 million customer accounts in the state experienced PSPS events, which can last multiple days and result in significant human and economic impacts[2]. Utilities outside California have also started to initiate such shutoffs due to the increasing threat of wildfires within their territory.

No region in the Western Interconnection, the wide area synchronous power grid spanning from Arizona and New Mexico to British Columbia and Alberta, is spared from the physical or societal impacts of wildfires. *Figure 1* is a snapshot of the distribution of large fires in September 2020, during the largest wildfire season on record for North America. *Figure 2* illustrates the far-reaching impacts of poor air quality due to particulate matter pollution from these wildfires during the same timeframe. Therefore, this is a regional problem that demands regional and cross-governmental solutions in order to manage the impacts over the coming decades. Although fires started by power lines are only one piece of a much larger puzzle, a Western Interconnection-wide Wildfire Mitigation Data System (WMDS) for electric utilities can reduce the wildfire risk posed by power infrastructure. This report will describe the WMDS framework, envisioned data usage, and key applications prior to concluding with a discussion on its overall benefits.

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[1] Michael Wara, A New Strategy for Addressing the Wildfire Epidemic in California, Stanford Woods Institute Climate and Energy Policy Program White Paper, 2021.

[2] Safety and Enforcement Division. *Public Report on The Late 2019 PSPS Events.* California Public Utilities Commission (CPUC), 30 Apr. 2020.

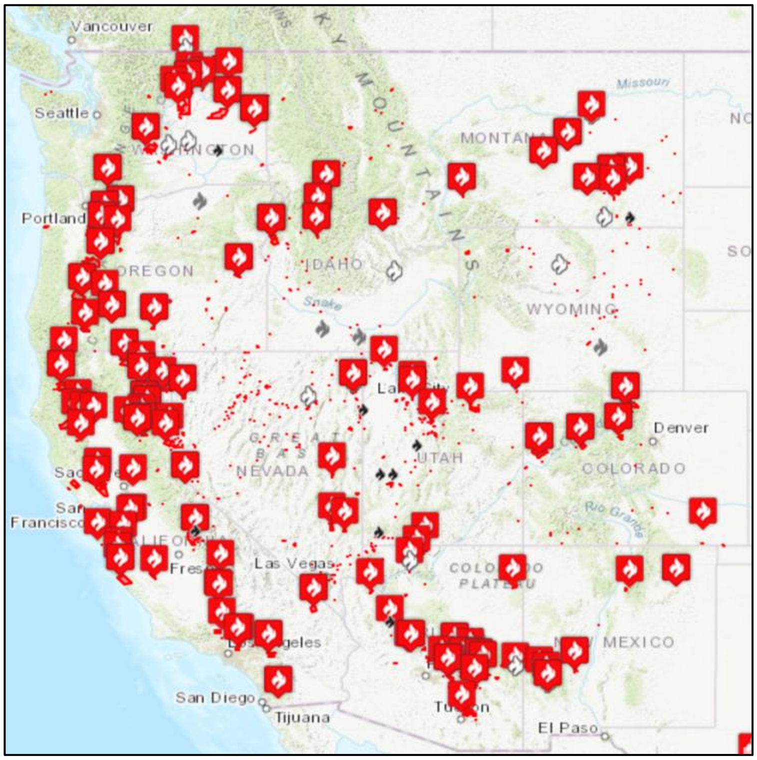

Figure 1. Active Class G Fires (> 5,000 acres) at 10:42 p.m. PDT on Sept. 14, 2020.

(Source: Fire, Weather, & Avalanche Center)

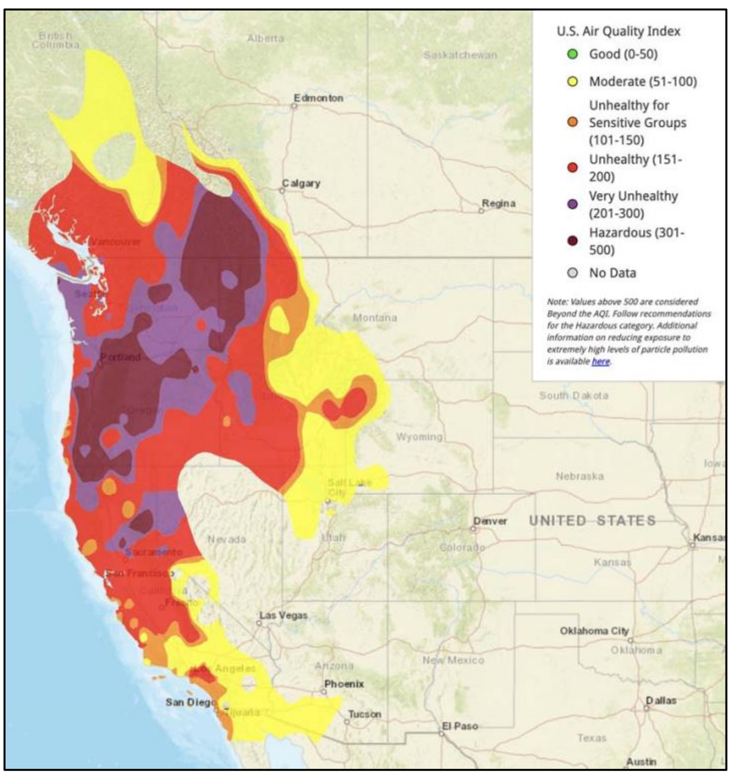

Figure 2. Air quality at 12:54 p.m. PDT Sept. 13, 2020.

(Source: AirNow.gov)

2. Wildfire Mitigation Data System (WMDS) Framework

There are examples of existing data systems that aggregate information from many utilities to provide useful insights. One of them is the North American Electric Reliability Corporation's (NERC) Transmission Availability Data System (TADS), which collects detailed information about individual outage events that, when analyzed at a regional level, will provide data that may be used to improve reliability[3]. Another example is the Institute of Nuclear Power Operations' (INPO) Consolidated Events Database (ICES), which captures equipment failure data from nuclear power plants to communicate best practices throughout the industry[4].

A WMDS would collect detailed information about individual ignition and probable ignition events from electric utilities that, when analyzed at the Western Interconnection level, will provide data that may be used by utilities and regulators to mitigate future ignition risk in the transmission and distribution (T&D) system. In 2019, across the 3 major California utilities (PG&E, SCE, SDG&E), there were 70,970 probable ignition events and 593 ignition events. This breakdown of probable ignition and ignition events, which is the specific terminology used in the WMDS framework, is displayed in *Figure 3*.

769: total instances of circuit damage during PSPS events	**555:** total number of ignition events in the distribution system
[*PSPS Circuit Damage*]	[*Distribution Ignitions*]
+	+
70,201: total instances of "near miss" events that could result in ignition	**38:** total number of ignition events in the transmission system
[Near Miss Events]	[*Transmission Ignitions*]
=	=
70,970: Probable Ignition Events	**593: Ignition Events**

Figure 3. 2019 Transmission and Distribution (T&D) Data from the 3 Major California Utilities

(Source: 2020 Wildfire Mitigation Plans from Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric)

Therefore, if data on probable ignition and ignition events from utilities throughout the Western Interconnection serve as inputs, the outputs can be quite informative. For instance, machine learning algorithms applied to this vast set of data can result in future vegetation management and grid hardening practices that are informed by ignition risk.

[3] Gagnon, Jean-Marie, et. al. *Transmission Availability Data System Phase II Report*. North American Electric Reliability Corporation (NERC), 11 Sept. 2008.

[4] Willard, Robert F. *Institute of Nuclear Power Operations*. Institute of Nuclear Power Operations (INPO). Written Testimony to the U.S. Senate Committee on Environment and Public Works, 13 Nov. 2019.

A WMDS can thus help utilities and regulators better understand ignition risk and, coupled with an understanding of ignition consequence from fire spread modeling, better manage the overall risk of catastrophic wildfires. The data system architecture is shown in *Figure 4*. Each probable ignition and ignition event should have associated data related to historical vegetation management and grid hardening activities at that section of the circuit, along with weather data at the time of the event, reported into the data system. The specific variables in each of these categories will be discussed further in Section 3.

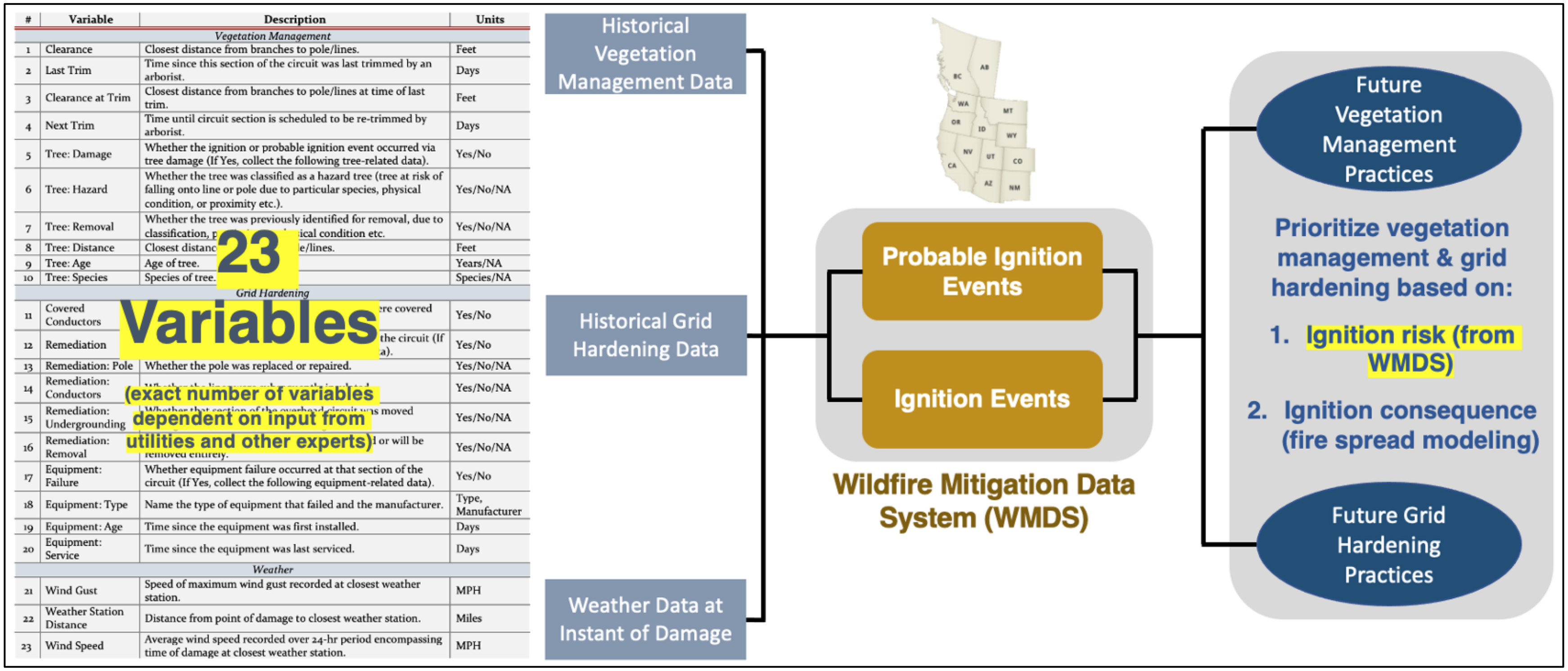

Figure 4. Data System Architecture for a Western Interconnection-wide Wildfire Mitigation Data System (WMDS) for Electric Utilities

3. WMDS Data Usage

Ultimately, the specific variables that will be collected in a WMDS depend on feedback from utilities and other subject matter experts. The list of variables will likely evolve as the data system develops and grows, changing with new insights from data analyses or new commercialized sensing technology. However, a preliminary list of 23 variables was developed during this research process and shown in *Figure 5*.

#	Variable	Description	Units
		Vegetation Management	
1	Clearance	Closest distance from branches to pole/lines.	Feet
2	Last Trim	Time since this section of the circuit was last trimmed by an arborist.	Days
3	Clearance at Trim	Closest distance from branches to pole/lines at time of last trim.	Feet
4	Next Trim	Time until circuit section is scheduled to be re-trimmed by arborist.	Days
5	Tree: Damage	Whether the ignition or probable ignition event occurred via tree damage (If Yes, collect the following tree-related data).	Yes/No
6	Tree: Hazard	Whether the tree was classified as a hazard tree (tree at risk of falling onto line or pole due to particular species, physical condition, or proximity etc.).	Yes/No/NA
7	Tree: Removal	Whether the tree was previously identified for removal, due to classification, proximity, or physical condition etc.	Yes/No/NA
8	Tree: Distance	Closest distance from tree to pole/lines.	Feet
9	Tree: Age	Age of tree.	Years/NA
10	Tree: Species	Species of tree.	Species/NA
		Grid Hardening	
11	Covered Conductors	Whether the lines at that section of the circuit were covered with an abrasion resistant insulating material.	Yes/No
12	Remediation	Whether remediation occurred at that section of the circuit (If Yes, collect the following remediation-related data).	Yes/No
13	Remediation: Pole	Whether the pole was replaced or repaired.	Yes/No/NA
14	Remediation: Conductors	Whether the lines were subsequently insulated.	Yes/No/NA
15	Remediation: Undergrounding	Whether that section of the overhead circuit was moved underground or will be moved underground.	Yes/No/NA
16	Remediation: Removal	Whether that section of the circuit was removed or will be removed entirely.	Yes/No/NA
17	Equipment: Failure	Whether equipment failure occurred at that section of the circuit (If Yes, collect the following equipment-related data).	Yes/No
18	Equipment: Type	Name the type of equipment that failed and the manufacturer.	Type, Manufacturer
19	Equipment: Age	Time since the equipment was first installed.	Days
20	Equipment: Service	Time since the equipment was last serviced.	Days
		Weather	
21	Wind Gust	Speed of maximum wind gust recorded at closest weather station.	MPH
22	Weather Station Distance	Distance from point of damage to closest weather station.	Miles
23	Wind Speed	Average wind speed recorded over 24-hr period encompassing time of damage at closest weather station.	MPH

Figure 5. Preliminary List of Data to be Collected for Ignition and Probable Ignition Events in the Proposed Western Interconnection-wide Wildfire Mitigation Data System (WMDS)

Hardware devices are already used for a variety of wildfire mitigation purposes, both by utilities and other entities. Sensors can be installed by line workers to alert utilities about downed wires, vegetation contact, equipment failure, and other line disturbances that pose a fire threat. These products can provide data for the vegetation management and grid hardening variables[5]. During high fire threat conditions, situational awareness is also important. Utilities throughout California, for instance, have deployed cameras and weather stations throughout their networks. These stations capture real-time data for temperature, humidity, and wind speeds[6]. Therefore, inputs for a WMDS can be collected automatically and transmitted to the centralized data system via existing technologies.

A variety of communication architectures have been proposed in the literature or implemented in electricity grids. For a WMDS, a three-layer structure that contains a device layer, a network layer, and an application layer is most suitable. Layer 1 (device layer) consists of the hardware: sensors and weather stations etc. Layer 2 (network layer) consists of the necessary communications networks such as 5G and the internet, which transmit the device-collected data to the application layer. Layer 3 (application layer) processes the raw data and in this example is a WMDS. A schematic of this structure is shown in *Figure 6*.

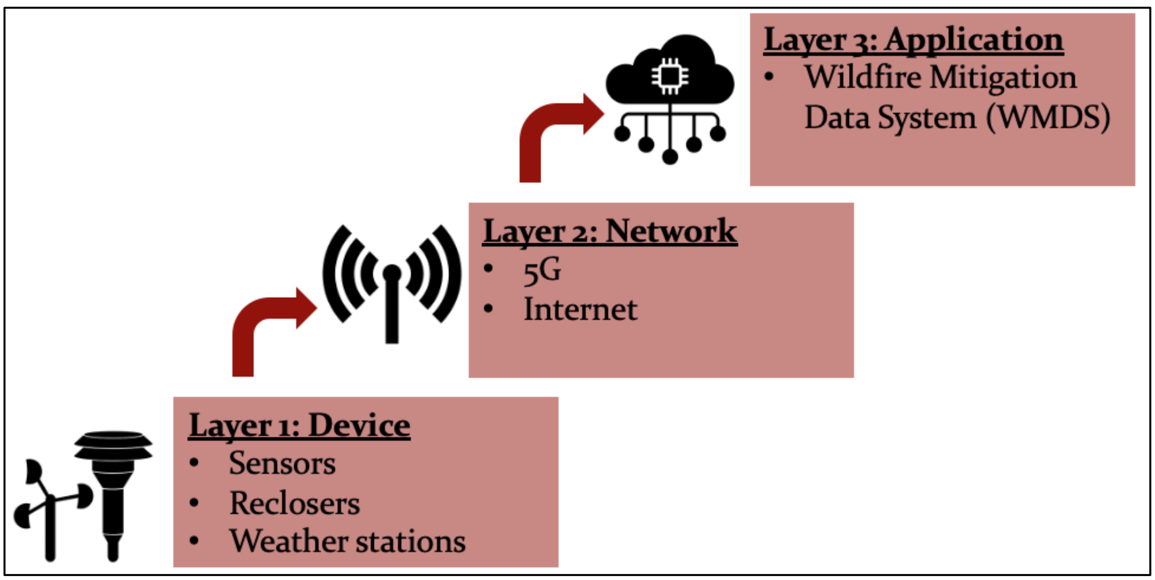

Figure 6. The Device Layer, Network Layer, and Application Layer for a Wildfire Mitigation Data System (WMDS)

Models using existing predictive data analytics methods can be built using the data collected in the application layer. These models can then be used to determine the ignition

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[5] Aclara Technologies LLC. Wildfire Mitigation with Sensors and Analytics. https://go.aclara.com/wildfire-mitigation-with-sensors-analytics.

[6] Largue, Pamela. *PGE installs 100th new weather station to bolster wildfire response*. Smart Energy International, 10 Sept. 2018. https://www.smart-energy.com/industry-sectors/energy-grid-management/pge-installs-100th-new-weather-station-bolster-wildfire-response/.

risk of other assets in the grid, for which the ignition outcome is unknown. This relationship is depicted in *Figure 7*. In fact, researchers are already conducting this type of analysis on publicly available electric power infrastructure data relevant to ignition risk, which will be examined further in Section 4.

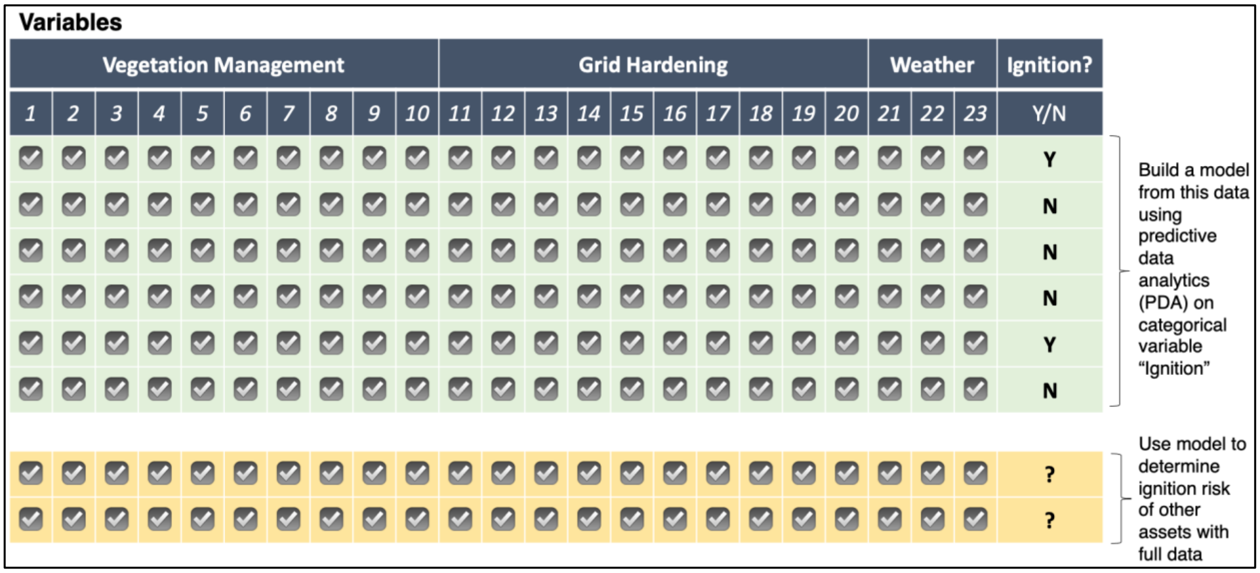

Figure 7. Schematic of Data Usage in a Wildfire Mitigation Data System (WMDS) to Build Predictive Models for Reducing Ignition Risk in Electric Power Infrastructure

4. WMDS Applications

The goal of a WMDS is to create a detailed blueprint for regional cooperation, in which computational power can be used to establish the best wildfire mitigation practices for all utilities throughout the West. Currently, no formal, structured, or scalable data sharing mechanism exists among these utilities to mitigate ignition risk from their assets. A WMDS can allow utilities to submit their data in exchange for access to a broader dataset that will help them improve their operations, reduce costs, and keep customers safe. This is beneficial to all utilities because the Western grid is interconnected, and access to more data of a higher quality can result in more effective predictive models.

The data will help utilities outside California build their ignition risk models and help the major utilities within California further calibrate their ignition risk models. This system also compliments the efforts and goals of the California Public Utilities Commission (CPUC), who are emphasizing data sharing and transparency in their regulatory role. A WMDS, as described in this paper, can help PG&E, SCE, and SDG&E improve on at least 15 of the 52 capabilities analyzed by the CPUC in their Wildfire Mitigation Maturity Model[7]. The capabilities are shown and highlighted in *Figure 8*. Sub-criteria in the CPUC model that are explicitly relevant to a WMDS include, among many others, A.II.a ("How is Ignition

[7] Wildfire Safety Division (WSD). *Utility Wildfire Mitigation Maturity Model*. California Public Utilities Commission (CPUC).

Risk Calculated") and D.II.b/D.II.e/D.II.h ("How are Inspections Schedule? – Patrol Inspections, Detailed Inspections, etc.").

Category	I. Capability	II. Capability	III. Capability	IV. Capability	V. Capability	VI. Capability
A. Risk assessment and mapping	1. Climate scenario modeling	2. Ignition risk estimation	3. Estimation of wildfire consequences for communities	4. Estimation of wildfire and PSPS risk-reduction impact	5. Risk maps and simulation algorithms	
B. Situational awareness and forecasting	6. Weather variables collected	7. Weather data resolution	8. Weather forecasting ability	9. External sources used in weather forecasting	10. Wildfire detection processes and capabilities	
C. Grid design and system hardening	11. Approach to prioritizing initiatives across territory	12. Grid design for minimizing ignition risk	13. Grid design for resiliency and minimizing PSPS	14. Risk-based grid hardening and cost efficiency	15. Grid design and asset innovation	
D. Asset management and inspections	16. Asset inventory and condition assessments	17. Asset inspection cycle	18. Asset inspection effectiveness	19. Asset maintenance and repair	20. QA/QC for asset management	
E. Vegetation management and inspections	21. Vegetation inventory and condition assessments	22. Vegetation inspection cycle	23. Vegetation inspection effectiveness	24. Vegetation grow-in mitigation	25. Vegetation fall-in mitigation	26. QA/QC for vegetation management
F. Grid operations and protocols	27. Protective equipment and device settings	28. Incorporating ignition risk factors in grid control	29. PSPS op. model and consequence mitigation	30. Protocols for PSPS initiation	31. Protocols for PSPS re-energization	32. Ignition prevention and suppression
G. Data governance	33. Data collection and curation	34. Data transparency and analytics	35. Near-miss tracking	36. Data sharing with research community		
H. Resource allocation methodology	37. Scenario analysis across different risk levels	38. Presentation of relative risk spend efficiency for portfolio of initiatives	39. Process for determining risk spend efficiency of vegetation management initiatives	40. Process for determining risk spend efficiency of system hardening initiatives	41. Portfolio-wide initiative allocation methodology	42. Portfolio-wide innovation in new wildfire initiatives
I. Emergency planning and preparedness	43. Wildfire plan integrated with overall disaster/ emergency plan	44. Plan to restore service after wildfire related outage	45. Emergency community engagement during and after wildfire	46. Protocols in place to learn from wildfire events	47. Processes for continuous improvement after wildfire and PSPS	
J. Stakeholder cooperation and community engagement	48. Cooperation and best practice sharing with other utilities	49. Engagement with communities on utility wildfire mitigation initiatives	50. Engagement with LEP and AFN populations	51. Collaboration with emergency response agencies	52. Collaboration on wildfire mitigation planning with stakeholders	

Figure 8. Capabilities that Can Be Advanced by a Wildfire Mitigation Data System (WMDS) within the CPUC's Wildfire Mitigation Maturity Model

Extensive research in wildfire mitigation activities for electric utilities is ongoing, conducted by universities, national labs, and the utilities themselves[8]. Specifically, researchers from Argonne National Lab and Lawrence Berkeley National Lab are building separate sets of models to predict wildfire incidents using publicly available utility data, and one of their shared objectives is to provide tools to smaller electric utilities that may not have their own dedicated wildfire risk analysis capabilities. Overall, the objectives of this research closely align with the objectives of our proposed WMDS. During discussions with these researchers, several barriers were identified: (1) The "Fire Incident Report" data is limited in scope and only available for the 3 major CA utilities, (2) Their models do not incorporate the vast set of "Probable Ignition Data" identified by the WMDS framework (near miss events and damage during PSPS events), (3) The distribution system is not analyzed, and (4) Utilities are reluctant to share non-publicly available data with outside researchers. A WMDS seeks to address these barriers by setting standards for data collection on ignition and probable ignition events through the entire Western Interconnection for both the transmission and distribution system and creating a platform

[8] Office of Electricity. *Wildfire Mitigation Webinar Series*. Department of Energy, Apr. 2021. https://www.energy.gov/oe/wildfire-mitigation-webinar-series.

to share that data with relevant researchers. Therefore, this proposal seeks to advance ongoing research while also creating possibilities for future research endeavors that will benefit the entire region.

5. Conclusion

With regards to data sharing, a WMDS as outlined in this report would not require any customer information or other sensitive information. This could be a publicly accessible data set to promote best practices for utility wildfire mitigation. Furthermore, it could harness the power of third-party research for the benefit of all. A subset of the various utilities that can benefit from this system, alongside the key characteristics, is shown in *Figure 9.*

As a first step, policy makers and regulators at the state level need to encourage more wildfire-related data sharing from electric utilities. The motivation, framework, and benefits presented here for a WMDS can serve as a useful starting point for state-level and local policies and ultimately inspire more integrated regional cooperation among state energy regulators, energy agencies, utilities, and other statekholders.

In conclusion, more robust regional data sharing can result in a reduction in utility-caused wildfires and subsequently an increase in grid reliability and resiliency. Data driven wildfire mitigation practices that are more widespread can reduce costs and ensure affordable rates. This is critical, as secure and equitable electric infrastructure is a key enabler of economy-wide decarbonization.

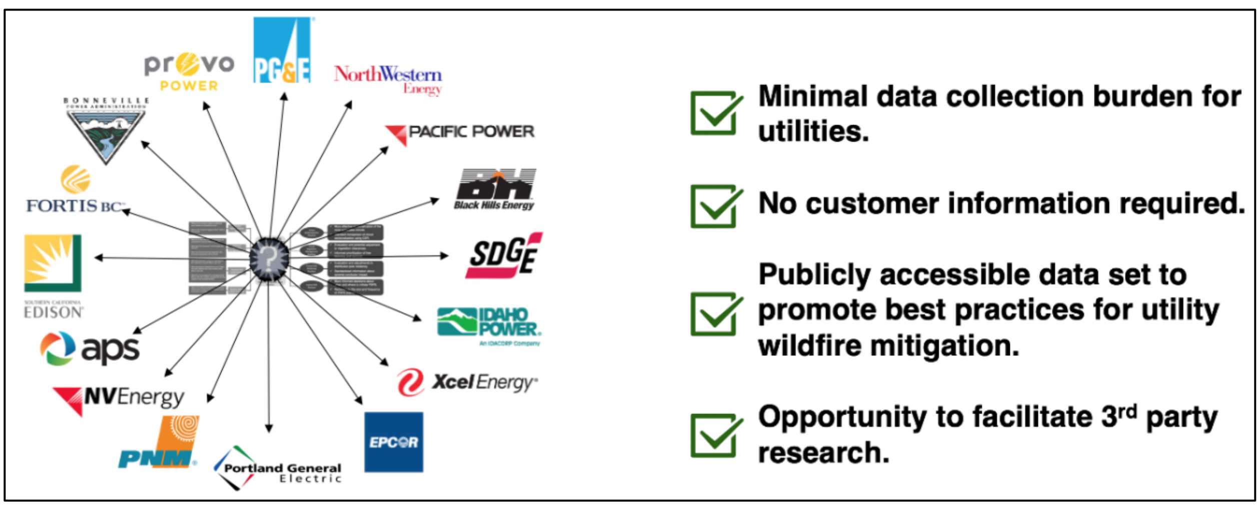

Figure 9. A Subset of Western Utilities that Can Benefit from a regional Wildfire Mitigation Data System (WMDS), Alongside Key Aspects of Such a System

Acknowledgements

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More Information

This work is a synthesis of prior research conducted throughout the 2020-2021 academic year. Prior publications for the project can be found at the link below.
https://west.stanford.edu/research/works/wildfire-mitigation-data-system-wmds-western-interconnection

Photo Credit: Gene Blevins (Reuters)