Pacific Northwest
NATIONAL LABORATORY

Wildfire Benefits of Advanced Grid Technologies

WILDFIRE RISK & RESILIENCE
@PNNL

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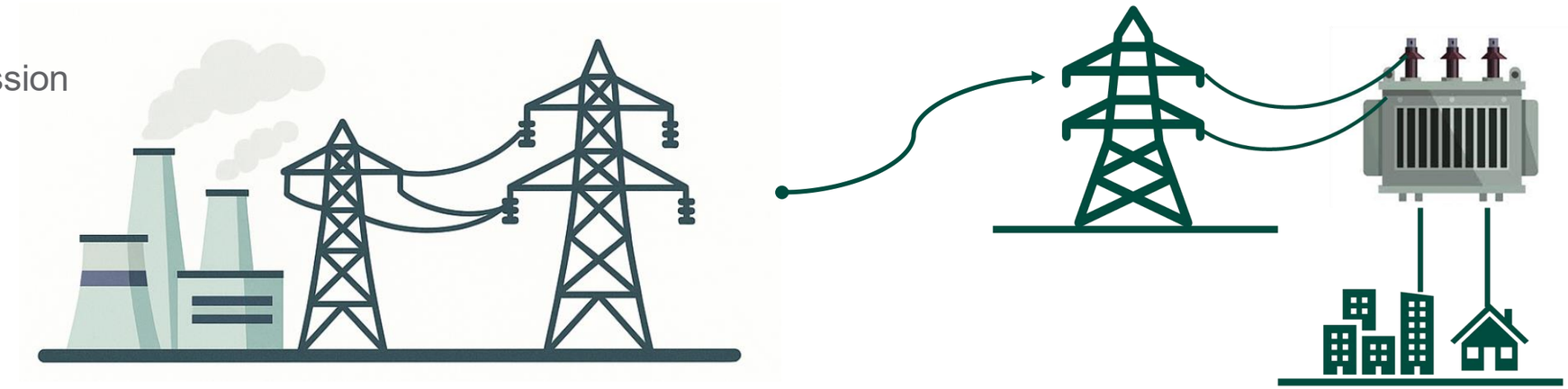
Background

- Sponsored by the U.S. Department of Energy's Grid Deployment Office, PNNL created a database of all known and discrete utility Wildfire Mitigation Plans (WMPs) from across the United States and Canada.
- The goal is to provide a single consolidated location for access to all WMPs. Plans are organized by various metadata:
  - Location of the authoring utility or entity
  - Year or range of years of the plan implementation period
  - Type of utility or entity
- The database is a component of a larger research program to establish credible industry metrics to assess and mitigate wildfire risk.
- To help make sense of hundreds of WMPs and their contexts, PNNL produced a series of citable short decks, organized by technical topics.

Advanced Grid Technologies (AGT)

- **Advanced Grid Technologies** are modern infrastructure, control solutions and protection schemes and that are designed to enhance power system efficiency, operational flexibility, safety and resilience both at *transmission* and *distribution* scale.



Dominant AGTs* on the transmission side:
- Dynamic Line Rating (DLR)
- Topology Optimization (by ISO/RTOs and large utilities)
- Advanced Power Flow Controls
- Advanced Protection Coordination

Dominant AGTs on the distribution side:
- Advanced Protection Schemes (breakers/reclosures)
- Undergrounding and Covered Conductors
- Topology Improvements (by utilities)

*for transmission-scale systems, these are sometimes also referred to as Advanced Transmission Technologies (ATTs) or Grid Enhancing Technologies (GETs)

Why are AGTs important strategies for wildfire mitigation?

- Wildfire Mitigation Plans (WMPs) across U.S. utilities— especially in high-risk Western states—are increasingly adopting AGTs to reduce ignition risk, enhance operational flexibility, and limit customer impacts from power shutoffs.
- In day to day “blue-sky” conditions, AGTs can help power systems to operate more efficiently, have more capacity and be responsive to changing conditions. Some example applications are:
  - Prevention of thermal overloads and line congestion.
  - Enable bidirectional power flow and integration of distributed, demand-side resources.
  - Fault detection and sectionalization to prevent high impact cascading failures.
  - Optimization of power flow by rerouting electricity under changing grid conditions such as renewable variability or peak load congestion.
- For wildfire, AGTs can mitigate risk or impacts through:
  - Early detection, monitoring and preventing escalation of wildfire-causing conditions.
  - Enhanced controls for efficient sectionalization and post-event recovery ensuring minimum service disruptions.
  - Optimized power delivery and maintenance of power quality during in-event periods.

Examples of Advanced Grid Technologies in Wildfire Mitigation Plans

Technology / Technique	Definition
Fast Trip Systems	Rapid fault detection and isolation reduce arc duration and ignition potential from conductor faults.
Adaptive Reclosures	Intelligent reclosure logic delays or prevents automatic re-energization in high wildfire risk conditions.
Undergrounding Conductor	Undergrounding conductors eliminates overhead ignition sources, making it a critical but costly wildfire mitigation strategy in utility wildfire mitigation plans.
Covered Conductor	An overhead power line with a non-insulated but weather-resistant covering over the conductor, designed to reduce contact-related faults and wildfire ignition risks
Advanced Fire-Safe Devices for Monitoring and Controls	Replacement of traditional expulsion-type fuses and surge arresters with devices that minimize ignition risks in wildfire-prone zones.
Dynamic Line Rating (DLR)	Adjusts transmission line capacity in real time based on temperature, wind, and conductor conditions.
Topology Optimization and Improvements	Reconfigures the grid's structure to improve reliability, minimize losses, and reduce wildfire or overload risks

AGTs in Wildfire Mitigation Plans

- **Fast-Trip Systems:** Widely adopted by California Investor-Owned Utilities (IOU); reduces fault energy to avoid ignitions from downed lines—used extensively in **SCE**'s High Fire Risk Area (HFRA) feeders (p. 481). Also used by **Avista (WA)** (p. 27) for risk-prone areas (Dry Land Mode Operations). **Xcel Energy** (p. 28) has an enhance power line safety settings program for addressing wildfire risks.
- **Adaptive Reclosures:** Delayed or disabled reclosers in high fire-threat areas to avoid reigniting faults—used in both **PG&E** (p. 276) and **SCE** (p. 14) mitigation protocols. During periods of high fire risk on high-risk circuits, **AZPS** implements its No-Reclose Strategy (p. 50). In cases where a fault is sustained, such as when a wire falls to the ground, the reclose mechanism disables automatic reclosing until a visual inspection can be carried out. **Rocky Mountain Power** (p. 90) considers a tailored elevated fire risk (EFR)-based reclosure operation strategy during high fire-risk periods.
- **Undergrounding Conductors:** A central mitigation measure in **PG&E's** plan (p. 3; 400 - 405), targeting 10,000 miles and selectively applied by **SCE** (p. 20) and **SDG&E** (p. 406) where cost-benefit justifies it (e.g., dense communities or critical infrastructure).
- **Covered Conductors: AZPS** (p. 46) using covered conductor to prevent contact between lines . **PG&E** (p. 61) considering covered conductors for both high and low voltage circuits. **SDG&E** (p. 152) has a dedicated covered conductor program for addressing wildfire risk.

AGTs in Wildfire Mitigation Plans (contd..)

- **Advanced Fire-Safe Devices (such as electronic fuse, advanced surge arresters etc.): AZPS** (p. 37) and **Oncor** are replacing link break expulsion fuses with alternative fusing options (such as electronic fuse) that reduce the expulsion of hot particles. **AZPS** (p.38) is exploring the potential for new surge arresters that fully disconnect the ground lead without shedding sparks. **NV Energy** (p. 74) is evaluating the use of high impedance fault detection to reduce arcing possibilities from protection system failure.

- **Dynamic Line Rating (DLR):** Under evaluation by **PGE** (OR) (p. 4) to dynamically adjust line capacity based on real-time weather and conductor conditions to avoid overloads during high-risk periods.

- **Topology Optimization and Improvements:** Integrated into **PG&E's** analytical tools for design and operation, which evaluates configurations to maintain service while minimizing wildfire risk (p. 460 – 463). PG&E has been installing sectionalizing devices on transmission system to segmentation of the transmission circuits traversing the HFTD (high fire threat districts).

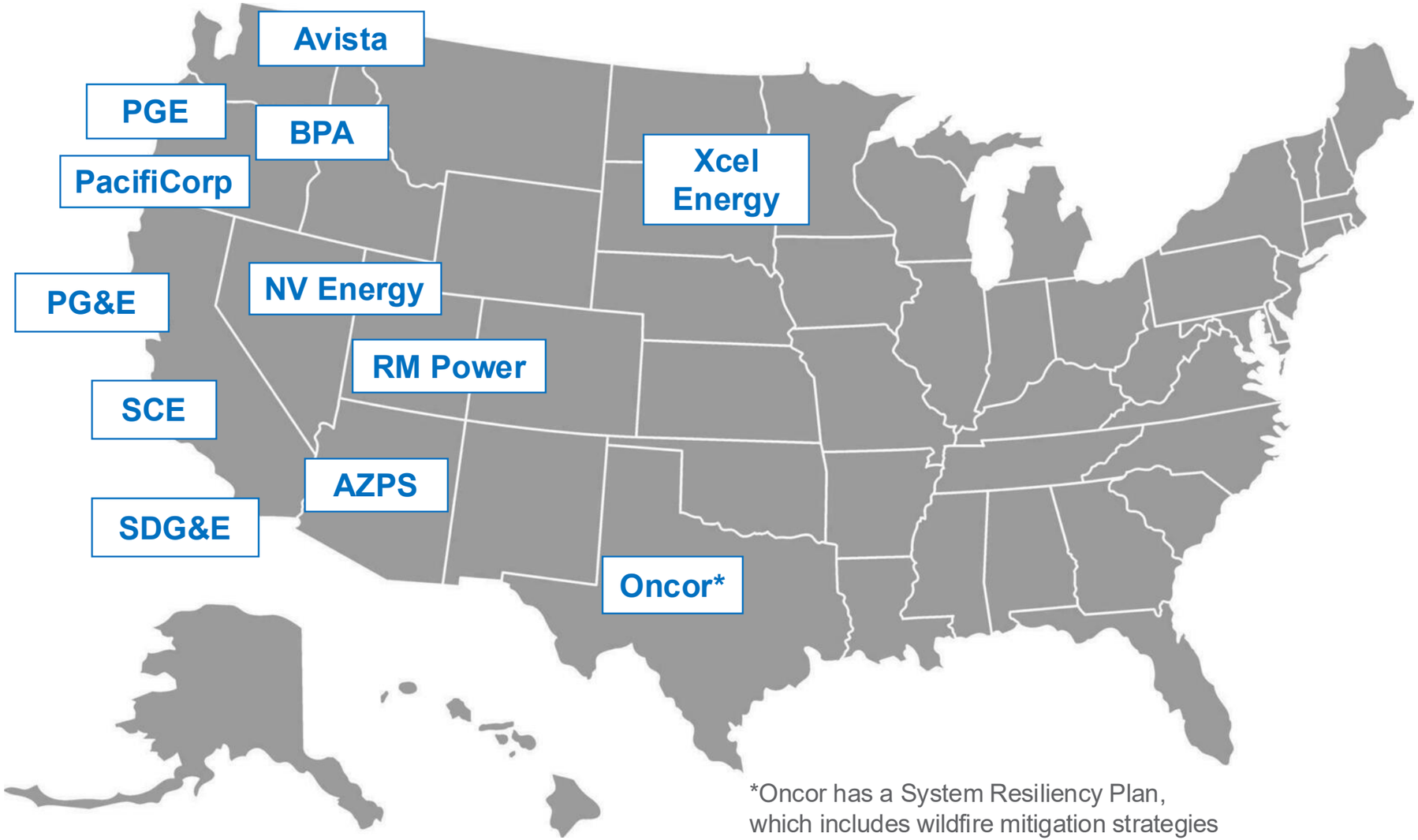
Other AGTs that can potentially be helpful in wildfire mitigation

Technology / Technique	Definition
Advanced Power Flow Controls	Advanced power flow controls are technologies that dynamically manage the direction and magnitude of electricity flows on the grid to optimize system performance and enhance reliability.
Reactive Power Compensation	Process of managing reactive power in an electrical system to maintain voltage stability and improve power factor, typically achieved using devices like capacitor banks, synchronous condensers, and FACTS (flexible alternating current transmission systems) devices such as Static VAR Compensators (SVCs) and Static Synchronous Compensators (STATCOMs).

These technologies do not appear in the reviewed WMPs, but they are used for other operational purposes and have the potential to mitigate ignition risk.

- **Advanced Power Flow Controls:** Utilities can deploy advanced power flow to reroute power away from high fire-threat areas during red flag warnings or other times of high wildfire risk.
- **Reactive Power Compensation** – Utilities can optimize reactive power devices like capacitor banks and FACTS devices to maintain voltage stability during wildfire threats, reducing long-distance power transfers and mitigating service interruptions.

AGTs in Wildfire Mitigation Plans of select US utilities



*Oncor has a System Resiliency Plan, which includes wildfire mitigation strategies

- **PG&E** – Pacific Gas & Electric
- **SCE** – Southern California Edison
- **SDG&E** – San Diego Gas & Electric
- **AZPS** – Arizona Public Service
- **BPA** – Bonneville Power Administration
- **PGE** – Portland General Electric
- **RM Power** – Rocky Mountain Power

Citation, Contacts, and Project Links

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All WMPs used in this analysis can be found at:

https://wildfire.pnnl.gov/mitigationPlans

For more information, contact wildfire@pnnl.gov

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Thank you