PUBLISHED ARTICLE

Beyond One-Size-Fits-All: How Flexible Recloser Design Strengthens Wildfire Mitigation Strategies

Wildfires pose an escalating threat to power systems, requiring solutions that can adapt to shifting environmental conditions and ongoing grid modernization efforts. Utilities must navigate the challenge of balancing reliability, safety, and cost-effectiveness in their wildfire mitigation strategies. While system hardening and automation have taken center stage in recent years, the adaptability of protective devices, particularly reclosers, is emerging as a critical factor in wildfire risk reduction. This article explores the critical role of flexible recloser design in wildfire mitigation, highlighting how adaptable technologies can help utilities safeguard power systems against the increasing threat of wildfires.

The Rising Costs and Consequences of Wildfires

Wildfires pose a severe and costly threat to power infrastructure, causing extensive damage, disrupting service, and incurring substantial costs. The following statistics highlight the widespread impact of wildfires on power systems:

- Over the past 50 years (excluding the last four), wildfires have caused an average of $1 billion in direct damages per year (adjusted for inflation).[1]
- More than 9,200 miles of power lines across the contiguous U.S. were exposed to large fires from 2000 to 2019.[2]
- The average wildfire ignited by power lines between 2015 and 2020 burned approximately 20 structures.[3]
- Between 2000 and 2016, California wildfires cost utilities more than $700 million in transmission and distribution related damages.[4]
- The cost of wildfire mitigation efforts for California utilities has been substantial, with $16.4 billion spent over a four-year period.

These statistics underscore the urgent need for proactive and effective wildfire mitigation strategies to protect power systems and ensure the reliable delivery of electricity to communities.

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The Need for Adaptability in Wildfire Mitigation

Utilities operate across diverse landscapes, each presenting unique wildfire risks. Mountainous terrains, urban-wildland interfaces, and rural areas require tailored mitigation approaches. Furthermore, climate change is expanding wildfire-prone regions, compelling utilities to reassess and adapt their strategies continually. This necessitates a shift from rigid, one-size-fits-all solutions to flexible approaches that can be customized to specific needs and evolving conditions.

Modernization initiatives further underscore the need for adaptability. As utilities integrate system hardening, undergrounding, and advanced protection schemes, flexible solutions become essential for seamless integration and optimal performance.

The Recloser's Role in Wildfire Mitigation

Reclosers play a crucial role in power system protection by automatically interrupting and restoring power flow in response to faults. The use of reclosers has evolved significantly since their inception in the 1940s. Initially, their primary function was simply to keep the lights on by restoring power after momentary faults. In the 2000s, their application became more refined, focusing on reliability improvements and minimizing industry indices like SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index). Today, with the growing threat of wildfires, recloser usage has been further fine-tuned to prioritize fire mitigation. This includes faster remote operation, rapid fault interruption, and even proactive power shutoffs during extreme weather events.

In the context of wildfire mitigation, the adaptability of reclosers is vital. Traditional reclosers with fixed parameters may not be sufficient to address the dynamic nature of wildfire threats. Modern wildfire mitigation demands precision and adaptability in recloser settings to respond effectively to evolving threats.

To effectively mitigate wildfire risks, utilities are leveraging flexible recloser settings that allow for real-time adjustments based on changing conditions:

- **Sensitivity Adjustments:** Fine-tuning sensitivity allows reclosers to detect high-impedance faults, often precursors to ignitions, which conventional overcurrent protection may miss.
- **Fast Trip Settings:** Rapid de-energization of lines during high-risk periods is crucial to prevent sustained arcing and ignition. Flexible reclosers enable utilities to implement fast trip settings without compromising coordination.
- **Integration with Real-Time Monitoring:** Integrating reclosers with weather monitoring and grid analytics allows dynamic adjustments to protection schemes based on real-time conditions. This proactive approach enhances responsiveness and reduces wildfire risk.

Utilities are increasingly recognizing the importance of flexible recloser design in their wildfire mitigation strategies. By adopting reclosers with adaptable settings and advanced functionalities, they can enhance grid resilience and minimize the risk of ignitions.

Flexible Recloser Design: A Closer Look

While various manufacturers offer reclosers with advanced features, G&W Electric's Viper®-ST recloser stands out as a prime example of design flexibility in wildfire mitigation. Its adaptability makes it suitable for diverse grid environments and evolving wildfire conditions.

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Looking Ahead: The Future of Wildfire-Resilient Distribution Grids

The evolution of wildfire-resilient grids will be driven by continuous innovation and adaptation. Advanced automation, AI-driven analytics, and real-time monitoring will further refine recloser responses to dynamic fire conditions. Utilities should prioritize solutions that allow for modular upgrades, ensuring long-term adaptability and compatibility with emerging technologies.

Investing in flexible protection schemes, rather than rigid solutions, will be crucial for balancing wildfire mitigation with grid reliability and cost-effectiveness.

Key areas of focus for the future of wildfire-resilient distribution grids include:

- **Advanced Grid Modeling:** Sandia National Laboratories is developing advanced grid modeling tools to simulate wildfire behavior and assess grid vulnerabilities. This research aims to improve utilities' ability to assess, plan, and adapt to wildfire risks.[6]
- **Microgrids:** Microgrids, localized electrical networks that can operate independently, offer enhanced resilience during wildfires. They can provide backup power to critical facilities and communities, minimizing disruptions caused by grid outages. Microgrids do, however, require specialized protection schemes when connecting to the utility grid to ensure safe and reliable operation. Reclosers like the Viper-ST enable those protection schemes, allowing one device to be used for both distributed energy resource (DER) and microgrid integration, further enhancing their value in wildfire mitigation and grid modernization efforts.
- **AI-Driven Analytics:** Integrating fire-ignition electrical fault data with high-resolution Earth observation data can enhance wildfire risk assessment and prediction. AI-powered analytics platforms can analyze vast amounts of data to identify patterns, predict potential ignition points, and optimize mitigation strategies.
- **Rerouting Power Flows:** Research has shown that rerouting power flows through vulnerable parts of the grid during dry, windy conditions can decrease the probability of wildfire ignition.[7] This methodology aims to improve decision-making in power systems operations to help utilities keep serving customers while reducing the risk of wildfire ignitions.
- **Wildfire Sensors:** The development of wildfire sensors that detect gases and particulate levels is a promising area of innovation.[8] These sensors can provide early warnings of fire ignitions, enabling rapid response and potentially preventing large-scale wildfires.
- **Paradigm Shift:** The increasing danger of wildfires necessitates a paradigm shift from a "reliability-first" approach to one that prioritizes resilience and safety in wildfire mitigation.[9] This shift involves adopting a more proactive and adaptable approach to grid management, accepting some level of decreased reliability in the interest of public safety.

By embracing these advancements and adopting a forward-looking approach, utilities can build more resilient distribution grids that can withstand the growing threat of wildfires and ensure the continued delivery of safe and reliable electricity.

KEY DESIGN FEATURES THAT ENHANCE WILDFIRE MITIGATION INCLUDE:

1.Dead-Front Design

The Viper-ST recloser's dead-front design significantly enhances safety by preventing flashovers at the recloser itself, such as those caused by animal contact. This design minimizes the risk of ignitions originating from the recloser and also minimizes exposure to live energy, reducing secondary ignition hazards and improving safety for personnel.

2. Multiple CT Ratio Options

The Viper-ST recloser offers multiple current transformer (CT) ratio options, allowing for greater granularity at low current readings. This is essential for detecting high-impedance faults and downed conductors, which are often precursors to wildfires. Lower CT ratios provide enhanced sensitivity, enabling utilities to set lower trip thresholds in high-risk areas and prevent these incidents from escalating into fires.

3. Adaptive Coordination with Other Grid Protection Equipment

The Viper-ST recloser seamlessly integrates with other grid protection technologies, such as G&W Electric's current limiting protectors CLiP® and distribution automation systems. This interoperability enables real-time coordination for faster fault clearing, minimizing the duration of fire-starting arcs.

4. Overhead & Underground Compatibility

The Viper-ST recloser offers flexible installation options, accommodating both overhead and underground systems. It is compatible with dead-front rubber goods, enabling direct connection to underground cables. This capability allows for versatile deployments, including riser poles, padmount applications, and fully insulated overhead installations. This versatility ensures consistent protection across diverse deployment environments.

CONCLUSION

Wildfire mitigation is an ongoing challenge that demands a comprehensive and adaptable approach. Flexible recloser design, exemplified by G&W Electric's Viper-ST, provides utilities with the versatility needed to tailor mitigation strategies to specific risk conditions. By prioritizing flexible solutions, utilities can enhance safety, improve system reliability, and contribute to a more resilient energy future.

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GW130-2025
2025.06/GF