WHITE PAPER

Sub-Transmission Protection: Enhancing Our Nation's Grid Resiliency

G&W Electric

The Vulnerability of Our Nation's Electrical Infrastructure

When customers flip on a light switch, they naturally expect the lights to turn on. It's only when the power abruptly shuts down, calls about outages come pouring in. For any utility, long power outages are their worst nightmare. With society so dependent on electricity, keeping the power running is not only convenient but costly and lifesaving. Critical frontline facilities such as hospitals, small businesses, financial centers and grocery stores are vulnerable to extended power outages.

To deliver electricity to millions of Americans, utilities across the country operate on an integrated power grid consisting of more than 200,000 miles of high-voltage transmission lines to deliver between 60-70 percent of the nation's electricity.

According to a report by the U.S. Department of Energy, the United States' electrical grid is the largest interconnected machine on the planet. To distribute electricity through this massive system, it requires transmitting voltage at high levels to make it possible to deliver electricity over great distances. Across the country, substations and transformers work to decrease voltage from high-power transmission lines to deliver safe levels of electricity to homes and businesses.

While it's been claimed to be the largest machine, it may also be one of the oldest still in operation. In 2015, the U.S. Department of Energy found 70 percent of power transformers are 25 years or older, 60 percent of circuit breakers are 30 years or older and 70 percent of transmission lines are 25 years or older.

As our electrical infrastructure continues to age it becomes more susceptible to blackouts, having enormous consequences on our society and economy. The U.S. Department of Energy's report concludes while power outages aren't frequent, they still occur and can be costly, "Today's electricity system is 99.97 percent reliable, yet still allows for power outages and interruptions that cost Americans at least $150 billion."

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[1] Congressional Research Service, 2014, Physical Security of the U.S. Power Grid: High-Voltage Transformer Substations
[2] U.S. Department of Energy, 2011, Smart Grid: An Introduction
[3] U.S. Department of Energy, 2015, Chapter 3: Enabling Modernization of the Electric Power System

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Weathering the Storm

With an aging system, weather-related outages have emerged as the greatest threat disrupting service to customers. As climate change has intensified the severity and frequency of extreme weather like hurricanes, winter storms, wildfires, heavy rains and winds, power outages have become more common leaving customers in the dark after the storm has passed.

An analysis by Climate Central found weather-related outages doubled and were responsible for 80 percent of all outages between 2003-2012 . More recently and still in everyone's recent memory, the 2020 hurricane season had 29 named storms, making it officially the busiest hurricane season recorded in the past 170 years. However, power outages aren't only limited to coastal states, the same report found Michigan led all states with 71 major weather-related outages.

Data from the survey determined, "Most of these outages come from damage to large transmission lines or substations, as opposed to the smaller residential distribution network."

The report dives further into the impact climate change has on our electrical infrastructure, but summarizes that climate change is:

"At most, partially responsible for this recent increase in major power outages, which is a product of an aging grid serving greater electricity demand, and an increase in storms and extreme weather events that damage this system. But a warming planet provides more fuel for increasingly intense and violent storms, heat waves, and wildfires, which in turn will continue to strain, and too often breach, our highly vulnerable electrical infrastructure."

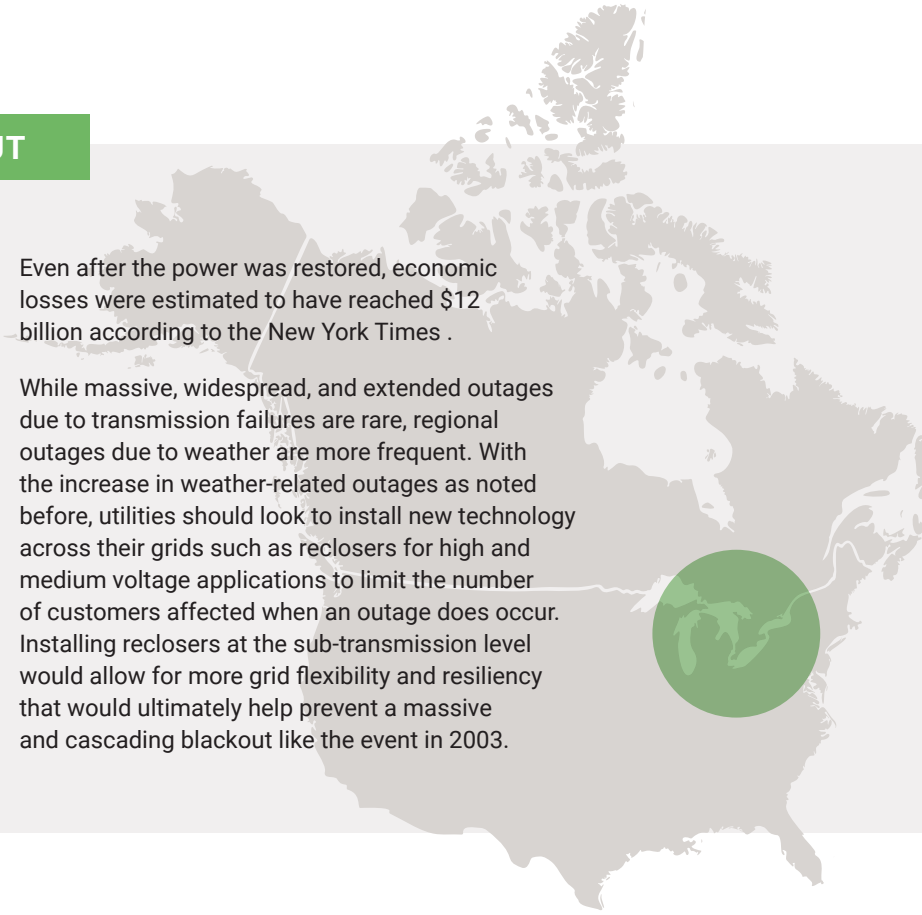
PREVENTING A MAJOR BLACKOUT

An outage due to transmission failure can occur from weather, equipment failure, computer problems, and human error. Since many electrical utilities provide service to customers over large regions and even state lines, a transmission outage could result in a major outage spanning several states due to the nature of the nation's interconnected grid.

In 2003, when a tree branch in Ohio came into contact with a power line, it triggered the adjacent power plant to shut down and caused a chain reaction of outages resulting in a massive blackout effecting nearly 50 million people in the eastern United States and Canada. Across the region, power was restored within a few hours, but some were left in the dark for two days, becoming the largest blackout in North American history.

Even after the power was restored, economic losses were estimated to have reached $12 billion according to the New York Times .

While massive, widespread, and extended outages due to transmission failures are rare, regional outages due to weather are more frequent. With the increase in weather-related outages as noted before, utilities should look to install new technology across their grids such as reclosers for high and medium voltage applications to limit the number of customers affected when an outage does occur. Installing reclosers at the sub-transmission level would allow for more grid flexibility and resiliency that would ultimately help prevent a massive and cascading blackout like the event in 2003.



[5] New York Times, 2004, A Year Later, Lessons From the Blackout

Weathering the Storm (continued)

The Current State of Sub-Transmission Protection

Ongoing reliability requirements of the grid have led to a gap in current market technologies. Requirements are pushing the need for reclosers over motor operated air break switches (MOABS), which do not provide the same functionality as fault interruption and isolation like reclosers. Equipment available on the market today and utilized out on sub-transmission systems do not provide overcurrent protection but only isolate de-energized lines and cannot be open while energized unless they come with load break interrupter attachments.

The equivalent technology, circuit breakers and circuit switchers, offer fault interrupting functionality at a high total cost due to the general requirement of being at ground level which requires a fenced area, foundations, and some type of control house.

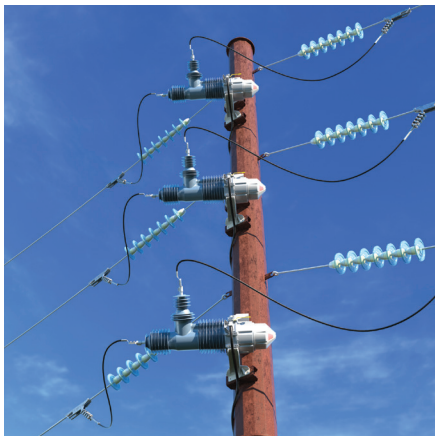
Improving Sub-Transmission Protection — Eliminating the Gap

Fortunately, the first of its kind high-voltage recloser for the sub-transmission space has recently been adapted by a few utilities in the northeastern United States. A self-contained recloser at this voltage level brings invaluable improvements to the systems' reliability and grid resiliency by adding a reliable switching device that brings distribution capabilities into sub-transmission applications. Additionally, it provides fault protection and high-speed isolation on overhead lines outside traditional substations only. With automation-ready capabilities, it enables utilities to have more control over performance. For example, if a sub-transmission line goes down, a recloser can automatically attempt to clear any temporary faults and actually isolate only that section of the grid to protect the substation and additional lines from going down, ultimately preventing an entire region from losing power.

Not only would installing self-contained reclosers across sub-transmission grids improve reliability and resiliency, it can reduce costs by eliminating maintenance on the very limited capability of legacy solutions (i.e. MOABS) and the need to build a fenced substation and control house that would be required to install equivalent fault protection capability between existing substations.

Finding Solutions to Meet Your Specific Application Challenges

When specifying a recloser for medium voltage and sub-transmission applications, utilities should consider looking for a partner who offers site-ready designs with pre-installed accessories or flexible solutions tailored to meet any unique environmental challenges. Since recloser systems are new to the sub-transmission market, it is important for utilities to partner with a manufacturer that has a history of engineering with the utmost attention to functionality and reliable performance. For utilities looking for power grid solutions of tomorrow, the cost of installing reclosers on sub-transmission lines would outweigh any future cost such as maintenance on air disconnect switches, replacing equipment and outage penalties associated with extended delays in restoration.



G&W ELECTRIC'S VIPER-HV RECLOSER

As the leading supplier of reclosers in North America, G&W Electric brings to bear the latest technology backed by more than 115 years of experience, training, and support. Its Viper recloser line for the medium voltage market is chosen by utilities all over North America for its strong performance in any environment.

G&W Electric's Viper-HV recloser is designed to provide overcurrent protection for temporary faults on overhead sub-transmission lines and provides utilities enhanced functionality on a pole without the high cost of a substation. The Viper-HV is the first recloser for sub-transmission grids, providing invaluable improvements to systems' reliability and grid resiliency.

The Viper-HV offers ultimate user flexibility by permitting a variety of installation configurations, including phase-over-phase and cross-arm version to match existing line infrastructure. Built to be a modular, turnkey solution, the Viper-HV is a reliable and cost-efficient alternative to the multiple limitations associated with available and utilized legacy equipment.

G&W Electric's Viper-HV Recloser

APPLICATIONS:

RECLOSER

High-speed clearing of temporary faults through radial overcurrent protection.

SECTIONALIZING

Load break switching, open tie points, and utility interconnection points.

AUTOMATION

System reconfiguration, automatic transfer, and FDIR/FLISR through state-of-the-art relay and communication options.

FEATURES AND BENEFITS:

MAINTENANCE FREE

The Viper-HV requires no oil or SF6, which eliminates the need for routine maintenance and improves personnel safety.

INCREASED RELIABILITY

Current carry path is protected from the environment through field-proven solid dielectric insulation. A high-speed magnetic actuator is connected to a single vacuum bottle so there are no gears or motors that might malfunction.

COMPACT 3-IN-1 DESIGN

The Viper-HV features a recloser, CTs, and voltage sensors integrated into a single space-saving design.

POLE TOP DESIGN

Offers more design flexibility and provides additional savings by not requiring a foundation in a fenced substation and control house.

SELF-CONTAINED PLUG-AND-PLAY INSTALLATION

The Viper-HV package includes a protection relay in an outdoor pole mount control with a connectorized control cable on both ends.

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This white paper is published by the experts at G&W Electric. Since 1905, G&W Electric has been a global supplier of electric power grid equipment. The company's product offerings include padmount and underground distribution switchgear, automation solutions, reclosers, current and voltage sensors, distribution and transmission cable accessories, and current-limiting system protection devices. The products are designed to the latest industry standards and backed by more than a century of engineering expertise. The result is time-proven, reliable performance.