GOING UNDERGROUND: REINVENTING RESILIENCE

Wood Mackenzie

S&C ELECTRIC COMPANY

INTRODUCTION

We are increasingly dependent on electricity to power essential aspects of our personal and professional lives, from smartphones, computers, and home health care equipment to HVAC systems and transportation. This makes the electrical grid the foundation for life as we know it.

The U.S. power grid is experiencing complexity for which it wasn't built, and there is still much more to come as our dependence on electricity continues growing. Increased demand from transport, data centers, and appliances will only keep adding to the load growth and stress. In addition, while the world is transitioning to electricity as a source of clean power, the U.S. is facing more frequent and severe weather threatening the grid's resiliency.

Although the US electrical grid is an engineering marvel, it is also showing its age. Much of the U.S. electric grid was built in the 1950s and 1960s, when the population was lower, there were fewer electric appliances, and storms were less destructive. The country's infrastructure is using the last century's technology to power it through this and into the future.

With these pressures in mind, it's clear that America's aging transmission and distribution systems need a significant overhaul. Underinvestment could make electricity service less reliable and hurt the nation's future economy.

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To transform the grid for the 21st century, take full advantage of the energy transition, and ensure resilient and reliable power no matter the weather, we must prioritize investment in the edge of the grid, where most of us plug in and live our lives.

Fortunately, the U.S. is embarking on its largest investment in electrical infrastructure since the 1960s under the broader Grid Resilience and Innovation Partnerships Program (GRIP).

The **$10.5 billion GRIP program** is intended to strengthen, diversify, and expand America's power grid while building resilience to climate and load stress.

But the investment is just the beginning. Building a 21st-century grid requires broad collaboration. Together, utilities, regulators, government, industry, and consumers have a unique opportunity to transform our grid infrastructure and address the growing demand for sustainable and resilient electricity.

This means upgrading existing transmission lines to incorporate distributed energy resources (DERs) and building new lines to bring energy from remote renewable sources to population centers. The distribution grid, which carries power to individual homes and businesses, will need even more investment than the transmission system.

Sixty percent of U.S. distribution lines have surpassed their 50-year life expectancy, and according to a report from the National Conference of State Legislatures, $1.5 trillion to $2 trillion in grid-modernization investments must be made by 2030 just to maintain reliability.

Consider these findings from analysts at Wood Mackenzie in their report, "Utility investment in grid modernization (H1 2023)":

$36.4 BILLION INVESTMENT

Twenty-five major investor-owned utilities (IOUs) have filed for a $36.4 billion investment to modernize their distribution grids. This grid-modernization investment grew exponentially between 2018 to 2023, with a 35% compound annual growth rate. The investment growth rate is rapidly accelerating, with 2022-2023 year-over-year growth 73% greater than that from 2021-2022.

80% OF GRID-MODERNIZATION INVESTMENT

DERs are the top driver for grid-modernization investment but are rarely used as a solution. Infrastructure hardening, advanced metering infrastructure, and distribution automation represent 80% of grid-modernization investment.

$3 BILLION SPEND

From these programs, top IOUs are spending less than $3 billion on reliability-driven distribution automation.

In this paper, we explore how investment in new technologies can help the country modernize its infrastructure for long-term resilience, specifically undergrounding residential distribution circuits to deliver resilience and reliability during severe weather events.

RESILIENCE AT THE GRID EDGE

As storm frequency and severity worsen across the country, many states, and the utilities that operate in them, are increasingly looking to underground more of their grid infrastructure. Utility regulators are also seeing this potential for improved resiliency. In Florida, for example, the Public Service Commission requires each IOU to file a storm-protection plan. Notably, this includes a requirement for plans to continue to move more of the overhead distribution system underground.

While moving infrastructure underground reduces the risk of storm-related outages, it creates other challenges. Chief among these are outages that still occur with underground grid infrastructure, primarily because of equipment and cable issues. Identifying and isolating faults and restoring power quickly to affected customers when it's all happening underground is no easy task.

Mike Spoor, who recently retired as vice president of power delivery at a large IOU in the southeastern U.S., has seen the devastation major storms cause firsthand and understands the value of undergrounding infrastructure.

"We have undergrounded hundreds of miles of line to improve our resiliency and in general this has been a vast improvement for our overall reliability and resiliency. Having said this, when a utility experiences an outage in its underground grid infrastructure, the difficulty of locating the fault can be quite challenging. You can't see it, and there are often accessibility challenges, as well. So, when there is an underground outage, the troubleshooting aspects become quite challenging. However, the EdgeRestore isolation capability enables utilities to minimize the number of customers impacted by the outage and restore service faster, too."

As Spoor notes, an underground grid is not immune to reliability issues. This can include cables that wear down over time and splices and elbows that are susceptible to aging. These types of underground failures are examples of how costs, safety, and reliability can still be challenging with underground electric infrastructure.

The first steps to identify and isolate a fault can take many hours of crew time and multiple costly truck rolls. This entails traveling from transformer to transformer to perform hours of manual testing along different points on the grid. These costs pile up while the customer is still without power and utility crews are exposed to numerous voltage risks. As a result, a single outage can result in customers being without power for many hours. Utilities see the impacts of this operationally and in critical customer-satisfaction metrics.

These examples are all during normal operations. Additional potential impacts during major storms can be devastating for customers and field crews.

RESTORING UNDERGROUND POWER AT THE GRID EDGE

Improvements are necessary for a grid facing more challenges than ever due to a combination of age, load and uses for which the grid was not designed. This includes two-way power flows and massive fluctuations as DERs increase.

To invest wisely, we must look at areas where there can be solid, measurable improvements in reliability and resilience, especially where there is a direct customer impact. Looking at improvements where the customer meets the grid—at the distribution grid edge—is a good place to start. The operational, regulatory, and customer drivers moving more of the distribution grid underground present interesting opportunities to accelerate these operational and customer improvements.

Is there a way to introduce self-healing technology at the grid edge, particularly for the underground distribution grid, that will reduce outages and improve customer metrics?

Consider a hardware solution that places intelligent devices with two-way power-line carrier communications on the underground grid that can locate where a fault has occurred, isolate it, and reroute power to customers in less than 60 seconds.

Customers previously affected by outages for many hours typically will have power restored within seconds and without crew intervention, eliminating truck rolls, minimizing O&M costs, and greatly improving crew safety.

S&C Electric Company, based in Chicago, Ill., has been innovating grid infrastructure for more than a century. The company recently introduced the EdgeRestore® Underground Distribution Restoration System, a first-in-the-world underground fault restoration system for residential neighborhoods.

Mike Edmonds, S&C's chief commercial officer, provides a perspective on how the EdgeRestore system is a gamechanger for utilities, particularly those in areas experiencing frequent major storms: "The EdgeRestore system is a groundbreaking fault-restoration system for underground circuits. With utilities moving more and more of their distribution lines underground to prevent outages from major events such as thunderstorms, high winds, and hurricanes, there needs to be a way to address underground faults quickly to improve resilience.

The EdgeRestore system does just that. It detects faults, then reroutes and restores power in less than a minute, making home users happy and giving the utility time to send out a crew."

What makes the EdgeRestore system such a critical part of the grid-hardening efforts is how it performs when a storm hits, Edmonds says. Many solutions in the marketplace are part of the resilience puzzle, but none are a leap forward in terms of reliably providing a new level of resilience. S&C's EdgeRestore system is that leap forward.

For more information on how your utility can ensure reliability and resilience at the grid edge, visit S&C Electric Company or contact us with any inquiries.

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