Enhancing the Modern Grid for Resiliency

Why a Tightly Integrated ADMS is Key

GRIDBRIGHT®

Secure and Sustainable Grid Integration

CONTENTS

INTRODUCTION

For over a decade, utilities have focused on modernizing the grid. Amazingly, existing grid modernization technologies can be enhanced to improve the grid's resiliency.

The approach to making the grid smart often includes installing smart or advanced meters, deploying high-speed communications to support the widespread deployment of remote sensors, and installing new advanced control center software to optimize grid operations.

The goals are typically to improve customer satisfaction, increase reliability, enable more renewable energy, and lower costs. While these are all admirable goals for grid operators, grid operators may have been making trade-offs that may inadvertently impact grid resiliency. An example is shutting power off in high-risk fire conditions, which decreases measured reliability but improves safety and system survivability, otherwise called resiliency. Another example is the common practice of attempting to automatically restore power into a fault on the chance that it was temporary or can be isolated by clearing a fuse, causing fuses to expel hot metal, and causing downed conductors to spark, potentially dangerous scenarios in high-risk wildfire conditions. These practices improve measured reliability by restoring power to customers without requiring crew action and reducing overall outage durations but at the cost of decreased resiliency.

Recently, there has been industry and DOE-funded research into new technologies such as advanced wireless fault indicators, phasor measurement units, and low-cost voltage and current sensors. These technologies can enhance the grid's resiliency, but they require components of the infrastructure deployed as part of the modernized grid. To deploy these technologies, utilities must leverage communication infrastructure already deployed for smart metering and remote monitoring and control, upgrade and integrate their distribution management systems, and use new mobile data systems to deploy new sensors in the field cheaply.

THE ROLE OF ADVANCED DISTRIBUTION MANAGEMENT SYSTEMS IN GRID MODERNIZATION

An Advanced Distribution Management System (ADMS) can be defined as the combination of multiple operational systems typically found in distribution control centers. These systems include Supervisor Control and Data Acquisition (SCADA), Distribution Management Systems (DMS), and Outage Management Systems (OMS). Over the past decade, conventional industry wisdom has consistently upheld that such convergence is advantageous. The convergence is attributed to creating a unified platform for distribution operations, eliminating the need for users to constantly switch between distinct systems to attain a single common operating picture. To illustrate, envision a scenario where a utility company encounters a sudden power outage. With an ADMS in place, the SCADA system would promptly detect device operations, the OMS would identify the affected outage area, the DMS would minimize the impacted area, and the OMS would support the prioritizing and dispatching restoration and repair tasks. This seamless orchestration not only enhances efficiency but also streamlines the user experience.

However, the practicality of integrating these systems has been a challenge for many early adopters who opted for separate platforms. Developing and maintaining tight integration between the three distinct systems often proved intricate and expensive and frequently fell short of the lofty expectations set by the vision of seamless integration. The experiences of these utilities highlight the complexity of harmonizing different technologies and underscore the need for a genuinely unified ADMS.

More recently, there has been a noticeable interest in the integration of Distributed Energy Resources (DERs) into their Advanced Distribution Management System (ADMS) solutions [1]. While the jury is still out, ADMS will likely assimilate a fourth distinct technology, Distributed Energy Resource Management Systems (DERMS). When the ADMS is managing DERs, the ADMS needs to communicate directly with a myriad of new types of utility controlled DERs. The ADMS also needs to connect and share with DER aggregators monitoring and controlling large numbers of smaller DERs, often located behind the meter. These new integrations are being done outside the traditional SCADA and IT integration data paths and potentially can be done through the cloud. GridBright is currently leading a research effort called Photovoltaic (PV) Integration using Virtual Airgap (PIVA) into a mechanism to communicate with numerous DERs in a highly secure manner [2]. Most ADMS vendors actively promote their DERMS capabilities in the current marketplace as additional modules seamlessly integrated into their existing ADMS platforms.

ENHANCING ADVANCED DISTRIBUTION MANAGEMENT SYSTEMS (ADMS) - FROM RELIABILITY TO RESILIENCY

But are we at the end-all final state for ADMS? Some recent industry trends and new research and development activity indicate that we have much further to go in the ADMS arena. The next frontier for ADMS to tackle is how ADMS can expand from a tool to support reliability improvement to a tool for improving resiliency.

The ADMS OMS suite helps improve reliability by enabling more efficient outage response with outage-clearing device identification, often incorrectly called outage prediction. The OMS is not predicting any outages. Instead, it identifies the most likely location where a protective device, such as a fuse, operated as part of the system protection that separated the faulted location from the rest of the circuit.

The ADMS DMS suite also helps improve reliability by including functionality to support Fault Location, Isolation, and Restoration (FLISR), isolating a faulted area to restore areas outside the faulted segment. Similarly, this FLISR capability is often called incorrectly self-healing, where it minimizes the impact of some damage to the feeder, yet nothing is "healed."

The Department of Homeland Security defines resilience as "the ability of systems, infrastructures, government, business, and citizenry to resist, absorb, recover from, or adapt to an adverse occurrence that may cause harm, destruction, or loss of national significance, and the capacity of an organization to recognize hazards and threats and make adjustments that will improve future protection efforts and risk reduction measures" [3]. The DHS definition is an abstract concept with little value to an engineer because engineers want and need to measure something to figure out how to improve it. They also want to be able to tell how well they did after they improved. Furthermore, we often want to understand the return on investment on any resiliency improvement. Ideally, an engineer could offer the community, regulators, and senior management different resiliency improvement options and the associated costs for decisions on what investments in resiliency have the most improvement per dollar spent.

Engineers do this today for reliability. Established IEEE standards for reliability metrics, such as SAIDI, CAIDI, and SAIFI exist [4]. Engineers routinely perform reliability studies to compare different possible reliability improvement programs. Furthermore, our modern-day ADMS with OMS functionality can measure the actual reliability defined by these metrics. The ADMS also helps the utility find the most common causes, types of failed equipment, and conditions related to the outages.

ENHANCING AN ADMS FOR RESILIENCY IN THE REAL WORLD

Last year, we noted that resiliency seemed to be the buzzword of the year at the 2022 IEEE Power Engineering Society conference [5]. At the 2023 IEEE PES conference, that observation remains valid. Several committees and working groups are attempting to put some rigor into defining resiliency as it relates to the power system. Even more significant, some groups are looking at how the power system can contribute to an overall resilient society, aligning closer with the DHS definition of resilience. Measuring resilience is going to be a tricky thing to tackle. Still, the goal is that in a few years, there will be IEEE standard resiliency metrics defined, like the way SAIDI, CAIDI, and SAIFI are reliability measurements.

In 2020 and 2021, GridBright participated in a California Electric Program Investment Charge (EPIC) research project with several partners, including San Diego Gas and Electric and Oracle, where the stated purpose was to "conduct a pre-commercial demonstration of a functioning fault location system that was utilized to create a training simulator for electric distribution system operators and other prospective users" [6]. The recommendations of this research include integrating even more numerous data sources into the ADMS, including weather data, smart meter alarms, wireless fault indicators, and Phasor Measurement Units (PMUs). It also concluded that an ADMS is an ever-increasing complex beast, and training the operators is critical for the system's success.

Benefits of the additional integrations identified in the report include "safety for the public" and "risk reduction," a component of resiliency as defined above. Directly quoting from the report:

- *The new training process and improved field equipment allow the operators to locate wire-down events quicker, reducing public exposure to a potentially energized system. Any system that hastens service restoration inherently enhances safety for the public, ensuring local infrastructure operates as intended (e.g., lighting, communications, water and sewer systems, traffic signals, and fire-fighting equipment) after faults of any kind cause service interruptions.*
- *Enables the organization to be better prepared for the future by offering more measures to mitigate/decrease the risk of starting fires due to wire down or possibly other events, thus significantly reducing the overall risk that the company and its customers face regarding wildfires.*
- *Reduces the need for test closures, which could make a more resilient utility by extending the life cycle of distribution equipment. Test closures into faults are extremely violent and contribute to equipment wear and tear. Reducing the frequency of test closures improves safety, reduces operating costs, and improves power quality.*

One of the use cases identified in the report leverages yet another research project that SDG&E has been intimately involved in called the Falling Conductor Protection (FCP) project, which is a high-speed solution designed to detect that a conductor is falling and de-energize it before it hits the ground [7]. The FCP concept is fascinating, given the potential benefits of not having live conductors hitting the ground and potentially creating wildfires.

How is this possible? First, consider that it takes 1.37 seconds for a conductor to fall from 30 feet to the ground. There is also a relatively new technology called Phasor Measurement Units (PMU). Commercial PMUs report high temporal resolution measurements, typically 30-120 measurements per second. PMU technology creates new grid monitoring and control opportunities, impossible with traditional SCADA measurements that might generate a measurement every two seconds or longer.

In this research project, PMUs were used to 1) detect rapid changes in voltage over time (dv/dt), 2) detect rapid absolute changes in voltage magnitude between two PMU locations, and 3) detect rapid absolute changes in phase angle between two points. Using the real-time PMU data stream, it was possible to accurately identify a falling conductor on a feeder based on these measurements in a fraction of a second.

The final challenge is to deploy fast enough communication to the protection equipment to detect and act in less than 1.37 seconds. In the research conducted on SDG&E feeders, accurate falling conductor detection and isolation has proven possible in both the lab and the field, with isolation occurring in a remarkable 0.2-0.5 seconds after the conductor starts to fall. Based on this success, SDG&E is beginning to deploy this technology in areas of high wildfire risk over the next few years.

To support wide-scale deployment, the FCP system needs to be appropriately integrated into the ADMS because the logic requires an accurate real-time reflection of the system model and topology, and second, the actions taken need to be reported back to the ADMS so that system operators have proper visibility into the steps being taken autonomously as part of their standard operating picture.

The resiliency-driven examples above indicate a trend toward more tightly coupled and integrated ADMS solutions. On the front end, the ADMS must talk to an ever-increasing number of field devices, such as wireless fault indicators, smart meters, and PMUs. And on the back end, it must be integrated with numerous external systems, such as DER aggregators and weather providers.

CONCLUSIONS AND SUMMARY

Resiliency can be improved by expanding and enhancing the intelligent grid that many utilities are currently implementing. The key to the enhanced smart grid is the ADMS. The ADMS, along with the integration of new sensors, external systems, and the addition of new algorithms, can support resiliency objectives. Because of this, ADMS vendors will compete by offering new out-of-the-box capabilities to help numerous new resiliency-based use cases. Nearly every one of these use cases requires new integrations. We will also see utilities, regulators, and communities conclude that an ADMS is not an optional, nice-to-have but a must-have system critical to improving the utility's resiliency posture. We will also see systems integrators and implementation teams deploy more ADMS solutions and build even more integrations as they seek to gain additional resiliency in the distribution system to meet the demands of the utilities.

WORKS CITED

[1] GridBright, "Are DERs making it easier to justify an ADMS?" https://www.gridbright.com/insights/are-ders-making-it-easier-to-justify-an-adms/

[2] GridBright, "PIVA: Photovoltaic (PV) Integration using Virtual Airgap (award DE-EE0009631)," https://www.gridbright.com/piva-photovoltaic-pv-integration-using-virtual-airgap-award-de-ee0009631/

[3] Department of Homeland Security, "DHS RESILIENCE FRAMEWORK Providing a Roadmap for the Department in Operational Resilience and Readiness," https://www.dhs.gov/sites/default/files/publications/dhs_resilience_framework_july_2018_508.pdf

[4] "IEEE Draft Guide for Electric Power Distribution Reliability Indices," in IEEE P1366/D7, May 2022, vol., no., pp.1-43, 14 June 2022.

[5] Nielsen, Terry, "Just returning from the IEEE PES GM", https://www.linkedin.com/posts/terry-nielsen-121a483_just-returning-from-the-ieee-pes-gm-resiliency-activity-6955675324755980289-KDH-

[6] San Diego Gas and Electric, "Safety Training Simulators with Augmented Visualization, Module 1, Focused Patrol Simulator" https://www.sdge.com/sites/default/files/EPIC-3%20Project%204%20Module%201%20Final%20Project%20Report.pdf , December 31, 2021.

[7] Dietmeyer, Dan, https://www.naspi.org/sites/default/files/2019-10/04_SDGE_Dietmeyer_20191029.pdf, October 29, 2019.

ABOUT THIS ARTICLE

THE AUTHOR

Terry Nielsen, EVP and Executive Consultant

Terry is an executive consultant and systems integrator specializing in power industry grid management systems. He has served over 50 electric utilities on five continents, improving their grid management and emergency response. He has served on the DistribuTech Advisory Board since 2001. He has over 30 years of experience in defining and developing software solutions for the utility industry. His experience includes the development, implementation, and integration of Energy Management Systems (EMS), Market Management Systems (MMS), Network Model Management Systems, Distribution Management

Systems (DMS), and Outage Management Systems (OMS). Terry is a Senior Member of the IEEE and an active member of several IEEE working groups.

COPYRIGHT

ABOUT GRIDBRIGHT®

GridBright is a boutique consulting and systems integration company. We help the electric industry implement smarter solutions for managing the modern grid. We specialize in advanced distribution management systems (ADMS), renewable interconnection, and distributed energy resources (DER) integration. To learn more, visit GridBright.com.