Transmission System Resiliency – An Overview

In November 2015, the North American Transmission Forum (NATF) published a brief summary of reliability and resiliency, and highlighted the electric industry's efforts related to these tasks. Since that publication, significant activity, research, and results have been achieved, and the Technical Advisory Group (TAG) created jointly between the Electric Power Research Institute (EPRI) and the NATF determined it was time to update, revise, and reinforce certain aspects related to reliability and resiliency.

BACKGROUND

The electric grid serves as a vital societal function and an essential aspect of national security. Every sector of the national economy, including food production, banking, manufacturing, and retail distribution, depends on it. Electricity users have come to expect a high degree of electric reliability and availability, and meeting those customer expectations is a fundamental delivery requirement for all electric utilities.

Beyond the economy, extended power outages can also have severe consequences on national defense, communications, water and waste water, healthcare, emergency management, transportation, and law enforcement. Considerations during outages also include interdependencies among critical infrastructures (e.g., the gas and electric industries); needs for workforce support; and local, state, and federal collaboration and assistance.

While delivery of electric service has been very consistent and highly reliable for much of the past 100 years of the development, expansion, and continuous operation of the power grid across North America, it was realized that the focus solely on reliability, based on frequency and duration of power outages, may be insufficient in improving system integrity and availability of electric power going forward.

Today, risk-based strategic planning and communications decisions are called for that may be different for each utility. One size does not fit all because of the many variables each utility faces, including dissimilar threat levels, available resources, corporate cultures and risk tolerances, geographical locations, and regulatory policies. Appropriate and cost-effective solutions must be determined by each utility.

RELIABILITY

Electric system reliability has been, and will always be, a fundamental objective of electric utility providers, because keeping the lights on and delivering electric service that meets customer expectations is the ultimate goal. For our purposes, *transmission system reliability is defined as the ability of the system and its components to withstand instability, uncontrolled events, and cascading failures, during normal operation and routine (i.e., reasonably expected) events.*

RESILIENCY

Electric utilities typically manage system reliability through redundancy and risk-management strategies to prevent disruptions from routine hazards. New hazards and the potential for extreme events, coupled with society's increased dependency on electricity, have raised the importance of grid resiliency.

Therefore, in our context, *transmission system resiliency is defined as the ability of the system and its components (i.e., both the equipment and human components) to minimize damage and improve recovery from non-routine disruptions, including high impact, low frequency (HILF) events, in a reasonable amount of time.* Resiliency includes a diverse range of topics, such as flexibility, hardening, security, and recovery.

HOW ARE NATF AND EPRI MEMBERS ADDRESSING RESILIENCY?

Improving resiliency requires a systematic, strategic approach and cost-effective solutions that may be unique for individual utilities. Elements to improve system resiliency are now more-frequently integrated into the planning, design, and construction processes. System investment strategies for hardening, upgrading assets, and spare equipment need to be cost-effective, flexible, and agile, while accommodating the adoption of new technologies. A plan of action to address resiliency needs to take an "all hazards" approach, illustrated in the following table, as certain resiliency measures can provide protection from multiple threats.

		Hazards/Threats								
		GMD	EMP	IEMI	Physical Attack	Cyber Attack	Severe Weather	Reduced Workforce	Single Point of Failure	Other
Modes	Assess									
	Prevent/ Harden									
	Detect/ Monitor									
	Recover/ Restore									

Since 2013, EPRI and the NATF have co-hosted numerous industry summits to drive action on various aspects of resiliency. The industry continues to make tremendous investments to improve systems, such as GMD studies, more-robust security measures (including work to address requirements of CIP V5 and CIP-014), new control centers, improved spare-equipment strategies, the creation of new modeling software to determine potential weak spots that were previously unrecognized, etc.

The NATF has been hard at work on a "Spare Tire" project investigating system operations under severely degraded control and communications conditions. In April 2016, EPRI launched a three-year project studying the potential impacts of an electromagnetic pulse (EMP) on the power grid. The results of this research and development will provide a factual basis for the industry regarding the threats, consequences, and potential mitigation measures for EMP. Additionally, a new EPRI project is looking at emergency recovery communications to be used after catastrophic (i.e., "Black Sky") events.

CONCLUSIONS AND NEXT STEPS

Efforts to improve reliability and resiliency involve risk-based, strategic decisions that may be different for individual utilities. Available resources, level of risk tolerance, geographical locations, and regulatory policies will influence the type of investments, planning, designs, construction, upgrades, and operations for each system. New threats, hazards, and vulnerabilities continue to arise even as utilities work to protect against today's challenges, so utilities must also remain vigilant for emerging threats.

The joint TAG will develop and publish additional resources covering in greater detail the many facets (e.g., flexibility, hardening, security, recovery, etc.) of reliability and resiliency.