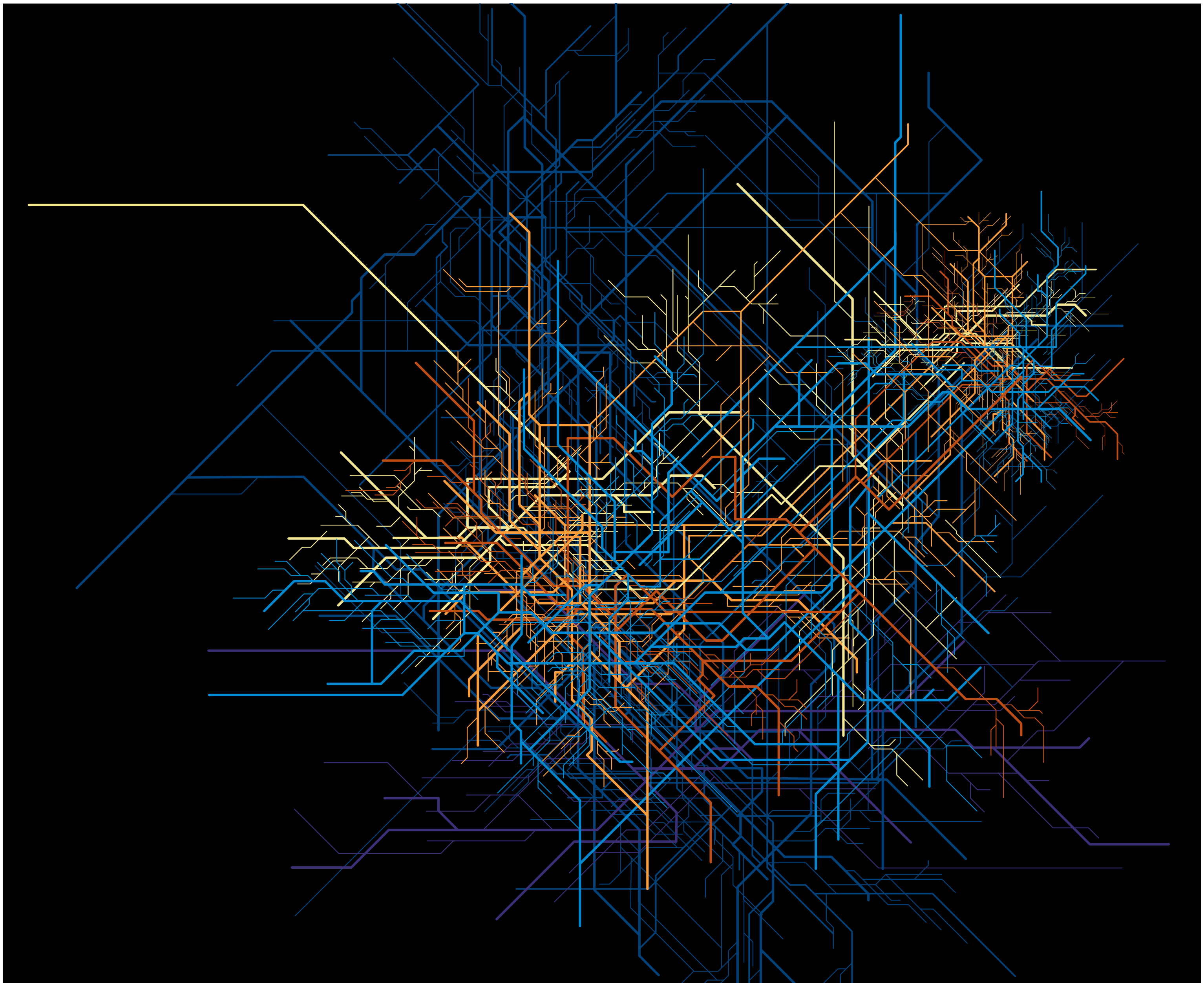

White paper

# Electric power and storm restoration
# Roadmap recommendations

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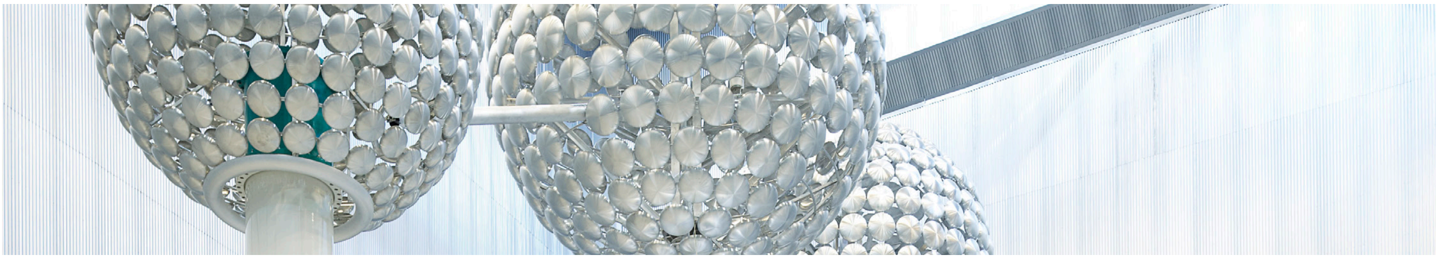

## Introduction

The devastation and financial losses caused by recent major storms will be a topic of discussion far into the future. In 2012, storms Irene and Sandy devastated communities in the Northeast leaving lingering and haunting questions of how to prepare for a future where massive storms may occur with greater frequency and greater intensity.

Hurricane Sandy's record blackouts and prolonged recovery caused many to question the electrical power system's vulnerability to severe weather. Sandy knocked out power to more than 8.5 million homes and businesses across 24 states, leaving many customers doubting claims that increased spending for grid modernization carries with it any reliability benefits.

As utilities and regulators address these issues, they will face tough decisions about strengthening the electric grid to withstand the stresses that come with severe weather events. Some have argued that the grid is vulnerable by design, and that efforts should be concentrated exclusively on storm preparedness. ABB subscribes to the broader view, shared by others, that in addition to process improvement for storm restoration, improving grid resiliency will require regulatory changes, technological solutions and infrastructure improvements.

Below are our thoughts on some specific technological solutions for storm restoration and preventive steps to include in the roadmap.

## Distribution Grid Management

Utilities are moving forward to modernize grids and a leading investment area is distribution grid management. These investments combine and integrate multiple technologies across utility information technology (IT) and operations technology (OT) to improve business operations during both normal and storm restoration. IT in this context is the utility enterprise-level software systems that include work and asset management, mobile work force management, geographic information and customer information systems. OT is the operational systems that include the SCADA/EMS for transmission operations, substation automation, distribution operations management, outage management, distribution automation to control devices in the field, and advanced applications that enable self-healing and improved efficiency.

The key components of this IT/OT concept for storm restoration are a distribution management system (DMS) that provides the control room with management tools for operating the distribution grid. A DMS is integrated to the utility's geographic information system to enable modeling, analysis, simulation and tracking of the current status of the distribution system. The DMS is also integrated to advanced metering infrastructure (AMI) or automated voice response systems to input customer outage notifications.

The DMS platform includes operational tools such as outage management, distribution SCADA and communications to control and monitor the distribution grid. During normal operations, volt/Var optimization applications drive grid efficiency. During system restoration in response to storms and other disturbances, the outage management system tracks the customers impacted by outages and the status of work crews and repairs. An advanced application called fault detection, isolation, and restoration (FDIR) or fault location, isolation, and service restoration (FLISR) enables a self-healing grid that can automatically isolate faulted sections of the grid and restore power to many customers by feeding unfaulted sections of feeders from adjacent lines. The execution of these applications requires communications to devices in the field such as capacitors, line voltage regulators, transformer load tap changers, reclosers, distribution automation switches, fault current indicators, and other sensors. Intelligent controllers for these devices complete the infrastructure for improved distribution grid management.

Another factor is media, customer and regulatory scrutiny on outage durations and the need for utilities to be able to both restore the grid as quickly as possible and effectively communicate on the restoration process. Meeting this demand requires DMS vendors to deliver integrated outage management and communications systems with their DMS offering. The complete IT/OT integration should also include a workforce management system to manage restoration resources, links to AMI, and operations business intelligence. The situational awareness provided by this business intelligence application is critical for communications on estimated time for restoration and numbers of impacted customers to internal stakeholders, as well as to government agencies, customers and the media.

Recent events have put a spotlight on customer communications around major weather-related events. Providing customers with tips and resources for assistance may be an area of utility operations that increases and expands through traditional and social media outlets to help customers deal with outages. Consumers are becoming accustomed to constant connectivity and utilities need to offer engagement like never before to stay up-to-date and relevant to consumers. We also see a shift of using every customer contact point, such as a meter installation or repair, as an opportunity for increased consumer engagement.

### Microgrids

Widespread power outages in the wake of severe hurricanes and storms clearly show the weakness of a centralized electrical grid and make a case for including distributed energy resources as part of a decentralized system of power generation and distribution. Microgrids increase reliability locally through redundant distribution, automated switches, distributed generation, energy storage and grid stabilization. Local generation and storage allow sections of the power grid to operate independently in an intentional island mode during a major grid disturbance. Efficiency is increased by locating generation close to consumption, which reduces electric line losses and costs associated with transmission.

Microgrids also support sustainability and resource diversity through the incorporation of renewable energy sources while maintaining grid stability. A microgrid will utilize distributed energy resources (power generation) throughout its system to provide power when disconnected from the main grid. This generation typically includes a combination of thermal generation and renewable generation. The microgrid can be scaled for different applications and implemented at government installations, medical facilities, first responder stations, and key retail facilities such as gas stations, pharmacies and grocery stores, etc. When implementing these microgrids, designs should include alternative generation sources, grid stabilization equipment, grid management software, energy storage, and a robust communications network.

The generation sources deployed throughout a microgrid can be varied. Traditionally diesel generators will be used for single building backup. New microgrids utilize multiple renewable and alternative-fuel generation sources (wind, solar, fuel cells, natural gas) capable of powering multiple loads. These alternative power sources not only allow redundancy but also reduce the dependency on fossil fuels for generation. If applied and managed properly, this generation not only provides backup support during emergency situations, but can also be used to help increase renewable energy penetration into the grid during normal operation.

For microgrids to operate effectively and in the most optimal manner, they must be properly managed. The coordination of devices can be done via integrated distribution grid management. Each group of devices, whether it is generators, switching devices or meters, has its own control system (distribution management, outage management, workforce management, etc.). The interconnection of these systems not only enables the disconnection from the main grid (if required), it also enables the most complete and optimal operation of the system. Outages can be isolated and pinpointed, appropriate generation resources energized, and the correct field personnel deployed to quickly respond to the critical area. Integrated distribution grid management makes this seamless.

In wake of recent storms, we need to look to the technologies and systems available to strengthen our electrical grid. Using localized generation to ensure critical loads can be served when primary power sources are not available is a tool to mitigate the consequences of widespread outages.

### Mobile Generation

One challenge to the recovery from hurricane Sandy was the inability of gas stations, grocery stores and other businesses to provide goods and service since there was no available power. Most gas stations and stores do not have back up generation and are subject to utility restoration priorities to get power.

Currently, there are limited structured programs in place for deploying mobile generation resources, or back-up power, as part of a major storm restoration.  ABB, like other equipment manufacturers, typically keeps a limited number of mobil generators in stock and when a disaster takes place, we try to pre-position that inventory for the recovery effort.  Advance notice, like we had for hurricane Sandy, helps with preparation. But absent that notice, equipment suppliers work through local distribution channels to ship inventory to the storm restoration location. Our distributors/dealers subsequently sell to affected businesses and often times, as was the case with Sandy, virtually all available equipment is fielded while blackout areas remain.

Establishing more robust back-up generation planning for critical commercial entities may be needed.  Similarly, the government should consider emergency mobile generation inventory plans as part of its overall disaster planning and response reviews.

## Conclusion

Utilities are providing due diligence to ensure that lessons learned from major storms are leveraged to improve planning and performance during future storms. Our ability to help utilities understand the impact of major storms and other disasters and to assess their practices or disaster containment simulations will be an important component of grid security going forward.

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