Atlantic Wind Connection

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Grid Resiliency, Its Economic and Security Impacts, and the Implications of AWC

December 2012

Hurricane Sandy Preliminary Review

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Background

On October 29, 2012, the storm that became known as "Superstorm Sandy" moved ashore near Atlantic City, NJ. While the high winds and rains affected 24 states, including the whole of the eastern seaboard, New Jersey and New York felt the brunt of the event.

By the time the storm receded, over 100 people had lost their lives, thousands had lost their homes, millions lost their electricity, and billions of dollars were lost from the economy. Mark Zandi, chief economist at Moody's Analytics, estimated that the storm will wind up costing upwards of $50 billion, with $30 billion in damages to households, businesses, and infrastructure and the remainder due to lost output from business, transportation, health care, government and other services. Zandi cautioned, however, that these totals could rise significantly.[1]

Governor Chris Christie pegged preliminary costs for the state of New Jersey at nearly $30 billion but also warned that the estimate would probably rise "once next summer's tourism season, population shifts and the effect on real estate values were taken into consideration." FEMA, meanwhile, estimated that nearly 72,000 homes and business in New Jersey were damaged.[2] With the State already struggling with a 9.8% unemployment rate, the longer-term effects of the loss of electricity to businesses and industry coupled with increasing concerns about the on-going vulnerabilities of the electricity grid should energize lawmakers to consider prioritizing reliable electricity delivery. Press reports suggest that New Jersey will look to the Federal government to pay for upwards of 90% of hurricane clean-up and recovery. Some of the State's ranking federal lawmakers anticipate that Congress will approve a supplemental spending bill.[3]

This memo reviews what is preliminarily known about the storm's effects on the electricity grid and the cascading effects on some parts of the State's critical infrastructure. Over the next months, federal, state, and local hearings, reviews, and inquiries will shed further light on the events of late October 2012. A fuller picture about the role of grid reliability will emerge at that point and can be factored into an analysis on how a fully functioning and appropriately developed AWC backbone can serve as a vital component of a reconstructed electricity delivery system.

[1] Napach, Bernice, "Hurricane Sandy Ranks Among the Worst Economic Disasters: Mark Zandi," Daily Ticker, 1 Nov. 2012, http://finance.yahoo.com/blogs/daily-ticker/hurricane-sandy-ranks-among-worst-economic-disasters-mark-182707911.html.

[2] "Christie Administration: Cost of Hurricane Sandy's damage to N.J. nearly $30B," Statehouse Bureau Staff, 23 Nov. 2012, http://www.nj.com/politics/index.ssf/2012/11/christie_administration_cost_o.html.

[3] Spoto, MaryAnn, "N.J. asking federal government to pay for 90 percent of Sandy recovery," 20 Nov. 2012, The Star-Ledger.

The Electricity Grid's Performance During and After Hurricane Sandy

Hurricane Sandy's high winds and rains, accompanied by a significant tidal surge, damaged or destroyed large numbers of transformers, switching stations, and transmission lines throughout New Jersey.

Thirteen switching stations and 49 high-voltage transmission lines were damaged in Public Service Electric & Gas' (PSE&G) service area alone. The storm also affected nearly 3,800 MW of generation in northern New Jersey including the Kearny, Linden, and Sewaren power plants.[4] PSE&G, Jersey Central Power & Light (JCP&L) and Atlantic City Electric saw a total of 2,200 transformers knocked out and 5,600 power poles destroyed.[5]

The scope of power outages in New Jersey was historic; sixty-five percent of New Jersey utility customers lost power due to the storm. New Jersey's biggest utility, PSE&G, saw 1.7 million (77%) of its customers go dark.[6] Throughout the entire United States, spread over 21 states, there were 8.5 million power outages, the highest outage total ever.[7]

In New Jersey, it took 11 days to return power to 95 percent of the population.[8]

If fully built out, AWC could have helped the overall system recover faster post-Sandy. Having the AWC act as an alternative south-north pathway paralleling the I-95 segment could have enabled load relief and eased overvoltage conditions in South New Jersey caused by too much generation/not enough load, unloaded transmission lines, etc., thus facilitating otherwise infeasible load switching on transmission lines that are needed for faster customer service recovery.

As well, the ability to control power injections and withdrawals through AWC terminals connecting to PJM's networks would also accelerate post-storm load service recovery by selectively energizing certain circuits.

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[4] Dombek, Carl, "PSEG Progresses on Returning Damaged Facilities to Service Post-Sandy," 25 Nov. 2012, http://www.energybiz.com/article/12/11/pseg-progresses-returning-damaged-facilities-service-post-sandy.

[5] Hennelly, Bob, "NJ After Sandy: To Rebuild or Re-Design," 16 Nov. 2012, http://www.wnyc.org/articles/new-jersey-news/2012/nov/16/nj-after-sandy-rebuild-or-re-design/.

[6] "PSE&G Service Restoration Update- Monday, November 12, 2012 at 3:30 p.m." PSE&G, 12 Nov. 2012, http://www.pseg.com/info/media/newsreleases/2012/2012-11-12.jsp#.UL-4MGcheSo.

[7] United States Department of Energy, Office of Electricity Delivery and Energy Reliability, "Hurricane Sandy Situation Report # 12," 3 Nov. 2012, http://www.oe.netl.doe.gov/docs/2012_SitRep12_Sandy_11032012_1000AM.pdf.

[8] "Power Outage Time after Sandy Not Extraordinary," 16 Nov. 2012, The Wall Street Journal.

The Effect of Grid Devastation on Critical Infrastructure

Hospitals: In the immediate aftermath of the storm, 30 hospitals in New Jersey—roughly one-third of the state's total—were dependent on generators to power their life-saving devices. Beyond providing acute care, hospitals throughout the affected area were indispensible in providing the services usually handled by pharmacies and community physicians forced to close because of the hurricane. As a RAND report acknowledged, "a health care facility can muddle along with limited supplies and a short-handed staff for several days, but it cannot function without power." [9] Yet examples abounded of medical personnel relying on flashlights for nearly 48 hours.[10]

New Jersey Health Commissioner Mary E. O'Dowd's advice for future storms was to, "Rely on generators and have plenty of fuel on hand to run them." [11] It is apparent that the future healthcare of New Jerseyans is made vulnerable by the condition of the electricity grid.

AWC could help re-energize the grid, by providing the power needed to re-start conventional power stations and restore normal grid operations. AWC's converters can be adjusted to provide increased support to the AC grid as needed to avert or mitigate AC complications.

Nuclear Plants: Hurricane Sandy forced three nuclear reactors to shut down, and a fourth, Exelon Corp.'s Oyster Creek facility in New Jersey, to declare an alert. One of the main challenges to the plants was potential disruption to power delivery that could degrade cooling systems in place to safeguard spent reactor fuel rods. If the rods overheat and are exposed to air, radiation releases are possible. According to press reporting, Oyster Creek at one point experienced a power disruption that necessitated the use of two backup diesel generators.[12]

While none of the nuclear plants operating in the storm ravaged area suffered a disaster like that of Fukishima in Japan, national and state lawmakers cited Hurricane Sandy as a wake-up call for updating nuclear safeguards and ensuring reliable power supplies to the plants. Representative Edward Markey of Massachusetts, the top Democrat on the House Natural Resources Committee, recently stated that, "U.S. regulators have an opportunity and a responsibility to prepare for natural disasters and extreme

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[9] Kellerman, Arthur, "Generation Ex," 15 Nov. 2012, RAND, http://www.rand.org/blog/2012/11/generation-ex.html.

[10] "Sandy Offers Lessons on Surviving Nature's Fury," 3 Nov. 2012, Modern Healthcare.

[11] Kitchenman, Andrew, "Nor'easter Tests Hard-Pressed Hospitals, Weary Medical Personnel, Overtired and Overstressed by Last Week's Superstorm, NJ Health Professionals Face Another Bout of Bad Weather," 8 Nov. 2012, Healthcare, http://www.njspotlight.com/stories/12/11/07/nor-easter-tests-hospitals-health-officials-still-recovering-from-sandy/.

[12] Guarino, Douglas, "Critics: Sandy Showed Nuclear Plants' Vulnerability to Weather, Sabotage," 1 Nov. 2012, Global Security Newswire, National Journal.

weather…and…an immediate first step is to fully implement the safety upgrades recommended by the Fukishima task force in a manner that ensures they are mandatory, in recognition of the fact that they are necessary to ensure the adequate protection of America's nuclear power plants." In March 2012, the Nuclear Regulatory Commission announced new rules inspired by the Fukishima Dai-Ichi plant incident.

The new NRC rules include requiring reactors to have emergency equipment in place to indefinitely survive a blackout.[13]

Critical loads, such as nuclear plants, can be specifically supported through the AWC system with dedicated and direct black start service. The AWC system can easily meet the four conditions for a "black start" capability. Black start capability is essential to assure the timely resumption of power supply to critical loads and to the re-energization of blacked out areas. The requirements for a resource to be counted on for such services are: 1) very high availability; 2) proper location; 3) adequate size; and 4) quick start capability, such as with voltage-sourced converters that can deliver the needed amounts of power with a click of a mouse. Such a capability is vital for fulfilling the NRC's recommendation to "strengthen station blackout (SBO) mitigation capability."

[13] Klimasinska, Kasia and Brian Wingfield, "Nuclear-Power Industry Survives Sandy's Readiness Test," 21 Oct. 2012, Bloomberg News.

Political and Popular Demand for Updated Infrastructure

In the time since Hurricane Sandy, political and popular calls for a hardening of the electricity grid have intensified. There is a rising chorus of voices questioning whether underfunding of grid reliability and redundancy projects multiplied the effects of the storm. Others have said that the efficiencies wrung out of the utilities sector over the last decade may have been wiped away by the tens of billions lost in productivity since the storm. New attention is being given to a 2009 report card from the American Society of Civil Engineers (ASCE) that reviewed the costs of the chronic underinvestment in the grid. The ASCE predicted that $1.5 trillion to $2 trillion in electric utility investments will be needed by 2030.[14]

In the next few months, the New Jersey Board of Public Utilities will begin exploring the possibility of the "selective'' burying of underground lines, recognizing the vulnerability of the current system."[15] South of New Jersey, in Maryland, the District of Columbia, and Virginia, power companies are costing out moving segments of their power lines that are most vulnerable to winds underground. North of New Jersey, Connecticut Governor Dannel Malloy is also urging utilities to move towards burying lines, recognizing that the economy of the region depends on electric reliability.

Former New York Governor George Pataki wrote in the Wall Street Journal that to, "make our electrical grid more reliable, serious consideration has to be given to burying electrical-distribution networks underground. This costly but critical investment would eliminate the need for utility poles and overhead wires, drastically reducing the need for repairs caused by wind and tree damage."[16]

Much of the discussion of burying lines is focused on on-shore projects where the costs of such a project could be prohibitively expensive. New momentum to increase the resiliency of the grid through off-shore undersea lines is being lauded as a way to turn the tragedy of Hurricane Sandy into a brighter future for New Jersey and the region.[17]

Pataki and others are championing increasing the use of high-voltage direct-current (DC) transmission lines and burying them underwater similar to the Cross Sound Cable between Connecticut and Long Island.[18]

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[14] "Hurricane Sandy Utility Outages May Be Worsened by Underinvestment, Lack of Planning," 2 Nov. 2012, The Huffington Post, http://www.huffingtonpost.com/2012/11/01/hurricane-sandy-utility-outages_n_2053120.html.

[15] Johnson, Tom, "Sandy Spurs New Look at Underground Power Lines, Grid Upgrade State BPU Chief Warns NJ Ratepayers Would Foot Bill for 'Incredibly Expensive' Measures" 21 Nov. 2012, NJ Spotlight.

[16] Pataki, George, "In Sandy's Wake, Time to Upgrade the Power Grid: For Starters, Bury Electrical-Distribution Networks Underground," 25 Nov. 2012, The Wall Street Journal.

[17] "Should Utility Electric Lines Go Underground? A look at the Costs," 13 Nov. 2012, Bloomberg News.

[18] Ibid: 16

There is also a growing recognition that the advanced age and out of date technology of the electricity grid also contributed to the pain and suffering from Hurricane Sandy. A recent article in Discover Magazine observed that the, "average substation transformer is 42 years old, two years older than the designed lifespan of a substation transformer. For the most part, our grid hasn't been modernized—it's largely mechanical equipment operating in a digital world… Perhaps most importantly, the grid isn't being prepared for the future."[19] As a comparison, 42 years ago in 1970, total U.S. consumption of energy was 67.838 quadrillion BTU. Today, the U.S. consumes 97.301 quadrillion BTU—nearly a 50% increase.[20] And yet most of the grid remains the same.

As New Jersey recovers from Hurricane Sandy, experts contend that it makes little sense to replace damaged electrical components with the same technology.[21]

Today's AC grid cannot be controlled optimally to direct power to where it is most needed. AWC represents the next generation of controllable grid technology. It uses advanced HVDC technology in a controllable, multi-terminal network. AWC will make New Jersey a leader in advanced transmission networks and set an example for the U.S., Europe, and Asia for how flexible, multi-terminal HVDC grids of the future will operate.

[19] Koerth-Baker, Maggie, "Droopy Lines Overloaded Grids," Discover Magazine Blog, 7 Aug. 2012.

[20] U.S. Energy Information Administration, "Section 1, Energy Overview, Figure 1.1, Primary Energy Overview, Selected Years, 1949-2011," *Annual Energy Review 2011.* Sept. 2012, http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf.

[21] Ibid: 16