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The CIP Report: Integrating Renewable Power, Securely

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Background

The concept of protecting electric system critical infrastructure is longstanding and deeply ingrained in the industry. Almost any utility worker will tell you that her or his primary duty is "keeping the lights on." Threats to electric infrastructure include severe weather, physical and cyber attacks, electromagnetic pulses, geomagnetic disturbances, interdependence with other critical infrastructure, such as telecommunications, fuel and water, pandemics,[1] human error, and uncontrolled (cascading) operational failures on neighboring systems.

Given the lack of storage, the speed of transmission, and the interconnectedness of the system, there are few other types of infrastructure, telecommunications being perhaps the only exception, where the impact of a failure is felt so widely, so quickly. For example, on August 14, 2003, the contact between a tree and a wire in Ohio at 2:02 p.m. set off two hours of increasing instability of the grid in the Cleveland-Akron area, which by 4:05 p.m., could no longer be controlled, resulting in a cascading blackout affecting approximately 50 million people in the northeastern United States and Canada ("the 2003 Northeast Blackout").[2]

The 2003 Northeast Blackout, like the massive blackout that affected the Northeast in 1965, became a turning point. The 1965 blackout spurred the growth of power pools and increased cooperation among utilities. The 2003 Northeast Blackout resulted in legislation that set the framework to transform the North American Electric Reliability Council, an industry-run organization that relied primarily on voluntary cooperation among utilities, into the North American Electric Reliability Corporation (NERC), an independently funded reliability organization tasked with developing and administering mandatory reliability standards (Reliability Standards), subject to oversight and enforcement, including civil penalty assessments, by the Federal Energy Regulatory Commission (FERC).

In the area of critical infrastructure protection (narrowly defined), the Reliability Standards include measures for perimeter control of critical assets and reporting of threats; other Reliability Standards specify operational safeguards ranging from training requirements to relay settings.[3] In September 2011, FERC proposed to adopt revised cybersecurity standards that, among other things, would impose "bright line" criteria for identifying critical assets.[4] Notwithstanding these efforts, grid security is an elusive prey.

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1. National Infrastructure Advisory Council, *A Framework for Establishing Critical Infrastructure Resilience Goals*, ("NIAC Framework Report"), (October 2010),48, available at http://www.dhs.gov/xlibrary/assets/niac/niac-a-framework-for-establishing-critical-infrastructureresilience-goals-2010-10-19.pdf.
2. U.S.-Canada Power System Outage Task Force, *Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations*, (September 2004), 1, and 45-72, available at https://reports.energy.gov/BlackoutFinal-Web.pdf.
3. Reliability Standards, Accessed on December 7, 2011, available at http://www.nerc.com/page.php?cid=2|20.
4. *Version 4 Critical Infrastructure Protection Reliability Standards*, Notice of Proposed Rulemaking, 136 FERC ¶ 61,184 (2011).

As recently as September 8, 2011, a blackout originating in Arizona caused a loss of power to southern California, parts of Arizona, and Mexico's Baja peninsula, including every customer of San Diego Gas & Electric Company.[5] Ultimately, protection must include both efforts to prevent problems from occurring, and enhancing the grid's ability to withstand and recover from those stresses that cannot be avoided.

Renewable Power

Against this backdrop — an industry committed to reliability and infrastructure protection, but facing a Herculean task — comes a new factor: renewable generation. Renewable generation encompasses intermittent or variable energy resources (VERs), such as wind and solar, as well as resources that may be more controllable, such as biomass, hydro, landfill gas and geothermal, but which for commercial or other operational reasons are often not fully dispatchable.

Many renewable generation facilities are smaller than their fossil fuel counterparts, and the sector includes a rapidly growing amount of distributed generation which may be interconnected directly to the distribution system or may serve load behind the meter (such as rooftop solar). For example, the California Public Utilities Commission released a report last summer stating that 194 MW of distributed solar generation capacity was installed in 2010, a 47 percent increase over 2009.[6] But, the 924 MW of installed solar capacity in California is spread over 94,891 sites,[7] which averages to less than 10 kW per site. In New Jersey, which rivals California in solar capacity growth, over 400 MW of solar capacity is generated from over 10,000 facilities.[8]

Renewable power has some inherent infrastructure protection benefits as well as the environmental benefits for which it is more generally sought. Wind and solar power are not dependent on fuel distribution infrastructures, and certain other renewable fuels are sourced locally (e.g., landfill gas and some biomass). Thus, failures of infrastructure in other sectors, such as rail transport (used for coal) or natural gas pipelines are less likely to impact such generation.[9] The "fuel" is domestic and, thus, not subject to national security concerns. Further, renewable power is often delivered through distributed generation sources, close to load, diversifying the risk posed by large central power stations, where terrorist activity or natural disasters can disable a large amount of capacity at once. While renewable resources are not immune from disruption, the U.S. pursuit of greener energy resources is adding more resilience to the grid through diversification.[10] But, renewables also add new challenges and opportunities.

In general, the NERC Reliability Standards for physical infrastructure and cyber protection of generation sources do not draw a distinction based on fuel source. However, unless a generator is specifically found to be critical to the reliability of the bulk power system or needed for black start or system restoration, NERC has exempted individual generating units. This includes units with a gross nameplate rating of 20 MVA or less or a plant with a gross nameplate rating of 75 MVA or less from inclusion in its compliance registry, because, generally, they are not deemed critical.[11]

5. For an interesting mathematical perspective on the intractability of grid failures, see Peter Fairley, *The Unruly Power Grid*, IEEE Spectrum, (August 2004), available at http://spectrum.ieee.org/energy/the-smarter-grid/the-unruly-power-grid/0.

6. Press Release, California Public Utilities Commission, *CPUC Report Shows Record Growth in Rooftop Solar Installs*, (July 5, 2011), available at http://docs.cpuc.ca.gov/published/News_release/138482.htm.

7. Ibid.

8. Nathanial Gronewold, "Solar Industry's Boom in N.J. Casts Shadow Over Program That Spurred It," *N.Y. Times*, (August 25, 2011), available at http://www.nytimes.com/gwire/2011/08/25/25greenwire-solar-industrys-boom-in-nj-casts-shadow-over-p-52495. html?pagewanted=all.

9. In contrast, coal-fired generation can be adversely impacted by issues with rail infrastructure, such as the 2005 rail line maintenance that disrupted coal deliveries from the Powder River Basin, affecting units as far away as Michigan and Louisiana and costing an estimated $228 million. See Stan Mark Kaplan, *Rail Transportation of Coal to Power Plants: Reliability Issues*, at CRS-7, (September 26, 2007), (identifying Powder River Basin as "the nation's largest single source of any fuel for electricity"), available at http://cnie.org/NLE/CRSreports/07Oct/ RL34186.pdf. Curtailments of gas supply added to the problems created by unusually cold weather in February 2011 in the southwest United States. The cold snap had an "unprecedented" effect on gas supply, and region-wide, 1.2 million MWhs of electric generation were lost, of which 12 percent was due to issues with gas supply or attempted switching from gas to alternative fuels. See Report on Outages and Curtailments During the Southwest Cold Weather Event of February 1-5, 2011, Item No. A-4, (September 15, 2011). Texas was particularly hard hit, losing 225 units representing 14,855 MW of which 4 percent was due to gas curtailments. See Texas Reliability Entity Event Analysis, February 2, 2011, EEA-3 Event, Public Report, (August 15, 2011), 19-20, 28 (TRE Event Analysis), available at http://www.texasre.org/CPDL/2011-02-02%20EEA3%20Event%20Analysis-public_final.pdf.

10. Renewable generation can be subject to disruptions, but differently than fossil-fuel generation. For example, the Texas cold snap in February 2011 caused numerous wind turbines to shut down due to low temperatures. See TRE Event Analysis, 25. The 1991 eruption of Mt. Pinatubo allegedly resulted in a reduction in solar radiation for solar power generation in southern California of 26-27%. See Kramer Junction Co., 64 FERC ¶ 61,025 (1993).

11. *NERC, Statement of Compliance Registry Criteria (Revision 5.0), (October 16, 2008), 8-9, available at http://www.nerc.com/files/Statement_Compliance_Registry_Criteria-V5-0.pdf.*

Accordingly, many renewable power generation sources are not directly subject to Reliability Standards. Instead, they are subject to compliance with their interconnection agreements, which generally provide the grid operator the right to disconnect a unit if it creates a disturbance or threatens the system. This approach puts security control in the grid operator's hands, without unduly burdening small projects with costs and requirements they cannot handle.

However, a recent decision by NERC, which has been upheld by FERC, threatens to expand the regulatory burden on larger renewable generation projects by imposing on them transmission owner and operator obligations. The issue centers on the interconnection facilities or "gen-ties," by which all units connecting at a transmission voltage interface with the grid. Typically, the owners and operators of non-exempt generation and the associated gen-ties register with NERC, and are regulated under the Reliability Standards solely as, "Generator Owners" and "Generator Operators." However, in at least three instances, NERC has determined that a gen-tie is integral to the bulk power system and required the owner and operator of each such gen-tie to also register with NERC as a "Transmission Owner" or "Transmission Operator" (as applicable). In the first of these cases, the facility at issue was a 1,092 MW gas-fired unit that shared a bus with a nuclear plant.[12] But this year, the new requirements were extended to two wind facilities, the larger of which was only 300 MW.[13] The affected companies and others opposed the imposition of this additional cost and burden, arguing that the interconnected plants were not themselves integral to grid reliability and the loss of the associated gen-tie would affect only the interconnected plant. Notwithstanding these protests, FERC has determined that these wind generation owners and operators will be required to register as, and comply with, at least some of the reliability standards applicable to transmission owners and operators.

Often, renewable resources, including wind, solar, and geothermal resources, are found in locations far from load centers and existing transmission corridors. As a result, the gen-ties needed to connect capacity located in these renewable-rich areas with the grid often include long transmission lines that are owned, and controlled at least in part, by the generation owner. Particularly where these lines traverse long distances and remote territory, they may be vulnerable to the elements, sabotage, or other disruptions and loss of the line strands the interconnected generator. The gen–ties for the two affected wind facilities were each over 70 miles long, but the decision did not rest on that fact; rather NERC found that operation of the line could affect other parts of the grid. However, critics argue that the decisions affecting these two wind facilities cannot be distinguished from other plants with transmission-voltage interconnections, and therefore this regulatory burden potentially looms over a number of units. The two cases are fact-specific and NERC continues to evaluate this issue, but if it continues down this path, many generator owners and operators, including those of renewable power, could be required to take on some of the responsibilities of transmission owners and operators. Decentralizing this responsibility among generators seems to be a step backward in advancing reliability.

The growth in the renewable sector, including the proliferation of small, new units and the location of large units remote from the existing grid, undoubtedly poses new security challenges. These include, for example, the potential for opening new portals for a potential cyber attack.[14] But devoting resources to making the grid more flexible and resilient so that problem areas can be quickly isolated and losses or fluctuations in load and generation can be absorbed, rather than seeking to stringently control each new portal, would benefit all users without discouraging smaller renewable projects and the benefits they bring to the grid.

Better integrating VERs into the grid requires understanding how they differ from more traditional resources. For example, at present, grid operators rely on a mix of direct controls and economic incentives to keep generation and load in balance. Low prices during periods of low load, or on parts of the system that are congested, discourage generation; and high prices, such as on summer afternoons, make participation feasible even for high-cost units. In nodal systems, the price may also be negative from time to time in certain locations — that is, requiring a generator to pay to generate. Grid operators also rely on units that can be ramped up or down to follow load through "automatic generation control" or "AGC." Thus, price signals and direct control feature heavily in assuring the appropriate balance of generation for grid stability.

12. New Harquahala Generating Co., 123 FERC ¶ 61,173, order on clarification, 123 FERC ¶ 61,311 (2008).

13. *Cedar Creek Wind Energy, LLC; Milford Wind Corridor Phase I, LLC*, 135 FERC ¶ 61,241, *order denying reh'g and clarifying*, 137 FERC ¶ 61,141 (2011).

14. *See* NIAC Framework Report, 48, (pointing to new digital control equipment as creating openings for potential cyber attacks).

However, VERs and certain other renewables have operating characteristics that are markedly different from fossil generation. Wind and solar energy are particularly vulnerable to climatic changes; when the wind dies down or cloud cover moves in, generation declines. For wind, the inertia of the blades will to some degree smooth changes in output, but for solar, the change is very abrupt and difficult to forecast. Thus, one impact of an increase in renewables is that the grid operator needs detailed forecasting tools and faster, flexible resources in order to respond.

Further, economic signals do not always work. For obvious reasons, wind and solar cannot ramp up if the units are already utilizing all their available "fuel," regardless of the price of power. Perhaps less obvious, although wind and solar can be curtailed if needed for reliability, commercial forces tend to skew renewable resources' responses to economic signals. First, renewable generation is typically eligible to receive a "renewable energy credit" or REC for each megawatthour of production and that REC has a market value. Second, some facilities, in particular wind, biomass, and geothermal facilities, may receive a "production tax credit" or PTC which, again, is based on production. Thus, unlike a fossil unit whose owner operates it (or not) based on the market price of power relative to the unit's variable operating cost (which is typically driven by fuel), a renewable facility's owner may not have an economic incentive to stop producing until the price of power is not only negative, but so negative that it offsets the value of any RECs and/or PTCs associated with that additional generation.

On top of this, renewable energy is frequently sold under bilateral contracts which include only a volumetric price — if the project does not generate, it is not paid — and give the buyer only limited rights to curtail. Such generators may schedule themselves to operate. Such provisions further insulate the generator from market prices and encourage maximum production whenever possible, regardless of load, congestion, or the preferred mix of generation for grid stability.

The addition of large quantities of generation that cannot be controlled by the grid operator either physically, such as with AGC, or by price signal creates an operational risk that increases the vulnerability of the grid. For example, California utilities are under a mandate to generate (or purchase) 33 percent of the power they sell at retail from renewables by 2020, which has required the California Independent System Operator Corporation (CAISO) to closely examine the potential impact on the grid. In a 2010 study assuming only a 20 percent mandate, it found that under certain production simulations, the prevalence of non-dispatchable generation (primarily nuclear and renewables) in low load hours, could potentially leave the grid operator with insufficient downward load-following capability.[15] Recommendations for improvement included better economic incentives to reduce self–scheduling and encourage operational flexibility.

Over a year ago, FERC initiated a rulemaking procedure to better integrate VERs into the grid. It proposed intra-hour transmission scheduling (15-minute intervals) to improve the correlation between real-time generation and schedules, mandates for VERs to provide meteorological and operational data to grid operators who are developing or deploying VER power production forecasting tools, and proposals to allow grid operators to recover the cost of regulation service needed to integrate variable resources.[16] The proposed rules are still under evaluation. In October 2011, FERC directed operators of the organized markets to restructure the payments offered for regulation service to include a performance factor in order to attract and reward resources that can respond with the greatest speed and flexibility and, thus, improve the ability of the operator to maintain a balanced system. Additional resilience could come through technological change, such as the development of additional storage resources, better forecasting tools, and smart grid technologies. All of these elements would contribute to a more robust grid, better able to sustain itself from multiple impacts, as well as better handle an influx of VERs.

Imposing protection measures has a cost and therefore should be carefully weighed against the benefits gained. But, infrastructure protection regulation that promotes, rather than burdens, a diverse generation pool that includes renewable power, and simultaneously focuses on building a more resilient grid, is an approach that can benefit all users of the electric grid.

15. CAISO, *Integration of Renewable Resources, Operational Requirements and Generation Fleet Capability at 20% RPS*, (August 31, 2010), 92-93, available at http://www.caiso.com/Documents/Integration-RenewableResources-OperationalRequirementsandGenerationFleetCapabilityAt20PercRPS.pdf.

16. *Integration of Variable Energy Resources,* Notice of Proposed Rulemaking, 133 FERC ¶ 61,149 (2010).

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Ms. Attanasio represents clients with respect to transactional matters such as the negotiation and drafting of project documents, and as regulatory counsel in connection with the acquisition and leasing of generation and transmission assets and mergers. Since 1997, Ms. Attanasio has regularly served as lead outside counsel in the negotiation and documentation of agreements for tolling services, power sales, requirements power and energy management services using customized bilateral agreements, standardized agreements (such as those created by EEI/NEMA, ISDA and NAESB) and hybrids, resulting in executed contracts for over 11,000 MWs of power. These contracts have included purchases and sales from facilities that use renewable fuels as well as conventional fossil-fuel units. She also assists clients to implement or respond to requests for offers for power.