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Satellite image of the continental United States at night
(NASA / Public Domain)

Resilient Power

A New Model for Grid Security

Lewis Milford & Samantha Donalds

In the last few years, Washington has been preoccupied with a debate about the security of the nation's electric grid. The debate is as old as the grid itself: as electrification has come to drive all commerce and government, making it a key element of the country's national security, what is the best way to protect the grid from terrorist, weather, or cyber-related threats or attacks?

As with most things of a political nature, where you stand depends on where you sit.

Proponents of coal, oil, and nuclear make the argument that traditional large-scale power plants are not only vital to grid stability, but also that this centralized generation model is the only economically or technologically feasible option.[1] It's an old argument wrapped in new national security rhetoric, and it's increasingly straining against the facts. More and more analysis and real-life examples show that distributed renewable energy, combined with energy storage technologies, can provide reliable power more affordably and reliably than the centralized generation alternatives.

The argument in favor of large-scale power plants is also based on incorrect assumptions about the true nature of grid stability. According to a recent study:

The vast majority of outages across the power system are caused by weather events rather than generation-level failures (including fuel supply failures). Furthermore, most outages caused by natural events harm electric T&D transmission and distribution assets in common ways, leading to the conclusion that the most practical way to improve resilience and reliability is to address T&D and grid operations rather than generation and fuel issues.[2]

In other words, the real threats – and solutions – to grid security occur not at the central generation level but at the local distribution level.

The U.S. electrical distribution system is a massive, outdated, and extremely fragile web of poles and wires. It is vulnerable not only to weather, but also to car crashes and squirrels. One small incident can cause a large and prolonged blackout. In the much less likely scenario of a terrorist attack on the electrical grid, the target would not be the distribution system but rather at the central generation or substation level, for maximum impact and ease of targeting.[3] In both scenarios, whether an outage is accidental or intentional, the centralized nature of our grid is a serious liability.

The best solution to the national security problem posed by power outages is the new field of distributed "resilient power.

WHAT IS RESILIENT POWER?

"Resilient power" is the ability to provide continuous, reliable power to critical facilities and services if the main grid goes down. In order to be truly resilient, the energy generation should be clean and affordable.

Resilient power systems include the following elements:

- Distributed generation. Smaller-scale clean energy resources located at, or near, the sites where the power will be used. Reduced transmission distance is both more affordable and more secure. Energy sources can include renewables like solar or wind or combined heat and power (CHP) systems.[4]

- Energy storage. Energy storage is often called the "holy grail" of the clean energy revolution for a good reason: it allows us to store clean solar and wind power for use when the sun isn't shining, and the wind isn't blowing. This is both an environmental and economic win.

- Smart grid technology. This includes the ability for building energy systems to act as a "microgrid" by islanding and disconnecting from the main grid, the ability to use energy storage for grid services, as well

Twentynine Palms, California, U.S.A. 1.2 megawatt photovoltaic arrays (Lance Cpl. Thomas Mudd / Public Domain)

as the ability to protect from cyberattacks.

HOW RESILIENT POWER SYSTEMS WORK

One of the most economically resilient power technology combinations is a solar photovoltaic system (PV), combined with energy storage (solar + storage).

When the main grid is functioning normally, the solar panels will generate power during daylight hours. The battery storage system will save excess generation for use during a power outage and be deployed for electric bills savings and monetizable grid services at strategic times.[5]

During the event of an outage, the solar + storage system will disconnect from the grid, allowing it to safely supply power to critical building loads, such as heating, common area lighting, or refrigeration. These "microgrid" systems can also be completely independent from the main grid, allowing the energy systems to provide 100 percent of a building's power needs at all times.

In the town of Sterling, Massachusetts, a solar + storage microgrid can power the town's police station and emergency first responder facility for up to 12 days in the event of a grid outage. Besides the benefits to community safety, the Sterling microgrid also has excellent economics, saving ratepayers USD 400,000 per year.[6]

Energy storage systems paired with other renewable technologies function similarly to solar + storage systems and provide a similar range of benefits. For example, the remote island community of Kodiak, Alaska relies on a wind+ hydro+ storage microgrid for clean, resilient, and affordable power.[7]

HOW RESILIENT POWER ENHANCES SECURITY AND SAVINGS

Resilient power technologies could benefit almost any facility type, from Walmart[8] to the U.S. military, but they are also well suited for facilities that support low-income and vulnerable populations (affordable housing, nursing homes), medical facilities (clinics, hospitals), and other critical community resources (fire stations, emergency shelters, wastewater treatment plants) where prolonged power outages could be catastrophic to local communities.[9]

Resilient power technologies make economic sense for many commercial customers, but not all – though the economics are greatly improved when the avoided costs of power outages are considered.[10] These costs can be substantial; power outages from Hurricane Sandy cost an estimated USD 27-52 billion in economic losses, including lost wages, spoiled inventory, and damage to the grid.[11]

HOW STATE AND LOCAL POLICY IS HELPING THE TRANSITION TO RESILIENT POWER

Following Hurricane Sandy's historic destruction and outages, states and municipalities began to develop programs to encourage the development of resilient power projects in their communities. Examples of state programs include the Massachusetts Community Clean Energy Resiliency Initiative,[12] Maryland's Community Resiliency Hub Grant Program,[13] and Puerto Rico's Disaster Recovery Action Plan.[14] Successful programs share many of the following elements: recognition of the importance of providing critical services in an emergency, prioritization of low income and otherwise vulnerable communities, provision of adequate funding and technical assistance, and support for a variety of use cases.

Policymakers take note: as disasters like Sandy and Maria become the new normal, the economic and humanitarian case for resilient power will only become more potent. To lessen the devastation and economic impacts from future power outages, we need a new definition of national strategy to include a resilient, distributed model of grid security.

[1] "The resiliency of the nation's electric grid is threatened by the premature retirements of power plants that can withstand major fuel supply disruptions caused by natural or man-made disasters and, in those critical times, continue to provide electric energy, capacity, and essential grid reliability services. These fuel-secure resources are indispensable for the reliability and resiliency of our electric grid - and therefore indispensable for our economic and national security. It is time for the Commission to issue rules to protect the American people from energy outages expected to result from the loss of this fuel-secure generation capacity." From "Notice of Proposed Rulemaking for the Grid Resiliency Pricing Rule," *Microgrid Knowledge,* September 2017, pages 2-3. 2 Alison Silverstein et al., "A Customer-focused Framework for Electric System Resilience," May 2018, page 13, <https://gridprogress.files.wordpress.com/2018/05/customer-focused-resilience-final-050118.pdf>.
[3] See: Thomas Griffith, "Strategic Attack of National Electrical Systems," *Air University Press*, 1994, <https://apps.dtic.mil/dtic/tr/fulltext/u2/a425504.pd>; For a recent example, see the 2014 attack on a substation in California: Rebecca Smith, "Assault on California Power Station Raises Alarm on Potential for Terrorism," *Wall Street Journal*, Feb. 5, 2014, <https://www.wsj.com/articles/assault-on-california-power-station-raises-alarm-on-potential-for-terrorism-1391570879>.
[4] Combined heat and power (CHP), also known as cogeneration, is an on-site power generation unit which produces and uses both electricity and heat. CHP systems are considered to be energy efficient because they make use of heat that would otherwise be wasted, and they can also be considered "clean" if powered by biomass rather than fossil fuels. CHP systems are commonly found on college campuses, hospitals, manufacturing facilities, and other large institutions. Learn more at https://www.epa.gov/chp/what-chp.
[5] Lars Lisell, "When Does Energy Storage Make Sense? It Depends," *National Renewable Energy Laboratory*, Feb. 28, 2018, <https://www.nrel.gov/state-local-tribal/blog/posts/when-does-energy-storage-make-sense-it-depends.html>. 6 "Sterling Municipal Light Department Energy Storage System," *Clean Energy Group*, 2018 <https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/sterling-energy-storage/>.
[7] Rachel Waldholz, "What can Kodiak teach the world about renewable energy? A lot," Alaska's Energy Desk, KTOO Public Media, Sept. 15, 2017, <https://www.ktoo.org/2017/09/15/can-kodiak-teach-world-renewable-energy-lot/>.
[8] Seth Mullendore, "Walmart + SolarCity = Solar+Storage," *Clean Energy Group*, November 2014, <https://www.cleanegroup.org/walmart-solarcity-solar-storage/>.
9 "Featured Resilient Power Installations," *Clean Energy Group,* <https://www.cleanegroup.org/ceg-projects/resilient-power-project/featured-installations/>.
[10] "Valuing the Resilience Provided by Solar and Battery Energy Storage Systems," *National Renewable Energy Laboratory and Clean Energy Group*, 2018, <https://www.cleanegroup.org/ceg-resources/resource/valuing-resilience-solar-battery-energy-storage/>.
[11] "Distributed Solar PV for Electricity System Resiliency," *National Renewable Energy Laboratory,* 2014, <https://www.nrel.gov/docs/fy15osti/62631.pdf>. 12 Todd Olinsky-Paul, "Massachusetts Gets Serious About Resilient Power," *Clean Energy Group*, July 2018, <https://www.cleanegroup.org/massachusetts-gets-serious-about-resilient-power/>. 13 Maryland Energy Administration - Resiliency Hub, <https://energy.maryland.gov/Pages/Resiliency-Hub.aspx>.
[14] "As Hurricane Michael damages the Southeast, Puerto Rico provides lessons on resilient power," Lew Milford, Clean Energy Group, October 23, 2018 <https://www.cleanegroup.org/as-hurricane-michael-damages-the-southeast-puerto-rico-provides-lessons-on-resilient-power/>.

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