CONNECTING MICROGRIDS WITH PUBLIC-PRIVATE PARTNERSHIPS TO MEET CRITICAL NEEDS

By J. Michael Barrett

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Lexington Institute

FUTURE OF THE POWER GRID SERIES

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EXECUTIVE SUMMARY

Moving forward with plans to address the modernization needs of the nation's electric grid is a vast undertaking, estimated to require some $2 trillion of investment over the next two decades. Providing the electricity that has become so essential to all aspects of American business, governmental and daily life requires updating not only the infrastructure and technology, but also the business and governance models that support it.

For example, as "smart grid" systems allow for two-way communication between the providers and end-users of electric power, the advanced capabilities required to effectively manage the constantly-changing conditions, user-demand and even the mix of energy sources that create enough supply, have become substantially more complex.

Fortunately, innovation is playing a major role in meeting these newly emerging challenges. Leadership from the federal departments of Energy, Defense and Homeland Security also has advanced through numerous modernization initiatives, as discussed in this report. Perhaps the most important example of this is the development of various pilot projects and experimental microgrids – miniature, self-contained power grids that can deploy the latest technologies, efficiently harness resources, and ensure localized community support through effective Public-Private Partnerships.

Indeed, many microgrid models allow for innovative partnerships between power utilities, civilian government agencies, military installations and other entities. These arrangements are fostering development of microgrids that effectively address the critical needs of various stakeholders, while also solving challenges for siting, financing, and governing their implementation.

This report considers different models, factors and considerations that support the success of such partnerships.

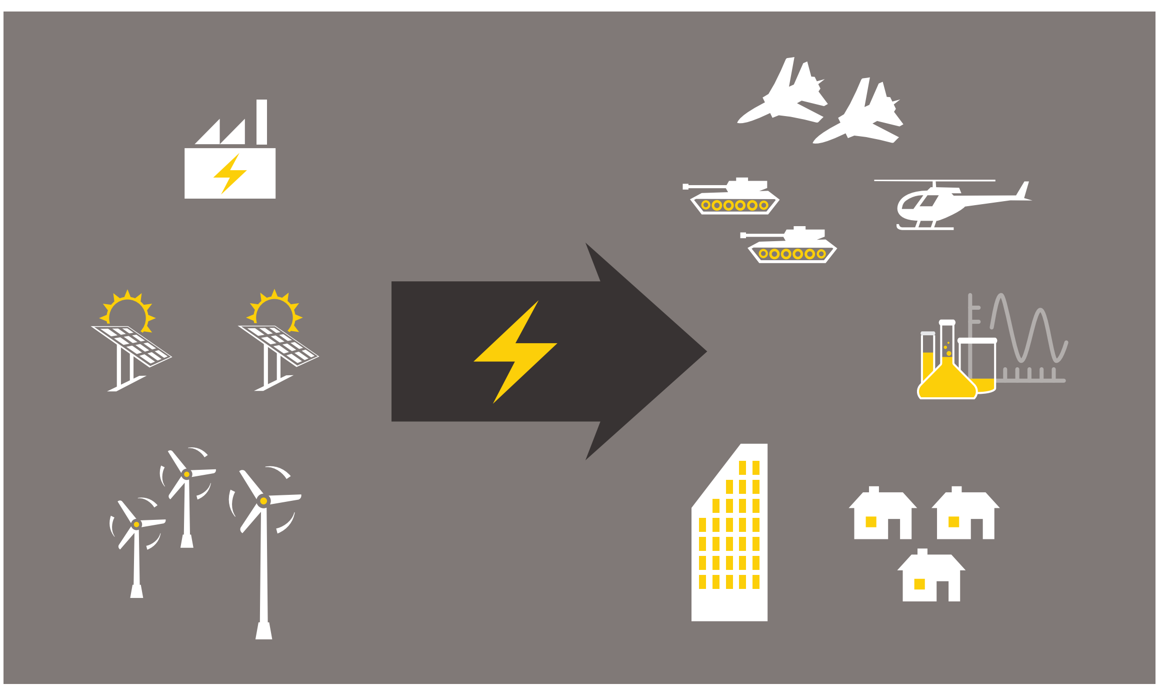
Details follow.

INTRODUCTION

The U.S. model of a mostly centralized and highly-regulated electrical power industry takes advantage of overall scale to provide affordable and "always-on" power to virtually any end-user across the country. At the same time, there is rising concern over the negative externalities of the current power grid, over both power quality and reliability, to include resilience against any prolonged disruption to the system as a whole, environmental impacts, potential vulnerabilities including the energy wasted by old generation and transmission equipment. As a result, the economics that underpin America's current and future means for generating, transmitting and delivering reliable, stable and affordable electrical power are undergoing a period of significant change.

Fortunately, the move to a more modern grid architecture is supported by the recent emergence of affordable, digital, and highly interconnected technologies that enable the development of a so-called "smart grid", which relies on two-way communication between suppliers and customers to allow both supply and demand to vary based on changing market conditions. And, just as importantly, the underlying technologies of the smart grid also allow for the much more seamless integration of purpose-built microgrids able to serve the specific needs of certain users including the military, industrial parks, and highly sensitive technological research facilities.

As a result, microgrids, which are essentially miniaturized self-contained power grids, can take advantage of both the latest in terms of distributed generation sources (including



Benefits from sharing assets and needs include maximizing efficiency of output from shared/optimized generation systems, shared capital and maintenance costs with opportunity to invest in newest technology to meet specific needs, and improved energy surety.

solar, wind, etc.) while being small enough to offer a more manageable model for ensuring a stable and more resilient system. At the same time, we are in the early stages of a two-decades-long modernization effort that will spend a projected $2 trillion to replace many aging pieces of the current electrical power grid infrastructure — a massive investment which offers a rare opportunity to re-think how the whole system of power generation, delivery and usage operates.

Given all these changes, there is a need for not only more modern technologies but also more updated governance and more collaborative cost, risk and resource-sharing. For example, Public-Private Partnerships between government and commercial entities can provide valuable solutions for addressing capital, facilities, or other needs, provided the details are optimally managed. For example, if a military base, civilian manufacturing facility, and local municipal critical infrastructure are all sharing a purpose-built microgrid, what are the practical impacts in terms of governance, regulatory oversight, cost-sharing, and preferred access to available power should a major disruption occur? More specifically:

- How can cooperation, financing, planning and shared responsibility be leveraged to strengthen the power grid for communities where vital national security functions share the grid with civilian communities?
- How can lines of communication be established and maintained for planning purposes and ongoing maintenance and improvements such that a microgrid can meet the essential needs of all users without becoming unaffordable?
- What should the relationship of the microgrid be with respect to the larger national power grid, and should certain resources be shared/integrated, and, if so, which ones, or should the microgrid exist solely as an island?

It is our hope that military, commercial, civic, scientific, industrial and other communities interested in the great potential of microgrids will be able to use this information as a starting point for assessing the practical, real-world benefits and associated costs and trade-offs involved in a smart, modern and resilient microgrid project. It does so by exploring, in order, "The What and Why of Microgrids", "Connecting Microgrids to the Main Grid", "Where: Optimal Siting Considerations", "Public-Private Partnerships for Managing Costs and Organizational Structure", and a case study, "SPIDERS and the Microgrid".

THE WHAT AND WHY OF MICROGRIDS

Multiple converging characteristics are driving forward-looking military bases, industrial parks, universities, critical infrastructure owners/operators and other communities to invest in the emerging potential of efficient, environmentally beneficial, and secure microgrids.

As Patricia Hoffman, Assistant Secretary of Energy for Electricity Delivery and Energy Reliability, described in testimony to the House of Representatives, "Advanced distribution systems that use microgrids and other distribution control strategies to enhance operational response and system recovery will be crucial to next-generation electric distribution systems that support a 21st century economy and society."[1]

A microgrid can take many different forms, but at its core it is best thought of as a self-contained electrical power system that includes localized power generation and distribution in order to maximize the connection between the end-user needs and the key operating characteristics of that specific microgrid.

For example, for some communities the decision to move to a microgrid is mostly about a focus on easily integrating alternative energies. For others, especially energy intensive commercial entities, the main driver is the desire for price stability amid a changing cost-benefit equation, for they recognize that the national power grid requires some $2 trillion of upgrade costs over the next decade – costs that will be borne by the installed user base, and which therefore likely translates into significant and somewhat unpredictable cost growth.

At the same time, others desire more control over very precise voltage and quality-related characteristics that can be enabled by localized power generation using newer transmission and distribution control technologies the overall grid is still years away from implementing. Finally, users such as military bases and critical infrastructure owners/operators have security concerns, including cybersecurity risks, that drive demand for a more resilient power supply to ensure mission critical activities can continue without any risk of power interruption. Indeed, in the face of mounting physical security concerns, evolving weather patterns and complex cyber integration challenges, ensuring the continued availability of power, come what may, is perhaps the

Solar panels form part of the Renewable Hydrogen Fueling and Production Station on Joint Base Pearl Harbor-Hickam. It is the only hydrogen station in Hawaii and about 30 hydrogen-powered vehicles use the JBPHH station. (Image: U.S. Navy, Mass Communication Specialist 2nd Class Daniel Barker)

The cost-benefit equation for a microgrid includes factors that were once beyond the control of the end-user, namely the ability to mitigate prolonged outages and to operate off-grid for an extended time.

most significant consideration for national security entities.

And yet, an important challenge remains in properly accounting for the differences between the standard costs of staying on the grid versus the multi-faceted microgrid benefits of reduced environmental impacts, harnessing more modern and efficient real-time generation and transmission technologies, and the value of an assured routine and *in extremis* power supply.

In other words, fully assessing the cost-benefit equation for a microgrid includes factors that were once beyond the control of the end-user, namely the ability to mitigate prolonged outages and to operate off-grid for an extended time. Indeed, without investing in a microgrid, often the only other way a user can insulate themselves from the risk of a power grid failure is to invest in a large number of heavy-duty back-up generators — most of which are relatively inefficient diesel generators that can be very costly as a means of providing even limited capability when used in a medium or long-term outage.

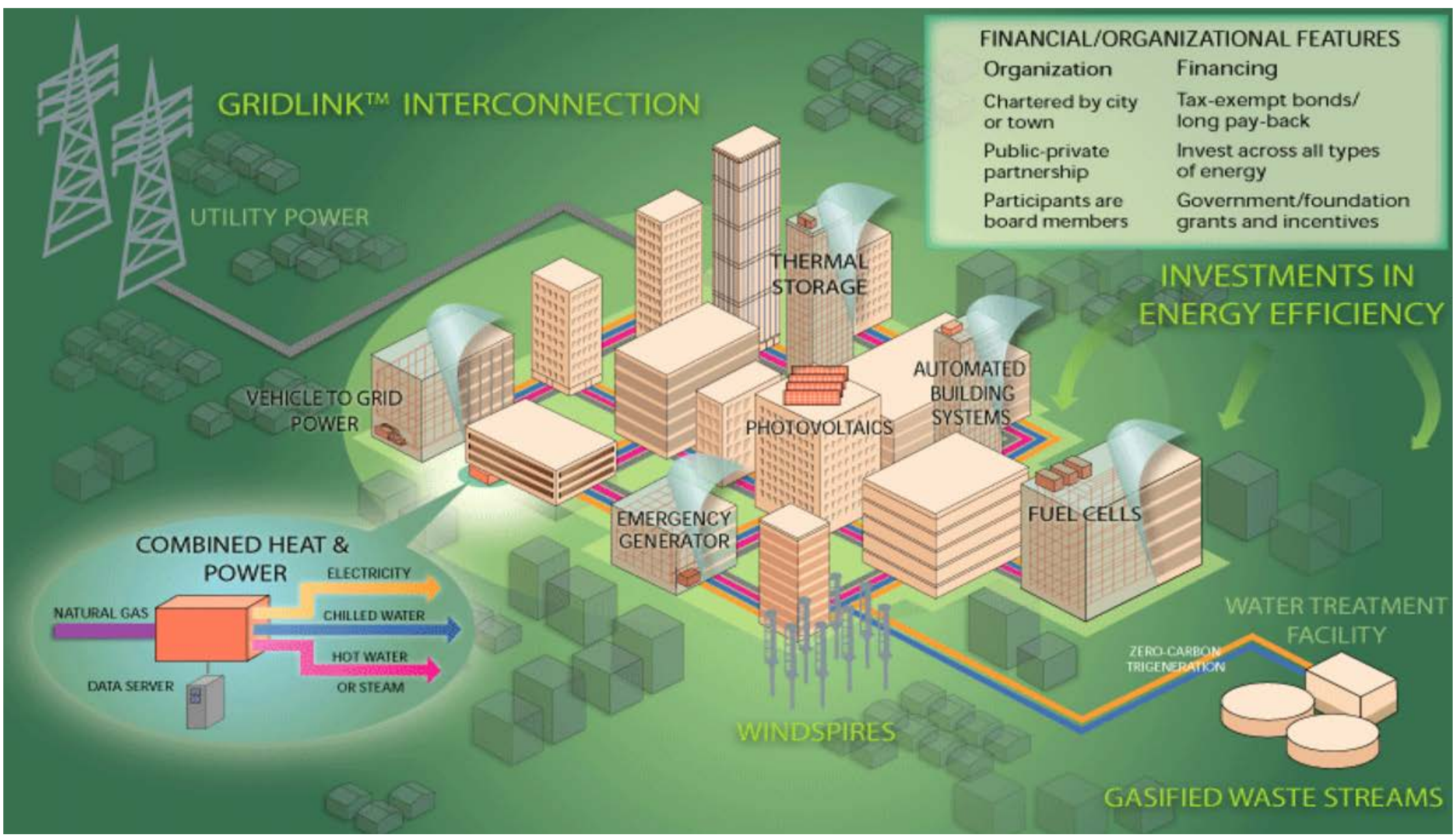
A microgrid, by contrast, creates energy surety at a stable cost, thereby offering a value that is akin to insurance, for it affords the ability to invest a little each day in higher operating costs in order to lessen the potential losses from a future prolonged outage. And this unique combination of benefits is why this movement is gaining momentum.

CONNECTING MICROGRIDS TO THE MAIN GRID

The costs and complexities of connecting locally-generated power to the national grid in a seamless fashion create significant challenges to the broader adoption of microgrids.

One of the main tenets of the cost-benefit case for development of microgrids is the ability to connect to the main power grid both as an access point for selling locally generated energy as well as for redundancy and reliability of electrical service. Indeed, while some microgrid users desire a complete move off the grid, for the vast majority a better solution is to blend both systems, sometimes selling their excess local power and at other times using the grid's power, whether it be due to local generation shortfalls or to cover downtime for a failure or offline repairs, etc.

In basic terms, the core technical issue in connecting local power sources to feed into the grid involves comingling, or "synchronizing," the electrical current generated from on-site power with that already flowing through the main grid in order to prevent mismatched and disruptive power flows that could affect the stability of the grid. This requires special care to avoid physical dangers to workmen as well as, often, upgrades to the local substation where you want to connect.



One model for a connector of different power supplies is Pareto Energy's "GridLink" interconnection device, designed to seamlessly integrate multiple different power sources and connect them to the grid as a combined flow of energy. (Image: Pareto Energy, "NYU Polytechnic Institute in Brooklyn")

However, a novel approach has been developed by Washington, DC-based Pareto Energy in the form of their proprietary "GridLink" interconnection device. Perhaps best thought of as an agnostic and seamless connector of differing forms of power supplies, Pareto describes GridLink as, "an innovative configuration of off-the-shelf, commercially-available power electronics equipment that is packaged into an eHouse. Its core consists of large inverters commonly used in the wind power industry to bring each power source in individually, combine these sources onto a single DC bus, and convert the combined power flows into a single AC current."[2] In so doing, the GridLink approach essentially blends together the feed of one or more locally generated power flows into a single, easily ingestible flow that can be directly connected to the existing power grid's systems.

WHERE — OPTIMAL SITING CONSIDERATIONS

> ***Where to Locate?***
>
> *Military and/or commercial installations with the potential for a collocated cost-sharing partner such as a logistics or manufacturing hub or research university.*

Microgrids are well-suited for locations servicing a discrete user base with relatively high energy needs and a recognized emphasis on energy surety. This includes users such as military bases, air and sea ports, industrial parks with a manufacturing component, and research universities.

Earlier this year, the federal Department of Energy launched a microgrid research study at UPS' Worldport and facilities in Louisville, Kentucky, to define institutional and regulatory challenges associated with development of industrial-based resilient systems. The project focuses on a microgrid incorporating renewable energy systems and includes a robust Public-Private Partnership involving UPS, the State of Kentucky, Oak Ridge National Laboratory and Louisville Gas & Electric.

The UPS Worldport project represents one of a number of promising Public-Private Partnerships for the development of microgrids announced earlier this year under the Energy Department's Grid Modernization Initiative. Partners for other projects include electric utilities, universities, national energy laboratories and state agencies.

In selecting a location for microgrids the main ingredient is a key driver that is not well served by the existing national power grid. Be the impetus environmental, reliability and quality, or increased resilience against disruptions, the drive for change will need to be led by an entity with significant desire to create that change. Beyond the main user, any location where two or more additional users are already collocated presents an attractive potential deployment spot because of the ability to take full advantage of economies of scale, an expanded set of needs as well as available assets, and the ability to distribute costs more broadly.

Consider the following hypothetical set of end-users:

- A military installation needing a high degree of energy security and resilience, but which also has available lands for locating solar arrays;
- A technology research park that requires unusually precise voltage and amperage control for use in sensitive research systems; and
- A large-scale computer server farm in need of energy security and resilience while able to harness significant amounts of the heat created during the power generation process to drive always-on steam-powered air conditioning units, thereby significantly increasing overall efficiency of the microgrid system.

By pairing such complementary user needs all parties may be able to use the shared microgrid to meet their shared as well as specific needs.

PUBLIC-PRIVATE PARTNERSHIPS FOR MANAGING COSTS AND ORGANIZATIONAL STRUCTURE

Financing a microgrid and funding all the attendant new infrastructure (or upgrading current infrastructure) can present a significant barrier to moving forward. Sharing the up-front costs, enabling access to usable space, and locking in commitment of long-term users requires leveraging the complementary aspects of public and private sector partners. This may include joint financing from the private sector and some initial public funding along with use of tools such as Enhanced Use Leases for building on government property.

Often such partnerships depend on ensuring timely appropriation of government money to cover up-front costs, always a challenge in the politically-charged environment of using public taxpayer funds. This is even more true for nearly any project with long-term payback periods (i.e., accepting current costs to enable future savings), but even more so for ones with complex sequential steps involving the timing of funding as well as potential delays from environmental impact studies, cross-jurisdictional considerations, and other legal and regulatory issues.

A PUBLIC-PRIVATE PARTNERSHIP ALLOWS A BROAD MIX OF PARTNERS TO OFFER AS WELL AS SHARE IN BENEFITS…

- *Military and other Federal, State and Local partners with a specific energy need*
- *Private sector energy users*
- *Private sector investors*

- *Available land*
- *Tax Credits for environmentally beneficial projects*
- *Tax-free bonds*
- *Seeding for Infrastructure Bank*

Accordingly, the best way to meet these challenges is to ensure there is significant local support for a project, which in turn requires a transparent and inclusive Public-Private Partnership that leverages the strengths of each parties' resource base. For example, if the federal or state government can reduce the investment risk of the project by providing seed capital, issuing tax-exempt bonds, and/or signing a Letter of Intent to purchase energy for a guaranteed period of time, the private sector can then provide investment capital at more favorable rates because total project risk is reduced. Similarly, perhaps the most important economic leverage comes through combining different organizational structures to take advantage of existing special incentives. This is because "tax credits benefits do not offer any direct value to municipalities or tax-exempt organizations. However, municipalities can partner with private entities that can use the tax credits. This kind of partnership can lead to more favorable project economics."[3]

Specifically, a military installation may be able to provide under-utilized land for the power generation facilities at a below-market lease rate while also serving as a single focal point for environmental impact analysis and related studies. State and local governments can also play an important role. For example, "New Jersey has created a $200 million resilience bank for the development of distributed energy resources at critical facilities. Other states, including California, Connecticut and New York, have developed Green Banks, which use public funding to leverage private capital; the funds may cover components of microgrids, such as solar energy."[4] Combining these various sources can enable better cost-benefit calculations for all involved, thereby improving the likelihood of successful project implementation.

Importantly, in creating such a Public-Private Partnership the leaders of the initiative should form an executive council comprised of key users and relevant political and community stakeholders in order to enable both up-front support for the project as well as supporting long-term consensus on investments in security, upgrades, maintenance and other issues of collective risk.

ENERGY STORAGE

Local power generation using solar, wind, hydro, or other sources can make a lot of sense for economic and environmental reasons. However, many such local energy sources produce power only during certain times, such as during daylight hours or when the wind is blowing.

The fact that electrical energy generally cannot be efficiently stored for later use and must instead be delivered for immediate consumption, creates a constraint which generates costs in terms of synchronizing supply and demand that outweigh many of its benefits.

There is hope on the horizon, however. Recent advances indicate that there is significant potential for design of ever more efficient and reusable batteries using novel materials. Research at Pacific Northwest National Laboratories' Advanced Battery Facility in areas as broad as gel-batteries, large liquid batteries, sodium sulfur batteries, supercapacitors, membrane batteries, redox flow batteries and new poly-ionics represent some of the most promising emergent options.[5]

Reports from Green Tech Media also describe several non-battery-based approaches, including chemistry-based solutions that apply excess energy during high production times to an electrolysis process to generate hydrogen and methane, then either storing the gases in large caverns for later use or cross-feeding the gas into pipelines for use in existing power systems. Similarly, compressed air energy storage would create massive "storage banks" in underground facilities to store air that can be released to drive turbines as needed, while another approach, called pumped hydro, would use the excess energy to move water uphill into a reservoir then harness the power of movement of the water between purpose-built reservoirs.[6]

Yet another large-scale energy storage idea, called advanced rail energy storage, uses a system of electric traction drive trains operating on a closed low-friction automated rail network. The trains transport a field of heavy weights between two storage yards at different elevations, using excess energy to climb the elevation. When needed, the shuttle-trains can return to the lower storage yard with their motors operating as generators, converting the potential energy of the heavy weights back into electricity in a process that can return as much as 80% of the original energy. Reported sizes ranging from a small installation with 200 megawatts of storage capacity up to large 2-3 gigawatt regional energy storage system with 16-24 gigawatts of energy storage capacity.[7]

Should some of these technologies prove viable it will change the equation when it comes to the widespread use of distributed energy. The lack of effective energy storage not only significantly reduces the viability of grid-scale use of distributed generation but also drives the operational need for all energy to be immediately produced, delivered and consumed when it is requested by an end-user. This means the issue of energy storage lies at the heart of many of the timing and supply challenges that utility operators must handle across the system as a whole. Fixing this single technological challenge could truly revolutionize the future of the energy sector, with far-reaching impacts across other sectors as well.

CASE STUDY: 'SPIDERS' & THE MICROGRID

In an effort to develop ever more resilient power for military and national security needs, the Departments of Defense, Energy, and Homeland Security have joined forces to develop a program called Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS). Comprised of three distinct phases, each progressively more challenging than the last and located across different test environments, SPIDERS was completed in 2015.

- **Phase One** was a single-circuit demonstration of a cyber-secure microgrid to handle waste water treatment at Joint Base Pearl Harbor-Hickam, Hawaii, and was completed in 2013. It consisted of a single distribution feeder, two electrically isolated loads, two isolated diesel generators, and an isolated photovoltaic array.
- **Phase Two** was a much more involved 2014 multi-building demonstration at Fort Carson, Colorado, that included integration of a large solar PV array and microgrid connected electric trucks. This phase demonstrated the viability of electrical-vehicle-to-grid energy storage as well as the integration of a solar-based microgrid feeding into the traditional power grid that serves the base. Consisting of three distribution feeders, seven building loads, three diesel generators, and a one-megawatt segment of the onsite PV array, as well as five bi-directional electric vehicle chargers, this phase successfully demonstrated the ability to tie together new microgrid functions alongside traditional power grid services.[8]
- **Phase Three**, completed in 2015, was located at Camp Smith, Hawaii, and represented the defense department's first installation-wide microgrid. It included new and existing generation sources to form a microgrid supporting the loads of the complete installation, including stationary prime power diesel generators designed for continuous use and a battery system to demonstrate near-instantaneous transition from utility power to microgrid operation. In so doing, the Camp Smith microgrid provided for full operation of the base during a simulated extended full electrical outage.[9]

*The **Smart Power Infrastructure Demonstration for Energy Reliability and Security** program addressed 4 critical requirements:*

- *Protect defense critical infrastructure from power loss due to physical disruptions or cyberattack to the bulk electric grid;*
- *Integrate renewables and other distributed generation to power defense critical infrastructure in times of emergency;*
- *Sustain critical operations during prolonged utility power outages; and*
- *Manage defense department installation electrical power and consumption efficiently, to reduce petroleum demand, carbon "bootprint", and cost.[10]*

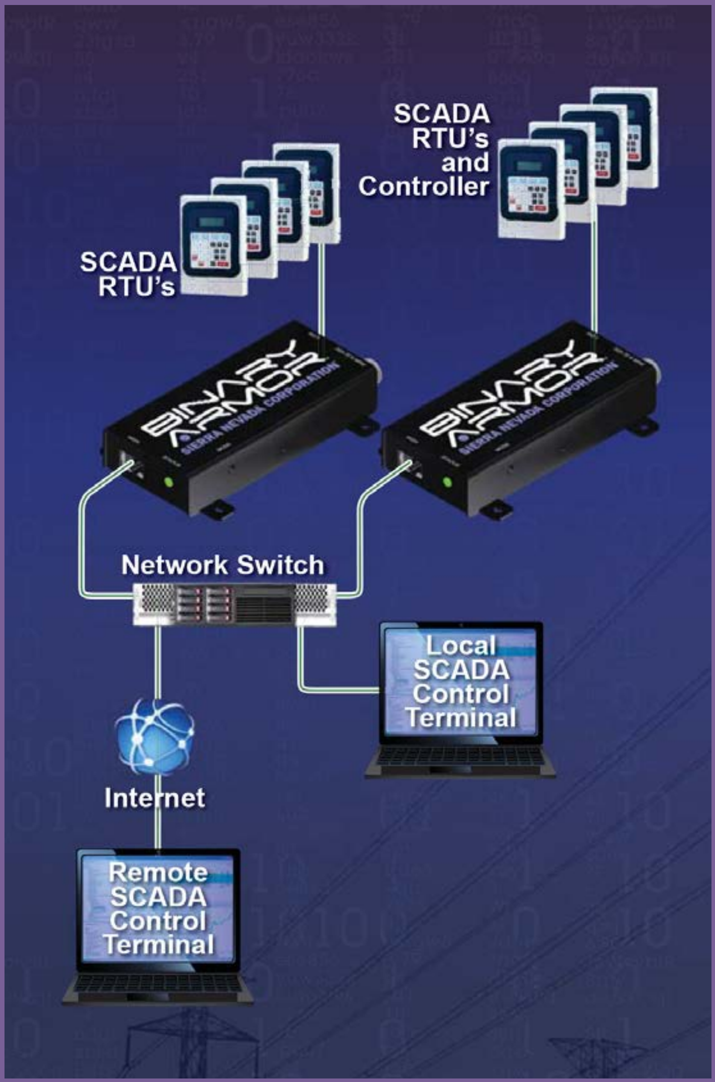
CYBER SECURITY TOOLS FOR SCADA

Ensuring the security and integrity of data used by the computer systems that control the power grid is a major concern throughout the entire electrical power industry. Firms that produce, transmit and deliver power are concerned about the safety of their workforce, their infrastructure, and their customers, as well as the physical and privacy concerns of the customers themselves and the community leaders, public health and law enforcement communities that would respond should a major cyber breach occur.

Fortunately, new technologies are being developed every day to help meet these very challenges.

One of the best ways to protect cyber systems is illustrated by rules-based message traffic monitoring that protects the integrity of infrastructure supervisory control and data acquisition (SCADA) networks. Because SCADA are responsible for remote monitoring of and adjustments to the physical components of the grid, they often represent the very point at which digital commands can create a real-world physical infrastructure failure. Tests and real-world events have occurred where manipulation of the data feeds for SCADA controls caused catastrophic systemic failures, most prominently the 2007 Idaho National Laboratory test and the 2010 STUXNET attack.

Many of the most advanced message control systems, such as Sierra Nevada Corporation's BINARY ARMOR® (pictured), are small, self-contained and ruggedized devices operating a secure and purpose-built operating system that is connected between the SCADA remote terminal units (RTUs) and the network router that connects out to the broader internet. These devices control the bi-directional flow of messages by ensuring only appropriate messages that conform to the specific roles, duties, and permissions associated with a given



Sierra Nevada Corporation's Binary Armor device.
(Image: Sierra Nevada Corporation)

RTU are allowed to pass through the network. They also integrate local and network-based event-logging with specific processes for ensuring validation of systems configuration and prevent tampering.

Such measures are an important component of a secure microgrid because, despite all the promise of a fully automated and digitized electrical grid, the all-too-real concerns about potential cyber breaches mean that users will not accept such risks without appropriate mitigation measures. Consequently, devices such as these may well become ubiquitous throughout the future of our modernized power grid, including inside of local microgrids and also at any point where a microgrid's control systems would connect to the broader national electrical grid.

CONCLUSION

Microgrids represent an important mix of new technologies that can significantly improve the operation and cost-benefit analysis of ensuring the robust, resilient delivery of 'always-on' clean energy. However, the myriad legal, political and financing hurdles that remain to be surmounted may prove too formidable for this industry to emerge in the near term. The best remedy for overcoming these impediments is a large-scale Public-Private Partnership that can combine multiple complementary resources, and that partnership will need a strong leader. A significant role will be played by the Department of Energy, which continues to support research projects and advanced design studies on microgrids around the country, including through its Grid Modernization Initiative.

Microgrids will play an important role in the future of U.S. and global electrical power systems. But to fulfill their potential microgrids still need significant further development involving robust Public-Private Partnerships, and the U.S. military should take the lead based on defeating risks to operational surety.

Nonetheless, given its relative size as a potential market driver, an equally important role may well be played by the Department of Defense. Indeed, as recently observed by industry insider John Carroll, "The military is the technology leader. Every utility is looking at the Department of Defense for how they are deploying microgrids. At conferences all over the country, utilities and municipalities are coming together to understand what the military has been doing… The military is absolutely the leader."[11] And so the next practical step may well be to ensure that the military acts as a responsible market-leading consumer by fully embracing this opportunity to help usher in a new era of modern, efficient and resilient microgrids that can serve as a feasible supplement to the nation's aging power grid.

ENDNOTES

1 Statement Of Patricia Hoffman Assistant Secretary For Electricity Delivery and Energy Reliability U.S. Department of Energy Before The United States House of Representatives Appropriations Subcommittee on Energy and Water Development, March 25, 2014.

2 Pareto Energy, "Frequently Asked Questions," accessed August 2016, http://www.paretoenergy.com/faq/

3 "Community Microgrids: A Guide for Mayors and City Leaders Seeking Clean, Reliable, and Locally Controlled Energy," *Microgrid Knowledge* (Energy Efficient Markets LLC, 2015).

4 Ibid.

5 James Conca, "Batteries Or Train-Pumpted Energy For Grid-Scale Power Storage," Forbes.com, May 26, 2016, http://www.forbes.com/sites/jamesconca/2016/05/26/batteries-or-train-pumped-energy-for-grid-scale-power-storage/#734ad9b57de5.

6 Giles Parkinson, "The Long-Term Storage Challenge: Batteries Not Included," GTM, December 17, 2013, http://www.greentechmedia.com/articles/read/the-long-term-storage-challenge-batteries-not-included.

7 Grid Scale Energy Storage, accessed August 2016, http://www.aresnorthamerica.com/grid-scale-energy-storage.

8 "Powering a Modern Military - Fort Carson: A Case Study," Sun Technics, accessed August 15, 2016, http://www.suntechnicsusa.com/us/fort_carson.html.

9 "Technology Transition Final Public Report: Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS), Joint Capability Technology Demonstration, Version 1," accessed August 15, 2016, http://energy.gov/sites/prod/files/2016/03/f30/spiders_final_report.pdf.

10 SPIDERS: The Smart Power Infrastructure Demonstration for Energy Reliability and Security, Sandia National Laboratories, http://energy.sandia.gov/wp-content/gallery/uploads/SPIDERS_Fact_Sheet_2012-1431P.pdf.

11 Lisa Cohn, "Military Advances Energy Independence with Microgrids," April 30, 2014, *Greenbiz*, https://www.greenbiz.com/blog/2014/04/30/military-advances-energy-independence-microgrids.

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