BEYOND THE FENCE LINE:

Strengthening Military Capabilities Through Energy Resilience Partnerships

ASSOCIATION OF DEFENSE COMMUNITIES

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CSL connects rapidly emerging technologies to the resilience objectives of the military, utilities, and state and local governments. www.convergestrategies.com

Cover photo: US Army, Public Domain

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1. INTRODUCTION

1.1. The Military Energy Partnership Imperative

The Department of Defense (DoD) is increasingly reliant on electric power for critical national defense missions. Domestic military installations are connected to the civilian electric grid, which is under threat from more frequent and extreme weather events, aging and outdated infrastructure, and cyber and physical attacks from determined adversaries. In response, DoD and the military services have issued strong energy resilience policies and developed dozens of energy resilience and distributed energy projects.

In order to scale the deployment of energy resilience projects to secure critical missions, DoD will have to continue and expand partnerships with states, communities, regulators, utilities and others. This paper identifies existing partnerships that have led to successful energy projects, and describes how those projects provide a roadmap to strengthen energy resilience for the military and surrounding defense communities.

The remainder of this section provides an overview of the evolving threat environment to U.S. critical infrastructure and military readiness. Section 2 summarizes DoD energy resilience strategy and policy, and provides an overview of energy resilience stakeholders at the headquarters, program and installation levels. Section 3 features case studies of leading edge energy resilience projects and highlights the defense community partnerships that were key to their success. Section 4 identifies opportunities for additional innovations in defense community partnerships for energy resilience.

1.2. Evolving threat environment

The unclassified synopsis of the 2018 National Defense Strategy acknowledges that in an increasingly complex global security environment the "homeland is no longer a sanctuary," and that "increasing digital connectivity of all aspects of life, business, government, and military creates new vulnerabilities."[1] Recent events have illustrated the threats to defense critical infrastructure and military readiness posed by environmental incidents and determined adversaries, particularly to the U.S. electric grid.

In 2018, the U.S. Department of Homeland Security (DHS) and Federal Bureau of Investigation (FBI) released reports detailing efforts by the Russian government to target critical American infrastructure networks, particularly within the energy sector.[2] The DHS and FBI reports describe the activities of several persistent and advanced Russian hacking units, which burrowed into utility company networks and, in at least one instance, gained access to a power plant's critical controls. Intelligence reports also indicate that China, Iran and North Korea are actively strengthening cyber capabilities to target critical infrastructure.[3]

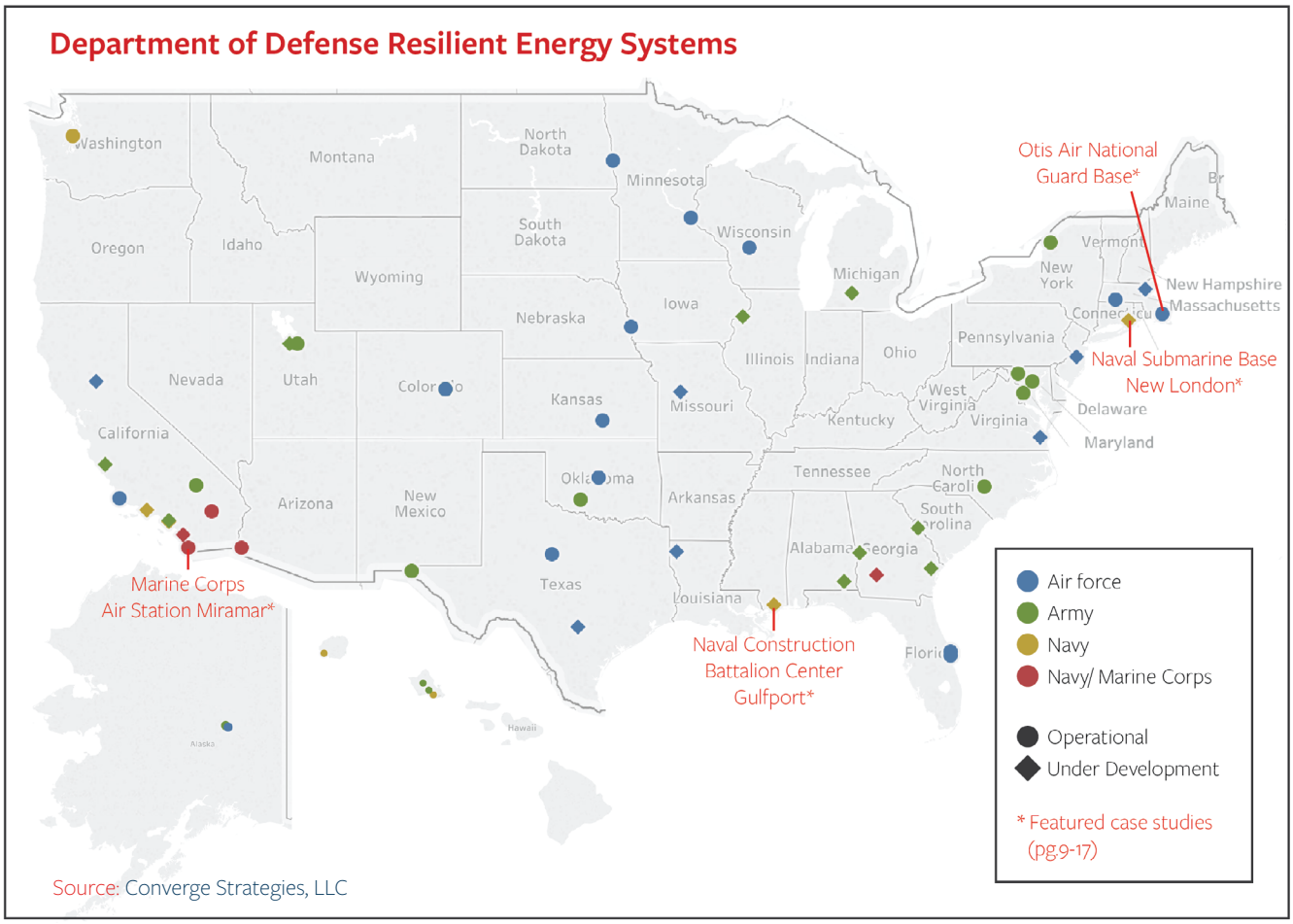
The electric grid also is at risk from disruptions caused by physical attacks. In 2013, gunmen severed local communications lines and opened fire on the Metcalf power substation in Northern California, disabling 17 high voltage transformers in less than 20 minutes.[4] Though the utility company was able to reroute power in order to avoid outages, repairs to the substation required 27 days of work and cost $15 million. The attackers were never identified. Other attacks have caused outages and longer repair times.[5]

Increasingly severe and frequent environmental effects from changes in climate are endangering military readiness and installation infrastructure. In October 2018, Hurricane Michael devastated Tyndall Air Force Base, Fla., and disrupted several other military installations in the Southeast.[6] DoD's view on national security and the changing climate is described in a 2018 report entitled, Climate-Related Risk to DoD Infrastructure Initial Vulnerability Assessment Survey (SLVAS). The SLVAS report states that "DoD looks at climate through the lens of its mission…changes in climate can potentially shape the environment in which we operate and the missions we are required to do…if extreme weather makes our critical facilities unusable or necessitate costly or manpower-intensive work-arounds, that is an unacceptable impact." The SLVAS report found that more than half of the military sites surveyed experienced the effects of extreme weather, including more than 225 experiencing flooding effects due to storm surge.[7]

2. ENERGY RESILIENCE IN THE DEPARTMENT OF DEFENSE

2.1. Advances in Military Energy Resilience

At most installations, energy resilience is provided through diesel generators and uninterruptible power systems tied directly to critical facilities and equipment. However, with increased emphasis on energy resilience over the past several years, DoD has invested significant resources in developing more comprehensive approaches to deploy and integrate



distributed energy resources. These resilient energy systems range from large onsite generators that power the entire base to advanced microgrids integrating multiple renewable generation sources. The map below shows examples of installations that have deployed a resilient energy system or have a system currently under development.[8]

In fiscal year 2017, DoD spent $3.3 billion on electricity and natural gas its installations. DoD energy infrastructure on bases has degraded as a result of cutbacks in military construction and maintenance funding,[9] resulting in a marked increase in significant power outages.[10] With budget shortfalls, DoD has attempted to leverage private sector financing to complete energy projects, with more than $2.9 billion in energy performance contract projects awarded since FY 2012.[11] DoD and the military services are expected to look to private sector financing as a critical tool to advance their resilient infrastructure goals going forward.

2.2. Energy Resilience Policy and Structure

In alignment with the National Defense Strategy, DoD's primary energy program priority is "to ensure the readiness of the armed forces by pursuing energy security and energy resilience."[12] To comprehend how DoD and the military services[13] are implementing that priority at military installations and defense communities, it is important to understand their policy and programmatic structures as they relate to energy resilience and national security. This section provides an overview of the energy resilience strategy and the specific energy resilience policies which align to the strategy for each entity.

2.2.1. Office of the Secretary of Defense (OSD)

OSD is responsible for assisting the secretary of defense in managing DoD.[14] Within the context of DoD's energy program, OSD's role is to establish principles and develop policy to be implemented by the military services.

Strategic objectives

In April 2018 Lucian Niemeyer, assistant secretary of defense for energy, installations and environment, emphasized the prominence of energy resilience in the department's overall strategy, telling the House Armed Services Committee it is "a top priority to ensure that our military capabilities and our ability to protect our nation's interests are assured through the delivery of reliable and resilient power."[15] Given federal assessments of commercial power grid vulnerability, Niemeyer said DoD plans to "concentrate resources on projects which will enhance the resilience of defense critical and task critical assets," and continue "development of distributed energy sources which can be used to power critical missions regardless of the condition of the commercial grid."[16]

Policy

OSD has issued a series of directives and instructions related to energy and resilience. DoD directives establish policies, assign responsibilities, and delegate authorities.[17] Procedures and processes for implementing directives are disseminated through DoD instructions. DoD establishes its energy policy through DoD Directive 4180.01 DoD Energy Policy, which states that "[i]t is DoD policy to enhance military capability, improve energy security, and mitigate costs in its use and management of energy."[18] The directive adds that DoD will improve the energy performance of installations and weapons systems, diversify energy supplies — including renewable energy sources and alternative fuels — assess energy risk to functions across the DoD enterprise, ensure that energy analyses are included in DoD requirements and acquisitions, develop and acquire technologies to meet DoD energy needs, partner with other governmental organizations and the private sector, and educate and train personnel in valuing energy as a "mission essential resource." Taken together, the specific elements of DoD Directive 4180.01 position energy assurance and resilience as central considerations.

The primary document that translates DoD's energy policy into more specific energy resilience strategy is DoD Instruction 4170.11 Installation Energy Management. DoD Instruction 4170.11 establishes requirements for DoD and the military services for energy resilience on military installations. Military services must "take necessary steps to ensure the security of energy resources," including establishing energy requirements that align to critical mission operations, ensuring primary and emergency power infrastructure is emplaced to meet those requirements, and testing and maintaining critical energy infrastructure regularly.[19] In addition, DoD Instruction 4170.11 explicitly allows for energy resilience solutions that include integrated, distributed and renewable energy sources, and encourages the consideration of alternative financing arrangements to implement projects using private sector capital.[20]

In order to implement the energy resilience requirements of DoD Instruction 4170.11, DoD issued a policy memorandum requiring the development of installation energy plans.[21] Installation energy plans need to be integrated into an installation's overall master plan and align to energy resilience and mission assurance objectives, and require the signature of the installation commander. These plans are intended to be unified documents that provide a path forward to increase energy resilience and contribute to mission readiness and assurance.[22] The military services are required to complete the majority of installation energy plans in FY 2019.

In addition to the policies discussed above, DoD has integrated energy resilience as a component in its mission assurance construct, requiring that critical defense systems and assets are accounted for and assessed within energy resilience programs.[23]

2.2.2. The Military Services

The military services are responsible for manning, training and equipping the forces, which, traditionally, has included responsibility for installation infrastructure. The following section includes descriptions of each service's energy program. Each has articulated strategic objectives for their energy programs, helping to determine the services' policies, programs and projects.

This section also provides a short overview of stakeholders with roles in energy resilience for the services. The roles, responsibilities and reporting structure of energy resilience stakeholders within DoD are complex and dynamic. Each of the services has its own unique approach to establishing and assigning energy resilience responsibilities. The stakeholder overview is not meant to be comprehensive. Rather, it is intended to provide readers with an initial introduction to the types of stakeholders which are active in shaping and implementing energy resilience efforts. The Annual Energy Management and Resilience Report provides more comprehensive structures of the energy programs of DoD and the services.[24]

US Army, Public Domain | *The solar array field and wind turbine at Tooele Army Depot, Tooele, Utah.*

Department of the Army

Strategic objectives

The Army Energy Security and Sustainability (ES2) strategy provides a "strategic roadmap to foster a more adaptable and resilient force that is prepared for a future defined by complexity, uncertainty, and rapid change."[25] The ES2 strategy establishes five strategic goals for energy-related initiatives and capabilities to follow: 1) inform decisions; 2) optimize use; 3) assure access; 4) build resiliency; and 5) drive innovation.

Policy

Army Directive 2017-07[26] establishes requirements for Army energy security to enhance installation resilience. The Army will "prioritize energy and water security requirements to ensure available, reliable, and quality power and water to continuously sustain critical missions," and will coordinate vulnerability and risk assessments of potential disruptions. The directive requires that Army installations be capable of powering critical missions for a minimum of 14 days, and encourages the proliferation of redundant and diverse energy supplies that meet evolving mission requirements in normal and emergency operations.

US Air Force, Public Domain | *Senior Airman Jacob Prine checks the fuel connection prior to a flight test of new, environmentally-friendly fuel.*

Department of the Air Force

Strategic objectives

The Air Force's energy vision, outlined in its Air Force Energy Flight Plan 2017-2036, is to "enhance mission assurance through energy assurance." The vision includes three strategic energy goals: (1) improve resiliency; (2) optimize demand; and (3) assure supply.[27] The Flight Plan further details strategic energy objectives that align to the strategic goals and provide benchmarks for the Air Force to measure its performance. In order to improve resiliency, for example, the Air Force will ensure that all mission critical functions have assured access to a reliable energy supply at all times by FY 2036.

Policy

Air Force Policy Directive (AFPD) 90-17 "establishes the framework for energy management within the Air Force; the Air Force energy management program addresses the use, conservation, and security of energy and water across all Air Force missions."[28] AFPD 90-17 requires that the Air Force be able "to power any infrastructure identified as critical to the performance of mission essential functions independent of the utility grid for the period of time needed to relocate the mission or for at least seven days, whichever is longer."[29] As many Air Force missions can be temporarily relocated during disruptive events — e.g., by flying aircraft to other installations — this policy is flexible to fit energy resilience capabilities to mission requirements as appropriate.

US Navy, Public Domain | *U.S. Navy Lt. Cmdr. Mike Dobling & Chief Steelworker Jesse Hamblin, set up an expeditionary solar system.*

Department of the Navy

Strategic objectives

The Department of the Navy's installation energy security objectives are defined in its Energy Security Framework (ESF) which was issued in 2018 by the assistant secretary for energy, installations and environment.[30] The ESF defines three pillars of energy security as 1) resiliency (capability to recover from utility failures); 2) reliability (capability to resist utility failures); and 3) efficiency (capability to reduce demand and costs for utilities). The Framework requires installations to assess performance against benchmarks and then prioritize investments to close the most critical energy security gaps first.

Policy

The ESF benchmarks are defined in the Navy Facilities Engineering Command (NAVFAC) publication P-602 "Three Pillars of Energy Security." Performance against the ESF benchmarks is to be assessed annually and used to develop risk mitigation plans and prioritize investments. For reliability, the Department of the Navy seeks to ensure utility system outages do not exceed identified frequency and duration levels. Shipyards, which are particularly critical to Navy readiness, have more stringent benchmarks than other installations. The resiliency of Department of the Navy installations is primarily measured by the duration that the installation can continue operations during a utility disruption as compared to the documented mission requirements. One to seven days of backup power is required, depending on the type of facility.

2.2.3. Stakeholder Structure for Military Energy Projects

Headquarters Level

Each military service has an identified senior executive for energy — the deputy assistant secretary for energy and sustainability is the Army's designated senior energy executive; the Navy's is the assistant secretary for energy, installations and environment; and the Air Force's is the assistant secretary for installations, environment and energy.[31]

Headquarters level personnel of DoD and the services develop strategy, design and disseminate policy, assign responsibilities and provide oversight to their respective energy programs. High-level budget and programming decisions are made at the headquarters level, while responsibility for execution of specific projects resides with personnel at the program office or installation level.

Program Office

Each of the military services established central program offices to coordinate and implement energy resilience and distributed energy projects. The Army Office of Energy Initiatives (OEI), Air Force Office of Energy Assurance (OEA), and Navy Resilient Energy Program Office (REPO)[32] have slightly different roles and responsibilities within their respective corporate structures, but each are responsible for developing installation energy and energy resilience projects.

Program office personnel coordinate between project proponents at the installation level and headquarters level personnel. Each program office includes project managers that are responsible for exploring project opportunities and navigating the project development process, as well as technical experts.

Installation

There are more than 500 DoD installations worldwide, each with different tenants, internal structures and footprints. In addition, installations vary widely in size and terrain, from small campuses with a few buildings to large complexes and training ranges that span hundreds of thousands of acres. For those interested in pursuing defense energy partnerships, the most relevant stakeholders will be the installation's leadership and those responsible for installation infrastructure, such as the director of public works at a Navy or Army installation or base civil engineer at an Air Force installation. Installations also can include tenants with energy and resilience goals and resourcing structures that are separate from those of the installation.[33]

3. SUCCESSFUL DOD ENERGY PARTNERSHIP CASE STUDIES

As discussed in Section 1.2, DoD and the military services have deployed advanced and distributed energy projects across the country. Many of these projects were built through partnerships with states, municipalities, utilities and industry. Though not all of these energy projects have delivered mission assurance or energy resilience benefits, their success demonstrates the potential for partnerships to help DoD meet its energy objectives. This section presents case studies of leading edge energy resilience projects in which defense community partnerships have been instrumental to success.

Each case study provides background on the military installation, details of the energy resilience innovations that were deployed and an overview of the defense community partnerships involved. For the purposes of this report, "defense community partnerships" refers to the policy, planning and resourcing efforts by state and local governments to support energy resilience projects at military bases. Each of these case studies involved many examples of such partnerships, both large and small, during the course of project development. This report does not attempt to comprehensively capture the full story of these partnerships and instead highlights a few specific types of collaboration, summarized on the right.

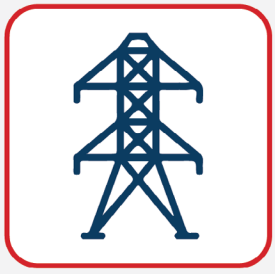
Each of the case studies prominently features one or more of these types of partnerships.

Partnership Types

Municipal partnerships, including joint planning, coordination and strategy development for energy resilience projects

State resources, including grants and financing provided through ratepayer funds or bonds

Military advisory councils, including guidance, advocacy and involvement from dedicated state military organizations



Utility engagement, including regulatory action to enable utility investments and direct cooperation with utility partners (e.g., municipal, cooperative or investor-owned utilities)

RESILIENT PV IN THE SOUTHEAST: Regulators, utilities, and DoD align for on-base solar projects

US Navy, Public Domain

Background

Naval Construction Battalion Center Gulfport (NCBC Gulfport) is a 1,100-acre installation located in Harrison County, Miss. The installation is home to the Atlantic Fleet Seabees, which include Mobile Construction Battalions that have deployed to conflict and disaster zones around the world, as well as to natural disaster relief efforts in the United States. The mission of NCBC Gulfport is to "maintain and operate facilities and provide services and material in support of Naval Construction Force Units."[34]

Naval Construction Battalion Center Gulfport, Miss., is leasing part of its land to host a solar photovoltaic (PV) system that sells electricity to the utility. In exchange for the lease, the project developer is building a microgrid that connects the PV with diesel generators and energy storage to power the base during blackouts. The Mississippi Public Service Commission has approved the power purchase agreement as part of a formal regulatory proceeding. This project is one example in which state regulators across the Southeast have authorized utility cost recovery for military energy resilience projects.

Energy Resilience Innovation

The 4.29 MW PV system at NCBC Gulfport is part of an 11-project, 310-megawatt portfolio of PV systems installed as part of Southern Company's Pentagon Partnership with the military.[35] Southern Company is the parent company of utilities in four southeastern states: Alabama Power, Georgia Power, Mississippi Power and Gulf Power (which serves parts of Florida). The NCBC PV system, which began operation in 2017, consists of more than 29,000 PV panels installed on approximately 23 acres of land. The PV system was developed by CB Energy LLC,[36] which entered into a 25-year power purchase agreement (PPA) with Mississippi Power. The project cost $6.2 million to install and was financed by WGL Energy Systems. WGL Energy will own the project over the term of the contract.[37]

In exchange for the use of its land, NCBC Gulfport will be able to use the installed energy infrastructure to support its resilience objectives. In 2016, the Navy entered into an enhanced use lease (EUL)[38] agreement with the project developer. Under EUL agreements, the military services can lease land to other entities in exchange for cash or "in-kind consideration" equal to the fair market value of the property. For the PV project, CB Energy agreed to construct a microgrid for NCBC Gulfport as its in-kind contribution which would include 1 MW of battery storage and 3 MW of diesel generation.[39] The PV system would be configured to supply the microgrid in the event of power disruptions. Construction of the microgrid is currently on hold while an expansion of the planned microgrid is explored.

Defense Community Partnership

State commissions regulate the rates that utilities can charge to customers in exchange for providing safe, adequate and

reliable electric service. In many states, state regulators have oversight over utility plans to build or procure energy resources, including authority over whether utilities can recover the costs of their investments from state ratepayers. A growing number of state commissions have considered and approved utility investments in projects that support energy resilience of military installations. This section summarizes the regulatory proceeding related to the NCBC Gulfport project, as well as similar proceedings involving Southern Co. utilities.

Mississippi Power and CB Energy submitted a joint petition to the Mississippi Public Service Commission for approval to include the PPA payments in the company's annual fuel cost recovery filing.[40] Mississippi Power noted that the PPA would result in a slight increase in rates during the first two years of operation but that it would place downward pressure on rates over the long-term.[41] The utility also noted that the PV system "provides the potential to improve energy independence and preserve the viability of a key Department of Defense installation in the region."[42] The commission authorized the utility to recover its costs associated with the PPA in a December 2015 order,[43] which enabled the project to move forward. The commission agreed that the project created an opportunity to put long-term downward pressure on utility rates, and found that the project created opportunities to add fuel diversity to the utility's portfolio and capture the benefits of solar generation for its customers.[44] The commission also found that because "the project generates energy from the sun, there will be no carbon emissions associated with its operation, which … serves to enhance the value of the project for [its] customers."[45]

The NCBC Gulfport project is only one example in which state regulators approved cost recovery for energy resilience projects associated with the Southern Co. Pentagon Partnership.[46] Examples in other states include:

Alabama. In 2015, the Alabama Public Service Commission authorized[47] Alabama Power to recover its costs to build and own a 10 MW PV system at Fort Rucker[48] and a 7 MW PV system at Anniston Army Depot.[49] The commission found that the projects would help meet military energy requirements. Commission staff also took the direct benefits of military base retention and the "indirect benefits associated with retaining residential and commercial loads that are highly dependent on the economic impact of each military base"[50] into account in their positive evaluation of the projects. The Army granted 30-year easements to the utility for use of its property and both projects have been configured to be "microgrid-ready"; i.e., infrastructure would be in place to enable islanding ability at a later date.[51] The Army is currently pursuing funding through the DoD Energy Resilience and Conservation Investment Program (ERCIP)[52] to convert the PV systems at both installations into microgrids.[53]

Georgia. The Georgia Public Service Commission has authorized Georgia Power to recover costs to build and own large-scale PV systems at military installations in a series of regulatory proceedings. In its regulatory orders, the commission consistently found that the projects contribute to the energy security and resilience objectives of the military services, promote fuel diversity within the state and represent significant investments in Georgia military installations. The PV projects include:

- Three 30 MW projects located at Fort Benning, Fort Gordon and Fort Stewart.[54] The Army is currently pursuing ERCIP funding to convert the PV projects into islandable microgrids.[55]

- A 31 MW project at Marine Corps Logistics Base Albany.[56] The base also is pursuing a separate microgrid that will be powered by biogas, landfill gas and diesel generation.[57]

- A 139 MW project at Robins Air Force Base.[58] Robins already is home to two 80 MW natural gas combustion turbines that Georgia Power uses as peaker plants during normal operations. These plants can be islanded to support the base during power disruptions.[59]

- Georgia Power also has received commission approval to build a 30 MW project at Naval Submarine Base Kings Bay[60] and a 32 MW project at Moody Air Force Base.[61]

OTIS AIR NATIONAL GUARD BASE MICROGRID: DoD and state collaborate to deploy resilient energy system


US Air Force, Public Domain

Background

Otis Air National Guard Base (ANGB) is part of Joint Base Cape Cod, which is located on the western portion of Cape Cod in Barnstable County, Mass. Otis ANGB is the home of the Massachusetts Air National Guard 102nd Intelligence Wing and the Distributed Ground Station Intelligence Group, which conduct 24/7 analysis with data from U-2, RQ-4 and MQ-9 aircraft. The mission of the 102nd is to provide worldwide precision intelligence and command and control, along with trained and experienced airmen for expeditionary combat support and homeland security.

Otis Air National Guard Base developed a microgrid that can power the entire installation for 120 hours during outages using wind power, advanced battery technology and diesel generation. Massachusetts supported the development of the microgrid using bond funds dedicated to support military energy projects through the Massachusetts Military Asset Strategy and Security Task Force.

Energy Resilience Innovation

The Otis ANGB microgrid is designed to power the entire ANGB campus for 120 hours during power interruptions. The microgrid has been under development since 2015 and is scheduled to be fully operational in the first quarter of 2019. The microgrid is the first wind-powered microgrid in DoD and connects on-base generation resources with new storage and control systems. Specifically, the microgrid connects an existing 1.5 MW wind turbine to an existing 1.6 MW diesel generator. It also includes a new 1.6 MW/1.2 MWh UltraBattery storage system. The UltraBattery is a lead acid battery with an ultracapacitor built into its electrode, which allows the system to provide greater power for longer periods than traditional storage options.[62] The microgrid is controlled by Raytheon's Intelligent Power and Energy Management Microgrid Control System, which enables the system to operate as an island during power outages and to earn revenue from electricity markets during grid-connected mode. The project is targeting a five-year payback on its initial investment by generating savings on-

base and by selling services such as frequency regulation and demand response in the wholesale power markets.

The microgrid was financed with $8.5 million in funding from DoD's Environmental Security Technology Certification Program (ESTCP) and a grant from Massachusetts (see below). The project also received in-kind support from several military units which directly supported construction.[63]

Defense Community Partnership

With the leadership of the Massachusetts Military Asset and Security Strategy Task Force (MASS-TF), the state provided funding to help make the 102nd Intelligence Wing's microgrid project at Otis ANGB a reality. Created in 2012, the MASS-TF aims to "protect and expand missions, jobs and economic investments at and surrounding Massachusetts' military installations."[64]

Together with its partner agencies in the state, the MASS-TF has focused on directing state resources to support military energy objectives. In 2014, the MASS-TF commissioned a study that identified opportunities for employing advanced energy technologies at each of the state's six military installations, such as microgrids, energy-efficiency upgrades and renewable energy.[65] Following the study, the state — using general obligation bond funds targeted through its FY 2015 capital investment plan[66] — provided grants to each military base to complete energy efficiency upgrades. The 102nd Intelligence Wing, for example, received $1.1 million from the commonwealth for high-efficiency boilers and an upgrade to the central energy management system.[67]

During the microgrid design process, the 102nd discovered the equipment installation requirements were larger and more complex than anticipated. The MASS-TF recommended the state provide $925,000 for the installation of the battery storage system to support the unit's energy resilience requirements. Otis ANGB held a formal ribbon-cutting ceremony on Aug. 29, 2018, to recognize the completion of the microgrid project, an undertaking that will transform how the installation manages and utilizes energy.

SUBASE NEW LONDON MICROGRID:
State and local support catalyzes project

Background

Naval Submarine Base New London (SUBASE New London) is a 687-acre installation located in Groton, Conn. The base is home to 11 submarine piers and more than 70 tenant commands. It employs more than 9,500 active duty, reserve and civilian personnel, representing close to 60 percent of the state's DoD workforce and almost all active-duty positions.[68] The mission of the base is to ensure and enhance national security by deploying combat-ready submarines and their crews and to train professional submariners.[69]

Naval Submarine Base New London is leasing part of its land to host a fuel cell project that will partially supply the power needs of the Connecticut Municipal Electric Energy Cooperative. In exchange for the lease, the base microgrid will receive power from the fuel cells during power disruptions. The microgrid has been supported by multiple defense community partners. The state of Connecticut has provided direct financial support through bond funds and through a resilience program created by the Legislature. The city of Groton has supported the project through its municipally-owned Groton Utilities through its municipally-owned Groton Utilities as affiliated energy cooperative, and by conducting energy resilience planning for its own critical infrastructure in collaboration with the installation.

Energy Resilience Innovation

SUBASE New London and the Navy entered into an EUL similar to the one employed at NCBC Gulfport. The base currently has a 4.75 MW natural gas turbine power plant with manual switches and two 750 kW diesel generators that supply backup power, a setup the Navy considers insufficient for resilience purposes and a "high operational risk."[70]

The Connecticut Municipal Electric Energy Cooperative contracted with FuelCell Energy to install two new 3.7 MW natural gas fuel cells on land leased from the base and will connect them to an existing installation substation. The

project is expected to be operational by mid-year 2019.[71] Electricity from the fuel cells will be purchased under a 20-year power purchase agreement by the energy cooperative. The entity is owned and governed by six municipal utilities in Connecticut and manages power supply on their behalf, as well as other customers in New England. During power outages, the electricity output from the fuel cells will supply electricity to 7.4 MW of critical load at the base in order to guarantee continuity of operations.[72] The new microgrid infrastructure, which includes Schweitzer Engineering Laboratories' Real Time Automation Controllers, also would allow the installation to remotely shut down specific facilities or devices (i.e. shed load) and supply power only to critical facilities during power outages. The microgrid distribution infrastructure is located underground and cannot be disrupted by snow or winds.[73]

Defense Community Partnership

SUBASE New London has partnered with state and local governments in support of the microgrid effort. At the state level, an important driver for collaboration on energy resilience was the federal Base Realignment and Closure (BRAC) process of 2005, during which SUBASE New London was initially selected for closure. The installation ultimately was not closed, and the Legislature established the Office of Military Affairs in 2007 with the primary mission of supporting and retaining SUBASE New London. In tandem, lawmakers approved a $50 million bond fund for base infrastructure upgrades that enhance military value.[74] During the 2005 BRAC process, DoD identified the base's vulnerability to the commercial electricity system as one of the factors behinds its recommendation for closure. In 2015, the State Bond Commission authorized the Office of Military Affairs to provide a $1.1 million grant to SUBASE New London for microgrid design and infrastructure upgrades.[75]

A second driver for state collaboration was Hurricane Irene and the October Nor'easter in 2011, which left 800,000 people in Connecticut without power for up to 12 days. A state report on the storm recommended microgrids as a solution for infrastructure resilience.[76] In 2012, Connecticut became the first state in the nation to create a statewide microgrid grant program.[77] The legislature passed a law that directed the state Department of Energy and Environmental Protection to establish a grant program to support the design, engineering and interconnection of microgrids at critical facilities. In 2018, the cooperative was awarded a $5.2 million grant under round four of the program, with the funds allocated to support microgrid electrical distribution infrastructure, controls and wiring, and load management capability at SUBASE New London in tandem with the new fuel cell generators.[78]

In addition to the financial support from the state, Groton, through Groton Utilities, also has supported the project. As described above, the energy cooperative will purchase electricity from the fuel cells, displacing purchases from the wholesale electricity market. Groton Utilities is one of six municipal utilities that own, govern and receive power from the energy cooperative. In addition, the cooperative maintains 6 MW of community solar gardens on Navy property adjacent to the installation, including 750 kW of storage. Groton Utilities serves as the distribution utility for the base and is owned by the city. Groton Utilities has supported microgrid interconnection and design to ensure a resilient energy supply. It also applied for a microgrid design grant from the state for its own critical infrastructure. The utility specified 28 critical facilities that a microgrid would support, including municipal water and wastewater facilities.[79] It said the base would benefit from its proposed microgrid "since it provides infrastructure and a potential building block conceptualization to expand the possibilities to the US Navy."

MCAS MIRAMAR MICROGRID EXPANSION: Community partnership provides cornerstone of DoD energy resilience plan

US Marine Corps, Public Domain

Background

Marine Corps Air Station (MCAS) Miramar contains 23,000 acres and is located 10 miles north of downtown San Diego. MCAS Miramar is home to the 3rd Marine Aircraft Wing, which is the aviation element of the 1st Marine Expeditionary Force. The 3rd Marine Aircraft Wing's mission is to provide combat ready expeditionary aviation forces capable of short notice worldwide deployment to Marine Air Ground Task Force, fleet and unified commanders.[80] About 9,300 Marines and sailors are assigned to MCAS Miramar, of whom 20 percent are deployed at any given time. An additional 1,700 civilians work at the installation.

Marine Corps Air Station Miramar developed a microgrid that can power the entire installation for three weeks using landfill gas, solar energy, storage, diesel generation, and natural gas. The base has worked with state and municipal partners in innovative ways at each stage of its energy resilience project development. The base is continuing to explore expansion of the microgrid using new technologies and authorities.

Energy Resilience Innovation

MCAS Miramar has pursued a broad range of energy resilience upgrades and improvements during the past decade utilizing an array of funding sources and procurement pathways. The base now has an installation-wide microgrid that is capable of supporting 100-plus facilities for three weeks, including critical missions such as the flightline. The microgrid incorporates two 1.4 MW natural gas generators, two 1.8 MW diesel generators, battery storage and two 1.6 MW, landfill gas-fueled generators. There is also more than 1.2 MW of solar PV installed within the islandable area of the microgrid. The microgrid has a sophisticated control system that allows it to automatically optimize generation and shed load. These capabilities enable the base to create additional revenue and savings by offsetting electricity purchases from the grid, reducing peak demand charges and participating in utility demand-response programs. In addition to the base-wide microgrid, Miramar

hosts a building-level microgrid that integrates multiple types of battery storage, controllable solar PV and electric vehicles. The remainder of this profile primarily focuses on the landfill gas component of the base-wide microgrid.

The Miramar landfill sits on approximately 476 acres on the south end of the installation. The Navy leases the landfill property to the city of San Diego and all waste management operations at the landfill are run by the city. Fortistar, a private company, operates two civilian landfill gas generating facilities associated with the Miramar landfill.[81] In 2009 Miramar was awarded $5 million by the DoD Energy Conservation Investment Program[82] to build a new 6.5-mile, 12kV distribution line from the landfill gas facility to the substation serving the installation's flightline. In 2012 Miramar signed a 15-year PPA with Fortistar for electricity produced from the landfill.[83] The PPA enabled the construction of the two landfill gas-powered, 1.6 MW gas generators and the installation of 43 new landfill gas extraction wells.[84] Although physically sited at the landfill, the two new landfill gas generators are directly connected to MCAS Miramar by the 12 kV distribution line; their entire output supplies the base.

During the course of the PPA, MCAS Miramar determined that one of the two landfill gas turbines is unable to operate for about 9 percent of the time due to landfill gas quality issues. As noted by the base, the unpredictable downtime of the landfill gas can pose challenges during island mode and can also cause utility bill spikes when operating in grid-connected mode.[85] MCAS Miramar plans to install a 3 MW battery storage system in 2020 that will be interoperable with the microgrid and will be used to even out the landfill gas output, rather than using a diesel generator. The load at MCAS Miramar also is expected to grow as the base expands to accommodate new missions, such as the Joint Strike Fighter.[86] As a result, MCAS Miramar is currently exploring the development of an additional 1.6 MW landfill gas generator in order to continue to meet the energy resilience requirements of new tenants.

Defense Community Partnership

The MCAS Miramar microgrid has benefited from defense community partnerships with both state and local entities, beginning with the original lease of Navy property to San Diego to create the landfill.

In 2018, Miramar was awarded a $5 million grant for its proposed 3 MW battery system from the Electric Program Investment Charge (EPIC) Program managed by the California Energy Commission. Miramar partnered with the University of California, San Diego to use the EPIC grant. EPIC was created in 2011 by the California Public Utilities Commission to fund clean energy research, demonstration and deployment projects that support California's energy policy goals and promote greater electricity reliability, lower costs and increased safety. The program is funded by a surcharge on the ratepayers of investor-owned utilities in the state. California Energy Commission funds also are supporting electric vehicle and battery components of the installation's building-level microgrid.

To expand the landfill gas capacity by 1.6 MW to a total of 4.8 MW, Miramar and the Navy Resilient Energy Program Office began working with the city to negotiate an intergovernmental support agreement (IGSA). The National Defense Authorization Act of 2013 authorized the military to enter into IGSAs with local and state governments if those agreements result in financial benefits or enhance mission effectiveness.

4. A ROADMAP TO ENERGY RESILIENCE AND MISSION ASSURANCE

The case studies presented in Section 3 are leading edge examples of resilient energy deployments that align with DoD energy policy and strategy. In each case, defense community partners are playing a pivotal role in the project's success. Partnerships such as these will need to be replicated and scaled across the country if DoD is to successfully enhance energy assurance for its missions at home and abroad. This section presents recommendations for enhancing military energy resilience partnerships with defense communities in two key areas: a) policy and planning; and b) resourcing.

Policy and Planning

States and cities can engage in a broad range of policy and planning efforts to support military energy resilience. These can include unilateral actions to bring their energy strategies, policies, programs and resources into alignment with DoD's, as well as direct partnerships with DoD in joint efforts. Examples of policy and planning innovation which could be considered by defense communities include:

- **Joint resilience planning.** In many cases, military installations are only as secure as the communities that neighbor them. Installations with energy resilient systems may still rely on interdependent civilian water, wastewater, communications and natural gas systems. There are opportunities for defense communities and the military to jointly map the critical infrastructure that serves installations and identify high-priority resilience investments. States and cities can also identify where homeland security or utility hardening investments could overlap with critical infrastructure near installations. States and cities could also identify opportunities to integrate the military into ongoing planning efforts related to energy assurance or extreme weather resilience.

- **Explore IGSAs.** As discussed in the case study of MCAS Miramar, IGSAs are a relatively new authority. The Government Accountability Office reports that 45 IGSAs had been approved by the military services as of July 2018 and none of them have been used to procure energy services.[87] IGSAs are a potentially compelling option, however, since they could provide military bases with additional flexibility for energy resilience procurement. The Navy's effort to negotiate an IGSA with San Diego for MCAS Miramar could create pathways for similar projects at other installations.

- **Defense community infrastructure investment.** The FY 2019 National Defense Authorization Act created the Defense Community Infrastructure Pilot Program[88] which enables DoD to contribute up to 70 percent of project costs for "investments in community infrastructure supportive of a military installation" if those investments "enhance the military value, resilience, or military family quality of life." For the purposes of the law, community infrastructure means "any transportation project; school, hospital, police, fire, emergency response, or other community support facility; or water, wastewater, telecommunications, electric, gas, or other utility infrastructure project that is located off of a military installation and owned by a state or local government." Although resourcing for the program remains uncertain, there are near-term opportunities for defense communities to engage with their installations to identify good candidates for funding under this new authority. Given DoD energy resilience objectives, for example, resilient energy systems that secure critical infrastructure in close proximity to DoD installations could be a promising area of focus.

- **State military advisory bodies.** At least 35 states and Guam have military task forces, commissions or councils that focus on supporting and retaining military bases for national security and economic development purposes.[89] To date, many of these advisory bodies have focused on issues such as encroachment. Military advisory bodies could explicitly prioritize energy resilience as an opportunity for collaboration. As seen in the cases in Alabama, Connecticut, Georgia, and Massachusetts states are intentionally supporting DoD energy mandates as base retention, infrastructure modernization and economic development strategies. Installation energy assurance capabilities and flexibility may not only help inform future BRAC decisions but may also help attract new missions.

- **Military energy resilience goals.** States have created policies that broadly encourage the alignment of state resources with military missions.[90] There are opportunities for states to establish goals that specifically align with military energy resilience objectives, such as committing to help installations meet their energy objectives by a certain date. Such goals can help align and focus state, local and military attention on practical cooperation opportunities.

- **State energy resilience policies.** The military has played a leadership role in the development of energy resilience strategy and policies for critical infrastructure. DoD possesses a wealth of lessons learned that defense communities can draw on as they craft their own energy resilience strategies in an era of emerging threats and surging distributed energy markets. State and local governments, for example, could explore civilian analogues to DoD energy resilience policies, or whether the coordinating functions provided by the military services' energy program offices could be replicated at the state level.

Resourcing

States have supported military energy resilience projects using a range of approaches and tools as demonstrated in the case studies. Although it has historically been challenging for the military to directly accept state funds, the 2019 National Defense Authorization Act added language allowing military installations to accept energy financial incentives from state and local government as part of Section 312 targeting "Further Improvements to Energy Security and Resilience."[91] This new authority creates opportunities to expand on proven models and to create new modes of resourcing. Examples of defense community resourcing for military energy resilience include:

- **State military infrastructure funds.** At the end of 2016, there were 13 states with programs to fund or finance projects that enhance the value of military installations, and four states that have created economic zones for enterprises that support military presence.[92] Some of these programs focus on energy investments,[93] but there are opportunities for energy resilience to be explicitly integrated into their mandates. As demonstrated by Massachusetts, state funds for cost-share purposes can be used to augment or attract DoD energy programs such as ESTCP or ERCIP.

- **State clean energy funds.** Many states across the country have established ratepayer-funded programs to support the deployment of clean energy. An increasing number of states have allocated funds for resilience projects through existing programs — e.g., EPIC in California — or have created new standalone programs — e.g., the Connecticut Department of Energy and Environmental Protection microgrid program. As of 2015, more than $400 million in state-managed programs had been dedicated to fund resilient power in the Northeast alone.[94] There are opportunities for state energy funds to explore partnerships with military bases. In 2018, for example, the Massachusetts Clean Energy Center awarded a community microgrids program grant to Hanscom Air Force Base.[95]

- **Utility and regulatory leadership.** In some cases, the utility's role in military energy resilience projects is limited to the interconnection process. As demonstrated by the cases across the Southeast and in Connecticut, utilities can play a leading and innovative role in national security investments as proponents, partners, owners and operators of military energy resilience projects. Particularly in states without electricity market competition, utility engagement in resilience projects can support regulatory decisions that spur security and economic gains for defense communities and military installations. Military energy resilience projects that diversify state generation portfolios can also place long-term downward pressure on electricity rates.

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