LESSONS LEARNED FROM

RETROFITTING EXISTING SOLAR WITH EMERGING TECHNOLOGIES [RESET]

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ABOUT DEPARTMENT OF DEFENSE, ENVIRONMENTAL SECURITY TECHNOLOGY CERTIFICATION PROGRAM

ESTCP is DoD's environmental technology demonstration and validation program. The Program was established in 1995 to promote the transfer of innovative technologies that have successfully established proof of concept to field or production use. ESTCP demonstrations collect cost and performance data to overcome the barriers to employ an innovative technology because of concerns regarding technical or programmatic risk, the so-called "Valley of Death."

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ABOUT CONVERGE STRATEGIES, LLC

Converge Strategies, LLC (CSL) is a consulting company focused on the intersection of clean energy, resilience, and national security. CSL works with civilian and military partners to develop new approaches to energy resilience policy and planning in the face of rapidly evolving threats, vulnerable infrastructure, and determined adversaries.

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ABOUT RETROFITTING EXISTING SOLAR WITH EMERGING TECHNOLOGIES [RESET]

Retrofitting Existing Solar with Emerging Technologies [RESET] (ESTCP Project # EW20-5330) focuses on developing a repeatable project structure for retrofitting existing Department of Defense (DoD) renewable energy assets with resilience technologies. RESET assesses the cybersecurity, legal, engineering, and financial feasibility of retrofitting existing solar photovoltaic (PV) generation at a military installation with resilience capabilities. RESET identifies lessons learned and recommendations applicable across the DoD enterprise.

BOTTOM LINE UP FRONT [BLUF]

#	RESET Lesson Learned	RESET Recommendation
1	DoD lacks a service-wide database of its existing renewable energy assets, including the characteristics that would determine if they are eligible for resilience retrofits to support critical missions.	DoD should survey their existing renewable energy assets to better understand which renewable energy assets meet baseline requirements for energy resilience retrofits.
2	DoD has not previously retrofitted existing third-party owned solar PV systems to incorporate resilience, and has no documented and coordinated processes on which to build.	DoD should use a database of existing renewable energy assets (*Recommendation 1*) to select projects that are suitable candidates for resilience retrofit demonstration and complete retrofit pilots.
3	DoD energy leadership has not issued policy for retrofitting existing solar PV with resilience capabilities.	DoD should develop policy that specifically promotes resilience retrofits for existing renewable energy assets.
4	DoD engineering organizations have not established a standard process for retrofitting solar PV with battery storage and service energy program offices have not coordinated resilience retrofits across the military services.	DoD should assign military service entities the responsibility to centrally identify and coordinate projects with installation civilian personnel.
5	Installation energy leadership often has not prioritized retrofitting solar PV nor understands how it could be accomplished using existing procurement pathways.	DoD installation energy leadership should identify project champions within their organization who are capable of prioritizing resilience retrofit projects and guiding them from ideation to execution.
6	DoD does not have designated funding sources or established financial pathways for energy resilience retrofits.	DoD should designate funding to pursue energy resilience retrofits and partner with other federal agencies focused on the deployment of clean, resilient technologies in order to reduce the upfront costs associated with battery storage.

Figure 1. Overview of RESET Lessons Learned & Recommendations

INTRODUCTION

DoD has acquired a large fleet of power plants located on or near its military installations during the past decade, including more than 2,000 renewable energy plants that generated 3,700 GWh in 2020 (ASD(S), 2021). Despite this large portfolio of renewable energy plants, few of them have been configured to provide energy resilience to the installations they serve. While there are notable examples of greenfield microgrid projects incorporating solar PV - such as the 30 MW solar PV system at Pacific Missile Range Facility Barking Sands in Hawaii (Rickerson, W., et. al., 2021) - DoD continues to rely overwhelmingly on backup diesel generators to provide energy resilience (ASD(S), 2020a). Thus far, DoD has not realized the potential of its existing renewable energy plants as a significant energy resilience resource because DoD, and the federal government more broadly, lacks the policies and processes for improving energy resilience of existing renewable energy assets.

The lessons learned discussed below reflect feedback from interviews with more than 40 energy resilience practitioners from across DoD and the private sector, as well as a series of energy resilience retrofit feasibility studies for a solar PV system at Edwards Air Force Base (EAFB). The recommendations describe steps that DoD policymakers and energy leadership should take to create an energy resilience resource that meets legislative clean energy mandates and Presidential Executive Orders (Exec. Order No. 13834, 2018; Exec. Order No. 14008, 2021). The recommendations adopt a staged approach for DoD to consider how a resilience retrofit initiative would move from the enterprise-level to the military services to the hundreds of installations located across the United States. These high-level recommendations build from the guiding questions captured in the report, *Considerations for Retrofitting Existing Solar with Emerging Technologies*, which contains specific recommendations for evaluating energy resilience retrofits on or near DoD installations.

LESSONS LEARNED AND RECOMMENDATIONS

LESSON 1

DoD lacks a service-wide database of its existing renewable energy assets, including the characteristics that would determine if they are eligible for resilience retrofits to support critical missions. While DoD has acquired a large amount of renewable energy assets over the past decade, DoD energy stakeholders lack an overall understanding of the total capacity of these systems across the military services, and which of them would be suitable for energy resilience retrofits. For example, DoD lacks an enterprise-level understanding of the contracting timelines of third party-owned renewable energy projects and when existing projects could be modified or renegotiated to optimize for resilience retrofits. As a result, DoD is unable to efficiently and systematically identify, catalog, and prioritize the most promising existing solar PV projects for potential resilience retrofits at DoD installations.

Recommendation 1: DoD should survey their existing renewable energy assets to better understand which renewable energy assets meet baseline requirements for energy resilience retrofits. For example, existing projects that are greater than 1 MW in size, have more than 10 years remaining on the existing contract, and have an existing cybersecurity Authority to Operate (ATO) may prove to be good candidates for a resilience retrofit because they reduce project complexities. While some Services (e.g., Army) have surveyed existing solar PV assets for overall performance, they have not included key engineering, cyber, or contracting considerations that would determine if they are optimal assets for resilience retrofits. A comprehensive database of existing asset characteristics and a focus on increasing energy resilience will help these assets meet mission load requirements with clean energy sources.

LESSON 2

DoD has not previously retrofitted existing third-party owned solar PV systems to incorporate resilience, and has no documented and coordinated processes on which to build. DoD emphasizes partnerships with private sector capital providers and system owners to deploy renewable energy (USD(AT&L), 2016). However, the practice of retrofitting existing third-party owned renewable energy assets with battery storage for resilience has not been sufficiently explored within DoD and across the Federal Government. The few examples of third-party owned federal solar PV assets that have been retrofitted with battery storage have thus far been optimized for revenue generation or cost savings rather than energy resilience to support mission continuity. For example, the Army's 25-year solar PV Power Purchase Agreement (PPA) with Ameresco at Fort Detrick, which was signed in 2013 and became operational in 2016, was recently modified

to include construction of an energy storage facility. The battery project will be configured to earn revenue through the PJM frequency regulation market, but it is not being configured to provide islandable resilience capabilities for the installation (Pina, A., et. al., 2021).

Recommendation 2: Since the process for third party-financed resilience retrofit projects has not been previously documented, DoD should use a database of existing renewable energy assets (*Recommendation 1*) to select projects that are suitable candidates for resilience retrofit demonstration and complete pilot retrofit efforts. Projects should be selected based on baseline engineering and cybersecurity requirements, as well as an installation's overall willingness to serve as a testbed for resilience retrofit demonstration. Lessons learned from these demonstration projects should inform future DoD energy policy development and equip DoD installation leadership and project developers with a defined process for energy resilience retrofits. These pilots would create a documented and coordinated process to guide future third-party resilience retrofits.

LESSON 3

DoD energy leadership has not issued policy for retrofitting existing solar PV with resilience capabilities. Despite the military services' interest in mission assurance and that DoD policies allow for and encourage the use of renewable energy for resilience, DoD lacks specific guidance for retrofitting existing renewable energy assets to provide energy resilience. As a result, energy resilience retrofits have been prioritized below new (i.e., greenfield) energy resilience projects by the program offices within each military service and by energy leadership at individual installations.

Recommendation 3: DoD should:

- *Develop policy that specifically promotes resilience retrofits for existing renewable energy assets.* Resilience retrofits may be cheaper and/or provide more effective resilience than building new projects. Resilience retrofits may also validate whether renewable energy projects that were marketed as "microgrid-ready" are capable of delivering the promised benefits of resilience. The development of this policy should be informed by demonstration projects (*Recommendation 2*) and establish DoD enterprise-wide goals for resilience retrofits on a per annum basis.
- *Issue more detailed guidance on how to evaluate energy resilience retrofit projects versus alternatives (i.e., new construction) to ensure that existing high-performing solar PV assets do not become stranded assets.* New policies that align clean energy and resilience investment would be consistent with recent executive and legislative actions (see Appendix for examples).

LESSON 4

DoD engineering organizations (e.g., AFCEC) have not established a standard process for retrofitting solar PV with resilience and DoD energy program offices (e.g., OEI) have not coordinated resilience retrofits across the military services. Each attempt to retrofit existing solar for resilience is explored on a case-by-case basis at the installation level, typically by energy managers attempting to find creative solutions to meet mission requirements at their installations. This bottom-up, one-off approach limits the amount of information sharing and practice exchange across the DoD enterprise. As a result, resilience retrofit examples are not widely available for installation level personnel to reference when encountering project barriers. For example, DoD lacks common network architectures for existing solar installations, and cybersecurity requirements for an energy installation are unclear. Energy resilience practitioners interviewed for the RESET project identified the lack of precedent and clear process as one of the most significant barriers to pursuing resilience retrofit projects.

Recommendation 4: DoD should assign military service entities the responsibility to centrally identify and coordinate projects with installation civilian personnel. These projects should align with a DoD policy to increase resilience retrofits of renewable energy installations (*Recommendation 3*). Centralizing knowledge will eliminate the need to rediscover the resilience retrofit process for each project while also ensuring projects are prioritized at the service-level to efficiently use limited DoD resources. The assigned military service entities could learn from the demonstration pilots (*Recommendation 2*) and create a streamlined process for their service that includes the appropriate engineering, cybersecurity, funding/financing, and contracting preferences. For example, DoD should provide guidance on cybersecurity architectures that can be adapted to existing installations, and contain relevant information for DoD-owned vs. third party installations. The entities could then use the renewable energy project database (*Recommendation 1*) to select the most beneficial projects and avoid wasting resources on projects that may have major roadblocks.

LESSON 5

Installation energy leadership often has not prioritized retrofitting solar PV nor understands how it could be accomplished using existing procurement pathways. While DoD has multiple organizations capable of originating and acquiring clean energy retrofits (e.g., engineering organizations and energy program offices), the responsibility for organizing and driving resilience retrofit projects on the ground lies with personnel from each individual installation. The military personnel at installations rotate every one to three years, which is currently shorter than the timeline for completing a retrofit. The loss of a project champion can be a major barrier to project

success because project knowledge - and motivation - may not be carried through to his/her successor. In addition, civilian personnel are not currently trained on how to implement these types of projects. Since there is little continuity provided across installation or during transitions, each retrofit effort may require individual personnel to "redesign the wheel" without advanced knowledge of the project roadblocks that they may encounter or the best practices for successful execution.

Recommendation 5: DoD installation energy leadership should identify project champions within their organization who are capable of prioritizing resilience retrofit projects and guiding them from ideation to execution. These project champions, ideally civilians with long-term career opportunities at the installation, should receive training on energy resilience and coordinate with engineering organizations and energy program offices to determine whether their installation's existing solar PV would be an appropriate candidate for a resilience retrofit project (*Recommendation 4*). Project champion engagement with engineering organizations and energy program offices will enable installation leadership to avoid roadblocks encountered at other installations and streamline retrofit project execution.

LESSON 6

DoD does not have designated funding sources or established financial pathways for energy resilience retrofits. Resilience retrofit projects compete for funding with energy conservation and energy resilience projects through programs with limited funding, such as the Energy Resilience and Conservation Investment Program (ERCIP). There are also uncertainties in terms of how DoD funds can be utilized for resilience retrofits. Until recently, blending funding from military construction (MILCON) and operations and maintenance (O&M) accounts was prohibited. The Energy Act of 2020, the FY 2021 NDAA, and the FY 2022 NDAA removed those prohibitions, but so far, few examples exist of successful co-mingling of funds. DoD energy resilience projects are constrained in their ability to attract private investment because of the complexities and uncertainties of the DoD project development and acquisition process. As seen in the Edwards AFB feasibility studies, the Air Force process for establishing a $/kWh price for a PPA extension was not communicated in advance to the capital providers risking the contract renewal. A lack of established, transparent processes can increase the perceived risks of financing DoD projects.

Recommendation 6: DoD should designate funding to pursue energy resilience retrofits and partner with other federal agencies focused on the deployment of clean, resilient technologies (e.g., Department of Energy) in order to reduce the upfront costs associated with battery storage. For example, DoD has worked with DOE's Office of Electricity and utilized

the Assisting Federal Facilities with Energy Conservation Technologies (AFFECT) program in the past to complete battery storage projects at DoD installations and these interagency partnerships should be strengthened in order to accomplish the goals of DoD's resilience retrofit policy (*Recommendation 3*). DoD should demonstrate the use of ERCIP within common contracting pathways, such as ESPCs, and more firmly establish precedent across the enterprise for blending of different "colors of money" to allow for energy resilience projects. DoD should also issue clear guidance to the energy program offices on how acquisition pathways can be utilized to support third party-financed energy resilience retrofits. The energy program offices should also clarify areas of process uncertainty, and effectively communicate acquisition processes and opportunities to private sector partners.

CONCLUSION

Retrofitting existing solar with battery storage and enhanced controls represents a unique opportunity for the DoD to strengthen the resilience of its installations. While resilience retrofit projects are technically possible, they are not currently prioritized by DoD leaders at the headquarters level. As a result, individual services and installations have not engaged with project developers to better understand how they could recapitalize existing assets located on or near installations to provide energy resilience. The staged approach outlined above provides a framework by which DoD could establish a resilience retrofit initiative and tap into its expansive portfolio of existing renewable energy assets; it is not intended to be exhaustive or capture the full suite of barriers, lessons learned, and best practices. For a more detailed look at resilience retrofit feasibility on DoD installations, please view the report *Considerations for Retrofitting Existing Solar with Emerging Technologies*. For more information about RESET, please contact mpringle@convergestrategies.com.

APPENDIX

Policy / Legislation	Key Takeaway	RESET Relevance
Executive Order (EO) 14057	Adopts a "whole-of-government" approach and directs the federal government, including DoD, to achieve ambitious clean energy goals, including 100% carbon pollution-free electricity by 2030 and net-zero emissions from overall federal operations by 2050.	Solar PV with battery storage is a 100% carbon pollution-free electricity source and can be leveraged to accomplish net-zero emission goals for federal operations.
Infrastructure and Investment Jobs Act (IIJA)	Authorizes tens of billions in new investment in energy infrastructure, including $250 million for federal facility energy upgrades, $1 billion for demonstration projects in rural areas, and $500 million for demonstration projects in economically hard-hit communities	Many DoD installations are located within rural and remote communities, which are able to partner with defense communities to achieve community resilience using solar PV with battery storage.
National Defense and Authorization Act (NDAA) for Fiscal Year (FY) 2022	Elevates the importance of energy and climate resilience to new levels, including codifying the National Security Climate Resilience Act and requiring that at least 10% of major military installations achieve energy net-zero and water or waste net-zero by FY 2035	Installations will need to combine clean energy with battery storage in order to meet both the DoD's net-zero and existing energy resilience requirements.
United States Army Climate Strategy	Establishes ambitious clean and resilient energy goals, including installing a microgrid on every Army installation by 2035 and achieving on-site carbon pollution-free power generation for Army critical missions on all installations by 2040.	Existing solar PV paired with battery storage can be configured to support larger, base-wide microgrids while achieving carbon pollution-free power generation for the installation.

Figure 2. Recent Federal Government Mandates that Support RESET Objectives

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