

ARMY NET ZERO

Lessons Learned in Net Zero Energy

June 2015

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MESSAGE FROM HONORABLE KATHERINE HAMMACK

Photo from U.S. Army 291555

The Army Net Zero Initiative is a holistic strategy founded upon long-standing sustainable practices and emerging best practices to manage energy, water, and waste at Army installations. The Net Zero Initiative was launched with installation-level pilot programs designed to serve as test beds to gather lessons learned, develop technical analysis and plans, and construct a solid foundation to transition and institutionalize the Net Zero concept throughout the Army. These installations include a total of seventeen Net Zero Energy, Water, and Waste installations that had a single focus of energy, water, or waste (six installations each), two integrated Net Zero Energy-Water-Waste pilot installations, and one statewide Army National Guard Net Zero Energy pilot program.

A Net Zero Energy installation reduces overall energy use; maximizes efficiency, energy recovery, and cogeneration opportunities; and offsets the remaining energy demand with the production of renewable energy. A Net Zero Energy installation's goal is to produce as much renewable energy on site as it uses over the course of a year. The Net Zero Energy sites represent installations of different physical sizes, geographic locations, and Army commands.

This report is a compilation of lessons learned from the Army's Net Zero Energy Pilot Implementation Program. It reinforces the concept and importance of Net Zero Energy and further develops the Net Zero Implementation Framework by presenting specific examples of activities in each of the framework's implementation phases.

The bulk of this report is devoted to highlighting the feedback from those involved with the Net Zero Energy pilot program, the installations selected for participation, the technical experts at the Army support organizations, and the national laboratories that provided assistance to those installations.

Honorable Katherine Hammack
Assistant Secretary of the Army
(Installations, Energy & Environment)
Washington, DC

COMMON FACTORS FOR NET ZERO ENERGY PROGRAM SUCCESS

The following common factors for success are the most important lessons learned from this study. These lessons learned were repeated frequently from multiple sources of feedback and significantly impacted the success of the Net Zero Energy programs at each installation.

- Leadership support and engagement at multiple levels is critical to an effective Net Zero Energy program.
- The Net Zero Energy approach should be an interdisciplinary, well-integrated, and holistic methodology of assessing, planning, developing, and implementing Net Zero Energy projects.
- Advanced planning for energy projects and incorporating energy as a primary consideration in designs are critical to the success of implementing the Net Zero Energy principles.
- Understanding the integration implications of proposed Net Zero Energy projects—between other energy projects, between projects and existing systems, and between projects supporting Net Zero Water and Waste—is crucial to implementing a cohesive and effective Net Zero Energy program.
- The capability, motivation, dedication, and capacity of the Net Zero Energy program leads are some of the most significant factors that affect an installation's success in pursuing Net Zero Energy.
- Net Zero Energy implementers and teams need appropriate training and skills. In addition, they should recognize and utilize all the available resources to successfully implement projects.
- Maintaining flexibility in pursuit of finding the right procurement approach for each project dramatically increases the likelihood of success.

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INTRODUCTION TO NET ZERO ENERGY

The Army's vision is to appropriately manage its natural resources with a goal of Net Zero installations in energy, water, and waste (Figure 1). Net Zero builds on existing Army sustainability efforts to integrate environmental, energy, and green procurement programs. This holistic strategy is targeted to improve management of Federal energy, water, and solid waste requirements with the goal of exceeding minimum targets where fiscally responsible. Net Zero is a force multiplier enabling the Army to appropriately steward available resources, manage costs, and provide soldiers, families, and civilians with a sustainable future. Implementing Net Zero Energy initiatives also improves an installation's energy security and sustainability and increases its resiliency—helping it anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

The Army's intent is that all installations evaluate the feasibility of achieving Net Zero and then implement Net Zero to the maximum extent practical and fiscally responsible through the following actions:

- Reduce overall energy use, maximize efficiency, implement energy recovery and cogeneration opportunities, and then offset the remaining demand with the production of renewable energy from on-site sources, such that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.
- Reduce overall water use, regardless of the source; increase efficiency of water equipment; recycle and reuse water, shifting from potable water use to non-potable sources as much as possible; and minimize inter-basin transfers of any type of water, potable or non-potable, such that a Net Zero Water installation recharges as much water back into the aquifer as it withdraws.
- Reduce, reuse, recycle/compost, and recover solid waste streams, converting them to resource values, resulting in zero landfill disposal.[1]

PURPOSE OF THIS REPORT

This report is focused on the energy facet of the Net Zero triad and touches briefly on considerations for integrated planning and projects at the nexus of energy and the other facets of water and waste. The report is designed to be an easily accessible compilation of lessons learned in implementing energy projects on Army and other military installations with particular emphasis on the process of pursuing Net Zero Energy. It is intended to serve as a reference to the implementers of Net Zero Energy processes and projects at Army installations around the globe. Input for this report was obtained from a broad range of technical and financial experts and Army personnel representing diverse geographic distributions. It draws heavily from the experiences of those involved with implementing Net Zero Energy at each of the Army's eight Net Zero pilot installations and one statewide Army National Guard location (shortened to "nine Army pilot sites" in subsequent mentions), as well as from the case studies resulting from projects they pursued. The nine Army pilot sites follow:

- Camp Parks Reserve Forces Training Area, Dublin, California
- Fort Bliss, El Paso, Texas
- Fort Carson, Colorado Springs, Colorado
- Fort Detrick, Frederick, Maryland
- U.S. Army Garrison Fort Hunter Liggett, Jolon, California
- U.S. Army Kwajalein Atoll, Republic of the Marshall Islands
- Sierra Army Depot, Herlong, California
- U.S. Military Academy, West Point, New York.
- Oregon National Guard, Oregon (statewide)

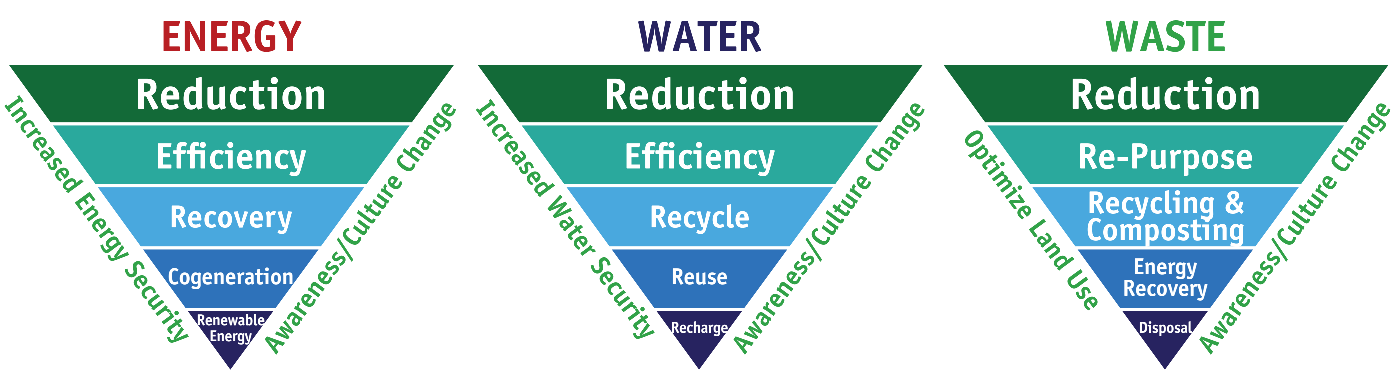

Figure 1. Net Zero concept. *Illustration from U.S. Army*

[1] Army (2014). *U.S. Army Net Zero: Commanders Guide.* (internal only). This introduction and Figure 1 are derived from the Commanders Guide, along with other content throughout the body of this report, as noted.

More important than compliance with policies, standards, and directives is the fact that pursuing Net Zero Energy can decrease costs, improve energy security, benefit the quality of life of personnel, and increase operational capabilities and resiliency.

Instead of presenting summary information on each site in the Army's Net Zero Installations pilot program, as in previous reports, this report is arranged by topic and categories of issues that Army installations will likely need to consider while developing energy projects.

POLICIES FOR NET ZERO ENERGY

Several Federal Government and Army-specific mandates and goals have given rise to Army policies centered on obtaining certain levels of energy efficiency, seeking renewable sources of energy, becoming more resilient, and improving energy security and sustainability. These goals, mandates, and policies include the following:

- In October 2009, Executive Order 13514 required all new buildings that enter design in fiscal year 2020 and after achieve Net Zero Energy by fiscal year 2030.[2] As buildings are designed and built to the standard of Net Zero Energy, installations will realize significant progress toward achieving overall Net Zero Energy.
- In October 2010, the Army issued a policy requiring greater efficiency in buildings.[3] As Net Zero Energy building projects improve the performance of existing buildings and raise efficiency standards for future construction, an installation's Net Zero Energy program will contribute to compliance with this policy.
- In December 2011, the presidential administration first announced a goal for the Federal Government to implement a total of $2 billion worth of energy savings performance contracts (ESPCs).[4] In April 2014, the administration announced a goal for an additional $2 billion investment.[5] Net Zero Energy efforts contribute toward these goals when ESPCs are included in the implementation approach used.
- In April 2012, the administration announced that each of the military services (Army, Navy, and Air Force) committed to installing 1 gigawatt, for a total of 3 gigawatts, of renewable energy generation by 2025.[6] Net Zero Energy implementation moves toward this goal when renewable energy generation is a component of those efforts.
- In August 2012, the Army confirmed the policy requiring all permanent Active Army, Army National Guard, and U.S. Army Reserve installations, sites, and facilities to reduce their energy use intensity by 3% per year from fiscal year 2008 through fiscal year 2015 (using fiscal year 2003 as the baseline), with the intent of reaching an overall goal of reducing energy use intensity by 37.5% by 2020.[7] Net Zero Energy efforts at installations will contribute toward this goal as projects decrease the energy use of existing buildings and elevate efficiency standards for future construction.
- On November 1, 2013, Executive Order 13653 called for all Federal agencies to improve resiliency in preparation for addressing the impacts of climate change.[8] As Army installations increase their energy independence through Net Zero Energy initiatives, they will also increase their resiliency.
- On January 28, 2014, Army Directive 2014-02 (Net Zero Installations Policy) was issued, which requires all permanent Active Army, Army National Guard, and U.S. Army Reserve installations, sites, and facilities to pursue—to the maximum extent possible within fiscal responsibility—Net Zero Energy, Water, and Waste.[9]

More important than compliance with policies, standards, and directives is the fact that pursuing Net Zero Energy can decrease costs, improve energy security, benefit the quality of life of personnel, and increase operational capabilities and resiliency.

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[2] The White House, Washington. Executive Order. Subject: Federal Leadership in Environmental, Energy, and Economic Performance. October 5, 2009, Accessed September 23, 2014: *http://www.whitehouse.gov/assets/documents/2009fedleader_eo_rel.pdf*

[3] Department of the Army, Washington. Memorandum for: See Distribution. Subject: Sustainable Design and Development Policy Update (Environmental and Energy Performance). October 27, 2010. Accessed July 3, 2014: *http://www.asaie.army.mil/Public/IE/doc/Sustainable%20Design%20and%20Dev%20Policy%20Update.pdf.*

[4] The White House, Washington. Memorandum for the Heads of Executive Departments and Agencies. Subject: Implementation of Energy Savings Performance-Based Contracting for Energy Savings. December 2, 2011. Accessed July 3, 2014: *http://www.whitehouse.gov/the-press-office/2011/12/02/presidential-memorandum-implementation-energy-savings-projects-and-perfo.*

[5] The White House, Washington. Fact Sheet: President Obama Announces Commitments and Executive Actions to Advance Solar Deployment and Energy Efficiency. May 9, 2014. Accessed July 3, 2014: *http://www.whitehouse.gov/the-press-office/2014/05/09/fact-sheet-president-obama-announces-commitments-and-executive-actions-a.*

[6] The White House, Washington. Fact Sheet: Obama Administration Announces Additional Steps to Increase Energy Security. April 11, 2012. Accessed July 3, 2014: *http://www.whitehouse.gov/the-press-office/2012/04/11/fact-sheet-obama-administration-announces-additional-steps-increase-ener.*

[7] Department of the Army, Washington. Memorandum for: See Distribution. Subject: Energy Goal Attainment Responsibility Policy for Installations. August 24, 2012. Accessed July 3, 2014: *http://www.armyeitf.com/downloads/ASA(IEE)%20energy%20goal%20attainment%20policy%20(24%20Aug%202012).pdf.*

[8] The White House, Washington. Executive Order. Subject: Preparing the United States for the Impacts of Climate Change. November 1, 2013, Accessed January 30, 2015: *http://www.whitehouse.gov/the-press-office/2013/11/01/executive-order-preparing-united-states-impacts-climate-change.*

[9] Secretary of the Army, Washington. Memorandum for: See Distribution. Subject: Army Directive 2014-02 (Net Zero Installations Policy). January 28, 2014. Accessed July 3, 2014: *http://armypubs.army.mil/epubs/pdf/ad2014_02.pdf.*

NET ZERO IMPLEMENTATION FRAMEWORK

The *U.S. Army Net Zero: Commanders Guide* (see footnote 1) contains an excellent presentation of the iterative steps that the Army has identified as integral to pursuing Net Zero initiatives. Much like that guide, this report is organized according to this overarching framework: Initiate, Assess, Plan, and Implement (see Figure 2). This report further defines and develops the concepts of the implementation framework and gives examples of the activities that may take place within each phase by correlating the Army framework to the principles of Project Fundamentals and the Project Development Framework developed by the National Renewable Energy Laboratory (NREL). These principles were developed for renewable energy projects, but are also applicable to energy efficiency projects.

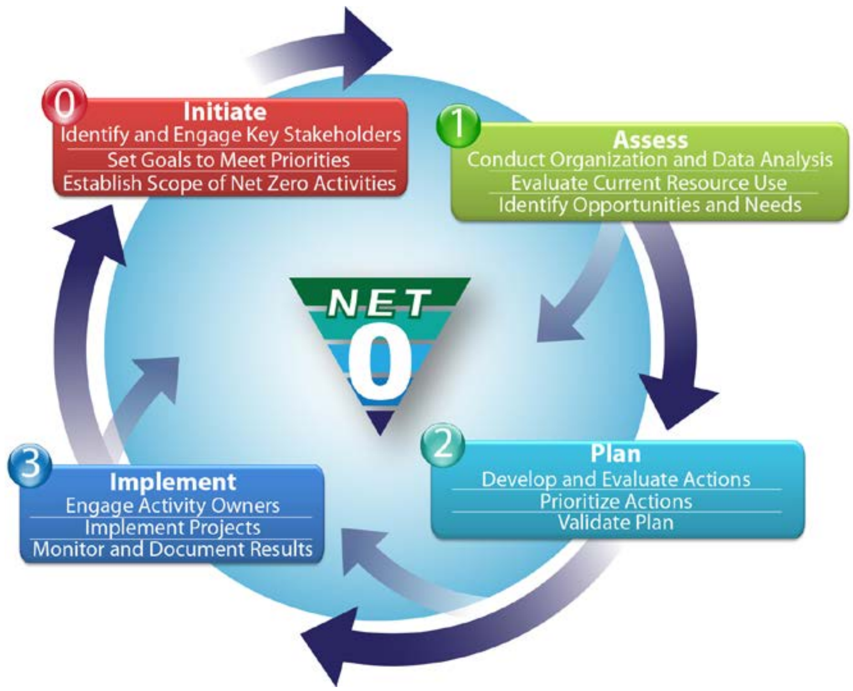

Figure 2. Net Zero implementation framework. *Illustration from U.S. Army*

Table 1. Project Fundamentals[10, 11]

Baseline	Economics	Policy	Technology	Consensus
Energy Market Drivers	**Market-Specific Dollars and Cents**	**Conditions for Success**	**What, Where, When, How Many**	**Defend, Defend, Defend...**
What defines the market and is it supportive of or a barrier to energy projects? • Market driver(s) • Source of fuel • Energy security requirements • Impact on economy • Impact on mission and operations • Industry structure • Regulatory structure • System structure	What are the dominant inputs to energy economics in your projects? • Economic tradeoffs and dependencies on other markets • Fuels • Avoidable utility charges (wholesale and retail rates) • Fixed utility charges • Forecasted utility rates • Applicable incentives • Costs and benefits	What is the pathway to secure contracting? What are the supports and barriers? • Army and government policy • Regulatory policy (such as interconnection regulations) • Contracting authorities • Economic development • Environmental policy • Licensing rules • Permit requirements	What are the commercially available technologies for the available resources? How do these align with the market? • Commercial and noncommercial definitions • Technical resource availability • Energy efficiency technical solutions • Market limitations or opportunities for each technology • Integration and reliability constraints	Who are the stakeholders whose support will be needed? Is the community supportive or obstructive? • Communicate • Create a forum • Defend fundamentals • Build consensus • Raise level of conversation • Repeat, repeat, repeat, and build consensus on defensible facts, not suppositions

[10] U.S. Department of Energy (DOE) Federal Energy Management Program (FEMP). *Large-Scale Renewable Energy Guide – Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities*. Washington, DC: DOE FEMP, March 2013. Accessed July 3, 2014: *http://energy.gov/eere/femp/downloads/developing-renewable-energy-projects-larger-10-mws-federal-facilities-large*. Some of the material in Tables 1 and 2 and the descriptions for the Project Fundamentals and Project Development Framework categories presented in the Lessons Learned section of this report were drawn from this source.

[11] Army Guide: Developing Renewable Energy Projects by Leveraging the Private Sector. Washington, DC: U.S. Army Office of Energy Initiatives, November 2014. Accessed March 11, 2015: *http://www.asaie.army.mil/Public/ES/oei/docs/2014%2011%2006%20Army%20Guide%20to%20Developing%20Renewable%20Energy%20Projects.pdf*. Some of the material in Tables 1 and 2 was drawn from this source.

Table 1 gives an overview of the five categories of Project Fundamentals, and includes examples of factors to consider and steps to be taken within each category.

Complementing and building on the concepts introduced in Project Fundamentals, NREL also developed a Project Development Framework that serves as a comprehensive methodology for implementing energy projects. The order of presentation of the elements of Project Fundamentals and the Project Development Framework is not meant to imply that the process for examining these features must always be linear. Instead, the elements of these frameworks are presented in an intuitive order to help structure the way that the project development process should be approached (i.e., thoroughly identify all the factors that will need to be considered and then execute the development process in a systematic way).

Table 2 depicts the seven elements of the Project Development Framework and gives examples of some of the considerations for each category, including activities to be undertaken.

Table 2. Project Development Framework Categories (see footnotes 10 and 11)

Site	Resource	Off-Take	Permits	Technology	Team	Capital
If No Site is Selected, No Project is Possible	**Engineering Assessment (Required for both RE[a] and EE[b])**	**Off-Take Contract (Revenue), or User of Energy**	**Anything That Can Stop a Project If Not in Place**	**Engineered System**	**Professional, Experienced, Diverse**	**Once All Is In Place, You Can Structure Financing**
• Site control and long-term control • Size, shape, and slope • Title due diligence and land value estimate • Location to load and transmission • Financial control • Lease considerations (fair value, assignment or collateral concerns) • Environmental aspects • Glint/glare analysis • Soils/geotech • Vehicle, labor, and O&M[c] access • Upgradeable • Other infrastructure • Survey	• Volume • Frequency • Variability (daily, monthly and seasonally) • Load profile • Weather dependence • History of data • Siting decisions • Technology suitability • Business case analysis • Life cycle cost analysis	• Credit of counterparty • Length of contract • Terms and conditions • Warranties • Assignment • Curtailment • Infrastructure/ interconnection • Performance • Milestones • Enforcement • Pricing terms (fixed or variable) • RECs[d] • Liability	• Local permitting/ entitlements • Building permits • Land disturbance • Environmental • Cultural impacts • Resource assessments • Wildlife impacts • NEPA[e] • Utility interconnection • Other utility or public commission approvals	• Engineering design plans • Construction plans • Engineered resource conversion technology • Design of balance of system • Design development or construction drawings • Specifications • Bid set	• DPW[f]–Energy • DPW–Environmental • Master planning • Operational staff • Range control • Technical expertise • Legal expertise • Financial expertise • Utility inter-connection expertise • Construction/ contract management • Operations	• Identify acquisition authority • Development equity • Project equity • Project debt • Tax equity • Grants, rebates, other incentives • Environmental attribute sales contracts (RECs) • Appropriated funds • Bond finance • Nonrecourse project finance

[a] Renewable energy
[b] Energy efficiency
[c] Operations and maintenance
[d] Renewable energy certificates
[e] National Environmental Policy Act
[f] Department of Public Works

The components of these two frameworks (NREL's Project Fundamentals and Project Development Framework) are iterative in nature. In addition, various categories of understanding each project's fundamental characteristics or pursuing project development will necessarily run concurrently or may need to be revisited throughout the development process. Similarly, the steps in the Army's Net Zero Implementation Framework, although part of a cyclical process, do not necessarily always occur sequentially.

Nevertheless, in this report, a correlation between the elements of these complementary frameworks is presented in an effort to strengthen the Army's approach and give more concrete examples of the types of activities that should be undertaken in each step of the process. This correlation is represented visually in Table 3 and serves to structure the rest of this report.

Another publication that provides a useful framework for structuring the activities required to develop renewable energy projects on Army installations is the *Army Guide: Developing Renewable Energy Projects by Leveraging the Private Sector* (see footnote 11).

Table 3. Correlating Three Project Frameworks

Army Net Zero Implementation Framework	NREL Project Fundamentals	NREL Project Development Framework
Initiate	Baseline	
Assess	Economics Policy	Site Resource
Plan	Technology Consensus	Off-Take Permits Technology Team
Implement		Capital

LESSONS LEARNED

	INITIATE	ASSESS	PLAN	IMPLEMENT
Implementation Phase	0	1	2	3

INITIATE

The first of the four phases of the Army's Net Zero Implementation Framework (Table 4), the Initiate phase consists of identifying and engaging key stakeholders, setting goals to meet priorities, and establishing the scope of Net Zero activities. This will require that installation energy teams have a fundamental understanding of their energy uses and opportunities and the realities of the markets in which they operate. A holistic and integrated planning approach needs to be determined and followed early in the process to facilitate setting goals and prioritizing efforts (see footnote 1).

Baselines are unique to each installation, as each has different mission requirements, energy costs, building types and ages, and renewable energy resources and incentives.

BASELINE

Baseline is the first principle of Project Fundamentals. Traditionally, the term "baseline" in energy projects refers to determining the existing level of energy use in a facility or group of facilities before pursuing an energy project. Although the Project Fundamental element of Baseline could include this traditional understanding of a facility's energy use, its definition is broader. It also refers to an objective analysis of the current energy market for the site that defines the market-based drivers supporting or motivating the development of an energy project. As a result, it is important to determine an installation's Baseline and identify corresponding priorities and goals in the Initiate phase of the Net Zero Implementation Framework. This analysis may consider the fuel source of the local utility; the local or imported energy supply; the existing or necessary infrastructure, such as interconnection requirements, to support a project; an assessment of competitive forces in the market; and a range of various factors such as incentives, transmission availability, and other market factors. Most Army energy teams will consider Army energy efficiency and renewable energy goals and support for the mission(s) at the installation (Figure 3), often including

Figure 3. An Army aerial mission (top) and training mission (bottom). *Photos from U.S. Army*

Table 4. Correlating The Frameworks—The Initiate Phase

Army Net Zero Implementation Framework	NREL Project Fundamentals	NREL Project Development Framework
Initiate	**Baseline**	
Assess	Economics Policy	Site Resource
Plan	Technology Consensus	Off-Take Permits Technology Team
Implement		Capital

some element of energy security as motivation for a project. This Baseline analysis, however, will likely need to go beyond Army goals alone to consider the market context that will motivate a privately financed project if such financing is required (see footnote 10).

Preliminary Audits, Assessments, and Analyses

The process of pursuing Net Zero Energy for the Army's nine pilot sites began with analyses of each installation's energy use, efficiency opportunities, and potential for renewable energy. These analyses revealed that a clear and thorough understanding of an installation's energy footprint is essential before planning and prioritization of any energy projects could begin. Because very few facilities are typically metered on Army installations, some level of energy assessment is often required to obtain this understanding.

The U.S. Army Corps of Engineers' (USACE) U.S. Army Engineering and Support Center at Huntsville, Alabama, administers the Energy Engineering Analysis Program (EEAP), which can be used to obtain such an assessment. This is a cost-reimbursable program, so interested energy teams at Army installations will need to have a level of funding available commensurate with the scope, scale, and complexity of the audit they need performed to give them the desired level of understanding of their current energy profile and opportunities.

The EEAP audit performed for Sierra Army Depot, for example, revealed that there was little opportunity to decrease energy consumption that was inherent to the installation's mission, but the audit did help the installation's energy team understand where their opportunities do exist. Sierra Army Depot has many large warehouses heated by natural gas radiant heaters throughout its heating season. These heaters currently represent the most economical option for heating the warehouses because of contractual obligations around the installation's natural gas supply. This heating requirement is unavoidable because of the nature of the mission carried out in those warehouses, but their team now understands that ground source heat pumps may be a viable opportunity for serving this heating load once the economic conditions to implement such a project are favorable.

The EEAP audit at Sierra Army Depot also found other opportunities to reduce energy consumption through projects such as water heating improvements, tightening and insulating building envelopes, and lighting upgrades. For example, the installation has many high mast lights used in parking areas (Figure 4). Many of these large (12 kW) parking lights are occasionally left on during daylight hours and energy could be saved with better lighting controls. Table 5 provides a summary of the findings from Sierra Army Depot's EEAP audit.

A useful technique for this overview-level of energy assessment is to perform detailed audits on only a representative portion of an installation's facilities. Energy modeling can then be performed for the characteristic facility types and extrapolated over the entire installation's square footage of facility space. Efficiency measures can then be tested on this macro-level model of an installation to determine where the largest opportunities lie and which types of measures are most beneficial.

Other energy analysis resources available to Army installation energy teams pursuing a greater understanding of their energy portfolio are audits, modeling services, and opportunity screenings that can be performed by engineering firms, non-governmental organizations, and some of DOE's national laboratories. The scope of these services may range from desktop screenings to detailed investigations, and will likely depend on the level of funding that an interested client has available to devote to such analysis.

Figure 4. Sierra Army Depot high mast lighting (12 kW). *Photo from Sierra Army Depot*

Table 5. Summary Results of Sierra Army Depot's EEAP Audit

ECM[a] Type	Number of ECMs	Total Energy Savings ($/year)	Installed Capital Cost	Simple Payback (years)
Heating	12	$30,150	$479,780	15.9
Hot Water	55	$5,313	$17,236	3.24
Lights	131	$119,073	$2,385,306	20.0
Building Envelope	24	$161,011	$906,213	5.63
Total	222	$315,547	$3,788,535	12.0

[a] Energy conservation measure

Any type of high-level audit—whether it be performed by an installation's own staff, technical experts from one of the national laboratories, or contractors hired under EEAP—can have limitations. These audits and analyses can help prioritize efforts, create energy plans, and develop projects, but it is likely that before any projects can actually be constructed, additional analyses will be required. Figure 5 is an example of a building-level energy analysis. A detailed model such as this may be required after high-level audits and before project implementation.

For some types of contracting vehicles, an investor will require more detailed audits of a contractor, and in almost all cases, contracting officers or other approval authorities will require a greater level of due diligence than was performed during initial audits or analyses. It is important for project teams to prepare leaders and other stakeholders to expect additional rounds of analyses so that support does not diminish as it might if these additional requirements come as surprises.

When a community of planning stakeholders shares energy goals and priorities, they understand how their own projects and priorities are affecting the broader energy goals. This common understanding can lead to a broader adoption of energy as a chief concern in all aspects of the master plan.

Integrated Planning

After a high-level assessment of an installation's energy situation, putting the possibilities that were identified in order of priority and planning for the actual projects will naturally follow. The approach to Net Zero Energy that has been taken by Army installations in Europe offers a valuable example of how to plan this effort. Within the U.S. Army in Europe (USAREUR), a holistic and inclusive methodology is used for Net Zero Energy planning. It examines installations as a series of interconnected systems and includes a series of stakeholder "visioning" sessions. This means that no energy project is viewed in isolation from the rest of an installation, and also that the priorities and goals of the energy plan are developed under broad consensus. One example of the holistic nature of this planning approach is the consideration of replacing a traffic signal with a traffic circle, or roundabout. Removing the signal eliminates the electricity consumption of that equipment while simultaneously reducing wasted energy and emissions of vehicles idling at the signal, all while ensuring adequate safety and mission capabilities of the installation. This would be one component of an overall master plan that considers the building energy and transportation systems on an installation for which a broad community of stakeholders agrees on and shares a vision.

The bottom line for planning energy projects is this: It needs to be done, and it needs to be integrated. Whether an

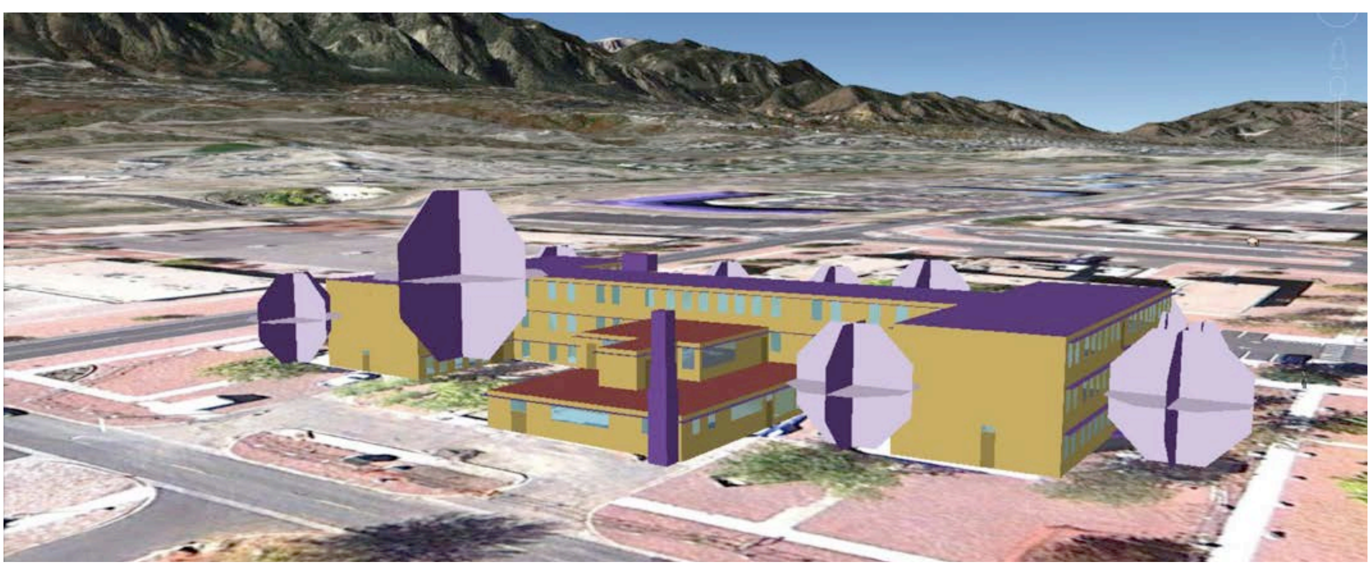

Figure 5. Example of a building energy model with shading objects. *Illustration from 2013 Google Earth, alterations by Mathew Leach, NREL*

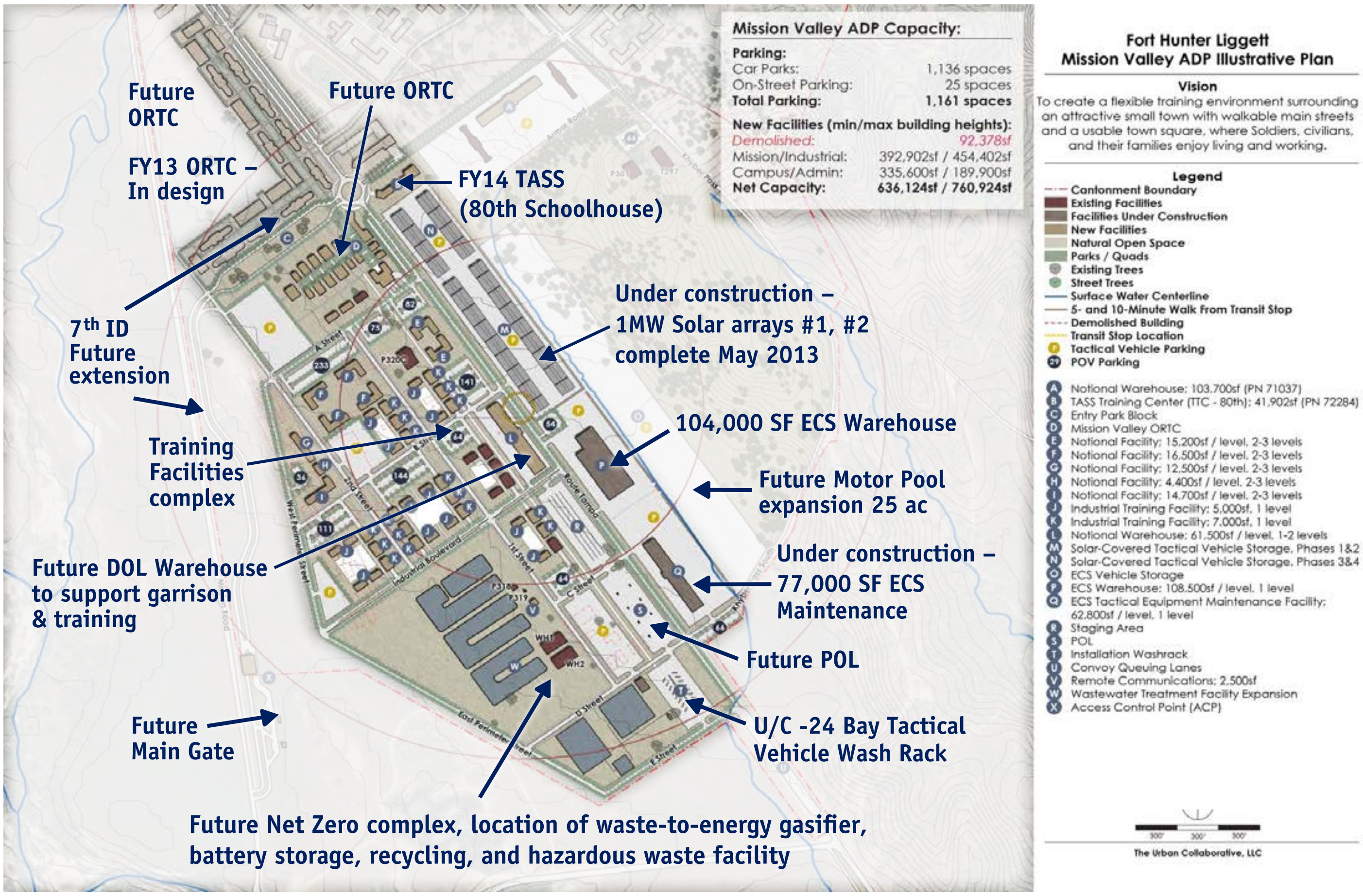

Figure 6. Fort Hunter Liggett master planning map showing a future energy project. *Illustration from Fort Hunter Liggett*

installation simply incorporates energy projects into its overall master plan or creates an entirely distinct energy master plan, the important aspect is that the installation's energy goals and priorities are identified and codified into a specific implementation plan with a concrete methodology for engaging stakeholders and building consensus around the plan. Doing so has several advantages that were realized by Fort Hunter Liggett:

- Energy projects will have designated sites intended for their development that are reserved in the master plan and agreed on by the community so that these projects will not have to compete against others.
- Incorporating energy projects into master plans can also streamline their development. At a minimum, project conceptualization can be completed early. Due diligence analyses and preliminary designs could also be developed. In addition, lengthy permitting processes—such as those required under NEPA—can be started early.
- Energy becomes an important facet of the master plan and influences other projects. When a community of planning stakeholders shares energy goals and priorities, they understand how their own projects and priorities are affecting the broader energy goals. This common understanding can lead to a broader adoption of energy as a chief concern in all aspects of the master plan. A few examples include establishing energy criteria for all new construction, prioritizing efficiency over convenience in transportation systems, and viewing energy efficiency as the driving consideration in procuring new or replacing old infrastructure or equipment. Figure 6 illustrates an important energy project identified in Fort Hunter Liggett's master plan.

Understand the Local Market

Throughout their planning process, installation energy teams need to understand the investment opportunities for energy projects in their area and where their particular installation fits into that landscape. The two components of this landscape depicted in Table 6 are important to understand.

It is essential for an installation's energy team to properly synthesize these two components of their particular landscape. For example, an Army post located in a rich solar resource area may still be unable to implement a solar energy project if its competing energy prices are too low. Conversely, an installation may have prematurely dismissed solar energy as a viable resource given its location, but if its energy prices are high enough, solar energy may be viable after all. It is important to know what is happening with local energy prices, renewable energy system costs, policies, and fuel sources, and to anticipate changes that may create new opportunities. For example, solar photovoltaic (PV) costs dropped approximately 50% between 2009 and 2013, as shown in Figure 7.

Army installation energy teams should be on the lookout for opportunities that are "wins" for their utility as well as themselves, and they should be ready to act on opportunities when they appear. Making a list of prioritized projects that are ready to execute when market conditions are right is beneficial. Fort Carson's PV array is a good example of this point. Fort Carson's energy team understood the surrounding landscape (as described in the preceding paragraph). So when Colorado instituted a renewable portfolio standard (RPS) requiring electric utilities to acquire a certain portion of their electricity from renewable sources, Fort Carson was ready to quickly implement a project that assisted its utility in meeting this new requirement while serving the installation with renewable energy at a competitive rate. Such opportunities are not limited to renewable energy projects alone: Pacific Gas and Electric Utility in California provides financial incentives for customers to build energy efficient buildings. Incentives like this should be examined for new construction projects as an opportunity to include additional energy-saving technologies.

Table 6. Evaluating the Local Energy Market

Physical Landscape	Market Landscape
What is the geography and topography of the installation's location?	Is the installation located in a regulated or unregulated energy market?
Is the installation in a region that favors particular renewable resources or requires high levels of air conditioning or heating?	Are the installation's energy prices high or low?
Is land available for large renewable energy projects?	What are state policies requiring the installation's local utility to do in terms of renewable energy?
Is the installation on an island where energy projects may have larger impacts on the electrical grid?	Is the installation a primary customer of the local energy utility or just one among many industrial consumers?

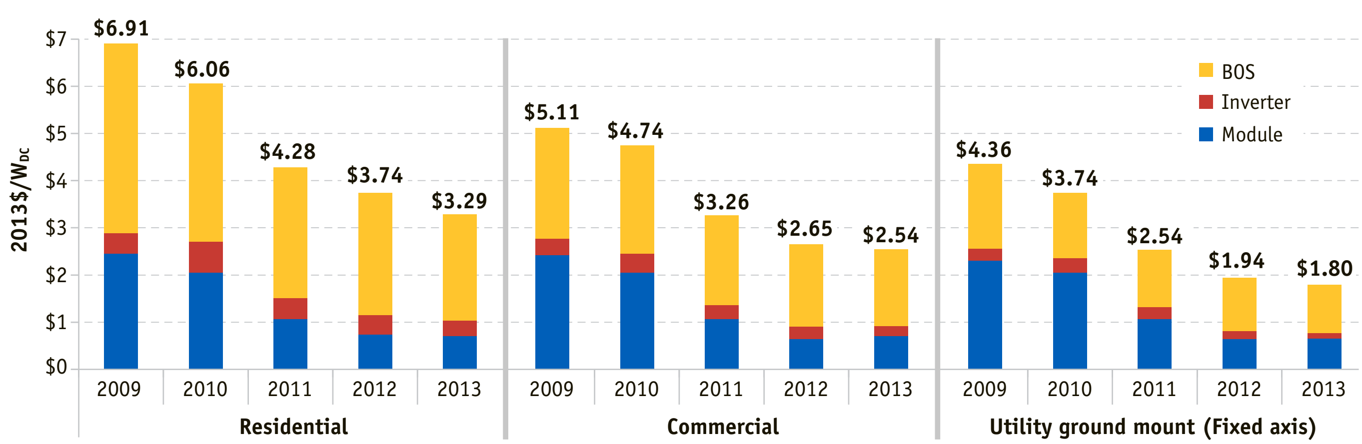

Figure 7. Bottom-up modeled system price of PV systems by sector, Q4 2009–Q4 2013. *Chart from http://www.nrel.gov/docs/fy14osti/62558.pdf*

ASSESS

The Assess phase of the Net Zero Implementation Framework (Table 7) involves analyzing the organization and its data, evaluating current resource use, and refining opportunities and needs. This phase involves greater detail than the preliminary and high-level types of assessments described previously. The economics and policies affecting project development need to be understood. In addition, the refined analysis should consider factors such as specific site selection, resource availability, and current and anticipated future energy use (see footnote 1).

ECONOMICS

After Baseline, the next important consideration of Project Fundamentals is Economics. An objective analysis of fundamental energy economics must be established early in the development process, but only after an installation's Baseline is understood and priorities are documented in an energy plan. It is appropriate, then, to undertake the analysis described in this section in the Assess phase of the Army's Net Zero Implementation Framework. This analysis must include both the market price of acquiring energy from existing sources (self-generated or utility-based)—and therefore what cost can be avoided by pursuing energy saving projects—and from any proposed renewable sources as comparison—for evaluating the viability of renewable energy. Typically energy efficiency projects are the most cost-effective option with the best economic return and should be considered before investing in renewable energy projects. When renewable energy projects are pursued, implementation teams need to ensure that such projects are life cycle cost-effective and justified based on a viable business case. Development and financing costs should be considered along with actual construction costs when considering project economics (see footnote 10).

In a few projects from the Army pilot sites, analysts observed that when market energy rates are so low that the economics of renewable energy projects were challenging, it was possible to find development approaches to pursue these projects that did not involve the installations funding the projects directly. PV projects at Fort Carson and Sierra Army Depot allow the local utility to access land on the installations to construct and operate a PV array

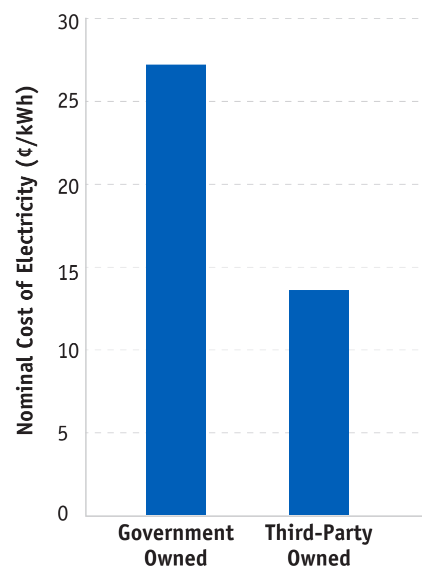

Figure 8. Energy cost difference between a government-owned and third-party-owned RE project

Table 7. Correlating The Frameworks—The Assess Phase

Army Net Zero Implementation Framework	NREL Project Fundamentals	NREL Project Development Framework
Initiate	Baseline	
Assess	**Economics** **Policy**	**Site** **Resource**
Plan	Technology Consensus	Off-Take Permits Technology Team
Implement		Capital

while delivering the electricity to the installation at very little or no up-front cost to the Army. This can be done through existing energy contracting vehicles already available to installations. Using third-party developers for these types of projects can significantly increase options for renewable energy development. For example, capital costs for third-party-owned PV projects can be as much as 50% less expensive than Army-owned projects because of tax incentives for which government entities are not eligible. Tables 8 and 9 and Figure 8 demonstrate the difference in energy prices available between otherwise identical government and privately owned renewable energy projects.

Another observation from the Net Zero pilot program is that energy costs on islands tend to be so high that renewable energy projects are generally more competitive. These significantly higher-than-normal costs can also create opportunities for installations in these settings to pursue technologies that are otherwise not viable. For example, on Kwajalein Atoll, an innovative seawater air-conditioning project is being evaluated. This could help consolidate the extensive air conditioning equipment needed on the island and reduce the associated operations and maintenance costs, which can be quite high for air conditioning units subjected to the corrosive tropical climate. Figure 9 shows some of the dispersed air conditioning units on Kwajalein Atoll, and Figure 10 illustrates the severe corrosion that such units can be subjected to on the island.

Due diligence in life-cycle cost analysis is a key to ensuring that adequate value is present for a proposed energy project. For example, one of the Army pilot sites planned a centralized energy system without adequately evaluating a distributed system as an alternative, and the project is now being reevaluated.

A final lesson learned in this early category of Project Fundamentals is to approach with caution projects for which economic viability requires that RECs generated by the project be sold. RECs are the value of each unit of energy generated from a renewable source associated with the sustainable or "green" attributes of that energy. In some states, the value of this attribute of the energy cannot be separated from and sold independently of the energy itself. In others it can be sold separately from the energy, so there can be a market for these RECs. Army policy is that it will not purchase RECs solely to meet Federal goals and that RECs created from renewable energy projects implemented with appropriated funds must be

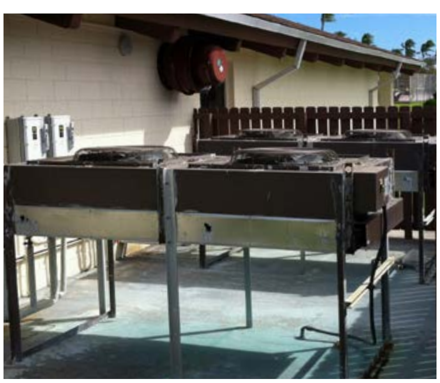

Figure 9. Dispersed air conditioning units at Kwajalein Atoll. *Photo from U.S. Army Kwajalein Atoll*

Figure 10. Example of an air conditioning unit destroyed by the corrosive climate of Kwajalein Atoll. *Photo from U.S. Army Kwajalein Atoll*

Table 8. Sample Financials from a Government-Owned Renewable Energy Project

Metric	Base
Annual energy	37,230,428
Power purchase agreement price	N/A
Levelized cost of energy nominal	27.22¢/kWh
Levelized cost of energy real	**22.11¢/kWh**
Internal rate of return (%)	12.00%
Minimum debt service coverage ratio	3.36
Net present value ($)	$2,386,955
Calculated power purchase agreement escalation (%)	1.00%
Calculated debt fraction (%)	50.00%
Capacity factor	21.3%
System performance factor (%)	0.82

Table 9. Sample Financials from a Third-Party-Owned Renewable Energy Project

Metric	Base
Annual energy	37,230,428
Power purchase agreement price	12.62¢/kWh
Levelized cost of energy nominal	13.55¢/kWh
Levelized cost of energy real	**11.00¢/kWh**
Internal rate of return (%)	21.11%
Minimum debt service coverage ratio	1.57
Net present value ($)	$6,525,698
Calculated power purchase agreement escalation (%)	1.00%
Calculated debt fraction (%)	50.00%
Capacity factor	21.3%
System performance factor (%)	0.82

retained by the Army.[12] This policy leaves open possibilities for sales or purchases of RECs produced from renewable energy projects implemented under third-party finance structures depending on project-specific economics and state regulations (see footnotes 6 and 9). One issue at play here is that RECs, once generated by a Federally owned project, may be considered Federal Government property, which introduces attendant issues of limited authority to sell such property. This has become a challenge for at least one Army-owned PV project. Ultimately, it may be possible for a renewable energy project that contributes to Army goals and an installation's Net Zero Energy efforts to benefit from selling RECs, but such arrangements should be examined carefully.

POLICY

Policy is the third principle of Project Fundamentals. Relevant policies and execution authorities must be addressed before expending significant resources pursuing a project while an installation is still in the Assess phase of the Army's Net Zero Implementation Framework. The contracting authority to purchase energy or execute a project and the legal basis to allow contractor access to a site must be clear. Army, state, local, and national regulatory policy environments, including environmental regulations, must be well understood for the project. Steps should be taken to work with these policies to create the conditions for success (see footnote 10).

One of the most commonly repeated lessons learned by the energy teams at the Army pilot sites is to begin coordination with the local utility early and continue to coordinate deliberately and consistently throughout the project development process. This is most directly applicable with renewable energy projects. The larger the project size, the more important coordination becomes. The reason is because energy generation projects will almost always require approval from the utility to interconnect with the electric grid infrastructure. This interconnection is required for such a project to operate. Utilities likely have different approval processes for different project sizes. In addition, they will likely specify limits to the size of generation projects they will allow to interconnect. There can be increasing levels of approvals as project sizes approach these limits. This was a hard-learned lesson for one Army-owned PV project in which there was no coordination with the utility until late in development. This led to significant delays in execution until the utility could coordinate and provide the needed approvals. For projects that are implemented through alternate financing methods, in which third-party developers do much of the development work, it is likely that these developers—familiar with interconnection requirements—will handle much of the coordination and approval with utilities.

This situation is more applicable to Army-owned projects in which a third-party developer is less likely to be participating. It is still important, however, for an installation's energy team to be involved with and informed about the utility coordination efforts. It may also be important to coordinate large energy conservation projects with local utilities, particularly if a goal of the project is to shave electrical load from peak, high-rate hours to off-peak, lower rate hours. This may have implications for an installation's energy rate structure and contractual obligations with a utility.

As an installation approaches true Net Zero Energy, then coordination with the utility will be crucial. For example, all utility costs may not be avoidable because even if an installation is a net zero consumer of energy, there will likely be standby charges levied on the Army to cover the utility's costs associated with maintaining the capacity to serve the installation's energy needs. Although no Army installations have encountered this situation yet, understanding other services' challenges may inform the Army's actions in the future. For example, an Air Force PV array was built in the service territory of a utility that was reaching the limits of variable generation sources it could effectively connect to its grid without causing power quality problems. The array was constructed with little or no coordination with the utility, and ultimately the utility refused to grant its approval for the array to interconnect. Additionally, Marine Corps projects on a particular installation have been affected by "departing load" charges from the utility as the installation's loads decrease.

SITE

The project Site is the first element of the Project Development Framework because a physical location for an energy project is required. It is essential for an installation energy team to select appropriate sites while the team is still assessing project alternatives in the Assess phase of the Army's implementation framework. Developers must be assured that they have access to the site for construction and operation of the facility for the term of the contract (i.e., site control). Without site control, a project will likely be unable to obtain financing. Army representatives may also need to understand whether the site is affected by Bureau of Land

[12] Department of the Army, Washington. Memorandum for: See Distribution. Subject: Department of the Army Policy for Renewable Energy Credits. May 24, 2012. Accessed March 17, 2015: *http://army-energy.hqda.pentagon.mil/policies/docs/May2012_Renewable_Energy_Credits_Policy.pdf*.

Management (BLM) withdrawal conditions, which affect terms of land use (see footnote 10).

Army National Guard site managers may wish to consider assessing all their disparate state sites in aggregate when evaluating their Net Zero policy implementation, if they are not using this approach already. This was done for the Oregon National Guard for its involvement with the Net Zero pilot program, and it proved to be very beneficial for the guard because energy generation in one area of the state where a particular resource is better can be counted toward the Net Zero status of the statewide portfolio of installations. Figure 11 illustrates how different projects around Oregon all contribute toward Oregon National Guard's Net Zero Energy program.

Holistic Assessments and Site Planning

A few of the observations about Site issues encountered when pursuing Net Zero Energy projects are related to the lessons learned from the Project Fundamental category of Baseline beginning on page 11. Some of these issues also have to do with the energy audits required to understand and establish an installation's Baseline, and may go beyond baseline energy audits to the types of follow-on audits and assessments that will likely be required before projects can be implemented. Installations should ensure that building-level audits are holistic and examine all renewable energy options at the building level. Sometimes, renewable energy possibilities are only evaluated at a macro or installation-wide level and they are left out of building-level audits. This approach may miss some promising opportunities for particular buildings. Installation energy teams also need to ensure that when audits of any level are performed, the supporting documents, assumptions, calculations, and details that supported the analyses are included in the deliverables required from whatever entity performed the service. An EEAP audit was performed for one of the Army pilot sites that turned out to include some inaccurate assumptions that affected the audit quality. Because the supporting details and calculations used in that audit were not required as deliverables, they are no longer available for reexamination.

Another Site observation related to that expressed in the Baseline Project Fundamental category covered earlier is

Figure 11. Locations of Oregon Army National Guard energy projects. *Illustration and photos from Oregon Army National Guard*

that energy planning should be holistic and incorporate all site considerations as a network of interconnected systems, instead of planning energy projects independent of one another and from the rest of an installation's infrastructure. Fort Carson offers one example of how this energy master planning can be done effectively. Fort Carson's team has designated a site near an existing centralized energy plant for future energy projects. Figure 12 shows Fort Carson's PV array, which is co-located with other energy project sites. Planning the co-location of assets in advance can create opportunities for synergies so that expansion, modernization, or addition of cogeneration capabilities to an existing energy asset may be possible.

Understanding the impact on one facet of the Net Zero triad (Figure 13) from projects in another facet is important. For example, rainwater capture and treatment will help an installation toward Net Zero Water, but it could increase energy consumption because energy is required to pump and purify that water. For this reason, all three facets of the Net Zero triad must be optimized together, not in isolation. The development of projects in each of the different triads should not be "stove-piped" by subject matter or separated from each other in time by implementing all energy projects in one phase and all water projects in a separate phase, for example. Additional examples of the integrated nature of the three Net Zero facets include the following:

- Reducing water consumption will likely also decrease energy consumption because water transportation and treatment processes can be large energy consumers.
- Evaporative cooling usually consumes less electricity than other cooling methods and can reduce overall water consumption if its energy savings offset electricity produced by conventional, water-intensive methods. However, an evaporative cooling system will likely increase local water consumption at the site.
- Waste-to-energy generation capacity is directly correlated to the volume of solid waste, so an increase in recycling of an installation's waste-stream will reduce the potential for waste-to-energy.

Integration of Net Zero Energy, Water, and Waste

- Reducing water consumption will likely also decrease energy consumption because water transportation and treatment processes can be large energy consumers.
- An evaporative cooling project may reduce energy consumption, but it will likely increase local water consumption at the site.
- Waste-to-energy generation capacity is directly correlated to the volume of non-recycled solid waste.

Figure 12. PV project at the consolidated energy site at Fort Carson. *Photo from Fort Carson*

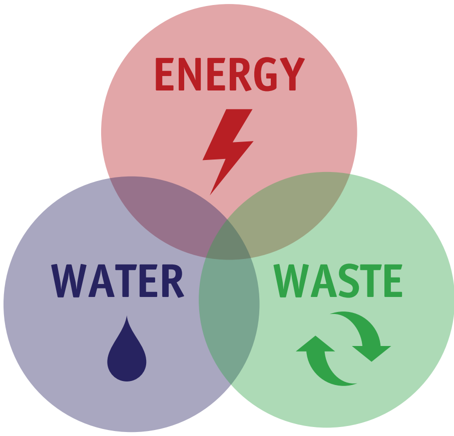

Figure 13. The nexus of energy, water, and waste

A final note about site assessments and planning is that the Army's accounting of real property square footage usually includes unconditioned spaces. This needs to be taken into consideration when such data are needed for Net Zero Energy development efforts. As a result, accurate square footage data for buildings must be validated and corrected for changes and unconditioned spaces before it can be used in any analyses or planning.

Ownership of Facilities and Control of Land/Resources

Another common observation among the Army pilot sites is that site control issues should be negotiated early. For large renewable energy projects that rely on a third-party developer or investor to own and/or operate a project, this should be a go/no-go milestone early in the development process. A very large PV project in which the Army had invested a substantial amount of time and development effort ultimately failed to be implemented because the parties could not come to mutually acceptable terms for the lease of the Army-owned site.

A lease for Army land can work, but it needs to be resolved early in the project development process. A PV project at Fort Detrick was successfully developed using an enhanced use lease.

Leased and Privatized Facilities

Leased and privatized facilities introduce another category of concerns when pursuing Net Zero Energy. The energy team at one of the Army pilot sites learned that when projects are done by a third party on property that is not owned or controlled by the Army, the Army can still have liability for some aspects of the project. In this particular instance, a large number of residential PV systems on the installation's privatized housing are all on the same feeder of the electrical grid. This leads to a net effect of one very large array. Normally, on larger arrays, advanced power electronics in the inverters designed to accompany large projects will correct for power quality issues. But such inverters are not typical on small, residential systems, which, when viewed as individual systems, have very low power quality concerns. In this case, the disparate residential systems are acting in aggregate like one large system with no power quality correction. Because the electrical feeder experiencing the power quality issue is on the Army installation, serving an Army load—from the utility's perspective—the Army is responsible for paying a power quality penalty on its utility bill.

This example applies to other Army or government agencies that are tenants on installations. For example, Fort Detrick houses many laboratory facilities. These facilities pay the installation for their energy consumption; however, they do not necessarily share the same goals for energy conservation and efficiency improvements as the installation. Army installations that host tenants must make additional efforts to influence the energy consumption of those tenants and hold them responsible for costs associated with the energy they produce or consume.

RESOURCE

Resource is the next aspect of the Project Development Framework. The particular ECM or renewable resource under consideration (sun, wind, biomass, waste to energy, or geothermal) needs to be characterized and understood at a level of detail and confidence appropriate to the project's stage of development. Vetting these data should occur during the Assess phase of the Army's implementation framework. Whether the Army or a developer is investing in this resource or performance data is an important consideration that can affect the viability and marketability of a project. Installing measuring equipment and collecting verifiable data can be costly and must meet lender or investor requirements if an energy team is pursuing third-party financing for a project. At a minimum, a project will likely need to meet Army contracting authority due diligence standards (see footnote 10).

All assumptions that can affect the performance of an energy project need to be thoroughly understood and vetted. One example of poor assumptions about resource quality and maintenance costs can be seen in another Service's wind turbine project. The site team had a flawed understanding of their wind resource and installed a wind turbine based on faulty assumptions. The turbine has never performed as predicted and may have even led to increased costs because the team didn't accurately anticipate the maintenance costs associated with this technology.

An energy use baseline or renewable energy resource quality data collection is required up front. The level of this data collection effort should be based on the magnitude of the investment and risks involved for a given technology. For example, wind projects—which are heavily dependent on accurate wind models and are inherently risky because of the uncertainty of predicting weather—require extensive resource validation before implementation. Figure 14 is a wind resource map that Fort Carson used in preliminary analysis of a proposed wind project and is an example of the kind of wind resource validation that is needed for wind projects. Another example includes selecting the most efficient cooling technology for a given location. Some technologies such as indirect evaporative cooling may be

economical only in certain conditions such as a hot and dry climate. It is far better to understand the quality of a resource or performance of an ECM before the project is implemented, rather than learning it from an under-performing project after it is already built.

A final lesson learned by the Army pilot site energy teams about validation of resources and performance of energy projects is that reports and studies done by credible third parties might be better received by the installation teams and stakeholders than analysis done by in-house personnel. At the same time, though, to maximize the benefit and usefulness of such third-party studies, the appropriate installation personnel must be closely involved with the study to ensure that the results and recommendations are accurate.

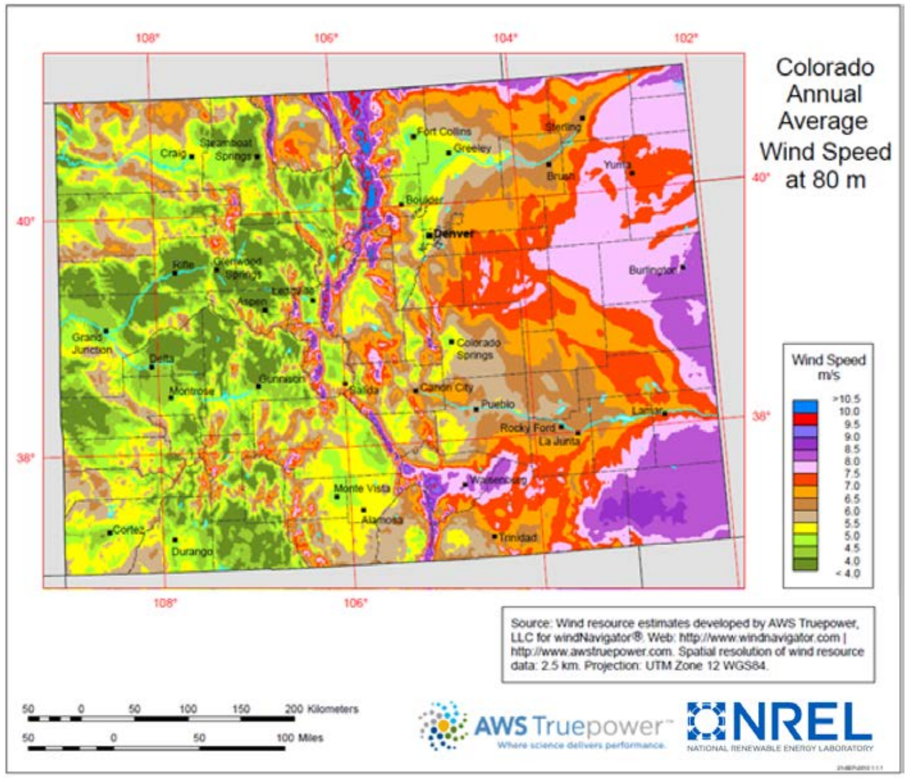

Figure 14. Colorado wind speed map at 80 meters. *Image from DOE WINDExchange, http://apps2.eere.energy.gov/wind/windexchange/images/windmaps/co_80m.jpg*

PLAN

The Plan step of the Net Zero Implementation Framework (Table 10) should result in a detailed and executable roadmap that will guide the implementation of the approach. To reach this detailed plan, teams need to be assembled and consensus among stakeholders achieved. The plan should consider important factors such as the evaluation and selection of particular technical solutions and possible hurdles in permitting and securing an off-taker for renewable energy systems if one is needed (see footnote 1).

OFF-TAKE

If the Army is not the sole consumer of the energy generated by a renewable energy project, consideration will need to be given to agreements with the other users of the energy, referred to as "off-takers." The Off-Take category of the Project Development Framework represents all things necessary to achieve a long-term contract with a customer to purchase the output of a renewable energy project. The long term contract(s), or off-take contract(s), establish the revenue profile for the project, which forms the basis of financing and thus heavily influences the feasibility of constructing a project. If an energy project will rely on an off-take arrangement, then, these details must be worked out in the Plan phase of the Army's implementation framework (see footnote 10).

Experiences with developing large-scale renewable energy projects on Army installations have shown that the Army can sometimes offer access to land for energy development at a lower cost than alternatives. This attracts developers and utilities that have an appetite for developing renewable energy projects. In addition, the resultant projects can meet the developer's or utility's needs and contribute toward an installation's Net Zero Energy goals and overall Army energy goals. This is true even if all the power produced is not consumed by the Army on the given installation. In this situation, understanding the market for off-takers and the contractual arrangements required is important for an Army installation. In some cases, access to the Army land can be granted through easements, and in other cases it is done through leases. When considering leases, Army teams should keep in mind that if the Army land is to be the lowest-cost option for an interested developer, the price of the lease will likely need

Table 10. Correlating The Frameworks—The Plan Phase

Army Net Zero Implementation Framework	NREL Project Fundamentals	NREL Project Development Framework
Initiate	Baseline	
Assess	Economics Policy	Site Resource
Plan	**Technology** **Consensus**	**Off-Take** **Permits** **Technology** **Team**
Implement		Capital

to be based on a fair market valuation instead of the "highest and best use" valuation that is frequently used in real estate development.

> Compliance with NEPA is usually the most significant permitting requirement in developing an energy project on an Army installation.

PERMITS

Projects may require a variety of permits before construction can be started; this category of the Project Development Framework covers a number of potential approvals; permitting actions; or processes that, if not completed, may stop the project. The category could include everything from local building permits and internal authorizations to satisfaction of NEPA requirements. With some limited exceptions, Army installation energy teams must comply with NEPA before they make any final decisions about proposed actions that could have environmental impacts. These efforts will primarily occur within the Plan phase of the Army's implementation framework (see footnote 10).

Compliance with NEPA is usually the most significant permitting requirement in developing an energy project on an Army installation. A common piece of feedback from those involved with the Army pilot program is to begin efforts to satisfy NEPA very early in project development. It should be completed before starting any procurement process. At least one Army pilot site learned about the importance of beginning the NEPA process early after a project had to be canceled when it was determined that the project could not be constructed on the selected site because of NEPA restrictions. There are also many examples of energy projects on military installations facing substantial delays when the NEPA process is not deliberately started early.

The process of interconnection approval from a local utility for energy generation projects can be relatively simpler than NEPA—and like NEPA, almost certainly universally applicable to Army projects. As noted in earlier sections of this report, it is important to begin these coordination efforts with the local utility early. The Oregon National Guard team observed that when interconnection size ceilings limit the size of desired renewable energy projects, it may still be possible to attain a large overall system size by breaking it into smaller projects. The size of each must be within the interconnection size limit set by the utility. As with any other approach, this needs to be coordinated with your utility.

TECHNOLOGY

A technology assessment and analysis may be the most straightforward part of establishing the Project Fundamentals. Available renewable resources, energy savings opportunities, and the commercially available technologies to harness the resource or realize the efficiencies must be assessed to establish the likely reliability of the project's performance, justify the need or benefit of the project to Army approval authorities, and gauge the investment community's willingness to finance it (if that funding approach is pursued). This assessment should include a constructibility review to establish site constraints. This category of Project Fundamentals is naturally linked closely to the Technology area of the Project Development Framework, which begins with the technical design feasibility of a given technology that was developed in earlier Project Fundamentals work and becomes more detailed through the project development process. This work culminates in selecting all technology vendors and manufacturers, securing quotes from engineering, procurement, and construction (EPC) contractors, selecting the team, and executing all supporting and related documentation such as warranties, guarantees, and performance requirements. Because these two topic areas are closely related, address many of the same technical considerations, and share lessons learned that span both phases of the project development process, they are presented in conjunction in this report even though it should be understood that their application in practice would occur at different times and with differing levels of effort. Given the specifics that are being investigated and developed in both of these activities, however, they will likely both be completed during the Plan phase of the Army's implementation framework (see footnote 10).

Energy Conservation Measures

In accordance with the Net Zero Energy hierarchy (see Figure 15), the Army pilot sites found that simple efficiency and energy reduction efforts should be pursued first, followed by more technically complicated ECMs and alternative sources of energy. These simple measures often offer the greatest value for their

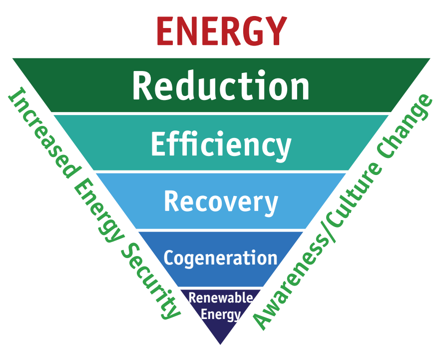

Figure 15. Net Zero Energy hierarchy.
Illustration from U.S. Army

investment, and efforts as simple as energy awareness campaigns have been successful, with an excellent example of this seen at Fort Carson. The viability of more complicated ECMs and renewable energy options can be affected by the lower loads resulting from simpler efficiency and reduction projects. For example, if a PV project is viable because it offsets energy consumed during peak hours when energy rates are highest, but some combination of ECMs is also intended to significantly reduce that peak load, pursuing one of these alternatives will affect the viability of the other.

Another common feedback point from the Army pilot sites has confirmed other studies that have been performed about the appropriate role for and efficacy of ECMs that seek to change building occupant behavior to save energy. A PNNL study shows that occupant education alone results in only negligible energy savings, so behavior-change ECMs should not only be informative, but also specific, targeted, and enforced to be effective.[13] Fort Carson found that educating occupants about changes to their building and its systems is important to maintain the improved performance expected from retrofit projects. After all, if a significant amount of money is spent on upgrading equipment, but the users of that equipment do not know how to use it or continue operating it in the same inefficient manner they did with the old equipment, that money will have been wasted. Figure 16 is an example of an energy awareness poster from Fort Carson that is tailored to a specific set of buildings.

Fort Carson found another low-cost ECM—limited recommissioning—in which systems are analyzed and simply "tuned up" or reset to optimal settings if they have been changed over time. The

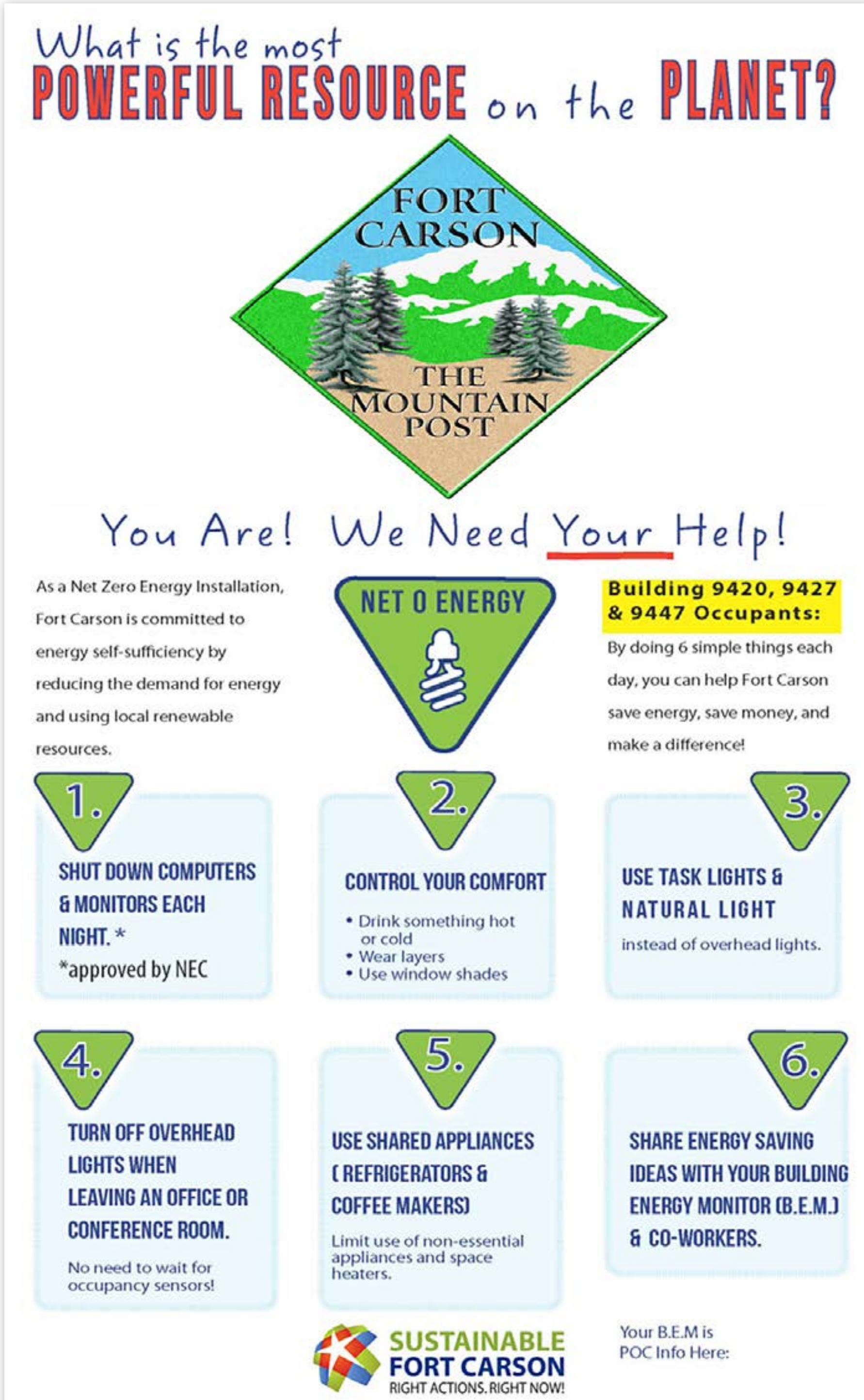

Figure 16. Fort Carson energy awareness campaign poster. *Illustration from Fort Carson*

[13] Judd, K.S.; Sanquist, T.; Zalesny, M.; Fernandez, N. The Role of Occupant Behavior in Achieving Net Zero Energy: A Demonstration Project at Fort Carson. Pacific Northwest National Laboratory, September 2013. Accessed July 3, 2014: *http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-22824.pdf.*

Fort Carson team first determined what controls systems were in place in various buildings (some were building-level only programmable thermostats, some were building-level systems automated and centrally controlled, and others were campus centralized systems). Next, the team made sure that each system was working according to how it was originally designed and being used correctly.

Centralization of energy systems can also be an effective way to increase efficiency. Such methods can be complex and costly, so care must be taken to correctly analyze the costs and benefits. Centralized systems can be more efficient and life cycle cost-effective than distributed ones, but that may not always be the case. If centralized systems are desired, it is always more cost-effective to implement them during new construction than to retrofit facilities after they are already built.

A final lesson learned about ECMs is that centralizing systems in historic infrastructure—such as that shown in Figure 17 on the storied campus of West Point—has the potential for multiple benefits, including the following:

- It limits the disruption to historic buildings by relying on centralized systems that can be housed outside of sensitive architecture.
- It is an approach that can offer greater efficiency opportunities.
- It may create opportunities for combined heat and power.

General Renewable Energy Considerations

The most common lesson learned by the Army pilot sites about renewable energy projects in general is that many ECMs, especially the "low-hanging fruit" measures (easy, quick, and relatively inexpensive to implement) can often be implemented simply with economic performance that makes them easy to justify. In many cases, though, renewable energy projects require grants or incentives to make them economically viable. Installation energy teams should be prepared for this potential difficulty as they approach these projects.

In another lesson learned that applies broadly to renewable energy projects, a renewable energy resource study should be holistic in nature and all possibilities should be examined with an open mind. As mentioned earlier, it may be a faulty assumption that just because an installation is located in a poor resource area, a given renewable energy technology is off the table. Conversely, assumptions that resources are good may be just as flawed and could lead to costly mistakes in project development. A thorough and honest resource assessment is therefore required. A methodology that may be most applicable to National Guard installations is illustrated well by the Oregon National Guard. Its energy teams are appropriately utilizing the different resources that exist where their disparate installations are located rather than taking a one-size-fits-all approach. For one of their sites with a good geothermal resource, they are pursuing geothermal. For sites where they have the best solar resources, they are pursuing solar projects.

The rest of this Technology section covers lessons learned about implementing renewable energy projects for some, but not all, of the different renewable resources, as well as issues with the

Figure 17. Historic buildings on the campus of the U.S. Military Academy at West Point.
Photo from U.S. Military Academy

Centralized Systems in Historic Infrastructure

- Limit the disruption to historic buildings because they can be housed outside of sensitive architecture.
- Offer greater efficiency opportunities.
- Create opportunities for combined heat and power.

Figure 18. Canopy-style PV mounting over the cantonment area of Fort Hunter Liggett.
Photo from Fort Hunter Liggett

integration of energy projects with one another and with other systems. It is not meant to be exhaustive of all the possible renewable energy technologies that installations may develop, nor of the issues that installations may encounter in doing so.

Solar

Canopy-style PV mounting—where the PV panels are mounted on top of elevated structures instead of on typical racking that is close to the ground—allows for multifunction land use. For example, the PV array installed at the cantonment area of Fort Hunter Liggett was built as 20-ft-tall canopies so that equipment can be parked underneath (see Figure 18), allowing for the continued original use of the land with the newly added benefit of providing shading for that equipment.

Structural evaluations of buildings that are being considered for rooftop PV are needed early. In an Energy Conservation Investment Program (ECIP) project at one of the Army pilot sites, PV panels were originally intended for installation on the tops of some buildings. These buildings, though, were later found to be structurally incapable of supporting the weight of the proposed systems.

Wind

It seems common with many military installations that the level of concern about wind turbines conflicting with aviation missions is disproportionate to the true level of risk they carry. Care is needed when siting wind turbine locations in proximity to aviation operations; however, these two functions are not completely incompatible, and military installations have succeeded in installing wind turbines near aviation operations when the associated restrictions were closely followed. Figure 19 illustrates how a mapping process can be used to ensure that the siting of a wind project will not interfere with radar operations. Restrictions that must be observed when installing wind turbines near aviation operations include, among others, height restrictions, glide-angle planes, and radar interference. These issues must be understood and overcome early in the development process. An Air Force-installed wind project on Joint Base Cape Cod (Massachusetts) is one such example of successfully implementing this type of project in close proximity to an aviation mission (see Figure 20).

Wind may also be viewed negatively because of aesthetic concerns from an installation's own population or a surrounding community. As a result, it is important to engage affected communities and overcome potential criticism about such projects from all stakeholders early in their development.

Biomass and Waste to Energy

Because these technologies can often invite scrutiny that is not typical of other energy projects, it is important to familiarize an installation's leadership and other project stakeholders with the concepts of waste to energy and biomass projects very early in the development process. Concerns with siting, logistics, and security are unique to these technologies because of their need for a continuous stream of feedstock.

A best practice with these projects is to site them on or near the perimeter of an installation. This can allow for the delivery

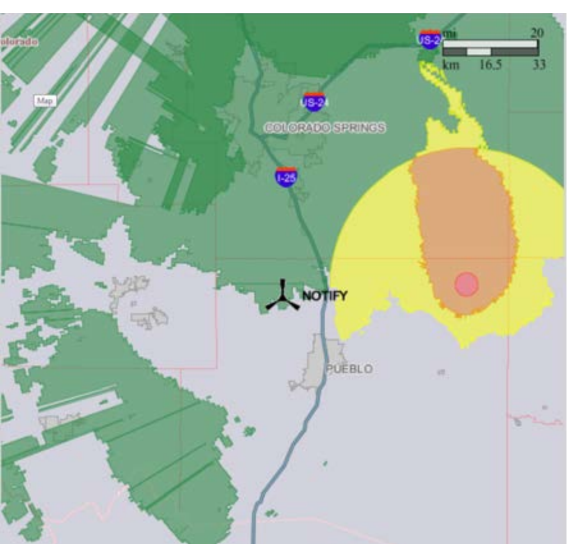

Figure 19. Wind project interference map. *Image from DOD Preliminary Screening Tool*

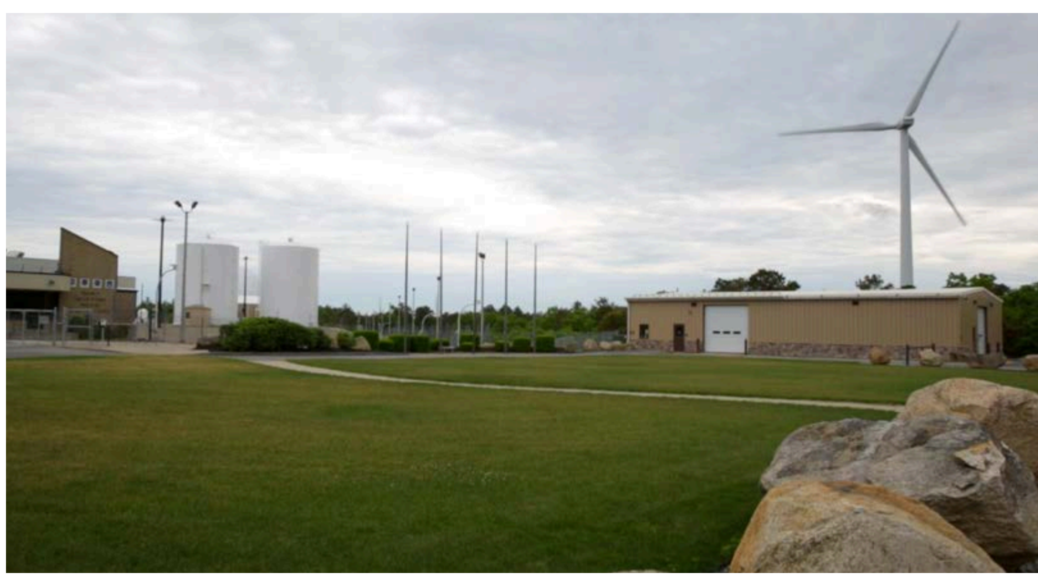

Figure 20. Wind project on Joint Base Cape Cod. *Photo from U.S. Air Force*

of the required feedstock (if its source is external to the installation) with minimum disruption to installation traffic patterns and security concerns.

Unlike other renewable energy technologies, biomass and waste to energy are particularly sensitive to and dependent on markets for fuel sources that are external to an Army installation. These technologies, in fact, could draw on regions that go well beyond the communities with which a given installation has historically interacted. It is important to understand these markets—such as forestry, mills, landfills, and waste hauling—early in the development of these projects. Installation teams should be aware that local market studies will be required for these technologies that are not required for other renewable resources.

Waste-to-energy projects, similar to other energy generation projects using solid forms of fuel, are more likely to succeed if they are developed as combined heat and power projects to serve both thermal and electrical loads at a site. The waste-to-energy plant at Norfolk Naval Shipyard in Portsmouth, Virginia is an example of this type of combined heat and power waste-to-energy system. If a combined heat and power project is not viable, possibly due to a low thermal load at the site, heat-only projects are more likely to succeed than waste-to-energy projects which only generate electricity. Heat-only systems are simpler, their technology is more established, they require more straightforward O&M, and they are less expensive than electricity-only systems. An example of a successful heat-only waste-to-energy plant is found at Redstone Arsenal in Huntsville, Alabama (see Figure 21).

Figure 21. Heat-only waste-to-energy plant at Redstone Arsenal in Huntsville, Alabama. *Photo from Covanta Holding Corporation*

Integration Issues and Microgrid Considerations

As mentioned in other sections of this report, a key factor to consider with integrating energy projects with one another and with other installation systems is that implementing one project can affect the performance or alter the viability assumptions of other projects. Technical integration issues must be considered, along with financial implications. For example, an efficiency project that reduces peak load may lower the efficacy of a PV project that was intended to offset that same peak load, and a natural gas combined heat and power project might invalidate the economic assumptions used to justify a planned PV project. Both of these aspects of integration must be accounted for in an integrated development process.

Examining the existing infrastructure of a particular installation to verify compatibility of intended energy projects is also important. If it is found that existing infrastructure is outdated or otherwise incompatible, the required modernization or compatibility modifications should be incorporated into the installation's overall energy plan and these adaptations should be included in the scope of the energy project for which they are required. In the example of the PV panels intended for the roofs of buildings that were found to be structurally inadequate, the problem could have been avoided if this deficiency had been noted early and structural modifications and reinforcement of the target buildings had been included as part of the original project scope. When leased or privatized facilities are involved, additional considerations and/or complications can arise in this area.

Note that most renewable energy systems and ECMs are designed to either feed power only to an operating utility system or reduce energy costs. Special hardware and operational approaches are needed if energy projects are to contribute to energy security and resiliency while ensuring cyber security. These measures can increase costs significantly, yet energy security may be a primary motivation for pursuing Net Zero Energy projects. Cyber security should be implemented with energy projects to ensure that the control of such systems is not vulnerable to exploitation. These factors may be of particular importance to National Guard installations, where part of their inherent mission is to be capable of responding to crises and natural disasters, when their surrounding communities may be without energy. Given the higher costs of energy projects implemented with energy security and resiliency as their aims, it may be difficult for them to gain acceptance, but this is because the value of energy security will likely not be fully realized by those affected until the crisis comes and they find themselves without the security they need. The next few observations relate to the issues of implementing some of these measures.

Power quality must be taken into consideration on large PV projects, batteries, and fuel cells (or when the aggregated effect of small disparate systems is the same as one large system). As already illustrated on page 18 with the example of many PV arrays on privatized housing, this is true in typical grid interconnection situations where energy security is not an objective. It is even more important,

however, when a project's objective is the ability to contribute to the energy security of an installation by being capable of continued operation on an installation's microgrid when power from the supplying grid fails. This is the case because of the nature of the direct current electricity that is produced by these technologies and adjustments that must be made to that electricity before it can be used on alternating current grids. A recent request for proposal (RFP) for a PV array at Fort Detrick serves as a good example of how to anticipate this requirement. This RFP included language that required that inverters be microgrid-ready (in other words, that they possess advanced functionality such as an adjustable power factor, communications with control systems, curtailment set points, and an electronic enable/disable function). Cyber security requirements for certain components (such as communication and control systems) may also need to be specified in an RFP. Figure 22 shows the area on Fort Detrick intended for the installation of this PV array.

Energy storage capabilities have long been and continue to be expensive components of energy security systems. They are likely, though, to be an essential part of many such systems for Army installations because they can serve as buffering systems when energy supplies and demands are rapidly changing on small microgrids and they can increase the resiliency of an installation by conserving limited fuel supplies. Even when they are not intended solely to boost energy security, it is important to not automatically rule out energy storage because it is assumed to be too costly. A recent report by the Rocky Mountain Institute shows that energy storage coupled with renewable energy is already cost competitive in certain markets where electricity rates are high, such as Hawaii and California.[14]

On islanded grids (i.e., stand-alone) or energy security systems such as microgrids, where a significant portion of the instantaneous power supply is likely to come from conventional diesel-powered generators, the impacts of incorporating variable sources of renewable energy such as solar and wind need to be well understood before they can be implemented. For example, the Navy installed wind turbines on two islanded energy grids without adequately accounting for integration issues. Now the Navy has difficulty balancing its baseline generation with the instantaneous production variability of the wind turbines at these locations.

Energy efficiency is also often not properly considered for microgrids. Investments in energy efficiency reduce the energy demand from critical loads and circuits that need to be supplied by a microgrid. Reducing energy demand reduces the investment required for a microgrid in terms of the generation capacity needed, and can allow back-up systems to operate longer on limited fuel supplies by reducing the energy required.

CONSENSUS

Consensus, the final element of Project Fundamentals, entails identifying key stakeholders (including local community and nongovernmental organizations), and then communicating with and building consensus among those project stakeholders. To generate buy-in, a common understanding of the project's objectives and fundamental characteristics, and a unification of purpose, are essential. Without consensus, staff and financial resources will not be made available, and stakeholders can become adversaries to the project when it is most vulnerable—before it gets off the ground. For this reason, consensus building is an activity that should be continuously implemented through all phases of the project development process. It is particularly important, though, as specific project details are determined and refined in the Plan phase of the Army's implementation framework (see footnote 10).

Figure 22. The NREL team surveys Area B, the site of Fort Detrick's 15-MW PV system.
Photo by John Nangle, NREL

[14] "The Economics of Grid Defection." Rocky Mountain Institute, CohnReznick Think Energy, and HOMER Energy. February 2014. Accessed July 3, 2014: *http://homerenergy.com/pdf/RMI_Grid_Defection_Report.pdf.*

"Net Zero is a journey, not a destination. It is not an all or nothing approach. Success is measured by moving toward Net Zero where practical and fiscally prudent."

–Kristine Kingery, Director, Army Sustainability Policy

Leadership Support

One of the most common topics for feedback from the Army pilot sites was the importance of leadership support for the Net Zero Program. The priority an installation's leadership places on Net Zero correlates directly to the level of support the program will garner from that leadership, so the implementers of the program must do all they can to help their leaders understand its importance and benefits. They should engage leaders early and often and articulate clearly that the program is about fiscal responsibility, gaining control of current energy costs, and mitigating energy use and cost increases in the future. The installation energy team should also emphasize that Net Zero Energy can be a strategically important step toward energy security and increased resiliency. Fort Hunter Liggett is a good example of successfully engaging the installation's leadership in the process and winning their support for the program. The installation energy team leader frequently briefs his local leadership about the program, the value and status of the projects in the pipeline, and the performance of completed projects. This constant program feedback helps to keep his leadership engaged and invested in the program's successes and responsible for the program's setbacks.

It was also observed that behavior-change programs are primarily effective when there is enforcement and proper incentivization. Leadership support is important when implementing energy behavior projects because enforcement and incentives are most effective when they are commander-directed.

For installations that steward historical and culturally sensitive infrastructure, leadership support early—and at the correct level—is especially important. In such circumstances, it's beneficial to engage appropriate stakeholders early to work through restrictions or conflicts imposed by historical and cultural preservation imperatives. This will also help in acquiring waivers or exceptions from the appropriate level when they are needed.

The director of the DPW is a particularly important level of leadership support that is needed for the success of a Net Zero Energy program. Fort Detrick's DPW director has been supportive and instrumental in the implementation of energy projects. This was partially facilitated because that installation's energy manager realized it was important to align his priorities with those of the DPW director and to couch energy projects in terms that he knew the DPW director would understand and support.

For National Guard installations, another level of leadership that is important to engage with are state legislators. Army policy dictates that National Guard facilities that are built with Federal funds are under the same standards, requirements, and expectations as regular Army facilities, but many of the facilities used by the National Guard are built with state funds, which are not under the same restrictions. It can be an immense help to a National Guard installation's overall efficiency and progress toward Net Zero Energy if state legislators and the priorities and policies they create are aligned with the goals of the Army's Net Zero Energy policy.

Net Zero Energy: Aspiration Versus Practical Reality

Another common observation from the Army pilot sites is that attaining actual Net Zero Energy will be out of reach for most installations. For some sites, then, the Army's Net Zero Energy initiatives and policy can be viewed as aspirational. The principles of an integrated approach to lessening resource dependence through a systematic methodology of reducing, reusing, and seeking sustainable resources are sound within a guiding paradigm, but understanding that truly achieving Net Zero Energy is impractical for many installations may free energy teams to take creative approaches that they might not otherwise be willing to take.

"Net Zero is a journey, not a destination. It is not an all or nothing approach. Success is measured by moving toward Net Zero where practical and fiscally prudent," said Kristine Kingery, the Army's Sustainability Policy director. This mindset can help to bound expectations and keep the workload on the implementers at a reasonable level.

In addition, implementation teams should view their work in pursuit of Net Zero Energy as naturally complementary and supportive of the work they are already doing. The Net Zero Energy program simply offers a more holistic, better integrated approach to doing that work. This perspective will help implementers and approvers view Net Zero Energy as contributing to and improving on their everyday work instead of as an onerous burden that may be out of reach.

Coordination and Communication

Some Army pilot sites found that better coordination is needed to effectively implement a Net Zero program. When coordinated planning is needed, a lack of transparency and communication between the different offices within the

DPW—such as between DPW–Energy and DPW–Environmental—can hinder project quality and development speed. Better coordination between the DPW and other installation stakeholders—such as between DPW and Range Control to determine appropriate siting—is needed as well. The value of a holistic, integrated assessment, planning, and development approach has been established, and to be effective, such an approach naturally requires close coordination among all the stakeholders and decision makers involved. In addition to vetting projects from within the DPW's sphere of influence, engagement with an installation's mission leadership and community needs to happen early and often to refine projects in development and bolster support for projects already under way. Doing so can build a committed network of stakeholders who all feel invested in a project. When challenges arise, an invested team will stay coordinated and respond quickly to overcome the challenges. When the location of a large battery system had to be changed at Fort Hunter Liggett to fit with the design of a microgrid, the project team, which was composed of diverse stakeholders and approvers, was able to act quickly to identify, vet, and approve a new location without affecting the project schedule. The battery system at Fort Hunter Liggett is shown in Figure 23.

Figure 23. The large battery storage system at Fort Hunter Liggett. *Photo from Fort Hunter Liggett*

Another significant lesson learned in the category of consensus-building is the need to communicate vision for and successes of the installation's program continuously. As already discussed, the Net Zero Energy program lead at Fort Hunter Liggett presents to his installation leadership often to keep them engaged and invested. He also builds community consensus and engagement by promoting his program to the population of the installation and the surrounding community through newsletters and promotional events and material. He holds together all the stakeholders of his program into a Net Zero Energy implementation team by keeping them informed and engaged. He achieves broad community support by empowering all stakeholders to contribute and participate however they can so that they feel ownership and pride in the program as well. He takes every opportunity he can to advertise his program to external parties to build a network of support ranging from administrators of grant or assistance programs to technical experts from the Army and other Federal agencies. He can then access that network to help accomplish his projects. The successes of his program attract external support and show that he is a willing partner for trying things that may be important to his extended network.

A final observation that should be noted in this category is an approach that has been espoused by USAREUR. When energy audits or assessments are performed, the results presented capture not only the economic performance of energy projects. They also communicate some of the nonmonetary benefits, such as sustainable characteristics, decreases in pollution, improvements in quality of life, and operational efficiencies. These factors can be difficult or even impossible to quantify, but they may still be considered important motivations for projects. If possible, these additional benefits should be enumerated and communicated.

Traits of a Successful Net Zero Energy Program Lead

- Meets regularly with installation leadership to keep them engaged
- Promotes the program to the installation's population and the surrounding community
- Builds community engagement through newsletters, promotional events, and materials
- Integrates all program stakeholders into a Net Zero Energy implementation team
- Empowers stakeholders to contribute so that they feel ownership and pride in the program
- Builds a network of external support
- Accesses an external network to help accomplish projects
- Uses the successes of the program to strengthen internal and external support

TEAM

Every project requires a team to execute it. The expertise of many professionals is required at different points in time, including some for the length of the project. Engineers and architects, attorneys, financial advisors and modelers, accountants, sales and marketing professionals, business managers, negotiators and lead project officers, and environmental and permitting specialists can all be necessary. No one entity provides the entire team with all the expertise needed; in the broadest application of this category, each stakeholder who has a key role in the project's success is viewed as a team member. Early on, it is essential to assemble a qualified Army team representing all aspects of the project including technical, financial, contracting, legal, real property, master planning, environmental, and operational aspects. The assembly of this team begins in the Initiate phase of the Army's implementation framework and should culminate in the Plan phase when the expertise areas of all necessary team members have been identified and the project team is fully assembled. The team needs to be assembled and start communicating and functioning cohesively before a project can move into the Implementation phase (see footnote 10).

Net Zero Energy Program Lead

Every Army installation should have a single individual designated to be the overall lead for that installation's Net Zero program. Individual designates for each facet of the Net Zero triad may also be necessary, although it may be most practical for the overall program lead to also serve as the lead for one or more of the distinct Net Zero facets. A designated program lead, then, may be the sole coordinator for all three aspects of the installation's Net Zero program, or he or she may be the lead coordinator of three other designated individuals who are in charge of each of the three facets, respectively. Figure 24 illustrates the possible leadership and coordination configurations of the overall Net Zero program and each of the three facets of the Net Zero triad.

All of these arrangements are valid and workable, and it is up to individual installations to determine the approach that best suits their needs and capabilities. The important point is that someone must be designated as the lead for the overall program as well as for each of its three components. The rest of the lessons learned presented in this section are related to the Net Zero Energy program lead, which was one of the most common topics of lessons learned gleaned from those involved with the Army's pilot program. The lessons learned are also applicable to the roles of the overall program lead and the leads of the other two components of an installation's Net Zero program.

The most common practice at the Army pilot sites was to designate the energy manager as the program lead; however, this was not universal. The Oregon National Guard designated its Construction and Facilities Management Office (CFMO) as the Net Zero program lead and drew on its network of resource efficiency managers from command-level down to the installation level to support these program leads. Either of these methods is valid and each likely has some advantages and weaknesses. Installation managers may also consider having their designated Net Zero overall program and/or energy lead as a special position on a commander's staff rather than located within the DPW. This would certainly help to elevate the priorities of the program in the view of other team members and the leadership, and it should simplify the process of planning and implementing in a holistic, integrated fashion. Again, it will be largely up to Army organizations and individual installations to determine

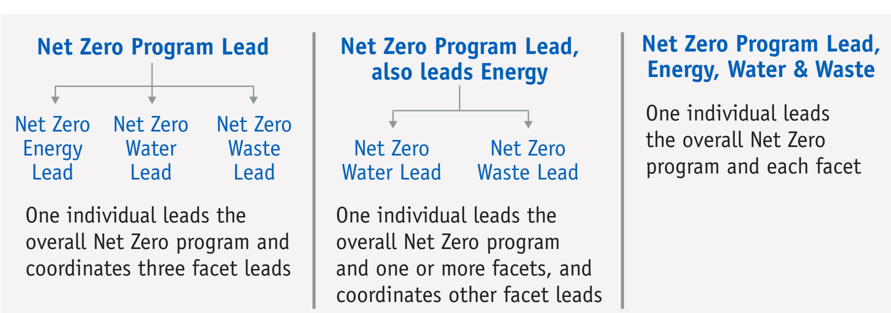

Figure 24. Net Zero program leadership options. *Illustration by Colton Heaps, NREL*

Common Members of a Net Zero Energy Team

- Engineers
- Architects
- Master planners
- Energy and utilities managers
- Financial analysts
- Contracting officers
- Attorneys
- Communications and cyber security professionals
- Environmental and permitting specialists
- Operations and maintenance personnel

A Net Zero Energy program lead serves as a team motivator, and must have enough "bandwidth" to provide effective shepherding of the installation's Net Zero Energy program.

how best to implement their Net Zero programs, but the important thing is that the appropriate person is designated to be the lead at each installation. The capabilities, motivation, and capacities of the designated Net Zero Energy program leads to pursue the priorities of the program were the most commonly noted factors for implementation success at the Army pilot sites.

Net Zero Energy program leads should be selected for and equipped with the appropriate skills needed to execute their roles effectively. This is likely why energy managers were so frequently selected to serve in these positions. Energy managers typically have a foundational level of knowledge about and experience with the required concepts. Even if the energy manager is not designated as the Net Zero Energy program lead, immediate access to that expertise at each installation is important. For this reason, it was noted that every Army installation should have the manpower authorization to have a full-time energy manager on staff, and not to assign this role as an additional duty. Whether it is the energy manager or someone else designated as the Net Zero Energy program lead, that individual will likely need to attend appropriate trainings to instill or refresh the skills that the position requires.

A persistent, committed, and motivated Net Zero Energy program lead serves as a team motivator and the prime implementer of the program. This staff-member must have enough "bandwidth" to provide effective shepherding of the installation's Net Zero Energy program. Although it was noted that each installation should have a full-time, devoted energy manager on staff, it was also found that it may be helpful for this person to be in a position to direct a staff and delegate tasks. The Net Zero Energy program lead at Fort Hunter Liggett wears dual hats as the installation's energy manager and the chief of the Engineering Branch within the DPW. In this position, he directs a staff of engineers. Because he is also the energy manager, they probably share his same priorities for energy. He is able to delegate tasks to this staff and the work of the entire engineering branch is likely influenced by his focus on and concern for the installation's energy issues.

The varying expectations, capabilities, and capacities of Net Zero Energy program leads across the DPWs of Army installations may impede the implementation of Net Zero Energy across the Army. The Net Zero Energy program lead at a given installation is likely not hired specifically for that role, which is typically acceptable if there is a mutual fit between the individual and the position, but high turnover of the individuals assigned to this position can reduce the effectiveness of a Net Zero Energy program. At a couple of the Army pilot sites, high turnover of Net Zero Energy leads—because it was an additional duty that switched frequently between various individuals within the DPW—resulted in a lack of continuity and inconsistent focus.

Leaders as Team Members

The importance of gaining support from an installation's leadership has been covered thoroughly in other portions of this report, but there is another aspect of this support and involvement that is worth emphasizing in this Team-centered section: Leaders should be brought on to the Net Zero Energy team as full team members and kept fully involved and informed of all actions the team takes. Helping them feel a part of the team will keep them engaged, informed, and committed to the process. Some successful examples of this were observed by participants at one of the Army pilot sites, who noted that successful installations tended to have their garrison commanders and DPW directors attending energy manager trainings and energy conferences. Certainly, this was a manifestation of the interest that these leaders placed in energy matters and reflected the priority they give this topic.

Leveraging Resources

Another common area for lessons learned by the Army pilot sites in this Team category is that of knowing and accessing the capabilities, both resident and external, needed to implement energy projects. Installation teams need to take time to catalog their installation's own capabilities, identify external resources that can help them fill capability gaps, and then appropriately access and use those resources.

Although having all the needed technical expertise in house is not absolutely required, having technically knowledgeable and capable local staff can be a great benefit to an installation's Net Zero Energy efforts. At one of the Army pilot sites, energy project decisions were made with good intentions but incomplete technical understanding. This led to energy projects that actually increased energy consumption and costs. Installation managers with less technical experience should take the time to seek advice from external resources with the needed expertise.

Sierra Army Depot managers found that their ability to tap into the expertise of DOE's Federal Energy Management

External Resources for Army Net Zero Energy Teams

The following Federal agencies and national laboratories can help diagnose energy issues and pursue technical solutions:

- U.S. Department of Energy Federal Energy Management Program
- U.S. Army Corps of Engineers Construction Engineering Research Laboratory
- U.S. Army Engineering and Support Center, Huntsville
- National Renewable Energy Laboratory
- Sandia National Laboratories
- Pacific Northwest National Laboratory
- Oak Ridge National Laboratory

Program (FEMP), USACE, and various national laboratories was very beneficial to their pursuit of Net Zero Energy. Many installation teams may need help to adequately diagnose energy issues and pursue particular technical solutions. These teams simply need to identify available resources and take the time to bring these experts into the project. Once adequate internal and external resources are involved, the role of the Net Zero Energy lead will also include that of being a "conductor" to ensure that the various resources are not duplicating efforts and that the products of their work are integrated.

Net Zero Energy program leads need to educate themselves about the various resources available to them, and then actively seek out and engage with those parties and programs. The energy program lead at Fort Hunter Liggett has been particularly successful in attracting grant-funded and demonstration projects to his installation because he fosters relationships with the administrators of the various programs and when he applies to a program, he consistently follows up.

A "fire and forget" approach to obtaining these kinds of external resources and support is not effective.

Energy teams should also make use of existing tools, reports, and screening methodologies to save time in their development efforts. For example, websites such as those maintained by the national laboratories and FEMP can be great sources of information about technologies, development and evaluation methods, and alternative financing options. Possible options for external resources include national laboratories, USACE, FEMP, other installations, U.S. Army Installation Management Command (IMCOM), utility companies, and the private sector.

Vince Guthrie, the utilities program manager at Fort Carson (Figure 25), observes that the Army's Net Zero Energy program can drive change in the private sector. "I like how we're pushing the Net Zero boundaries because what we're accomplishing is having positive impacts far beyond our installation boundaries."

A category of external resource that is applicable only to National Guard installations is the state's National Guard Construction Branch. The Net Zero implementers of the Oregon National Guard found that their Construction Branch had to be encouraged to change priorities and learn a new way of doing things. They were accustomed to meeting Oregon energy efficiency design standards and the projects they execute are governed by state policies rather than Army construction standards. A Net Zero Energy goal requires more aggressive efficiency standards, so they had to be informed of the higher Army expectations and encouraged to meet them.

Figure 25. Fort Carson's utilities program manager, Vince Guthrie, serves as its Net Zero program lead. *Photo from Fort Carson*

"I like how we're pushing the Net Zero boundaries because what we're accomplishing is having positive impacts far beyond our installation boundaries."

–Vince Guthrie, Fort Carson Net Zero Energy Program Lead

IMPLEMENT

The Implement phase of the Net Zero Implementation Framework (Table 11) can take many forms at an installation. These can include using existing programs and funds, enacting alternate management strategies, attempting pilot programs and new partnerships, conducting technology demonstrations and transitions, and educating and engaging stakeholders. The critical considerations in this phase are identifying the capital required to execute the projects and determining the appropriate method of raising, acquiring, or attracting it (see footnote 1).

CAPITAL

The financial resources required to pay all costs necessary to build a project can likely be attracted to the project once all categories of development are complete and unknowns eliminated. The resources necessary to get to that stage are not the same as those before the Implement phase of the Net Zero implementation framework; these earlier development risk capital investments are typically recovered at the start of construction. Implementation capital resources may be as straightforward as an installation directly funding its own projects or they may be complicated, comprising a mix of debt and equity providers, including tax equity investors, banks or institutional lenders, and other grants or government support for renewable energy projects. Many more complex sources exist, such as vendor financing or government or corporate bond financing, but the message is the same for all of them—for the elements of project finance, a rigorous project development process must be complete and fully documented in order to attract capital (see footnote 10).

Available Assistance and General Procurement Considerations

One of the most important lessons learned about securing the capital needed to implement an energy project is to find the appropriate procurement approach for each undertaking. The correct approach is simply the one that happens to work for the specific project at that time. There is no single procurement approach that will work for every project every time at every installation, so Net Zero Energy teams need to consider and pursue a broad range of procurement strategies for every project they develop. The method the

Table 11. Correlating The Frameworks—The Implement Phase

Army Net Zero Implementation Framework	NREL Project Fundamentals	NREL Project Development Framework
Initiate	Baseline	
Assess	Economics Policy	Site Resource
Plan	Technology Consensus	Off-Take Permits Technology Team
Implement		**Capital**

team used at Fort Hunter Liggett seems to be most effective of all the Army pilot sites. Their approach has been to pursue multiple avenues of funding for the same project, often at the same time. This gives them flexibility and backup options if their primary funding preference falls through for a given project. If a particular procurement method does not pan out for a given energy project, that project does not necessarily die. Continuing to pursue each project under different procurement methodologies increases the likelihood that one of them will succeed. Installation teams may not be able to predict which procurement method will ultimately succeed for each project, so it is important that they stay flexible and persistent.

A few of the Army pilot site teams found that it was beneficial to maintain a list of "shovel-ready" projects for which they had done as much of the predevelopment and development work as possible ahead of determining the procurement approach. With this strategy, when an appropriate opportunity comes along, such as a grant, demonstration program, or end-of-year funds, the newly available funds can be applied for quickly and easily because most of the preparation has already been done, and the project is ready to move forward swiftly.

Once the procurement strategy is secured for a project, it is also important to approach proposal and selection criteria correctly. Installation teams need to ensure that their methods are tailored to fit the needs of procuring the latest energy efficiency and renewable energy technologies. An RFP at one of the Army pilot sites was an adaptation of a conventional energy generation procurement RFP that included dated and generic language, which called for the system to have "continuous output" of energy. The problem was that the RFP was for a PV array, which produces variable output. It took some creative interpretation of the intent of the RFP on the part of a contracting officer to successfully award a contract. Energy project teams should also base selection on the highest net present value instead of other possible criteria such as lowest cost or shortest payback.

As with the integrated and holistic approach of planning and implementing Net Zero projects that has been espoused throughout this report, installations should also employ a deliberate and consolidated methodology for investment. A capital investment strategy that accounts for desired energy investment is important to help prioritize efforts. Such a strategy may be a distinct product created by an installation, or it may be incorporated into an energy master plan or an overall installation master plan.

The remainder of this section of the report presents lessons learned about different sources of capital funding, including alternative financing and direct funding options. This is not meant to be an exhaustive list of all the possible methods of accessing project capital that may be available to installations, nor does it describe all the issues that may be encountered in doing so.

Alternative financing options leverage private capital to decrease overall project costs by taking advantage of tax and depreciation benefits that are not available to government agencies. Alternative financing options include ESPCs, power purchase agreements (PPAs), and utility energy service contracts (UESCs). These contracting vehicles and their attendant authorities and limitations can be complicated. Fortunately, several resources are available to the Army to help determine which of these mechanisms may be right for an installation and to assist in implementing them. The USACE's Huntsville Center, along with FEMP and several of the national laboratories can furnish expert guidance and assistance with these procurement techniques.

Table 12. Comparison of Different Financing Methods

	Alternative Financing	Government Financed
Options	• Energy savings performance contracts (ESPCs) • Power purchase agreements (PPAs) • Utility energy service contracts (UESCs) • General Services Administration (GSA) Areawide contracts • Long-term land lease agreements	• Appropriated funds • Demonstration programs
Advantages	• Third-party owner bears risk • Can offer lower energy costs due to tax incentives • Can be flexible and responsive to changes mid-procurement	• Greater return on investment may be available with immediate ownership • Can offer greater control of project characteristics
Challenges	• Contracting authorities may be complicated • Difficult for Government to realize full value of projects (ownership may not be an option until later, if at all)	• Government bears risk • Appropriation process can be lengthy and inflexible • Large up-front investment takes time to recoup

Direct funding and other project execution options include demonstration programs and appropriated funding. Table 12 lists these options and presents some of the advantages and challenges associated with them.

> "Every post should have [an energy savings performance contract] to get things done."
>
> –BJ Tomlinson, Fort Bliss Net Zero Energy team member

Energy Savings Performance Contracts

ESPCs allow Federal agencies to accomplish energy savings projects without up-front capital costs or special congressional appropriations. An ESPC is a partnership between a Federal agency and an energy service company (ESCO). The ESCO conducts a comprehensive energy audit for the Federal facility and identifies improvements to save energy. In consultation with the Federal agency, the ESCO designs and constructs a project that meets the agency's needs and arranges the necessary financing. The ESCO guarantees that the improvements will generate energy cost savings sufficient to pay for the project over the term of the contract. After the contract ends, all additional cost savings accrue to the agency. Contract terms up to 25 years are allowed. The average contract price for a DOE ESPC contract undertaken by a Federal agency between 1998 and 2012 was $9.3 million.[15] Typically ESPCs need to be at least $2 million in size to generate interest from the private sector. One benefit of using the ESPC mechanism is that all projects are bundled into one financial cash flow. As long as the cash flow works out, the project can move forward. This allows for energy efficiency and renewable energy projects to be bundled, essentially allowing some of the less costly measures to pay for some of the more costly measures. This is valuable for projects that include energy goals because a site does not need to stop implementing efficiency after the low-hanging fruit opportunities have been exhausted.[16]

ESPCs may be the most commonly used alternative financing method for implementing energy projects on Army installations, and several of the Army pilot sites have them in place or are working to implement them. Generally, teams at these installations found them beneficial and a useful, streamlined vehicle by which to accomplish desired projects. BJ Tomlinson, the Acting Division Chief of the Business Operations and Integration Division at Fort Bliss, and one of the members of the Net Zero Energy team there said that, "Every post should have one to get things done."

Note, however, that as with any execution method, ESPCs have their limitations. A few of the Army pilot site teams that had ESPCs in place noted that installations should take certain precautions when procuring and selecting an ESCO for their ESPC. They advised that installations should ensure that the scoping document used in the procurement of an ESPC should be detailed, specific, and based on preliminary opportunity evaluations performed by a party separate from the solicited ESCO(s). Some of the Army pilot site teams felt that it would be best to have an independent contractor perform this preliminary analysis and then to put the package of identified opportunities out to a competitive bid among the interested ESCOs. There is debate within the community of ESPC contracting officers and project managers whether this approach adds enough value to the process to justify its added cost and complexity, but it is a valid approach that installation teams may feel is most appropriate for their situation. At a minimum, it is certainly useful to have some kind of baseline energy assessment performed before beginning the ESPC procurement process so that when ESCO proposals are received, they can be validated by the installation's procurement team against what they already know about their energy landscape.

The Army pilot site teams also felt that ESCO proposals should provide details up front on how they will verify savings and conduct the measurement and verification (M&V) of the ECMs once they are implemented. These details may not typically be provided in initial proposals (instead, they might be supplied once an ESCO is selected and after they have developed more detailed execution plans), but it is a good point that including M&V procedures in the selection criteria for an ESPC may be worthwhile.

It is important to understand that an ESCO's concern is with maximizing its margin while minimizing its risk, so an ESCO may not accept projects that have slimmer margins and are inherently more risky for inclusion in an ESPC. Examples of such projects include complex, cutting-edge, or less-established technologies. Other programs such as the grant or demonstration opportunities that

[15] DOE ESPC Delivery Order Summary. Accessed July 30, 2012: *http://www1.eere.energy.gov/femp/pdfs/do_awardedcontracts.pdf.*

[16] The descriptions of the alternative financing methods (ESPC, PPA, and UESC) were drawn from material on the FEMP website. Accessed July 3, 2014: *http://www.energy.gov/femp.*

are discussed next may still be available to pursue these kinds of projects in which installation teams are interested. A consequence of this preference of ESCOs to avoid complexity and risk is that Army procurement teams should be cautious about basing selection criteria on the inclusion of these types of projects. They should carefully evaluate the proposals of ESCOs that enthusiastically present these options, because when it becomes time for the ESCO to actually implement them, there may be delays and reticence on the part of the ESCO.

Another observation about the ESPC procurement process is that it may be worth using appropriated funds as a down payment on an ESPC. Doing so reduces the overall cost of financing, and it will allow the financed money that an ESCO brings to the table to go further toward more projects. This offers a greater return on an installation's investment than simply purchasing what it could afford with those available funds.

A related observation is that ESPC procurement teams should not try to shorten the length of an ESPC contract, which may be the natural tendency of conservative decision makers and procurement personnel. Instead, they should allow for longer contract terms that will allow an ESCO to make a maximum number of projects financially viable (more costly projects require longer payback periods). In this way, more work can be accomplished.

A technically knowledgeable contracting officer's representative (COR) with a strong leadership relationship with the ESCO can also be important to ensuring an effective ESPC, especially when the nature of the ESPC contract is multitask-order. One of the Army pilot site teams has encountered difficulty in getting their ESCO to implement some of the projects that they want done. These projects are known by the installation's team to be valid through third-party evaluation, yet the ESCO seems willing only to pursue its own interests and priorities, which are projects that have larger margins for the ESCO. A strong COR may be able to better influence an ESCO in this situation. M&V for some of the ECMs implemented under this same ESPC is also inadequate. The level of effort and intensity required of an M&V measure should be commensurate with the complexity of the ECM and the magnitude of its energy savings rather than an arbitrary one-size-fits-all approach or a lowest-cost option.

A final note about ESPCs is that having an ESPC in place may affect an installation team's ability to do other projects and obtain funding from other sources in the future. For example, the team at Sierra Army Depot found that a daylighting project for warehouses that they hoped to do could not be implemented because their installation's ESPC already included a lighting modification project for those same buildings. The ESCO was already being paid an annual fee for the savings that resulted from the earlier lighting improvements. This meant that a daylighting project with a cost justification based on further reducing lighting costs was incompatible because now a portion of the lighting costs was unavoidable no matter what additional improvements were made. The annual payments to the ESCO are fixed for the life of the contract and cannot be reduced under the rationale that now the installation was saving even more. At least one of the Army pilot site teams also found that having an ESPC in place may be hampering their eligibility—real or perceived—to receive funding from some other grant, demonstration, and assistance programs offered by the Army.

Power Purchase Agreements

PPAs allow Federal agencies to finance on-site renewable energy projects with no up-front capital costs. With a PPA, a developer installs a renewable energy system on agency property under an agreement that the agency will purchase the power generated by the system. The developer uses the cash flow provided by the agency's power payments over the life of the contract to finance the construction of the project. After installation, the developer owns, operates, and maintains the system for the life of the contract. This type of agreement allows the developer to capture the tax incentives that would have otherwise been forfeited by the Federal agency. By capturing all of the tax incentives and rebates, the developer can offer the power to the Federal agency at a much lower cost than the agency would have otherwise been able to secure (see footnote 15).

At least two separate PPA contracting authorities are available to Army installation teams interested in pursuing this type of project. One is DOD's own contracting authority, commonly referred to as the 2922A Authority, which can authorize contracts of up to 30 years in length. In the Army, this authority requires approval from the Assistant Secretary of the Army (Installations, Energy & Environment) and it has not yet been widely used. A PV array being developed at Fort Detrick will be the first project implemented by the Army under this authority, but it has been used more widely by other service branches, with successfully operating projects at multiple Navy and Marine Corps installations such as China Lake, Barstow, and Twentynine Palms (all in California).

The process for pursuing a competitive solicitation under 2922A Authority may be streamlined using the Army's multiple award task order contract (MATOC). The

Figure 26. Fort Carson solar array. *Photo from Fort Carson*

MATOC was established by USACE, and provides a task order procurement vehicle with an established pool of prequalified developers for four renewable energy technologies: solar, wind, biomass, and geothermal. In all of the projects procured under the MATOC, the Army will only buy power from the selected developer, and does not own, operate, or maintain the generating assets that are built on federal land. As renewable energy opportunities at Army installations are assessed and validated, the USACE Huntsville Center will issue a competitive task order RFP to the prequalified bidders for the specific technologies.[17]

The second PPA contracting authority available to some Army installations is that of the Western Area Power Administration (WAPA). An Army installation in WAPA's service territory is eligible to make use of this authority under a program that WAPA established to assist other Federal agencies. It is known as the Renewable Resources for Federal Agencies (RRFA) program, and it "lends" use of the WAPA contracting authority to Federal agencies to implement PPA contracts with terms of up to 40 years in length. Fort Carson successfully used this authority for its first PV array, as seen in Figure 26. The other power marketing administrations may have similar authorities, but they do not have established programs to help other Federal agencies. If an Army installation with an interested team is located in the service territory of one of these other power marketing administrations, it may be worth exploring whether they are able and willing to lend their contracting authority in the way that WAPA does.

General Services Administration's Areawide Contract

Another method of purchasing energy that may contribute to an installation's Net Zero Energy program is the General Services Administration's (GSA) Areawide contract. This is an existing GSA contract which can be particularly useful when an installation has non-excess land available, there is an existing economical local distribution system, and the installation demand is sufficient to use the energy produced by a new energy-producing facility. The authority utilized in this case permits the purchasing of power for up to 10 years with regulated utilities. This method was used successfully for a PV project at Fort Huachuca, Arizona.

Utility Energy Service Contracts

Another way for Federal agencies to implement energy efficiency and renewable energy projects is through utilities. Federal agencies often enter into UESCs to implement energy improvements at their facilities. With a UESC, the utility typically arranges financing to cover the capital costs of the project. Then the utility is repaid over the contract term from the cost savings generated by the energy efficiency measures. With this arrangement, agencies can implement energy improvements with no initial capital investment. The net cost to the Federal agency is minimal, and the agency saves time and resources by using the one-stop shopping offered by the utility (see footnote 15).

[17] U.S. Army Office of Energy Initiatives, Army Guide: Developing Renewable Energy Projects by Leveraging the Private Sector, Washington, DC: U.S. Army Office of Energy Initiatives, November 6, 2014. Accessed February 5, 2015: *http://www.asaie.army.mil/Public/ES/oei/docs/2014%2011%2006%20Army%20Guide%20to%20Developing%20Renewable%20Energy%20Projects.pdf.*

Long-Term Land Lease Agreements

For a project developed as an ESPC, PPA, GSA Areawide contract, or a UESC, a component of that project may need to include a real estate transaction that allows a utility or developer access to the Army land to be developed. One method of granting this access is a long-term land lease agreement, such as the enhanced use lease (EUL). EULs can also be avenues to make non-excess installation land available for renewable power generation when there are off-takers other than the installation for the energy generated. While EULs utilized in this fashion do not provide for the procurement of renewable energy directly, they provide revenue through land lease payments from energy projects. With this approach, the installation may still obtain credit for generating renewable energy even though it is not consuming the power, and it can also realize some revenue, which may be used for other projects benefiting a Net Zero Energy goal. EULs can also provide in-kind services or projects in lieu of lease revenue that could provide other benefits to an installation.

Appropriated Funding

Several sources of direct funding may be available to Army installations, but they are all generally based on money that has been appropriated by Congress for O&M, modernization, or new construction—the latter of which is generally called military construction (MILCON). The following paragraphs describe lessons learned about approaches that installations have taken to fund energy projects themselves from these appropriated funds.

Some of the advantages to maintaining a prioritized list of shovel-ready projects have already been conveyed, and keeping such a list is almost essential if end-of-year funds are to be used to implement any Net Zero Energy projects. At Sierra Army Depot, for example, approximately $230,000 in end-of-year money was quickly used to upgrade incandescent light fixtures in 27 warehouses with energy efficient light-emitting diode (LED) fixtures.

The Fort Hunter Liggett team has found that a significant portion of their Facilities Sustainment, Restoration, and Modernization (FSRM) budget can also be used for energy projects if the DPW director and garrison commander share the priorities of the Net Zero Energy program. The utilities modernization component of

Less Common Appropriated Funding and Demonstration Programs

Energy Conservation Investment Program (ECIP)—A DOD program designated for Recovery Act projects that reduce energy and water usage, and consequently, costs. This program includes construction of new, high-efficiency energy systems and the improvement of existing systems.

Facilities Sustainment, Restoration, and Modernization (FSRM)—The utilities modernization component of FSRM provides funds for policies, programs, and projects identified in the Army Energy and Water Campaign Plan. This program helps installations comply with Federal requirements, and improves infrastructure performance and efficiencies for nonprivatized systems, including buildings and facilities.

Strategic Environmental Research and Development Program (SERDP)—A DOD environmental science and technology program, executed in partnership with DOE and the Environmental Protection Agency. SERDP invests in basic and applied research and advanced development.

Environmental Security Technology Certification Program (ESTCP)—A DOD environmental technology demonstration and validation program. The program helps identify and demonstrate cost-effective technologies that address DOD's highest-priority environmental requirements.

FSRM funding is particularly applicable to Net Zero Energy projects because it is intended specifically for the types of projects that can improve energy efficiency and produce renewable energy that are sought in pursuit of Net Zero Energy.

A less well known appropriated funding source available to installation energy teams is ECIP. This program is also advantageous to a Net Zero Energy program because, as the PV project example cited on page 27 illustrates, this program is intended for the exact types of projects which will be a part of a Net Zero Energy plan.

USACE personnel note that if appropriated funds are available to installations, they should be directed at projects that have longer payback periods because ESPCs can efficiently implement the simpler, shorter payback projects without supplemental appropriated funds. The projects that have longer payback periods are the most difficult to implement no matter what procurement approach is used, so if an installation has cash in hand, it should direct it toward projects that need the cash the most. In some cases, there are limitations to the length of payback period allowed for projects implemented using appropriated funds. IMCOM's Operation Order (OPORD) 13-174 and its predecessor 10-257 limit ECMs that can be implemented using FSRM funds to projects with payback periods of 10 years or less. Regulations governing ECIP projects limit the payback period allowed based on project-specific life cycle cost assessments and stipulated expected lifespans for particular technologies.

Demonstration Programs

Another method for implementing energy projects on Army installations is through technology demonstration programs. The Strategic Environmental and Research and Development and Environmental Security Technology Certification Programs (SERDP and ESTCP) are examples of such an implementation method.

A few of the Army pilot sites had projects funded under the ESTCP and the teams found it to be very helpful. Because the ESTCP's funding is fairly limited, it is appropriate to use only with demonstration-type projects or for technologies that are still under research and development.

On a general note about demonstration programs: the teams at Forts Carson and Hunter Liggett have found that being a willing participant in these types of projects opens up opportunities beyond just the demonstration projects themselves. It establishes networks, bolsters an energy team's reputation, and educates its participants about available resources. The Net Zero Energy program lead at Fort Hunter Liggett is a particularly good example of how to establish connections in various assistance and funding programs and then maintain relationships with those connections to obtain as much assistance as he can for his installation's program. By doing so, he has established a positive reputation for himself as a willing partner and keeps himself in the loop for new opportunities as they arise.

CONCLUSION

As Army installations carry out the Net Zero Energy policy, the elements of Project Fundamentals and the Project Development Framework developed by NREL can illustrate and elaborate the Army's implementation process and serve as a useful reference for the types of factors their energy teams will need to consider. There are a large number of lessons that have been learned from the Net Zero pilot program that can be broadly categorized according to the elements of these frameworks. Chief among these issues are the need for the following:

- A dedicated and equipped Net Zero Energy program lead
- A well-coordinated and capable team
- Supportive leadership
- An integrated and holistic planning process
- Flexibility and persistence in acquiring the appropriate procurement method for each desired priority and project.

ABBREVIATIONS AND ACRONYMS

BLM .... Bureau of Land Management

CFMO....... Construction and Facilities Management Office

COR......... contracting officer's representative

DOD........ U.S. Department of Defense

DOE .... U.S. Department of Energy

DPW........ Department of Public Works

ECM .... energy conservation measure

EE........... energy efficiency

EEAP........ Energy Engineering Analysis Program

ECIP .... Energy Conservation Investment Program

EITF......... Energy Initiatives Task Force

EPC......... engineering, procurement, and construction

ESCO .... energy service company

ESPC........ energy savings performance contract

ESTCP....... Environmental Security Technology Certification Program

EUL......... enhanced use lease

FEMP .... Federal Energy Management Program

FSRM .... facilities sustainment, restoration, and modernization

GSA......... General Services Administration

IMCOM ..... U.S. Army Installation Management Command

LED......... light-emitting diode

M&V .... measurement and verification

MATOC ..... multiple award task order contract

MILCON .... military construction

NEPA .... National Environmental Policy Act

NREL........ National Renewable Energy Laboratory

O&M........ operations and maintenance

OASA .... Office of the Assistant Secretary of the Army

OEI .... Office of Energy Initiatives

OPORD ..... operation order

PNNL .... Pacific Northwest National Laboratory

PPA .... power purchase agreement

PV .... photovoltaic

RE .... renewable energy

REC......... renewable energy certificate

RFP .... request for proposal

RPS .... renewable portfolio standard

RRFA........ Renewable Resources for Federal Agencies

SERDP ...... Strategic Environmental and Research and Development Program

UESC .... utility energy service contract

USACE ...... U.S. Army Corps of Engineers

USAREUR ... U.S. Army in Europe

WAPA....... Western Area Power Administration

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