

# 2015 PROGRESS REPORT

## Army Net Zero Initiative

**October 2016**

Assistant Secretary of the Army  
(Installations, Energy and Environment)



# **2015 Progress Report Army Net Zero Initiative**

October 2016

Prepared by Pacific Northwest National Laboratory for OASA (IE&E)

## Message from Honorable Katherine Hammack

In October 2010, I announced the creation of the Army Net Zero Initiative. Net Zero is a holistic strategy founded upon the Army's long-standing sustainable practices and incorporation of emerging best practices to manage energy, water, and solid waste at our installations. The Army's mission depends on access to energy, water, and waste resources. Their strategic management ensures the Army of tomorrow is better positioned to meet emerging mission requirements.



We launched the Net Zero Initiative with 17 pilot installations on April 19, 2011. The pilot installations meet a variety of criteria. Each pilot volunteered, has support from both the Senior Mission and Garrison Commanders, represents diverse geographic constraints, and supports varied mission requirements. The pilots serve as test beds to help the Army gather lessons learned, develop technical analysis and roadmaps, and construct a solid foundation to transition and institutionalize the Net Zero concept throughout the Army. The pilot installations continue to serve as model communities for energy security and sustainability while we apply the Net Zero concept to all Army installations. Moving the initiative forward, the Army assigned oversight responsibility of the Net Zero Initiative to our land-holding Commands in 2014. The Commands continue to institute Net Zero concepts and processes across their installations.

This Army Progress Report summarizes the pilot installations' and Commands' progress toward achieving Net Zero, highlighting resource consumption reduction, efficiency improvements, sustainable resources such as renewable energy and alternative water, and waste stream recovery. I am pleased to announce that pilot installations have been successful in integrating Net Zero principles into their project execution and day-to-day operations. Net Zero Energy pilot installations have been effective in reducing the energy use and generating renewable energy. Net Zero Water pilot installations have driven down water consumption while finding sustainable alternative water sources. Net Zero Waste pilot installations have made significant progress in reducing the volume of solid waste generated, increasing their recycling rates, and targeting larger waste streams.

Even as our installations face funding and manpower challenges, we have seen great successes across all of the Commands, where the Army is using creative solutions to fund projects, reduce costs, and build partnerships that move Net Zero forward. Overall, the Army is using the Net Zero framework as a mission enabler making our installations more resilient. We will continue to pursue Net Zero measures to the maximum extent practicable and fiscally prudent.

A handwritten signature in black ink, appearing to read 'KH', followed by a long horizontal line.

**Katherine Hammack**

**Assistant Secretary of the Army for Installations, Energy and Environment**

## Executive Summary

### Background

The Army's Net Zero Initiative is a comprehensive strategy to support energy security and sustainability with a focus on energy, water, and solid waste management at Army installations. Our vision builds on long-standing sustainability practices and incorporates new and emerging best practices. The Army is creating a culture that recognizes the value of sustainability measured not just in terms of financial benefits, but in terms of the benefits to quality of life, relationships with local communities, the preservation of options for the Army's future, and maintaining mission capability and resilience.

The overall objective of the Army's Net Zero Initiative is to implement Net Zero measures to the maximum extent practicable and fiscally prudent by doing the following:

- Reducing overall energy use, maximizing energy efficiency, implementing energy recovery and cogeneration opportunities, and then offsetting the remaining demand with the production of renewable energy from onsite sources, so that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.
- Reducing overall water use, regardless of the source; increasing use of technology that uses water more efficiently; recycling and reusing water, shifting from potable water use to alternative sources as much as possible; and minimizing inter-basin transfers of any type of water, potable or non-potable, so that a Net Zero Water installation recharges as much water back into the aquifer as it withdraws.
- Reducing, reusing, recycling/composting, and recovering solid waste streams, converting them to resource values, resulting in zero landfill disposal.

### Net Zero Pilot Installations

In October 2010, the Assistant Secretary of the Army for Installations, Energy and Environment, the Honorable Katherine Hammack, announced the creation of the Army Net Zero Pilot Installation Initiative. To launch the Net Zero Initiative, the Army identified 17 pilot installations and 1 statewide energy pilot to serve as test beds in identifying best practices and sound approaches that could be leveraged enterprise-wide across the Army (Figure ES.1).

As part of this progress report, each pilot installation provided data on their Net Zero progress from fiscal year (FY)11 through FY15. Overall, the pilot installations are making significant progress toward Net Zero.



**Figure ES.1. Net Zero Pilot Installations**

Through the end of FY15, the Net Zero Energy pilot installations:

- Reduced energy use by 307 million British thermal units (Btu) compared to FY11, which represents a 5% reduction despite significant increases in mission-driven growth.
- Reduced energy use intensity (measured in thousand Btu per facility gross square foot) by 13% compared to FY11.
- Generated nearly 28,700 megawatt-hours (MWh) of renewable energy. Of this total, 77% was consumed onsite, totaling 22,300 MWh; the energy generated could power 2,600 homes in the United States for one year.<sup>1</sup>

Through the end of FY15, the Net Zero Water pilot installations:

- Reduced potable water consumption by 636 million gallons compared to FY11, which represents an 11% reduction; this water savings is equivalent to providing potable water to more than 5,800 U.S. homes for one year.<sup>1</sup>

<sup>1</sup> Energy Information Administration. 2016. *How much electricity does an American home use?* Washington, D.C. <https://www.eia.gov/tools/faqs/faq.cfm?id=97&t=3>.

- Reduced potable water use intensity by 14% compared to FY11.
- Produced 89 million gallons of alternative water by reclaiming wastewater and harvesting rainwater onsite.

Through the end of FY15, the Net Zero Waste pilot installations:

- Reduced the generation of municipal solid waste by 9,400 tons compared to FY11, which represents a 7% reduction; this savings is equivalent to displacing the amount of trash produced by 11,700 people in the United States for one year.<sup>2</sup>
- Diverted 58% of this generated waste from landfill disposal.

Through the pilot installations, we have highlighted successful application of Net Zero concepts to be leveraged across the Army. These include:

- Training personnel to integrate the triple bottom line of the Net Zero strategy.
- Leveraging multiple funding streams and technology demonstration programs.
- Building partnerships to gain expertise in innovative and emerging technologies.
- Using Resource Efficiency Managers to advance project ideas to implementation.
- Collaborating with the Office of Energy Initiatives to deploy renewable energy projects.
- Developing strategic plans for implementing Net Zero technologies.
- Standardizing sustainable procurement that institutionalizes Net Zero practices.

## Command Overview

Army land-holding Commands currently manage their Net Zero Initiatives. Each Command highly values communication in sharing successes and lessons learned, both with other Command sites and throughout the Army. Targeted communication products provide valuable information to all levels of personnel about a variety of topics relevant to the Net Zero Initiative. Although each Command has its own communications strategy, nearly all of the Commands share best practices and lessons learned through periodic teleconferences and articles in Army publications. The Commands also use communications to train and educate personnel involved in implementing the Net Zero strategy. In addition to enhanced communication, the Commands are embracing effective ways to facilitate implementation of projects that incorporate Net Zero principles, including the use of third-party financing to pay for projects. Commands have also reported that project champions who keep projects moving forward are key to project success.

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<sup>1</sup> U.S. Environmental Protection Agency. 2016. *WaterSense: Water Use Today*. Washington, D.C. [https://www3.epa.gov/watersense/our\\_water/water\\_use\\_today.html](https://www3.epa.gov/watersense/our_water/water_use_today.html).

<sup>2</sup> U.S. Environmental Protection Agency. 2014. *Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012*. Washington, D.C. [https://www3.epa.gov/wastes/nonhaz/municipal/pubs/2012\\_msw\\_fs.pdf](https://www3.epa.gov/wastes/nonhaz/municipal/pubs/2012_msw_fs.pdf).



## Path Forward

Over the last four years, the Army's Net Zero Installation Pilot Initiative established a framework that defined the Net Zero strategy, piloted Net Zero concepts at installations, built partnerships, and assigned responsibilities to the Commands. The Oregon Army National Guard, Fort Hunter Liggett, and Camp Parks reduced energy use and aggressively pursued renewable energy generation. For example, Fort Hunter Liggett anticipates that onsite renewable energy generation will offset their total energy consumption by FY20. Fort Carson and Fort Buchanan have employed alternative water sources through wastewater reclamation and rainwater harvesting to offset the use of potable water. Fort Carson projects that by FY20 the installation will offset more than 50% of its potable water with reclaimed wastewater. For Net Zero Waste pilot installations, Fort Bliss, Fort Polk, and Fort Hunter Liggett have significantly increased their respective municipal solid waste (MSW) diversion rates from FY11 to FY15. For example, Fort Polk increased their MSW diversion rate by 50% from FY11 to FY15.

To continue striving toward achieving Net Zero goals over the next four years, Department of the Army Headquarters (HQDA), Commands, and installations will continue to work together to further implement Net Zero actions. Of key importance, Army leadership will continue to bring visibility and support to the Net Zero Initiative and incorporate Net Zero approaches in Army policy and guidance. HQDA will continue to refine the method to measure and verify the Net Zero objectives to help installations track progress. In addition, HQDA will provide technical assistance to Commands and installations in deploying technologies that help to integrate Net Zero principles.

Commands will continue to share best practices and deploy Net Zero management approaches and technologies to leverage these experiences across the Army. Commands will deploy training and awareness campaigns to incorporate Net Zero across all three areas and continue to invest in Resource Efficiency Managers because they have been particularly successful in executing energy and water projects.

Installations can also take specific actions to continue moving toward Net Zero. Installations will continue to leverage funding through third-party financing and demonstration projects to deploy innovative energy, water, and waste management technologies with the goal to drive down demand. Installations will continue to implement renewable energy projects to reach towards Net Zero Energy. Similarly, installations will build strategies for alternative water projects, searching for sustainable sources of water, especially in drought-prone areas. For Net Zero Waste, installations will advance projects by using the Qualified Recycling Program, incorporating sustainable procurement, and investigating viable markets for recycling and/or reusing nonhazardous solid waste.

As the Army continues to improve and build on the current framework, we are well positioned to maintain the mission while reducing our dependencies on natural resources. Overall, the Army is leading the Net Zero charge, based on the founding idea that sustainable Army communities are more resilient, more compatible with local community needs, and more mission capable.

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## 1.0 Introduction

The Army's Net Zero Initiative is a holistic strategy for achieving sustainability and energy security that manages energy, water, and solid waste at Army installations. The Army's vision is built on long-standing sustainability practices and incorporates new and emerging best practices that support resource security. Net Zero is a force multiplier that enables the Army to steward available resources, manage costs, and provide Soldiers, families, and civilians with a sustainable future. In October 2010, the Army introduced the Net Zero Pilot Installation Initiative. The Army launched the initiative at 17 pilot installations and 1 statewide energy pilot, to serve as test beds for identifying lessons learned and Net Zero best practices. In January 2014, the Army expanded the Net Zero Pilot Installation Initiative to an Army-wide initiative through Army Directive 2014-02.<sup>1</sup> This Directive sets the Net Zero policy and assigns responsibilities to the Army Commands for all installations to strive toward Net Zero.

The Army's Net Zero Directive requires Army Commands to evaluate the feasibility of achieving Net Zero at their installations and to implement projects with Net Zero principles to the maximum extent practicable and fiscally prudent by:

- Reducing overall energy use, maximizing efficiency, implementing energy recovery and cogeneration opportunities, and then offsetting the remaining demand with the production of renewable energy from onsite sources, so that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.
- Reducing overall water use, regardless of the source; increasing the use of technology that uses water more efficiently; recycling and reusing water, shifting from potable water use to alternative sources as much as possible; and minimizing inter-basin transfers of any type of water, potable or non-potable, so that a Net Zero Water installation recharges as much water back into the aquifer as it withdraws.
- Reducing, reusing, recycling/composting and recovering solid waste streams, converting them to resource values, resulting in zero landfill disposal.

This report summarizes the progress to date made by the pilot installations and Army Commands; identifies best practices in energy, water, and waste management; and delineates the Army's next steps to continue advancing toward Net Zero.

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<sup>1</sup> U.S. Army. 2014. *Army Directive 2014-02 – Net Zero Installation Policy*. Washington, D.C.

## 2.0 Background

The Army Net Zero Initiative applies the principles of integrated design to ensure the Army appropriately manages its resources as mission enablers. The Net Zero strategy is one that builds on the Army's long-standing sustainable practices to manage energy, water, and waste at Army installations. Implementing Net Zero requires coordinated efforts among many levels of the Army's installation management community (Table 2.1). (See Appendix A for an overview of each organization.) The Army's Net Zero concept recognizes that more-sustainable Army installations are more resilient, compatible with local community needs, and mission capable.

**Table 2.1. Participating Net Zero Army Organizations Roles and Responsibilities**

Organization	Role in Net Zero
Office of the Assistant Secretary of the Army (Installations, Energy and Environment) (OASA (IE&E))	<ul style="list-style-type: none"> <li>• Develop the Net Zero strategy and policy.</li> <li>• Represent Army environmental and sustainability interests.</li> <li>• Provide strategic oversight and direction for Net Zero implementation.</li> </ul>
Office of the Assistant Chief of Staff for Installation Management (OACSIM)	<ul style="list-style-type: none"> <li>• Establish guidance and secure program resources.</li> <li>• Share best practices and lessons learned across Commands.</li> <li>• Report progress toward Net Zero status.</li> </ul>
Land-Holding Commands	<ul style="list-style-type: none"> <li>• Implement Net Zero practices to the maximum extent practical and with maximum fiscal prudence.</li> <li>• Work to gain local, regional, and national (where applicable) support for Net Zero goals.</li> <li>• Oversee installation performance.</li> </ul>
Installations	<ul style="list-style-type: none"> <li>• Strive toward Net Zero Energy, Water, and Waste where fiscally responsible and in support of mission accomplishment.</li> </ul>

Net Zero is one of the founding concepts within the Army's overarching Energy Security and Sustainability (ES<sup>2</sup>) Strategy.<sup>1</sup> The ES<sup>2</sup> Strategy presents a strategic roadmap for the Army to foster a more adaptable and resilient force that is prepared for a future defined by complexity, uncertainty, and rapid change. The ES<sup>2</sup> Strategy is designed to address the Army's energy and sustainability direction and establish how the Army adopts security, resiliency, and future choices as organizing approaches. The ES<sup>2</sup> Strategy expands on and replaces the 2009 Army Energy Security Implementation Strategy by including operational energy and sustainability, while strengthening the focus on resource management for Army installations.

Not only does the Net Zero Initiative help the Army meet mission-critical needs, it also helps meet Federal energy and sustainability-related mandates, including Executive Order (EO)

<sup>1</sup> U.S. Army. 2015. *Energy Security & Sustainability (ES<sup>2</sup>) Strategy*. Washington, D.C. <http://www.army.mil/e2/c/downloads/394128.pdf>.

13693<sup>1</sup>, the *Energy Policy Act of 2005*,<sup>2</sup> and the *Energy Independence and Security Act of 2007*.<sup>3</sup> EO 13693 includes requirements for Federal agencies to implement Net Zero strategies.

## 2.1 Pilot Installation Overview

In April 2011, the Office of the Assistant Secretary of the Army for Installations, Energy and Environment (OASA (IE&E)) identified 17 Net Zero pilot installations to demonstrate Net Zero strategies and concepts: six in each category of Net Zero Energy, Waste, and Water; two integrated Net Zero Energy-Water-Waste pilot installations; and one statewide Army National Guard (ARNG) Energy pilot program (Figure 1).



**Figure 1. Net Zero Pilot Installations**

The 17 pilot installations are striving to reduce the overall consumption of resources within their respective assigned categories to an effective rate of zero by FY20. The key purpose of the pilot initiatives is to serve as test beds for demonstrating Net Zero concepts and technologies and to determine the applicability of Net Zero practices across the Army Commands.

<sup>1</sup> Executive Order 13693. 2015. "Planning for Federal Sustainability in the Next Decade." 80 FR 15871–15884. *Federal Register*, The White House, Washington, D.C.

<sup>2</sup> 42 U.S.C. 15801 et seq. 2005. *Energy Policy Act of 2005*. Public Law 109-58, as amended.

<sup>3</sup> 42 U.S.C. 17001 et seq. 2007. *Energy Independence and Security Act of 2007*. Public Law 110-140, as amended.

The Army purposely identified a diverse set of pilot installations based on installation mission, size, current activities, and location to ensure that the pilot installations represented the diversity of Army installations. The pilot installations range in size (both in population and physical acreage), are geographically diverse, and include representation from all Army Commands. They also support a range of Army missions from research and testing at Kwajalein Atoll; to education at West Point; to production and manufacturing at Tobyhanna Army Depot; and to training, deployment, and sustainment of units and teams for combat at Fort Carson.

The pilot installations have and will continue to serve as model communities for sustainability and quality of life while the Army takes an even broader approach by expanding and applying the Net Zero concept Army-wide. Appendix B through Appendix D of this report provide an overview of each pilot installation's Net Zero progress in the areas of energy, water, and waste, respectively.

## 2.2 Past Net Zero Supporting Activities

The Army developed pilot-specific Net Zero Energy and Water roadmaps to evaluate the potential of reaching Net Zero Energy and Water by FY20 and described the strategy for achieving an installation's Net Zero goals. The baseline assessments evaluated the current conditions of the installation, pinpointed opportunities, and analyzed future performance.

The Net Zero Energy roadmaps identified 345,000 million British thermal units (Btu) in energy savings annually across nine Army installations. Renewable energy was also evaluated to determine the appropriate technologies each pilot installation should consider in pursuing Net Zero Energy.<sup>1</sup> The Net Zero Water roadmaps identified a total of 688 million gallons (Mgal) per year of water reduction potential from life-cycle cost (LCC)-effective water conservation measures alone. The roadmaps also investigated potential sources of alternative water.<sup>2</sup>

In addition to the roadmap support, the pilot installations and OASA (IE&E) held monthly Net Zero conference calls and two workshops to collaborate on best practices and lessons learned.

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<sup>1</sup> U.S. Army. 2014. *Army Net Zero Energy Roadmap and Program Summary Fiscal Year 2013*. Washington, D.C.

<sup>2</sup> Pacific Northwest National Laboratory. 2013. *Army Net Zero Water Balance and Roadmap Programmatic Summary*. Richland, Washington.

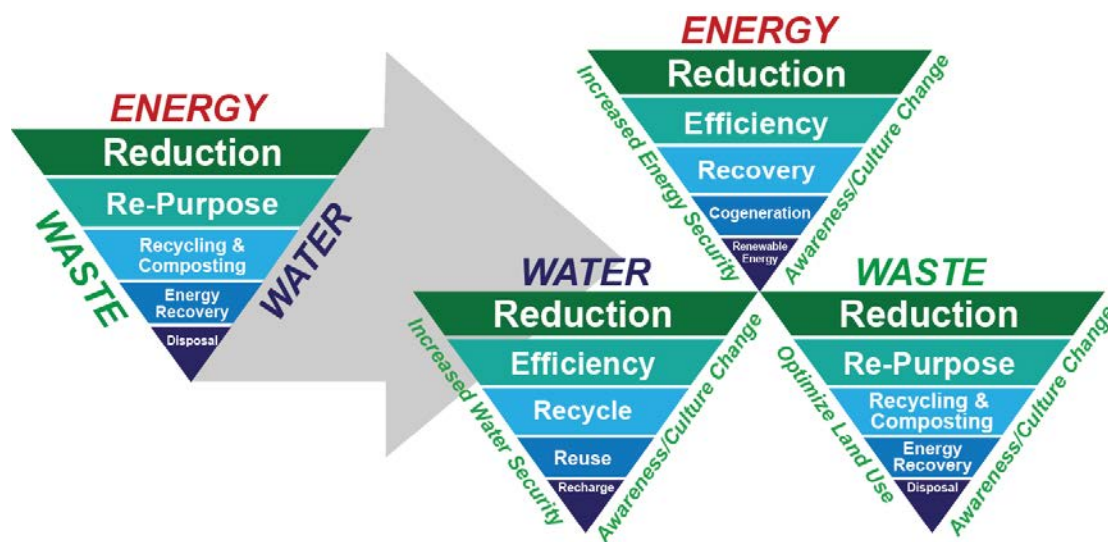
## 2.3 Net Zero Hierarchy

A key element of the Army's Net Zero Initiative is its Net Zero hierarchy, composed of five interrelated steps that vary for each of the Net Zero focus areas of energy, water, and waste.

The steps of the integrated hierarchy are as follows:

- Reduction includes conserving resources, maximizing efficiency in existing facilities, and eliminating generation of unnecessary waste.
- Re-purposing involves diverting wasted energy, water, and waste to a secondary purpose.
- Recycling and composting involves managing the solid waste stream, reusing water, and using cogeneration where one source creates two forms of energy (heat and electricity).
- Recovery involves capturing and converting waste streams into usable resources, such as converting waste to energy or reclaiming wastewater for beneficial use.
- Disposal of waste, implementation of renewable energy projects, and recharging groundwater are the last of the interrelated steps of the Net Zero hierarchy, and are to be implemented only after maximizing all other steps in the hierarchy.

The Net Zero Pilot Installation Initiative clarified the individual Net Zero Energy, Water, and Waste objectives. These resource-specific hierarchies better reflect the objectives of each Net Zero focus area (Figure 2).



**Figure 2.** Net Zero Hierarchy

The system of hierarchies depicted above provides the specific order in which actions need to be implemented. The hierarchies prioritize reduction and efficiency efforts to reduce demand first. The goal is to integrate these interrelated steps into the installation's long-term planning efforts, while also evaluating the benefits of installation management actions and projects on a number of variables, including cost-effectiveness.

## 3.0 Net Zero Actions and Activities

The Army is implementing Net Zero through collaboration, partnerships, and outreach activities. Through these actions, the Army is building a support network to help accelerate implementation across its installations.

### 3.1 Collaboration and Partnerships

The Army continues to collaborate with multiple partners to advance the Net Zero Initiative. Partners include the U.S. Environmental Protection Agency (EPA), North Atlantic Treaty Organization (NATO), U.S. General Services Administration (GSA), and the U.S. Department of Energy (DOE).

The Army established a collaborative relationship with the EPA's Office of Research and Development (ORD) under a 2011 Memorandum of Understanding. As the relationship has evolved, the Army and EPA-ORD have undertaken demonstration projects at the pilot installations and at additional Army installations. The lessons learned from each of these demonstration projects can be applied to Army installations and communities throughout the U.S. (Table 3.1).

In February 2015, the Army participated in a NATO-hosted workshop on triple-Net Zero (Energy, Water, and Waste) in Sønderborg, Denmark. The workshop focused on developing strategies to help military installations and small cities implement and integrate triple-Net Zero by leveraging Army work.

The Army also collaborated with GSA to research technologies and approaches for constructing high-performance buildings. The Fort Carson Energy Research Project—a collaboration of GSA and DOE's Pacific Northwest National Laboratory and the National Renewable Energy Laboratory (NREL)—determined that Fort Carson could (1) reduce their building energy use by 25% by optimizing building envelopes, (2) reduce lighting energy use by up to 50% by using daylighting technologies, and (3) increase overall energy-saving behavior using targeted actions, such as informational campaigns for building occupants.<sup>1</sup>

By building on the expertise obtained from outside organizations, the Army is acquiring experience with and knowledge of Net Zero technologies, methods, and systems, from advanced wastewater treatment and green infrastructure to high-performance building techniques. These collaborative efforts are equipping the Army with demonstrated technical approaches to disseminate across the Commands and bring the Army closer to achieving Net Zero.

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<sup>1</sup> U.S. General Services Administration. 2014. "GSA Helps Army Attain Net Zero Energy." Washington, D.C. <http://www.gsa.gov/portal/content/197707>.



**Table 3.1. Army Net Zero and EPA Partnership Demonstration Projects**

<b>Aberdeen Proving Ground, Maryland – Triple Value Simulation Modeling</b>	
<b>Project Description:</b> Aberdeen Proving Ground partnered with EPA to conduct a systems approach analysis to identify the interconnections among energy, water, and waste using the “Triple Value System” (3VS) model. The 3VS model characterizes the linkages between industrial, societal, and environmental systems. The project will customize the model to Aberdeen based on existing data and will use it to inform the installation about how to invest resources that include all three components of the 3VS.	<b>Anticipated Outcome:</b> The study results will provide a strategy for quantifying benefits, synergies, and trade-offs associated with a coordinated approach to achieving Net Zero Energy, Water, and Waste in a manner that improves sustainability, quality of life, and resilience to climate impacts or other disruptions. The lessons learned will be applied in other locations that need alternate methods to assess project viability.
<b>Fort Huachuca, Arizona – Organic Waste Diversion</b>	
<b>Project Description:</b> EPA-ORD, the U.S. Army Corps of Engineers Construction Engineering Research Lab, and Fort Huachuca have partnered to evaluate organic waste diversion and co-digestion and biogas generation at their wastewater treatment plant (WWTP). The project has included a feasibility study of different waste management options and demonstration of small-scale food waste diversion technologies.	<b>Anticipated Outcome:</b> This ongoing study will provide Fort Huachuca with information about the feasibility of co-digestion at their WWTP compared to other potential food diversion strategies. The project will develop a guidance document for other installations working to evaluate organic material diversion strategies and co-digestion opportunities.
<b>Fort Riley, Kansas – Containment and Control of Contaminated Wastewater</b>	
<b>Project Description:</b> Military wash racks capture large volumes of wastewater from tactical vehicles that are often contaminated with biological pollutants. Fort Riley partnered with EPA-ORD to demonstrate a mobile water treatment device for vehicle wash, called an advanced oxidation practices trailer, which treats the wastewater so it can be recycled through the system. The trailer uses ultraviolet light and ozone to inactivate and remove biological agents.	<b>Anticipated Outcome:</b> Results from this project will help advance technologies and treatment processes for vehicle wash water for improved water security. The Army can provide data to installations that are seeking methods for treating large volumes of vehicle wash water captured during an indoor or outdoor biological contamination event. This project was completed and the final report is being written.
<b>Fort Riley, Kansas – Water Reuse Technologies</b>	
<b>Project Description:</b> Working with EPA-ORD, this project is demonstrating a decentralized wastewater treatment technology using effluent mining techniques. Water quality data are sampled from a commercially available aerobic membrane bioreactor (MBR). The project uses analytic systems to monitor MBR performance and to detect and predict the poor water quality of the effluent.	<b>Anticipated Outcome:</b> Water quality data are being monitored and sampling is under way. Results from the treatment and monitoring technology assessments will inform decision-making about adopting effluent mining technologies for safe water reuse at other installations, municipalities, and/or small communities.
<b>Fort Riley, Kansas – Green Infrastructure</b>	
<b>Project Description:</b> EPA-ORD installed permeable pavers on the outer edge of a new parking lot next to an elementary school and monitored performance over time, including clogging rate, rainfall capture, and change in groundwater chemistry. The project is also monitoring the school’s existing stormwater capture-and-use system to determine the amount of rooftop runoff captured and changes in water chemistry.	<b>Anticipated Outcome:</b> This project will further the understanding of green infrastructure technologies for sustainable water resource management. The project is beginning to gather data and is also exploring ways to use green infrastructure as an educational platform.

## 3.2 Outreach, Behavior Change, and Awareness Campaign

Many sites adopted outreach and began to implement behavior change and awareness campaigns to involve all members of the Army community in contributing to Net Zero. Changes in occupant behavior can reduce costs, thereby freeing up funds for other critical mission needs. Encouraging good behavior creates habits in the workplace that carry over to the home, and fosters a sense of community among Soldiers and units. Table 3.2 provides examples of successful outreach efforts at Army installations in the areas of energy, water, and waste.

**Table 3.2.** Examples of Successful Outreach Efforts at Army Installations

### Energy

Fort Irwin, California, partnered with their local utility, Southern California Edison in FY11, on demand response. The utility asked the post to minimize power use during specific times. The installation informed personnel of each event using social media. The outcome that year, and each subsequent year, has been at least a \$52,000 billing credit and \$1.7M in avoided electricity costs. Another example is the Commander's Energy Conservation Cup competition at Detroit Arsenal, in Michigan. The competition consisted of 14 buildings tracking monthly energy consumption over a six-month period with consumption compared to the same period from the previous year. During the first six months, a total of \$72,000 was saved. The first place building saved over 17% from the previous year. U.S. Army Garrison (USAG) Benelux implemented a school awareness campaign that included student drawing contests and training for teachers on energy and water conservation, which resulted in a cost savings over one year of \$6,720.

### Water

Fort Riley, Kansas, partnered with EPA-ORD and Corvias, the Residential Communities Initiative partner, in a successful water conservation outreach program with family housing, which included smart meters that provided water data to help inform residents about reducing water use. Overall, the program showed an 8% savings in monthly water use.

### Waste

Fort Polk, Louisiana, Joint Base Lewis-McChord, Washington, and Fort Bliss, Texas/New Mexico, have created programs to influence recycling behavior. The recycling programs offered incentives that used proceeds from the sale of recyclables to fund recreational activities for Soldiers and families and to promote additional waste projects. Fort Hood, Texas, implemented an outreach program with events and activities, including school activities, recycling flash mobs, yard sales, and briefings for new Soldiers and employees. Partially as a result of the campaign, Fort Hood has seen a steady increase in solid waste diversion.

## 3.3 Army Headquarters and Command Net Zero Initiatives

The Department of the Army Headquarters (HQDA) is systematically incorporating Net Zero approaches throughout its policies and programs. The Army's policy memos for Executive Order energy and water goal attainment both address Net Zero as the end goal. The Army's sustainability design and development policy includes Net Zero Energy, Water, and Waste, and the requirement to evaluate and implement deconstruction (versus traditional demolition) where there are regional opportunities to reuse building materials. Updates to the Army's facility management regulation (AR 420-1), the Army's environmental protection regulation (AR 200-1), and the Army's food program regulation (AR 30-22) will all incorporate Net Zero approaches. The Army's sustainable procurement "Quick Guides" also incorporates Net Zero requirements.

In January 2014, Army Directive 2014-02, signed by the Secretary of the Army, directed all permanent Army installations to pursue mission-focused Net Zero strategies where fiscally prudent. As a result, the Commands are developing strategies to deploy Net Zero practices across all of their installations.

All four Army Commands launched strong communication programs focused on facilitating information exchange, identifying best practices, tracking progress, and sharing success stories and lessons learned. Commands are also focusing on resource reduction first and leveraging current funding streams, such as alternative financed projects through energy savings performance contracts (ESPCs) and utility energy service contracts (UESCs).

The Commands developed tailored programs to support the Net Zero Initiative. The Installation Management Command (IMCOM) launched a program focused on communications, including quarterly teleconferences with Net Zero pilot installations. IMCOM expanded these meetings to include all IMCOM installations, so that all installations could benefit from the experience of the pilot installations. IMCOM hosts special training events that include implementation of a building energy monitor program, preventative maintenance, and building retuning training.

The Army National Guard (ARNG) Bureau Sustainability Team hosts monthly Net Zero calls to facilitate communication and collaboration between state energy managers and other sustainability personnel across the ARNG. ARNG focused on culture change by providing training and education for energy managers. ARNG published a design guide for new construction and major renovations that includes elements for Net Zero Energy, Water, and Waste. ARNG leverages the results of comprehensive energy and water evaluations to implement energy and water projects using sustainment, restoration, and modernization funds.

The U.S. Army Reserve (USAR) built a three-tiered energy, water, and waste strategy, which included assessing 10 additional sites for Net Zero feasibility. USAR developed comprehensive Net Zero roadmaps for each location, which have become strategies to help deploy projects that incorporate Net Zero principles. The USAR performs multiple comprehensive energy and water evaluations across their regions and leverages the results to implement LCC-effective projects through existing funding streams. USAR uses advanced meter data across its inventory to better manage energy and water and improve operations. In addition, the USAR maintains a SharePoint site to track progress and best practices, and has implemented a comprehensive communications plan. Sustainability success stories are published throughout the Army using Facebook, Twitter, a blog, and a website. USAR coordinates an energy and water dashboard with field offices that monitors the progress made by sites on the key action plans tied to the Net Zero goals.

The Army Materiel Command (AMC) leadership engages in weekly reviews of their industrial programs and installation progress. During these reviews conducted throughout the year, Commanders provide briefings about their installations' energy, water, and sustainability programs. The Command is developing an energy module for the AMC New Commander's course. Successes are communicated by publishing articles in AMC and Army publications. Recently, stories about renewable energy projects at Tooele Army Depot and Sierra Army Depot were published Army-wide.

### 3.4 Accelerators and Challenges

As the Army continues to implement Net Zero principles, we have faced successes and challenges. Funding has been and can be expected to continue to be a challenge as the Army works to implement Net Zero. While we do not expect a windfall of new appropriated money or greater cost avoidance potential for Net Zero projects, we continue to be creative in using third-party financing, our people and programs, and demonstration projects.

Installations are leveraging different funding options to implement projects that incorporate Net Zero principles, including public-private partnerships such as ESPCs and UESCs. (See Appendix A for a list of the common funding types the Army uses.) These funding mechanisms have been successfully applied to many projects.

Another challenge that affects all three of the Net Zero areas is the low cost of commodities. For water and energy, the cost to purchase them is often so low that efficiency projects are not cost-effective. For waste specifically, landfill tipping fees are sometimes so low that recycling and reuse are inadvertently discouraged.

Despite these challenges, the Army is making progress toward achieving Net Zero. Commands note that increased support from Army leadership helps the Net Zero Initiative succeed. For example, the pilot installations found that the energy and water roadmaps informed their project execution by identifying the largest consumers of resources. Commands also note that Resource Efficiency Managers (REMs) help to advance strategic information, which accelerate the implementation of energy and water projects.

In the area of Net Zero Energy, the Office of Energy Initiatives (OEI) has implemented several large renewable projects that are moving some installations closer to Net Zero Energy. Installation, Commands, and the OEI continue to assess renewable energy potential at installations. The assessment includes NREL-conducted renewable energy planning and optimization studies at Army installations, and screening of sites for cost-effective renewable energy projects. Recent renewable energy projects include a large scale solar-wind hybrid project at Fort Hood that is capable of generating 65 MW of electricity. In FY15, Fort Drum commissioned a 60 MW biomass plant, allowing the installation to be energy independent. OEI assisted in developing a strategic partnership by leasing land on Schofield Barracks to Hawaii Electric for the development of a 50 MW biofuel plant. The Army will leverage the lessons learned from these projects to accelerate installation of renewables across the Army between FY16 and FY20.

In the area of Net Zero Water, the USAR developed a strategic plan to increase the use of alternative water. The strategic plan led to the initiation of a rainwater harvesting pilot project at two USAR sites, which will be used for vehicle washing to offset the use of potable freshwater. The project will serve as a test bed that may lead to similar projects across the USAR. However, measuring progress toward the Net Zero Water goals can be a challenge because no process or method is in place for collecting and reporting data on groundwater recharge.

In the area of Net Zero Waste, most installations are challenged by the low cost of landfill disposal. Thus, we expect most installations to have difficulty completely eliminating landfill

disposal. Despite these challenges, Commands are successfully using the Qualified Recycling Program (QRP) as an essential part of Net Zero Waste execution. The QRP allows installations to retain the proceeds from the sale of recyclables for use in implementing other sustainability projects.

### 3.5 Support to Energy Security, Water Security, and Land Use Optimization

Addressing energy security and sustainability is operationally necessary, financially prudent, and essential to mission accomplishment. Striving to manage Army installations on a Net Zero Energy, Water, and Waste basis is creating a culture that recognizes the value of sustainability measured not only in terms of financial benefits, but also in terms of the benefits of maintaining mission capability, quality of life, relationships with local communities, and preserving options for the Army's future. The Army's ES<sup>2</sup> Strategy establishes the foundation for the Army's security and sustainability activities, of which Net Zero is a key component.

*"If we can become more resource independent, we can become more sustainable, which means we can focus on our mission – serving and protecting this nation"<sup>1</sup>*

*Honorable Katherine Hammack*

A Net Zero Energy installation has fewer energy requirements and therefore relies less on fossil fuels and energy resources produced offsite. Energy reduction and efficiency efforts reduce vulnerabilities associated with reliance on external energy production and delivery systems. Onsite renewable energy systems can enable an installation to operate critical loads, support services, and even daily activities during grid outages or service disruptions. As we continue our aggressive energy reduction and efficiency efforts, the Army is adopting an energy security assessment methodology to ensure that energy security concerns are part of integrated energy master planning. To date, we have completed nine assessments and are working to clarify the requirements for all installations.

In 2011, the Army developed the Army Water Security Strategy, which builds a foundation for water security objectives and identifies issues that need to be addressed to ensure adequate water supplies are available. The key objective of both the Water Security Strategy and Net Zero Water is to aggressively reduce freshwater demand while offsetting the use of freshwater with alternative sources to better position installations to handle water issues such as drought or supply disruptions. For example, Fort Buchanan has reduced water demand while accessing onsite water resources, thereby reducing reliance on purchased potable water from the local municipality and making the installation more water secure in times of drought and emergency.

Reducing resource waste reduces financial cost and generates less solid waste, thereby creating a more secure operation. Net Zero Waste activities strive to reduce or avoid waste by using improved purchasing practices, re-purposing materials where feasible, and recycling or

<sup>1</sup> Ferdinando L. 2013. "Net Zero provides energy security, saves resources, protects Soldiers." ARNEWS, June 6, 2013. [http://www.army.mil/article/104959/Net\\_Zero\\_provides\\_energy\\_security\\_saves](http://www.army.mil/article/104959/Net_Zero_provides_energy_security_saves).

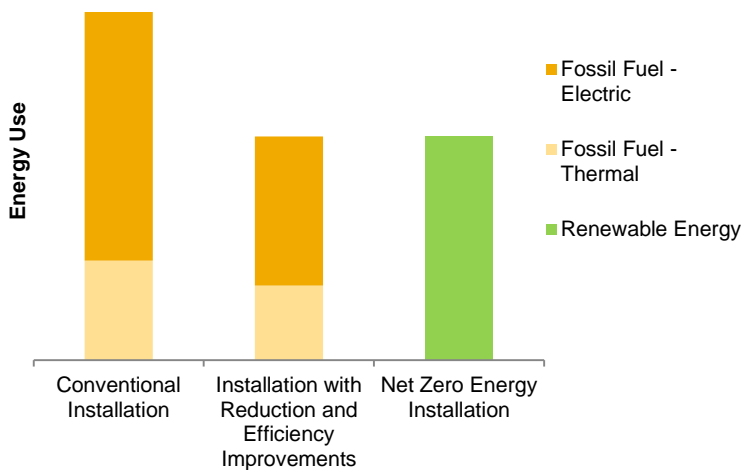
composting materials to eliminate land-based waste disposal where environmentally prudent and cost-effective. By sending less waste to landfills, Net Zero Waste efforts minimize the need to expand or replace landfills, thereby saving the land for conservation or other uses. Effective management of purchasing practices throughout the life-cycle to disposal can reduce both financial and resource waste, thereby supporting greater operational flexibility and security.



## 4.0 Net Zero Energy

Net Zero Energy builds on the Army's well established energy efficiency and sustainability practices. Since FY11, the Army has leveraged existing Federal and U.S. Department of Defense (DoD) energy programs with the goal of providing increased energy reliance and security, increasing Army operating flexibility, and exceeding minimal targets, where fiscally prudent.

Net Zero Energy installations first focus on reducing energy through conservation, followed by energy efficiency. After reducing energy use as much as possible and implementing energy efficient technologies, Net Zero Energy installations implement energy recovery and cogeneration where feasible. Lastly, these installations use onsite renewable energy sources to meet remaining energy demands.



### Net Zero Energy Definition:

An installation that reduces overall energy use, maximizes efficiency, implements energy recovery and cogeneration opportunities, and then offsets the remaining demand with the production of renewable energy from onsite sources, such that the Net Zero Energy installation produces as much renewable energy as it uses over the course of a year.

**Net Zero Energy:** This chart depicts the Net Zero Energy conceptual framework. It shows the requirement to reduce the demand for fossil fuels and offset fossil fuel use with onsite renewable energy.

Spanning all of the hierarchy steps are “Increase Energy Security” and “Awareness/Cultural Change.” The first overarching action acknowledges that no individual Net Zero Energy step alone ensures energy security, rather the Net Zero Energy hierarchy synergistically maximizes installation energy resilience. The second overarching action emphasizes the need to integrate awareness, culture change, and stakeholder buy-in across all sequenced steps of the Net Zero Energy hierarchy.

Net Zero Energy's overarching action of increasing energy security aligns the prioritized hierarchy with the Army's renewed focus on enhanced energy resiliency as reiterated in the ES<sup>2</sup> Strategy. Net Zero Energy installations are taking concerted steps to maintain continuity of operations by implementing integrated and distributed technologies and procedures to ensure

critical systems can remain operational during disruptive events. IMCOM leveraged recent campus renovations to invest in equipment that promotes both energy efficient and resilient operations. For example, recent heating and cooling equipment upgrades (e.g., replacing air-cooled with water-cooled centrifugal chillers) have included combined heat and power (CHP) capabilities that can produce electricity and thermal energy from natural gas, thus maintaining electricity service during a grid power outage.

As part of the Army's energy security efforts associated with the ES<sup>2</sup> Strategy, an Energy Security Integrated Process Team (IPT) was created to inform decision-making across diverse Army organizations. The IPT focuses on energy security for installation-critical infrastructure, bringing together leadership at all levels of the Army as well as several stakeholder organizations dedicated to information technology, finance, and facility management. The IPT's security objectives help structure an Army enterprise-wide effort that complements the Net Zero Energy successes realized at the installation level.

All four Army Commands further apply this cross-organization collaboration approach to Net Zero Energy principles by hosting regular Net Zero Energy meetings. These meetings provide a valuable opportunity to share best practices and lessons learned across pilot and non-pilot installations. They provide a forum in which program managers can disseminate important information and answer questions about a range of Net Zero Energy topics, including available funding sources (e.g., appropriations, performance-based contracting options), measurement and verification strategies, and milestone setting. These teleconference and in-person meetings facilitate targeted communication both horizontally and vertically across the Commands that are crucial to sustaining initiatives as interdisciplinary as Net Zero Energy.

## 4.1 Reduction

The Army's highest priority for Net Zero Energy is energy reduction. Reduction includes maximizing energy savings in existing facilities by implementing cost-effective energy management practices. By FY15, the Army reduced total energy use by nearly 21 trillion Btu since the baseline year of FY03. In addition, the Army saved approximately 1.5 trillion Btu of supplied energy annually just since FY11. This represents an 18% reduction in energy use intensity (EUI) (measured in 1,000 Btu/ft<sup>2</sup>). Innovative strategies and technologies currently being implemented at Net Zero Energy installations could accelerate Army-wide energy reductions even further in coming years as proven solutions are rolled out across the service.

Because dedicated funding sources are not available for the Net Zero Energy Initiative, Army Commands emphasize LCC-effective solutions when pursuing all tiers of the Net Zero Energy hierarchy. IMCOM directs its installations to implement no-cost/low-cost actions across all IMCOM installations. Strategic partnerships help all Commands cost-effectively reduce their energy consumption.

The ARNG spearheads energy reduction efforts through a variety of means, including personnel engagement. Occupant engagement initiatives and educational programs challenge commonly held perceptions that energy reduction is a hardship by demonstrating the successes at Net Zero pilot sites, such as Camp Rilea, Oregon. The Oregon ARNG's sustainability plan

documents efforts to increase the energy awareness of state and Federal stakeholders responsible for managing the organization's energy profile. The Colorado ARNG's Operation ResourceWi\$e emphasizes similar occupant engagement strategies.

USAR established an energy security strategy focuses on energy reduction as a key element in the program. USAR developed a building energy monitor program, which monitors building performance to find no and low cost improvements. AMC focuses on reducing consumption in its industrial processes and leverages partnerships with energy services and utility companies to maximize the scale of energy reductions.

## 4.2 Efficiency

Improving energy efficiency is the second highest priority in the Net Zero Energy hierarchy. No-cost/low-cost solutions that optimize performance of existing equipment (e.g., heating, ventilating, and air-conditioning [HVAC], lighting systems) as well as more capital intensive retrofit measures can greatly reduce an installation's demand profile, thereby eliminating the need for expensive, and sometimes insecure, augmentation of a site's supplied energy sources.

Once a site determines that the proposed energy conservation measures are LCC-effective, appropriated funding can be used to fund the projects that have the largest savings-to-investment ratios. Performance contracting mechanisms, such as ESPCs and UESCs, are cost-effective approaches to implementing energy and water projects because the initial capital expenditure burden is defrayed via third-party financing.

As an integrated Net Zero pilot installation, Fort Bliss credits third-party financing for the installation's \$60 million investment in a portfolio of implemented projects from FY11 through FY15. These energy efficiency projects, including an installation-wide lighting retrofit to electronic T8s with occupancy sensors, HVAC direct digital controls (DDCs), inauguration of a centralized building operations command center, and electric chiller and motor upgrades. Cumulatively, these efforts facilitated the site's 23% EUI reduction between FY11 and FY15.

The ARNG must navigate both Federal and state ownership of onsite facilities when developing a Command energy efficiency project portfolio program. Facilities that are primarily supported by Federal funds are prioritized for efficiency upgrades over those that have little or no Federal support. With most of the facilities having a Federal share and funding shortfalls from state budgets, projects are targeted based on the return on investment and whether the state can fund their share of the project. Since being designated a Net Zero Energy pilot installation in FY11, the Oregon ARNG implemented a statewide rollout of energy projects that achieved nearly 37 billion Btu in annual energy savings and \$1 million in annual cost savings. Project highlights include \$2.8 million in major lighting retrofits and compressed air projects that achieved over 1 million kWh in annual electricity savings at Camp Withycombe.

The USAR credits a UESC with funding the efficiency gains achieved at its Parks Reserve installation, including retrofitting all outdoor lighting with light-emitting diodes, upgrading the heating system in the barracks to reduce natural gas usage, and installing building automation system DDCs.

AMC has a successful third-party financing program that ensures incorporation of Net Zero principles in installation ESPC and UESC projects. For example, AMC implemented a comprehensive ESPC at Fort Letterkenny Army Depot that included a major refurbishment of industrial processes, thereby achieving a 25% reduction in site energy use. AMC also seeks to bundle energy measures with planned infrastructure improvements to maximize efficiency project returns on investment. Such efforts at Sierra Army Depot enabled completion of 16 energy efficiency projects between FY11 and FY15. Implemented measures include improved building insulation and high-efficiency HVAC upgrades. Through building sub-metering, the garrison optimized rollout of these efficiency technologies to the highest onsite energy users. Post-implementation sub-metering indicates approximately 8% annual electricity savings at several shop facilities.

### 4.3 Recovery

Energy is recovered from energy waste streams, such as exhaust air, condenser heat, cascading return hot water, or chilled water streams. Boiler stacks and wastewater sources that have a thermal gradient are other energy recovery applications that installations can pursue.

Recovery projects are site-specific and require case-by-case investigation. In addition, the opportunities are not widespread, which limits implementation of recovery projects. The Oregon ARNG recovers heat from paint booths, and the Michigan ARNG captures natural gas from orphan/abandoned wells to heat buildings and to power backup generation units. Other installations are investigating recovery opportunities that may be implemented in the future. For instance, Fort Detrick investigated the possibility of recovering their incinerator stack heat/steam as usable energy instead of releasing this valuable byproduct into the atmosphere.

### 4.4 Cogeneration

While generally capital intensive, cogeneration applications (e.g., CHP) enable installations to simultaneously produce and effectively use electricity and heat (i.e., thermal energy). Net Zero Energy installations should investigate cogeneration opportunities when they need centralized heat or power, especially large year-round heat loads.

Kwajalein Atoll, which currently generates all power used onsite from diesel generators, investigated highly efficient cogeneration alternatives, including a prototype solid-state thermoelectric generator to replace deteriorating diesel generator engines. Aberdeen Proving Ground converted their steam generator into a CHP cogeneration plant, thereby avoiding \$4.4 million per year in electricity costs.

### 4.5 Renewable Energy

The Net Zero Energy hierarchy acknowledges that, in most situations, the preceding four strategies (i.e., reduction, efficiency, recovery, and cogeneration) will not completely satisfy a given installation's load profile. Any remaining demand is met through the onsite generation of

energy from renewable sources (e.g., solar photovoltaics [PV], wind turbines, biomass, hydroelectric, and geothermal).

Within the last five years, the Army greatly expanded its onsite renewable energy portfolio. Between FY11 and FY15, total renewable energy generated on Army installations increased an order of magnitude, rising to 174 MW in FY15. The share of the Army's energy consumption derived from renewable energy sources commensurately increased, rising to nearly 2% of total consumption by FY15.

The most commonly deployed renewable energy technology is solar PV; all nine Net Zero Energy pilot installations use solar PV to help meet their Net Zero goals. Fort Hunter Liggett installed over 3 MW of PV and plans to install another 5 MW. Camp Parks installed 2 MW of PV and plans to install another 2 MW. Both installations plan to use batteries to store excess energy during daylight hours for use overnight. This allows them to maximize the savings from and security of solar generation.

Installations are also implementing small-scale and building-integrated technologies, such as solar water heating, ground source heat pumps, and solar lighting. ARNG installed 72 small-scale renewable energy projects in FY14. In areas where biomass resources are abundant, including Oregon and Michigan, the ARNG is implementing projects to replace thermal energy now produced from propane.

Innovative renewable energy projects being investigated and implemented include geothermal cogeneration, electricity production from a desalination project, wave energy, wind funnels, and hybrid solar. Many of these projects are using the DoD Environmental Security Technology Certification Program (ESTCP) or other methods to test new technologies. (See Appendix A for information about ESTCP.)

In some locations, low energy costs and limited real estate pose a challenge for renewable energy implementation. Fort Carson solved this by identifying a consolidated site for PV, requiring a single environmental assessment for multiple projects, and reducing operations and maintenance costs. Fort Detrick combines renewable energy and building space requirements to assess the best use of land and energy sources; such assessment is especially valuable for installations near metropolitan areas where real estate is limited and expensive.

Overall, Army Commands and installations are implementing the Net Zero Energy hierarchy by prioritizing activities that first reduce energy consumption, subsequently improve installation energy efficiency, and ultimately develop onsite, LCC-effective renewable energy projects that will meet their remaining site energy demand. The Army has made substantial progress toward meeting Net Zero Energy objectives by FY20, with the potential for Fort Hunter Liggett to reach true Net Zero Energy at an earlier date. Camp Parks has already identified their strategy to meet 85% of the way to Net Zero Energy by FY20.

## 4.6 Net Zero Energy Pilot Installation Progress

Energy data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table 4.1:

- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded the Federal energy reduction goal and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Energy by FY20, generating as much renewable energy as consumed
- **Significant progress** - This classification distinguishes sites that have:
  - Exceeded the Federal energy reduction goal and/or made significant progress since being a selected pilot in FY11
  - Made progress towards renewable energy generation but are not projected to generate enough renewable energy to be near Net Zero Energy by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in energy reduction and renewable energy generation

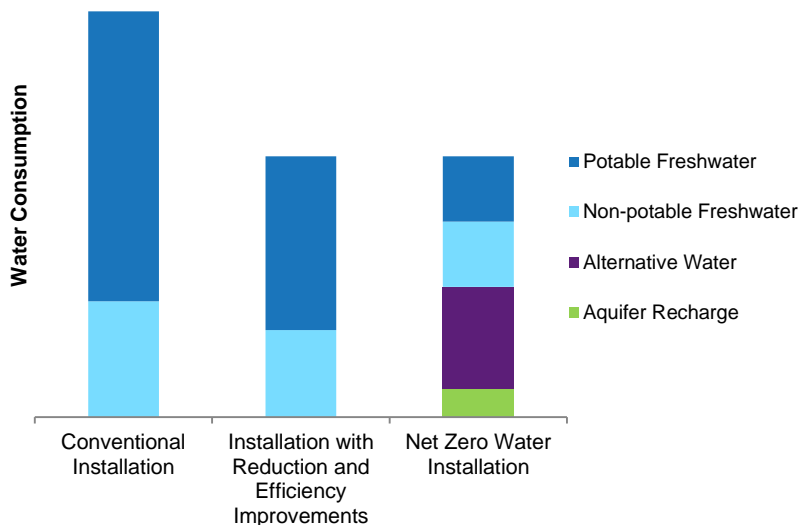
**Table 4.1. Net Zero Energy Pilot Installation Progress Status**

Installation	Net Zero Energy Progress
Fort Hunter Liggett	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Carson	Significant progress
Fort Detrick	Significant progress
Parks Reserve	Significant progress
Sierra Army Depot	Significant progress
Kwajalein Atoll	Minimal progress
Oregon National Guard	Minimal progress
West Point	Minimal progress



## 5.0 Net Zero Water

The Army's Net Zero Water hierarchy follows the same overall hierarchy as Net Zero Energy. A Net Zero Water installation's highest priority is reducing freshwater demand, followed by improving efficiency by implementing water-efficient technologies and practices. Next, Net Zero Water installations maximize alternative water use through recycling and reuse to reduce the demand on freshwater sources, thereby preserving these surface or groundwater sources for future use. The final step in the hierarchy is focused on recharging water back to the original water source.



**Net Zero Water Definition:**  
An installation that reduces overall water use, regardless of the source; increases efficiency of water equipment; recycles and reuses water, shifting from potable water use to alternative sources as much as possible; and minimizes 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.

**Net Zero Water:** This chart depicts the Net Zero Water conceptual framework. It shows the requirement to reduce the demand for freshwater while offsetting its use with an equivalent amount of alternative water use and aquifer recharging.

The overarching objectives of Net Zero Water are “Increased Water Security” and “Awareness/Cultural Change.” Net Zero Water balances water availability and use to preserve a sustainable water supply for years to come, which better positions installations to handle water supply disruptions, thereby creating a more secure operation. This concept is of increasing importance because water scarcity is a serious issue in many parts of the U.S. and around the globe. Net Zero Water also emphasizes the need to integrate awareness and culture change to ensure successful projects.

IMCOM's program is focused on water reduction and leveraging ESPCs and UESCs to finance projects. IMCOM holds quarterly water conference calls that feature a special topic or best practice to be shared with all IMCOM installations.

The ARNG Net Zero Water strategy focuses on collaborating with its states via monthly Net Zero calls with sustainability personnel across the ARNG. ARNG also focuses on culture change through training and education for energy managers on water topics.

The USAR has a robust Net Zero Water program that includes bi-monthly calls, which include training and sharing of best practices. A Command-level dashboard tracks progress. The USAR performs comprehensive energy and water evaluations across their regions that emphasize water efficiency and evaluation results are used to implement LCC-effective water efficiency measures.

AMC also holds quarterly conference calls to share lessons learned and best practices and to identify specific water issues. AMC uses third-party financing to deploy water efficiency at their installations and also deploys leak detection technology to reduce overall water losses.

## 5.1 Reduction

As of FY15, the Army reduced potable water use by nearly 10 billion gallons since the baseline year of FY07. This represents a 21% reduction in potable water use intensity (WUI; measured in gallons per square foot). The Army also reduced the use of industrial, landscaping, and agricultural (ILA) water, totaling over 1 billion gallons in ILA water savings in FY15, a 21% reduction compared to the FY13 baseline. These efforts show the Army's commitment to exceeding established goals and moving toward Net Zero Water.

The first step in the Net Zero Water hierarchy is to reduce water use from all freshwater sources. By reducing freshwater demand, an installation will require less alternative water to offset freshwater consumption. This step focuses on reducing water use through conservation (e.g., scaling back landscape irrigation during drought).

IMCOM made water reduction the priority of their Net Zero program. IMCOM has dedicated energy managers with the formal responsibility for water management at installations to expedite project implementation. These energy managers receive specific training in water management. ARNG focuses on water reduction through training/education and communications. USAR leveraged work from their energy program and developed a water security strategy. The strategy's cornerstone is reducing water demand through their building energy monitor program and water reduction checklist, which targets specific operational improvements. AMC focuses on infrastructure upgrades and leak detection and repair projects, which significantly reduce water use.

Fort Bliss provides a great example of focusing on water reduction. Fort Bliss created a design guide that includes a provision to convert turf grass into desert landscaping across the installation. By using grass-to-desert landscaping, Fort Bliss reduced the irrigation area of their grounds and is significantly curbing their future water needs—a milestone toward meeting the installation's Net Zero Water goals.

## 5.2 Efficiency

Increasing water efficiency is the second highest priority for Net Zero Water installations. Water efficiency refers to equipment and processes that overall use less water for the same function. The USAR built an impressive program for identifying water efficiency projects by conducting comprehensive water evaluations across many of their sites. Projects identified through the evaluations are directly funneled into the USAR five-year budget cycle to be funded. IMCOM and AMC found that implementing water efficiency projects through alternatively financed projects, such as ESPCs, has been key to their success. The Army is also using the DoD's Strategic Environmental Research and Development Program (SERDP) as a test bed for innovative water technologies, such as advanced water treatment. (See Appendix A for information about SERDP.)

Fort Carson is particularly successful at implementing water efficiency projects. Using their existing ESPC program, Fort Carson retrofitted nearly 200 buildings with high-efficiency plumbing fixtures. The installation also implemented an advanced irrigation control system that uses weather data to optimize the irrigation schedule. In addition, Fort Carson leveraged their ESPC to implement water efficiency projects across the garrison, including high-efficiency plumbing fixtures and commercial kitchen equipment. In FY15, Fort Carson reduced water consumption by 208 Mgal compared to FY11, achieving a 47% reduction in WUI.

## 5.3 Recycle and Reuse

The third and fourth tiers of the Army's Net Zero Water hierarchy are water recycling and reuse. Water recycling and reuse refer to using water streams multiple times either by cycling water through the same process more than once or by reusing discharge water from processes in other applications.

An example of water recycling is a closed-loop vehicle wash facility, which stores the discharge water from the wash cycle for use in the next cycle. Fort Bliss, Fort Carson, and Fort Riley recycle water in tactical vehicle wash facilities, where water is cycled through the system multiple times. An example of water reuse is to reclaim wastewater treated in a WWTP for landscape irrigation. An inclusive term that encapsulates water recycling and reuse is alternative water. Obtaining alternative water sources is critical to Net Zero Water. Alternative water allows a site to work toward the ultimate Net Zero Water goal, which is to completely offset the use of freshwater supply. In FY15, installations used approximately 850 Mgal of alternative water.

### **Alternative Water Definition:**

*Alternative water is supplied from sustainable sources not derived from fresh surface or groundwater sources. Alternative water sources include harvested rainwater, reclaimed wastewater, gray water, captured condensate, and reused process discharge water.*

Fort Buchanan, Fort Riley, and Joint Base Lewis-McChord installed rainwater harvesting systems as part of their Net Zero Water objectives. Fort Carson reclaims water from their onsite WWTP. Fort Carson expanded their reclaimed plant in FY14 and is planning further expansion using their existing ESPC.

Camp Rilea also reclaims onsite wastewater for landscape irrigation. Tobyhanna Army Depot reclaims onsite wastewater for their plant processes. Plans for future alternative water projects at pilot installations include onsite wastewater reclamation at Fort Buchanan, reclaimed water and rainwater harvesting at Aberdeen Proving Ground, and expansion of Tobyhanna Army Depot's reclamation plant for industrial uses.

## 5.4 Recharge

The lowest tier in the Net Zero Water hierarchy is to recharge water back to the original water source with the intent of completely offsetting the use of freshwater. Installations can accomplish recharge through green infrastructure and low-impact development, whereby stormwater is retained onsite and infiltrated into local groundwater. Infiltration basins can directly infiltrate treated wastewater or stormwater into groundwater.

Camp Rilea installed rapid infiltration basins that recharge their groundwater with treated wastewater. Fort Riley is partnering with EPA to demonstrate a permeable pavement project at a local school, which infiltrates stormwater through the pavers to recharge their groundwater. As part of the project, EPA is measuring elements such as infiltration rate and groundwater chemistry. Tobyhanna Army Depot's Net Zero Water efforts include discharging treated wastewater to their local waterway to recharge their groundwater.

The progressive actions taken by Army Commands to reduce water use and improve efficiency, and then use onsite sources of alternative water and recharge local watersheds, show the Army's commitment to sustainable water management. Camp Rilea serves as a great success story in that the site recharges as much water into their groundwater as they withdraw, while also reducing water demand. As installations move forward with this step of the Net Zero Water hierarchy, they can use innovative approaches such as collaborating with water utilities to store water in groundwater supplies, which allows utilities to tap additional resources during times of water shortages.

## 5.5 Net Zero Water Pilot Installation Progress

Water data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table 5.1:

- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded Federal water reduction goals and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Water by FY20, completely offsetting freshwater supply with alternative water and/or groundwater recharge
- **Significant progress** - This classification distinguishes sites that have:

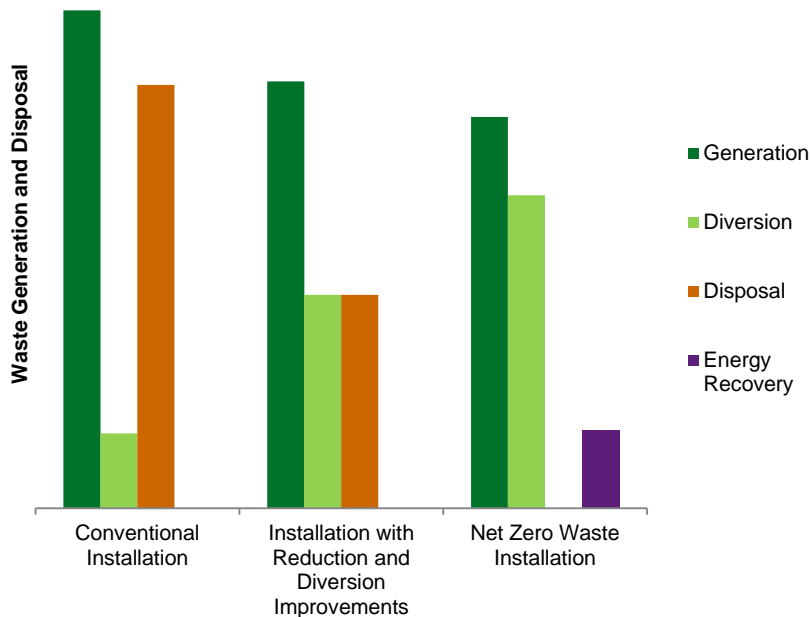
- Exceeded Federal water reduction goals and/or made significant progress since being a selected pilot in FY11
- Made progress towards alternative water production and/or groundwater recharge but are not projected to be near Net Zero Water by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in water reduction and alternative water production/groundwater recharge

**Table 5.1. Net Zero Water Pilot Installation Progress Status**

Installation	Net Zero Water Progress
Camp Rilea	Projected to meet Net Zero
Tobyhanna Army Depot	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Buchanan	Significant progress
Fort Carson	Significant progress
Joint Base Lewis-McChord	Significant progress
Aberdeen Proving Ground	Minimal progress
Fort Riley	Minimal progress

## 6.0 Net Zero Waste

A Net Zero Waste installation reduces, reuses, and recovers waste streams, and converts them to resource values, which results in zero solid waste being sent to a landfill. Net Zero Waste follows the same conceptual hierarchy as Net Zero Energy and Water. The top of the hierarchy represents the most effective strategy, which should be the installation's primary focus, and the installation should only dispose of waste after considering all preceding tiers. Disposal is to be effectively Net Zero or minimized to the greatest extent.



### Net Zero Waste Definition:

An installation that reduces, reuses, recycles/composts, and recovers solid waste streams, converting them to resource values, resulting in zero landfill disposal.

**Net Zero Waste:** This chart depicts the Net Zero Waste conceptual framework. It shows the requirement to reduce waste generation, increase diversion, and recover waste streams to eliminate the need for disposal.

Spanning all of the hierarchy steps are “Optimized Land Use” and “Awareness/Cultural Change.” The first overarching action eliminates land-based waste disposal where environmentally prudent and cost-effective. This results in the Army’s ability to optimize land use to meet mission requirements. Awareness/Cultural Change is the second cross-cutting approach, whereby the site implements a proactive outreach campaign.

The Army is committed to achieving the waste diversion goals set forth in the DoD Strategic Sustainability Performance Plan (SSPP) and, where fiscally prudent, striving to achieve Net Zero Waste. The Army tracks progress toward these goals and annually reports its Army-wide



diversion rates to the Office of the Secretary of Defense for the DoD SSPP. For FY15, the Army reported an overall diversion rate of 51% for nonhazardous solid waste and 77% for construction and demolition (C&D) waste, thereby meeting both of the DoD goals.

IMCOM's Net Zero Waste focus is on increasing the attention and visibility of installation leadership to the importance of effective management of waste resources, and increasing collaboration between Net Zero pilot installations and other installations through IMCOM quarterly meetings. IMCOM is also targeting organic waste, which is a significant portion of their waste stream.

Although the ARNG does not have a Net Zero Waste pilot installation, they have been implementing changes to increase waste diversion across their states. Twenty-two ARNG states now have QRPs. The Indiana ARNG incorporated language requirements for recycling of 50% nonhazardous solid waste and 60% of C&D waste into construction contracts.

In addition to supporting its Net Zero Waste pilot site Fort Hunter Liggett, the USAR collects recycling data from installations and regions to better track recycling progress. USAR also holds bi-monthly waste meetings with its waste managers to discuss issues and paths forward for the waste and recycling programs at each installation and region. The USAR established a goal for 10 pilot Net Zero Reserve Centers to pursue Net Zero elements including waste, where viable; they conducted site assessments and developed Net Zero roadmaps for each pilot Reserve Center, and are providing continual support at each site to implement changes.

AMC is progressing toward Net Zero Waste at its installations. Several installations have QRPs and very high diversion rates, mainly due to the weight and high recycle value of scrap metal. Sierra Army Depot achieved a 95% solid waste diversion rate in FY15 by recycling over 5,200 tons of steel and wood. Lake City Army Ammunition Plant achieved a 93% diversion rate in FY15 by recycling more than 24,800 tons of brass, steel, and metals. Red River Army Depot recycled nearly 12,000 tons of steel helping them reach a diversion rate of 82%.

## 6.1 Reduction

The most efficient way to keep waste out of landfills is to eliminate products or materials that become waste. The reduction strategy starts with improved purchasing practices, which include actions such as optimizing quantities, eliminating unnecessary packaging, leveraging "take back" options, and using bulk dispensing instead of individual packets. Bringing only essential materials onsite helps avoid waste. When a product or material cannot be avoided altogether, reducing its environmental impact by buying alternatives with recycled content that also can be recyclable or compostable materials helps with diversion later in the waste strategies.

Army installations are implementing sustainable procurement policies and are partnering with other Commands to ensure all contracts include sustainable practices. Waste reduction policies establish central supply points, passing ordinances on paperless processing, reducing printing and/or using double-sided printing, conducting a junk mail opt out marketing campaign, providing education on food waste reduction at dining facilities and education on bulk purchasing, and phasing out Styrofoam in dining facilities. Fort Hood installed water bottle refill stations to reduce the purchase of plastic water bottles.

## 6.2 Re-purpose

Once a material arrives at an installation, it should be used for its intended purpose for as long as possible. When items are no longer needed by the original purchaser, they can be reissued for use by other Army organizations (e.g., pallets, furniture). When that is no longer feasible, the material should be considered for other potential purposes that can be achieved with minimal modification. Re-purposing or reusing products and materials that would have been considered waste allows the complete value of the goods to be retained and reduces the need to purchase new items. The re-purposing strategy is second on the Net Zero Waste hierarchy because it supports the reduction philosophy of limiting what needs to be purchased and therefore disposed.

Installations such as Fort Polk have established “re-stores” with excess or reclaimed office and packaging material that allow usable items no longer needed by the original users to be reissued to others, thereby significantly reducing the amount of waste and consumption of material. Wooden pallets are a ubiquitous item at most Army installations worldwide that would have previously ended up in landfills. Where possible, usable pallets are reused or issued to other Army organizations for use. Most Army installations are shredding broken wooden pallets and using them as ground cover.

Deconstruction also allows materials to be reused to the greatest extent and aids in recycling efforts. Fort Carson, Joint Base Lewis-McChord, and Fort Leonard Wood are pursuing deconstruction opportunities (versus traditional demolition) where feasible and cost-effective to increase reuse of building materials.

## 6.3 Recycling and Composting

Once an item can no longer be used for its intended purpose, recycling allows it to be used as raw materials to make other items. Composting is considered recycling of organic waste because the organic matter is degraded to produce mulch or soil conditioner. Although recycling and composting are primary strategies for waste diversion, they are not higher in the Net Zero Waste hierarchy because they require energy and resources to process the materials, which make them much less cost-effective.

Army installations are systematically increasing internal rates of recycling. One example is Fort Carson, which issued a new solid waste management contract that requires their contractor to recycle a percentage of everything picked up. Additionally, Fort Carson waste managers included a clause in their contract stating that this percentage would grow over time, which encouraged the waste company to implement additional recycling.

Army pilot installations are using waste characterization studies and recycling assessments to identify target waste streams that could be recycled. Fort Polk is conducting building-level recycling assessments to ensure that organizations have the knowledge and resources to succeed in their recycling programs and to provide guidance on establishing best management practices within their facilities. Fort Bliss conducted waste characterization studies that resulted in the pursuit of wood and food waste solutions.

The Net Zero Waste pilot installations continue to attribute their diversion success to their strong QRPs. Fort Hunter Liggett launched a QRP in 2014, built the program in two years, and made their first sale of more than 500 tons of commodities in FY15.

Army installations have increased their composting efforts as well. Beyond nearly universally mulching lawn clippings, installations target a variety of organic wastes, including food waste, tree debris, wood chips, yard waste, and horse stable waste. At Fort Detrick, a new waste management contract led to sewage sludge being diverted to a composting facility, which significantly supported the post's progress toward the Net Zero goal. Fort Carson also sends their waste treatment biosolids to an offsite composting facility.

Army pilot installations are investigating the potential for food waste composting. Fort Hood is implementing a food waste composting pilot with nine food facilities. The pilot helped Fort Hood identify that it generates 12 tons of food waste weekly. Joint Base Lewis-McChord composted 3,278 tons of putrescible organic waste in FY15; nearly one-third of that amount came from food waste from dining facilities and commissaries.

## 6.4 Energy Recovery

Waste that cannot be feasibly reduced, re-purposed, recycled, or composted may be a candidate for disposal via waste-to-energy (WTE) technologies to minimize waste volume and capture energy for other uses. Energy recovery is near the bottom of the Net Zero hierarchy because it requires energy and resources for processing and only retains the material's thermodynamic value. WTE should only be implemented after all the higher tiers of the Net Zero Waste hierarchy have been implemented to their fullest.

Two pilot installations currently have access to a WTE facility: USAG Grafenwoehr uses a community WTE facility and Fort Detrick operates incinerators that are equipped with waste heat boilers that produce steam for use on-post. However, several other installations are working toward energy recovery. Through an ESTCP, Fort Hunter Liggett is installing a WTE gasification system that will produce a syngas from waste; full operation of the system is expected in FY17. Joint Base Lewis-McChord is working to modify solid waste contracts to allow the transfer of waste to a regional anaerobic digester facility that is under construction.

## 6.5 Disposal

Disposal refers to sending waste to a landfill (on- or off-post) for final disposition. The goal for Net Zero Waste installations is to implement all of the higher tiers in the hierarchy and to minimize waste disposal to the greatest extent possible. As the actions on the Net Zero Waste hierarchy are implemented, the volume of solid waste disposed in landfills will significantly decrease.

All Army installations are working to reduce the total volume of waste disposed in landfills. Three of the Net Zero Waste pilot installations currently operate on-post solid waste landfills (Fort Bliss, Fort Detrick, and Fort Hood) and the other five use off-post facilities.

Fort Detrick eliminated almost all of the material going to their landfill. By redirecting their waste treatment sludge from the landfill to an off-post composting facility, they greatly reduced the necessity for landfill cover and mix materials. Fort Bliss projects that they will be disposing only 23% of their waste by FY20, which puts them on the path to Net Zero Waste. Currently, the only material that Fort Detrick disposes in their landfill is the ash from their on-post WTE facility, which operates at 95% efficiency to significantly reduce the amount of ash being landfilled. The installation plans to increase the incinerator efficiency by installing a new control system to further increase landfill diversion.

USAG Grafenwoehr also effectively produces zero landfill. German law prohibits the use of landfills for untreated waste and provides community diversion infrastructure and WTE. The exception is road debris, which cannot be recycled and must be landfilled in a special waste disposal site. Therefore, USAG Grafenwoehr will only be landfilling materials that by law are required to go to the special waste disposal sites.

Army Commands are reducing waste generation and increasing recycling and re-purposing. These efforts move installations closer to zero landfill disposal and underscore the fact that the Net Zero hierarchy can result in significant progress toward Net Zero Waste. Nearly all of the pilot installations exceeded the 50% DoD waste diversion goal in FY15 and expect to continue increasing their diversion through FY20.

## 6.6 Net Zero Waste Pilot Installation Progress

Waste data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table 6.1:

- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded the Federal waste diversion goal and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Waste by FY20, eliminating landfill disposal
- **Significant progress** - This classification distinguishes sites that have:
  - Exceeded the Federal waste diversion goal and/or made significant progress since being a selected pilot in FY11
  - Made progress towards zero landfill disposal but are not projected to be near Net Zero Waste by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in waste diversion and landfill elimination

**Table 6.1. Net Zero Waste Pilot Installation Progress Status**

Installation	Net Zero Waste Progress
Fort Detrick	Projected to meet Net Zero
USAG Grafenwoehr	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Carson	Significant progress
Fort Hood	Significant progress
Fort Polk	Significant progress
Joint Base Lewis-McChord	Significant progress
Fort Hunter Liggett	Minimal progress

## 7.0 Net Zero Integration

Integrating Net Zero into the Army's operations and planning processes is a force multiplier that enables the Army to take a holistic approach to installation management. Commands and installations are also integrating Net Zero across energy, water, and waste. Their efforts highlight sustainable facilities and resource management, as well as synergies that illustrate how reducing the use of one resource can help save others.

IMCOM capitalizes on synergies between water, energy, and waste savings. Joint Base Lewis-McChord is using reclaimed water pumped underground as a geothermal source for heating tactical equipment maintenance facilities—reducing the potable water bill and heating costs. Many IMCOM installations, such as Fort Riley, Fort Carson, and Fort Buchanan, have implemented high-efficiency showerheads and faucets that not only save water, but also reduce the amount of energy required to heat the water.

Fort Bliss is using the savings and revenues from their QRP to fund native landscaping at their golf course—replacing turf areas with drought-tolerant landscaping. Once implemented, the waste reduction efforts at Fort Bliss will reduce water use and showcase how installations use additional finance streams to support multiple Net Zero efforts. Fort Detrick combines renewable energy and building space requirements to assess the best use of land and energy sources, which is especially valuable for installations near metropolitan areas where real estate is limited and expensive.

The Army National Guard Bureau "Sustainability Team" integrated communications across energy, water, and waste to collaborate with sustainability managers in all three areas as part of their Net Zero Initiative. This program includes working groups to address challenges and share best practices among the readiness centers. ARNG also published a design guide for new construction that encompasses a holistic approach to new building construction that covers energy, water, and waste.

The USAR's Sustainability Branch created a Net Zero Energy, Water, and Waste Initiative that leverages information across all three areas. USAR uses an energy dashboard to monitor progress across their regions and installations, and replicated the dashboard for their Net Zero Water and Waste programs. The USAR also conducted comprehensive energy, water, and waste evaluations at multiple facilities and leveraged the results to develop a project list with the potential for achieving large energy, water, and waste reductions across the Command.

AMC made great strides in finding synergies at individual installations. AMC evaluated measures that reduce both water and energy consumption through their ESPCs. Reducing the process water needed for the Radford Army Ammunition Plant and Holston Army Ammunition Plant decreased electricity use by the electrical water pumps. While water was previously seen as a nearly free resource at these AMC installations, the reduced electricity use led to a better understanding of the cost benefit of water reduction.



## 8.0 Conclusion and Path Forward

From FY11 through FY15, the Army has established a framework for Net Zero by:

- Defining Net Zero
- Piloting Net Zero concepts at 17 installations
- Developing roadmaps that map pathways to Net Zero
- Assigning responsibilities to the Commands
- Communicating best practices and lessons learned
- Assessing interim progress.

By taking these steps, the Army developed an overarching strategy to guide installations striving toward Net Zero. Net Zero Energy pilot installations exemplifying Net Zero principles include the Oregon ARNG, Fort Hunter Liggett, and Camp Parks. These installations have reduced energy use and aggressively pursued renewable energy generation. Fort Hunter Liggett projects that renewable energy generation will offset all energy consumption by FY20. Successes at Net Zero Water pilot installations include those at Fort Carson and Fort Buchanan. Both installations are capitalizing on alternative water sources through wastewater reclamation and rainwater harvesting to offset the use of potable water. Fort Carson projects that by FY20 the installation will offset more than 50% of its potable water with reclaimed wastewater. For Net Zero Waste pilot installations, Fort Bliss, Fort Polk, and Fort Hunter Liggett have significantly increased their respective municipal solid waste diversion rates from FY11 to FY15, and the collective diversion rate for all eight Net Zero Waste pilot installations has reached 58% (compared to the DoD goal of 50%).

Appendices B through D provide an overview of each Net Zero Energy, Water, and Waste pilot installation's progress toward meeting Net Zero objectives, focusing on progress starting in FY11. Each installation's overview contains information provided directly from the installation about their Net Zero initiatives. The overviews include consumption data, highlights of the installation's projects, and progress toward Net Zero. Appendix E provides information about Net Zero efforts at other Army installations that were not a part of the original pilot initiative.

Moving forward, the Army will pursue Net Zero by leveraging the lessons learned and best practices garnered from the pilot installations to facilitate project execution across the Army. We will continue to support the Net Zero Initiative by:

- Continuing to provide Army leadership support and direction
- Furthering development of energy and water security as it relates to Net Zero, and integrating a holistic approach that incorporates energy, water, and land planning into mission security
- Developing a validation method for determining when an installation achieves Net Zero
- Continuing to incorporate Net Zero approaches in Army policy and guidance.

We will also support Net Zero goals by integrating Net Zero principles into existing programs. Specifically, the Army will do the following:

- Disseminate best practices and standards for technologies across the Army Commands that ensure successful projects are cross-cutting.
- Include Net Zero approaches in existing Army installation management training to build a knowledge base at the installation level that will be used to execute projects.
- Use REMs to facilitate project implementation.
- Leverage funding through demonstration programs (e.g., SERDP and ESTCP) to evaluate innovative technologies.
- Use third-party financing (e.g., ESPCs and UESCs) to implement energy and water projects, and ensure these funding mechanisms are incorporating innovative technologies.
- Collaborate with OEI when developing renewable energy projects. OEI offers guidance on how sites can better navigate the host of regulatory barriers that can often impede renewable energy project planning and implementation.
- Investigate a standard method for Commands to value water, which will include non-market elements, such as eco-system impact and future risk due to climate change. These considerations will provide the true cost of water in LCC analyses.
- Perform leak detection surveys and distribution system condition assessments to reduce water losses and build strategies for alternative water project deployment.
- Modify service contracts to include elements of sustainable procurement and add requirements for material diversion and tonnage reporting in waste management contracts.
- Use the QRP to provide funds for implementing waste avoidance and recycling/composting efforts.

These steps will help us continue to improve and build on the current Net Zero framework. Overall, the Army is a leader in Net Zero, based on the founding idea that sustainable Army communities are more resilient, compatible with local community needs, and mission capable.

## Appendix A

### Acronyms and Overview Information

#### A.1 Acronyms and Abbreviations

3VS	Triple Value System
AEMR	Army Energy Management Report
AEWRS	Army Energy and Water Reporting System
AMC	Army Materiel Command
ARNG	Army National Guard
Btu	British thermal unit(s)
C&D	construction and demolition
CERL	Construction Engineering Research Laboratory
CHP	combined heat and power
DDC	direct digital control
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
EA	environmental assessment
ECIP	Energy Conservation Investment Program
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ES <sup>2</sup>	Energy Security and Sustainability
ESPC	energy savings performance contract
ESTCP	Environmental Security Technology Certification Program
EUI	energy use intensity
ft <sup>2</sup>	square foot (feet)
FY	fiscal year
GSA	U.S. General Services Administration
GSF	gross square foot
HQDA	Department of the Army Headquarters
HVAC	heating, ventilating, and air-conditioning
ILA	industrial, landscaping, and agricultural
IMCOM	Installation Management Command
IPT	Integrated Process Team
JBLM	Joint Base Lewis-McChord
kBtu	thousand British thermal units
KSF	thousand square feet

LCC	life-cycle cost
LED	light-emitting diode
MBR	membrane bioreactor
Mgal	million gallons
MICC	Mission and Installation Contracting Command
MILCON	military construction
MMBtu	million British thermal units
MSW	municipal solid waste
MW	megawatt
MWh	megawatt-hour
NATO	North Atlantic Treaty Organization
NREL	National Renewable Energy Laboratory
O&M	operations and maintenance
OACSIM	Office of the Assistant Chief of Staff for Installation Management
OASA (IE&E)	Office of the Assistant Secretary of the Army for Installations, Energy and Environment
OEI	Office of Energy Initiatives
ORD	Office of Research and Development
OSD	Office of the Secretary of Defense
PG&E	Pacific Gas and Electric Company
PV	photovoltaics
QRP	Qualified Recycling Program
REM	Resource Efficiency Manager
SERDP	Strategic Environmental Research and Development Program
SIR	savings-to-investment ratio
SSPP	Strategic Sustainability Performance Plan
SWARWeb	Solid Waste Annual Reporting Website
UESC	utility energy service contract
USACE	U.S. Army Corps of Engineers
USAG	U.S. Army Garrison
USAR	U.S. Army Reserve
WTE	waste-to-energy
WUI	water use intensity
WWTP	wastewater treatment plant
YTC	Yakima Training Center

## A.2 Participating Net Zero Army Organizations

**Office of the Assistant Secretary of the Army for Installations, Energy and Environment (OASA (IE&E)):** OASA (IE&E) establishes policy; provides strategic direction and supervises all matters pertaining to infrastructure, Army installations and contingency bases, energy, and environmental programs to enable global Army Operations. OASA (IE&E) created the Net Zero strategy and policy, oversees the progress of the initiative, and provides overall initiative direction.

**Office of the Assistant Chief of Staff for Installation Management (OACSIM):** OACSIM is the principal military adviser to the OASA (IE&E) for installation management, military facilities investment requirements and strategy, housing, installation environmental management and stewardship, privatization, and energy security and sustainability. OACSIM establishes guidance, delivers training, helps secure program resources, and shares best practices and lessons learned to help Commands achieve Net Zero goals.

**Land-Holding Commands:** Commands consisting of the U.S. Army Installation Management Command, the Army National Guard, the Army Reserve, and the U.S. Army Materiel Command.

**Installation Management Command (IMCOM):** IMCOM handles the daily operations of most active duty U.S. Army installations around the globe. IMCOM's mission is to deliver and integrate base support to enable readiness for a self-reliant and globally responsive all-volunteer Army.

**Army National Guard (ARNG):** ARNG is a reserve component of the U.S. Armed Forces. Composed of National Guard military members and units from each state, the District of Columbia, and the territories of Puerto Rico, Guam, and the Virgin Islands, the National Guard can be deployed or mobilized for Federal and domestic missions.

**U.S. Army Reserve (USAR):** USAR is the Federal reserve force of the Army. With 16 operational and functional Commands, 7 support Commands, and 4 training Commands, the Army can mobilize individuals or parts of units from the Army Reserve to meet the needs of a mission.

**Army Materiel Command (AMC):** AMC is the Army's provider of materiel readiness—equipping, sustaining, and enabling the warfighter through technology, acquisition support, materiel development, and logistics power projection—across the spectrum of joint military operations. AMC is headquartered at Redstone Arsenal, Alabama, and affects or has a presence in all 50 states and 153 countries.

**Installations:** All enduring active Army, Army National Guard, U.S. Army Materiel Command, and U.S. Army Reserve installations, sites, and facilities operated and/or maintained by Federal funds in the continental United States and outside the continental U.S.

### A.3 Funding Types

**Energy Savings Performance Contract (ESPC):** Performance-based contracting option where a third-party energy services company provides project capital investment. Project capital costs and financing are recuperated via energy and/or water cost savings over a maximum 25-year contract term. ESPCs are recommended to fund energy/water efficiency projects as well as renewable energy and alternative water. Project execution should normally take two to three years.

**Military Construction (MILCON):** Appropriations option for infrastructure-related projects that exceed \$1 million in capital costs. While no specific project financial thresholds must be met to award MILCON funds, energy and/or water conservation measures associated with MILCON-funded capital projects should be LCC-effective. Project execution should not take more than five years.

**Sustainment:** Defined by the Office of the Secretary of Defense (OSD) as maintenance and repair activities necessary to keep an inventory of facilities in good working order. It includes regularly scheduled adjustments and inspections, preventative maintenance tasks, and emergency response and service calls for minor repairs. It also includes major repairs or replacement of facility components (which are an opportunity to incorporate Net Zero strategies) that are expected to occur periodically throughout the life-cycle of facilities. This work includes regular roof replacement, refinishing of wall surfaces, repairing and replacement of heating and cooling systems, replacing tile and carpeting, and similar types of work.<sup>1</sup>

**Restoration:** The restoration of real property to such a condition that it may be used for its designated purpose. Restoration includes repair or replacement work to restore facilities damaged by inadequate sustainment, excessive age, natural disaster, fire, accident, or other causes.<sup>1</sup>

**Modernization:** The alternation or replacement of facilities solely to implement new or higher standards, to accommodate new functions, or to replace building components that typically last more than 50 years (such as the framework or foundation).<sup>1</sup>

**Utility Energy Service Contract (UESC):** Performance-based contracting option where utility partners provide project capital investment. Project capital costs and financing are recuperated via energy and/or water cost savings over a maximum 25-year contract term. UESCs are recommended to fund energy/water efficiency projects as well as renewable energy projects. Project execution should normally take two to three years.

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<sup>1</sup> The Office of the Secretary of Defense. 2013. *DoD Financial Management Regulation. Volume 2B. Section 080104*. Washington D.C.  
[http://comptroller.defense.gov/Portals/45/documents/fmr/Volume\\_02b.pdf](http://comptroller.defense.gov/Portals/45/documents/fmr/Volume_02b.pdf)



## A.4 DoD Technology Demonstrations

**Energy Conservation Investment Program (ECIP):** OSD managed appropriations for energy conservation, water conservation, and/or renewable energy projects. To be considered, energy conservation projects need to have a savings-to-investment ratio (SIR) of at least 1.25, whereas water conservation and renewable energy projects need SIRs of at least 1.0. Project execution should not take more than two years.

**Environmental Security Technology Certification Program (ESTCP):** The ESTCP is DoD's environmental technology demonstration and validation program. Its goal is to identify and demonstrate cost-effective technologies that address DoD's highest priority environmental requirements.

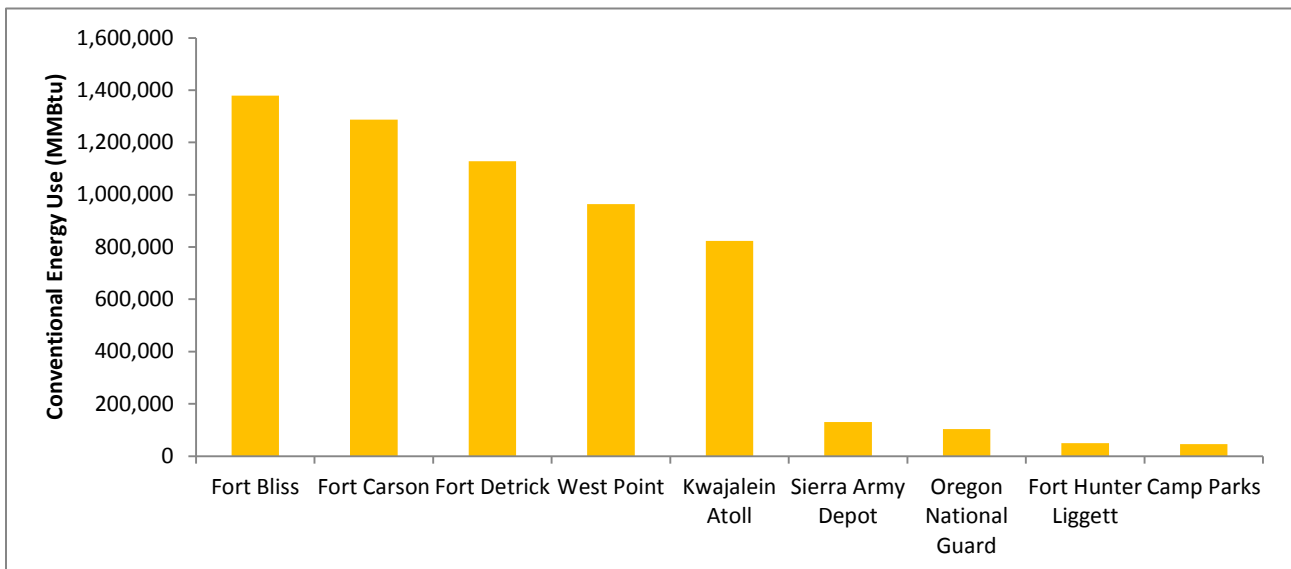
**Strategic Environmental Research and Development Program (SERDP):** The SERDP is DoD's environmental science and technology program that is executed in partnership with DOE and EPA. SERDP invests in basic and applied research and advanced development.

## Appendix B

### Net Zero Energy Pilot Installations

Each Net Zero Energy pilot installations provided an overview of their Net Zero progress to date. The associated one-page summaries in this appendix include the following:

- Information about the installation's location, Army Command, facility square footage in thousand square feet (KSF), and population
- Charts that illustrate consumption data for reported fiscal year (FY)11 through FY15 and projected years FY16 through FY20, including
  - Conventional energy use (electric and thermal) in million British thermal units (MMBtu) (reported data collected from the Army Energy Management Report (AEMR) and projected data provided by the installation)
  - Renewable energy consumed onsite in MMBtu (reported data collected from AEMR and projected data provided by the installation)
  - Energy use intensity (EUI) measured in thousand Btu (kBtu) per gross facility square foot (GSF) (conventional energy only)
  - The EUI reduction goal set forth in Executive Order 13693 that mandates a reduction of 2.5% annually through FY25 based on an energy baseline of FY15.
- Narrative that highlights the installation's Net Zero Energy projects and successes and challenges related to meeting Net Zero objectives.



**Pilot Installation Energy Use:** The chart depicts the pilot installations' FY15 conventional energy use to provide a relative comparison of installation consumption.

### Net Zero Energy Pilot Progress

Energy data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table B.1:

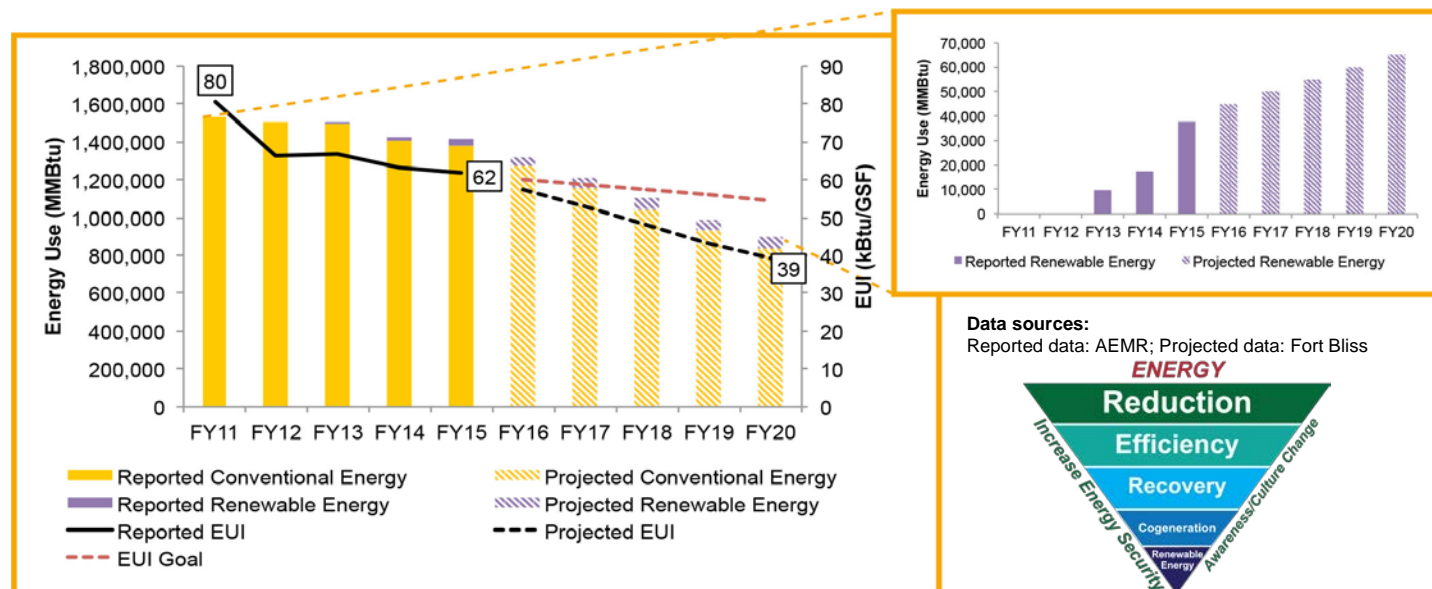
- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded the Federal energy reduction goal and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Energy by FY20, generating as much renewable energy as consumed
- **Significant progress** - This classification distinguishes sites that have:
  - Exceeded the Federal energy reduction goal and/or made significant progress since being a selected pilot in FY11
  - Made progress towards renewable energy generation but are not projected to generate enough renewable energy to be near Net Zero Energy by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in energy reduction and renewable energy generation

**Table B.1. Net Zero Energy Pilot Installation Progress Status**

Installation	Net Zero Energy Progress
Fort Hunter Liggett	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Carson	Significant progress
Fort Detrick	Significant progress
Parks Reserve	Significant progress
Sierra Army Depot	Significant progress
Kwajalein Atoll	Minimal progress
Oregon National Guard	Minimal progress
West Point	Minimal progress

## Fort Bliss

El Paso, TX | IMCOM | FY 15 Facility Size: 22,900 KSF | FY15 Population: 46,600



## REDUCTION

Fort Bliss had a steady reduction in energy use from FY11 through FY15 and achieved a 8% reduction in total energy use and 23% reduction in EUI by FY15.

## EFFICIENCY

Fort Bliss credits third-party financing for the installation's \$60 million investment via their ongoing energy savings performance contract (ESPC) in implemented energy conservation measures from FY11 through FY15. These energy efficiency projects included an installation-wide lighting retrofit to electronic T8s with occupancy sensors, heating, ventilation, and air-conditioning (HVAC), direct digital controls (DDCs), inauguration of a centralized building operations command center, and electric chiller and motor upgrades, all of which facilitated the site's 23% EUI reduction between FY11 and FY15.

## RECOVERY

Fort Bliss assessed and identified energy recovery as not being economically feasible at this time.

## COGENERATION

Fort Bliss evaluated integrating a cogeneration process for their 16 megawatt (MW) generator, but the generator is in standby mode for the majority of the time due to an interruptible tariff and is not economical to operate.

## RENEWABLE ENERGY

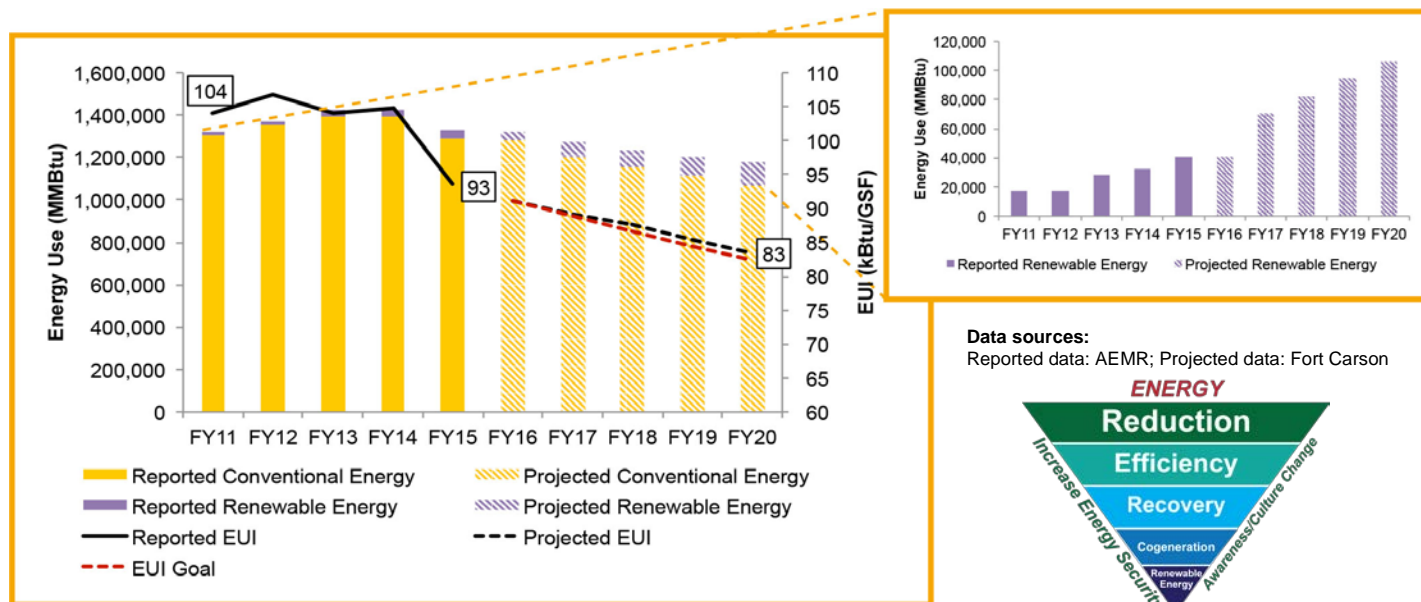
Through various funding mechanisms, including third-party ESPCs and Energy Conservation Investment Program (ECIP) appropriations, Fort Bliss installed an aggregated 6 MW of solar capacity on or near 26 facilities as of FY15. Projects less than 10 MW in capacity included rooftop solar photovoltaics (PV) and solar hot water heating at the building level. Fort Bliss continues to pursue large-scale renewable energy projects that have capacities greater than 10 MW by collaborating with the Office of Energy Initiatives (OEI). The installation's renewable energy project pipeline could expand onsite renewable energy capacity 10-fold by FY20. However, lessons Fort Bliss learned through their collaboration with OEI enabled other installations in more favorable regulatory environments to expedite large-scale renewable projects, thereby moving them closer to Net Zero Energy. The regulated electricity market currently serving most of the installation could impede the installation's progress toward Net Zero Energy.

## CONCLUSION

Fort Bliss seeks to leverage their dry, sunny climate to pursue a Net Zero Energy strategy largely defined by onsite solar projects. The installation's focus on self-producing renewable energy also increases installation energy resiliency.

## Fort Carson

Colorado Springs, CO | IMCOM | FY 15 Facility Size: 14,200 KSF | FY15 Population: 31,900



### REDUCTION

Fort Carson's energy use remained steady from FY11 through FY15. Because their building stock increased over this same time period, Fort Carson's EUI dropped 10% between FY11 and FY15.

### EFFICIENCY

Fort Carson has used a variety of funding mechanisms, including ESPCs and ECIP, to compete a number of efficiency measures across the site. Completed projects include interior and exterior lighting retrofits, building envelope improvements, and three liquid pool covers.

### RECOVERY

Opportunities for energy recovery, such as the boiler stack heat at the central heating plant, were investigated but no cost-effective opportunities were identified.

### COGENERATION

In a partnership with the Construction Engineering Research Laboratory (CERL), Fort Carson investigated the feasibility of installing a cogeneration plant for the new Combat Aviation Brigade complex and found it to not be economically viable. Cogeneration is being further investigated by the ESPC contractor.

### RENEWABLE ENERGY

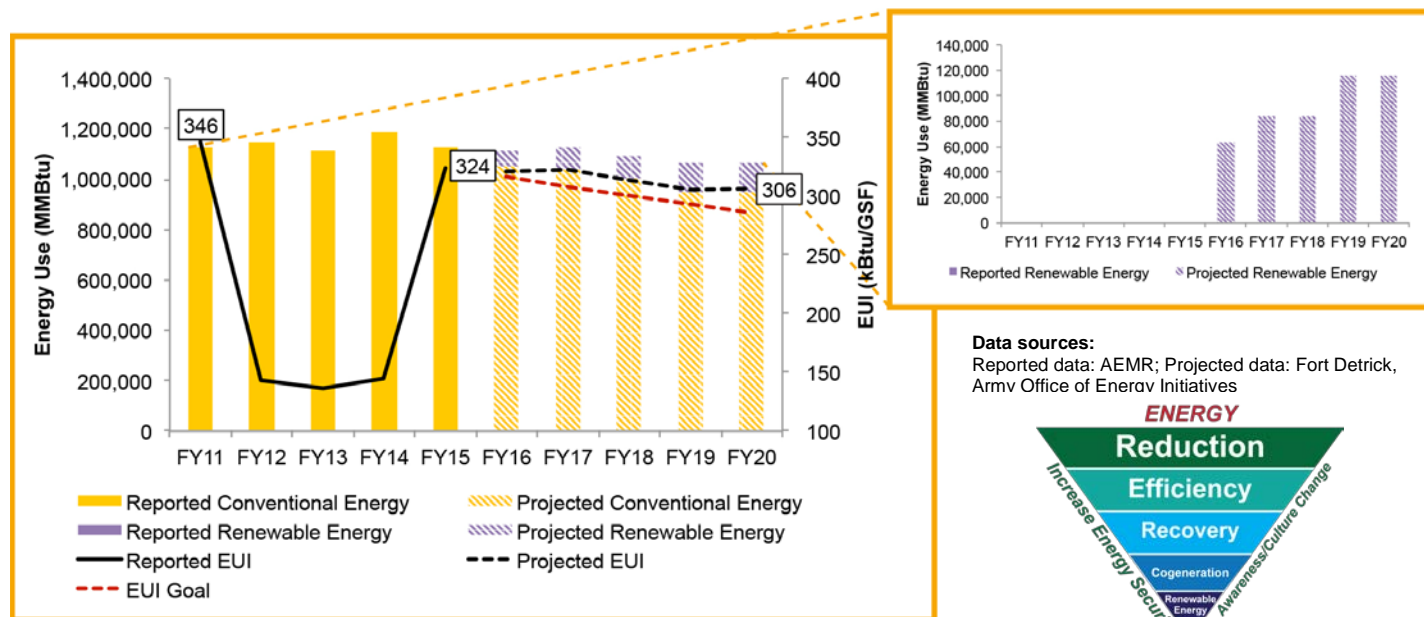
From FY11 through FY15, Fort Carson installed 5 MW of onsite PV, and 100% of the production is consumed onsite. The total PV generation supplies approximately 4% of Fort Carson's annual electricity needs. Beyond PV, Fort Carson uses solar hot water system and solar wall technologies. Eight facilities also use ground source heat pumps. From FY16 through FY20, Fort Carson plans to expand their use of onsite renewables to increase energy resiliency. In addition, a Net Zero environmental assessment (EA) was conducted to identify Fort Carson's "PV Consolidated Site," which is a central location for solar arrays funded by multiple military construction (MILCON) projects. Having a central location for PV installation lowered operations and maintenance (O&M) costs, thereby increasing PV life-cycle cost (LCC)-effectiveness. Lowering O&M costs was crucial due to the installation's inexpensive blended electricity rate (\$0.55/kWh).

### CONCLUSION

Fort Carson has focused on energy efficiency and renewable energy strategies, primarily funded by their five-year-old ESPC, to advance toward Net Zero Energy. Looking to FY20, Fort Carson will pursue restoration and modernization funds for more than 20 projects to fund fuel switching, exterior lighting, and retro-commissioning opportunities.

## Fort Detrick

Frederick, MD | IMCOM | FY 15 Facility Size: 3,500 KSF | FY15 Population: 11,100



**ENERGY**  
**Reduction**  
**Efficiency**  
**Recovery**  
**Cogeneration**  
**Renewable Energy**  
**Awareness/Culture Change**

## REDUCTION

Fort Detrick's energy use was stable from FY11 through FY15. The large fluctuation in Fort Detrick's EUI between FY11 and FY15 was largely due to the inclusion of Walter Reed Army Medical Center square footage in the installation's total facility floor area from FY12 through FY14 and exclusion of the center's square footage in FY15. Fort Detrick installed over 30 smart meters to improve management of energy systems and drive down energy use.

## EFFICIENCY

Fort Detrick recently upgraded their exterior lighting to solid-state light-emitting diode (LED) street light fixtures and began to decentralize their steam boiler plant to high-efficiency distributed boilers.

## RECOVERY

Fort Detrick leveraged their existing waste management infrastructure to develop one of the most successful incinerator plants in the Middle Atlantic region. Fort Detrick is investigating recovering their stack heat/steam as usable energy instead of releasing this valuable byproduct into the atmosphere.

## COGENERATION

The installation does not currently operate a cogeneration plant, but a feasibility study is planned to evaluate cogeneration at the Central Utilities Plant.

## RENEWABLE ENERGY

Onsite renewable energy development, specifically an aggressive rollout of solar PV across the garrison, is central to Fort Detrick's Net Zero Energy strategy. The installation's 18 MW solar farm has been fully operational since February 2016. Another 200 kilowatts (kW) of rooftop solar has been in operation since June 2016. By FY19, another planned onsite 7 MW solar farm will provide electricity to the installation's central utility plant. These projects will effectively double Fort Detrick's onsite renewable energy generation in five years. The installation has a solar-powered exterior lighting at the main post and a feasibility study to include solar-powered exterior fixtures at the garrison's Silver Spring Annex is under way.

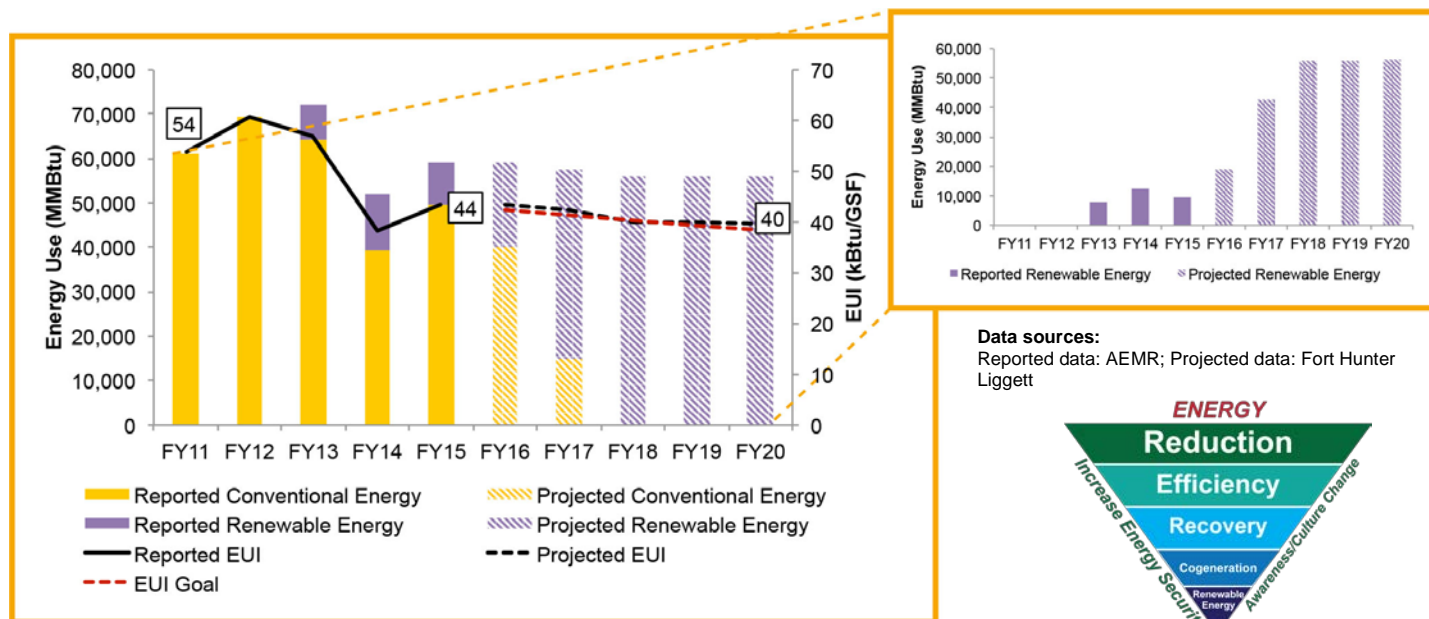
## CONCLUSION

Fort Detrick made Net Zero Energy progress despite limited project space and high construction and labor costs at the garrison's location near Washington, D.C. Fort Detrick plans to further use ESPCs to minimize the upfront capital cost associated with achieving Net Zero Energy by FY20.



## Fort Hunter Liggett

Fort Hunter Liggett, CA | Army Reserve | FY 15 Facility Size: 1,400 KSF | FY15 Population: 2,200



### REDUCTION

Fort Hunter Liggett reduced energy use by 3% from FY11 through FY15 and achieved a 19% reduction in EUI in FY15. In FY14, the energy manager, Todd Dirmeyer, won a Secretary of the Army Energy and Water Management Award for individual achievement in energy management. To help maintain their effective energy management, Fort Hunter Liggett hired a Resource Efficiency Manager (REM) in FY15.

### EFFICIENCY

Energy efficiency projects implemented at Fort Hunter Liggett include building retuning, lighting upgrades, and ground source heat pump retrofits. A utility energy service contract (UESC) project currently being implemented includes HVAC upgrades and controls, LED fixtures, and building controls recommissioning.

### RECOVERY

Through an Environmental Security Technology Certification Program project, Fort Hunter Liggett is in the process of constructing a WTE facility on-post, which is expected to be operational in 2017.

### COGENERATION

Fort Hunter Liggett is not pursuing cogeneration because of inadequate heating load and no access to natural gas.

### RENEWABLE ENERGY

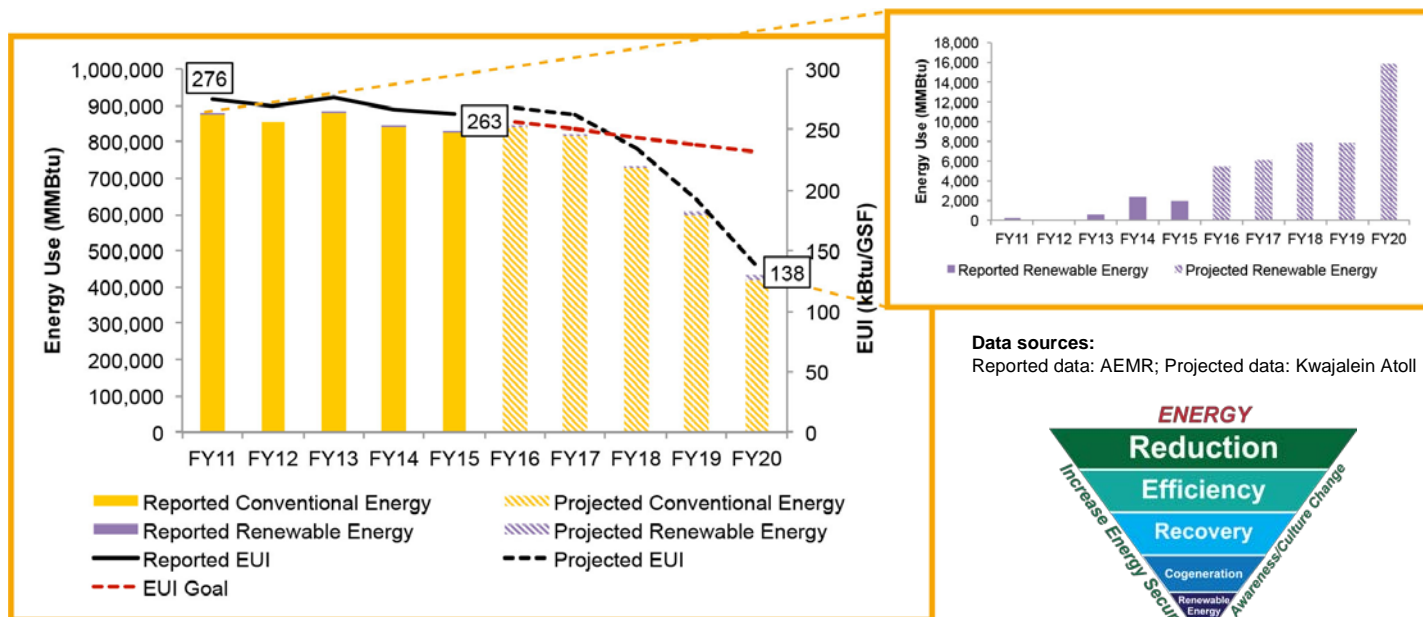
Fort Hunter Liggett had great success using ECIP to install several large PV systems, and therefore may achieve Net Zero Energy as early as FY18. Three 1 MW systems were installed in FY13, FY14, and FY15, respectively; another 5 MW system is planned for FY17 and FY18. The installation expects to complete a small waste-to-energy (WTE) unit in FY17, which supports both Net Zero Energy and Waste goals.

### CONCLUSION

Fort Hunter Liggett used a combination of resources to reduce energy consumption and EUI, integrate renewable energy and energy security into installation operations, and potentially become the Army's first Net Zero Energy installation. Continued success of the energy management program, however, will require even more manpower.

## Kwajalein Atoll

Kwajalein Atoll, Marshall Islands | IMCOM | FY 15 Facility Size: 3,100 KSF | FY15 Population: 2,400



## REDUCTION

Kwajalein Atoll's energy use remained relatively steady from FY11 through FY15, reducing 6% in total energy use and 5% in EUI over this time frame. The installation expects their EUI reductions to accelerate as more energy measures are implemented via an ESPC starting in FY17.

## EFFICIENCY

Energy efficiency measures implemented by the installation include a 2012 LED street lighting retrofit funded through appropriations.

## RECOVERY

Kwajalein investigated the recovery of waste energy from the incinerator, but determined that the project was infeasible.

## COGENERATION

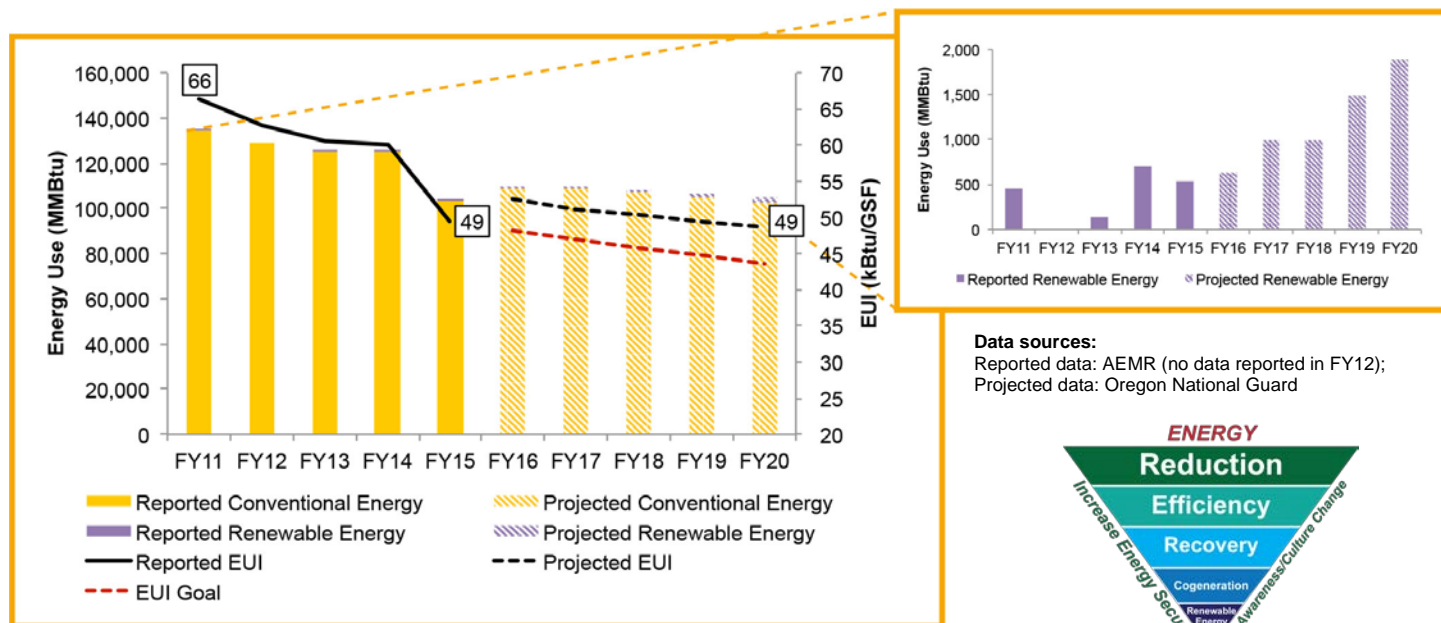
Because space for energy generation is limited on Kwajalein Atoll, the garrison is pursuing highly efficient cogeneration alternatives, including a prototype solid-state thermoelectric generator to replace deteriorating diesel generator engines. The installation is investigating the use of the Environmental Security Technology Certification Program (ESTCP) and CERL program to demonstrate this innovative technology. Shifting to onsite cogeneration sources will further increase Kwajalein's energy resilience by limiting dependence on externally supplied diesel fuel.

## RENEWABLE ENERGY

Using ECIP funds, the installation commissioned 468 kW of roof-mounted solar PV, which is already online. An aggressive portfolio of onsite renewable energy generation, planned to occur from FY16 through FY20, is the centerpiece of Kwajalein's strategy for progressing toward Net Zero Energy status by FY20. An additional 7 MW of PV, solar hot water collectors, and 9 MW of wind planned to occur from FY17 through FY20, largely associated with the installation's proposed Army Family Housing project, will enable onsite renewables to handle approximately 65% of this housing complex's energy load by FY20.

## CONCLUSION

While remoteness creates implementation challenges, including high material and labor costs, minimal available project land area, and a limited number of energy services company competitors for ESPC solicitations, Kwajalein will continue to leverage their past energy efficiency accomplishments and planned renewable energy investments to pursue Net Zero Energy status by FY20.



## REDUCTION

The Oregon Army National Guard (ARNG) reduced energy consumption by 8% from FY11 to FY15 across this diverse group of sites. The completion of large energy efficiency projects and milder weather caused the drop in FY15 energy consumption. Oregon ARNG is developing an agency-wide sustainability plan focused on energy efficiency and will reinforce continued positive stakeholder outreach with the public, tenants, and regulators. The Oregon ARNG has found that behavior change efforts are far more cost-effective than equipment replacement.

## EFFICIENCY

Through ESPCs and internal project development, Oregon ARNG implemented a variety of energy conservation measures across their centers, including boiler replacements, lighting retrofits, and system commissioning. Oregon ARNG will continue to take advantage of REMs, ECIP, and state, local, and utility incentive and grant programs to implement projects. Efficiency upgrades planned through FY20 include HVAC, lighting, envelope, and control upgrades.

## RECOVERY

Oregon ARNG plans to investigate heat recovery from process uses.

## COGENERATION

Oregon ARNG is investigating the potential for geothermal cogeneration, electricity production from a desalination project, and wind and wave energy.

## RENEWABLE ENERGY

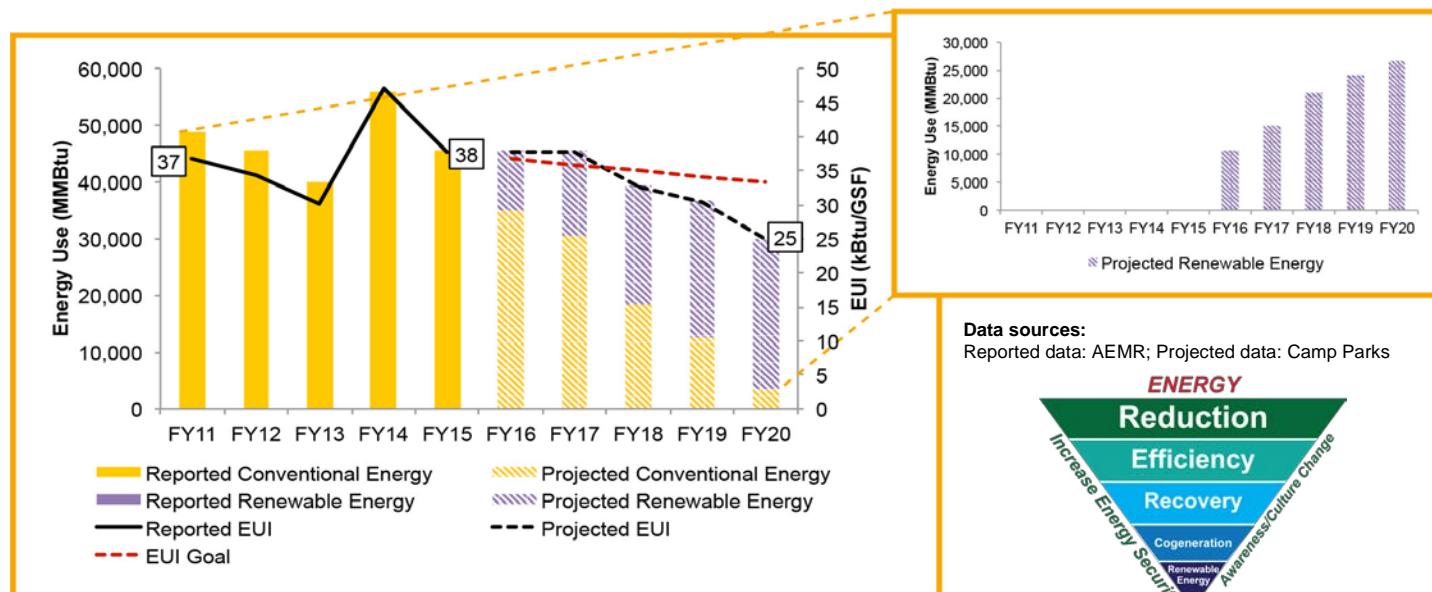
Oregon ARNG analyzed the entire facility portfolio to find opportunities for renewable energy production. To date, Oregon ARNG has implemented nine PV arrays. Additional PV projects are planned FY19 and FY20, and biomass projects displacing high-cost propane will be completed in FY16 and FY17.

## CONCLUSION

Oregon ARNG represents the Army's only statewide Net Zero initiative, all 51 Oregon ARNG sites are included. Priority is given to the low-cost/no-cost, large benefit opportunities, then the largest consumers for short payback projects and largest benefit measures, and finally the higher cost but cost-effective measures.

## Parks Reserve Forces Training Area

Dublin, CA | Army Reserve | FY 15 Facility Size: 1,200 KSF | FY15 Population: 3,100



### REDUCTION

Parks Reserve Forces Training Center, also known as Camp Parks, reduced energy use from FY11 to FY15 by 7%. The large increase in energy consumption in FY14 was due to a significant increase in Soldiers being trained during that time frame. The reduction in FY15 was primarily due to efficiency efforts; the tenant usage and training personnel remained constant.

### EFFICIENCY

Camp Parks implemented innovative efficiency projects through alternative financing using an ESPC and appropriated funds. Projects included LED lighting, HVAC upgrades, and controls. Other planned projects include skylights, retro-commissioning, a cool roof, and natural gas hot water heater conversion to electric.

### RECOVERY

Currently, Camp Parks does not have energy recovery. The installation plans to investigate energy recovery from air source heat pumps to supplement hot water in the barracks and the laundry facility.

### COGENERATION

Camp Parks is not pursuing cogeneration because of an inadequate heat load.

### RENEWABLE ENERGY

Large-scale, multi-year projects will be funded primarily with ECIP and ESPCs going into 2020. A 2 MW ground-mounted PV system was installed through ECIP and will be operational in FY16, meeting over 20% of the site energy needs. ESTCP was used to test a hybrid solar PV-thermal array and a fuel cell (the fuel cell was decommissioned in FY 15). Battery storage, a microgrid system, additional PV, and undergrounding of distribution lines contribute to the site's energy security.

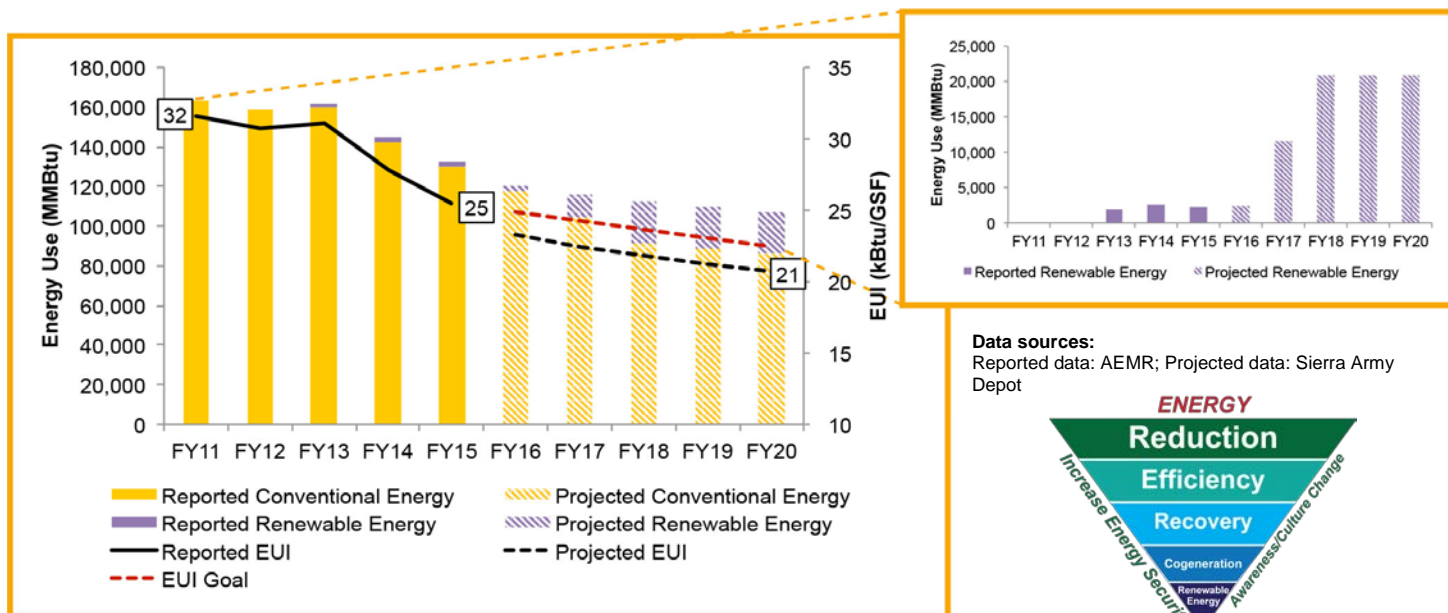
Camp Parks overcame challenges including the increase in training and PV interconnection with the grid. Grid interconnection depends on cooperation of the local utility, which sometimes is reluctant to give large-scale projects high priority. Camp Parks will implement future projects in smaller phases, and has learned to engage with the utility early in the planning phase to help smooth the way.

### CONCLUSION

Camp Parks focused on energy efficiency efforts and plans to implement renewable energy, energy security, and additional energy efficiency projects to achieve Net Zero Energy in FY20.

## Sierra Army Depot

Herlong, CA | AMC | FY 15 Facility Size: 5,200 KSF | FY15 Population: 1,500



### REDUCTION

Sierra Army Depot had a steady reduction in energy use from FY11 through FY15 and achieved a 19% reduction in total energy use and EUI by FY15, despite the number of personnel on the base increasing by 164% between FY03 and FY15. Additionally, new non-Army operations began onsite in 2015, adding energy requirements. The significant progress in reduction is shown by the decrease in energy per capita, which was 207 MMBtu/capita in 2003 and 87 MMBtu/capita in 2015. Meter readings were used to identify high energy users and target the high mast lights throughout the site for replacement with solar powered lights. Placing electric power correction units on several shop facilities resulted in approximately 8% savings.

### EFFICIENCY

At least 16 energy efficiency projects have been completed since FY11, and another 5 are in the budget cycle through FY20. These include standard projects such as installing insulation and high-efficiency HVAC equipment, as well as building-integrated renewable energy projects and innovative projects using phase change materials. The site is also pursuing a UESC for implementing energy efficiency projects. An innovative approach using phase change material produced natural gas savings, and will be used in the future on buildings with both heating and cooling to maximize effectiveness.

### RECOVERY

Currently, Sierra Army Depot does not have viable energy recovery project options.

### COGENERATION

The installation is considering a cogeneration project using natural gas electric generators for FY17 ECIP funding, which would provide heat for several buildings.

### RENEWABLE ENERGY

The site is working with the local electric utility provider to install a solar array that will provide 40% of the current annual electric demand, once it overcomes contractual and regulatory challenges. The installation is pursuing a future UESC to implement an additional solar array to help move the installation toward Net Zero.

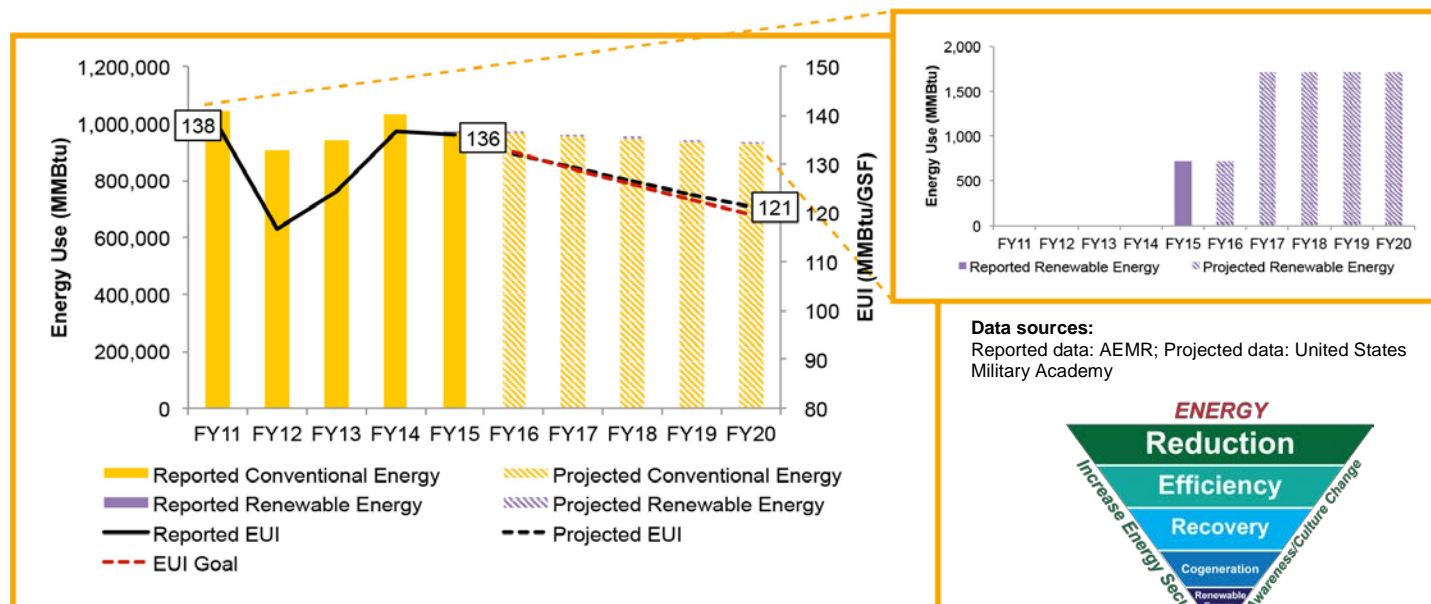
### CONCLUSION

With these innovative projects, Sierra Army Depot will continue to reduce energy consumption and deploy renewable energy on their path to Net Zero.



## United States Military Academy

West Point, NY | IMCOM | FY 15 Facility Size: 7,100 KSF | FY15 Population: 13,000



### REDUCTION

The United States Military Academy, also known as West Point, is approximately as energy intensive in FY15 as it was FY11, despite an academic building expansion and air conditioning added to historic, previously unconditioned facilities.

### EFFICIENCY

West Point used appropriations, Sustainment funding, and their ongoing ESPC to tailor site-specific energy efficiency projects, including central steam to natural gas boiler conversion. Additionally, the campus is leveraging the Army's REM program to exceed comprehensive energy evaluation requirements mandated by the *Energy Independence and Security Act of 2007*. West Point's new buildings incorporate many energy efficiency measures. A recently constructed barracks with a 50-year design life meets American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard 189.1, including radiant heating and cooling piping in the foundation, a tighter building envelope, and integrated building systems.

### RECOVERY

West Point investigated recovering waste heat from an exhaust stack through an ESTCP, but there was not adequate space in the central heating plant.

### COGENERATION

A study performed by the Corps of Engineers determined that cogeneration is not economically feasible at this time and West Point will pursue a 5 MW gas-fired electric power plant. As technology opportunities advance, cogeneration will be reevaluated.

### RENEWABLE ENERGY

The campus made strides toward satisfying its residual energy demand through onsite renewables by installing a 200 kW solar PV array on the roof of the Tennis Center, which came online in FY15. A newly constructed building includes a solar hot water heating system.

### CONCLUSION

West Point has challenges in implementing Net Zero objectives, but using a variety of funding mechanisms and personnel resources will position West Point to continue progress toward Net Zero Energy from FY16 through FY20.

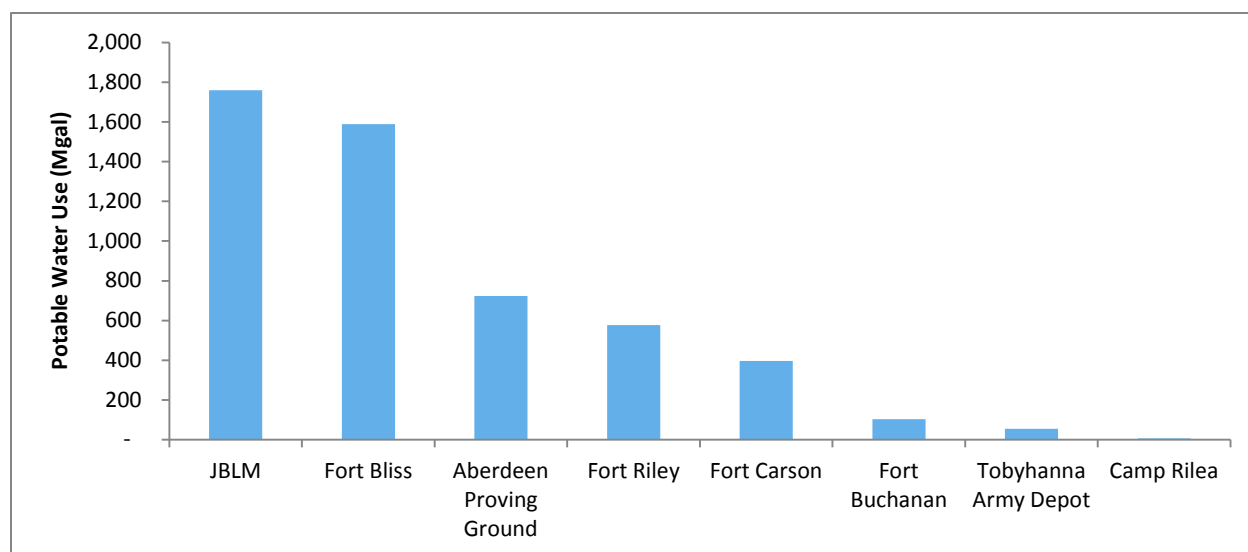


## Appendix C

### Net Zero Water Pilot Installations

Each Net Zero Water pilot installations provided an overview of their Net Zero progress to date. The associated one-page summaries in this appendix include:

- Information about the installation's location, Army Command, facility square footage in thousand square feet (KSF), and population
- Consumption data for reported years fiscal year (FY)11 through FY15 and projected years FY16 through FY20, including
  - Potable water use in million gallons (Mgal) (reported data for FY11-FY15 was collected from the Army Energy and Water Reporting System (AEWRS) and projected data provided by the installation)
  - Industrial, landscaping, and agricultural (ILA) water use in Mgal (if applicable) (reported data for FY11-FY15 was collected from AEWRS and projected data provided by the installation)
  - Alternative water use in Mgal (if applicable) (reported data for FY11-FY15 was collected from AEWRS and projected data provided by the installation)
  - Groundwater recharge in Mgal provided by the installation (if applicable)
  - Potable water use intensity (WUI) measured in gallons per gross facility square foot (GSF)
  - Net Zero WUI glide path reduction through FY20, with a reduction goal of 52%
- Narrative that highlights the installation's Net Zero Water projects and successes and challenges related to meeting Net Zero objectives.



**Pilot Installations Water Use:** The chart depicts the pilot installations' FY15 potable water use to provide a relative comparison of installation consumption.

### Net Zero Water Pilot Progress

Water data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table C.1:

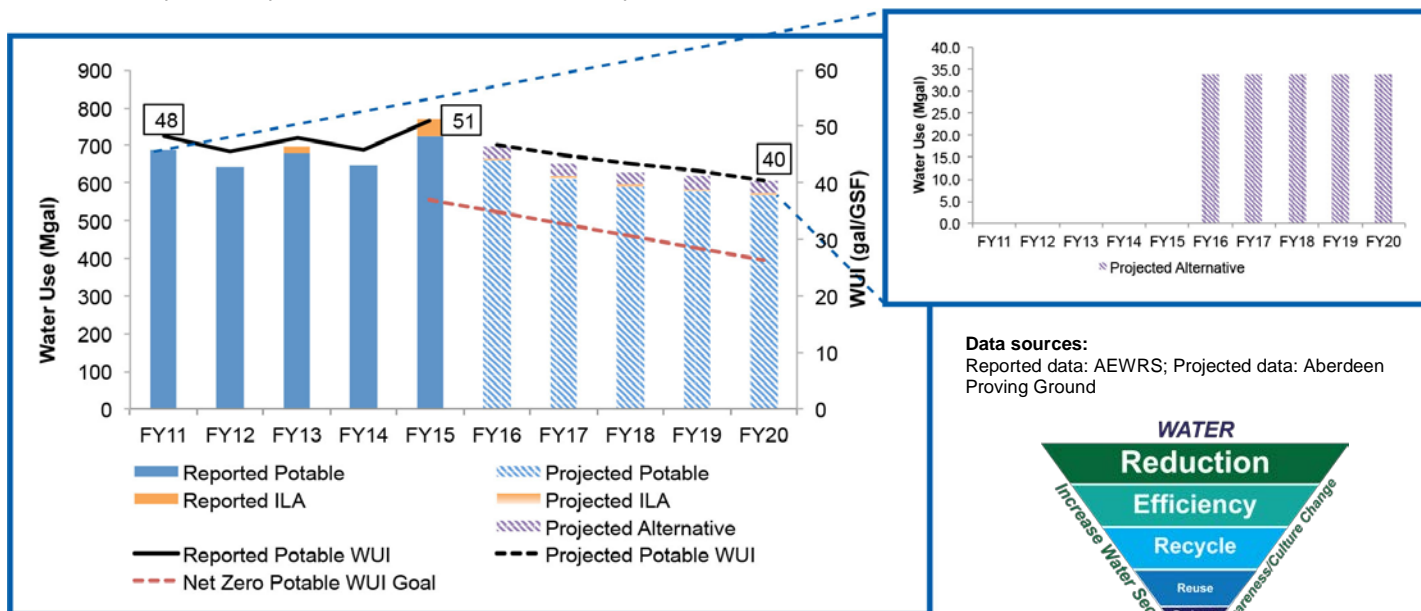
- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded Federal water reduction goals and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Water by FY20, completely offsetting freshwater supply with alternative water and/or groundwater recharge
- **Significant progress** - This classification distinguishes sites that have:
  - Exceeded Federal water reduction goals and/or made significant progress since being a selected pilot in FY11
  - Made progress towards alternative water production and/or groundwater recharge but are not projected to be near Net Zero Water by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in water reduction and alternative water production/groundwater recharge

**Table C.1. Net Zero Water Pilot Installation Progress Status**

Installation	Net Zero Water Progress
Camp Rilea	Projected to meet Net Zero
Tobyhanna Army Depot	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Buchanan	Significant progress
Fort Carson	Significant progress
Joint Base Lewis-McChord	Significant progress
Aberdeen Proving Ground	Minimal progress
Fort Riley	Minimal progress

## Aberdeen Proving Ground

Aberdeen, MD | IMCOM | FY15 Facility Size: 14,100 KSF | FY15 Population: 22,000



### REDUCTION

Aberdeen Proving Ground's water consumption had been primarily trending down since FY11, with a 6% decrease of potable water since FY07, but the site did not achieve the Net Zero potable WUI goal reduction of 32% in FY15. The site uses ILA water to offset the use of potable water.

### EFFICIENCY

Aberdeen Proving Ground is implementing water efficiency through an existing energy savings performance contract (ESPC) project, and is replacing plumbing equipment with high-efficiency fixtures. The installation is also converting their distributed steam system to internal hot water boilers to reduce water use.

To assist in implementing efficiency projects, Aberdeen Proving Ground is working with the U.S. Environmental Protection Agency Office of Research and Development (EPA-ORD) to implement a sustainability model that uses economic, social, and environmental elements to assist the installation in better managing its water.

### RECYCLE/REUSE

Aberdeen Proving Ground is also implementing alternative water projects through their ESPC project. An ESPC project under construction will reclaim treated water from the Canal Creek groundwater treatment plant for boiler plant makeup. For future projects, the site is investigating rainwater harvesting and reclaiming wastewater from an onsite treatment plant.

### RECHARGE

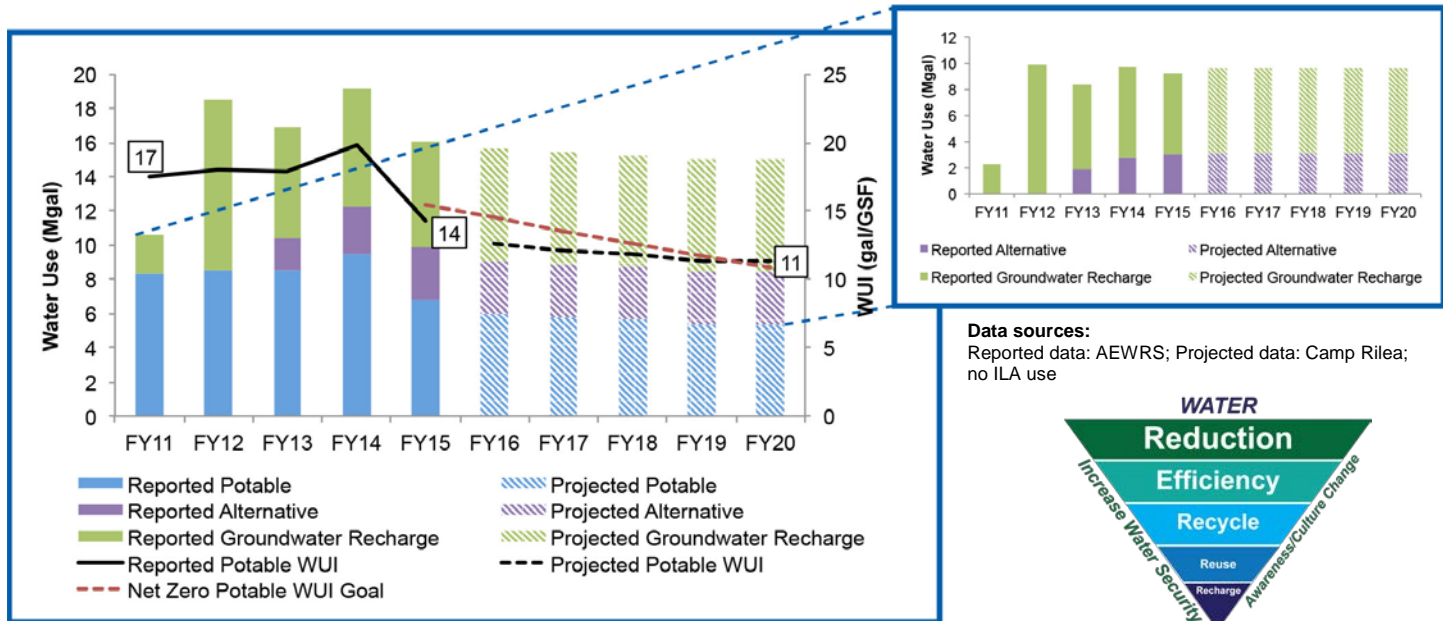
Aberdeen Proving Ground currently is not recharging their local aquifer and has no future plans for doing so.

### CONCLUSION

The installation faces distinct challenges in reaching Net Zero Water and likely will not meet the FY20 goals. The site has a high number of non-reimbursable tenants, which have mission-driven facilities, making water conservation difficult to implement. Also, part of the site receives water from a local municipality that does not charge a marginal water rate, which provides no cost savings for water reductions. Even with these challenges, Aberdeen Proving Ground is working toward Net Zero Water by leveraging their ESPC and working with EPA-ORD to find innovative solutions.

## Camp Rilea

Warrenton, OR | National Guard | FY15 Facility Size: 483 KSF | FY15 Population: 500



## REDUCTION

Despite an uptick in water use in FY14 due to increase in soldier training, Camp Rilea has reduced freshwater demand by 18% since FY11 and exceeded the Net Zero potable WUI reduction goal of 32%. Camp Rilea has instituted several water reduction efforts. During dry summer months, Camp Rilea stops irrigating landscape areas, allowing turf to go dormant. The site also converted high-water-use landscape plants to native plants. This saved money through reduced mowing and upkeep of plants.

The site also pursued public education and outreach, including conservation announcements at the main gate, flyers, and training for full-time employees. Camp Rilea is partnering with the U.S. Army Corps of Engineers (USACE) on advanced metering that will enable the site to calculate fair charges for transient tenants and provide water conservation incentives.

## EFFICIENCY

Informed by their Net Zero roadmap, Camp Rilea pursued a water audit, leak detection, and repairs of the distribution system, which reduced water losses by over 0.5 Mgal between FY14 and FY15. High-efficiency showerheads and faucet aerator retrofits were implemented, and other costly items such as toilets and urinals are replaced upon failure.

## RECYCLE/REUSE

Camp Rilea built a reclaimed water plant that treats wastewater and produces Class A non-potable water used in irrigation. Coming online in 2013, the reclamation plant filters the wastewater using reverse osmosis filtration and also provides disinfection. The Class A water provides irrigation for 11.6 acres of the main cantonment area. The wastewater reclamation plant treats 3 Mgal of wastewater each year.

## RECHARGE

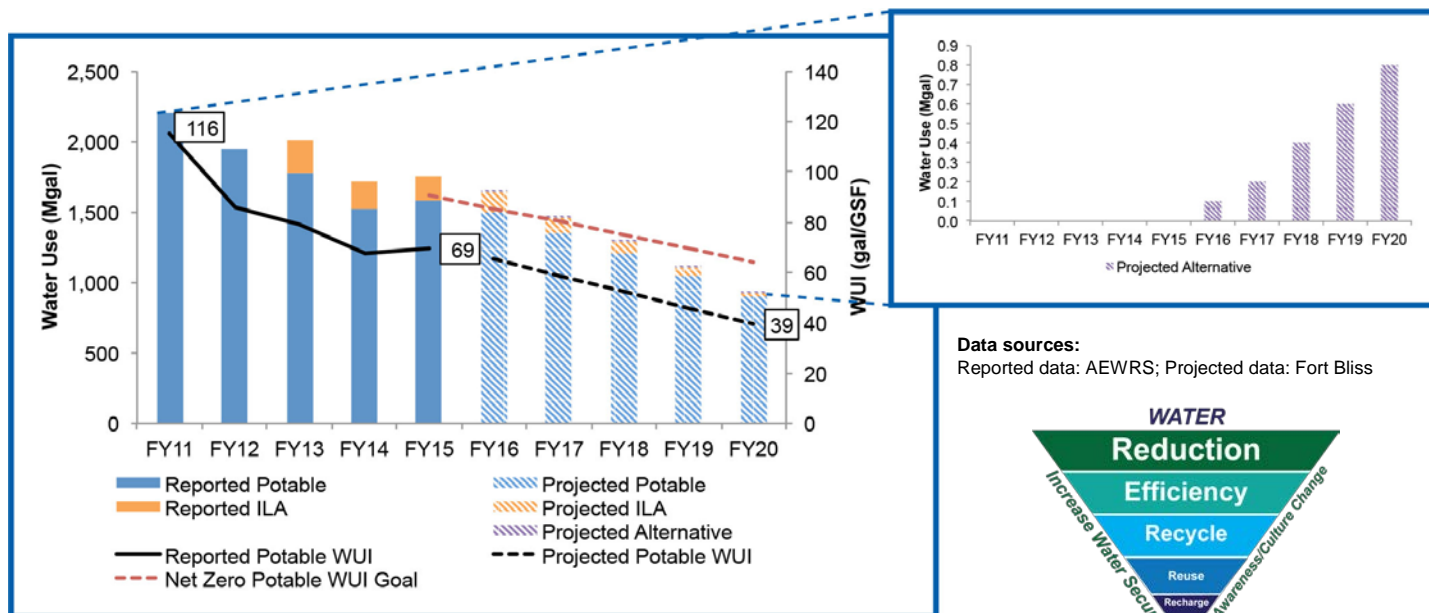
A cornerstone project that incorporates Net Zero principles at Camp Rilea consists of rapid infiltration basins that recharge the site's groundwater, which came online in 2011. Wastewater is drawn from the wastewater settling basins, treated, and is sent to four rapid infiltration basins. Treated wastewater is injected into the local aquifer via the rapid infiltration basins to recharge the groundwater. Since FY11, the basins have recharged the site's groundwater annually with approximately 7 Mgal of treated wastewater and stormwater.

## CONCLUSION

Camp Rilea built an inspiring Net Zero Water framework by reducing freshwater demand while completely offsetting the use of freshwater with alternative sources and groundwater recharge.

## Fort Bliss

El Paso, TX/NM | IMCOM | FY15 Facility Size: 22,900 KSF | FY15 Population: 46,600



### REDUCTION

In FY15, Fort Bliss reduced water use by 617 Mgal compared with the FY11 baseline. Fort Bliss exceeded the Net Zero WUI reduction goal, achieving a 48% reduction, and is on track to exceed the 52% reduction by FY20. The installation uses ILA water to irrigate two golf courses, which helps to offset potable water use. The site reduced ILA water use by 24% since FY13.

Fort Bliss created a “grass-to-desert” landscaping initiative that converts conventional turfgrass to native landscaping. This initiative uses Qualified Recycling Program (QRP) funds for the design as a first step to seeking the funds to execute the project. Fort Bliss’ “stop-watering-the-streets” program is reducing irrigating times and ensuring irrigation nozzles are properly aligned, which is reducing the amount of water spilling into streets and hardscape.

### EFFICIENCY

Informed by the Net Zero roadmap, the site’s primary water use is irrigation, which is the focus of water efficiency improvements. An ESPC project is under way that is implementing an advanced weather-based irrigation control system and upgrading the irrigation system equipment. Fort Bliss also implemented high-efficiency plumbing retrofits through their ESPC. Fort Bliss uses sustainment, restoration, and modernization funds and military construction (MILCON) funds to implement water efficiency projects where life-cycle cost analysis results are favorable.

### RECYCLE/REUSE

Fort Bliss recycles water in two tactical vehicle wash facilities, where water is cycled through the system multiple times. The site is exploring a potential onsite wastewater plant to reclaim treated wastewater as an alternative water source through an Environmental Security Technology Certification Program demonstration project that will reclaim wastewater for a cluster of buildings.

### RECHARGE

Fort Bliss currently does not recharge their local aquifer, but is considering a future project to reinject reclaimed wastewater into their groundwater, among other options, to reflect a regional approach to water management.

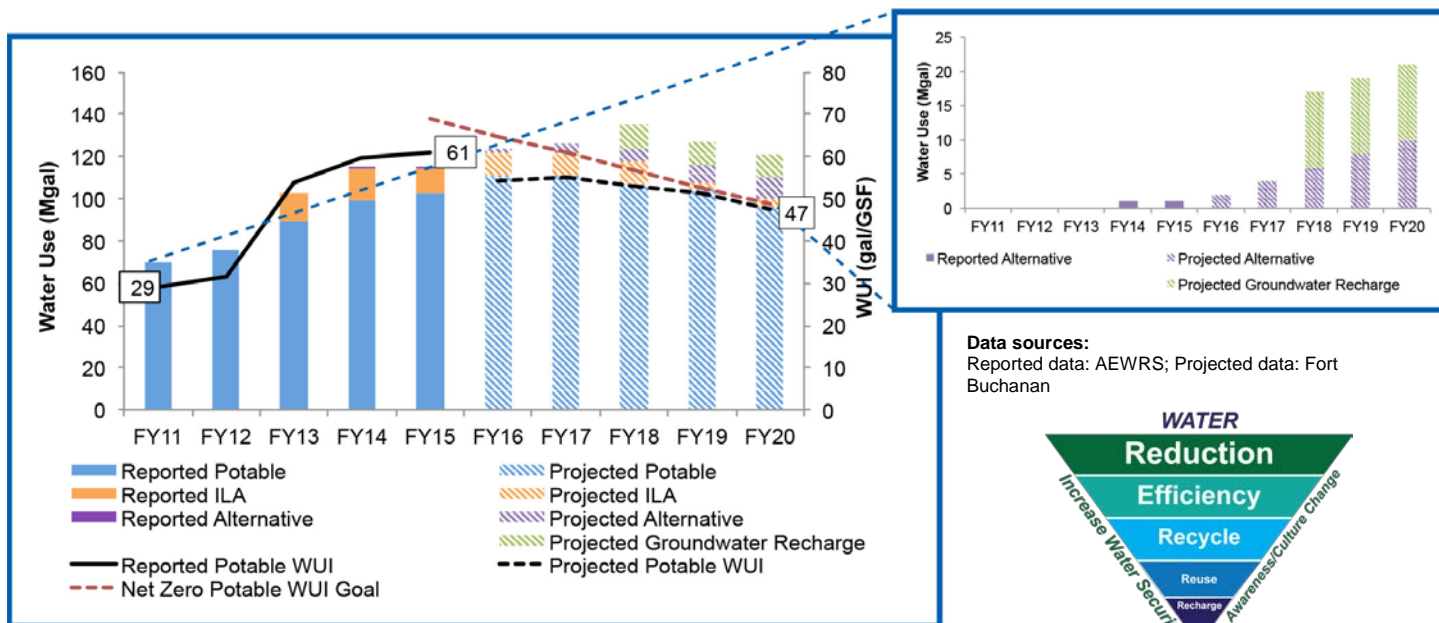
### CONCLUSION

The installation plans to aggressively pursue water efficiency, alternative water projects, and aquifer recharge to strive toward Net Zero Water by FY20.



## Fort Buchanan

San Juan, Puerto Rico | Army Reserve | FY15 Facility Size: 1,700 KSF | FY15 Population: 5,500



## REDUCTION

Fort Buchanan's water use increased from FY11 through FY15 because of significant growth experienced by the installation. However, Fort Buchanan achieved large water reduction from the baseline year of FY07, reducing total potable water use 78 Mgal and potable WUI reduction of 40%, exceeding the Net Zero potable WUI reduction goal. Fort Buchanan is pursuing additional initiatives to reduce water use. For example, the installation contracted a hydraulic modeling study to evaluate their existing potable distribution system. The installation will use the study results to prioritize line replacement and repair to decrease losses and help secure the water distribution system.

In addition, Fort Buchanan has an advanced water-metering program that uses interval data to better manage water use. Under the site's ESPC, a leak detection survey was performed that found and repaired eight leaks. To reduce purchased potable water, potable and non-potable wells were drilled onsite as part of the installation's ESPC.

## EFFICIENCY

The site leveraged their ESPC to implement water efficiency projects. The site implemented an irrigation efficiency project that included a new distribution system and advanced weather-based controls at the golf course. Fort Buchanan also used their ESPC to implement high-efficiency plumbing fixtures post-wide.

## RECYCLE/REUSE

The installation used their ESPC to implement innovative alternative water projects. Fort Buchanan installed 10 building rainwater harvesting systems used to flush toilets. In the next phase of their program, Fort Buchanan is working with the USACE and Pacific Northwest National Laboratory to evaluate the use of reclaimed wastewater from an onsite plant. The goal is to reclaim wastewater for golf course irrigation to offset freshwater use.

## RECHARGE

Currently, Fort Buchanan is not recharging their groundwater, but is investigating onsite injection of treated wastewater into the site's aquifer.

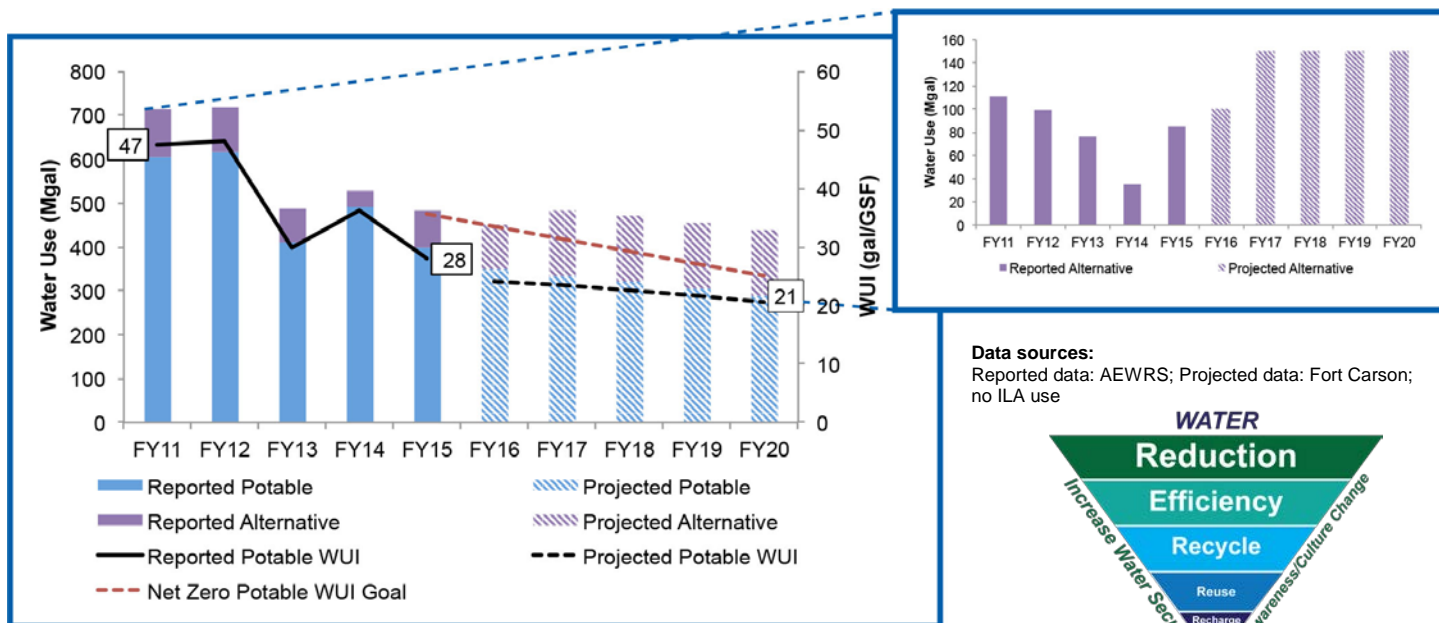
## CONCLUSION

Fort Buchanan's Net Zero Water Initiative is very innovative with a focus on reducing system losses and tapping into alternative water to offset freshwater use. Highlighting this success, Mr. Anibal Negrón, Chief of the Environmental Division at Fort Buchanan, won the GreenGov Presidential Sustainability Hero Award in FY14 for the development of the Net Zero Water program, among other sustainability initiatives at the installation.



## Fort Carson

Colorado Springs, CO | IMCOM | FY15 Facility Size: 14,200 KSF | FY15 Population: 31,900



### REDUCTION

In FY15, Fort Carson reduced water consumption by 208 Mgal from FY11 and exceeded the Net Zero WUI reduction goal, achieving a 47% reduction. The installation is on track to exceed the 52% reduction by FY20.

### EFFICIENCY

To increase water efficiency in buildings, Fort Carson leveraged their Net Zero roadmap, which determined that the largest end-uses at the site are plumbing and irrigation. Fort Carson has very successfully used their existing ESPC program to implement high-efficiency plumbing fixtures in nearly 200 buildings. In addition, the site has used Sustainment funds to implement an advanced irrigation control system that uses weather data to optimize the irrigation schedule. Fort Carson has partnered with the local utility to get rebates on high-efficiency plumbing fixtures and pre-rinse nozzles in dining facilities.

### RECYCLE/REUSE

Fort Carson's Net Zero Water initiative focuses on reclaiming treated wastewater from the installation's onsite wastewater treatment plant (WWTP), which significantly offset the use of potable water for landscape irrigation by 86 Mgal in FY15. Fort Carson expanded the reclaimed plant in FY15 using Energy Conservation Investment Program funds and is planning further expansion using the site's existing ESPC. The expansion will provide reclaimed water to irrigate additional landscape grounds across the post, which will increase reclaimed water use to 150 Mgal by FY20. Fort Carson may face a future challenge in expanding the reclaimed water plant because of a new Colorado State regulation that will require additional water treatment, which would require a significant investment.

### RECHARGE

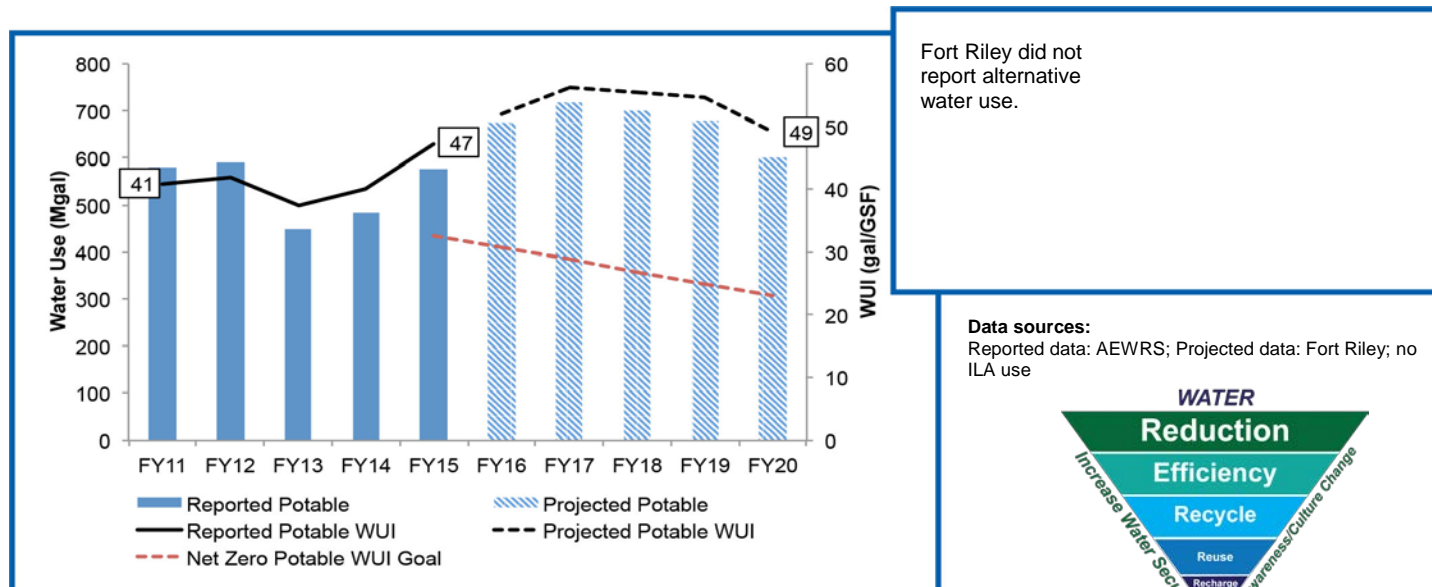
Fort Carson lacks the ability to recharge water to the originating watershed because the installation is supplied water through an inter-basin transfer from their municipal supplier.

### CONCLUSION

Overall, Fort Carson has made impressive progress toward their Net Zero Water objective of expanding the use of reclaimed water, and is projecting to offset over 50% of freshwater use with alternative water by FY20.

## Fort Riley

Fort Riley, KS | IMCOM | FY15 Facility Size: 12,200 KSF | FY15 Population: 22,000



## REDUCTION

In FY15, Fort Riley reduced water use by 4 Mgal from FY11, yet the installation's WUI increased by 16% over the same time frame. The installation's aging infrastructure, large water leaks, increased irrigation areas, and a malfunctioning cooling tower are culprits in the installation's increased water use. To help drive down water use in the future, Fort Riley is planning to meter family housing, which is the largest water user. Providing metered data to occupants as part of a long-term behavioral change effort will reduce water use.

Fort Riley is also targeting rehabilitation of water lines to reduce potable water use. The installation collaborated with EPA-ORD and Corvias, the Residential Communities Initiative partner, in a successful water conservation outreach campaign for family housing that included smart meters to monitor water use. The program yielded an 8% overall savings in monthly water use.

## EFFICIENCY

Fort Riley leveraged their ESPC to install high-efficiency plumbing fixtures in existing buildings. For new construction, Fort Riley requires LEED (Leadership in Energy and Environmental Design) standards that include a comprehensive set of water efficiency provisions. The installation is also targeting irrigation efficiency projects at the cemetery.

## RECYCLE/REUSE

Fort Riley installed two rainwater harvesting systems that provide water to flush toilets and provide makeup water for a cooling tower. The installation also worked with EPA-ORD on a membrane bioreactor project that treats wastewater directly from the sanitary sewer distribution system. EPA-ORD worked closely with Fort Riley to install and operate the system, and is investigating the potential to reclaim the treated wastewater for the central vehicle wash facility.

## RECHARGE

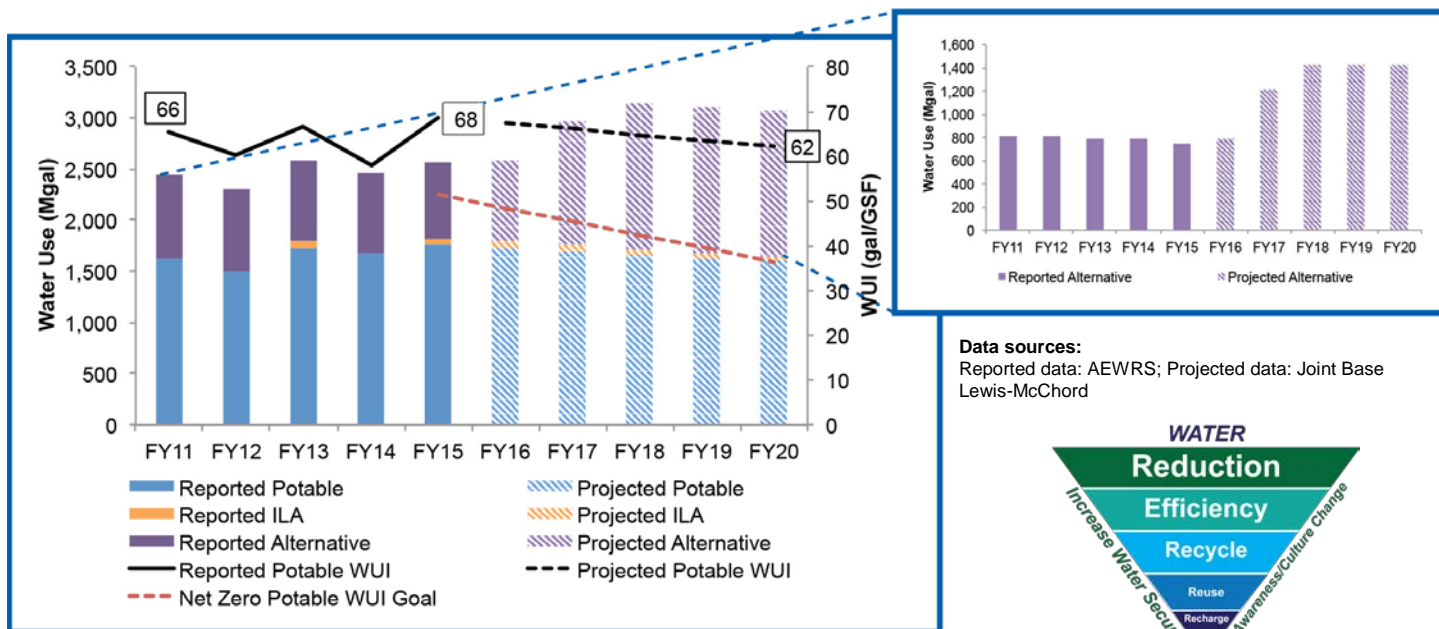
EPA-ORD is also demonstrating a permeable pavement project at a Fort Riley elementary school, which infiltrates stormwater into the ground to recharge the groundwater. EPA-ORD is assessing infiltration rate and groundwater chemistry. Results from this evaluation will inform decision-making about adopting these technologies at other installations, municipalities, and/or small communities.

## CONCLUSION

Although Fort Riley is not on the path to achieving Net Zero Water by FY20, their innovative partnership with EPA-ORD is helping accelerate innovative technologies and Net Zero concepts Army-wide.

## Joint Base Lewis-McChord

Joint Base Lewis-McChord, WA | IMCOM | FY15 Facility Size: 25,700 KSF | FY15 Population: 57,400



### REDUCTION

Joint Base Lewis-McChord (JBLM) reduced potable water use by 130 Mgal in FY15 compared to FY11 and reduced their potable WUI by 10%. The installation reduced ILA water use by 18% over the same time frame. Despite these reductions, the site did not achieve the Net Zero reduction goals because of increased water use from the FY07 baseline due to Fort Lewis combining forces with McChord Air Force Base in 2010. Also, recent warmer temperatures have increased irrigation needs. To help reduce water use, the site has an active leak detection and line replacement program through Sustainment funds. JBLM also plans to install water meters on buildings and processes to provide water use trends to will help improve water management. JBLM is currently converting traditional turf along their golf courses rough area to native turf to reduce irrigation needs during dry summer months.

### EFFICIENCY

The installation has an award-winning irrigation efficiency program at their golf courses, where the site is implementing distribution system upgrades, advanced controls, and native landscaping. The site also plans to implement high-efficiency plumbing projects for FY16 through FY19.

### RECYCLE/REUSE

JBLM uses treated brackish water in a water-source heat pump system at the installation's hospital. The installation implemented a rainwater harvesting system, which began operating in FY15 and collects rainwater for landscape irrigation that can offset 5,000 gallons daily of potable groundwater. The installation has programmed project to reclaim wastewater discharged from the new sanitary sewer treatment plant as part of the Net Zero Water projects.

### RECHARGE

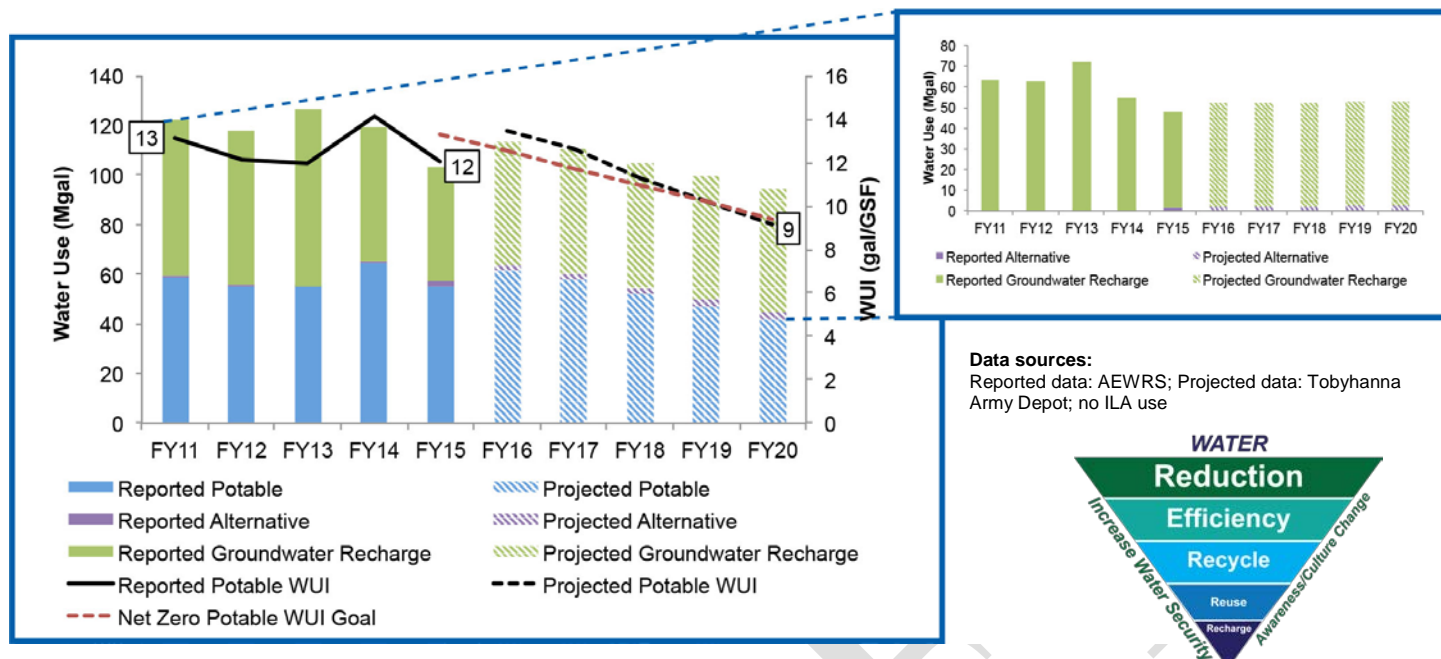
The site is implementing low-impact development, such as permeable pavement, to infiltrate stormwater back to the groundwater. The installation is working with the local government to ensure that they are meeting the reporting requirements of low-impact development projects as part of the ongoing efforts to reduce stormwater discharging to the Puget Sound. This effort is an important component of the installation's Net Zero efforts.

### CONCLUSION

To establish accurate reduction goals, JBLM plans to establish an adjusted baseline to account for the joint basing with the Air Force in 2010. A critical step in the site's Net Zero plan is to clearly define Net Zero Water and communicate the concept of offsetting potable groundwater with reclaimed wastewater and groundwater recharge. This is helping the installation prioritize projects and get stakeholder buy-in at all levels.

## Tobyhanna Army Depot

Tobyhanna, PA | AMC | FY15 Facility Size: 4,600 KSF | FY15 Population: 4,800



### REDUCTION

In FY15, Tobyhanna Army Depot exceeded the Net Zero WUI reduction goal, achieving a 39% reduction. The installation is on track to meet the 52% reduction by FY20.

The site reduced their water use through an active leak detection program, using advanced leak logging equipment that constantly monitors for system leaks. A single leak was identified and repaired; it accounted for 4 Mgal of annual water loss. The installation also performs real-time monitoring of system water pressure that can identify operational issues.

### EFFICIENCY

Tobyhanna Army Depot increased the efficiency of a large reverse osmosis system by optimizing the system design and operation. The system optimization included adding an advanced filtration system, pressure balancing to maintain consistent flow rates through the system, biological growth control, and system monitoring. These system efficiency improvements drastically reduced the amount of makeup water required. In addition, the improvements extended the life of the filter membranes that reduced overall operation costs. The installation also increased water efficiency by retrofitting plumbing fixtures with high-efficiency equipment.

### RECYCLE/REUSE

The installation upgraded their onsite WWTP to allow them to produce reclaimed wastewater. The upgrade includes additional treatment and storage to reclaim wastewater for reuse in plant processes. The installation plans to expand the use of reclaimed wastewater to 3 Mgal per year for other industrial uses.

### RECHARGE

Tobyhanna's Net Zero Water initiative includes releasing water back to the site's watershed by discharging treated wastewater to the local waterway, which recharges the groundwater through infiltration.

### CONCLUSION

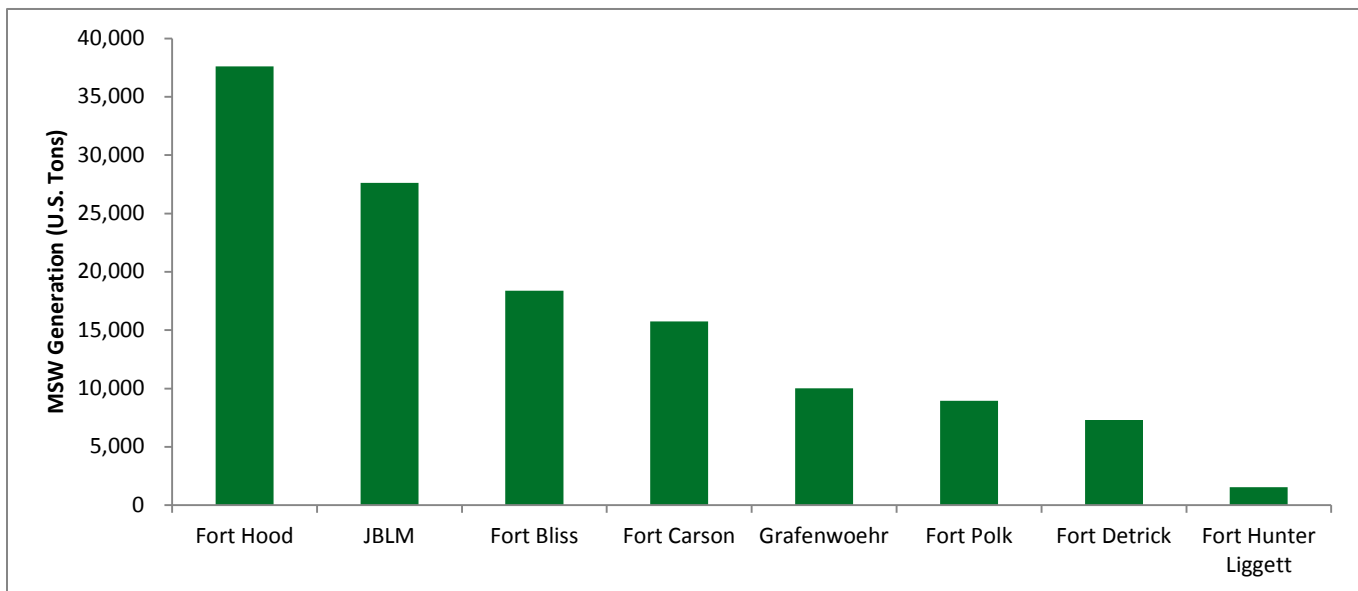
Tobyhanna's Net Zero framework allows the site to essentially close the loop on their water use by returning the water to the originating watershed. The installation projects that they will reduce their potable WUI by 52% in FY20 and return 100% of the amount withdrawn.

## Appendix D

### Net Zero Waste Pilot Installations

Each Net Zero Waste pilot installation provided an overview of their Net Zero progress to date. The associated one-page summaries in this appendix include

- Basic information about the installation's location, Army Command, facility square footage in thousand square feet (KSF), population, and per capita waste generation (in pounds per day [lb/day])
- Charts that illustrate consumption data for reported fiscal year (FY)11 through FY15 and projected years FY16 through FY20, including
  - Municipal solid waste (MSW) generation in U.S. Tons (reported through the Solid Waste Annual Reporting Website (SWARWeb) and projected data provided by the installation)
  - MSW diversion percentage (reported through SWARWeb and projected data provided by the installation) not including waste-to-energy (WTE)
  - The Department of Defense (DoD) diversion goal of 50% by FY15
  - Landfill diversion percentage for those installations with WTE plants to show progress in meeting the Net Zero Waste goal of zero landfill disposal.
- Narrative that highlights the installation's Net Zero Waste projects and successes and challenges related to meeting Net Zero objectives.



**Pilot Installations Waste Generation:** The chart depicts the pilot installations' FY15 MSW generation to provide a relative comparison of installation waste generation.



### Net Zero Waste Pilot Progress

Waste data and project implementation for each pilot installation was carefully reviewed to differentiate the progress the pilot installations achieved working towards Net Zero. The installations were classified into three groups, shown in Table D.1:

- **Projected to meet Net Zero** - This classification distinguishes sites that have:
  - Exceeded the Federal waste diversion goal and/or made significant progress since being a selected pilot in FY11
  - Projected to meet or nearly meet Net Zero Waste by FY20, eliminating landfill disposal
- **Significant progress** - This classification distinguishes sites that have:
  - Exceeded the Federal waste diversion goal and/or made significant progress since being a selected pilot in FY11
  - Made progress towards zero landfill disposal but are not projected to be near Net Zero Waste by FY20
- **Minimal progress** - This classification distinguishes sites that have:
  - Made minimal progress in waste diversion and landfill elimination

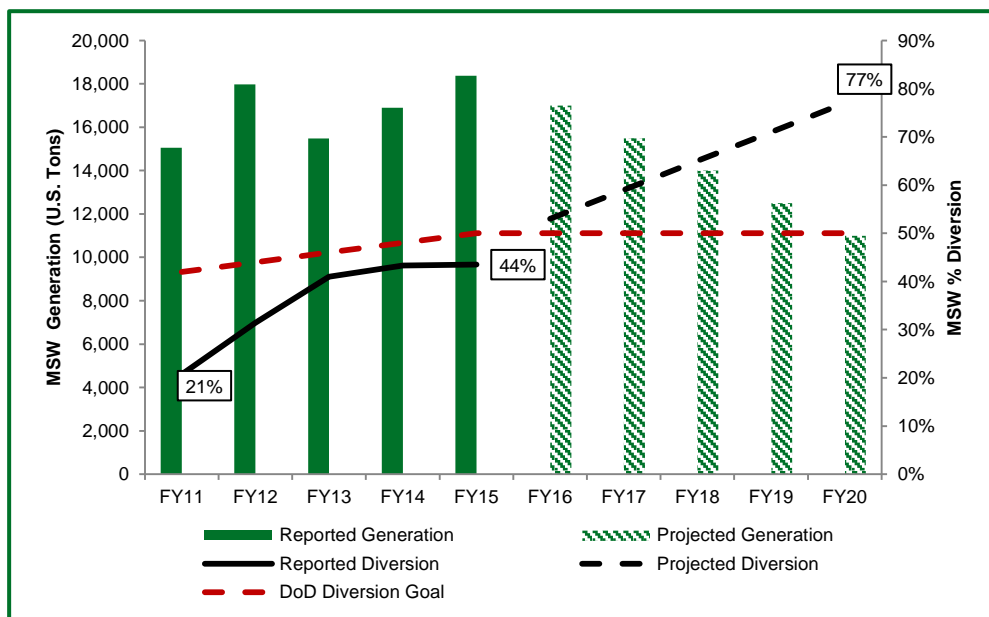
**Table D.1. Net Zero Waste Pilot Installation Progress Status**

Installation	Net Zero Waste Progress
Fort Detrick	Projected to meet Net Zero
USAG Grafenwoehr	Projected to meet Net Zero
Fort Bliss	Significant progress
Fort Carson	Significant progress
Fort Hood	Significant progress
Fort Polk	Significant progress
Joint Base Lewis-McChord	Significant progress
Fort Hunter Liggett	Minimal progress



## Fort Bliss

El Paso, TX | IMCOM | FY15 Facility Size: 22,900 KSF | FY15 Population: 46,600 | FY15 Per Capita Waste Generation: 2.2 lb/day



### Data sources:

Reported data: SWARWeb; Projected data: Fort Bliss



## REDUCTION

To support waste reduction, Fort Bliss is enhancing their 2010 “Green” Procurement Policy to implement sustainable and green purchasing.

## RE-PURPOSE

Fort Bliss initiated the “Reuse Roundup” with the Junior Enlisted Family Center to collect and donate reusable household goods to other military families.

## RECYCLING/COMPOSTING

Fort Bliss increased their solid waste diversion rate since 2011, diverting an additional 1,800 tons of MSW in FY15 (a 23% higher diversion rate than FY11). This steady increase is partly due to a significant outreach program, initiating single-stream recycling, and the success of their Qualified Recycling Program (QRP). Construction and demolition (C&D) generation varies by year depending on the types of construction projects occurring, if any; Fort Bliss reported 99% diversion of C&D waste for FY15. Fort Bliss enforced contracting clauses in all local Mission and Installation Contracting Command (MICC) and U.S. Army Corps of Engineers contracts and required diversion data as a deliverable for each contract.

Characterization studies at Fort Bliss identified the opportunity for wood debris shredding/composting and food waste dehydration/composting. In addition, the installation developed a performance work statement for waste diversion that integrates recycling and waste hauling to maximize the diversion rate (scheduled for FY17).

## ENERGY RECOVERY

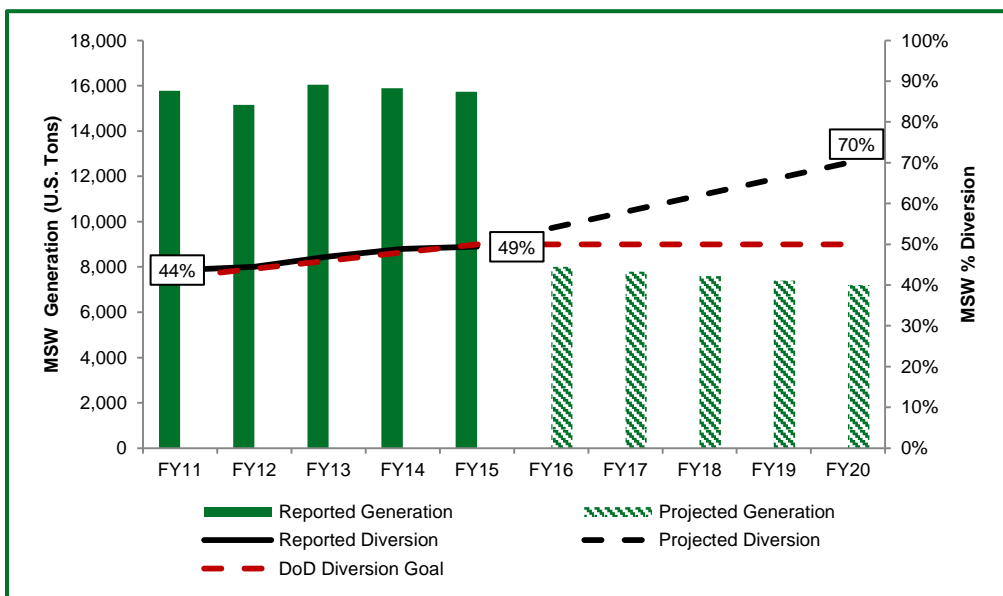
Fort Bliss attempted to develop a WTE plant using both onsite and offsite MSW, but legal issues cancelled the project in 2013. There are no current plans for WTE at Fort Bliss because the annual waste stream is too small to fuel an economically feasible plant.

## CONCLUSION

The Fort Bliss Net Zero goals are to minimize landfill deposition and attain the highest achievable diversion rate. Fort Bliss also strives to have support from Unit Commanders to increase participation in their program. Fort Bliss reports that they are on the path to meeting their Net Zero goals, but the site will not meet zero landfill by FY20 without a WTE solution.

## Fort Carson

Colorado Springs, CO | IMCOM | FY15 Facility Size: 14,200 KSF | FY15 Population: 31,900 | FY15 Per Capita Waste Generation: 2.7 lb/day



**Data sources:**  
Reported data: SWARWeb; Projected data: Fort Carson



### REDUCTION

To support waste reduction, Fort Carson is developing a green procurement plan.

### RE-PURPOSE

Fort Carson implemented a furniture reuse program, working with the Defense Logistics Agency to donate excess, serviceable furniture to charity in lieu of landfill disposal.

### RECYCLING/COMPOSTING

Fort Carson gradually has increased their high diversion rate since 2011, reporting 49% for FY15. The installation implemented a single-stream recycling program in FY14 in low-recycle areas. The QRP continues to support itself financially and to incentivize recycling within the military units. C&D generation varies by year depending on what types of construction projects are occurring, if any; Fort Carson reported 81% diversion of C&D waste for FY15. Fort Carson requires that building demolition include elements of deconstruction to help recycling efforts.

To increase recycling, Fort Carson executed an MSW contract that requires the contractor to recycle a percentage of everything they pick up, with the percentage growing over time. Other improvements include the addition of mattress, electronic, and battery recycling. The site also implemented a Net Zero unit contest to incentivize recycling within military units. Fort Carson sends yard debris, dining facility food waste, and sewage treatment plant biosolids to a local composting operation.

### ENERGY RECOVERY

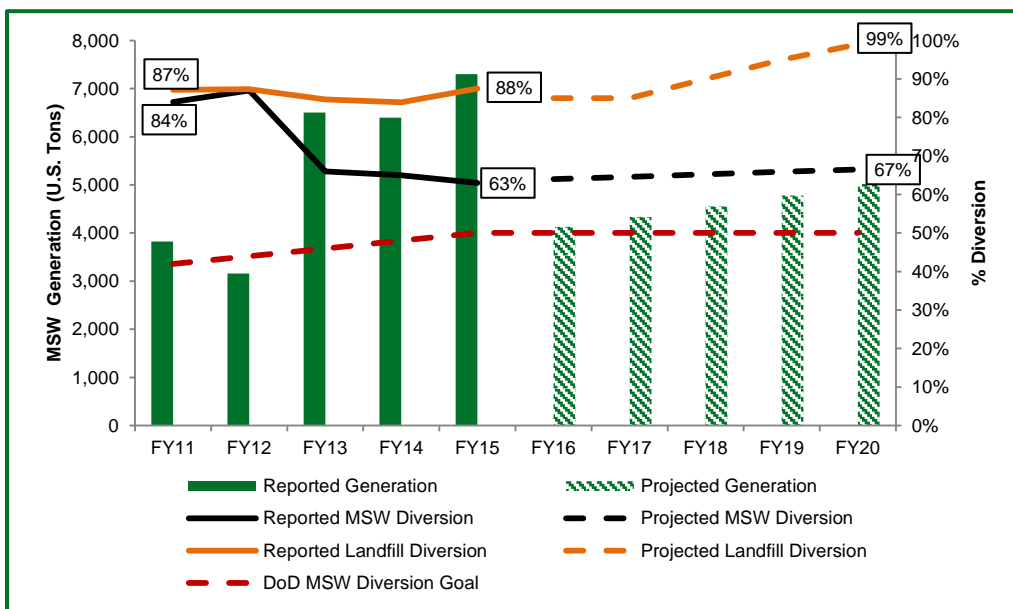
Fort Carson collaborated with their local utility to demonstrate the use of wood waste co-fired with coal to generate energy, which the site bought back under a new rate. Although successful, when stricter regulations were placed on the co-firing unit, it ceased operations.

### CONCLUSION

Fort Carson is on track to continue improvement in waste diversion, but the installation is concerned that this will plateau due to challenges with Soldier participation and the cost to recycle some items. In addition, the two challenges continue to be low landfill costs compared to recycling revenue and Soldier participation. This, coupled with the lack of economically feasible WTE options, makes Net Zero Waste by FY20 unlikely at the site.

## Fort Detrick

Frederick, MD | IMCOM | FY15 Facility Size: 3,500 KSF | FY15 Population: 11,000 | FY15 Per Capita Waste Generation: 3.6 lb/day



### Data sources:

Reported data: SWARWeb; Projected data: Fort Detrick



## REDUCTION

An onsite landfill that needs daily cover adds to the higher waste generation rate. The site will begin diverting sewage sludge in FY16, removing the need for daily landfill cover, which currently adds to waste generation.

## RE-PURPOSE

Fort Detrick runs a thrift store for repurposing household items including furniture, clothing, and appliances. Older buildings such as the Army Forces Reserve Center and former firehouse are repurposed for other activities instead of being demolished.

## RECYCLING/COMPOSTING

Fort Detrick had a slight drop in diversion over the last few years due to loss of recycling center employees. However, the site still exceeded the diversion goal; a rate of 63% was reported for FY15. The installation established a contract with a local compost facility to accept wastewater treatment sludge, which could increase the diversion rate by 20% in FY16. C&D generation varies by year depending on what types of construction projects are occurring if any; Fort Detrick did not generate any C&D data to report in FY15. All clean wood is shredded at the landfill and hauled offsite to a local farmer for mulch.

A major issue affecting success at Fort Detrick is the loss of its recycling center employees since 2012. Each reduction in manpower caused a corresponding reduction in recycling rate. Having to share labor created inefficiencies that prevent material segregation at the rate that was occurring with designated recycling center staff. To remedy this situation, an upcoming custodial contract renewal will include collecting and separating recyclable materials.

## ENERGY RECOVERY

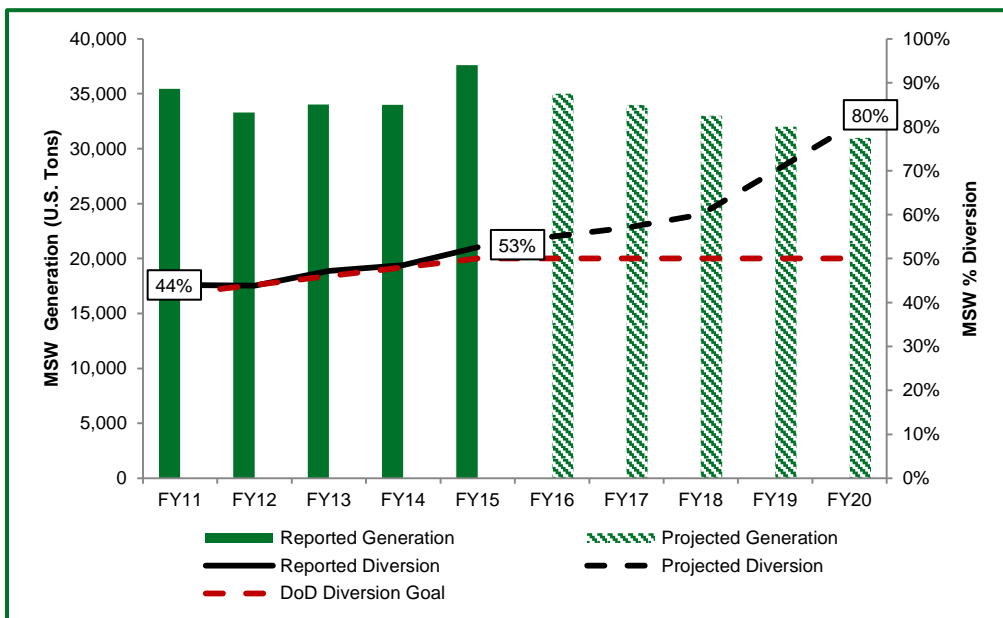
Fort Detrick operates an incinerator stack heat/steam system to reuse valuable heat energy instead of releasing it into the atmosphere. The units have waste heat boilers that produce steam for use on the installation. Currently, the only material landfilled on Fort Detrick is the ash from incineration.

## CONCLUSION

Fort Detrick's overall program goal is to achieve Net Zero Waste by FY20. Fort Detrick is currently on track to meet the goal of zero landfill by FY20, with the understanding that the site needs to determine an alternative to sending incinerator ash to a landfill.

## Fort Hood

Killeen, TX | IMCOM | FY15 Facility Size: 20,700 KSF | FY15 Population: 66,700 | FY15 Per Capita Waste Generation: 3.1 lb/day



**Data sources:**  
Reported data: SWARWeb; Projected data: Fort Hood



## REDUCTION

To reduce waste generation, Fort Hood implemented paper reduction efforts, including paperless processing, reduced printing, double-sided printing, and a junk mail opt out campaign. The site also offered education to the dining facilities on food waste reduction and bulk purchasing, and installed water bottle refill stations to reduce the need to purchase of plastic water bottles. In addition, Fort Hood has continued its success with a zero boot print challenge, communication campaigns, and Net Zero workshops. However, continual education and training is required due to high Soldier turnover.

## RE-PURPOSE

Re-purposing efforts include an onsite thrift store, installation yard sales, charity donations, moving box reuse program, furniture reuse programs, and a reusable bag education campaign. Fort Hood is working on a program to help collect and donate personal items from relocating Soldiers.

## RECYCLING/COMPOSTING

Fort Hood diverted 53% of their solid waste in FY15, increasing 11% from FY11. This success is partly due to adding single-stream recycling in housing areas and ensuring accurate data are reported for all diversion efforts. In addition, they have designated unit recycle coordinators. C&D generation varies by year depending on what types of construction projects are occurring, if any. Fort Hood reported 71% diversion of C&D waste for FY15, a slight decline attributed to cancellation of its C&D Inert Material Management Unit operation, which had significantly reduced material reuse.

The Recycle Center began accepting plastic bags and plastic types 4–7, glass, hard drives, and coat hangers, and purchased a Styrofoam condenser. Future plans include expanding to a single-stream recycling operation.

Fort Hood has a yard waste composting facility. The installation recently completed a successful food waste pilot study, which has transitioned to an on-post food waste composting program; it has the potential to divert 44% of food waste entering the landfill. Currently, food waste is partially handled through donations to local pig farmers and food dehydrators.

## ENERGY RECOVERY

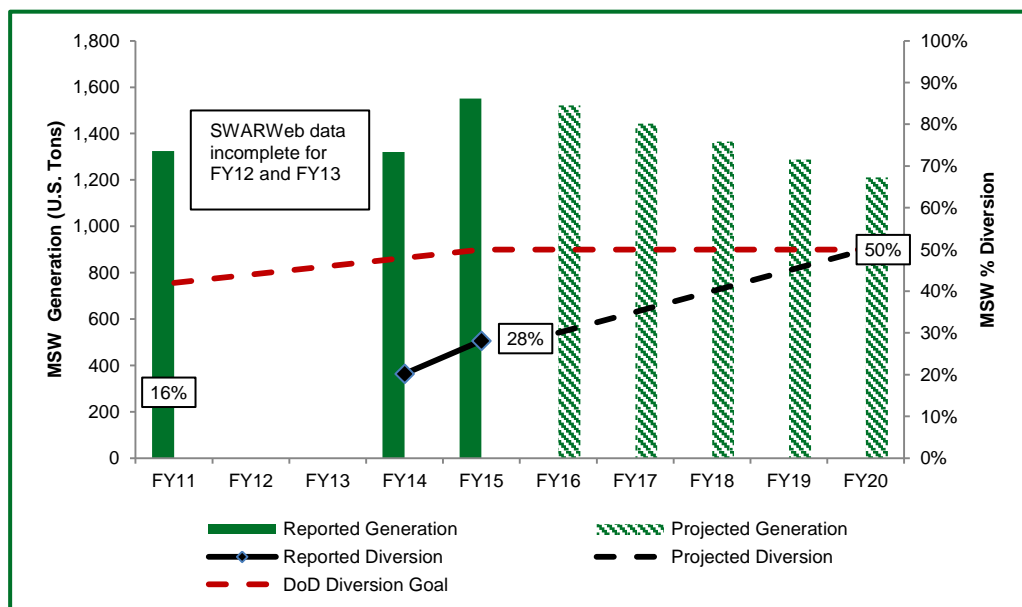
Fort Hood is researching small-scale WTE technologies but this is a low priority for the installation.

## CONCLUSION

Fort Hood defined a path to Net Zero through continual education, incentives, single-stream recycling, and increased composting, and will continue to increase efforts to divert recyclables through the new single-stream operation and expand composting with the future onsite food waste composting facility. Combining these two efforts, Fort Hood has the potential to divert 75% of the material currently entering the landfill.

## Fort Hunter Liggett

Fort Hunter Liggett, CA | Army Reserve | FY15 Facility Size: 1,400 KSF | FY15 Population: 2,200 | FY15 Per Capita Waste Generation: 3.9 lb/day



**Data sources:**  
Reported data: SWARWeb; Projected data: Fort Hunter Liggett



### REDUCTION

Fort Hunter Liggett's waste generation increased 227 U.S. Tons between FY11 to FY16 due to growing operations. Waste generation data from the installation is incomplete in SWARWeb for FY12 and FY13.

### RE-PURPOSE

The installation does not currently have reuse/re-purposing efforts.

### RECYCLING/COMPOSTING

Fort Hunter Liggett has increased their solid waste diversion since FY11 by 12%, reporting 28% in FY15. This doubles the tonnage of waste diverted. Due to the site's remote location, recycling is challenging. However, they successfully established a QRP. The ability to sell collected materials should increase the diversion over the next few years and provide funding for other Net Zero hierarchy actions. C&D generation varies by year depending on what types of construction projects are occurring, if any.

Fort Hunter Liggett's program was built in two years and they had their first sale in FY15. The program diverted more than 500 tons of commodities (FY15 = 388 tons; FY14 = 103 tons) and generated just over \$1 million since its inception. The site is exploring the development of composting to help address food waste.

### ENERGY RECOVERY

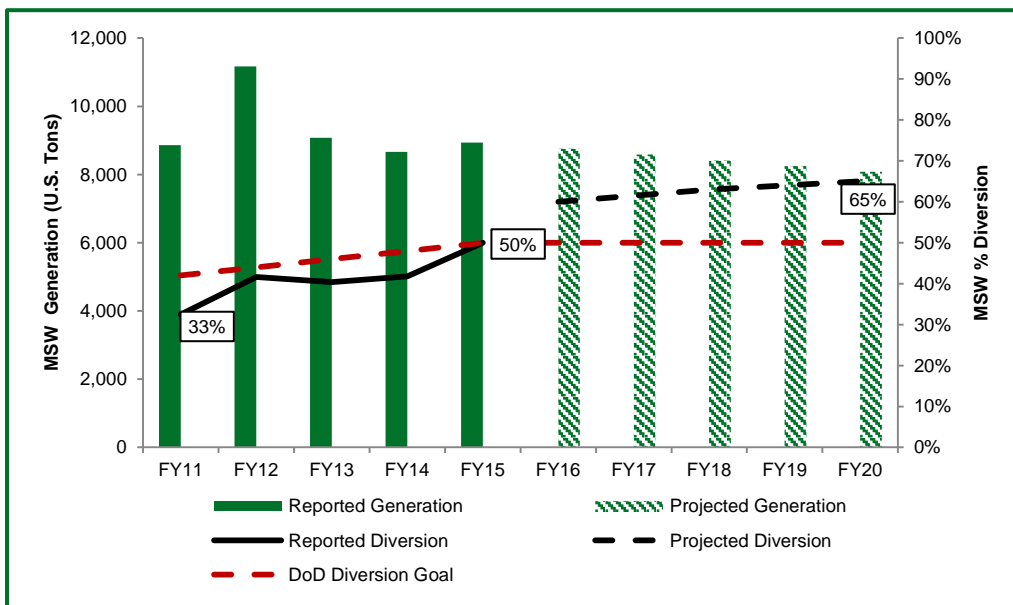
Through an Environmental Security Technology Certification Program project, Fort Hunter Liggett is in the process of constructing a WTE facility on-post, which is expected to be operational in 2017. The gasifier is a 10-ton/day unit but is limited to burning wood chips and therefore the installation expects that a very small percentage of total waste will be sent to the unit. Fort Hunter Liggett is researching options for making more waste available to the WTE, including wood debris and telephone poles; the installation is pursuing collaborations with the Army National Guard's Camp Roberts.

### CONCLUSION

Fort Hunter Liggett is striving to reach zero landfill by FY20, but doing so is contingent upon their WTE expanding waste beyond wood chips and food waste being addressed. The site plans to continue to focus efforts on the upper tiers of the Net Zero hierarchy: reduce, re-purpose, and recycle.

## Fort Polk

Fort Polk, LA | IMCOM | FY15 Facility Size: 8,500 KSF | FY15 Population: 19,700 | FY15 Per Capita Waste Generation: 2.5 lb/day



### Data sources:

Reported data: SWARWeb; Projected data: Fort Polk



## REDUCTION

Fort Polk made efforts to promote waste reduction through culture change, including use of a recycling video to educate environmental compliance officers, a set of public service announcement videos for Public Affairs Offices, and the Net Zero Waste Facebook page.

## RE-PURPOSE

To support re-purposing onsite, Fort Polk implemented reuse programs: the Office Supply ReStore and the Packaging Supply ReStore. Fort Polk collects and chips green waste during installation cleanup events to be used onsite.

## RECYCLING/COMPOSTING

Fort Polk waste generation is fairly stable and its MSW diversion increased by 27% since FY11, which, when coupled with changes in the site's generation rate, equates to 14,860 fewer tons of waste going to landfill. This success is partly due to the site's QRP-managed recycling center, curbside recycling program, and outreach and incentives program. Fort Polk reported 70% diversion of C&D waste for FY15, but the percentage varies by year depending on the types of construction projects occurring. The C&D contracts do not currently include Net Zero Waste concepts; it is a future priority to address the contract changes and coordination needed to incorporate deconstruction and other Net Zero approaches.

To increase recycling, Fort Polk is conducting building-level recycling assessments to ensure the resources are available and to provide guidance on best management practices. Fort Polk is also implementing efforts to establish a Net Zero Waste Council and working groups to manage the path forward.

Fort Polk initiated a curbside recycling program that supplements its manned recycling center and 24-hour drop off. The installation established an incentive program that transfers generated recycling funds to the generating unit based on the percentage of paper and cardboard recycled during the program year. Food waste and composting is a future priority. Challenges for Fort Polk include the lack of infrastructure to handle hard-to-recycle items and flexibility of contracts to incorporate language to increase materials diverted and to implement a diversion-based contract.

## ENERGY RECOVERY

Fort Polk does not have access to regional WTE options and has not identified any viable options for an onsite WTE.

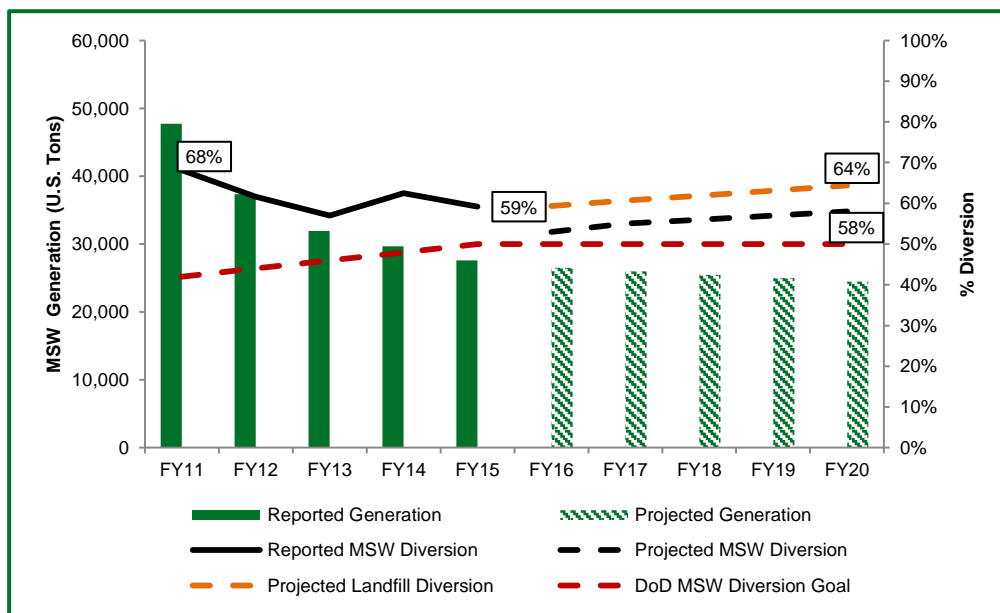
## CONCLUSION

Fort Polk's goal is to eliminate waste entering landfills before FY20. The site is focusing on recycling and waste reduction. To meet Net Zero Waste goals by FY20, Fort Polk will need to have WTE, a comprehensive organic waste solution, a fully supportive solid waste management contract, and rotational waste solutions.



## Joint Base Lewis-McChord

Tacoma, WA | IMCOM | FY15 Facility Size: 25,700 KSF | FY15 Population: 57,400 | FY15 Per Capita Waste Generation: 2.6 lb/day



**Data sources:**  
Reported data: SWARWeb; Projected data: Joint Base Lewis-McChord



### REDUCTION

Joint Base Lewis-McChord (JBLM) updated their integrated solid waste management plan to include the Yakima Training Center (YTC); however, plans for waste reduction will require support from the MICC.

### RE-PURPOSE

Re-purposing activities include swap meets, yard sales, and thrift store donations.

### RECYCLING/COMPOSTING

JBLM has maintained their high diversion rate since FY11, reporting 59% for FY15. The site reported 100% diversion of C&D waste for FY15. The installation collects and stockpiles waste concrete and asphalt generated from in-house projects, then reclaims the material to provide high-quality aggregate for onsite projects.

JBLM expanded their recycling program to include lead acid battery, textile, toner cartridges, and book recycling. They also expanded their composting program, and in FY15 one-third of the 3,278 tons of organic materials composted was food waste from dining facilities and commissaries, creating significant cost savings. The composting stream now includes wood debris, yard waste, horse stable waste, and biosolids from the wastewater treatment plant. The site also is piloting the use of compostable service-ware at the dining halls to maximize composting opportunities.

JBLM now includes the YTC. This adds a new set of challenges based on a more geographically remote and rural location with a depressed to non-existent local recycling market.

### ENERGY RECOVERY

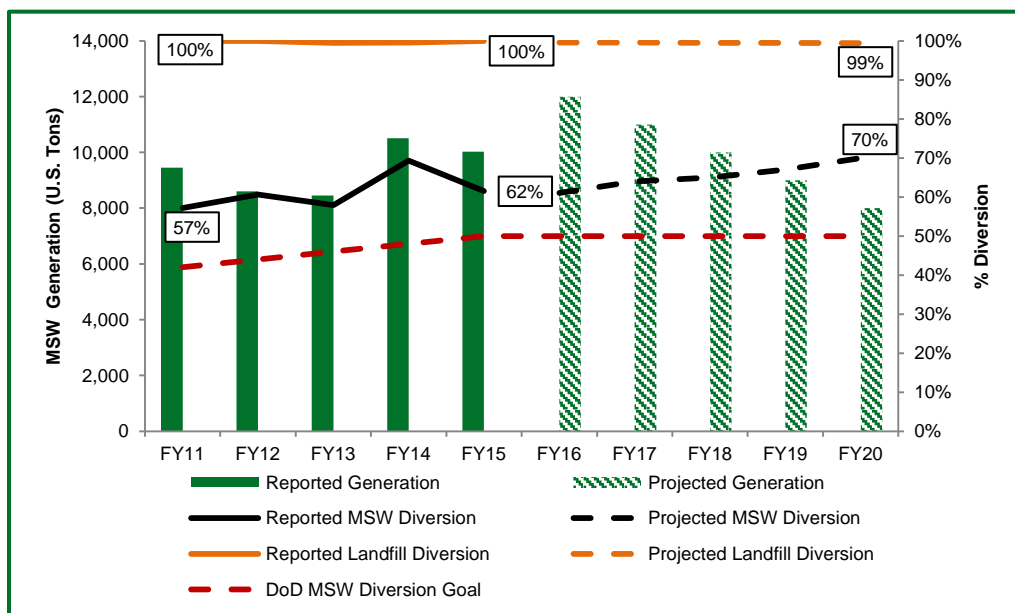
A regional WTE anaerobic digester facility is being constructed near the installation. The installation is working to modify the refuse contract to ensure transport to that facility is economically feasible.

### CONCLUSION

JBLM's goal is to meet Net Zero Waste by FY20. JBLM is on track to reach their goal by FY20 if the site can secure a contract with the regional WTE and resolve the YTC challenge.

## USAG Grafenwoehr

Grafenwoehr, Germany | IMCOM | FY15 Facility Size: 12,400 KSF | FY15 Population: 19,800 | FY15 Per Capita Waste Generation: 2.8 lb/day



**Data sources:**  
Reported data: SWARWeb; Projected data: USAG Grafenwoehr



## REDUCTION

U.S. Army Garrison (USAG) Grafenwoehr, an installation that is a part of USAG Bavaria, has equipped the motor pools with bulk dispensing units to eliminate individual packaging waste.

## RE-PURPOSE

USAG Grafenwoehr uses two Free-cycle Centers to encourage re-purposing. The site now returns empty toner cartridges to the manufacturer for refilling. In addition, installation housing residents host yard sales. Currently, tree cuttings are chipped onsite and used as ground cover.

## RECYCLING/COMPOSTING

USAG Grafenwoehr has continued to improve their high solid waste diversion rate since FY11, and sent nothing to a landfill in FY15. The slight drop in diversion rate from FY12 to FY13 was due to an increase in short-term rotational units, which are not trained to the level of the stationed units and families; this affects the amount of material being recycled. The number of units onsite for a given year will continue to cause fluctuations in the overall diversion rate. C&D generation varies by year depending on the types of construction projects that are occurring, if any. USAG Grafenwoehr reported 99% diversion of C&D waste for FY15.

To increase recycling, the garrison added containers for personal electronic waste to the recycling centers. Grass and brush trimmings are composted offsite via a contract.

## ENERGY RECOVERY

For FY15, the site reported 0 tons sent to a landfill. All non-recyclables in the MSW are shredded and sent to an offsite WTE facility. Any data reported in previous years as MSW disposal is road rubbish, which must be diverted to special waste disposal sites and cannot be recycled, by German law.

## CONCLUSION

USAG Grafenwoehr is currently meeting the zero landfill goal for MSW. The site will continue to focus on the upper tiers of the Net Zero Waste hierarchy as much as possible, while adhering to the local laws and regulation.

## Appendix E

### Non-Pilot Net Zero Installations Overview

Since the Net Zero Directive 2014-02 was issued in January 2014, Commands have been supporting Net Zero activities at all installations. This appendix provides an overview of non-pilot installations that are pursuing implementation of the Net Zero strategy. The information below was submitted by the Commands and highlights the next steps non-pilot installations are taking to expand Net Zero practices across the Army.

#### E.1 Installation Management Command

Installation Management Command (IMCOM) supports projects that implement the Net Zero principles across many of their installations. Information below highlights examples of specific projects from several installations.

##### **Fort Bragg, North Carolina**

Fort Bragg's energy program includes both energy efficiency projects and renewable energy. The installation has achieved a steady decrease in energy use intensity (EUI) since fiscal year (FY) 2003. A FY15 decrease of 5% was accomplished by recommissioning equipment, re-tuning building control systems, using more efficient technology, and educating occupants. In addition, energy efficient technologies are used in new construction and renovation. Energy projects are funded through the Energy Conservation Investment Program (ECIP), Environmental Security Technology Certification Program (ESTCP), and energy savings performance contracts (ESPCs). Although renewable energy is challenging due to compatible land use issues, a 5 megawatt (MW) cogeneration system was installed in 2002 and became operational in 2004. Fort Bragg has reduced water usage by implementing water conservation plans and policies. However, opportunities for recycling and reuse of water are limited and mainly consist of rainwater harvesting for irrigation. All water is used, treated, and returned to the same river basins therefore helping the installation reach Net Zero Water.

Fort Bragg has a Net Zero Waste program that includes the reuse of construction and demolition (C&D) waste such as concrete, brick, and asphalt; the waste is diverted to a crushing operation. Serviceable pallets are collected and reused, while unserviceable pallets are ground and mixed with mulch. Lithium ion batteries that are disposed are tested, and all batteries with a 30% charge or more are reissued to units for training exercises. Recycling of bottles, cans, cardboard, brass, and metals is promoted. An incentives program is in place to encourage maximum participation. Food waste from dining facilities is composted. Waste projects are funded by a Qualified Recycling Program (QRP) and an environmental quality program. These efforts have led Fort Bragg to achieving a municipal solid waste (MSW) diversion rate of 32% and C&D diversion rate of 62%.

**Joint Base Myer-Henderson Hall, Virginia**

Joint Base Myer-Henderson Hall (JBM-HH) is continually planning new energy projects for reduction in energy consumption. The use of light-emitting diode (LED) lighting technologies has made a significant improvement in reducing electric consumption and the need for operations and maintenance (O&M) services for many buildings at JBM-HH. ESPCs and utility energy service contracts (UESCs) are used to implement various efficiency projects. A new solar photovoltaic (PV) renewable energy contract for Fort McNair building rooftops is under way. The contract development team included the National Renewable Electric Laboratory with support from the local utility companies in the review and development of this new purchase power agreement contract. Energy projects are submitted to IMCOM for approval and award, including ECIP funding.

High-efficiency plumbing fixture projects are used to reduce water use. Research has identified a one million gallon water storage tank, installed by the U.S. Army Corps of Engineers (USACE), which can be used to store stormwater for an alternative water source for irrigation or emergency use. ESPCs and UESCs are used to install water projects. The ECIP is also used to fund water projects.

JBM-HH diverts several tons of manure from horse stables per week to a manure composting operation. Currently, JBM-HH is investigating two potential Net Zero Waste initiatives: 1) municipal solid waste (MSW) diverted to offsite to a waste energy plant, which if successful will result in 100% waste diversion; and 2) partnership with the local county, which offers recycling and composting, for waste disposal and recycling to realize the cost savings from the economies of scale.

**Picatinny Arsenal, New Jersey**

The Picatinny Arsenal achieved over 38% reduction in site EUI and over 46% reduction in site total energy usage from FY03 to FY15. Efficiency improvements were achieved through an ESPC that included a thermal energy decentralization project as well as continual improvements in heating, ventilation, and air-conditioning (HVAC) controls, lighting efficiency, and building envelopes. A 2 MW cogeneration system is under review to be funded through a modification to the existing ESPC. A 600 kilowatt (kW) solar PV system was installed, will be expandable to over 1 MW, and is expected to produce 5 to 7% of daily electricity use. Past and expected future funding sources have included ESPCs and Sustainment funding sources.

**Fort Drum, New York**

The installation installed a biomass plant that supplies 100% renewable electricity and energy security. The environmental program has a single-stream recycling program to divert landfill disposal.

**Fort Lee, New Jersey**

The installation successfully deployed a food waste composting system that has been expanded to additional sites.

### **Joint Task Force-Bravo–Soto Cano Air Base, Honduras**

Soto Cano Air Base is currently planning projects that include Net Zero principles including the following:

- Energy efficiency improvement through HVAC projects.
- Renewable energy project planning, including
  - Construction of a substation that will connect to Honduras National grid (which is 51% renewable)
  - Installation of a 5 MW PV system
  - Use of biofuels (biodiesel and dry biomass options)
- Water awareness campaigns
- Plumbing fixture retrofit projects
- Installation of wastewater treatment for effluent reuse
- Establishment of a QRP
- Closure of Soto Cano's landfill and finalization of a contract with the local municipality
- Investigation of waste-to-energy technologies.

## **E.2 Army National Guard**

The following information provides highlights of individual state's progress in implementing Net Zero projects at Army National Guard (ARNG) sites.

### **California ARNG**

- Camp Parks Armory and Field Maintenance Shop updated to LED lighting via the Pacific Gas and Electric Company (PG&E) Direct Install program. There are plans to do more of these projects as quickly as possible for both PG&E and Southern California Edison territory accounts.
- California ARNG is working to implement a small PV system at Okinawa Armory and a 10+ MW PV system at Los Alamitos.

### **Colorado ARNG**

- Colorado ARNG continuously optimizes buildings via commissioning, energy audits, and the Operation ResourceWi\$e occupant engagement program.
- Colorado ARNG installed weather sensors and irrigation controls at several sites to reduce landscape watering.

**Georgia ARNG**

- Georgia ARNG runs a single-stream recycling program at the Clay National Guard Center, one of Georgia ARNG's largest waste-producing installations, and diverted approximately 31.4 tons of MSW in FY15. Personnel are looking into converting this program into a multi-stream QRP and expanding the existing program statewide across all facilities.

**Indiana ARNG**

- Indiana ARNG is working to install hybrid energy and wind prototype projects. After a short test period, Indiana ARNG will decide which system to install on future projects.
- Indiana ARNG updated construction contracts to require recycling of 50% of nonhazardous solid waste and 60% of construction and demolition waste.

**Kentucky ARNG**

- Currently, 75% of energy used at the site is from onsite renewable resources. The site also initiated a recycling program and is performing waste audits to determine actual waste disposal, and performing a feasibility study to assess the incineration of solid waste. The Wendell H. Ford Training Center produces 21% of their electric capacity needed onsite using 883 kW of PV. The site upgraded exterior lighting to LEDs with dual control photo motion sensors, upgraded interior high-bay lighting to LEDs with occupancy sensors, and used direct digital control to optimize HVAC scheduling for building occupancy. The site also initiated an energy awareness campaign to educate individuals at all facilities.

**Michigan ARNG**

- Fort Custer will deploy a 252 kW solar array and a 200 kW wind funnel.
- Camp Grayling will deploy 2,000 kW wind funnels and a virtual pipeline to capture natural gas from orphan/abandoned wells to heat buildings and to power backup generation units in anticipation that it will lead into one or more micro-turbines. Personnel operate wells to provide water throughout the installation and wastewater is treated onsite.
- Both Fort Custer and Camp Grayling have aggressive QRPs.
- Michigan ARNG is exploring partnership agreements with local partners to deploy biomass energy to areas that have biomass resources and is working on contractual agreements with service partners who will recycle residual solid waste.

**Minnesota ARNG**

- The Minnesota (MN) ARNG implemented the Energy Efficiency Challenge, which is an outreach program that tracks and facilities energy performance and incentivizes efforts to increase conservation and reduction. Two exemplary programs include Alexandria and Long Prairie armories, both achieving a 29% reduction in energy use. The program is funded through a QRP.



- MNARNG is implementing a geothermal heating/cooling system composed of horizontal and vertical wells that features an annual savings of 1941 MMBtus.

#### **New Jersey ARNG**

- The New Jersey ARNG implemented a "High Efficiency Lighting Program" (HELP) to install LED fixtures.

#### **New York ARNG**

- The energy manager is collaborating with the planning, construction, and engineering department to install rainwater harvesting capability as part of roof upgrades.

#### **New Mexico ARNG**

- The New Mexico ARNG is recycling used oil, antifreeze, drained/crushed filters, and sealed lead acid batteries.

#### **North Carolina ARNG**

- The North Carolina ARNG performs retro-commissioning design services to identify opportunities for improved energy performance.

#### **Texas ARNG**

- The Texas ARNG performs audits of solid waste agreements to ensure that construction contracts provide C&D diversion as part of invoicing.

### **E.3 U.S. Army Reserve**

The U.S. Army Reserve (USAR) developed a Net Zero program across the Command that incorporates Net Zero principles. The initial activity was an assessment of the potential for integrated Net Zero Energy, Water, and Waste at 10 locations across the Command. Comprehensive Net Zero roadmaps were developed for each site that identified Net Zero Energy, Water, and Waste projects, including energy and water efficiency, renewable energy, alternative water, and waste reduction. Overall, these roadmaps identified 40,700 million British thermal units (MMBtu) in energy savings, 6.6 million gallons (Mgal) of water savings, and an 86% reduction in waste generation. The USAR developed a detailed strategy to help these sites implement the projects and move toward Net Zero. The 10 pilot installations are

- American Samoa Army Reserve Center, American Samoa
- Guam Army Reserve Center, Guam
- Maui Army Reserve Center, Maui, Hawaii
- Saipan Army Reserve Center, Saipan
- March Army Reserve Center, Riverside, California
- Sloan Army Reserve Center, Sloan, Nevada

- Ceiba Army Reserve Center, Ceiba, Puerto Rico
- Orlando Army Reserve Center, Orlando, Florida
- Puerto Nuevo Army Reserve Center, San Juan, Puerto Rico
- Joliet Army Reserve Center, Wilmington, Illinois.

Other USAR sites have made progress toward Net Zero, as follows:

- Fort Buchanan currently generates 35% of their energy demand from renewable sources.
- Fort Hunter Liggett has been awarded an ECIP project to install a secondary wastewater treatment system to reclaim wastewater for non-potable uses.
- American Samoa has been awarded an ECIP project to install 325 kW PV system.
- Maui Army Reserve Center completed the installation of a 99 kW PV system.

## E.4 Army Materiel Command

The following information provides an overview of the progress made by Army Materiel Command installations in implementing Net Zero projects.

### **Anniston Army Depot, Alabama**

- Anniston Army Depot is working with Alabama Power and the U.S. Environmental Protection Agency's Office of Energy Initiatives to reach 30% renewable energy production. A solar project now under construction will have a 10 MW capacity.
- The site has a scrap wood chipping operation that diverts this waste stream from landfill disposal.

### **Blue Grass Army Depot, Kentucky**

- Blue Grass Army Depot installed a leak detection system and is using Sustainment funds to repair and replace distribution lines.
- Blue Grass Army Depot runs a QRP that collects waste paper, metals, and plastic materials for recycling. The site is also reducing landfill costs by mulching wood crates and non-serviceable wood pallets, which saves over \$250,000 in annual landfill costs.

### **Corpus Christi Army Depot, Texas**

- The site awarded a multi-phase ESPC that includes infrastructure improvements; the contract involves a 19% expected decrease in the installation's annual energy consumption and 6 MW solar PV project.

### **Crane Army Ammunition Activity, Indiana**

- Crane Army Ammunition Activity has several ongoing efforts to improve energy efficiency, including installation of digital programmable thermostats, installation and

repair of steam traps, inspection and repair of compressed air systems, and installation of a high-efficiency boiler in one of the site's facilities. Combined, these projects are estimated to save 16,750 MMBtu annually.

- The site is also pursuing a UESC to address steam system efficiency improvements, compressed air system improvements, and a utility monitoring controls system.

#### **Holston Army Ammunition Plant, Tennessee**

- This site is evaluating the feasibility of using an existing treated wastewater recycle loop, which, if successful, would allow the facility to recycle a portion of treated industrial wastewater to be reused as process water.
- The site installed a leak detection system to monitor the potable water distribution system.

#### **Iowa Army Ammunition Plant, Iowa**

- The Iowa Army Ammunition Plant commissioned two geothermal systems and upgraded to solar-powered streetlights.
- From 2012 to 2014, the site replaced existing water mains throughout the facility, thereby decreasing facility water use by more than 33%.

#### **Lake City Army Ammunition Plant**

- Lake City Army Ammunition Plant achieved a 93% diversion rate in FY15 by recycling more than 24,800 tons of brass, steel, and metals.

#### **Letterkenny Army Depot, Pennsylvania**

- The site installed a wash rack recycling system as part of their ESPC.

#### **Military Ocean Terminal, Concord, California**

- This site is establishing an inter-service agreement with the USAR to use a 500 kW solar array. The site also cut energy costs by 15% by staggering nighttime security lighting when not in mission status.
- In 2015, the site diverted 56% of all solid waste.

#### **Red River Army Depot, Texas**

- The Red River Army Depot installed a biomass boiler that uses wood dunnage that otherwise would have been disposed in the landfill. The site's diversion rate is currently over 50%.
- Red River Army Depot recycled nearly 12,000 tons of steel for a diversion rate of 82%.

#### **Scranton Army Ammunition Plant, Pennsylvania**

- The Scranton Army Ammunition Plant has several ongoing process-related projects intended to reduce energy use, including replacement of subway shot blast equipment,

installation of a smaller boiler to meet process heating requirements during the non-heating season, implementation of a quick forge press die changing system, and installation of a small batch heat treatment system. The combined annual energy savings is estimated to be 55,590 MMBtu based on 2014 production levels.

- The site implemented an ultrafiltration/reverse osmosis treatment system for finishing process wastewater. The system is expected save 1.5 Mgal of water annually.

#### **Sierra Army Depot, California**

- The site is working with the local electric utility provider to install a solar array that will provide 40% of the current annual electric demand.

#### **Tooele Army Depot, Utah**

- Tooele Army Depot installed 4.8 MW of renewable electrical generation capacity that will be operational in spring 2016. Combined with current ongoing and future funded projects, the site expects to achieve Net Zero Energy by 2020.
- The site is replacing water distribution lines and installing a leak detection system.