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NREL Furthers U.S. Marine Corps Air Station Miramar's Move Toward Net Zero Energy

The U.S. Marine Corps Air Station (MCAS) Miramar is striving toward its goal of becoming a "net zero energy installation" (NZEI), which entails producing as much energy as it uses over the course of a year. In conjunction with the U.S. Department of Energy's Federal Energy Management Program, the National Renewable Energy Laboratory (NREL) has partnered with MCAS Miramar to develop a plan for meeting this goal and to create an NZEI template for widespread replication across the military.

A 2008 report from the Defense Science Board concluded that critical missions at military bases are facing unacceptable risks from extended power losses. To address this concern, the U.S. Department of Defense intends to establish NZEIs, defined as military installations that produce as much energy on site from renewable energy generation, or through the on-site use of renewable fuels, as they consume in their buildings, facilities, and fleet vehicles. To achieve NZEI status, an installation must minimize its energy consumption through conservation and efficiency measures, then meet the balance of energy demand with renewable energy.

Defining the Problem

The first step for MCAS Miramar, located north of San Diego, California, was to determine an "energy boundary" to which the net zero goal would apply. The NZEI concept focuses on the use of local clean energy resources, and in order to be net zero, the energy must be produced and consumed within the same boundary. For this project, the boundary was the physical border of the installation.

Working with MCAS Miramar, NREL determined which energy uses within the boundary would be included in the NZEI analysis. The energy uses examined were all the on-site

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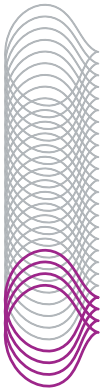
As part of its move toward net zero energy, MCAS Miramar installed this 250-kilowatt solar carport in April 2010. Courtesy of MCAS Miramar

The Spectrum of Clean Energy Innovation



Fundamental Science

Market-Relevant Research

Systems Integration

Testing and Validation

Commercialization

Deployment

Through deep technical expertise and an unmatched breadth of capabilities, NREL leads an integrated approach across the spectrum of renewable energy innovation. From scientific discovery to accelerating market deployment, NREL works in partnership with private industry to drive the transformation of our nation's energy systems.

This case study illustrates NREL's innovations in Deployment.

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electrical and thermal energy needs, plus fleet fuel use. Tactical fuel, which is mainly jet fuel, was excluded. NREL and MCAS Miramar also accounted for the energy required to transport fleet fuel and generate electricity for the base by distinguishing between site and source energy. For example, most fossil-fueled power plants operate at efficiencies of about 33%, so the analysis of on-site electricity use needed to account for the actual energy used at the power plant.

Once this boundary was defined, NREL helped MCAS Miramar inventory its energy consumption and found that the base's operations relied on three primary energy sources—electricity, natural gas, and petroleum-based fuels—and had a total source energy use of approximately 870 billion Btu per year. With this full energy consumption profile, the project turned to identifying potential energy measures.

Meeting MCAS Miramar's NZEI Goal

MCAS Miramar's leadership in energy projects did not start with the NZEI initiative. Over time, the base has invested heavily in energy efficiency and advanced metering. For ground transportation, MCAS Miramar currently features compressed natural gas and biodiesel refueling infrastructures, and the base plans to add a refueling capability for E85, a blend of 85% ethanol and 15% gasoline. This infrastructure will allow the station to fully leverage its large inventory of alternative fuel vehicles and neighborhood electric vehicles, while also optimizing fleet operations and reducing petroleum consumption.

The base has also explored several renewable energy and energy efficiency measures for implementation in the near future, including a 3-megawatt (MW) landfill gas system, 2.3 MW of solar power, 600 solar-powered street lights, and a 100-kilowatt concentrating solar power system. Building on this initial work, NREL performed extensive analysis to identify future opportunities that present a least-cost combination of energy efficiency and renewable energy to achieve NZEI status.

NREL's NZEI planning included analysis of a microgrid with distributed generation sources to continue critical base operations despite a disruption to the regional electrical grid. As the name implies, microgrids are small, independent power grids providing power to a limited area or a small number of loads. Implementing a microgrid with renewable energy, energy storage, and generators will ensure the air station's ability to continue critical operations during an extended emergency. A microgrid will also allow MCAS Miramar to participate in local grid support activities like customer demand response, potentially interfacing with building energy management systems. Furthermore, a microgrid could increase the efficiency of the distribution system by helping to match the power consumption on base with the availability of renewable energy.

NREL simulated various configurations for the distributed energy resources to evaluate performance and achieve the lowest cost of energy. Assessments included energy efficiency retrofits, renewable energy projects, changes to the power distribution grid, and transportation management. NREL also analyzed several combined heat and power opportunities for the base, including fuel cells, which use electrochemistry to efficiently convert fuels into heat and electricity, and microturbines, which are small gas-fired combustion turbines that also produce both heat and electricity.

The analysis found a combination of energy measures that would best meet MCAS Miramar's NZEI goal, including additional solar power, solar water heating, energy efficiency measures, and daylighting. In addition, NREL identified an opportunity to cost-effectively deploy microturbines and fuel cells that would use renewable bio-gas from nearby wastewater treatment facilities to provide up to 2.8 MW of power. These systems would not only produce heat and electricity, but also strengthen the air station's ability to provide power to critical operations using its own microgrid.

A Template Based on the First "Green Marine Corps Base"

MCAS Miramar's energy leadership, combined with NREL's implementation plan, has put the base on track toward achieving NZEI status. Focusing just on the air station's facilities, MCAS Miramar is on track to achieve a 43% reduction in source energy use by 2012 through projects that the air station had already planned. NREL's additional preliminary implementation plan would allow the base to achieve net zero electrical energy and a 90% reduction in building source energy use by 2015.

These efforts have earned some additional accolades and responsibilities for the base: in recognition of its past leadership and aggressive planning, the U.S. Marine Corps selected MCAS Miramar to become the first Green Marine Corps Base.

Based on the MCAS Miramar project, NREL is creating a standardized NZEI assessment and planning process template for other military bases. Widespread replication is planned, with assessments already underway at several installations, including the U.S. Air Force Academy in Colorado, the U.S. Navy's South Potomac Site, and the U.S. Army Garrison's Pohakuloa Training Area in Hawaii.

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