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The U.S. Department of Energy's (DOE) Federal Energy Management Program (FEMP) facilitates the Federal Government's implementation of sound, cost-effective energy management and investment practices to enhance the nation's energy security and environmental stewardship.

Solar hot water collectors and photovoltaic panels on the Camp Pendleton 53 Area training pool are tilted to maximize solar radiation collection.

U.S. Marine Corps Base Camp Pendleton: Using the Sun for Hot Water and Electricity

U.S. Marine Corps Base Camp Pendleton, covering 125,000 acres including 17 miles of Southern-California coastline, is the largest expeditionary training facility on the West Coast. More than 41,500 marines and family members call the base home, which reaches a daytime population of approximately 100,000.

In fiscal year 2007, Camp Pendleton saved energy and money and reduced greenhouse gas (GHG) emissions through solar hot water (SHW) and photovoltaic (PV) arrays. The base implemented two integrated solar thermal/PV systems at its 53 Area and 62 Area training pools. The projects demonstrate Camp Pendleton's continuing commitment to energy conservation while helping meet Federal requirements for on-site renewable energy and solar hot water generation.

System Overview

With a capacity of 500,000 gallons each, the Camp Pendleton training pools provide daily training for Marine Corps personnel year round. The pools typically use natural gas for water heating and electricity for pumps and other mechanical equipment. Camp Pendleton decided to change current practice and take advantage of its abundant solar resources to displace natural gas and electricity consumption.

While solar hot water and photovoltaic technologies have a long history within the Federal sector, Camp Pendleton took a unique, integrated approach. Each pool is equipped with 152 SHW collectors (covering 6,384 square feet) and 108 PV modules (covering 1,485 square feet). The integrated system is supported by a ground-mounted steel structure. Each solar array is tilted to maximize available solar radiation. This approach reduces the system's structural footprint as well as infrastructure and project costs.

Each solar thermal collector is capable of producing 39,400 British thermal units (Btu) of energy each day, resulting in combined annual energy production of 4,371 million Btu (MBtu) for both arrays. As a result, Camp Pendleton eliminates its annual consumption of 54,726 Therms of natural gas for heating the two pools.

Technology Overview

Solar hot water systems convert sunlight to thermal energy. A solar collector absorbs the sun's radiation to produce heat. This heat is transferred to water that can then be held in a storage tank for use. There are several types of systems that follow from this basic operation.

Solar water heaters for swimming pools are similar to traditional systems designed for buildings. A collector is mounted to a roof, consisting of a thin, flat, rectangular box that faces the sun. Tubes run through the collector, carrying water that absorbs heat from the collector. The warm water is then circulated to the pool by the pumping and filtration system. The pool itself acts as a storage tank for the hot water.

Photovoltaics, or solar cells, convert sunlight directly into electricity. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic effect.

Photovoltaic cells are made from various types of semi-conducting materials. To increase their electrical output, multiple PV cells are assembled to form a panel, which can be assembled to form a larger PV array. Inverters convert direct current (DC) electricity produced by the PV cells to alternating current (AC)—the electric current used to power most appliances and devices.

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Integrated solar hot water and photovoltaic panels offset energy consumption for heating and pumping systems at the Camp Pendleton Area 62 training pool.

Each PV array is rated to generate 31,600 kilowatt-hours (kWh) of electricity annually, resulting in a combined offset of 63,200 kWh annually.[1] Combined annual electric and natural gas savings for the two training pools is 5,587 MBtu. The Camp Pendleton solar project also reduces annual GHG emissions, including 725,610 pounds of carbon dioxide and 850 pounds of nitrogen oxide.

The Camp Pendleton solar systems were part of a whole-building approach to conserve energy. Other upgrades made to the training pool equipment include variable frequency drives and temperature controls. This equipment allows staff to minimize energy consumption and maximize use of solar resources throughout the day. Temperature controls are tied to a base-wide energy management control system (EMCS) that allows operators to monitor all systems at the training pool from remote locations. The result reduces energy costs and the project's payback period.

Project funding originated through a utility energy service contract (UESC) with San Diego Gas & Electric and through Energy Conservation Investment Program (ECIP) funding. The two integrated solar systems cost $1.1 million to construct, but will save the base an estimated $101,600 in electricity and natural gas costs annually. Camp Pendleton offset some of the construction costs through a California Solar Initiative Expected Performance Based Buydown (EPBB) incentive of $90,285. Final payback for the project is less than 10 years.

[1] Based on manufacturer data and independent testing by the National Solar Rating and Certification Corporation

Project Summary

Camp Pendleton's innovative approach to harvesting solar energy significantly increases on-site renewable energy generation while reducing operational costs. The combined projects offset a significant percentage of energy typically consumed in these energy intensive facilities. Utilizing both SHW and PV systems at the training pools ensures that the facilities use less energy and are less dependent on the electric grid and natural gas infrastructure for ongoing operations.

Camp Pendleton completed construction on the 53 Area and 62 Area training pools in 2007. By the end of 2010, Camp Pendleton will have projects in place to add solar thermal and or photovoltaic arrays to all training pools.

Project At a Glance

Federal Facility	Marine Corps Base Camp Pendleton
Pool capacity	500,000 gallons per swimming pool
System Overview	Integrated solar hot water/photovoltaic arrays
SHW Collector Area	6,384 square feet per swimming pool
PV Panel Area	1,485 square feet per swimming pool
Solar Thermal Output	4,371 MBtu annually (combined)
Solar Electricity Output	63,200 kWh annually (combined)
Utility Partner	San Diego Gas & Electric
Year of Completion	2007
Total Cost	$1.1 million
Annual Energy Cost Savings	$101,600
Utility Incentive	$90,285 (California Solar Initiative EPBB)
Payback	10 years

Resources:

Federal Energy Management Program
http://www.femp.energy.gov/

Department of Energy (DOE) Solar Energy Technologies Program
http://www.solar.energy.gov/

Department of Defense Energy Conservation Investment Program
http://www.acq.osd.mil/ie/energy/ecip/ecip.shtml

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