Customer Success Story:
Pennyrile Rural Electric Cooperative Corporation

Market segment
Solar energy

Eaton powers Kentucky's largest solar installation at Fort Campbell—advancing sustainability and energy security efforts

Location:
Fort Campbell, Kentucky

Challenge:
Design, installation and containment of Phase I development of Kentucky's largest solar photovoltaic (PV) array—a 1.9-megawatt (MW) renewable energy plant featuring a ground-mount array on a former landfill site

Solution:
In collaboration with the local utility, Eaton designed a complete end-to-end solar power collection and distribution package connecting the site's solar ground-mount racking and ballast system safely and reliably to the local infrastructure

Results:
Completion of the first phase of a planned 5 MW solar array that will help the U.S. Army reduce operating costs while contributing to the renewable energy goals and energy independence

"Pennyrile is committed to pursuing the critical and necessary infrastructure innovations that better support greater energy and cost savings for our customers, residents and neighbors. Our team is excited to observe the long-term efficiencies achieved by the Fort Campbell project and equally proud to have served our community in establishing the largest solar array in the state of Kentucky to date."

John Wheeler, vice president of engineering, PRECC

Background

In response to the Presidential mandate for federal agencies to meet 20 percent of their electricity needs through renewable energy sources by 2020, the U.S. Army has set a net zero energy goal, with commitment to deploying 1 gigawatt of renewable energy generation by 2025.

This call to action for enabling sustainable energy was taken up at Fort Campbell, home to the 101st Airborne Division (Air Assault). Fort Campbell's mission is to support the training, mobilization and deployment of mission-ready forces; and, in order to support that mission, the site is committed to transforming, modernizing and sustaining the local installation infrastructure supporting the troops and their families at home. Fort Campbell houses the third largest military population in the Army and is the seventh largest Army base under the Department of Defense.

Fort Campbell aimed to reduce energy intensity on-site by 3 percent annually through 2015 or by 30 percent by 2030. To achieve this standard, Fort Campbell began evaluating alternative energy portfolios that include biomass, natural gas from local shale formations, energy efficiency, geothermal and solar. It sought partnership with a local energy provider as a means of accelerating solar development.

Pennyrile Rural Electric Cooperative Corporation (PRECC) is the local utility in the Fort Campbell area. The company serves more than 47,000 members in parts of nine counties. The utility maintains 5,066 miles of distribution line supported by 99,317 poles, and is one of 155 municipals and electric cooperatives served by the Tennessee Valley Authority.

"Military installations are in need of local utilities and other resources to help them develop their own energy source," said John Wheeler, vice president of engineering, Pennyrile. "But the primary motivations for the Fort Campbell solar project are energy independence and security."

EATON
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Concrete ballasted ground mount racking system installed on capped landfill

In May of 2005, Pennyrile entered into a Basic Operating Agreement with the U.S. Army under which a Utility Energy Services Contract (UESC) project or series of projects could be developed at Fort Campbell supporting energy savings and renewable energy. The project proposed collaboration between the U.S. Department of Energy, Oakridge National Laboratories, the Kentucky Energy and Environment Cabinet, and Pennyrile to redevelop a former landfill site as a 5 MW solar photovoltaic array plant servicing the immediate community.

The U.S. Army leveraged its UESC with Pennyrile and an additional $3.1 million Energy Efficiency/Renewable Energy grant from the state of Kentucky in order to implement the first phase of the renewable energy project at Fort Campbell. The UESC project enables Fort Campbell to implement energy and operational improvements with little or no initial capital investment. Pennyrile financed approximately 500 kW of the array and Fort Campbell entered into a power purchase agreement (PPA) for the remainder. This enabled the capital costs to be financed by Pennyrile who is paid over the contract term using the cost savings generated by the energy conservation measures (ECMs) implemented.

Pennyrile selected Eaton to conduct the solar feasibility audits, design and installation based on Eaton's extensive experience. Eaton has conducted over 370 solar feasibility site audits for the U.S. Navy and built four major U.S. solar installations with the Veterans Administration. For a successful solar photovoltaic turnkey project spanning design through construction, Eaton support includes: feasibility studies, AC interconnection analysis, direct current (DC) and PV system engineering, turnkey construction, utility interconnection substations, equipment and system manufacturing and commissioning, monitoring services and long-term maintenance.

Based on this track record and range of services, Eaton received multiple contracts from Pennyrile to support the Fort Campbell installation through engineering, procurement and construction system design services as well as a range of electrical balance of system solutions, including testing and commissioning of the new solar photovoltaic ground-mount installation at Landfill #5.

The ECMs, savings and project costs were derived from discovery phase activities conducted by Pennyrile and Eaton. Annual solar electric production for the Phase I project was estimated at 2,466 MW alternating current (AC) megawatt hours (MWh) with all power produced by the solar modules to be consumed directly by Fort Campbell. The Phase I construction project was awarded in September 2014 with construction underway by December.

Challenge

One of the most unique aspects of the Fort Campbell project is the site chosen for the installation. The 20 acres of retired and capped landfill pose unique environmental challenges for a ground-mount solar installation.

The solar project site is on a 52-acre landfill, which was operational from 1981 to 1987 when it was closed in accordance with Kentucky solid waste management practices. It utilized a trench and fill design and accepted kitchen and municipal waste deposited in 18-ft deep trenches. Trenches were covered with 2 ft of compacted soil, and a clay cap was installed over the entire landfill in 1996. Contamination test wells ring the entire landfill and are monitored by the Fort Campbell Environmental Office.

The landfill cap was not to be penetrated by the solar PV installation; the engineering team had to determine a maximum loading that was not to be exceeded during construction. Because waste is a highly compressible material that undergoes consolidation via decomposition, increasing the overburden pressure on the waste mass will result in settlement.

A second challenge for the Fort Campbell installation was found in the availability of three separate switching schemes into which the new solar site can export power. The existing relays associated with each of the switching schemes had to be carefully analyzed to ensure there would be no nuisance feeds in the event of reverse flow current onto the Pennyrile distribution lines.

Solution

Eaton provided the design, engineering, procurement and construction of the solar installation. Eaton worked with RBI Solar to address the challenging landfill conditions and used a special ground-mount ballasted system for the site.

The site leverages 16,000 (325 W) monocrystalline solar modules, supplied by Pennyrile. The PV panels are placed two-high in portrait orientation at a module tilt of 20 degrees and azimuth angle of 180 degrees. The in-row space is approximately 10 ft, accessible for maintenance and designed to keep the solar PV modules out of shade between 9 a.m. and 3 p.m. throughout the year.

The solar PV array collects and distributes power from the DC side to the AC point of connection using a complete package solution designed by Eaton. The end-to-end solution helps ensure that Fort Campbell can maximize its energy harvest and simplify maintenance through the safest and most reliable power management solutions available. Eaton's critical equipment provisions included a Power Xpert® 1670 kW solar inverter and direct-coupled Power Systems series transformer; 12 kV medium voltage, metal-enclosed switchgear; 1000 Vdc Crouse-Hinds® series solar combiner boxes; and B-Line® series cable tray solutions. To enhance reliability and safety, Eaton also provided electrical system commissioning and staff training.

Maintenance access road for Phase I installation

Eaton Crouse-Hinds series DC disconnect and B-Line series cable management system

Balance of system equipment supplied and installed by Eaton included 12 switched string combiner boxes with fuses and integrated DC disconnect switches and surge suppression, as well as all wiring and connectors. All the cables connecting the modules to the combiner boxes and the combiner boxes to the inverters are located on the landfill and routed above ground in cable trays, conduits or a combination of both. The cable trays and conduits are specially routed so that they support the ballasts. All metal components of the module racks and cable trays connect to a grounding system that is integrated with the inverter grounding loop.

The power generated from the system ties into the existing 12.47 kV base distribution loop and a new 12.47 kV overhead line installed from the solar substation to the closest 12.47 kV pole near the landfill site on Market Garden Road.

Eaton's PVGard™ Web-based monitoring system is used to proactively monitor the inverter, AC equipment and a wide range of weather parameters. The software allows the Army DPW and Pennyrile to manage the output of the PV systems while also assuring the utility's metering and grid connection requirements are met.

Eaton's Electrical Engineering Services & Systems (EESS) Division managed the project installation work. The installation team was provided with very specific site loading requirements to account for the landfill cap and these specifications guided equipment selections that could safely be used for the installation. Additionally, Pennyrile provided data for the existing relays used in the switching schemes to export power. Eaton's power system engineers ensured the existing settings would not cause nuisance trips.

The Eaton Nashville district office assisted in the construction, testing and commissioning of the project, and will also provide continued support throughout the life of the solar PV system.

Results

Construction on Phase I of Fort Campbell's ground-mount solar array was completed in September 2015 and the system is currently operational. The project enables 1.9 MW of renewable energy that will help the U.S. Army installation reduce its operating costs while also contributing to the renewable energy goals of the nation.

Phase I of the project represents a total investment of over $5M by the U.S. Army and its partners in renewable energy. The $3M grant funds awarded to Pennyrile from the state of Kentucky also allowed the project to meet its 10-year payback requirement from the Fort Campbell UESC during the completed Phase I of the project. Phase II will pursue the addition of a 3.1 MW array with additional PPAs.

"Pennyrile is committed to pursuing the critical and necessary infrastructure innovations that better support greater energy and cost savings for our customers, residents and neighbors," said John Wheeler, vice president of engineering for PRECC. "Our team is excited to observe the long-term efficiencies achieved by the Fort Campbell project and equally proud to have served our community in establishing the largest solar array in the state of Kentucky to date."

Based on the Building Life Cycle Costs (BLCC) System Analysis, the new solar PV array is expected to deliver an estimated annual energy cost savings of $180,000 to Fort Campbell. The initial solar array installation is expected to annually produce approximately 2,466 MWh of sustainable electricity, which is equivalent to removing 358 cars from the road.

Fort Campbell's purchase of the green power generated on-site also avoids an estimated 2,335 tons of carbon dioxide emissions, which is equivalent to the annual GHG emissions avoided by 109 garbage trucks of waste being recycled instead of landfilled.

The success of the landfill's special ground-mount for solar also creates an exemplary model of how to reclaim brownfield sites to spur renewable energy development. Future project replications can build on the discoveries at Fort Campbell to better support related initiatives sought by the Environmental Protection Agency.

Eaton MV switchgear, Power Systems series MV transformer and Power Xpert solar inverter

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