A bnp media Publication

June 2007 • Vol 32, No. 6

ENERGY & POWER MANAGEMENT

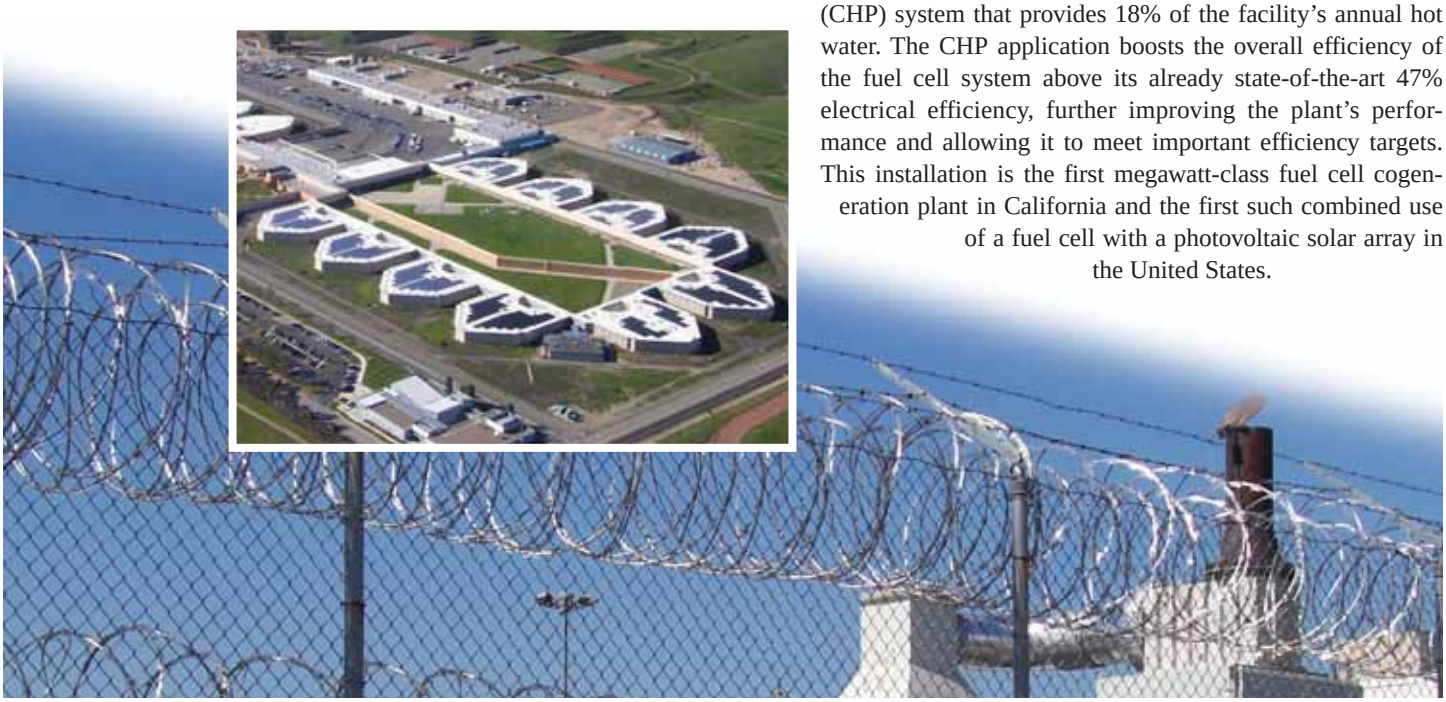
Serving the commercial, industrial and institutional markets

Santa Rita's Fuel Cell Adds Reliability TO SOLAR INSTALLATION

Facility requires high reliability solution to rising energy costs

BY ANDREW SKOK

The number of green, energy-saving power installations is expanding, and solar photovoltaic applications are among the most popular, particularly in California. But solar panels generate power only during sunshine and cannot always best address facility load requirements. Alameda County Jail in Dublin, CA, found fuel cells a good way to reliably augment its solar installation while keeping its commitment to clean, efficient power. In doing so, the Santa Rita facility further defrayed its energy costs using cogeneration. Operated by the County of Alameda, the Santa Rita jail recently installed a 1-megawatt (MW) carbonate stationary fuel cell power plant to complement its 1.2-MW rooftop solar power system and to help meet its electrical load, estimated at 3.2 MW. In addition to meeting half the facility's annual electricity needs, the fuel cell is part of a combined heat and power (CHP) system that provides 18% of the facility's annual hot water. The CHP application boosts the overall efficiency of the fuel cell system above its already state-of-the-art 47% electrical efficiency, further improving the plant's performance and allowing it to meet important efficiency targets. This installation is the first megawatt-class fuel cell cogeneration plant in California and the first such combined use of a fuel cell with a photovoltaic solar array in the United States.



Santa Rita's Fuel Cell Adds

Reliability

TO SOLAR INSTALLATION

The Fuel Cell

The high-temperature, high-efficiency carbonate fuel cell provides base load power for Santa Rita using natural gas provided through the existing distribution network. This ability to use an available, proven, and relatively inexpensive fuel is an important advantage over other types of fuel cells that require external fuel processing to obtain a supply of hydrogen.

The DFC1500 fuel cell has a modular design and contains separately configured units for direct current (dc) power, electrical balance of plant, heat recovery/oxidant supply, and fuel and water treatment. Each module is arranged on its own skid to provide both efficient transport to the installation site and ease of access for future plant maintenance. Initial site work and construction for the fuel cell at Santa Rita began in October 2005, with the system coming online at full power in May 2006.

The fuel and water treatment module contains fuel cleanup and deoxidizing reactors to treat the natural gas, as well as reverse osmosis and water-softening equipment to receive, treat, and store a supply of municipally supplied water. The heat recovery unit/anode gas oxidizer (HRU/AGO) module then takes the treated fuel and cold water and produces a heated fuel/steam mixture for delivery to the dc power module, which consists of four 250-kilowatt (kW) dc fuel cell stacks.

The electrical balance of plant (EBOP) module converts the stack's direct current to alternating current for use in conjunction with the existing utility grid. This module contains the inverter, control system, operator interface, transformers, and all grid interconnection hardware.

The system's resulting net output of 8,000,000 kWh of electricity per year provides approximately 50% of the Santa Rita facility's electrical requirements. The added efficiency of the fuel cell, compared to conventional boiler conversion of natural gas, provides an annual net electricity savings for Santa Rita of $266,825, a total savings of $6.6 million over a 25-year period.

The DFC1500 is one of three stationary, high-efficiency carbonate fuel cells manufactured by FuelCell Energy, Inc., which currently offers power plants producing 300 kW to 2.4 MW of power. Hallmarks of these fuel cells include the ability to operate at normal atmospheric and temperature conditions, an internal reforming process that does not require an external supply of hydrogen but can instead use readily available fuel stock, and a clean, quiet operation that helps minimize plant-siting issues.

The 1-MW fuel cell was chosen for Santa Rita for a number of factors, most notably its optimal size to address the facility's power and hot water needs and its Ultra-Clean emissions signature. In addition, the modular design encompasses the fuel cell stacks, comprising a single integrated unit rather than four individual stacks. This significantly reduces the costs associated with siting and installing the fuel cell and connecting it to the cogeneration system. This simplified design also reduces the costs of servicing.

CHP

Because of its high operating temperatures, the carbonate fuel cell is the most efficient commercial fuel cell type for CHP. Cogeneration from the waste heat associated with the energy conversion process is a key differentiator for large stationary fuel cell applications. Santa Rita's system converts over 1.4 million British thermal units of waste heat to hot water each year, significantly boosting the plant's overall efficiency and saving the facility money. CHP also enhances the cleanliness of the power production by increasing the use of energy created by noncombustible processes.

Santa Rita's Fuel Cell Adds **Reliability** TO SOLAR INSTALLATION

CHP changes the power paradigm when considering the tradeoffs between waste heat from the fuel cell and electricity production. Electricity produced during the cogeneration process has a value ten times as high as the associated waste heat, a fact underscored by the recent price surge for grid-supplied electricity, natural gas, and other fuels. Therefore reducing electrical power purchased from the grid can save significantly more money than generating larger quantities of heat for a given application.

Traditional CHP installations using microturbines or reciprocating engines have typically been sized to address 90% of a site's heating requirements, with an emphasis on using the waste heat to maximize the benefit of their overall efficiencies. While this approach does maximize the efficient use of waste heat, it can also mask the lower overall efficiency of the motor-driven system when compared to a fuel cell system. For example, with an electrical power generation efficiency of approximately 20%, a microturbine would provide a 1 to 3 ratio of electricity to waste heat. A reciprocating engine operating at approximately 35% electrical power generation efficiency yields an electricity-to-heat ratio of 1 to 2. Generating less electricity from the system means buying more electricity from the grid, and at higher prices.

In contrast, Santa Rita's fuel cell system, with an electrical power generation efficiency of 47%, provides two units of electricity for each unit of waste heat. While still capturing the majority of the waste heat from its own operating process, it creates significantly more high-cost, high-value electricity, electricity that does not need to be purchased from the grid. This advantage means significantly higher dollar savings, particularly during periods of peak electrical demand. As the focus of new distributed power generation sites shifts to a need for cheaper, cleaner electricity, the advantages of a fuel cell system become more apparent.

Backing Up The Photovoltaic Array

The fuel cell is only the most recent addition to Santa Rita's alternative energy and money saving projects. Prior to the fuel cell installation, the correctional facility completed comprehensive energy-saving retrofits, including a 1.2-MW rooftop photovoltaic solar array, a refitted chilled water plant, and innovative cool roof membranes on all 18 of the facility's housing units. The solar array alone can generate over 500 kW of peak power per hour on a sunny day.

But power consumption at the facility doesn't synchronize with the sun's output, as peak demand occurs between 7:00 and 10:00 p.m. To meet its clean energy commitment, the facility required a clean, efficient, and reliable backup for electricity generation. Reliance on the existing electrical grid would not maximize cost savings or environmental benefits.

With its design for continuous operation and its interconnection with both the grid and the solar array, the fuel cell effectively flattens peak load demand. Depending on the time of day and temperature conditions, and particularly during summer months when peak demand is highest, the system can provide between 80% and 90% of the correctional facility's power needs. During the early morning hours, when peak load (and peak electricity cost from the grid) is also significantly lower, this percentage may drop to less than 70%.

Distributed Generation

In addition to cost savings, the fuel cell provides Santa Rita with many other tangible benefits. Because the fuel cell makes its energy through a noncombustible process, it produces virtually zero emissions of nitrogen oxides (NOx) or sulfur oxides (SOx). This helps improve the air quality at the site, in addition to helping Santa Rita and Alameda County meet important clean air target requirements.

The DFC1500 is certified to meet the stringent distributed generation emissions standards established by the California Air Resources Board (CARB). Meeting this standard qualifies the fuel cell as an Ultra-Clean technology and also exempts it from air pollution control and air quality district permitting requirements. The certification also qualifies the fuel cell for preferential rate treatment by the California Public Utilities Commission (CPUC), which includes the elimination of additional costs for exit fees and standby charges. Combined with additional incentives from CPUC's Self Generation Incentive Program (SGIP), the DFC1500 demonstrates its ability to save Santa Rita money, not only with its efficient operation, but also with fast-track installation and rate benefits.

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The fuel cell not only runs cleanly, it runs quietly. The significant reductions in ambient noise, compared to a traditional boiler-fired system, provide an unobtrusive power source for a quieter environment at the correctional facility and a reduced impact on the surrounding area.

Perhaps the most significant additional benefit of the fuel cell to an institution such as Santa Rita is its 24-hour reliability and independence from the local electrical grid. In the wake of recent natural disasters such as Hurricane Katrina, as well as the earlier rolling blackouts in California, fuel cell installations at critical institutions such as hospitals and emergency centers quickly demonstrated their value by supplying reliable power for days or even weeks before grid-supplied electricity was restored. In such circumstances, Santa Rita can rely on the fuel cell as a reliable, independent power source to help maintain order and predictability within the facility, even as it continues to meet its targets for clean, efficient power. *e&pm*

About the Author: **Andrew J Skok** is a senior marketing executive for FuelCell Energy in Danbury, CT, where he has over 28 years of experience in many different management positions. Areas of Mr. Skok's focus have included R&D, new product development, service group development, sales, business development, and marketing. Mr. Skok's responsibilities have ranged from technical support and training to the company's OEM distributors, and certification of the company's products.