

COUNTY OF ALAMEDA, CALIFORNIA



SANTA RITA JAIL FUEL CELL POWER PLANT

Sustainability Context

Fuel cells are among the cleanest, most reliable sources of power generation today. They provide continuous high-quality power 24 hours a day, with ultra-low emissions and quiet operation; and the exhaust heat byproduct can be used for combined heat and power (CHP) applications using hot water, steam or chilled water to heat or cool buildings. Running the fuel cell reduces the Jail's demand for power from the local utility, thus reducing greenhouse gas emissions from conventional combustion-engine power plants.

The Santa Rita Jail fuel cell is the first megawatt-class fuel cell cogeneration plant in California and one of the largest in the United States. Alameda County has demonstrated that employing sustainable energy technologies is a smart way for public agencies to revitalize and modernize their facilities while helping to reduce greenhouse gas emissions.

Project Goals

The Santa Rita Jail is the third largest county detention facility in California and the fifth largest in the nation. It holds approximately 4,000 inmates and consumes more energy than any other County government building. Alameda County's goal was to reduce its peak electricity demand and to improve the security and reliability of power supply at the Jail. This was the third major project aimed at improving efficiency and employing sustainable energy sources at the Santa Rita Jail. Previously, the County had completed comprehensive energy retrofits and improvements and had installed the nation's largest rooftop solar power system (1.2 megawatt) at the Jail.

Results

- Annually generates 8,000,000 kWh of electricity (50% of Jail's needs)
- Produces 1.4 MM Btu of waste heat (18% of Jail's needs)
- Overall system efficiency of 58%
- 98.5% reduction in NO_x emissions compared to standard power plants
- CARB certification as an ultra-clean distributed generator
- Expected life: 25 years

The project was completed on budget. This megawatt-class fuel cell cogeneration power plant underscores Alameda County's commitment to its Climate Change Leadership Strategy by demonstrating the real-world application of ultra-clean power generation. Also, it has garnered interest from various public and private parties statewide, adding to positive exposure for the County.

Enhanced Construction Outreach Program and subcontractor selection applied to this project resulting in a subcontracting participation of 60% small and local businesses, 44% minority-owned businesses, and 14% women-owned businesses.



Location and Dates

Santa Rita Jail, Dublin, California
Construction began November 2005
Startup completed May 2006
Dedication held August 2006

Project Components

- One-megawatt DFC1500, molten carbonate fuel cell power plant (single module with four 400-cell internal stacks) used as base load power in parallel with utility grid and on-site solar power system
- Associated heat recovery cogeneration equipment used to pre-heat hot water system
- UtilityVision® Control System for measurement and verification of performance

Lead Department

General Services Agency, Energy Services Division

Finances

Total Project Cost: \$6.1 million (Incentives: \$2.4 million)
Gross Savings over 25 Years: \$21.6 million (\$864,391/yr)
Net Savings over 25 Years: \$6.6 million (\$266,825/yr)
Annual Net Electricity Savings: \$266,825
Internal Rate of Return: 10.4%

Environmental Impact Reduction

The 1-MW fuel cell is a source of ultra-clean power at the Santa Rita Jail. This installation combined with the previously installed rooftop solar power array and energy efficiency upgrades will reduce power purchases as much as 80% during peak-demand summer months. This translates to avoided greenhouse gas emissions of 3,200 tons annually, equivalent to planting approximately 900 acres of trees.

Ultra-clean, on-site power benefits Alameda County and the surrounding region by reducing grid power purchases from conventional, combustion-engine power plants, especially during peak summer months, when demand is the highest.

Project Process

Chevron Energy Solutions developed and constructed the project. The DFC1500 fuel cell power plant was manufactured by FuelCell Energy.

The project involved careful planning and management of utility interconnection applications and construction targets in order to meet financial incentive requirements, which essentially meant that all non-fuel-cell infrastructure had to be complete before the arrival of the fuel cell equipment at the project site. This work included the concrete equipment pad, underground piping for gas and water lines, and high voltage electrical service.

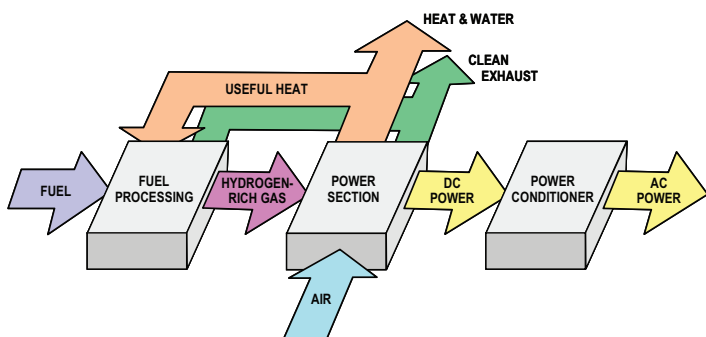
Chevron Energy Solutions managed all of the time-sensitive activities associated with obtaining funding through PG&E's Self-Generation Incentive Program, including completing all applications and working closely with utility staff.

In compliance with Alameda County's Enhanced Construction Outreach Program, local companies were employed for various design engineering and construction services. On-site training for operations and maintenance personnel was also provided as part of the contract.

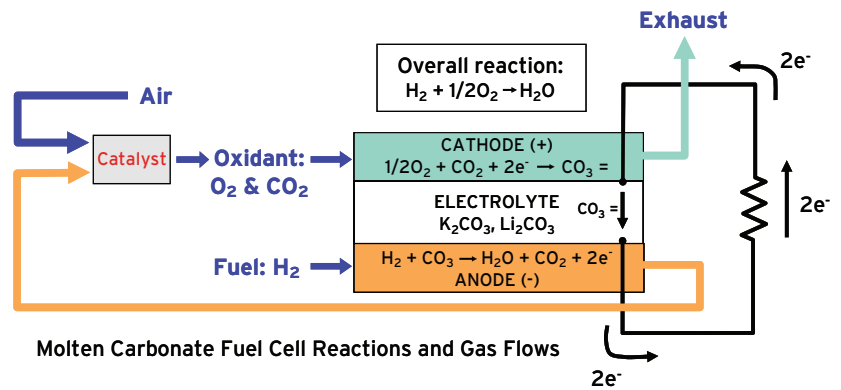
The fuel cell's performance will be continuously monitored through UtilityVision®, Chevron Energy Solutions' web-based energy tracking and reporting system. UtilityVision® offers County and Jail staff immediate access to all fuel cell output information including electricity production, waste heat recovery, and fuel consumption.

How It Works

Fuel cells convert chemical energy from fuels containing hydrogen directly into electricity and heat without combustion. Fuel cells are composed of many individual cells grouped together in a stack. Molten carbonate fuel cells are designed for continuous operation, as they provide little or no generation during the multi-day process of gradually raising internal temperatures to the 1,000 degree F in order to melt the electrolyte.



To extract hydrogen (H₂) fuel from natural gas (CH₄), natural gas is combined with steam to create hydrogen and carbon dioxide. (Natural gas and water are purified in the plant onsite.) The oxidant gases (O₂ and CO₂) react with electrons returning from the DC circuit to produce a carbonate ion (CO₃²⁻). Hydrogen is fed into the anode where it reacts with the negatively charged carbonate ion (CO₃²⁻) that has traveled through the electrolyte and reacts with H₂ in the anode to produce steam, CO₂, and electrons that feed the DC circuit that generates electricity.



Highlighted Infrastructure

FuelCell Energy integrated all of the fuel cell components within the power plant. Chevron Energy Solutions ensured that all utility interconnection points were integrated with the fuel cell and the rest of the Jail's infrastructure. Chevron ES designed the heat exchanger equipment, which captures the fuel cell's exhaust heat byproduct for water and space heating purposes at the Jail.

The fuel cell plant is connected to the utility grid and operates in parallel to the grid. It has a continuous output of one megawatt of power with a 45% efficiency rate. It has a 20-year design life, excluding routine maintenance and overhauls.

Related Projects

Prior to installing the 1-MW fuel cell, Alameda County completed an integrated solar power system project and comprehensive energy efficiency improvements at the Santa Rita Jail. This work consisted of a 1.2 MW rooftop solar array, chilled water plant retrofit, cool roof membrane on 18 housing units, and a Demand Response Smart Control System (UtilityVision®).

With solar electric generation, the Jail reduced its overall energy cost and specifically reduced purchases of expensive, peak energy from the local utility. With energy efficiency and demand-side management technologies, the Jail maximized the value of its solar investment while modernizing the facility.

These improvements, combined with the clean fuel cell power generation, are removing 3,200 tons of greenhouse gas emissions from the atmosphere each year. This is equivalent to planting 900 acres of trees.

For More Information

<http://www.acgov.org/srjp>

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Santa Rita Jail Fuel Cell Power Plant

Santa Rita Jail's DFC®1500 is a complete natural-gas-to-high-quality AC electric power generating system. It consists of four matched modular skids, which were assembled at the site into a complete power plant.

1. Fuel Cell Power Module – generates DC power
2. Electrical Balance of Plant – converts DC power to high-quality AC power and controls the entire power plant
3. Fuel Treatment Skid – cleans and prepares the process gas streams for the fuel cell power module
4. Anode Gas Oxidizer (AGO) – uses process heat for all on-board heat requirements



Associated Cogeneration Equipment and Monitoring System

A secondary heat recovery unit, designed by Chevron Energy Solutions, was added to the fuel cell power plant. This unit increases the overall efficiency of the fuel cell power plant by recovering excess heat not being cycled back into the fuel cell process and uses it to pre-heat hot water inside the Jail.



To enable system performance monitoring, Chevron Energy Solutions installed UtilityVision®, a web-based monitoring and reporting system that gives Alameda County staff real-time information on how the fuel cell is operating, including data on waste heat recovery and fuel consumption.

DFC®1500 At-A-Glance

- 1-megawatt molten carbonate fuel cell
- Manufactured by FuelCell Energy, Inc., of Danbury, Connecticut
- Size: 26.5 ft high by 43 ft wide by 40 ft long
- Power Output: 1000 kW, up to 1700 kVA
- Voltage: 480VAC, 50 or 60 Hz
- Noise: <70 dB(A) @ 10 ft

Fuel Cell Technology

Fuel Cell Basics

Fuel cells are electrochemical power generators. As long as air and any hydrocarbon fuel, such as natural gas, are supplied, a fuel cell will extract the hydrogen from the fuel and produce electricity and heat continuously without combustion and the pollutants associated with burning fuel.

The key reaction in every fuel cell requires hydrogen and oxygen. Some fuel cells require pure hydrogen. Others have to make it externally in a "reformer" and then send it to the fuel cell. In the Direct FuelCell®, manufactured by FuelCell Energy, hydrogen is produced directly inside the fuel cell, where it is immediately consumed in the reaction, rather than in an inefficient, external reformer.

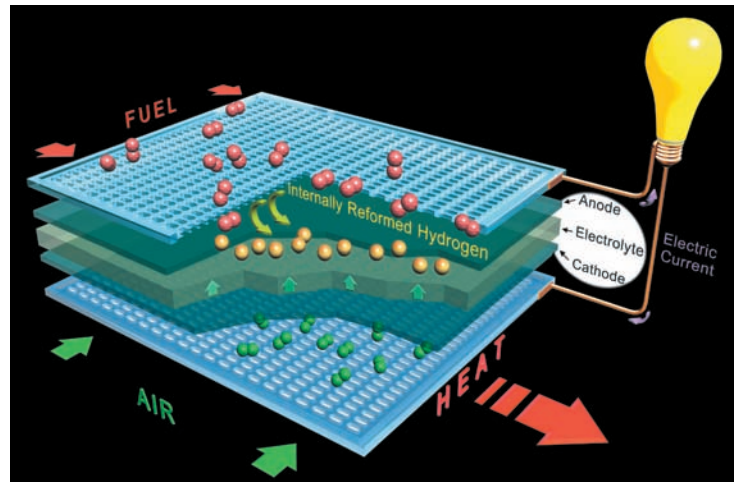
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The overall reaction within any hydrogen fuel cell is:



This reaction produces about one volt per cell. Several hundred cells are stacked together to produce a useful voltage for power production. The DFC®1500 uses four fuel cell stacks connected in parallel, each containing about 400 cells.

The DFC stack is a molten carbonate fuel cell (MCFC), which is one type of hydrogen fuel cell that operates at an approximate temperature of 1200°F. Fuel (hydrogen) is supplied to each anode (negatively charged electrode) and oxidant (O₂ & CO₂) is supplied to each cathode (positively charged electrode). Between the two electrodes is the electrolyte which is rich in carbonate (CO₃) compounds and is a liquid at operating temperature.



Direct FuelCells®

Direct FuelCells® can use hydrocarbon fuels, such as pipeline natural gas, without the need to first create hydrogen in an external fuel processor. They are a high-temperature, high-efficiency type of fuel cell designed for stationary applications. This type of fuel cell power plant has specific benefits and features:

- They are the most efficient fossil fuel generators in this size range – they produce more electricity using less fuel.
- They run quietly, making them friendly neighbors.
- They are certified by the California Air Resources Board to operate continuously without an air permit, allowing for easy siting.
- They produce high quality electricity for today's high-tech systems.
- They can operate on a variety of fuels, promoting fuel diversity and energy reliability, across a range of applications and settings.



The ability to operate directly on readily available fuels makes for a simpler, more efficient system than externally processed systems. The high operating temperature produces a high-quality by-product heat that can be used for process, heating, or cooling purposes, thus increasing the plant's energy efficiency. The more efficient a power generator is, the less carbon dioxide it produces. Carbon dioxide is considered a greenhouse gas.

Alameda County Santa Rita Jail Dublin, California



History of Santa Rita Jail

The original Santa Rita Jail opened in January 1947. It served as a replacement for the County Prison Farm that operated on 275 acres next to Fairmont Hospital in San Leandro. The old Jail encompassed about 1,000 acres of a World War II military base known as Camp Schumacher and included a Navy Brig that was later converted into a maximum-security facility known as Greystone. Later, the Jail's eight-barrack complex underwent another conversion when it became a minimum and medium security facility known as the Compound. Women were housed in a horseshoe shaped barracks known as Women's Quarters.

Over time, the Santa Rita Jail became overcrowded and it was difficult and costly to operate the aging facility in a safe and secure manner. Design and development of a "new" Santa Rita Jail began in 1983. Construction costs of the new 1-million-square-foot Santa Rita Jail totaled about \$172 million. State bonds, augmented by matching local funds, financed the new construction. On September 1, 1989, Sheriff Charles Plummer gave the order to open the facility and inmates were transferred to the new Jail.



The New Santa Rita Jail

The Santa Rita Jail's mission is to cost-effectively operate as a humane, safe and secure facility while facilitating the criminal justice system and fostering public safety. It serves four main functions: (1) receiving and processing arrestees, (2) pre-trial detention, (3) incarceration of local sentenced prisoners, and (4) holding inmates who are enroute to state prisons or other jurisdictions.

The Jail holds about 4,000 inmates housed in one of eighteen modern housing units. It is considered a "mega-jail" and ranks as the third largest facility in California and the fifth largest in the nation. Santa Rita is accredited by the American Correctional Association, which makes it the only facility in California holding this prestigious award.

The facility is recognized as one of the most technologically innovative jails in the world. A robotic system speeds delivery of laundry, supplies, and food to all areas of the 113-acre campus. State-of-the-art criminal justice systems serve the internal operation, while the nation's largest rooftop solar power systems converts enough electricity to power nearly one-half of the facility's electrical needs during daylight hours. A new 1-megawatt fuel cell plant reduces power purchases during peak-demand summer months by as much as 80 percent.

Sheriff Plummer's philosophy of cost-effective delivery of services is reflected in the private sector partnerships that support the Jail's operation. A modern cook-chill food service operation produces 12,000 economical meals per day. On-site medical and mental health services save money while reducing the patient load at county medical facilities.

Throughout its history, the Santa Rita Jail Facility has served the criminal justice system and contributed to the safety of the citizens of the County of Alameda by providing a safe, secure, and humane environment for inmates and staff.

Santa Rita Jail Quick Facts

Primary Functions

- Receive and process arrestees
- Provide pre-trial detention
- Incarcerate local sentenced prisoners
- Hold prisoners enroute to state prisons or other jurisdictions

Staffing

283 badged employees

159 civilian employees

400 volunteers

Cost

Approx. \$174 million

Funded by bonds and sale of county property

Monthly food costs: over \$500,000

Approx. \$1.2 million per month for inmate health care

Housing

18 housing units

Capacity for 4,000 inmates

5th largest jail in the U.S. based on inmate count

Operations

Serves 12,000 meals per day

Handles 10,000 pounds of laundry per day

10,000 light fixtures

7,000 windows