



**County of Alameda  
Santa Rita Jail Case Study**

**Smart Energy Strategies  
Integrating Solar Electric Generation and Energy Efficiency**



Photo by M. Muniz

April 2002

**A Partnership of Alameda County,  
PowerLight Corporation, and CMS Viron Energy Services**

## **Smart Energy Strategies Integrating Solar Electric Generation and Energy Efficiency**

### **Executive Summary**

In Spring 2002, Alameda County successfully completed the fourth largest solar electric system in the world atop the Santa Rita Jail in Dublin, California. The Santa Rita Jail is the largest energy user of Alameda County's government buildings. This solar installation, the nation's largest rooftop system, was commissioned to help Alameda County reduce and stabilize future energy costs.



Photo by R. Solari

This smart energy project reduces the jail's use of utility-generated electricity by 30 percent through solar power generation and energy conservation. Clean energy is generated by a 1.18 Megawatt installation consisting of three acres of solar photovoltaic panels. Even before the

entire installation was complete, the initial solar systems of 650 kW helped Alameda County weather the California state energy crisis by reducing the jail's monthly electric bill and replacing pollution-generating electricity with clean, on-site solar power. Improved building efficiency measures applied in tandem with solar electric power generation optimized Alameda County's investment in their own, on-site solar power supply.

### Benefits to Alameda County and California

- Over 2.4 million kWh of annual electricity is no longer purchased from the power grid
- Avoided emissions of 38,000 tons of carbon dioxide and 24,000 lbs of nitrogen oxide, major contributors to smog, acid rain and global warming.
- Enhanced solar electricity generation facility with reduced need for maintenance
- PowerLight's solar PV tiles protect roof
- Lower operational costs
- Generates community goodwill and elevates Alameda County's status as a progressive energy leader

### System Specifications

System Size:	1.18 Megawatts
Annual Power Generated:	1,460,000 kWh
PowerLight Photovoltaic Roof Tiles	9,726
Solar Array Size (square feet)	130,000
Solar Array Size (acres)	~ 3 acres



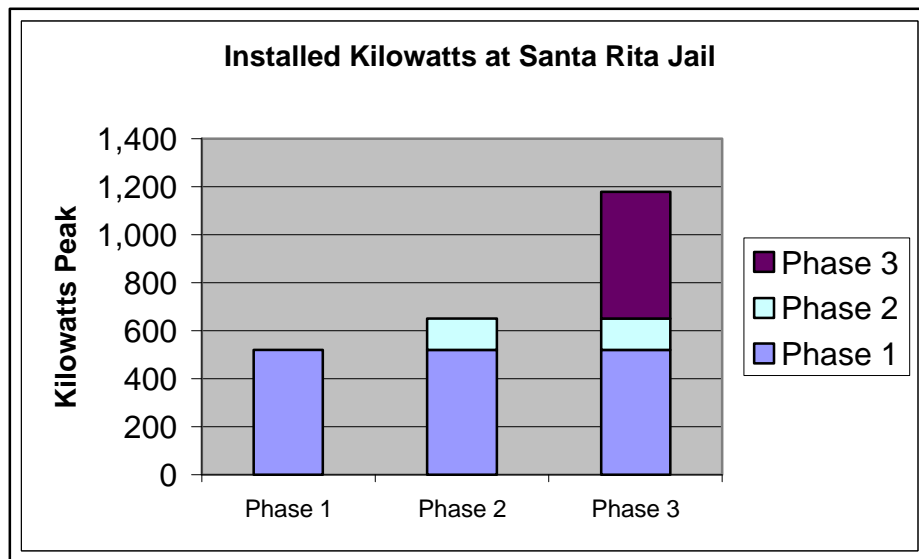
This case study presents the results of Alameda County's Santa Rita Jail solar electric power program, including system costs, savings, and performance, for the period of January 2001 through March 2002. The Santa Rita Jail solar installation was performed in three phases:

Phase 1: This first solar project, installed in July 2001, consisted of a 519 kW photovoltaic rooftop system located on the top of six of the jail's eighteen housing units, a chiller replacement with variable speed drive, a cool roof and an energy management system upgrade. The primary motivation was to reduce high electricity costs because of the California energy crisis.

Phase 2: In October 2001, Alameda County took advantage of increased California state solar energy incentives and installed a second solar electric system of 131 kW on top of an additional two housing units.



Phase 3: After the successful implementation of the first two solar installations, Alameda County purchased a third solar photovoltaic system in April 2002 to further reduce operating costs and to demonstrate that large-scale solar power is feasible and economically attractive for a large energy user, such as the Santa Rita Jail. Fourteen of the jail's eighteen housing units now have solar photovoltaic systems installed on their roofs. A summary of the capacity of these projects is presented in the figure below:



### Background

For years, Alameda County has been a leader in smart energy strategies. This is a direct result of the vision and leadership from the County's Board of Supervisors and General Services Agency to reduce the County's annual overall energy usage and costs.

A number of cost-effective energy efficiency programs were launched in 1993, when the County's General Services Agency hired its Energy Program Manager, Matt Muniz, P.E. One of Muniz's first projects was to retrofit over 12,000 fluorescent light fixtures with energy efficient T-8 lamps and electronic ballasts and install innovative lighting controls throughout the County's Santa Rita County Jail in Dublin, CA. Later Mr. Muniz's energy team replaced over 550 inefficient fractional horsepower exhaust fan motors with premium efficiency motors at a payback of less than one year. Both of these projects are part of Pacific Gas & Electric's (PG&E) "PowerSaving Partners" demand-side management program. As a Power Saving Partner, the County has received over \$2.3 million in direct incentive payments and ultimately reduced electricity costs at the jail by one-third.

Charged with the task of achieving even greater energy savings at other Alameda County facilities, the County's energy program staff implemented a number of other energy efficiency measures that presently total over \$4 million in annual cost avoidance savings. These measures included lighting retrofits in 95% of County owned-buildings, the installation of state-of-the-art building automation systems in 25 facilities, replacement of most chillers with energy

efficient and CFC-friendly equipment, and installation of Variable Frequency Drives to the HVAC systems in County facilities.

### **Program Goals**

Alameda County established the following goals at the inception of the solar program:

- Evaluate the feasibility of solar electric (photovoltaic, or PV) technology for the Santa Rita Jail and other Alameda County buildings.
- Reduce the Santa Rita Jail utility operating cost, and the risk of future fuel price volatility, in a cost-effective manner.
- Contribute to California sustainability and environmental preservation.

### **The Right Partner**

Alameda County chose PowerLight Corporation, a Berkeley, California firm, to design, manufacture, install, and maintain their solar electric systems. PowerLight is the leader in delivering large grid-connected PV systems, and has developed and patented the solar mounting system technology used at the Santa Rita Jail. The reason for choosing PowerLight's protective solar electric rooftop products was that they not only provided energy savings from solar electric generation, but offered additional benefits of HVAC savings through thermal building insulation and extended roof life.



Photo by D. Lichtenberger

*"I thought that we had completed all the cost-effective energy saving measures that were possible at the jail. But with over a half-million square feet of unused flat roof space at the jail and the recent drop in prices for solar cells, PowerLight and I immediately saw that solar electricity was the perfect solution for further demand reduction" - Matt Muniz, Alameda County's Energy Program Manager*

### **Challenge**

How could Alameda County achieve its vision of becoming a leader in solar energy? Could the economics of large-scale solar photovoltaic systems be cost effective? How would such a large capital purchase be financed?

### **Solution**

By leveraging one of California's most plentiful resources—the sun—and embracing renewable solar photovoltaic technology to generate clean reliable power, Alameda County significantly reduced its operating costs and helped to contribute to California's sustainability. The abundant solar electric incentives available in California, such as the California Energy Commission's Emerging Renewables Buy-down program, made the solar electric system affordable in its own right. However, an even more affordable idea was borne: to combine on-

site solar electric generation with reductions in the jail's overall energy use by implementing energy conservation and sophisticated energy management measures.

PowerLight Corporation soon thereafter contracted with CMS Viron Energy Services, to showcase the synergy between the latest advancements in solar PV and state-of-the-art energy efficiency technology. CMS Viron is a 27-year old firm based in Overland Park, Kansas and a subsidiary of CMS Energy, a leading utility and diversified energy group based in Michigan doing business in 21 different countries.

Alameda County, PowerLight, and CMS Viron then crafted an integrated solar electric generation and energy efficiency plan with the goal of exceeding the County's 10% internal rate of return threshold for energy projects. This plan now serves as a model for other local governments and large commercial customers concerned about rising electricity rates, reliability, and the nation's increasing environmental concerns.

*"Over the past several years, Alameda County has reduced electricity use by more than 30 percent...We are confident that solar energy is a very smart addition to our overall energy strategy" – County Supervisor Scott Haggerty*

### **Technological Innovations**

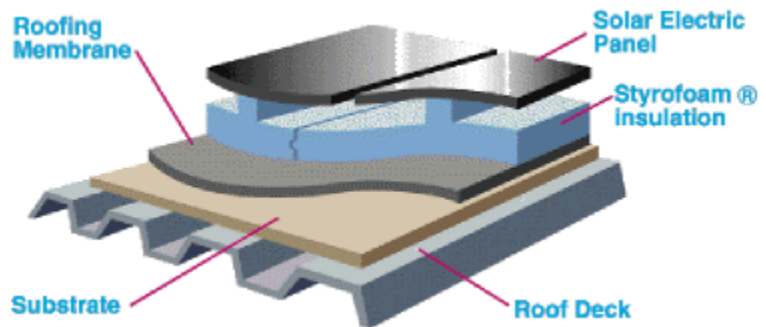
The Alameda County solar project offers proof that solar electricity and energy efficiency are a robust blend of technological innovations well suited to respond to California's stressed power grid. Linking Santa Rita Jail's solar electric installation with energy efficiency upgrades and state-of-the-art energy management software, Alameda County is able to reduce its peak power consumption at Santa Rita Jail by 30%.



Photo by M. Muniz

## Solar Photovoltaic (PV) Installation Provides Multiple Benefits:

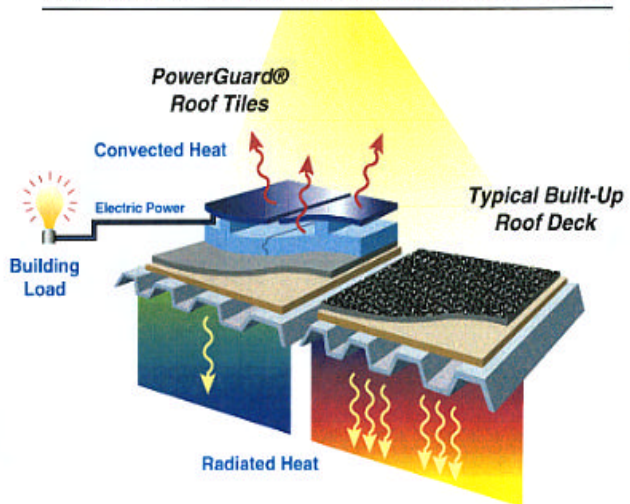
PowerLight's PowerGuard® product is a patented photovoltaic (PV) roof tile assembly that delivers clean solar electricity to the building. PowerGuard® tiles incorporate state-of-the-art PV cells backed with insulating polystyrene foam, turning the sun's free energy into usable power while increasing building thermal insulation and extending roof life. A key innovation of these roof tiles is that they can be installed on flat rooftops without penetrating the roof membrane.



### Roof Protection and Energy Savings

PowerGuard technology offers unique characteristics of an insulating substrate that serves to protect and insulate the roof, as well as reduce the interior building temperatures. PowerGuard provides HVAC (heating, ventilation, and air conditioning) savings in several ways. The modules sit several inches above the surface of the building roof, effectively shading the roof like a huge umbrella. The shading reduces the peak temperature of the roof reducing both conductive and radiant heat transfer into the building interior. The illustration (right) compares the relatively low radiated heat internal to a roof covered with PowerGuard solar tiles with that of a typical built up roof deck without PowerGuard.

### PowerGuard® - Power Generation & HVAC Savings



“Cool Roof” Membrane: By applying a “Cool Roof” reflective coating on the jail’s existing roof, the roof area not covered by solar tiles now reflects 65% of the solar energy. This effectively reduces the roof’s temperature during the hot summer months by 50 degrees Fahrenheit. Peak electrical demand reductions result from the reduced air conditioning requirement in the occupied spaces below.



PowerGuard® Solar Electric System on the roof of the Santa Rita Jail with cool roof reflective coating.

Photo by M. Muniz



Replace Inefficient Equipment: Large electricity savings were achieved by replacing an old inefficient chiller with a new 850-ton high efficiency chiller that does not use CFCs that contribute to the degradation of the ozone layer. New variable speed drives attached to the new chiller, chilled water pumps, and cooling towers respond directly to the precise real-time cooling requirements needed to deliver chilled water instead of operating at 100% speed all of the time.



**Modified central plant cooling tower installation features an 850-ton high efficiency chiller**

Photo by R. Solari

Smart Energy Management Optimizes Overall System: Implementation of UtilityVision<sup>SM</sup>, a computerized energy management system developed by CMS Viron, automatically reduces peak power consumption during dips in solar-generated electricity. These dips may be caused by normal weather conditions such as cloud cover. For example, if clouds block the sun for five minutes on a summer afternoon, UtilityVision<sup>SM</sup> will automatically reduce power consumption proportionately so that no additional purchases of expensive peak priced electricity are necessary.



**Solar Installation at the Santa Rita Jail consists of nearly 3 acres of Power-Light's roof top PV tiles.**

Photo by D. Lichtenberger



## Economic Gains

The approach used by Alameda County demonstrates that integrating innovative solar electricity systems with energy efficiency and energy management technologies offer worthwhile economic benefits to end-users.

- The 1,178 kilowatt (1.2 MW) solar PV installation on top of the Santa Rita Jail consists of roughly 9,700 PowerGuard tiles mounted on fourteen medium and minimum-security housing units in Dublin, California. This solar array covers 130,000 feet, which is equivalent to approximately three acres of solar photovoltaic tiles.
- Total gross project costs for the solar photovoltaic system, cool roofing, and energy efficiency upgrades were approximately \$9 million. State government incentives and loans from the California Energy Commission<sup>1</sup> and the California Public Utility Commission<sup>2</sup> that are available to all city and county governments, helped make the project financially attractive.

## Economic Benefits

The solar project goals were to reduce the Santa Rita Jail's utility costs as well as contribute to California's sustainability and environmentally sound initiatives. In addition, this PV system also helped to offset the air conditioning loads of the jail by providing additional roof insulation.

The PowerGuard photovoltaic system on the Santa Rita Jail facilitates the generation of as much as 915 kWac at mid-day. Additionally, PowerGuard's special insulating properties have reduced the jail's peak roof temperatures, yielding HVAC savings. PowerGuard's PV tiles and protective membrane roofing system are designed to shield the roof from UV radiation and protect against thermal cycling—two environmental factors that greatly undermine a roof's life span. It is estimated that the roof membrane protection will increase the roof life to approximately 25 years while reducing air-conditioning loads.

Alameda County's solar electric power program had an internal rate of return of over 10%, which met their energy investment hurdle. Net savings to Alameda County in its first year of operation will average \$410,000. These savings are based on current (February, 2002) Pacific Gas and Electric electricity rates. Gross savings to Alameda County over the 25 year life of the project will total \$15 million.

**PowerLight Corporation's PV System on the Santa Rita Jail generates as much as 915kWac at mid-day and simultaneously reduces the jail's air conditioning load.**



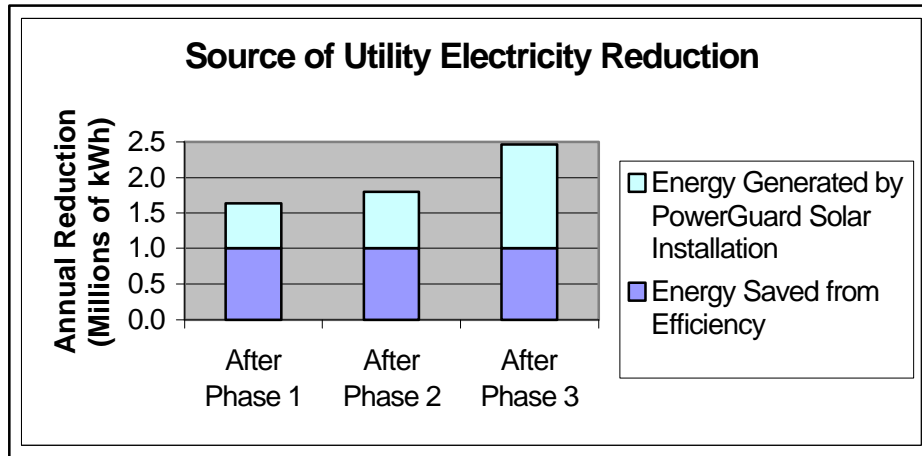
Photo by R. Solari

<sup>1</sup> For more information, please visit [www.energy.ca.gov/efficiency/financing/index.html](http://www.energy.ca.gov/efficiency/financing/index.html)

<sup>2</sup> Administered through PG&E and other investor owned utilities; please visit [www.pge.com/selfgen](http://www.pge.com/selfgen) or your local investor-owned utility website for more information.

### Benefits to Alameda County and California

Over 2.4 million kilowatt-hours of annual electricity consumption are diverted from the power grid by the Santa Rita Jail project. These savings benefit all state consumers by reducing grid power purchases, most of which occurs on-peak -- during times of the tightest supply and highest demand. Additionally, by supplying clean on-site power, the PV system will help defer costly transmission and distribution upgrades. This is an especially critical concern in the severely constrained Tri-Valley transmission line area.



Over 2.4 million kilowatt-hours of annual electricity consumption are diverted from California's power grid by the Santa Rita Jail solar project

### Environmental Savings

Alameda County's solar-powered installations spare the environment from thousands of tons of harmful emissions, such as nitrogen oxides, sulfur dioxide and carbon dioxide, which are major contributors to smog, acid rain and global warming.

It is estimated that over the 25-year lifetime of the Santa Rita Jail's photovoltaic systems, the solar-generated electricity will reduce emissions of nitrogen oxides by 24,000 pounds and carbon dioxide by 38,000 tons. The environmental savings are based on the average California utility generation mix, calculated from values provided by the U.S. Department of Energy. These emission reductions are equivalent to not driving 126 million miles or removing over ten thousand autos from roadways.

Alameda County Solar Project	Predicted Energy	Offset Emissions 25 Years		Equivalent to Saving	
		Global Warming CO <sub>2</sub> (lbs)	Smog NO <sub>x</sub> (lbs)	Not Driving Miles	Removing Autos from Roadways
Santa Rita Jail	1,460,000	3,024,813	965	5,047,657	404
Total over 25 year life:	36,500,000	75,620,325	24,125	126,191,417	10,095

The environmental benefits linked to the 1,178 kilowatt solar PV system and energy efficiency improvements over the life of the Santa Rita Jail project are considerable.

## **System Performance**

Accountability is a key component of this project. The project's performance data is posted on the Internet so that other local governments and commercial customers can review and analyze the performance of both the solar installation and the energy efficiency measures.

## **Lessons For Other Local Governments**

Alameda County has shown that large-scale solar PV systems can indeed be a cost effective investment if available financing and subsidy mechanisms are fully leveraged, and even more cost effective if the system is integrated with the facility's energy management infrastructure.

*"The solutions offered through our alliance with PowerLight reflect the future of the energy industry. As energy becomes more expensive, other public agencies will follow Alameda County's lead and perform energy efficiency upgrades to help manage costs and revitalize aging facilities." - CMS Viron President John Mahoney*

## **Cost Management**

Another compelling aspect of this project was the purchasing and installation strategy. By purchasing multiple demand reduction measures through an integrated project with PowerLight under a single contract, administrative and management costs were lower than if the measures had been contracted separately.

## **Goodwill**

Alameda County received public recognition for its environmental stewardship, and garnered positive press and goodwill in the community.

## **Media Coverage**

Alameda County's leadership in environmental stewardship generated positive press in both national and local communities and was applauded for implementing smart energy strategies using clean on-site solar electric power and energy conservation. Positive media coverage generated by this three-way partnership of Alameda County, PowerLight and CMS Viron includes:

Associated Press  
BusinessWeek  
CBS National Evening News  
C/NET Radio  
Consulting Specifying Engineer  
Contra Costa News  
Contractor Magazine  
Engineering News Record INC. Magazine  
Los Angeles Times  
KABC TV (Los Angeles)  
KCBS AM (Bay Area)  
KGO TV (San Francisco; and National)  
KGO AM (Bay Area)  
KLIV radio (San Francisco)  
KPIX TV (San Francisco)  
KQED FM (Bay Area)

KRON TV (San Francisco)  
KTVU TV (Bay Area)  
Mother Jones Magazine  
National Public Radio  
Oakland Tribune  
Sacramento Bee  
San Francisco Chronicle  
San Jose Mercury News  
Silicon Valley Business Ink  
Tri Valley Herald  
Wired News  
Industry newsletters, including:  
Clean Power, DOE EREN Network News, ENN  
News, Green Energy News, NREL newsletters,  
Solar Electric Power, Solar Energy Bulletin,  
Solar Today.



### **About PowerLight**

PowerLight Corporation is the nation's leading designer, manufacturer and installer of commercial grid-connected solar electric products and systems. Founded in 1991, PowerLight's products deliver reliable, affordable, clean power for commercial and government customers throughout the US and worldwide. In 2000 and 2001 INC. Magazine ranked PowerLight among the top 400 fastest growing privately held companies in the US.

### **About CMS Viron**

CMS Viron Energy Services, a subsidiary of CMS Energy Corporation, is an engineering-based energy services company, specializing in energy performance contracting and turnkey energy projects. CMS Viron is accredited by the National Association of Energy Service Companies, is a charter EPA Energy Star Building Ally, and is qualified by the US Department of Defense and Department of Energy. CMS Viron has offices throughout the United States. CMS Energy Corporation is a \$15 billion international energy company operating in 21 countries.



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