Utility-Scale Solar Power Generation Facilities in California

Requested by
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Executive Summary

Background

There is growing interest within Caltrans to install utility-scale solar power electrical generation facilities in its right of way (ROW), on the rooftops of primary structures or outbuildings, or on vacant parcels owned by the agency. The term "utility-scale solar power generation facility" in the context of this Preliminary Investigation is defined as a facility that generates solar electric power (utilizing panels to generate electricity) and feeds into the surrounding power grid, supplying the regional utility with electricity. Typically, these facilities have generation capacities of 100 to 2,000 kW, and operate under a power purchase agreement (PPA) or a net-metering agreement with the regional utility.

Note: A PPA is a financial agreement between a developer and customer under which the developer is responsible for the design, permitting, financing and installation of a solar energy system on a customer's property, at little to no cost to the customer. PPA terms typically range from 10 to 25 years, and the developer is responsible for system operation and maintenance. At the end of the PPA's term, the customer can extend the PPA, have the developer remove the system or purchase the system from the developer.

Under a net-metering agreement, customers receive credit for the retail value of the electricity that their solar photovoltaic systems generate. The customer pays only for the net amount of electricity used from the utility that exceeds the amount of electricity generated by the customer's solar system (and any additional charges related to electricity use).

Caltrans is interested in learning about the activities of California public agencies with regard to the design, installation, maintenance, operation or lease of utility-scale solar facilities. Of particular interest is information about the installation of these facilities—where they are located, how they were designed and financed, and what best practices can be used for their deployment. Caltrans is also interested in touring these facilities.

To assist Caltrans in gathering information about these facilities, CTC & Associates surveyed people with knowledge of selected utility-scale solar generation facilities installed by California public agencies. A literature search identified other solar projects within California and on the West Coast that may be of interest to Caltrans, as well as related resources produced by state and national experts.

Summary of Findings

Utility-Scale Solar Power Generating Projects in California

Contacts to state and regional agencies and associations along with a literature search identified solar power generation facilities installed by six California public agencies. These agencies were surveyed to gather information about the facilities. The table below provides highlights of the projects that respondents described; additional information is available in the appendices to this report.

Each of the facilities described below is available for a facility tour. Contact and location information for each facility is included in the project summaries that appear in the **Detailed Findings** section of this report.

Selected Utility-Scale Solar Power Generating Projects in California						
California Public Agency	**Facility**	**Year Installed**	**Facility Description**	**Energy Produced**	**Funding**	**Vendor or Consultant**
City of Corona	Water reclamation facility	2010-2012	Vacant parcel	280 kW (second phase)	Federal grant and local utility funds	Not specified
City of Dinuba	Wastewater reclamation facility	2009	7-acre vacant parcel	1,000 kWh	PPA	Chevron Energy Solutions
	Five unspecified sites that benefit an adjacent city utility or building	2013	Vacant parcels and parking lot	Sized to fit location	Bond funds	OpTerra Energy Services
City of Madera	Wastewater treatment plant	2009	5-acre vacant parcel	250 kWh	PPA	SunEdison, Inc.
City of Palo Alto	Municipal Service Center	2008	Carports and pole-mounted systems	75 kW	Grants and federal/utility incentives	Multiple
	Pearson Arastradero Preserve Gateway Building	2006	Mounted on straw bale buildings	500 W	Grants and federal/utility incentives	Multiple
	Baylands Interpretive Center	2008	Rooftop (low tilt)	15 kW	Grants and federal/utility incentives	Multiple
	Cubberley Community Center Gym	2008	Rooftop and shade canopy	118 kW	Grants and federal/utility incentives	Multiple
	Mitchell Park Community Center	2014	Rooftop	55 kW	Grants and federal/utility incentives; bond funds	Multiple
City of San Rafael	Public works facility	2017	Rooftop	193 kWh	PPA (20-year lease)	Optony, Inc. SolEd Benefit Corporation

Selected Utility-Scale Solar Power Generating Projects in California						
California Public Agency	**Facility**	**Year Installed**	**Facility Description**	**Energy Produced**	**Funding**	**Vendor or Consultant**
City of San Rafael	Community center	2017	Rooftop and shade canopies	231 kWh	PPA (20-year lease)	Optony, Inc. SolEd Benefit Corporation
Sonoma County Water Agency	Primary structure	2006/2007	Rooftop and carport	1,700 kWh*	Utility incentives	Unspecified third-party contractor
	Pond embankment; grass field	2006/2007	Ground-mounted panels on 3.7-acre vacant parcel	1,700 kWh*	Utility incentives	Unspecified third-party contractor

* All Sonoma County Water Agency facilities together produce 1,700 kWh.

Development Practices

All respondents used a third party—a power company or consultant—to assist with vendor selection or to design and build their solar power generation facilities. Several used a PPA to fund the facility, while others used grants, bond funding, and federal and utility incentives.

Respondents offered the following guidance and practices to agencies deploying a facility:

- Be cautious when considering the use of a bulk purchasing process when developing projects for several districts or municipalities (city of San Rafael).
- Carefully review the contractor's design (Sonoma County Water Agency).
- Consider hiring an in-house expert to provide the expertise needed for project development (city of Madera).
- Consider including the cost of maintenance in the funding package for a new facility (city of Palo Alto).
- Hire a third party to provide the expertise needed for project development (cities of Madera and San Rafael).
- Include performance monitoring in contracts for facilities under third-party ownership (city of Palo Alto).

Respondents noted few challenges, among them:

- Sizing a system for a utility with varied uses (city of Dinuba).
- Inability to use overproduction that is credited at a much lower rate than energy costs (city of Dinuba).

Other California Public Agency Solar Projects

Three projects constructed by Borrego Solar, Inc. are highlighted to supplement the facilities described above. The facilities, constructed for Campbell Union School District, Helix Water District and Newport Mesa Unified School District, employ roof-mounted and solar shade structures. One site is net-metered and the other two operate under a PPA. Each of these agencies installed systems at multiple sites; taken together, the energy production from all sites may be outside the bounds of the power-generating capacity of interest to Caltrans.

Related Resources

Other California Projects and Guidance

We highlight other California-based solar projects described in case studies and other publications, including:

- City of Chico solar power generating projects installed at the city's water pollution control plant and at a downtown parking system. The systems generate 1,107 kW and 91 kW, respectively.
- A solar energy system at University of Southern California's Wrigley Marine Science Center generates 98 kWh of electricity per day.
- A joint project with Amonix that installed solar panels at the University of California, Irvine produces 60 to 70 kW of electricity per panel.

Publications that provide guidance for developing solar power generation facilities include:

- A 2017 annual report produced by Caltrans summarizes the agency's efforts in connection with facilities built using Clean Renewable Energy Bonds.
- A 2015 webinar presented by the acting director of Alameda County General Services Agency addresses how municipalities can collaborate on solar procurement projects, provides a collaborative procurement model and project examples, and offers lessons learned.
- A 2011 best practices guide, produced in part by Joint Venture: Silicon Valley Network, "is intended to assist commercial and government entities in the process of organizing and executing a collaborative solar purchase. … The guide outlines a list of best practices, which together constitute a 12-step process to capture the economic and practical benefits of a joint purchase."

Other State Practices

Given the proximity of Oregon to California, we provide information about Oregon Department of Transportation's (DOT's) practices and guidance for developing solar power generation facilities in the ROW.

National Guidance

A 2016 Federal Highway Administration (FHWA) publication offers guidance and examples of projects using solar energy technologies in ROWs. Two other FHWA publications, produced in 2010, examine procuring and implementing solar projects on public buildings.

Gaps in Findings

Because they typically relied on power companies or third-party contractors for design and installation, survey respondents had relatively little to say about the design process, best practices for deployment and maintenance, and challenges.

Our contacts led us to a relatively small number of facilities. While we were able to identify other facilities through independent research, the small sampling of projects highlighted in this report may not be representative of all utility-scale solar power generating projects in California. Additional research and contacts may yield information about other solar power generating facilities of interest to Caltrans.

Next Steps

Moving forward, Caltrans could consider:

- Contacting survey respondents to gather additional information about their facilities and to request a tour of these facilities.
- Exploring the use of a third party to help determine needs and assist with the contracting process.
- Reviewing in detail the publications that offer best practices for collaborative solar procurement.
- Contacting Oregon DOT to learn more about the agency's ROW solar installation.

Detailed Findings

Utility-Scale Solar Power Generating Projects in California

Caltrans is interested in learning about the design, installation, maintenance, operation or lease of utility-scale solar power electrical generation facilities installed by California public agencies in public rights of way (ROWs), on the rooftops of primary structures or outbuildings, or on vacant parcels owned by the agency. These facilities typically have generation capacities of 100 to 2,000 kW and operate under a power purchase agreement (PPA) or a net-metering agreement with the regional utility.

Note: The Solar Energy Industries Association defines a PPA (see https://www.seia.org/research-resources/solar-power-purchase-agreements):

> A solar power purchase agreement (PPA) is a financial agreement where a developer arranges for the design, permitting, financing and installation of a solar energy system on a customer's property at little to no cost. The developer sells the power generated to the host customer at a fixed rate that is typically lower than the local utility's retail rate. This lower electricity price serves to offset the customer's purchase of electricity from the grid while the developer receives the income from these sales of electricity as well as any tax credits and other incentives generated from the system. PPAs typically range from 10 to 25 years and the developer remains responsible for the operation and maintenance of the system for the duration of the agreement. At the end of the PPA contract term, a customer may be able to extend the PPA, have the developer remove the system or choose to buy the solar energy system from the developer.

Go Solar California describes net energy metering in California (see http://www.gosolarcalifornia.ca.gov/solar_basics/net_metering.php):

> Net energy metering, or "NEM," is a special billing arrangement that provides credit to customers with solar PV [photovoltaic] systems for the full retail value of the electricity their system generates. Under NEM, the customer's electric meter keeps track of how much electricity is consumed by the customer, and how much excess electricity is generated by the system and sent back into the electric utility grid. Over a 12-month period, the customer has to pay only for the net amount of electricity used from the utility over-and-above the amount of electricity generated by their solar system (in addition to monthly customer transmission, distribution, and meter service charges they incur).

We reached out to the following organizations that were expected to have knowledge of or experience with this type of solar power generation facility:

- California Department of General Services.
- California Energy Commission
- California public utilities.
- California State Association of Counties.

- California Statewide Communities Development Authority.
- League of California Cities.
- University of California Advanced Solar Technologies Institute (UC Solar).

After receiving a limited response to our inquiries, we contacted selected public agencies identified through a literature search to obtain additional feedback. Brief project summaries, listed below, present the feedback we received from the following facility owners:

- City of Corona.
- City of Dinuba.
- City of Madera.
- City of Palo Alto.
- City of San Rafael.
- Sonoma County Water Agency.

Project contact information for each facility can be used to request a tour for Caltrans staff.

City of Corona

Facility Description

In May 2010, the city's Department of Water and Power completed installation of the first phase of a solar power generation system at its Water Reclamation Facility 1 at a cost of $878,417. The system supplements current electrical needs for daily plant operation. A second phase of the project, completed in August 2012, added 1,246 solar panels generating 280 kW of power. Cost of the second phase was $1,025,348.

Funding

The city used funding from its Electric Utility Fund (578) (a fund to account for the operation and maintenance of the electric utility) to complete the first phase of the project. Funding for the second phase came from three sources:

- Energy Efficiency and Conservation Block Grant Program grant. This U.S. Department of Energy program provides financial and technical assistance to help state and local governments create and implement a variety of energy efficiency and conservation projects.
- Unspecified electric utility funds.
- Water Reclamation Capital Replacement Fund. This city fund provides for the capital improvement projects associated with repair, replacement and regulatory improvements to the sewer collection system and the water reclamation facilities.

Project Contact

Nelson D. Nelson, Public Works Director, 951-817-5765, nelson.nelson@coronaca.gov.

Location

Department of Water and Power: 755 Public Safety Way, Corona, California.

Related Resources

Project Completion Summary: Solar Power System, Project No. 09-0309, City of Corona, California, undated.
See Attachment A.
This document provides a summary of the first phase of the solar project completed at the city's Water Reclamation Facility 1.

Project Completion Summary: Solar Power System, Water Reclamation Facility #1, Phase II, Project No. 15-0310, City of Corona, California, undated.
See Attachment B.
This document provides a summary of the second phase of the solar project completed at the city's Water Reclamation Facility 1.

City of Dinuba

Facility Description

The city of Dinuba has one solar power generation facility located at its wastewater reclamation facility and five additional solar facilities, varying in size, located throughout the city.

The solar facility located at the wastewater reclamation facility was built in 2009 on a vacant 7-acre parcel. The facility produces 1,000 kWh and benefits up to 50 city meters. The city worked with Chevron Energy Solutions, which contracted out the design and construction. (In 2014, Chevron finalized the sale of its renewable energy subsidiary, Chevron Energy Solutions, to OpTerra Energy Services.)

Five additional solar facilities were constructed in 2013 on vacant parcels and a parking lot. The kilowatts produced by each facility are fit to size based on the location. Four of these sites benefit an adjacent city utility or building. The city worked with OpTerra Energy Services for the design and construction. The city owns these facilities.

Funding

The wastewater reclamation facility project was funded with a PPA, with no construction costs incurred by the city. At the end of the PPA, the city has the option to purchase the facility. The other five solar projects were funded through bonding and are owned by the city.

Deployment Recommendations and Challenges

Challenges included sizing a system for a utility with varying uses and needs, and the inability to use overproduction that is credited at a much lower rate than energy costs.

Project Contact

Blanca Beltran, Public Works Director, 559-591-5924, bbeltran@dinuba.ca.gov.

Location

Wastewater Reclamation Facility: 6676 Avenue 412, Dinuba, California. The five additional sites are located throughout the city.

Related Resource

OpTerra Energy Services, 2017.
https://opterraenergy.com/
This is the web site for the company the city of Dinuba worked with to design and construct five solar facilities in 2013.

City of Madera

Facility Description

In 2009, SunEdison, Inc. designed and constructed a solar power generation facility at the city's wastewater treatment plant. The facility is located on a 5-acre vacant parcel and produces approximately 250 kWh.

Funding

The project was funded through a PPA with SunEdison, Inc.

Deployment Recommendations and Challenges

The city is currently considering another solar project and is exploring three options:

- Hiring someone to serve as an "in-house guru."
- Using a third-party engineering firm to help analyze what is most effective for the proposed facility, write the request for proposal (RFP) and complete construction.
- Partnering with an energy firm that can provide a turnkey project.

The city is also considering a hybrid of these three options.

City representatives feel they lack the in-house expertise needed to identify "when they are getting a good or bad deal." A request for quotation from consultants has been issued to guide the city through the project development process.

The respondent indicated that, as with any other large capital project, "there's a lot of heavy lifting," also noting that SunEdison managed the installation and is responsible for facility maintenance.

Project Contact

David Randall, Public Works Director, 559-661-5461, drandall@cityofmadera.com.

Location

13048 Rd 21 1/2, Madera, California.

Related Resource

SunEdison, Inc., 2017.
http://investors.sunedison.com/
This is the web site for the company that designed, constructed and now maintains the city of Madera's solar facility.

City of Palo Alto

Facility Description

To date, the city of Palo Alto has installed six photovoltaic (PV) systems on city-owned properties. The newest installations in city parking structures (see **Related Resources** below) are part of the city's Palo Alto CLEAN (Clean Local Energy Accessible Now) program. This program purchases electricity generated by renewable energy generation systems located in the City of Palo Alto Utilities' (CPAU's) service territory. As a "feed-in tariff" program, utilities like CPAU pay a "fixed price (tariff) for the power that is 'fed into' their electric grid from local generation systems." Power purchased under this program comes from projects in the 100 to 500 kW range via PPAs.

Five of the city's PV installations were installed between 2006 and 2014. One of these sites is off-grid and four are net-metered. The sites are described on the city's web site (see http://www.cityofpaloalto.org/gov/depts/utl/residents/resources/pcm/pv_on_city_facilities.asp) and below. These sites generate electricity or hot water and reduce operating costs. The total rated power capacity of the systems is 264 kW.

Municipal Service Center, 3201 East Bayshore Road

- This site has two separate PV systems: three carports in the employee parking lot and seven pole-mounted tracking systems. While the carport modules [solar panels] have a fixed tilt and orientation, the trackers move to follow the sun, which increases the amount of electricity generated throughout the year.
- PV system specifications: Each tracker has 12 SunPower modules and a Wattsun tracking unit. The M Bar C custom carport has 408 Evergreen modules. Each system has one SatCon inverter. The total capacity for this site is 75 kW (16.7 kW for the trackers and 61 kW for the carport).
- Installation date: 2008.

Pearson Arastradero Preserve Gateway Building, 1530 Arastradero Road

- This site uses solar energy to power the lights and electric equipment and heat the water on the buildings made from straw bales. The solar power system uses batteries because this site is not connected to the electric grid.
- PV system specifications: 12 Unisolar modules, one Xantrex inverter, 500 watts, eight batteries.
- Solar water heating system specifications: ProgressivTube passive solar water heater, 40 gallons.
- Installation date: 2006.

Baylands Interpretive Center, 2775 Embarcadero Road

- PV modules are installed on the roof at a low tilt to minimize visibility.
- PV system specifications: 136 Sharp modules and four SMA inverters for a total capacity of 15 kW.
- Installation date: 2008.

Cubberley Community Center Gym, 4000 Middlefield Road

- PV modules are mounted on the roof and on a canopy to provide shade to the south-facing cardio rooms.
- PV system specifications: 96 Schott modules on the canopy, 520 SunPower modules on the roof and two Xantrex inverters for a total system capacity of 118 kW.
- Installation date: 2008.

Mitchell Park Community Center, 3700 Middlefield Road

- This site has many sustainable design features and uses solar energy to generate electricity and heat the water for the library and community center.
- PV system specifications: 262 SolarWorld modules, one Refusol inverter, two Advanced Energy inverters for a total capacity of 55 kW.
- Solar water heating system specifications: 14 Heliodyne drainback collectors with 668 gallons of storage capacity.
- Installation date: 2014.

Funding

The city's five legacy PV installations were funded using grants and incentives from the federal government and CPAU. The solar facility at Mitchell Park Library and Community Center was constructed using bond funds.

Deployment Recommendations and Challenges

No maintenance funding was included in the funding packages for the city's first three solar projects, which reduced the funding needed on the front end but presented challenges on the back end. The city was required to fund maintenance out of the savings realized from the project. City staff recommend including performance in contracts for facilities under third-party ownership.

Project Contact

Dennis Huebner, Maintenance Operations Manager, 650-496-6970, dennis.huebner@cityofpaloalto.org.

Location

Municipal Service Center, 3201 East Bayshore Road, Palo Alto, California.

Related Resources

"City of Palo Alto Paves the Way for More Electric Vehicles with Local Renewable Energy," News Release, City of Palo Alto, California, September 2017.
http://www.cityofpaloalto.org/news/displaynews.asp?NewsID=4018
From the news release: On Monday, July 24, the City of Palo Alto unveiled new solar panels installed atop parking carports of two public garages and electric vehicle (EV) charging stations that are powered by the renewable energy generated on-site.
….

Last year, Komuna Energy was selected to build, own and operate the solar rooftops. The ability to structure the contract as a competition for leasing rights was facilitated by the City's Feed-in-Tariff program, known as Palo Alto CLEAN (Clean Local Energy Accessible Now), which the Clean Coalition advocated for in 2013. Palo Alto CLEAN standardizes the process for selling local renewable energy to the utility and will make it possible to buy all the solar energy generated through Palo Alto CLEAN at a fixed price. Komuna Energy has five projects in Palo Alto participating in the CLEAN program with a total capacity of 1,587.40 kilowatts (kW).

Palo Alto Photovoltaic Demonstration Project Summary, City of Palo Alto, California, 2008.
See Attachment C.
The document provides a summary of three solar projects completed in May 2008 by Timmons Design Engineers and Arkin-Tilt Architects (consultant) and SPG Solar, Inc. (contractor): Municipal Services Center, Cubberley Community Center Gym and Baylands Interpretive Center. These installations were completed with funds from U.S. Department of Energy grants and co-funded by CPAU.

Field Verification Inspection Summary: CPAU PV Partners Program, Mitchell Park Library, City of Palo Alto, California, December 2014.
See Attachment D.
This document is the inspection form used for the Mitchell Park Community Center PV project and provides system specifications and other details of the system.

PV on City Facilities: See How the City of Palo Alto is Using Solar Power on City-Owned Sites, City of Palo Alto, California, 2016.
http://www.cityofpaloalto.org/gov/depts/utl/residents/resources/pcm/pv_on_city_facilities.asp
From the web site: The City of Palo Alto has five sites using clean renewable solar energy to generate electricity or hot water and reduce operating costs. These projects have been funded from grants and incentives from the Federal government and the City of Palo Alto Utilities. The Mitchell Park Library and Community Center was constructed using bond funds. The total rated power capacity of the solar photovoltaic (PV) systems is 264 kilowatts (kW)

City of San Rafael

Facility Description

The city completed three solar power generation installations in 2017:

- Rooftop of the city's public works facility (produces193 kWh).
- Rooftop of the Albert J. Boro Community Center (produces 87 kWh).
- Shade canopies for the community center parking lot (produces 144 kWh).

The first two facilities came online in February 2017; the third was operational in August 2017. The city hired a consulting firm, Optony, Inc., to conduct a feasibility study and help with hiring a contractor for the solar installation. The city selected SolEd Benefit Corporation (SolEd) to design and build the three facilities. SolEd retains ownership of all three sites.

Funding

The projects were funded through a 20-year lease PPA with SolEd.

Deployment Recommendations and Challenges

Lacking a method to compare vendor bids, the city hired Optony, Inc. using a bulk purchasing process in which the city served as the lead agency for several districts. While it was expected that this approach would lead to cost savings, these savings were not realized. The survey respondent does not recommend using the bulk purchasing approach, noting that it may be more appropriate for use in the private sector than with government entities. The city saved time and obtained the needed expertise by hiring a trusted, neutral third party.

The respondent also noted that it can be difficult to obtain buy-in from key players in the development process. It is also important to understand the facilities receiving the solar installation. For example, it may be advisable to replace a roof before its useful life is exhausted—before rooftop solar panels are installed—to save money in the long run.

Project Contact

Cory Bytof, Sustainability Coordinator, 415-485-3407, cory.bytof@cityofsanrafael.org.

Location

- Rooftop of the public works facility: 111 Morphew Street, San Rafael, California.
- Rooftop and shade canopies of the Albert J. Boro Community Center: 50 Canal Street, San Rafael, California.

Related Resources

SolEd Benefit Corporation, 2013.
http://sol-ed.com/
SolEd designed and built the city of San Rafael's three solar power installations. Among the company's services are:

- Energy audits, feasibility studies and resource assessments to determine the best fit for each customer site. Financing and oversight of an entire project.

- Comprehensive operations and maintenance for all systems.
- Installation of extra metering to allow for tracking of system performance and reporting of energy savings.

Optony, Inc., undated.
http://www.optonyusa.com/
From the web site: Optony, Inc. is a global research and consulting services firm focused on enabling government and commercial organizations to design, procure and manage commercial and utility-grade renewable power systems.

Sonoma County Water Agency

Facility Description

The solar power generation facilities owned by the Sonoma County Water Agency were built in 2006 and 2007 by a third-party contractor selected from a competitive RFP process that sought design-build services to develop solar PV systems.

One facility is split between a building roof and a carport. Other facilities occupy vacant parcels, with one ground-mounted facility on a south-facing 22-degree slope of a pond embankment, and another ground-mounted facility on a grass field. The facilities together cover 3.7 acres and produce 1,700 kWh.

Funding

Funding for the projects was obtained through Pacific Gas and Electric Company's Self-Generation Incentive Program. This program focuses on integrating renewable energy and reducing greenhouse gas emissions to support California's climate and clean air goals.

Deployment Recommendations and Challenges

The agency recommends meticulously reviewing the contractor's design. While the respondent noted that solar PV contractors do not provide extensive documentation for their installations, the documentation provided has proved to be adequate. In terms of ongoing maintenance, the systems' inverters required repair or replacement over the past few years.

Project Contact

Dale Roberts, Principal Engineer, 707-547-1979, dale.roberts@scwa.ca.gov.

Location

204 Concourse Boulevard, Santa Rosa, California.

Related Resources

Learn About the Self-Generation Incentive Program, Pacific Gas and Electric Company, 2017.
https://www.pge.com/en_US/business/solar-and-vehicles/your-options/solar-programs/self-generation-incentive-program/self-generation-incentive-program-faqs.page
This web site provides information about the program used by Sonoma County Water Agency to fund its solar facilities.

Photovoltaic Summary Project Sheet, Sonoma County, California, undated.
See Attachment E.
This spreadsheet provides technical information on the Airport Treatment Plant, 404 Aviation Building and the Sonoma Valley Treatment Plant projects.

Installation Plan: Powertracker Photovoltaic Solar Array, Sonoma Valley County, Sonoma, California, May 2007.
See Attachment F.
This document provides construction drawings and an installation plan for a county project.

Installation Plan: Powerguard and Fixed Tilt Structure Photovoltaic Solar Array, Sonoma County Water, Santa Rosa, California, January 2006.
See Attachment G.
This document provides construction drawings and an installation plan for a county project.

Airport Treatment Plant Photovoltaic Project, Sonoma Valley County, Sonoma, California, April 2007.
See Attachment H.
This document provides construction drawings for the Airport Treatment Plant project.

Other California Public Agency Solar Projects

To supplement the project summaries presented above, a literature search identified public-sector projects in California completed by Borrego Solar, Inc., a privately owned commercial solar installer (see https://www.borregosolar.com/). Three of these projects are highlighted below:

- Campbell Union School District.
- Helix Water District.
- Newport Mesa Unified School District.

Contact information for individuals who might be able to assist with a facility tour is provided.

Campbell Union School District

Facility Description

Borrego Solar designed and built roof-mounted solar installations and solar shade structures at nine school sites and one district site. The facilities are net-metered. Each system is sized to offset approximately 70 percent of the current electricity usage. Energy production at each site ranges from 69 to 236 kW. Together the facilities produce 200,000 kWh per month (2.4 million kWh annually).

Funding

The project was funded using a zero percent interest loan from the California Energy Commission. As the Borrego Solar, Inc. web site indicates, “[a]fter paying for the solar systems and a full 25 years of operations and maintenance, the district expects to realize more than $8 million in net benefits over the first 25 years of operation.”

Possible Contact

David Radke, Maintenance and Grounds Director, 408-364-4200, ext. 7204, dradke@campbellusd.org.

Location

155 N. Third Street, Campbell, California.

Related Resource

"Campbell Union School District: The 10 Arrays, Totaling 1.5MW, is Expected to Save the District More Than $8 Million Over the Life of the Systems," Borrego Solar, Inc., 2016.
https://www.borregosolar.com/commercial-solar-systems/campbell-union-school-district
This web site describes the Campbell Union School District's solar installations.

Helix Water District

Facility Description

Solar arrays were installed on three rooftops and on a newly constructed elevated shade structure in the water district's storage yard. The installations include 1,232 solar panels that produce 37,833 kWh per month and cover 21,662 square feet. The system is operated and maintained under an integrated PPA with Borrego Solar, Inc.

Funding

Under a PPA, Helix Water District "didn't have to pay for the solar asset and in turn will pay a rate for the energy produced that is less than what they're paying San Diego Gas & Electric. Under the agreement, for the next 20 years, the Helix W[ater] D[istrict] will purchase approximately 454,000 kWhs of clean energy per year, which is about 90 percent of the energy consumed by the OC [operations center]. At the end of the PPA term, the District can renew the contract, purchase the system outright or have it removed should a more efficient technology become available."

Possible Contact

Brian Olney, Water Quality and System Operations Director, 619-667-6242, brian.olney@helixwater.org.

Location

7811 University Avenue, La Mesa, California.

Related Resource

"Helix Water District: Solar is Covering Nearly 90% of the Energy Consumed at the Operations Center," Borrego Solar, Inc., 2016.
https://www.borregosolar.com/commercial-solar-systems/helix-water-district
This web site describes the Helix Water District's solar project.

Newport Mesa Unified School District

Facility Description

Thirty-two elevated shade structure systems were installed across the school district. The sites produce 169,682 kWh per month and are net-metered. The vendor notes that the 32 sites are among the most solar systems installed for any school district in the country.

Funding

The school district used state incentives and loans to fund the solar installation, which limited up-front capital expenditures. The funding package for the $13 million project included:

- $3 million zero percent interest loan from the California Energy Commission.
- $5 million in funds from Special Reserve Funds for Capital Outlay Projects.
- $5 million from Proposition 39 (funding associated with the California Clean Energy Jobs Act).

In addition, the district will receive a performance-based incentive from the California Solar Initiative program for the first five years the installations are in operation. Savings from the PV installations are expected to pay back the investment and provide an income stream over the 25-year life of the system.

Possible Contact

Dr. Frederick Navarro, Superintendent, 714-424-5031, superintendent@nmusd.us.

Location

2985 Bear Street, Costa Mesa, California.

Related Resources

"Newport Mesa Unified School District: Borrego Solar Built 32 Systems Across the District—Among the Most Systems for Any District in the Country," Borrego Solar, Inc., 2016.
https://www.borregosolar.com/commercial-solar-systems/newport-mesa-unified-schools-district
This web site describes the Newport Mesa Unified School District's solar project.

Solar Photovoltaic Program Projects: Sample of Solar Panels Planned At NMUSD Facilities, Newport Mesa Unified School District, 2015.
http://web.nmusd.us/solar
This district web site provides additional information about solar installations.

The California Solar Initiative, Go Solar California, State of California, California Energy Commission and California Public Utilities Commission, 2017.
http://www.gosolarcalifornia.ca.gov/csi/index.php
This program offers cash back for installing solar power generation facilities on homes and businesses.

Related Resources

The resources below are organized in three categories:

- Other California projects and guidance.
- Other state practices.
- National guidance.

Other California Projects and Guidance

Other Solar Projects

"City of Chico Generates Clean Energy with SunPower," *Case Study*, SunPower Corporation, undated.
https://us.sunpower.com/sites/sunpower/files/media-library/case-studies/cs-city-chico-generates-clean-energy-sunpower-tracker.pdf
This case study describes two solar power generating projects installed in the city of Chico:

Water Pollution Control Plant
Date Completed: October 2005.
System Peak Capacity: 1,107 kW.
System Area: 5 acres.
Solar Electric Tiles: 5,824.
Products: SunPower Tracker (the tracker follows the sun from early morning to late afternoon).

Downtown Parking System
Date Completed: July 2004.
System Peak Capacity: 91 kW.
PV Surface Area: 940 square feet.
Solar Electric Tiles: 480.
Products: SunPower Parking System (fully engineered mechanical mounting system to securely fasten the solar electric panels, providing strength as well as structural integrity).

"Solar Energy System Up and Running at USC's Catalina Island Facility," Darrin S. Joy, *USC News*, University of Southern California (USC), April 11, 2016.
https://dornsife.usc.edu/news/stories/2309/solar-energy-system-up-and-running-at-uscs-catalina-island-facil/
From the online article: The installation and launch of a solar energy system at the USC Wrigley Marine Science Center marks a significant step in the university's efforts to boost sustainability.
….

The 23 kW solar energy system—a donation from Helix Electric, a national electrical contractor—includes 88 solar panels generating an average of about 98 kilowatt hours of electricity per day, or nearly 3 megawatt hours each month.

The energy output covers about 20 percent of the electrical burden for the center's dormitory and kitchen and dining facilities, marking a major energy offset for the site.
….

The installation of the new solar energy system was a collaboration involving the Wrigley Institute, USC Capital Construction and Helix Electric. The latter organization, in conjunction with solar equipment manufacturers SolarWorld Americas Inc. and SMA America, donated the system components and installation.

"Sun-Tracking, Concentrating Systems Boost PV Efficiency," Adam Plesniak, SPIE, 2014.
https://www.youtube.com/watch?v=e-C0eN-6iig
This YouTube video explains the technology behind a joint solar project between University of California, Irvine and Amonix. The PV system produces 60 to 70 kW of electricity per panel and is designed to track the sun to improve PV efficiency. The panels shown in the video are located on the University of California, Irvine campus. The panel size would be appropriate for ROW and vacant parcel locations.

California Resources and Guidance

Clean Renewable Energy Bonds Program: 2017 Annual Report, Caltrans, 2017.
See Attachment I.
From the executive summary: The 2017 CREBs [Clean Renewable Energy Bonds] Annual Report includes the following information:

- The status of each facility on which Caltrans has installed photovoltaic energy systems as part of the CREBs Program. (Exhibit 1).
- An accounting of the costs for each photovoltaic energy system installed or acquired by Caltrans. (Exhibit 1).
- A description of the energy savings Caltrans has achieved by acquiring or installing photovoltaic energy systems. (Exhibit 3).
- A review and analysis of the expected cost savings at the time of issuance of the bonds (Exhibit 2) versus actual annual savings. (Exhibit 3).

Solar Power Hour: Collaborative Solar Procurement for Municipal Agencies, Thomas Yurysta and Caroline Judy, September 2015.
http://resources.solarroadmap.com/Solar-Power-Hour-M3-M6.pdf
This webinar presented by a senior project manager for Optony, Inc. and the acting director of Alameda County General Services Agency addresses how municipalities can collaborate on solar procurement projects and provides a collaborative procurement model. The webinar provides project examples and lessons learned, including:

- Need a strong, regional convener to ensure project stays on timeline.
- Must sign up the lead agency first as it is the best support for outreaching to other participants.
- Develop clear messages to build awareness quickly and move forward without confusion.
- Vendors should include a time-based discount to their proposals.
- Sign up fewer agencies, with larger potential and in a regional cluster. Send out a survey to conduct high-level screening.
- Host and support high-level political champions.
- Arrange site tours for participating agency staff to visit finished projects.

Purchasing Power: Best Practices Guide to Collaborative Solar Power Procurement, World Resources Institute and Joint Venture: Silicon Valley Network, 2011.
https://jointventure.org/images/stories/pdf/purchasing-power-guide.pdf
From the guide's purpose statement: This Best Practices Guide is intended to assist commercial and government entities in the process of organizing and executing a collaborative solar purchase. … The guide outlines a list of best practices, which together constitute a 12-step process to capture the economic and practical benefits of a joint purchase.

Experts in the solar energy field, including those specializing in regional collaboration, helped to develop the best practices presented here. They are based on extensive research and real-world experiences, and are supported by case studies (one a private sector collaborative and one with public-sector participants). These two cases were unique models of regional collaboration, among the first in the country at this scale. Like all new approaches to a problem, both efforts encountered challenges along the way. Throughout the guide, we illustrate the lessons learned from these challenges, point out pitfalls to avoid, and highlight ways to streamline the process. We also provide resources, such as solicitation and procurement documents, participant questionnaires, and evaluation criteria.

Other State Practices

Given the proximity of Oregon to California, we provide below information about Oregon Department of Transportation's (DOT's) practices and guidance for developing solar power generation facilities in the ROW.

Oregon

Solar Highway Program: From Concept to Reality; A Guidebook for Departments of Transportation to Develop Solar Photovoltaic Systems in the Highway Right-of-Way, Oregon Department of Transportation, November 2016.
http://www.oregon.gov/ODOT/Programs/Solar%20Highway%20documents/Solar-Highway-Program-Guidebook.pdf
From the guidebook:

> This guidebook is intended to provide an overview for state Departments of Transportation (DOTs) of the process for developing solar photovoltaic (PV) projects in the highway right-of-way. The goal is to help others navigate the process towards a successful solar PV installation by providing step-by-step information, case studies and additional resources.
>
> The information presented in this guidebook is based on the experience of the Oregon Solar Highway Program as well as industry best practices.

Among the topics addressed are ranking candidate sites, assessing candidate site feasibility, evaluating business models, identifying and selecting a solar developer, and completing project delivery and implementation. A feasibility and implementation checklist begins on page 59 of the guide (page 60 of the PDF).

Oregon Solar Highway Program, Oregon Department of Transportation, undated.
http://www.oregon.gov/ODOT/Programs/Pages/Solar-Highway.aspx
From the web site: On December 19, 2008, the nation's first solar highway project started feeding clean, renewable energy into the electricity grid, and the first Oregon Solar Highway project has been operating seamlessly ever since. The 104-kilowatt (dc) ground-mounted solar

array, made up of 594 solar panels, is situated at the interchange of Interstate 5 and Interstate 205 south of Portland, Oregon, and offsets over one-third of the energy needed for freeway illumination at the site.

"The Oregon Solar Highway: Alternative Uses of Highway ROW," Joseph A. Gray, Oregon Department of Transportation, *Joint Meeting for Subcommittee on Design and Subcommittee on Right of Way and Utilities*, May 2011.
http://modot.org/business/outdoor_advertising/documents/AASHTO%20Presentations%202011/The%20Oregon%20Solar%20Highway.pdf
This presentation describes the Interstate 5 and Interstate 205 interchange solar demonstration project that was installed on a 0.2-acre footprint. A utility-managed limited liability company owns and operates the facility. Oregon DOT has a PPA to buy the electricity produced at the same rate as conventional grid power. The private partners used state and federal tax credits and state utility incentives to help finance the $1.28 million project.

National Guidance

Renewable Energy Generation in the Highway Right-of-Way, Federal Highway Administration, 2016.
https://www.fhwa.dot.gov/environment/sustainability/energy/publications/row/renewablerow.pdf
From the introduction:

> State Departments of Transportation (DOTs) are increasingly exploring the use of highway right of way (ROW) to accommodate renewable energy technologies. The ample lands DOTs manage are often close to electrical loads and have sometimes already been disturbed, potentially making these properties ideal locations for renewable energy applications.
>
> Highway ROW renewable energy projects can:
>
> - Add value to ROW assets and create a revenue source for State DOTs to offset energy demand and operating costs.
> - Reduce greenhouse gas (GHG) and other pollutant emissions.
> - Promote energy security by diversifying energy generation and delivery methods.
> - Foster the creation of a local green job market that enhances the viability of the Nation's renewable energy industry.

A spreadsheet that begins on page 4 of the report (page 5 of the PDF) provides examples of the use of solar energy technologies in ROWs. Two Oregon ROW solar projects are described in this publication; see the citations on page 21 for more information about Oregon DOT's solar power generating projects.

Procuring and Implementing Solar Projects on Public Buildings, Sarah Truitt, Kim Owens and Craig Schultz, U.S. Department of Energy Technical Assistance Program, December 2010. https://www.energy.gov/sites/prod/files/2014/05/f15/procuring_and_implementing_solar_projects_on_public_bldgs-how_to_avoid_common_pitfalls_12-8-10.pdf
The following describes the intended audience and goals for this webinar:

AUDIENCE

EECBG [Energy Efficiency and Conservation Block Grant] and SEP [State Energy Program] grantees that seek guidance on procuring and implementing current and future Solar PV or Solar Water Heating (SWH) projects on public buildings.

GOALS

- Outline good practices for PV and SWH RFP process.
- Describe how to avoid 5 common PV and SWH pitfalls.
- Illustrate practices and pitfalls with a case study.
- Direct audience to helpful tools and resources to support solar procurement and implementation.

Related Resource:

Procuring and Implementing Solar Projects on Public Buildings: How to Avoid Common Pitfalls (Text Version), U.S. Department of Energy Technical Assistance Program, December 2010.
https://energy.gov/eere/wipo/procuring-and-implementing-solar-projects-public-buildings-how-avoid-common-pitfalls-text
This is the transcript of the commentary that accompanied the webinar cited above.