

Executive Summary: Draft PA No. 10 – Local Solar Projects

Description

A local solar program would entail installing solar photovoltaic (PV) panels on SCWD and SqCWD properties to provide an emissions-free renewable energy source that reduces the use of grid electricity and the associated indirect GHG emissions. This assessment included a preliminary review of SCWD and SqCWD properties to identify examples of potential solar PV project sites and understand the size requirements of potential projects. The example sites identified include the proposed **scwd**² desalination facility (SCWD and SqCWD), the Bay Street Reservoir site (SCWD), numerous SCWD properties, SqCWD's headquarters buildings, and SqCWD's Fairway Drive property. Other sites could present additional project opportunities but would need to be evaluated further.

Amount of GHG Reduction

For the purpose of this assessment, the following projects were analyzed:

- Solar PV panels could be installed on the roofs of several buildings at the proposed **scwd**² desalination facility. The estimated space available would hold approximately 300kW, which could offset approximately 94 MT CO₂e per year over 30 years. This project could be shared by SCWD and SqCWD based on their respective desalination plant operation.
- SCWD could offset approximately 388 MT CO₂e per year over 30 years by installing 780 kW of solar PV panels on two tanks at the Bay Street Reservoir site and a total of 455 kW on several other sites (listed in Table 2). These projects could reduce approximately 55 to 90% of the potential GHG reduction goals for SCWD.
- SqCWD could offset approximately 268 MT CO₂e per year over 30 years by installing 104 kW of solar PV panels on its administration building and 750 kW on its Fairway Drive property. These projects could reduce approximately 15 to 20% of the potential GHG reduction goals for SqCWD.

Project Life and Sustainability

Local solar projects would continue to provide GHG reduction (and energy) for the life of the project and beyond. The project would be sustained by normal maintenance to repair any infrastructure deterioration.

Project Cost

Table ES-1 summarizes the estimated costs of the example projects discussed above.

Table ES-1: Local Solar Program Summary

| Example Projects | Size | Life | Average Annual GHG Reduction (MT CO ₂ e/yr) | Capital Cost (\$ mil) | Average Annual Net Cost (\$/yr) ¹ | Lifecycle Energy Cost (\$/kWh) | Lifecycle GHG Reduction Cost (\$/MT CO ₂ e) | Space Required (1 kW/ 100 SF) |
|---|--------|------|--|-----------------------|--|--------------------------------|--|-------------------------------|
| scwd ² desalination facility | 300 kW | 30 | 94 | \$1.8 | \$70,000 | \$0.13/kWh | \$580 | < 1 acre |
| Bay Street (SCWD) | 780 kW | 30 | 245 | \$4.7 | \$182,000 | \$0.13/kWh | \$580 | < 2 acres |
| Small properties (SCWD) | 455 kW | 30 | 143 | \$2.7 | \$106,000 | \$0.13/kWh | \$580 | ~ 1 acre |
| Admin Bldg (SqCWD) | 104 kW | 30 | 33 | \$0.6 | \$24,000 | \$0.13/kWh | \$580 | < 1 acre |
| Fairway (SqCWD) | 750 kW | 30 | 235 | \$4.5 | \$175,000 | \$0.13/kWh | \$580 | < 2 acres |

¹Includes energy savings.

Draft Project Assessment No. 10 – Local Solar Projects

Description

This assessment estimates the energy generation and GHG reduction potential from the development of local solar photovoltaic (PV) projects. SCWD and SqCWD investment or participation in non-local solar and other renewable energy projects is discussed in Project Assessment No. 9. Rebate programs for residential and commercial solar projects are discussed in Project Assessment No. 3.

Background

Solar energy refers to a number of technologies that derive their energy from the sun. This assessment focuses on PV solar electric systems, in which sunlight is converted directly into electricity using solar panels. A PV system includes PV panels, support structures to direct panels toward the sun, and components that convert the direct-current (DC) electricity produced by modules to alternate-current (AC) electricity.

A local solar program would entail installing solar photovoltaic (PV) panels on SCWD (or potentially the City of Santa Cruz) and SqCWD properties to provide an emissions-free renewable energy source that reduces the use of grid electricity and the associated indirect GHG emissions. Solar PV systems could be mounted on top of SCWD or SqCWD structures (such as buildings and water tanks, as shown in Figure 1), on other municipal-owned structures (such as parking garages), or mounted on the ground on property owned by SCWD or SqCWD. The solar PV systems could produce energy to directly provide power to SCWD or SqCWD facilities, or could connect to the overall electrical grid to indirectly provide power to SCWD or SqCWD facilities. When the solar PV system is not producing energy, electrical power would be obtained from the overall electrical grid through Pacific Gas and Electric (PG&E).

Figure 1: Existing Solar PV Installation on SCWD's Graham Hill WTP



With regard to coordinating with PG&E and connecting to the overall electrical grid, there are four categories of solar PV projects: 1) Behind the Meter; 2) Virtually Behind the Meter; 3) Virtual Meter Aggregation; and 4) In-front of the Meter. These categories are described below.

Behind the Meter

A Behind the Meter project describes a solar PV facility that is sited at a facility where the electricity is consumed, all or in part by the account holder. The solar PV system connects to the facility behind the PG&E meter and replaces some or all of the power from PG&E. When the solar PV system is not producing energy, electrical power would be obtained from the overall electrical grid from PG&E.

Net energy metering (NEM) applies to Behind the Meter solar PV projects less than 1 MW in size. NEM is a method of metering the energy produced and consumed by a customer that has a renewable resource generation project, and it credits the customer with the value of the generated electricity. Effectively, the meter runs backwards, causing a credit on the customer's bill. The benefit of NEM is the deferred cost of the electricity at the retail rate that SCWD/SqCWD would not have to purchase – an avoided cost. Net excess generation (NEG) beyond one month's actual usage is carried over as a credit for a 12-month cycle, but is zeroed out after one year, so SCWD/SqCWD would not be paid for any remaining excess generation. A NEM Behind the Meter project should be sized so that the project does not create any NEG over the course of a year.

Virtually Behind the Meter

A Virtually Behind the Meter project describes a solar facility that is sited at a location other than where some or most of the electricity is consumed. The electricity is transmitted over the overall electrical grid to the user. This approach is relatively new and was included in California Senate Bill (SB) SB1 and updated by California Assembly Bill (AB) AB510. Municipalities in California can install solar PV systems at facilities on different properties and can use the electricity generated to credit electricity bills at other properties (with some restrictions). Generally, if a facility produces more solar electricity than it uses, that excess energy can be used to credit the generation portion of another benefiting account. However, the same entity needs to be the account holder at both the point of generation and the benefiting account.

Therefore, electricity produced from a PV solar array at one SCWD or SqCWD facility location (within the SCWD or SqCWD geographic boundaries) can be used to offset the SCWD or SqCWD energy generation charges at other locations (per AB 2466, codified as Section 2830 of the California Public Utilities Code). This credits the generation portion of the utility bill, while the benefiting account still pays the transmission costs and other utility fees.

Virtual Meter Aggregation

Another potential option is for SCWD and/or SqCWD, and other government entities (such as the City of Santa Cruz or school districts) to pool land resources and identify properties that have space and favorable characteristics for a PV system within SCWD/SqCWD geographical boundaries. This aggregation has some restrictions, but if there are municipal facilities with open roof tops and low electricity demands, a solar PV project could get credit via virtual net metering at other properties/accounts.

In Front of the Meter

An In-front of the Meter project describes a project in which the PV system is located at a site where there is no electricity use by the project owner, and the electricity produced by the solar facility is sold to a utility at wholesale rates through the Feed-in Tariff (FiT). These projects are generally larger (approximately 2 to 20 megawatts) to maximize efficiency. Since generated electricity is sold to PG&E, **scwd**² would not get credit for KWh generated or for the associated GHG reductions. Since there are favorable Behind the Meter and Virtual Behind the Meter projects available, this assessment does not address potential In-front of the Meter projects.

History and Technical Maturity

Solar PV cells were developed in the 1950s in the aerospace industry and have been used in utility-scale applications for nearly 30 years. Improved technology has allowed for the expansion of solar PV applications over time, and today there are many utility-scale and small-scale uses. Federal and state incentives have greatly increased the use of solar PVs as a renewable energy resource for electricity. In California, there are over 95,000 solar PV installations totaling almost 950 MW (<http://gosolarcalifornia.org/>). In the Santa Cruz area, over 2 MW of solar PV have been installed on local residences and businesses in the past 5 years under the California Solar Incentive (CSI) program (http://www.californiasolarstatistics.ca.gov/current_data_files/).

SCWD currently has two solar installations – a 74 kW system on the administrative office and 128 kW system on the operations building at the Graham Hill Water Treatment Plant (GHWTP).

Reliability and Operational Complexity

Although research continues to improve the efficiency of solar arrays, this is considered a reliable and mature technology. The operational complexity of a solar PV system would be low. O&M activities would include periodically cleaning the PV panels and performing modest routine maintenance and testing.

Sustainability

A local solar PV system would produce renewable energy for at least the life of the project, which is assumed to be 30 years. The project would be sustainable and could continue beyond the life of the project through routine maintenance and parts replacement as required.

Local Considerations

Economy

Local solar PV systems could benefit the local economy through job creation, and training of PV system installers and service providers. The local PV systems could provide reliable energy at a low impact to the environment. Local projects would reduce local energy use and could provide opportunities to help to educate the community on renewable energy.

Table 1 provides a partial list of companies that have been involved in the sale and installation of solar PV equipment in the Santa Cruz area. The average size of the local projects is approximately 5 kW.

Table 1: Local Solar Vendors

| Contractor | Location | Average System Size | # of Projects |
|--------------------------------------|-----------------|----------------------------|----------------------|
| Real Goods Energy Tech Inc. | Santa Cruz | 4.9 kW | 258 |
| Solar Technologies | Santa Cruz | 4.8 kW | 229 |
| REC Solar, Inc. | San Francisco | 4.2 kW | 36 |
| Solcon Solar Construction | Santa Cruz | 3.8 kW | 25 |
| Akeena Solar, Inc. | Campbell | 3.7 kW | 25 |
| SolarCity | San Mateo | 11.4 kW | 24 |
| Anderson Solar Controls | Scotts Valley | 4.6 kW | 17 |
| Santa Cruz Solar | Santa Cruz | 3.6 kW | 11 |
| Suns Up Solar (Putt Construction) | Santa Cruz | 4.6 kW | 7 |
| Full Circle Energy Cooperative, Inc. | Fresno | 5.2 kW | 7 |
| Petersen-Dean, Inc. | Los Gatos | 5.1 kW | 7 |
| Borrego Solar Systems, Inc. | Oakland | 4.5 kW | 6 |
| Renewable Power Solutions Inc. | San Jose | 5.8 kW | 5 |
| Poco Solar Energy, Inc. | Santa Clara | 4.6 kW | 5 |
| Gregory Heitzler Design | Santa Cruz | 6.0 kW | 5 |

Source: California Public Utility Commission and California Energy Commission “Go Solar California” website: <http://www.californiasolarstatistics.ca.gov/search/contractor/>

Environment

Air: Solar PV systems do not produce air pollution or GHG emissions, and they prevent pollution by displacing conventional power generation sources.

Land: Larger solar PV projects require large, unobstructed, and unshaded areas, typically 100 square feet per kW. A 100 kW system would require approximately 10,000 square feet, or approximately one quarter acre of land. Land impacts would be mitigated if the installation space is on land that is already disturbed or improved (ie – on rooftops or parking lot shade structures).

Water: Solar PV systems use only a modest amount of water during periodic cleaning.

Noise: Solar PV systems produce little noise pollution. Larger inverters can make a “humming” sound similar to transformers. The sound can be mitigated by locating inverters in an enclosure or within existing maintenance or electrical yards, and locating them away from residences or offices.

Aesthetic/Visual: Visual impacts from solar PV installations coincide with space constraints, and solar PV systems impact a viewshed in proportion to the size of the project. Placement of the system is the main factor that affects visual impact. For example, roof-top systems integrating solar PVs into existing structures would minimize visual impacts, whereas utility-scale installations would likely occupy large open spaces that would be visible from a considerable distance.

Waste By-products: Installed solar PV systems generate no waste by-products from their operation.

Energy Production and GHG Reductions

The PVWatts calculator, developed by the National Renewable Energy Laboratory, estimates electricity production in terms of kilowatt-hour (kWh) per year per kilowatt (kW) installed at a selected location and can be found at: <http://www.nrel.gov/rredc/pvwatts/>. Using meteorological weather data for a selected location, PVWatts determines the solar radiation, which is then converted into energy. According to the PVWatts calculator, a 1 kW PV installation in the Santa Cruz area would generate approximately 1,200 kWh per year for a fixed-tilt system on a roof top and facing due south. The actual output of existing SCWD projects was approximately 110,000 kWh at the administration offices and 146,000 kWh at GHWTP, which are close to the estimates by PVWatts.

Potential Solar PV Projects

This assessment included a preliminary review of SCWD and SqCWD properties to identify examples of potential solar PV project sites and understand the size requirements of potential projects. The example sites identified include the proposed **scwd**² desalination facility (SCWD and SqCWD), the Bay Street Reservoir site (SCWD), numerous SCWD properties, SqCWD's headquarters buildings, and SqCWD's Fairway Drive property. Other sites could present additional project opportunities but would need to be evaluated further.

scwd²

SCWD and SqCWD could choose to offset some or all of energy related to the **scwd**² desalination plant. The proposed desalination plant running at half capacity would use approximately 6,800 MWh per year. At 1,200 kWh per kW installed, approximately 5,700 kW of solar PV would be needed to offset this energy usage. This translates into approximately 13 acres.

Based on the preliminary layout of the proposed **scwd**² desalination facility, there appears to be approximately 30,000 square feet of roof space on the MF/UF, SWRO, and Control buildings. At 12 kWh per year per SF, the PV panels could provide approximately 323,000 kWh per year or about 5%.

SCWD

Bay Street Reservoir (Virtual Behind the Meter): Based on information from SCWD, the Bay Street tank site (at 200 Cardiff Place) will have two, 223-foot diameter concrete tanks that will provide a total roof area of approximately 78,115 square feet. There would not be a significant space available for ground-mounted panels. At 12 kWh per year per SF, the Bay Street tank roofs could provide approximately 841,000 kWh per year.

Various Identified SCWD Properties (Behind the Meter or Virtual Behind the Meter): In 2006-2007, an assessment of the solar potential for SCWD-owned facilities was conducted. Table 2 lists the sites identified with the best potential for installing solar PV systems. In addition to those shown in Table 2, SCWD identified and ruled out other sites based on size, access, shading, and other issues. The estimated combined square footage available at the potential future sites totals approximately 45,500 SF, or over 1 acre. At 12 kWh per year per SF, these sites could provide approximately 546,000 kWh per year combined.

Table 2: Assessment of Solar Potential for SCWD Properties

| Location | Estimated Area Available (SF) | Actual/Estimated Energy Generation (kWh/yr) |
|-----------------------------------|-------------------------------|---|
| Existing Locations | | |
| Graham Hill WTP | 12,300 | 146,000 |
| Administration Bldg | 7,400 | 110,000 |
| Total Existing | 19,700 | 256,000 |
| Potential Future Locations | | |
| Graham Hill WTP – Lab | 2,000 | 24,500 |
| Parking Lot 1 – Soquel/Front | 8,400 | 101,000 |
| Parking Lot 2 – Locust Garage | 8,400 | 101,000 |
| Golf Lodge Delaveaga | 7,200 | 86,400 |
| Municipal Wharf | 6,200 | 74,400 |
| Recycling Center at Landfill | 5,200 | 62,000 |
| Corp yard | 4,800 | 57,000 |
| Sanitation Shop Corp Yard | 3,300 | 39,300 |
| Total Potential | 45,500 | 546,000 |

Source: Santa Cruz Water Department Memorandum, February 2007.

In addition to the sites identified in the 2006-2007 assessment and shown in Table 2, the SCWD has several other smaller properties (including reservoirs, wells, and pump stations) with small electricity needs that could be assessed in the future.

Additional Potential Areas of Exploration (Virtual Behind the Meter): SCWD properties were evaluated with the goal of identifying several properties that are large enough to develop a substantial solar array ranging in size from 500 kW (1 acre) to 5,700 kW (13 acres). The sites also need to be a reasonable distance from a transmission line and have little shading.

SCWD owns over 100 properties, ranging in size from less than 100 SF to over 1,000 acres. The largest properties lie outside the agency’s geographic boundaries in the upper watershed areas of Newell, Laguna, and Zayante creeks, but are located within Santa Cruz County’s Timber Preserve Zones. A solar array potentially could be developed on these properties, but several elements must be considered:

- Proximity to transmission lines.
- If the properties are outside the service territory, the energy generated cannot be wheeled to agencies’ electricity meters.
- The properties may need to be rezoned.
- A timber harvest plan may be required. (The public may respond unfavorably to harvesting trees in order to build a solar PV project.)

SqCWD

Table 3 lists some of the sites identified by SqCWD staff as potential locations for solar PV projects.

Table 3: Operations Department Initial Assessment

| Potential SqCWD Locations for Solar | Notes |
|--|---|
| Main Headquarters Administration and Maintenance Buildings | |
| Garnet Well and Opal Treatment Plant | |
| Country Club Well | Large parcel |
| Altivo Well | |
| Mar Vista Tanks and Boosters (Tank 2) | Substantial electrical usage |
| Madeline Well | |
| Seascape Tank and Boosters | |
| Bonita Well | Large parcel |
| Ledyard Well | |
| Fairway Tank | |
| San Andreas Well | |
| Cornwell Tank and Boosters | |
| Aptos Booster Station | |
| Aqua View Tanks and Boosters | Substantial electrical usage |
| Aptos Creek Well | Substantial electrical usage |
| Tannery Well and Treatment Plant | |
| Seascape Well | |
| Austrian Tank and Boosters | |
| Main Street Well and Treatment Plant | limited space |
| T. Hopkins Well and Treatment Plant | limited space |
| Papermill | Vacant lot not planned for future development |
| Suncatcher Court | Vacant lot not planned for future development |
| Rincon | Vacant lot not planned for future development |
| Hillcrest | Vacant lot not planned for future development |

SqCWD Headquarters (Virtual Behind the Meter): SqCWD is interested in installing solar PV panels on the roofs of the administration and maintenance buildings at its main headquarters. The areas of the roofs are approximately 5,800 SF and 4,600 SF, respectively. At 12 kWh per year per SF, this could provide approximately 112,000 kWh per year.

Fairway Drive (Virtual Behind the Meter): Similar to SCWD, SqCWD owns many properties within their upper watershed areas with similar site considerations. SqCWD has a property on Fairway Drive (APN 040-431-06) that is approximately 2.8 acres in size (Figure 2). This property houses a storage tank, but the remainder of the property appears to be mostly open space with good sun exposure. A ground-mounted solar array of 500 kW to 1 MW potentially could be constructed at this site. Assuming 1,200 kWh per year produced per kW installed, a 750 kW project at this site could generate approximately 809,000 kWh per year.

Figure 2: Potential SqCWD Site for Ground Mounted Solar Array



Potential Additional Areas of Exploration (Behind the Meter): This assessment included a cursory review of SqCWD’s land holdings. Fairway had the ideal characteristics for siting a solar facility, but additional properties may meet these criteria. As a next step, SqCWD would undertake a more detailed review and rank each of their properties by its ability to successfully house a solar array.

Since solar PV systems do not produce GHG emissions, the projects would offset the indirect GHG emissions associated with the purchase of electricity from PG&E. Table 4 summarizes the potential energy production and GHG reductions for analyzed solar PV projects.

Table 4: Estimated Energy Production and GHG Reduction for Solar PV Projects

| Project | Size | Average Annual Energy Production (kWh/yr) ¹ | Average Annual GHG Reduction (MT CO ₂ e/yr) ^{1,2} | Lifetime GHG Reduction (MT CO ₂ e/yr) |
|---|--------|--|---|--|
| scwd ² desalination facility | 300 kW | 323,000 | 94 | 2,800 |
| Bay Street (SCWD) | 780 kW | 841,000 | 245 | 7,300 |
| Small properties (SCWD) | 455 kW | 491,000 | 143 | 4,300 |
| Admin Bldg (SqCWD) | 104 kW | 112,000 | 33 | 980 |
| Fairway (SqCWD) | 750 kW | 809,000 | 235 | 7,100 |

¹Includes decline of energy production due to degradation of equipment over 30 years.

²Based on 2009 PG&E emission factor of 641.35 lbs CO₂e/ MWh.

This project could reduce approximately 55 to 90% of the potential GHG reduction goals for SCWD, and 15 to 20% of the potential GHG reduction goals for SqCWD.

Cost

According to data available on the Go Solar California website, 2,400 PV projects (including residential, commercial, and governmental) were completed under the CSI program in the first 6 months of 2011. The average installation cost of these projects was \$5.40 per watt.

Capital Cost: Average PV module prices are currently approximately \$3.00 per watt, and installation costs can range from \$2.00 to \$4.50 per watt. The variation in this price range is dependent upon the size of the system (economies of scale), physical location, new versus existing structure, and siting challenges (i.e. equipment, penetrations, slope). This assessment assumes a conservative \$6.00 per watt installed cost for the Santa Cruz area.

The cost estimate for a potential project includes photovoltaic panels, fixed-tilt solar arrays, inverters, wiring, engineering, installation, utility grid interconnect, warranty, 5 years of maintenance, and 5 years of performance monitoring and reporting service (an eligibility requirement by some of the financial incentive programs).

O&M Cost: Maintenance requirements depend upon the system size. Regular maintenance is minimal over the life of the system and includes periodically cleaning the panels, as well as testing and cycling the inverters. The lifetime of most PV arrays is between 20 and 30 years, and failures that require replacements are rare. PV arrays degrade at a rate of approximately less than one percent of total system capacity per year, since energetic particles from the sun produce physical damage to silicon-based solar cells. Manufacturer warranties and PPA's usually take this degradation into account. However, the inverter needs to be replaced every 10 years for approximately \$0.70 per watt installed, and this cost is usually included in the vendor maintenance agreement. (<http://www.solarbuzz.com/Inverterprices.htm>)

Incentives and Rate Structures: A part of the Go Solar California campaign, the California Solar Initiative (CSI) offers rebates to customers in California's investor-owned utility territories. CSI rebates vary according to system size, customer class, and performance and installation factors. The subsidies decline in "steps" based on the volume of solar megawatts confirmed within each utility service territory. In 2011, the CSI rebate applicable to a 100 kW array is the Performance Based Incentive (PBI), which pays out an incentive based on actual kWh production over a period of five years. Currently, the CSI program is oversubscribed, and new CSI projects are not guaranteed an incentive at this time (<http://www.csi-trigger.com/>).

Lifecycle Cost: The average energy cost for the resource, assuming a project life of 30 years, with a 5 percent bond, and NEM rate structure (retail rate of \$0.15/kWh escalating at 2%), would be approximately \$0.14/kWh. This is similar to the levelized cost of utility power from PG&E of \$0.14/kWh.

Table 5: Estimated Solar PV Project Costs

| Project | Life (yrs) | Capital Cost (\$ mil) | Average Annual Net Cost (\$/yr) ¹ | Lifecycle Energy Cost (\$/kWh) | Lifecycle GHG Reduction Cost (\$/MT CO ₂ e) |
|---|------------|-----------------------|--|--------------------------------|--|
| scwd ² desalination facility | 30 | \$1.8 | \$70,000 | \$0.13/kWh | \$580 |
| Bay Street (SCWD) | 30 | \$4.7 | \$182,000 | \$0.13/kWh | \$580 |
| Small properties (SCWD) | 30 | \$2.7 | \$106,000 | \$0.13/kWh | \$580 |
| Admin (SqCWD) | 30 | \$0.6 | \$24,000 | \$0.13/kWh | \$580 |
| Fairway (SqCWD) | 30 | \$4.5 | \$175,000 | \$0.13/kWh | \$580 |

¹ Includes energy savings, but not CSI incentives. The CSI incentive program is currently oversubscribed and all un-confirmed projects are not guaranteed an incentive.

Summary of Advantages and Disadvantages

Advantages

- Creates local jobs.
- Mature technology with low risk.
- Environmental considerations are low.
- Low O&M requirements and costs.
- No fuel costs.

Disadvantages

- Relatively large space or land requirements.
- Limited sites available for SCWD/SqCWD.
- Financial incentives (CSI) may not be available for new solar PV projects.
- High purchase/installation costs per kW relative to other forms of electricity.
- Non-local solar projects could take advantage of better solar insolation resources. For example, a 1 kW PV installation near Barstow, California is estimated to produce almost 1,500 kWh per year versus 1,200 kWh per year in the Santa Cruz area.

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