A Photovoltaic and Energy Storage Consultancy

June 13, 2014

Martin Klauss, Assistant Superintendent
Business and Administrative Services
Oak Park Unified School District–OPUSD
5801 Conifer Street,
Oak Park, CA 91377.

Dear Mr. Klauss,

Please find attached my report analyzing the proposal that the OPUSD has received from SK Solar (Rev. 6-12/14) for a 155 kW photovoltaic system to be installed at Oak Park High School. My report follows the Scope of Work offered to you in my Proposal of May 12, 2014.

Scope of Work:

- Predicted energy production
- Energy bill savings and Performance Based Incentive (PBI)
- Operation and maintenance responsibilities and costs
- Cash Flow including Net Present Value taking into account energy cost escalation, discount rate and inflation rate
- System configuration and equipment specification
- System orientation and location
- System monitoring (system operation, energy production, warnings and fault notification)
- Engineering, Procurement and Construction schedule
- Milestones and Progress Payment
- Equipment and workmanship warranties
- Non-energy benefits
- Educational opportunities based on monitoring, system performance history and projections, environmental (non-energy) benefits, based on web access and browser-based tools

Sincerely yours,

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Technical and Cost Analysis of "Solar Energy Engineering, Procurement and Construction Agreement" (Rev. 6-12-14) by SK Solar Inc.

Preface

The principal focus of this report is a comparison of the quoted costs to own and operate a 155 kW_{stc} solar electric system and the savings estimated by the vendor. These savings include cash incentives (rebates) from the State of California and reductions in the electricity bill realized by the production of electricity by the solar electric system.

Properly estimating electricity production requires the specification of the solar electric equipment, the orientation and placement of the solar panels, and the geographic location of system. It also requires a detailed understanding of the electricity rates of Southern California Edison, the electrical utility.

This report will rely on a solar electric simulation tool–the CSI EPBB Calculator–which is capable of calculating energy production and rebates. Energy bill savings will be calculated by comparing the electricity bill with and without the solar electric system.

The period of this analysis is 25 years.

The costs include the acquisition costs, based on a 120 month loan at 4.25%, the operation and maintenance costs, and out-of-warranty equipment maintenance costs.

Specification of Solar Electric System

The solar electric system is comprised of two separate systems, a 59.26 kW_{stc} roof mount system and a 95.20 kW_{stc} ground mount system.

59.26 kW_{stc} Roof Mount System

- 214 each SolarWorld SW280 mono PV modules
- 2 each Solectria PVI 23TL inverters
- Roof mounted, with a 3" to 6" clearance
- 15 degrees PV module tilt
- 180 degrees azimuth
- Location: 899 N. Kanan Rd., Oak Park, CA, 91377

95,200 kW_{stc} Ground Mount System

- 340 each SolarWorld SW280 mono PV modules
- 4 each Solectria PVI 23TL inverters
- Ground mount, >6" clearance
- 15 degrees PV module tilt
- 180 degrees azimuth
- Location: 899 N. Kanan Rd., Oak Park, CA, 91377

Comments on These Systems

The specified PV module tilt angle for both systems is 15 degrees. If the roof pitch is 15 degrees, the module tilt angle is okay (i.e. the PV system is "flush mounted"). If the roof is (essentially) flat, a 15 degree pitch will require considerable inter-row spacing and a site survey is recommended to insure that adequate roof space exists for this system.

Furthermore, a 15 degree PV tilt angle is technically challenging for a shade structure, with 9-14 degree PV modules tilts more common. Since the choice of tilt angle affects the electricity production, the tilt angle for the ground mount needs to be confirmed.

It is recommended that a site survey be performed to determine–among other matters–the most appropriate PV module tilt angle for both the roof mount and ground mount systems.

No monitoring system has been specified. The monitoring system is an essential component supporting Operation and Maintenance, as a monitoring system will provide remote, near-real-time measurements of system performance, fault detection and indication, and display of error codes. It will also be a crucial part of any educational program. A complete specification of the hardware, integration into the rest of the system, and functionality should be negotiated and incorporated into the Agreement.

CSI EPBB Simulation

The California Energy Commission "CSI PV Calculator" must be used in conjunction with a PBI rebate application. This calculator is in turn is based on the National Renewable Energy Laboratory's (NREL's) PVWatts v.2 calculator.

The use of 2 each Solectria PVI 20TL inverters on the 59.26 kW_{stc} Roof Mount System will probably result in *inverter overload*, and the CSI calculator will not allow the use of this combination of PV modules and inverters. In other words, this combination of PV modules and inverters does not qualify for a PBI rebate. Using 2 each of the PVI 23TL or PVI 28TL inverters result in the same annual energy production 93,075 kWh. Accordingly, the PVI 23TL will be used for further benchmarking of the 59.26 kW_{stc} Roof Mount System.

The use of 4 each Solectria PVI 20TL inverters on the 95,200 kW_{stc} Ground Mount System result in an annual energy production of 147,121 kWh, while the use of 4 each PVI 23TL inverters results in an annual energy production of 148,672 kWh. This latter choice will result in a 1.0% increased PBI rebate and a 1.0% increase in energy bill savings. The PVI 23TL inverter will cost more to purchase, so an analysis as to which choice is more cost effective will not be done at this time. Accordingly, the PVI 23TL will be used for further benchmarking of the 95,200 kW_{stc} Ground Mount System.

No accounting for shading has been performed because no shading data is available at this point in time. A detailed shading analysis should be performed, as part of a Site Survey and the impact on energy production and the PBI rebate should be taken into account.

Results of the CSI EPBB simulations

Attached are the energy production predictions based on CSI EPBB simulations of each system using SolarWorld SW280 mono PV modules and Solectria PVI 23TL inverters. In summary,

59.26 kW_{stc} Roof Mount System:

- 93,075 kWh/1st year,
- PBI rebate $53,053 total (based on $0.114/kWh, and payable in five equal, yearly increments).

95,200 kW_{stc} Ground Mount System:

- 148,672 kWh/1st year,
- PBI rebate $84,743 total (based on $0.114/kWh, and payable in five equal, yearly increments).

155,460 kW_{stc} Ground Mount System:

- 241,747 kWh/1st year,
- PBI rebate $137,796 total (payable in five equal, yearly increments).

Exhibit M of the SK Solar Agreement shows an energy production of 254,901 kWh/1st year (5.4% greater estimate than my estimate), and a total PBI rebate of $138,197 (0.2% greater than my estimate). A 2% error in energy production estimates and PBI rebate are not significant, in my opinion.

Predicted Energy Bill Savings

This is a complicated calculation because Oak Park High School is on a Time of Use TOU-8-B-APS tariff. This means that rate for electricity varies during the time of day, whether the day in question is a "weekday" or a "weekend/holiday" and seasonally (eight "Winter" months and four "Summer" months).

Taking these various factors into account results in the following 1st year energy bill savings:

59.26 kW_{stc} Roof Mount System:

- $6,922
- An average of $0.073/kWh

95.20 kW_{stc} Ground Mount System:

- $10,898
- An average of $0.073/kWh

155.46 kW_{stc} System

- $17,720
- An average of $0.073/kWh

Exhibit M of the SK Solar Agreement shows a first year energy bill savings of $22,941 for an average of $0.090/kWh. This is 29.4% greater than my estimate. This difference is quite significant, in my opinion. I have checked my calculations and I believe that they are consistent with the SCE rates for TOU-8-B-APS.

Other Cost Elements

The SK Solar proposal does not include any estimates for Operation and Maintenance expenses. I would include an annual O&M expense of 0.5% of the purchase price or $2,630/yr.

The SK Agreement does not specify a system monitor, although a conversation with Jonas Didzbalis at SK Solar confirmed that a system monitor will be included as part of the system. I recommend that a system monitor have the following functionality:

- Web hosted
- Reports system AC power total and for each inverter with no more than 15 minutes latency
- Stores and is able to display system energy production each hour for any day, each week, each month and each year.
- All information that is stored locally in each of the Solectria inverters, including fault conditions and error codes.
- Notification system (messaging, cell call or email) in case of out of specification operation or system faults.

EPC Agreement Sections 2.1: Contractor's Obligations, The Work

Section 2.1(h). Delivery of these documents should be part of "Final Completion Certificate"

Section 2.1(h). This training should be completed prior to "Final Completion Certificate"

EPC Agreement: Sections 2.5 "Unanticipated Conditions" and Section 7.16 "Miscellaneous"

Section 2.5. A Site Survey should be conducted prior to executing the Agreement in order to minimize the chances of discovery of existing on-site conditions that would significantly complicate or preclude Contractor from installing the proposed PV System.

Section 7.16. The precautions mentioned in this section should include a Site Survey including the determination of location of underground utilities.

EPC Agreement Sections 2.12: Warranty

As mentioned below, it should be the responsibility of the Contractor should "stand behind" any manufacturer's warranties. This includes the procurement, installation and certification of any equipment replaced under warranty by the Contractor, at no cost to the District.

EPC Agreement Section 4: Commencement and Completion

Paragraph 4.1(a) should read "...Exhibits A and C."

EPC Agreement Exhibit A: Construction Schedule

This schedule appears reasonable.

EPC Agreement Exhibit C: Scope of Work

This exhibit needs more detail. It should mention the SCE Interconnection Agreement and Permit to Operate. This Exhibit should be carefully reviewed together with Exhibit L "Definitions" and the definitions themselves may need to be modified

EPC Agreement Exhibit E: Schedule of Values a/k/a Milestones and Progress Payments

In general, the milestones lack sufficient detail to understand if progress and deliverables have been achieved.

I suggest the following payment percentages and progress/deliverables for consideration:

- 10%: down payment
- 10%: Delivery of Final-Build-to plans and approval of same by District
- 20%: Securing Ventura County building/electrical permit and SCE Interconnection Agreement
- 35%: Delivery of substantially all equipment
- 15%: "Substantial Completion"
- 10%: "Final Completion Certificate" to include
    - Sign-off by Ventura County building/electrical permit
    - Receipt of any "as built" corrections approved by Ventura County
    - Approval by SCE of Interconnection Agreement
    - Receipt of SCE Permit to Operate
    - Delivery of Commissioning Report
    - Delivery of "Owner Manual" containing documentation of all major equipment items, operation and maintenance manuals for all major equipment

items, warranties, details of connection of monitoring system to local area network, web hosting, and functionality of monitoring system.

Any changes to the milestones and progress payments will need to be reflected in Exhibits C Scope of Work and Exhibit L "Definitions".

EPC Agreement Exhibit H: Warranties

SK Solar's workmanship warranty should provide for timely repair/replacement of any defects in workmanship and a time period for such repair/replacement should be specified in the Agreement.

It is recommended that SK Solar to "stand behind" all manufacturer's warranties. This means that SK Solar would procure, install and certify any equipment that is replaced under any manufacturer's warranty, at no cost to the District.

EPC Agreement Exhibit M: Estimated Production and Savings

As mentioned above, I recommend that this document be revised as follows:

- Estimated electricity production 241,747 kWh/1st year (0.5% annual decrease in energy production)
- PBI rebate $137,796 total (payable in five equal, yearly increments).
- Predicted energy bill savings of $17,720 (with an annual escalation of 3.9%)
- Annual O&M costs of $2,630 1st year with an annual inflation rate of 2.0%
- Discount rate of 5.1%
- I have included a spreadsheet, based on a spreadsheet provided by SK Solar, showing the Cash Flow for 25 years.

Non-energy Benefits

This work element applies to a Prop 39 procurement and is not within the scope of this report.

Educational Opportunities

In terms of negotiating the Agreement, OPUSD stakeholders should have an opportunity to weigh in on the functionality of the monitoring system, in terms of interface and functionality. This may require specific hardware or specific features to be included in the monitoring system.

Oak Park High School - Cash Flow Analysis

Project Summary	
Customer Name	**Oak Park Unified**
Installer Name	**SK Solar**
City, State	Oak Park, California

System Summary	
Proposed System Size (kW DC)	155.46 kWstc
Solar Modules	SolarWorld
System Mounting Type	Rooftop and Ground Mount
Estimated Yr. 1 Output (kWh)	241,747

Tax Assumptions[1]	
Investment Tax Credit	$0
Federal Tax Rate	0%
State Tax Rate	0.00%

Cash Purchase Summary	
25-Yr Total Savings	$96,938
Incentives	$0.114/kWh PBI for 5 yrs
Purchase Price Calculations	
Purchase Price	$466,500
Add-on for Bonding and Prevailin	$23,000
Sales Tax	$36,578
Total	$526,078

Output (kWh/kWstc/day)	4.26
Cost ($/Wstc)	$3.39

Year	Est. System Production (kWh)	Cash Purchase Amount	Down Payment	Est. Utility Rate	Est. Utility Savings	Est. Performance Based Incentives	Est. Finance Payment	Estimated Operation & Maintenance Expense	Est. Annual Cash Flow	Est. Cumulative Cash Flow
1	241,747	($526,078)	($65,000)	$0.073	$17,648	$27,559	($56,678)	($2,630)	($79,102)	($79,102)
2	240,538			$0.076	$18,244	$27,421	($56,678)	($2,683)	($13,695)	($92,797)
3	239,336			$0.079	$18,861	$27,284	($56,678)	($2,737)	($13,270)	($106,067)
4	238,139			$0.082	$19,498	$27,148	($56,678)	($2,791)	($12,823)	($118,890)
5	236,948			$0.085	$20,158	$27,012	($56,678)	($2,847)	($12,355)	($131,245)
6	235,763			$0.088	$20,839		($56,678)	($2,904)	($38,743)	($169,988)
7	234,585			$0.092	$21,543		($56,678)	($2,962)	($38,097)	($208,085)
8	233,412			$0.095	$22,272		($56,678)	($3,021)	($37,428)	($245,513)
9	232,245			$0.099	$23,025		($56,678)	($3,082)	($36,735)	($282,248)
10	231,083			$0.103	$23,803		($56,678)	($3,144)	($36,019)	($318,267)
11	229,928			$0.107	$24,608			($3,206)	$21,401	($296,866)
12	228,778			$0.111	$25,440			($3,271)	$22,169	($274,697)
13	227,634			$0.116	$26,300			($3,336)	$22,964	($251,733)
14	226,496			$0.120	$27,189			($3,403)	$23,786	($227,947)
15	225,364			$0.125	$28,108			($3,471)	$24,637	($203,310)
16	224,237			$0.130	$29,058			($3,540)	$25,518	($177,793)
17	223,116			$0.135	$30,040			($3,611)	$26,429	($151,363)
18	222,000			$0.140	$31,056			($3,683)	$27,372	($123,991)
19	220,890			$0.145	$32,105			($3,757)	$28,349	($95,642)
20	219,786			$0.151	$33,191			($3,832)	$29,359	($66,283)
21	218,687			$0.157	$34,313			($3,909)	$30,404	($35,879)
22	217,593			$0.163	$35,473			($3,987)	$31,486	($4,393)
23	216,505			$0.169	$36,672			($4,067)	$32,605	$28,212
24	215,423			$0.176	$37,912			($4,148)	$33,764	$61,976
25	214,346			$0.183	$39,193			($4,231)	$34,962	$96,938

Assumptions	
* Utility Savings estimates are based SCE TOU-8-B-APS tariff and an annual escalation of 3.9%	3.90%
* Annual decrease in electricity production is 0.5%	0.50%
* Annual Inflation is 2.0%	2.00%
* Discount rate is 5%	5.00%
* Interest Rate is 4.25%	4.25%
* Estimated Operation and Maintenance Expense as a percentage of purchase price	0.50%
* Production values are based on the CSI EPBB Calculator	