Solar Overview

photo credit: Sacramento Municipal Utility District

Lon W. House, Ph.D.

530.676.8956

www.waterandenergyconsulting.com

ACWA Spring Conference

Technical Session

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San Jose, CA

The Partners

- Powerlight (www.powerlight.com)
- Founded in 1991, PowerLight is a privately held company. It is the largest solar installer in the world. Inc. Magazine ranked PowerLight Corporation among the top 500 fastest growing privately held companies for the past five consecutive years.

- Worldwater & Power Corp. (www.worldwater.com)
- Since 1984, World Water & Power Corp. (a publicly traded company - wwwat.ob) has been an international solar engineering and water management company specializing in high-powered, patented solar technology that provides independent electricity to reduce or eliminate grid electric costs and/or to power motors and pumps up to 600 hp.. WorldWater & Power has completed projects in more than 20 countries.

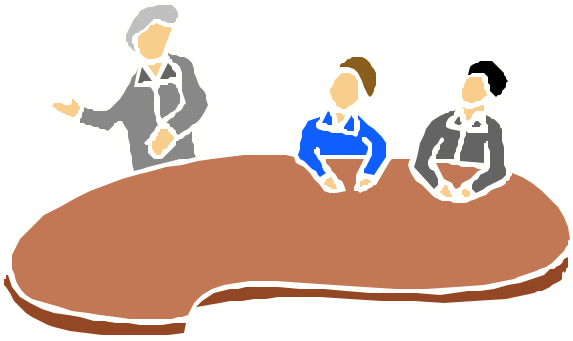
The Deal

- **PowerLight** will meet or beat any competitor's offer in terms of the verifiable net cost of the energy produced by an installation (cents/kWh). PowerLight's proprietary technology is called PowerTracker. It features an integrated, single-axis design that enables the photovoltaic modules to automatically follow the path of the sun throughout the day. This results in increased energy generation over stationary systems.
- **WorldWater** will meet or beat any competitor's offer in terms of installed cost ($/MW). Proprietary technology offered by WorldWater include equipment that enables a solar system to interact seamlessly with the grid and to sense grid power interruptions with an ensuing immediate switch to solar drive to continue motor/pump operations during blackouts.

Contac

- **Powerlight:** Rick Whisman Major Accounts
- 2954 San Pablo Avenue Berkeley, CA 94702
- rwhisman@powerlight.com
- 510.868.1270 – Direct 415.370.4298 – Cell
  510.540.0552 – Fax
- **Worldwater:** Leon Woods Marketing Manager
- 400 Capitol Mall, Suite 900 Sacramento, CA 95814
- leon@leonwoods.com
- 916.449.3929 – Direct 916.444.0270 – Fax
- **ACWA Energy Advisor** Dr. Lon W. House Water and Energy Consulting
- 4901 Flying C Road Cameron Park, CA 95682
- lwhouse@innercite.com
- 530.676.8956 – Direct 530.409.9702 – Cell
  530.676.8947 – Fax
- **ACWA** Marcia Wulff Business Services Coordinator
- 910 K Street, Suite 100 Sacramento, CA 95814
- marciaw@acwa.comd
- 916.441.4545 – Direct
- 916.325.2306 – Fax

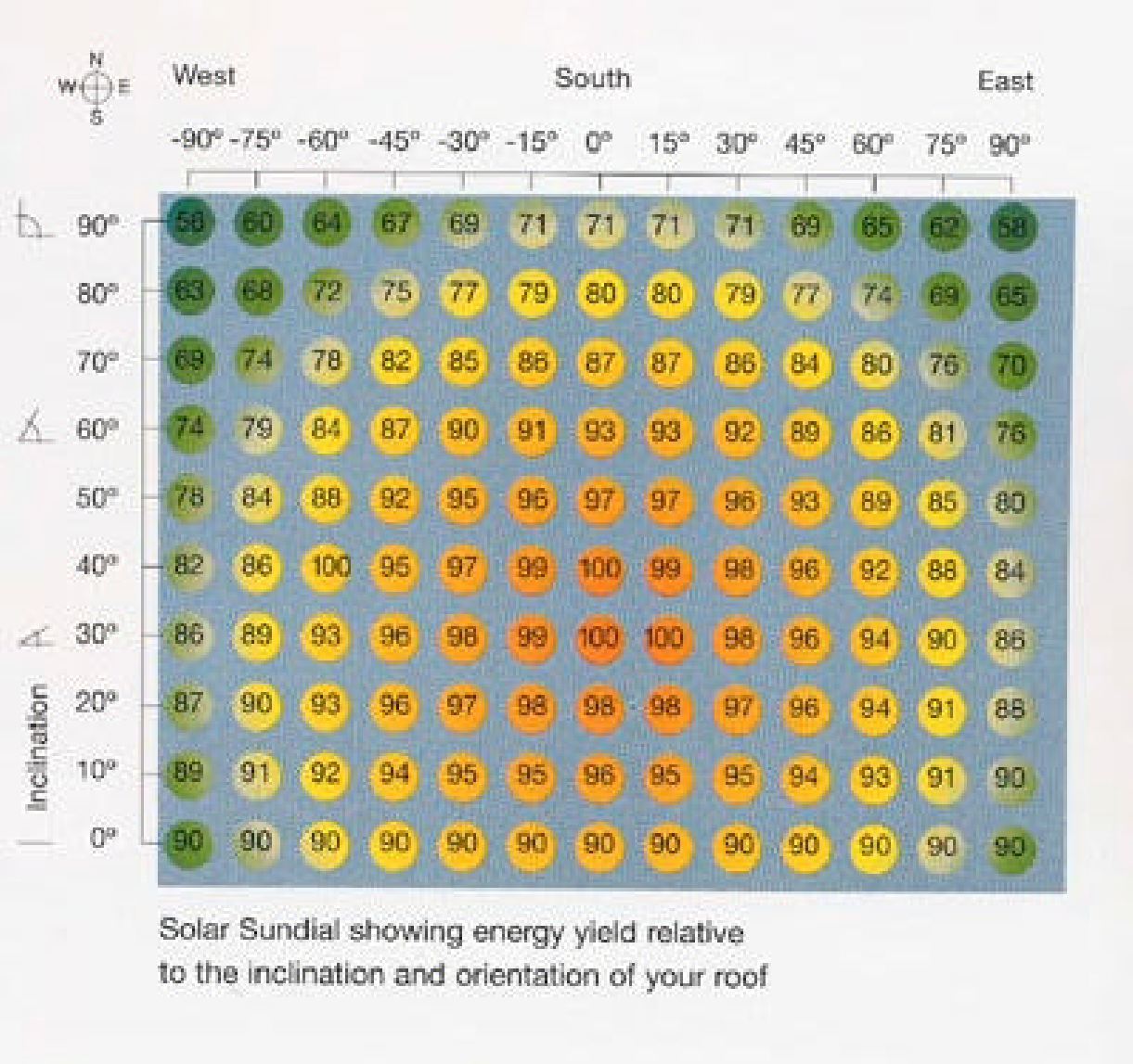
The Process



- **1) How to Get Started -** Call someone:
  - the company directly if you're interested in only one company.
  - Lon or Marcia if you want both companies to compete for your business.
- **2) Decide who's going to manage the process and do the evaluation**
  - 1) you can do it yourself, 2) you can hire an outside consultant, or 3) you can have Lon do it for a fixed fee.
- **3) Site visit/orientation** Companies will come out, visit your sites, take a bunch of measurements, ask a bunch of questions.
- **4) Companies go away, and return with a proposal .**
- **5) The proposals are evaluated for conformity with your wishes, and an economic evaluation is performed.**
- **6) You decide which company you wish do business with.**
- **7) You negotiate a contract(s) with that company.**
- **8) Construction begins.**

- **Note: This assumes you have already been notified of the award of your solar incentive reservation. Otherwise, there is a wait in here while your solar incentive reservation filters through the utility.**

Site Orientation



Solar Sundial showing energy yield relative to the inclination and orientation of your roof

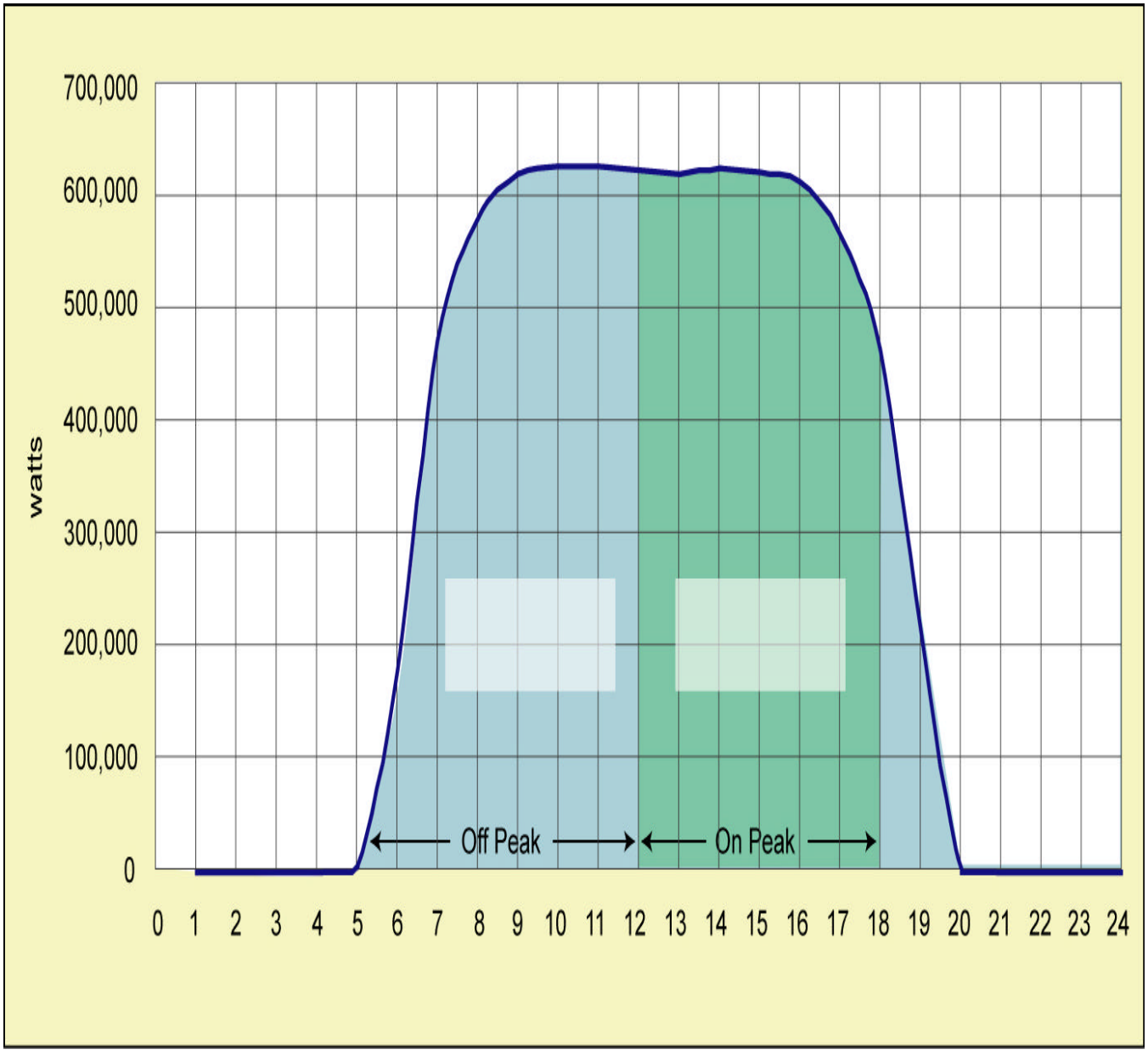
• The Most Likely Installations

Grid-tied solar system (alternating current) This type of system requires no storage equipment (i.e. batteries). In these applications, grid-tied inverters must be used that meet the requirements of the utilities. They must not emit "noise" which can interfere with the reception of equipment (e.g. televisions), switch off in the case of a grid failure and retain acceptable levels of harmonic distortion (i.e. quality of voltage and current output waveforms). This type of system tends to be an optimum configuration from an economic viewpoint because all the electricity is utilized by the owner during the day and any surplus is exported to the grid. Meanwhile, the cost of storage to meet night-time needs is avoided, because the owner simply draws on the grid in the usual way. Also, with access to the grid, the system does not need to be sized to meet all you loads.

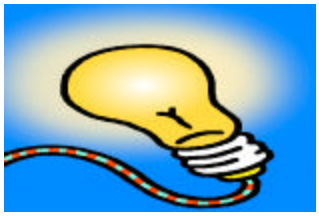
- **Stand alone direct drive** installations are also available where the solar is used to directly drive a pump.

1 mw solar generator

Solar Generation Profile

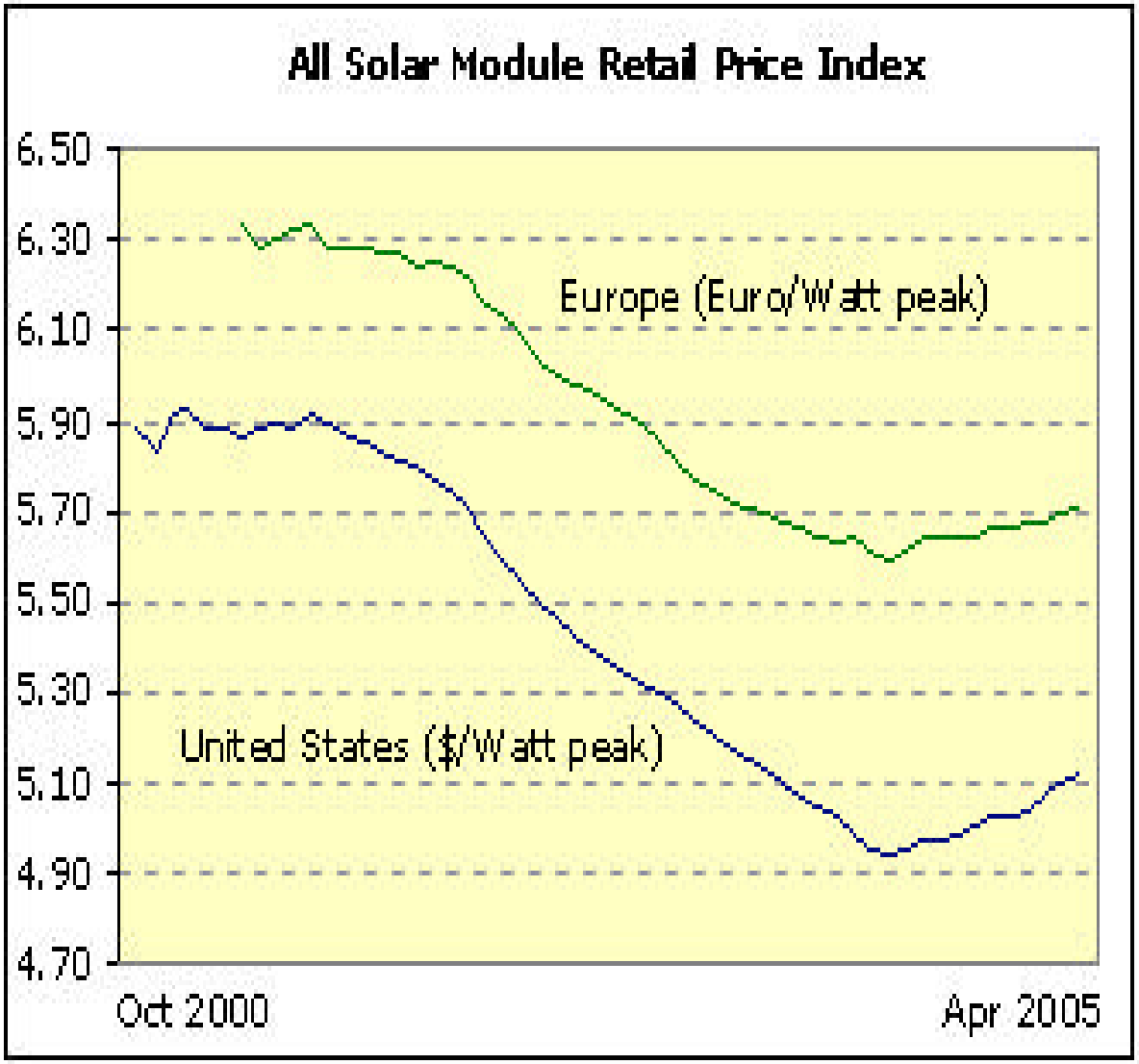


Useful Info



- 1 kilowatt equates to 1000 watts.
- One kilowatt-hour (kWh) equals the amount of electricity needed to burn a 100 watt light bulb for 10 hours.
- A 1 kilowatt peak Solar System will generate around 1,600 kilowatt hours per year in a sunny climate and about 750 kilowatt hours per year in a cloudy climate.
- A personal computer (10 hours a week) uses 150 kilowatt hours. A small laser printer uses 90-100 watts while printing, and 5 watts when electricity connected, but not printing
- A typical high power solar module generates 100 Watts and measures about 2 feet by 4 feet.
- A sunny location (i.e. Los Angeles, USA) receives approximately 5.5 hours of sunlight on average throughout the year.
- A typical silicon cell Solar Module will have a life in excess of 20 years. It's electric generating capacity may degradate gradually between 0-20% over its useful life.
- Although, solar modules are often warranted for 20 years or more, the warranty on the overall solar energy system, inclusive of the other components, should be 5 years or more.
- Solar Modules do produce electricity even on cloudy days, some 10-20% of that on sunny days (it can vary outside this range though).
- Systems attached to the electricity grid balance their overall energy supply with supplies from the electricity grid.
- The solar module (also called a "solar panel") itself accounts for between 40-50% of the total cost of an installed solar energy system. Solar Energy (photovoltaic) prices have declined on average 4% per annum over the past 15 years.
- For an installed system costing $9 per watt peak, this equates to about 25-30 US cents per kilowatt hour in a sunny climate.
- A 1 kilowatt Solar System (about 10-12 solar modules) requires about 100 square feet of installation area. Double the square feet area, if you are using thin film technology modules.
- A 1 MW system will take up about 4 acres.

Solar Module Prices



How Will Guarantee Be Guaranteed?

- ACWA has already prescreened solar companies with regard to reputation, financial ability, customer relations, capability, etc.
- In most cases, you'll have Powerlight and Worldwater competing against each other, so you'll have a cost comparison.
- ACWA will be tracking industry solar prices - so you can make that comparison also to be guaranteed the best prices.

April 2005 Module Prices

- PRICE SURVEY: APRIL 2005
- Solar Electricity 20.81 cents per kWh (Up 0.14 c/kWh)
- UNITED STATES solar modules $5.12 per Watt Up 2 cents
- Number <$4.50/Wp 458 (down 19) (20% of survey)
- Lowest Mono- Crystalline Module Price US$3.63/Wp
- Lowest Multi- Crystalline Module Price US$3.41/Wp
- Lowest Thin Film Module price US$4.14 /Wp

- **All Solar Module Index**
- Price Per Watt Peak ($/Wp)
-

- Apr 2005 5.12
- Mar 2005 5.10
- Feb 2005 5.08
- Jan 2005 5.04
- Dec 2004 5.03
- Nov 2004 5.03
- Oct 2004 5.00
- Sept 2004 4.99
- Aug 2004 4.98
- July 2004 4.98
- June 2004 4.96
- May 2004 4.94
- Apr 2004 4.96
- Mar 2004 4.99
- Feb 2004 5.02
- Jan 2004 5.05
- Lowest Prices ($/Wp) As of April 2005, there are currently 458 solar module prices below US $4.50/Wp.
- The lowest retail price for a multi-crystalline module is $3.41/Wp. This price is exhibited by a US dealer. The lowest retail price for a mono-crystalline module is $3.63/Wp from a US based dealer. The lowest thin film module price is a US$4.14/Wp per Watt from a German dealer.

- **All Inverter Price Index**
- US $ per Continuous Watt
-

Apr 2005	0.836
Mar 2005	0.836
Feb 2005	0.835
Jan 2005	0.835
Dec 2004	0.835
Nov 2004	0.834
Oct 2004	0.831
Sept 2004	0.831
Aug 2004	0.831
July 2004	0.831
June 2004	0.830
May 2004	0.830
Apr 2004	0.830
Mar 2004	0.831
Feb 2004	0.829
Jan 2004	0.831

California PV Numbers (1/2005)

System Cost Table
- Level 1 Photovoltaics, January 2005

LEVEL 1 (Photovoltaics)		Statewide SELFGEN Projects to Date									
		Total # Projects	Total kW	System Size				$/Watt Installed			
System Size	Status			Low	Avg	High	St. Dev.	Low	Avg	Median	High
< 50	Complete	139	5,027	30	36	50	6	$ 4.71	$ 8.83	$ 9.00	$ 15.47
	Active	163	5,950	25	37	50	6	$ 5.60	$ 8.90	$ 9.00	$ 13.44
51 - 100	Complete	55	3,994	51	73	100	16	$ 4.93	$ 9.03	$ 8.91	$ 16.21
	Active	127	9,295	50	73	100	13	$ 3.10	$ 9.16	$ 8.99	$ 28.21
101 - 200	Complete	46	6,552	100	142	200	38	$ 4.73	$ 8.38	$ 8.13	$ 15.90
	Active	109	15,188	100	139	200	32	$ 3.89	$ 8.84	$ 8.97	$ 15.91
201 - 500	Complete	27	8,626	201	319	480	93	$ 4.64	$ 7.59	$ 7.89	$ 9.05
	Active	71	21,448	200	302	497	91	$ 6.40	$ 8.55	$ 8.68	$ 13.59
501 +	Complete	9	6,702	521	745	1,050	215	$ 4.51	$ 7.97	$ 7.57	$ 11.45
	Active	33	26,893	513	815	1,000	191	$ 5.76	$ 8.23	$ 8.49	$ 9.70
	Total Completed	**276**	**30,902**								
	Total Active	**503**	**78,773**								
	Total Programs	**779**	**109,675**								

Things to consider - Technology

- What type of cells are proposed

- Monocrystalline Silicon Cells: Made using cells saw-cut from a single cylindrical crystal of silicon, this is the most efficient of the photovoltaic (PV) technologies. The principle advantage of monocrystalline cells are their high efficiencies, typically around 15%, although the manufacturing process required to produce monocrystalline silicon is complicated, resulting in slightly higher costs than other technologies.
- Multicrystalline Silicon Cells: Made from cells cut from an ingot of melted and recrystallised silicon. In the manufacturing process, molten silicon is cast into ingots of polycrystalline silicon, these ingots are then saw-cut into very thin wafers and assembled into complete cells. Multicrystalline cells are cheaper to produce than monocrystalline ones, due to the simpler manufacturing process. However, they tend to be slightly less efficient, with average efficiencies of around 12%., creating a granular texture.
- Thick-film Silicon: Another multicrystalline technology where the silicon is deposited in a continuous process onto a base material giving a fine grained, sparkling appearance. Like all crystalline PV, this is encapsulated in a transparent insulating polymer with a tempered glass cover and usually bound into a strong aluminium frame.
- Amorphous Silicon: Amorphous silicon cells are composed of silicon atoms in a thin homogenous layer rather than a crystal structure. Amorphous silicon absorbs light more effectively than crystalline silicon, so the cells can be thinner. For this reason, amorphous silicon is also known as a "thin film" PV technology. Amorphous silicon can be deposited on a wide range of substrates, both rigid and flexible, which makes it ideal for curved surfaces and "fold-away" modules. Amorphous cells are, however, less efficient than crystalline based cells, with typical efficiencies of around 6%, but they are easier and therefore cheaper to produce. Their low cost makes them ideally suited for many applications where high efficiency is not required and low cost is important.

- **Concentrators or non concentrators** Solar cells operate more efficiently under concentrated light. This has led to the development of a range of approaches using mirrors or lenses to focus light on to specially designed cells and use heat sinks, or active cooling of the cells, to dissipate the large amount of heat that is generated. Unlike conventional flat plate PV arrays, concentrator systems require direct sunlight (clear skies) and will not operate under cloudy conditions. Concentrators are more expensive than flat plate - make sure the increased cost is recovered in increased electricity production.
- **Tracking or non tracking** Ground mounted installation can be stationary, single axis tracking, or two axis tracking. Single axis tracking follows the sun's path from horizon to horizon through the sky during the day. Two (or double) axis tracking follows the sun from horizon to horizon and adjusts to the sun's varying height in the sky through the day and seasons. Tracking is more expensive than stationary, uses some energy, and increases the mechanical complexity of the system. Make sure that increased energy production estimates are reasonable and enough to recover the increased cost.
- **Back-up (operate when grid down) or not** When the grid goes down, most solar shuts off. If you want the ability to operate independent of the grid ask for it. Some technologies (e.g. batteries) can be very expensive.

Things To Be Careful of

- Solar modules - make sure you know exactly which type (manufacturer, module type, name and number) is being proposed. They all have different performance and operating characteristics.
- Make sure you know exactly what inverter (manufacturer, module type, name and number) is being proposed. They all have different performance and operating characteristics.
- Make sure that the proposal is customized for your site (location, latitude, microclimate). Your electricity production will vary.
- Make sure that you know they are talking about when they mention electricity production. You'll need electricity production at module, at the inverter, and at the meter in order to check and do a comparison.
- It is important to independently check all assumptions and numbers in your proposal. Small variation can have big impacts on energy production.

Incentives (>30kW)

- **CPUC** program Self Generation Incentive Program (SGIP) Incentive Amount 2005 Photovoltaic $3.50/wWatt.. Decreasing to $3.00/Watt 1/1/2006. Limited to 1 MW 30 kW - 1 MW. A total of $112,500,000 was allocated for 2005, which was rapidly oversubscribed, causing the utilities to cease accepting applications. However, on March 7th Commissioner Peevey ordered the utilities "to apply future year funds to this year's projects." and stated that "(U)se of future funding should be a stopgap measure until the Commission makes a decision on authorizing additional funding." (R.04-03-017).
- **CEC** Emerging Renewables Program. This program has $10 million set aside for a pilot Performance-Based Incentive Program for all sizes of PV projects, including those over 30 kW.
- **Federal** Tax credits. The Renewable Electricity Production Credit (REPC) is a per kilowatt-hour tax credit for electricity generated by qualified energy resources. The REPC provides a tax credit of 1.5 cents/kWh, adjusted annually for inflation, for wind, solar, closed-loop biomass and geothermal. The adjusted credit amount for projects in 2005 is 1.9 cents/kWh. The U.S. federal government offers a 10% tax credit to businesses that invest in or purchase solar or geothermal energy property in the United States. The tax credit is limited to $25,000 per year, plus 25% of the total tax remaining after the credit is taken. Note, although water agencies can't take advantage of these directly, Worldwater set up a solar power purchase arrangement between you and private investors to allow them to take the tax credits.
- The solar companies will work with you in this area to make sure everything is taken care of.

Conclusion

- It just takes a phone call to get started.
- The price guarantees ACWA has are the best in the business.
- Given the high level of competition for rebates in California, it is important to get into the queue as soon as possible.
- ACWA is there for support throughout this process.