The first megawatt: SolFocus, Victor Valley College dedicate North America's only 1MW CPV array

By **Tom Cheyney**

As solar PV project sizes increasingly reach double-digit megawattage with triple-digit just around the temporal corner, a single-megawatt system doesn't have quite the allure it had just a few years ago. But sometimes a megawatt's more than just a measure of installed generating capacity – reaching the million-watt mark can have potent symbolic as well as practical value, especially for a technology transitioning into the commercial realm.

Case in point: SolFocus's recently dedicated 1MW (AC) high-concentrator photovoltaic installation located on the campus of Victor Valley College in the high desert of Southern California northeast of Los Angeles, which is the largest (H)CPV deployment in North America to date and the Mountain View, CA-based company's biggest project as well.

The neatly ordered grove of 122 SF1100S double-axis tracker arrays, posted in the dusty ground on a six-acre parcel where carrots and rabbit brush once grew, is divided into three "subfields" serviced by a pair of Satcon 500kW inverters and one 250kW model, and monitored by a SunEdison SEEDS system. Within a half-hour of sunrise, the ground-mounted systems are cranking at full power, following old Sol and carrying that broad-shouldered performance curve over the course of the day until an hour or so before dusk.

Each 8.4kW-rated array is made up of 28 300W panels, which are in turn composed of 20 power units containing the high-efficiency solar cells and reflective glass optics that facilitate that whopping 650x concentration factor and superior power density (at least when the conditions are right). On the stationary pole holding the tracker, a control box hangs down at eye level in the back, while an anemometer and solar radiance monitor perch on the top of the system.

The front of the arrays bear little resemblance to a crystalline-silicon or thin-film PV system, their eye-catching series of optical/cell assembly components producing an upside-down funhouse mirror quality when you get up close. The backside of the panels resemble rows of oversized muffin pans, the metal coffering

a design change for the power units from the original flat surface, one that has translated into 30% less aluminum being used and an easier-to-ship form factor, according to SolFocus.

In a sense, the VVC site is as much a Spectrolab project as it is SolFocus's, since each square-centimeter-sized cell assembly in every one of those units – over 68,000 triple-junction III-V cells in all (that's a lot of muffins) – was fabricated by the venerable cell manufacturer. The patch of desert also represents one of the Boeing solar division's biggest terrestrial PV installations to date and is only an hour-plus drive from the company's Sylmar, CA, production fab.

The higher the cell efficiency goes, the better that all-important metric – levelized cost of energy (LCOE) – gets for a CPV system. Current conversion efficiencies are nearly 39%, translating to SolFocus panel efficiencies of 26%.

When the cell numbers reach 40% (which Spectrolab says will happen by late 2010, with much more headroom for continuous improvement), then the panel efficiency will pop to about 26.7%. This calculation allows that for every 1% of increase in cell efficiency, about a 0.67% jump in system efficiency will follow (with more possibly squeezed out via optical enhancements and other schemes to reduce light losses), explained Nancy Hartsoch, SolFocus's energetic VP of marketing and oft-quoted spokeswoman of all things CPV.

From an LCOE standpoint, if the levelized costs were, say, 14.9¢/kWh, for example, then the 1% increase in cell efficiency would drop LCOE by 2.3% to less than 14.6¢/kWh, she said. The LCOE numbers for the US$4.46 million VVC project over its 25-year lifetime? An estimated 8.5¢/kWh, going down to 1.5¢/kWh when performance-based incentives factor in, according to company documents.

The power-output reality on the ground at VVC is that although the panels carry the IEC-certified and CEC-listed 300W rating, they actually perform closer to 315W. During a follow-up phone interview after the well-attended dedication ceremony in late May, she explained the case of the bonus wattage.

"Once we started running in decent volumes at our [50MW] factory [in China], where every panel that comes off the line is flash tested on our own solar simulator and so every panel we know the power rating of, what we started discovering is – and we believe a lot had to do with quality and automation – that even with the same rated cells, [that there is] a steady increase in the number of watts these panels [showed]."

"At the point where we got enough data to say 'look, they're all fluctuating at ±5% right at 315W,' it didn't make sense to keep selling them as 300W panels because they were performing better than that," she noted.

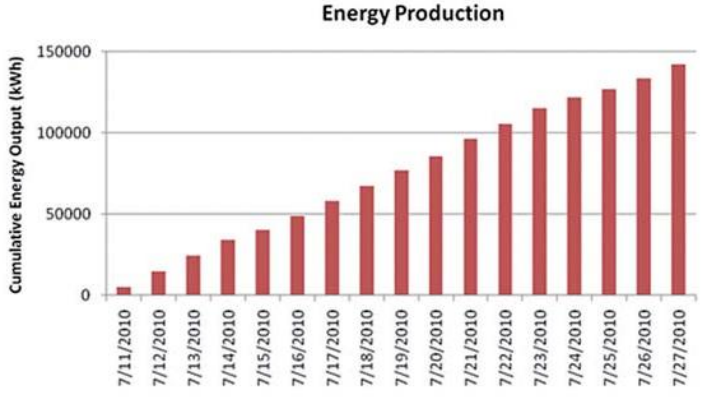
Another positive: the extra wattage could lead to higher-than-predicted performance-based incentives, a key part of the California Solar Initiative-backed project's financial foundation, and will also provide a cushion for the CPV firm in meeting its own five-year performance guarantee.

SolFocus has its panels in for recertification at TÜV, but she's not sure if that process will be fast-tracked soon or have to go through the whole regimen of testing again and take longer; once the tests are done, the company will be able to get its higher-rated panel listed with CEC.

If one assumes that each panel is actually 315W and thus each array more like 8.8kW, the installed capacity of the field goes up to 1.076MW, or the equivalent of adding another half-dozen panels. Since there is plenty of inverter redundancy built in – a total of 1.25MW – all of the potential DC energy generated should be captured and converted into AC and then sent through the rest of the system to rest of the VVC campus, where it will supply about a third of the college's electrical demand, or about 2.6MWh per year.

The decision to scale the inverters in such a way came via learning garnered from a demo system that SolFocus set up for a proposed project in Colorado that never panned out, recounted Hartsoch.

"It's very easy with CPV to undersize inverters because they're based on average power," she said. "Often your DNI (or direct normal irradiance, the measure of solar energy pouring down on a specific



Cumulative energy output for the Victor Valley College CPV power plant for two weeks in July.

The SolFocus-equipped CPV power plant project under construction in Crete.

location) is higher than your average DNI, so if your average DNI for the year is 7.2 (which happens to be the VVC site's irradiance), there's a lot of days of the year well above that. If you don't size your inverters for maximum energy you potentially can generate, you're going to be throwing energy away."

One little secret not uttered during the opening ceremony speechifying was the fact that the VVC's CPV field was actually not quite 100% operational and online at that point.

In late July, Hatsoch told me that "the system went on line in late May. We did some additional testing, inspections, and then [went through the] customer acceptance period, and officially turned the plant over to Victor Valley College during the last week of June. The systems have been performing well."

For the 30 days leading up to that late July update, the VVC system had offset more than 246,109 lb (868kg) of carbon dioxide, 65lb (29.5kg) of nitrogen oxide, and 12lb (5.5kg) of sulfur dioxide, equivalent to the output of 248 cars or 179 homes, according to data shared by the company exec.

The cumulative energy production chart for the July 11-27 period (shown in the graph) reveals the system's steadily growing power output, climbing close to 150,000 kilowatt-hours.

The purpose of the new solar power system is not just to produce energy but to generate interest in green and sustainable career paths, and play a key role in academic and vocational programming at the community college. Hartsoch told me the company hired a summer intern, actually a middle school teacher (part of a local program), to work with VVC on ways to fold SolFocus's technology into existing coursework.

She also noted that as part of the arrangement, some company folks would periodically guest lecture at the campus, and that students will likely be recruited to help with gathering/monitoring and analyzing data from the field. The school itself, which has had PV design/installation and other courses in its curriculum for several years, plans to use the new teaching resources to help build a broad-based program in sustainability.

SolFocus hopes to showcase its system at VVC and sign up more community colleges and other centers of higher education for more (ad)ventures in concentrator PV. Hartsoch believes two or three similar projects could "start in the ground" in California before year's end, with another one possible in Arizona.

Of course, the company is not just hitting the books in the academic sector: she cited several, smaller demo-scale installations just built or being built in Mexico, South Korea (not the first place that comes to mind with CPV, the VP admitted), Colorado, and elsewhere.

The long-postponed 10MW project in Greece has started to move forward, but there's been a change in the developer company. Environ has taken over from Samarus, Hartsoch told me in a late July update. She also sent me a recent photo of the project, which is set in the hills among the olive trees on the island of Crete.

"We have begun installation of 1.24MW of the project," she said. "The poles are in but the arrays are not yet up. This is one of about 15 sites in the project, which are each around 80kW. You'll note how steep the terrain is in the one photo, where anything that wasn't tracking on two axis would have been an issue. We anticipate power generated there by mid-August at the latest."

She also updated me on the status of the Alice Springs Airport 235kW project in Australia, noting that developer Ingenero "has completed system installation," but that "the trenching and electrical interconnection has been delayed due to floods."

"I believe that it will be completed in the next couple of weeks," she said in late July, "and our engineers (SolFocus is the equipment supplier on this one) will be onsite in mid-August for the commissioning." As the accompanying photo shows, the "systems are in but the project is not yet complete."

Hartsoch had to cut one of our chats short, being called to the boss's office to help with a presentation for some visiting Chinese government officials. A few minutes before the final interruption, she quipped that "twice a week there's someone here with grandiose ideas. Yesterday, we had someone here with 500MW to deploy in a country I've never heard of. And you know, some of those might happen."

When and if megascale CPV projects start to go from dream to reality, one can look back to installations like Victor Valley College, where it all started with that first megawatt.

VVC photos by Tom Cheyney; other photos courtesy of SolFocus.

This feature is a revised and updated version of a blog that originally appeared on PV-Tech.org.

The Alice Springs Project in Australia features 235kW of CPV arrays.