

****[Solar Startups, Part 1: c-Si, Installers, Financiers, BoS, Misc](#) (Updated May 20)]****

Over the last four years VC investment in solar has gone from a modest trickle to a roaring flood. In 2005 VCs invested about \$200 million in solar startups. When the dust settles at the end of 2008, they will have invested about \$4.5 billion in about 150 new solar startups in the four years from 2005 to 2008.

Green tech media has compiled a list of these firms with funding info and a few words on each startup's technology.

In Part 1 we'll cover:

- Silicon Wafer Technology (c-Si)
- Solar Installers and Solar Financing Firms
- Solar Balance of Plant (Inverters etc.)
- Solar System Monitoring, Manufacturing Tools and Software

In the coming installments we'll cover

- CPV
- Next Gen PV
- Thin-Film Solar
- Concentrating Solar Thermal
- Winners and Losers
- And look ahead to 2009

The list includes VC-funded firms as well as other private firms looking for funding. We've divided it up by technology. If we've missed any let us know – remember this list is private companies only.

Silicon Wafer Technology Startups

[1366 Technologies](#): MIT spin-out 1366 boasts of a new cell architecture and a light-capturing ribbon interconnect to increase the efficiency of multi-crystalline solar cells. Funded with more than \$12M from North Bridge Venture Partners, Polaris Venture Partners, et al.

[21-Century Silicon](#): Low cost solar-grade polysilicon manufacture via a proprietary furnace design. \$1M from Solar EnerTech in September 2008.

[6N Silicon](#): 6N Silicon is a developer of solar grade silicon purification technology. More than \$26M in funding from Good Energies, Ventures West, and Yaletown Venture Partners.



[Advent Solar](#): Emitter-Wrap Through (EWT) back-contact solar cell technology. Its 2007 \$73

million round was from @Ventures, ZBI Ventures, Sun Mountain Capital, Globespan Capital Partners, Battery Ventures, EnerTech Capital Partners, New Mexico Co-Investment Partners, and Firelake Capital.

[AE Polysilicon](#): Production technology to lower the cost of polysilicon using an integrated, closed-loop, fluidized bed reactor production process. Funding from private, strategic, and government sources.

[Blue Square Energy](#): 14.6 percent efficient solar cells from upgraded metallurgical grade (UMG) silicon. It has received about \$3 million from the DOE's Solar America Initiative but boardroom shake-ups seem to have delayed closing further VC funding.

[CaliSolar](#): CaliSolar uses less expensive metallurgical grade silicon to make solar cells. Founded in 2006 with more than \$110 million in 2 rounds of funding from Advanced Technology Ventures, Globespan Capital Partners, and Hudson Clean Energy.

[Confluence Solar](#): High-quality single crystal silicon at a lower cost. \$12.7 million Round A from Convexa Capital, DC Chemical, Scatec Adventure, Oceanshore Ventures, et al.

[ET Solar](#): More than \$50 million raised in two rounds from NewMargin Growth Fund, China Equity Links, et al. for this Nanjing-based integrated manufacturer of PV products including ingot, wafer, module, and dual-axis tracking systems.

[Gamma Solar](#): Private firm building 200 micron thick bifacial silicon solar cells with a reported efficiency of >16%. Angel funded and seeking venture capital.

[NorSun](#): [Scatec](#)-founded firm, building single crystal silicon wafers with \$8.5 million from Itochu and \$23 million from Norsk Hydro.

[Peak Sun Silicon](#): Peak Sun Silicon looks to produce granular polysilicon using a tribromosilane-based continuous manufacturing process operating at near atmospheric pressure and at lower temperatures with improved energy efficiency. They closed a Round A in 2008 that included a \$14M loan from the Oregon Department of Energy.

[RSI Silicon](#): RSI claims to have developed a process to manufacture solar grade silicon with a purity of 99.9999+ percent (6N's). It is funded by David Gelbaum's Quercus Trust.

[SBM Solar](#): 90W and 140W PV modules using a polymer cover sheet instead of glass that reduces the weight of the panel by 50%, allows for customization, and enables BIPV applications. Seeking VC funding.

[Senergen Devices](#): Stealth startup with funding from VantagePoint Venture Partners, et al. for Si PV cells.

[Silicon Genesis](#): Kerf-free silicon wafers for solar markets (and other technologies). Most recent round in 2007 was \$23 million from Convexa, H&Q Asia Pacific, Lake Street Cap, Riverside

Management, Firsthand Tech and Spencer Energy.

Solar Notion: \$10 million round A funding from hedge fund Third Point for solar panels and silicon manufacturing.

[Solaicx](#): Solaicx' manufacturing technology yields higher quality single crystal solar ingots and wafers optimized for PV applications, designed for the high volume, continuous production. Its \$27 million round C in 2007 was led by the D. E. Shaw group with Mitsui Ventures, Applied Ventures, Firsthand Capital Management, Big Sky Ventures and Greenhouse Capital Partners.

[Solar Cell Repower](#): Improving solar cell efficiency – “repowering non-prime solar cells” with a \$1.5M Round A from NorthZone Venture in December 2008. Based in Norway.

[SpectraWatt](#): An Intel spin-out planning to manufacture and supply photovoltaic cells to solar module makers with \$50 million in funding from Intel Capital, Cogentrix Energy, PCG Clean Energy and Technology Fund and Solon.

[Suniva](#) (a.k.a. Solarity): Nano-structured high efficiency polysilicon solar cells with more than \$55M in funding from NEA., Goldman Sachs Group, HIG Group, Cogentrix and Quercus, et al.

Twin Creeks Technologies: Twin Creeks Technologies is an early stage, VC-funded solar start-up founded in January 2008. Using silicon fabrication processes. Received \$13.1M Round A from Crosslink Capital and Benchmark in Q1 2008. \$52M Round B led by Artis Capital and DAG Ventures at 7X series A price in Q3 2008. Attempting to make Si cheaper than CIGS or CdTe. CEO is Siva Sivaram.

[Wriota](#): Novel silicon processing technology for PV, ICs, memory, and FPDs with funding from Intel Capital, Allen & Buckeridge.

Solar Installers, Integrators, Financiers, BIPV

[Aquus Energy](#): Commercial and residential solar energy systems integrator in the Mid Atlantic and Northeast US received funding from Oppenheimer & Co. Aquus acquired installer [Mercury Solar Systems](#) and [Energy Enterprises](#).

[Armageddon Energy](#): Armageddon's hexagonal module is easier to handle and better accommodates the contours of a rooftop and includes an integrated microinverter. Armageddon claims that its' affordable systems enable mainstream consumers to buy into solar with much lower installation time and cost. Currently seeking VC funding.

[Axio Power](#): Axio Power develops, finances, and constructs large-scale solar projects. Taking on private equity funding in 2009.

[Clean Power Finance](#): In 2007 CPF acquired Solar Pro Tools, a subscription-based software service which enables PV, solar domestic hot water, and solar pool heating pros to generate sales quotes and incentive forms. CPF provides “Point-of-sale” residential solar financing and is

working with Conergy.

[Cleansource Power](#): Cleansource's "Solar Energy Service" – under an SES contract, CleanSource Power pays all costs incurred in the design, installation, commissioning and maintenance of a solar energy system. In return, the client purchases all of the energy produced from that system.

[Envision Solar](#): Building solar car-ports and projects, partnered with Kyocera with ~\$3 million in VC and angel funding.

[Eshone Energy](#): Founded in 1995, Eshone is a solar power integrator providing turnkey, grid-connected systems for public and commercial sectors

[GreenSun Energy](#): Angel funded commercial-scale solar projects with integrated financial solutions.

[GroSolar](#): Solar installation and service with \$10 million Round B funding in 2007 from NGPETP, SFJ, Calvert, Allco, on top of a \$2 million Round A in 2006.

[Helio Mu](#): A "micro utility" selling power not solar panels with no upfront costs. Funding for Helio Mu's projects comes from the Green Energy Community Investment Fund, a fund jointly owned by Helio Micro Utility and Citi Community Capital, a division of Citi.

[Mondial Energy](#): Private, Canadian solar firm offering installation and PPA financing for solar thermal systems.

[MP2 Capital](#): Financial services firm focused on the renewable energy industry arranging PPAs, finance and development.

[Orb Energy](#): With funding from Zouk Ventures and the Singh Family, Orb Energy is a residential and commercial solar system integrator and financier and installer (?), looking to franchise its business although it's difficult to tell from the company's very annoying Website. It is focused on India.

[Ready Solar](#): Modular PV with pre-installed micro-inverters (from Enphase), claiming 50% reduction in installation time with >\$300K in angel funding and seeking VC.

[Recurrent Energy](#): Solar services and system financing for commercial roofs with more than \$85 million in funding from Hudson Clean Energy and MDV. Recurrent Energy is a developer and owner of onsite solar power systems, selling energy to customers at competitive rates via a PPA.

[Redwood Renewables](#): Integrated solar roofing tiles with built-in electrical interconnects that use recycled polymers as their base. The company's investors include a roofing manufacturer. They are seeking Round B funding.

[Renewable Funding](#): Renewable Funding develops and delivers solutions for renewable energy

and energy efficiency financing. Cities raise funds through bonds, and the consumer pays it back through property taxes. Renewable Funding provides on-line application processing coupled with a financial package that provides reasonable interest rates and low risk.

Sierra Nevada Solar: ~\$4.5 in angel funding in 2007 from EarthBright et al.

[SoCore Energy](#): With \$1.5 million in private funding, SoCore is a solar system developer promoting PPAs focused on commercial, low-rise buildings.

[Solairedirect](#): French integrated solar power provider recently raised \$25M from Demeter Partners, Schneider Electric Ventures, TechFund, et al. Raised \$8 million in 2007.

[Solar Century](#): Funded by VantagePoint Venture Partners, Scottish and Southern Energy, U.K.-based Solar Century builds solar homes, commercial and public sector projects

[SolarCity](#): SolarCity claims to be the largest installer of small residential solar in California. Investors include Draper Fisher Jurvetson, JP Morgan and Elon Musk. A \$21 million Round C closed in 2007 and \$30 million was invested in 2008 by First Solar, et al. The firm recently created a solar leasing program as well.

Solar Red: A solar installation company seeking VC, looks to lower cost of residential and small solar installation by integrating the process into the construction or renovation of a house and by using micro-inverters.

[Soltage](#): Soltage finances and installs solar panels on the roofs of its customers, maintains and operates the systems, then sells the power back to the clients. Series A funding closed in late 2006.

[Solar Power Partners](#): SPP develops, owns and operates distributed solar energy facilities and sells solar-generated electricity through PPAs. SPP has received \$100M of equity and debt financing to date from United Commercial Bank, Globespan Capital Partners, The Enlightened World Foundation, Carrelton Asset Management, Dry Creek Ventures, Silicon Valley Technology Group, and Energy Investors Funds.

[Standard Renewable Energy](#): Solar panel installation for businesses and homeowners funded with an \$8 million Series A in 2007 and a \$7.2 million Series B in 2008 led by the Quercus Trust.

[Standard Solar](#) – Raised \$8.5M in October and \$3.5M in March 2008 from Truecast Capital, et al. They are a turnkey solar system developer and integrator.

[Sterling Planet](#): A retail provider of solar and renewable energy. It received investment from Low Carbon Accelerator in 2007.

[SunEdison](#): Solar electricity as a service, not a product with more than \$160 million in debt and equity funding from Goldman Sachs, Allco Finance Group, MissionPoint Capital Partners,

Greylock Partners, HSH Nordbank, Applied Ventures, Black River Commodity Clean Energy Investment Fund

[Sungevity](#): Sungevity provides price quotes and enables installation, coordination, and service of PV systems. It raised \$2.7 million in funding in 2007 from German solar companies Solon and I-Sol Ventures plus several angel investors.

[SunRun](#): \$12 million round in June 2008 led by Foundation Capital and a commitment for up to \$105 million in financing from an affiliate of US Bancorp in November 2008. SunRun owns the solar panels it installs on residential roofs and sells its customers electricity at a low fixed rate, eliminating the need for homeowners to purchase solar hardware.

[Tioga Energy](#): Tioga's \$14 million Series A in 2007 included investors NGEN Partners, Draper Fisher Jurvetson, Rockport Capital, DFJ Frontier, and Kirlan Ventures. Tioga provides solar power purchasing services for large and small commercial customers.

Solar Balance of Plant

[1-Solar](#): A winner of the 2007 CCTO, 1-Solar is developing a lighter-weight and more reliable inverter architecture that converts DC to AC in a single step and with fewer components than conventional HF inverters. The design "eliminates the need for an intermediate high voltage DC bus and its associated storage capacitors." 1-Solar claims to have signed a 60,000-unit distribution agreement with a Southern California solar distributor and plans to offer inverters in the 1 to 50kW range.

Accurate Solar: Inverters and MPPT "Smart Cards"

[Apollo Solar](#): Modular inverters, charge controllers and energy management systems, and communications for residential solar electric systems. Privately held firm with DOE SEGIS funding and a \$4.5M equity round in October 2008. Apollo is a spin-off of Electronic Design Lab.

ArrayConverter: Currently seeking VC funding, ArrayConverter is designing "self-monitoring AC modules with a distributed inverter architecture.

[Azuray](#): Microinverter startup received \$8 million from NEA in May 2008. Rohini Chakravarty of NEA is on the company's board. Terri Fiez, a former Oregon State University professor, is the CEO.

[EnPhase](#): Distributed inverter architecture incorporates micro-inverters into each solar panel instead of on each "string" of solar panels, potentially generating more power and providing additional monitoring and security benefits. Its most recent VC funding round led by Rockport was \$15 million in Sept 2008 in addition to the \$6.5 million previously raised. Other investors include Applied Ventures and Third Point Ventures.

[EOS Renewable Technologies](#): EOS' PC board-based module uses "dynamic impedance matching" to extract more usable power from solar panels, particularly in low-light conditions.

EOS is a self-funded holding company using technology invented by [XET](#). The product has been used as a per-panel charge controller in conjunction with batteries for off-grid military "solar back-pack" applications although the technology has been licensed to [Cool Earth Solar](#) for CPV systems. EOS claims that in light conditions of 150W/m²-400W/m² they can provide 100% more usable power.

[Green Ray Solar](#): GreenRay received \$2.2 million from the DOE SAI program and closed a \$500,000 seed round in 2007 from the Massachusetts Technology Collaborative. Their micro AC inverter allows a DC solar electric or PV module to produce AC power.

[MPPC Technology](#): For distributed MPP and inverter architectures, Maximum Power Point Control (MPPC) is the exact calculation of the Maximum Power Point (MPP) coordinates (voltage and current and therefore power). MPPC Technology is conducting on and off-grid tests in Europe and India. Pre-VC.

[Petra Solar](#): Petra received \$14 million in first round funding from DFJ Element and BlueRun Ventures in April 2007. They are attempting to improve PV Balance of System performance and cost with fast maximum power point tracking (MPPT). Their power electronics IP is licensed from UCF.

[Princeton Power Systems](#): Inverter and power conversion technology with Round C funding from GHO Ventures in 2008. PPS also received funding from the DOE Solar Energy Grid Integration Systems (SEGIS) program for a 100kW demand response inverter with integrated control capabilities for dynamic energy storage and demand response through load control.

[PV Powered](#): Privately held PV Powered builds inverters for residential and commercial PV as well as data monitoring modules. The company claims to be the largest U.S.-based manufacturer of solar power inverter technology and has received \$5 million from the DOE's Solar Energy Grid Integration System (SEGIS) program, a \$24 million effort to develop advanced inverters and balance-of-system components as well as funding from the DOE SAI program.

[SmartSpark Energy Systems](#) – Received a Series A from Battery Ventures with technology licensed from the University of Illinois. Their SolarBridge product is a PVAC micro-inverter. Other investors include Illinois Ventures and ITEC.

[Solar Edge](#): Distributed inverter architecture using custom chip sets, junction boxes, and inverters built to maximize the energy harvesting capability of PV systems by correcting MPP mismatch, minimizing shading loss, etc. The firm has received \$34.8 million in funding from Walden International, Opus Capital, and Genesis Partners, et al.

[SunLink](#): SunLink closed a B round with funding from Clean Pacific Ventures and the Angeleno Group for their aluminum mounting systems for commercial PV.
Sympagis: DC to DC boost funded by NGEN

[TerraWatt Power](#): A solar-inverter startup, is in the midst of raising a \$1.5M round of funding, President Gary McDaniel told Greentech Media. They claim to have raised \$1.5M in angel

funding and \$1M in grants. Their inverter technology, like many other entrants, uses Maximum Power Point Tracking (MPPT). Additionally, their inverter disconnects from the grid during outages and feeds electricity directly into the home.

[Tigo Energy](#): Israeli startup Tigo raised \$6 million in funding from Matrix Partners and OVP Venture Partners in June 2008. Tigo Energy's products can improve output power, up-time, and reliability on existing and new solar installations Tigo claims to improve power output (kWh) in excess of 20 percent depending on weather conditions.

Solar Monitoring, Software, Manufacturing Tools and Processes, Etc.

[BT Imaging](#): BTi improves solar cell efficiency and manufacturing yields by applying luminescence imaging to the manufacturing of silicon wafers and solar cells. Seed funding and a \$2 million Round A from Allen & Buckeridge, Uniseed, and NSi.

[Deck Monitoring](#): Monitoring commercial solar systems with a rich web-enabled interface.

[Energy Recommerce](#): Web-based solar monitoring and management solutions for the commercial market. Funding from Dry Creek Ventures.

[Five Star Technologies](#): Cavitation technology-based ink formulations for screen-printable solar inks for front surface contacts. VC funding from Morgenthaler Partners, Industrial Technology Ventures, Reservoir Venture Partners et al. for a number of markets including solar.

[Draker Labs](#): A renewable energy monitoring company, raised a Round A from strategic investor Campbell Scientific and FreshTracks Capital in August 2008.

[Fat Spaniel](#): Fat Spaniel provides monitoring, reporting, and remote management for PV and other renewable energy systems. It closed an \$18 million Series B in January 2008 from investors Ignition Partners, Element Partners, Chrysalix Energy, PCG Clean Energy & Technology Fund, and Applied Ventures. The firm closed a \$7 million Round A in 2006.

[Locus Energy](#): Low-cost, revenue-grade, web-based performance monitoring for solar systems and distributed generation.

[Mythos Solar Power](#): Funded by The Hartley Family Trust, Mythos builds web based renewable energy monitoring applications designed to monitor and manage any widely dispersed renewable energy power supply supporting large scale IP video surveillance systems and wireless infrastructure.

PVXchange:

[SiC Processing](#): Recovering and conditioning of the slurry used in the wire sawing process of solar silicon production. Their most recent round in 2007 was ~\$73 million from Zouk Ventures, Merrill Lynch Corporate Principal Investments Group, CC Private Equity Partners, Masdar Clean Tech Fund, Foursome Investments, et al.

[SiXtron Advanced Materials](#) raised ~\$12M in VC from Ventures West, iNovia Capital,

Innovatech sud du Québec, FIDD, and MSBi Capital to develop a silane-free process for producing anti-reflective coatings for silicon solar cells. SiXtron is working with an NREL optical furnace to optimize the metallization process for the antireflective coatings. SiXtron's process uses a solid, silicon-based polymer.

[Xjet](#): Xjet raised \$9 million from Gemini Israel Funds, Good Energies and Spirox, et al. for deposition technology used in solar cell manufacturing.

Miscellaneous

[Kotak](#) (India): With \$8M in financing from KPCB, Sherpalo Ventures, and Applied Materials, Kotak deploys solar power installations, and builds and distributes solar appliances such as solar water heaters, water pasteurizers and solar drying systems.

[Snow Peak Energy](#): Solar parking structures

[Veranda Solar](#): Low-power output, consumer-oriented on-grid solar modules. With integrated inverter. They've received seed funding in business plan competitions and are seeking VC funding.

Solar Startups, Part 2: CPV (Updated May 20)

CPV is a zero billion dollar market that looks great on paper, especially when the price of silicon is high. Scores of firms are trying to stake out their corner of the CPV sector in anticipation of tremendous market growth and technical advances.

We've compiled a list of these firms with funding info and a few words on each startup's technology.

They include Low Concentration PV firms, High Concentration PV firms and firms attempting to dethrone the oligarchy that controls Triple-Junction Cells.

[Ahura Energy](#): Pre-VC solar concentrator systems for thermal and solar applications. Seeking \$4.5 million.

[Banyan Energy](#): Banyan is a startup seeking funding and developing a set of optics to concentrate sunlight within a PV module. The company claims their optics platform can achieve concentration levels ranging from 2x up to 500x. Banyan's first product is a low-concentration module.

[Concentrator Optics](#): German-based Concentrator Optics designs and produces Fresnel lenses for the CPV market with funding from Belgium-based VC [Capricorn Venture Partners](#). The market for solar Fresnel lenses is estimated to reach \$280 million in 2011, according to the Capricorn press release (Take that figure with a grain of salt).

[Concentrix](#): A Fraunhofer Institute spin-off with investment from Good Energies, Concentrix has installed about 100 kW of HCPV systems and is now building a 25-MW production line.



[Cool Earth Solar](#): Mylar balloon-based concentrator system received \$21 million in funding in early 2008 from an unnamed PE investor. At a recent conference, CEO Rob Lamkin said that they were currently using triple junction cells but silicon would eventually be used.

[Covalent Solar](#): Covalent is an early stage, pre-VC firm spawned from MIT targeting a dye-based luminescent solar concentrator without tracking or cooling. The system looks to use both triple junction and silicon cells and could have eventual BIPV applications.

[Cyrium](#): Quantum dot-based triple-junction solar cell startup with VC funding from the Quercus Trust, et al. Here's a link to a [relevant patent](#) awarded to the company and its CTO, Simon Fafard.



[Distributed Solar Power](#): Israel-based firm developing a CPV/CHP system that produces electricity and heat using sun-tracking miniature PV concentrators. The system has a claimed ~75 percent efficiency and is intended for on-grid customers. It can produce high quality heat for steam generation, cooling and AC (using absorption cooling), space and water heating, and process heat. The firm is working with Italy's [Shap](#) and has raised \$1.2 million from Israel's Aurum Ventures et al.

[Energy Innovations](#): EI's low-profile "Sunflower" is a 2 axis tracking HCPV system incorporating Fresnel lenses. EI's VC investors include MDV and Idealab.

[EnFocus Engineering](#): Lens-based, low-profile III/V system for rooftop applications. EnFocus recently received a \$3 million Solar America Initiative award from the DOE.

[Everphoton](#): Taiwan-based HCPV with TJ cells.

[Extreme Energetics](#): With "clear transistor" technology licensed from HP, Extreme Energetics is developing CPV systems and looking for funding.

[Greenfield Solar](#): Greenfield Solar raised ~\$1.5 million in early 2008 with a plan to license and franchise a CPV system design. The company's high-efficiency PV chip is a custom [edge illuminated chip design](#) from PhotoVolt.

[GreenVolts](#): \$30 million in VC funding from Oak Investment Partners in September 2008. Greenvolts has a 2-MW PG&E contract for their low-profile CPV system to be deployed near Tracy, Calif. The-2MW system is hailed as one of the largest CPV systems undertaken.

[Microlink Devices](#): Received \$3.2 million from the DOE SAI PV Module Incubator program for multijunction solar cells. Microlink claim that its MOCVD technology and unique processing steps minimizes the amount of GaAs used in the solar cells.

[MegaWattSolar](#): With investment from Scatec and iEnergies, MegaWattSolar builds dual axis CPV "solar trees" using silicon modules and 10 to 50X concentration.

[Morgan Solar](#): Angel-funded Morgan Solar uses "Light Guide Solar Optics" (LGSO) to direct sunlight to the edges of an optical element in their CPV system.

[MST](#): Founded by Dov Raviv, MST will build CPV solar farms in combination with Vanadium flow battery storage. Their website claims the major cost reduction element will be achieved by constructing automatic production and assembly lines.

Netcrystal: NetCrystal is using a technology developed by Peumans' group at Stanford, funded by [Wellington Partners](#), Siemens, and X-Seed. Netcrystal's SBIR Phase I project is focused on the development of high-efficiency, lightweight, non-tracking, microconcentrator PV arrays based on stretched silicon. According to the SBIR document: "The stretchable silicon process can achieve accurate placement and electrical wiring of thousands of miniature solar cells in one parallel and potentially low-cost step."

[Optony](#): Pre-VC thin-film CPV.

[Prism Solar](#): Prism Solar uses transparent holographic optical elements in its passive concentrator design. Has received more than \$2 million in funding from CounterPoint Ventures, Phoenix-Fire, et al.

[Pyron Solar](#): Triple Junction based 2-axis HCPV with arrays floating in water. Pyron received \$2 million in first-round funding from [New Energies Invest](#) in 2007. Pyron received another \$1 million in a [second closing of its Round A from NEI in mid 2008](#). The funding will finance a pilot demonstration of Pyron's technology with a Southern California utility, according to Doug Carriger, the company's CEO.

[Pythagoras Solar](#): Israel's Pythagoras builds "Medium" concentration solar cells using silicon. Funded by a \$10 million Series A from Precede Technologies, Israel Cleantech Venutres, Evergreen Venture Partners, and Pitango Venture Capital.

[QuantaSol](#): "Strain-Balanced Quantum Well" triple-junction PV cells from this U.K.-based, VC-

funded startup with [technology](#) developed at Imperial College London. QuantaSol claims that the spectral response of an SB-QWPV cell can be tuned to maximize conversion efficiency under a "wide range of radiation spectra by varying composition and thickness of the III-V semiconductor nano-layers in the active region of the solar cell."

[QuNano](#): Sweden's QuNano raised a 6.1 million Round A in 2006 from Provider Venture Partners, Teknoinvest, BTG, LU Innovation, et al. Their heterostructured nanowire technology has applications in PV. This PV technology was spun-out in 2008 as a new firm, [Sol Voltaics](#), with additional investment from Scatec targeting CPV applications for their advanced nanostructured III-V materials.

[Scaled Solar](#): SF-based and privately-held, Scaled Solar's press release claims that the firm has entered into two supply agreements for its HCPV systems in July 2008. The end applications for the systems are powering solar farms totaling 75 MW in the SF Bay Area and California's Central Valley starting in 2009.

[Skyline Solar](#): Stealth-mode LCPV vendor using silicon. Helmed by Bob MacDonald (formerly of SolFocus) Skyline has closed a roughly \$25 million round from New Enterprise Associates, et al. and is targeting large installations (as opposed to residential applications). The company claims its product "combines the best of thin film (low area cost) and silicon PV (high reliability and efficiency)." Skyline's CEO provided the following tidbits: The firm is commercializing a "high-utilization" silicon PV system (more Watts per wafer) and its technology is based on linear concentration with a strong kinship to CST.

[Solaria](#): With considerable funding from Q-Cells, Sigma Partners, NGEN and Moser Baer, Solaria is building a low concentration system in the traditional flat-panel footprint. Solaria's technology is based on dicing or "singulating" a standard silicon wafer and mounting these strips on a substrate with a lensing system that essentially halves the requirement for silicon. Its 25-MW line in the Philippines will be ready for production by the end of this year and follows a fabless model by using a third party operator.

SolBeam: With seed funding from NGEN, SolBeam is building flat panel concentrators. Here's a [SolBeam patent](#).

[SolFocus](#): One of the first VC-funded CPV startups with technology licensed from PARC, it acquired a glass manufacturer and a tracker company to control their supply chain and are in the process of raising another funding round. It has completed the first 200-kW phase of a 3-MW system in Spain operated by ISFOC. At one point Spectrolab was their designed-in supplier of solar cells but that might have changed as SolFocus attempts to liberate itself from the III/V solar cell oligopoly. The company's most recent round in 2007 was ~\$63 million from NEA, Moser



Baer, et al.

Solar Junction: III-V materials startup Solar Junction CEO Jim Weldon and VP Craig Stauffer confirmed that their VC funding from ATV, DFJ, and NEA was “north of \$3 million,” the company’s goal is to create very high-efficiency, triple-junction cells for CPV systems, and that the “secret is in the EPI.”

Solar Systems: Privately held Australian firm with a \$100M investment from Australian utilities currently using a dish-based CPV system but moving towards power tower (?). Solar Systems placed a large (350 MW 10 year) order with Spectrolab for III/V cells.

Soliant: VC-funded by Rockport, Nth Power, Trinity, Rincon, GE, Convexa, this firm started life as a low-concentration company, now targeting standard panel footprint 500X HCPV for rooftop applications. Their first round in 2006 was \$8 million, it received \$4 million from the DOE SAI in 2007, and \$21 million in Q3 2008.

Stellaris: Funded by King Hill Capital, Convexa Capital and iEnergies with a \$6 million Round A in 2007, Stellaris builds non-tracking LCPV with technology stemming from the Northeast Solar Energy Center. Here’s a link to Stellaris’ solar [patent](#).

Stellaris, a company that assembles solar modules in Lowell, MA, has already received \$6.1 million in funding to develop techniques for packaging silicon and thin-film cells. The company, represented at the conference by CEO James Paull, is seeking further financing in 2010.

Sunovia: Working with [EPIR](#), in which it has a significant equity position, Sunovia is attempting to develop CdTe on Si, for a multijunction solar cell with initial applications in CPV. Sunovia received \$12M in funding from an undisclosed source in 2008.

Sun Phocus: Early stage holographic planar concentrator technology for BIPV applications.

Sunrgi: Hollywood, Calif.-based private company claiming 2000X concentration with proprietary heat sinking and cooling technology. Seeking VC funding. Here’s some more [info](#).



[SV Solar](#): VC-funded startup with a \$10 million round A led by Bessemer Venture Partners and presumably sourced by Justin Label, BVP's cleantech partner. The company calls its product a "flat plate internal concentrator solar module," and is using an "Asymmetric, linear focus optic with 2-3X geometric concentration." SV has recently moved into a 15,000 sq. ft. headquarters/pilot production facility in Sunnyvale, Calif. and has begun producing test samples on its pilot line

[Whitfield Solar](#): U.K.-based Whitfield Solar is spun out of Reading University and uses an array of Fresnel lenses to concentrate the sun's energy. Whitfield's initial products are silicon-based and compete with flat-plate PV panels.

[ZenithSolar](#): Israel-based ZenithSolar, founded by Roy Segev, has developed a modular and scalable high-concentration P.V system



[Zytech](#): Private firm headquartered in Spain manufacturing LCPV and HCPV. Zytech is a Spanish company with captive manufacturing and strategic sourcing in China. KPMG Hong Kong's advisory practice is representing the firm in its fund raising efforts.

[Solar Startups, Part 3: Next-Gen PV \(Updated May 20\)](#)

In this edition: Silicon Inks, Quantum Dots, Organic PV, Stretched Silicon and Other Oddities with Potential.

We continue our long list of private solar firms with Next Gen PV.

Arguably some of these next gen startups could be crowbarred into the thin-film or CPV category but unproven materials, processes, and substrates land them in this miscellaneous bucket. Many of these are still in the lab, proof-of-concept stage and will never become commercialized. But one of these technologies might be the "black swan" that changes PV economics. If you know of one we've missed, add a comment and we'll get it included.

[3GSolar](#) (a.k.a Orion Solar): An Israel-based solar startup funded with at least \$1 million from 21 Ventures (21 Ventures has a relationship with [The Quercus Trust](#)). Orion builds flexible DSCs. Vesta Capital Corporation, traded on Canada's TSX has signed an LOI to acquire 3G for \$10M in what looks like a reverse merger to take the Israeli firm public.

Bandgap Engineering: With \$1.4M in funding from NEA and MGEF, Bandgap Engineering is "nanoengineering silicon" and "putting an intermediate band in Si solar cells to improve efficiency." Their CTO has written a paper, "Intentional Interface Defects as a Means of Band Gap Engineering and the Applications to Photovoltaics."

[Bloo Solar](#): Formerly known as Q1 NanoSystems, Bloo Solar has IP from UC Davis and builds nano-structured "bristles" layered with CdTe as the PV material although other materials can be used. The bristled substrate provides greater surface area and acceptance angle. The firm has received \$100,000 from an NSF grant and are looking for their first VC round.

[eQsolaris](#): Micro-concentrator solar cells using [Kyosemi's](#) free-fall droplet photodiode "Sphelar" cells with an optical and electrical connection from Energy Related Devices. eQsolaris is seeking capital for a pilot production plant.

[FlexCell](#): a-Si deposited on flexible plastic film via a very high frequency (VHF) plasma deposition technique. It received \$9 million from Q-Cells in 2006.

[G24i](#): Dye sensitized thin film solar cells headquartered in Wales and funded with \$30M in 2008 from 4RAE and Morgan Stanley Principal Investments.

[Heliatek](#): German-based organic PV startup with more than \$5 million in seed and round A funding from HTGF, BASF Venture Group, Bosch and Wellington Partners.



[Innovalight](#): A \$7.5 million round B and a \$28 million round C from Convexa Capital, Scatec, Apax, ARCH, H&H, Sevin Rosen and Triton for ink-like application of PV with nano-particles of silicon. DOE funding and \$5 million in debt and equity from SVB.

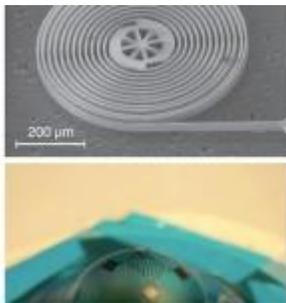
[Konarka](#): "Nano-enabled polymer photovoltaic materials" -- organic PV with more than \$100 million in VC investment and grants since 2001 from a very long and probably impatient list of investors including 3i, DFJ, NEA, Partech, Good Energies, Vanguard Ventures, et al. The firm claims to build PV materials for portable power.

[Lightwave Power](#): Solar energy based on nanoarrays -- large area thin-film arrays of repeating nano and micro-sized structures that can absorb, convert, and control light over a range of wavelengths, produced on flexible substrates. Founded in January 2008, their lead investor is 21 Ventures.

[NanoGram](#): The company's third and most recent funding round of \$32 million came from ATA Ventures, Bay Partners, Harris & Harris, IVP, Nth Power, Rockport Capital Partners, SBV Venture Partners, Technology Partners, Global Cleantech Capital, Masdar Clean Tech Fund, Mitsui Ventures, et al. Its laser and nanotech processes have applications in solar thin films.

[NanoMas Technologies](#): NanoMas builds highly conductive metallic nanoparticles for use in printed electronics, conductive pastes, solar cells and IC chip packaging. They closed a \$3.2M Round A in Q4 2008 with funding from BASF Venture Capital, Earthrise Capital Fund, and NanoMaterials Investors.

Nano Si: Funded by The Quercus Trust, Nano Si Solar emerged from the University of Illinois. Founder Professor Munir Nayfeh has developed particles for increasing the efficiency of solar cells.



Netcrystal: NetCrystal is using a technology developed by Peumans' group at Stanford, funded by [Wellington Partners](#), Siemens, and X-Seed. Netcrystal's SBIR Phase I project is focused on the development of high-efficiency, lightweight, non-tracking, microconcentrator PV arrays based on stretched silicon. According to the SBIR document: "The stretchable silicon process can achieve accurate placement and electrical wiring of thousands of miniature solar cells in one parallel and potentially low-cost step."

[NewCyte](#): An array of vertically-aligned carbon nanotubes form 3D solar cells from researchers at Georgia Tech. The research is sponsored by the Air Force Office of Scientific Research and the AFRL, and Intellectual Property Partners. MBE is used to coat the nanotubes with CdTe and CdS which act as the p-type and n-type PV layers.

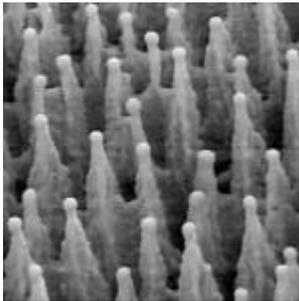
OmniPV: fka UltraDots, funded by Morgenthaler Ventures and InterWest Partners. The firm uses a thin layer of a non-silicon material to harness solar energy. Ultradots, OmniPV's predecessor had [patents](#) in using nanoparticles and QDs for authentication purposes.

Photon Synergy: Pre-VC startup developing "nano solar technology." Silicon nanocrystals?

[Plextronics](#): Printed organic solar cells using active-layer solar inks with more than \$22 million in funding from The Solvay Group, Firelake Capital, Birchmere Ventures, Draper Triangle Ventures, Newlin Investment, Applied Ventures et al.

[Quantum PV](#): Affiliated with [Desert Silicon](#), Quantum PV is developing high efficiency PV cells based on porous silicon. Seeking funding.

[QuNano](#): Sweden's QuNano raised a 6.1 million Round A in 2006 from Provider Venture Partners, Teknoinvest, BTG, LU Innovation, et al. Its heterostructured nanowire technology has applications in PV. This PV technology was spun-out in 2008 as a new firm, [Sol Voltaics](#), with additional investment from Scatec targeting CPV applications for their advanced nanostructured III-V materials.



[SiOnyx](#): Funded by Harris & Harris, Polaris Ventures, and RedShift Ventures -- SiOnyx' "black silicon" creates shallow junction photonics with possible applications in PV. Their laser process induces atomistic changes to Si detector materials with significant increase in optoelectronic response.

[Semprius](#): Transfer printing technology for semiconductor devices including solar cells with a \$4.1 million Series A in early 2007 from Arch Venture Partners, Intersouth Partners, and Illinois Ventures. Strategic investment from Applied Materials added in mid 2007.

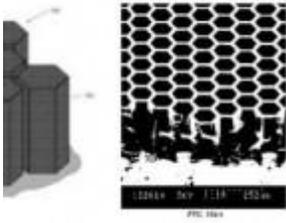
[Solaroad](#): Solar power generation from a-Si and thermionic temperature-activated materials.

[Solaris Nanosciences](#): DSSCs via Solaris' "NanoAntenna" (plasmon?) materials with funding from Yellowstone Capital, et al.

[Solarmar](#): Organic solar cells on flexible plastic with an 8 percent efficiency target using UCLA-developed technology. Acquired by AMREL in 2007.

[Solasta](#) – Solasta is a DOE funded, pre-VC firm attempting to develop high efficiency solar by separating the path traveled by light from the path traveled by electrons using nanostructures.

[Solexant](#): IR nanostructures (QDs) integrated into thin film solar cells to increase efficiency and reduce cost with \$4.3 million in its 2007 Round A funding and an \$18.1 million Round B from X/Seed Capital, Firelake, Medley Partners and Trident Capital in November 2008.



Solexel: Funded by KPCB and Technology Partners, Solexel is in stealth but here's a guess — the company develops microfabrication and MEMS technology to integrate mechanical features and microelectronics on a silicon surface for PV applications. These [patents](#), invented by Mehrdad Moslehi describe a 3D thin-film solar cell (TFSC) fabricated with a reusable template substrate. And [these](#) filings describe a pyramidal 3D TFSC.

StarSolar: Pre-VC start-up, winner of MIT competition working on photonic crystals in solar cells.

Stion (a.k.a. NStructures): \$6 million first round in 2006, \$15 million second round in 2007 from Khosla Ventures, Braemar Energy Ventures, Moser Baer PV, General Catalyst, and Lightspeed Venture Partners. A stealthy high-efficiency thin-film startup using unnamed materials deposited in vacuum based on the work of Dr. Howard Lee.

Sunlight Photonics: Integrating photonic crystals into existing silicon production.

Vanguard Solar: Funded by its founders and a federal grant, Vanguard produces thin film PV material using CdSe on carbon nanotubes. The proposed manufacturing process is roll-to-roll at room temperature in a Chemical Bath Deposition process. The firm is working with Batelle, Chasm Tech, and Lockheed Martin Space Systems.

Voxtel: DOE-funded nanocrystal quantum dots with applications in PV devices.

Wakonda: "Virtual Single Crystal" high-efficiency, thin-film solar cells using III-V semiconductors on flexible metal foils. Wakonda claims to be able to produce a Ge film on a flexible metal substrate to replace expensive Ge crystal wafer substrate. The company raised a \$9.5 million round A from ATV, General Catalyst, Polaris, Applied Ventures and MGEF. Here's a link to one of Wakonda's [patents](#).

Companies such as [Nanostellar \(catalytic powders for diesel engines\)](#), [e-Solar](#), and [Mission Motors](#) have shifted toward similar intellectual property/component models, as well. The [trend started in 2008](#).

http://www.nytimes.com/2010/10/13/business/energy-environment/13solar.html?_r=4&bl=&adxnnl=1&adxnnlx=1287014415-8b+JCjL6g+USgk0eEPUU3w Silicon Valley's Solar Innovators Retool to Catch Up to China]

Solyndra, Nanosolar and MiaSole

Founded by veterans of the valley's chip and hard-drive industries, these companies attracted billions of dollars in venture capital investment on the hope that their advanced "thin film" technology would make them the Intels and Apples of the global solar industry.

Silicon Valley companies like Solyndra, Nanosolar and MiaSolé continue to receive hundreds of millions of dollars in customer orders and some plan to expand local manufacturing. But the rapid rise of low-cost Chinese manufacturers has made investors — [who once envisioned the region's future as Solar Valley](#) — skittish about backing new capital-intensive start-ups.

"I don't see another Solyndra being done," said Anup Jacob, whose [private equity](#) firm, Virgin Green Fund, has invested significantly in Solyndra.

In the third quarter of 2010, venture capital investment in solar companies [plummeted to \\$144 million](#) from \$451 million in the year-ago quarter, according to the Cleantech Group, a San Francisco research firm.

****[www.ampulse.com Ampulse Corporation]****

Littleton, CO 80127

****[<http://gigaom.com/cleantech/intersolar-thin-film-solar-startups-race-to-build-plants-despite-recession/> Intersolar: Thin-Film Solar Startups Race to Build Plants, Despite Recession]****

earth2tech

Jennifer Kho

July 17, 2009

Several thin-film startups, such as [PrimeStar Solar](#) and [www.appliedquantumtechnologies.com/ Applied Quantum Technology], are building solar factories.

PrimeStar Solar, which is developing cadmium-telluride films, is building its first commercial factory in San Francisco and plans to have it up and running by the fourth quarter of this year, CEO Brian Murphy said at the Intersolar North America conference Thursday. The company, which was founded in 2007 and is [http://www.primestarsolar.com/solar-energy-news/_pdf/2008-06

[11% 20GE% 20Becomes% 20Majority% 20Shareholder% 20in% 20Emerging% 20Solar% 20% 20Technology% 20...pdf backed by GE](#)], opened a pilot plant in October of last year. That plant has been making full-sized panels (about 2×4 feet) in small quantities and testing them in the field. Now, the company is building a high-volume, automated factory, Murphy said.

PrimeStar's technology was [http://www.pv-tech.org/chip_shots/_a/chasing_first_solar_primestars_seymour_shares_more_info_about_cdte_upstart/

[initially developed](#)] by the [<http://www.nrel.gov/solar/> National Renewable Energy Laboratory], which said it had achieved [<http://www.nrel.gov/news/press/2007/500.html> [a world record efficiency](#)] of 16.5 percent in the lab. Murphy said the company achieved "double-digit" efficiency with mini-modules last year.

PrimeStar plans to sell its modules to utilities for large-scale solar projects, where it sees the biggest opportunity for cadmium-telluride films.

Santa Clara, Calif.-based Applied Quantum Technology, which is developing technology to reduce manufacturing costs for cells based on copper-indium-gallium-diselenide, is building a 15-megawatt pilot factory. The company, which is using a technology to make solar cells called reactive sputtering, expects to begin selling in 2011. Applied Quantum also has achieved double-digit efficiencies, validated by the National Renewable Energy Laboratory, and ultimately hopes to design factories that can be modular, “bolt-on” attachments to glass plants around the world.

Another CIGS company, SoloPower, also [last week announced](#) it hopes to get a government loan guarantee to build a commercial factory next year. Alain Harrus, a partner with [Crosslink Capital](#), an investor in SoloPower, told us it’s important to work toward mass production now, even though the market isn’t ready yet: “We don’t want to miss the market window.”

End of Article

[<http://www.green-wifi.org/index.html> Green WiFi]

A number of entities focus on addressing the digital divide by providing internet access to developing areas. [Green WiFi](#) has developed a low cost, solar-powered, standardized WiFi access solution that runs out-of-the-box with no systems integration or power requirements. All that is required is a single source of broadband access. Green WiFi nodes can be deployed on rooftops to form a self-healing network that hops the source signal over a virtual 802.11b/g grid. These nodes require no fixed installation or power tie-ins, these nodes can form an unplanned, mobile grid that can grow or be relocated as needed.

<http://www.blog.thesietch.org/2007/03/27/early-morning-solar-gadget-solar-wifi/>

XO Dock Project

Green WiFi has been advising a team of 5 students from the [<http://www.sjsu.edu/lucasschool/> [San Jose State University](#)] business graduate program for engineers on an OLPC XO docking and charging station for Haitian Schools. The goal of the XO Dock project is to provide an affordable, reliable, and safe docking system solution to meet the needs of educational institutions in developing countries.

[The 21st NREL Industry Growth Forum](#)

http://www.nrel.gov/technologytransfer/igf21_presentations.html
Denver, Colorado October 28-30, 2008

[Ampulse](#)

<http://www.ampulse.com/>

Golden, Colorado

Ampulse is developing a next-generation Film-Silicon Photovoltaic cell technology, blending the high conversion efficiencies of present-day crystalline silicon photovoltaics with the attractive manufacturing costs and application flexibilities of the emerging thin-film PV (TF-PV). The technology was pioneered at NREL and ORNL; the company was founded in 2007 and received its seed capital from Battelle Ventures and Innovation Valley Partners, and is a recipient of Technology Commercialization Funding from the Energy Efficiency and Renewable Energy Agency (EERE) of the U.S. Department of Energy. Through its CRADA and WFO partnerships with NREL and ORNL, and leveraging their extensive research efforts, Ampulse has exclusive

rights to a comprehensive IP portfolio of more than 60 patents covering its unique silicon deposition techniques and substrates, a portfolio which extends to the major international solar markets in Europe and Asia.

Deeya Energy, Inc.

www.deeyaenergy.com

Fremont, CA

Deeya Energy, Inc. is a cleantech company dedicated to developing and manufacturing electrical energy storage systems. Deeya Energy is backed by leading Silicon Valley venture firms including NEA, BlueRun, DFJ, and Element Partners. Deeya Energy's management team is comprised of veterans from the fields of industrial power, energy storage, telecommunications, semiconductors, and chemical industries.

Deeya Energy's patented innovation, the L-Cell, is based on a novel battery technology originally developed by NASA in the early 1970s. The L-Cell technology is the heart of the ESP product family. This technology offers very large storage capacity, superfast charging, and is capable of operating in rugged outdoor environment with temperature ranges from -5°C to 50°C. Deeya's ESP is a powerful complement to wind, solar, biomass, and other renewable energy generation platforms. By cost effectively storing Grid or Electricity Board power, wind, solar, and other renewable power, the ESP significantly reduces diesel generator usage thereby lowering greenhouse gas emissions.

ElectronVault, Inc.

www.electronvault.com

Woodside, CA

ElectronVault, Inc. is ideally positioned to capitalize on the \$52.6 billion global energy storage industry by reimagining the energy storage system as a durable good with an appealing total cost of ownership. The company has developed industry-leading, proprietary storage systems, which are more efficient than current battery-based energy storage technologies. ElectronVault's products leverage any existing battery chemistry to lower the cost of acquisition in a broad range of energy storage systems used for a wide range of applications. Coupled with a highly granular maintainability—down to the individual battery cell level—

MegaWatt Storage Farms™, Inc.

www.megawattsf.com

Woodside, CA

MegaWatt Storage Farms, Inc. is a privately held corporation formed in 2007. MegaWatt will develop and operate electricity storage facilities across the United States at strategic locations, connecting dir

ectly to the high voltage grid. The deregulation of power markets and the availability of megawatt sized batteries are key enablers. We use a proven battery technology that has more than 12 years of operational experience and has an installed base of more than 100 sites and 260MW. MegaWatt's revenues will come from long-term contracts for storage services with major utilities, allowing project financing to be used for rapid expansion.

MicroLink Devices, Inc.

www.mldevices.com

Niles, IL

MicroLink Devices, Inc. is an ISO 9001 certified semiconductor manufacturer and is developing a range of high-efficiency solar cell products for use in solar concentrators. MicroLink was established in 2000 by Noren Pan, the current president and CEO, to manufacture semiconductor materials used in transistor amplifiers for wireless devices. Over the last two years, the intellectual and physical capital used for transistor material manufacture has been successfully applied to solar cells. MicroLink has developed a process for making high-efficiency solar cells at a significantly reduced cost. This process is performed at MicroLink's 30,000 square foot facility in Niles, IL. The company has applied for several patents in the field of solar cell structure and fabrication. MicroLink is owned by a small group of private investors.

Optony, Inc.

www.optony.com

Optony, Inc. is pioneering the commercialization of TFC solar technology for the commercial solar market. Privately held and formed in 2007 in Silicon Valley, Optony's TFC solar products combine thin film and concentrator photovoltaics to deliver two key requirements for the widespread adoption of solar technology on commercial rooftops: high efficiency and low cost. The company has received support from angel investors and the Department of Energy, and additionally is in a cooperative research and development agreement (CRADA) with the National Renewable Energy Laboratory (NREL). Optony has already demonstrated high performance prototypes which it continues to refine in preparation for commercialization.

Photon Synergy, LLC

www.photonsynergy.com

Henderson, NV

Photon Synergy, LLC (PS) is a privately held company formed in 2007 by Dr. Xiaoming He. PS is developing its patent-pending breakthrough nano solar technology, which has demonstrated solar device energy conversion efficiency greater than 45% (in its spectral responsive region) in two independent solar testing laboratories. The company expects to lead the next generation photovoltaic (PV) commercialization based on this technology because of the significant cost reductions associated with such dramatically higher efficiencies. PS has been utilizing its proprietary supporting network for early-stage development and is now in the process of seeking strategic partnerships to accelerate progress. The sample of the proof-of-concept is available for demonstration in sunlight or any established solar testing laboratories.

Solar Red, Inc.

<http://red-solar.com/>

Foster City, CA

Solar Red, Inc. (SR) is a privately held start-up company that was formed in 2008. SR is focused on reducing residential photovoltaic (PV) installation costs. Installation represents almost half of the cost of a residential PV system today. SR has developed a system that cuts the cost of residential PV installation in half. SR's smart wiring and mounting system is installed by roofers during roof installation. SR's system fits in with existing roofing materials and procedures,

adding almost no cost to the installation of a roof. Once SR's wiring and mounting system is installed, SR's solar panels snap into place in 30 seconds apiece.