Workshop Announcement

Mobile Off-Grid Solar CPV Electrical Power and Water Purification Systems

Saturday, November 12, 2011 -- 10am-5pm
Sunday, November 13, 2011 – 10am-3pm

Presidio Graduate School
36 Lincoln Blvd at Graham Street
The Presidio, San Francisco, CA 94129

Co-chairs: Dwight Collins (Presidio Graduate School) dcollins@presidioedu.org
Russ Genet (California Polytechnic State University) russmgenet@aol.com
Kiran Shah (Chroma Energy Pvt.,Ltd., India) kirny@chromaenergy.in
Workshop Coordinator: Cheryl Genet (Collins Educational Foundation) cherylgenet@msn.com

Agenda

Saturday, November 12th Talks and Discussions

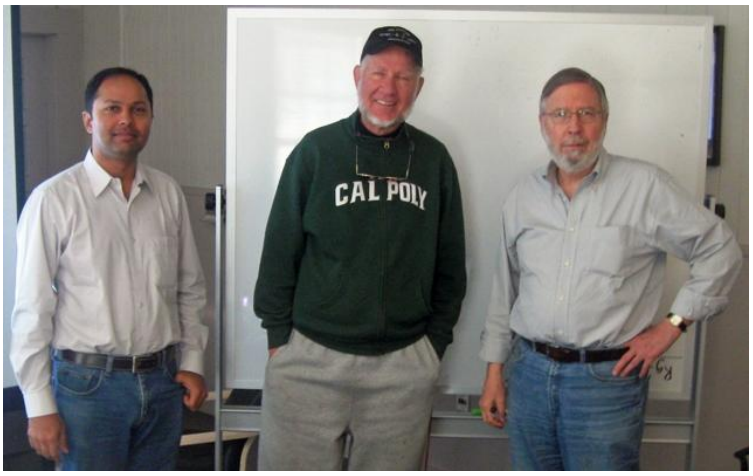
10:00 - 11:00	Welcome and Overviews	
	Presidio Graduate School Welcome	Dwight Collins
	Attendee Introductions	All
	Overview & Workshop Objectives	Russ Genet/Dwight Collins
	Solar Power	Kiran Shah
	Structural Analysis	Abe Lynn
	Lightbucket Telescopes	Laura Rice
11:00 - 11:30	Break	
11:30 - 1:00	Background Tutorials	
	CPV Basics (20 min)	Kiran Shah
	CPV Optical considerations (10 min)	Herb Hayden
	Water Purification Basics (20 min)	Tom Joseph
	Flat Panel Mobile Systems (10 min)	Travis Semmes
	Small Business Considerations (15 min)	Dave Genet
	Development & Commercialization (15 min)	Dariush Rafinejad
1:00 - 2:00	Lunch (Compliments the Collins Educational Foundation)	
2:00 - 3:00	Working session: Rapid Prototype Design	Kiran lead
3:00 - 3:30	Working session: Project Planning	Russ lead
3:30 - 4:00	Break	
4:00 - 4:30	Working session: Sustainability/Business	Dwight Collins lead
4:30 - 5:00	Wrap-up	

Sunday, November 13th Strawman Design Session

10:00 - 11:00	Discuss Requirements
11:00 - 12:00	Rough Out Major Parameters
12:00 – 1:00	Lunch Break
1:00 - 2:00	Develop Quantitative Spreadsheet
2:00 - 3:00	Discuss and Record Economic and Production Considerations

The workshop was co-chaired, left to right below, by Kiran Shah, Russ Genet, and Dwight Collins. Kiran, a mechanical engineer, came all the way from India where his company, Chroma Energy, is developing a tracking megawatt low cost concentrated solar power system that uses Fresnel lenses to concentrate the solar power. Kiran is also keenly interested in mobile solar power systems that use mirrors as the sunlight concentrator and triple junction solar cells to produce electricity. The waste heat could be used to purify water in a membrane distillation system. Russ, an astronomer, has a special interest in “light bucket” telescopes. These are non-imaging, light-concentrating telescopes with very low quality optics used for high speed photometry, spectroscopy, and other applications. The similarity of these low cost, large portable telescopes to mobile solar power systems led to an interest in the latter. Dwight, an operations research analyst, is an instructor at the Presidio Graduate School and President of the Collins Educational Foundation, which

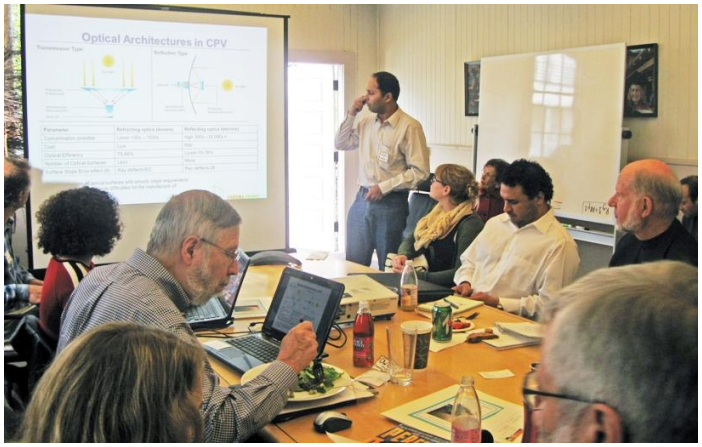
sponsored the workshop. Dwight has a keen interest in helping make human existence on our planet more sustainable.



The workshop was well attended with about two dozen conferees from the Presidio Graduate School, California Polytechnic State University, Stanford University, the University of California, Berkeley, and industry.

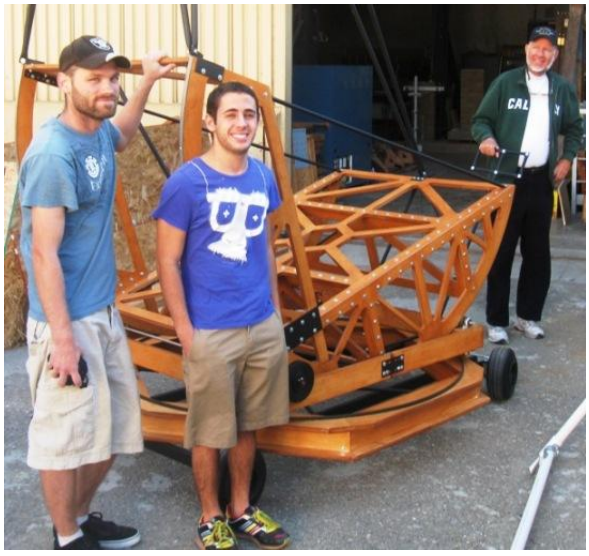
Students were well represented, with students from the Presido, Stanford, and Cal Poly.

We were very pleased to hear two talks from Kiran, one an overview of solar power, and the other on the basics of concentrated photovoltaic systems. The efficiency of triple junction solar cells is currently approaching 50% and may go much higher. Only a few cells are required, as they can run at very high power levels. Thus while they are more expensive per cell, if the mirror concentrator can be very low in cost, then the overall system cost can be reduced as compared to flat panel systems. For both mobile CPV power systems and light bucket telescopes, the key is low cost, lightweight, and environmentally rugged mirrors.



Cal Poly student Laura Rice (left) and Abe Lynn (one of her instructors), described the structural design of the world's largest portable telescope. Laura and her team at Cal Poly (Mounir El Koussa and Mike Vickers), used the engineering techniques they had learned to design skyscrapers to design this very stiff yet low cost structure.

The bulk of the structure was automatically CNC milled from sheets of high quality plywood, although in production aluminum sheet would be used. Mike (left) and Mounir are shown standing beside the structure at the engineering "high bay" at Cal Poly, with Russ, he project mentor on the right.



The mirror for this lightweight, low cost telescope has been made by Display and Optical Technologies Inc. (DOTI). Mike Itz, DOTI President gave a call-in talk that described the process they use to slump ordinary soda-lime plate glass into telescope mirrors. For telescopes, the plate glass is ground and polished on the top side, and then coated with aluminum in a vacuum chamber and overcoated with a clear layer of silicon oxide. For solar power mirrors, the same slumping process would be used, but the back side of the mirror would be silvered and sealed and no grinding or polishing would be required. Shown below is a "squarish" 2.4 meter mirror prior to having its back side silvered and overcoated.

Another approach to low cost mirrors has been pioneered by Lisa Brodhacker, an Organic Chemist at Lander University, and her students. One way to avoid expensive grinding, figuring, and polishing is to spin a liquid material in a container at a constant speed. The material will naturally assume a parabolic shape. If the material is an epoxy, it will harden while spinning and a mirror of the correct optical shape will have been formed without the expense of optical figuring. Of course the devil is in the details.

Chemist Lisa Brodhacker (Lander University) and her students and associates are able to produce very lightweight, low cost, large-aperture mirrors at a very small fraction of the cost of ground and polished glass parabolic mirrors.

Lisa Brodhacker and one of her undergraduate student researchers hold a 25 inch spin-cast epoxy mirror (above). The oven for spinning 2-meter mirrors is in the background. A platter is supported by a very stiff air bearing. Oven panels with heating elements keep the epoxy at an elevated temperature while it sets to reduce shrinkage.

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A low cost alternative to the mirrors described above is the use of prime focus (on axis) satellite dishes. Epiphany Solar Water Systems uses 2.4-meter dishes for their solar water distillation systems. The segmented dishes are easy to ship and can assembled on site. Optically reflective plastic inserts

are added to the front surface of the dishes. Although these systems do not also generate electricity, Epiphany envisions this as a future evolution of their systems.

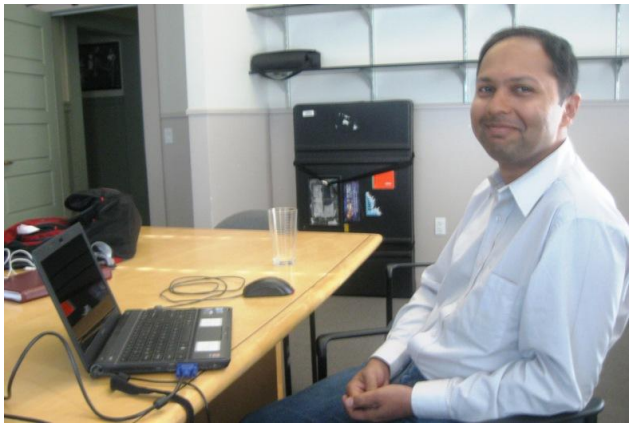
Three of Epiphany Solar Water Systems 2.4-meter satellite dishes that have been converted for use as solar water purification systems. Tom Joseph, President of Epiphany (below) explained how their low cost solar systems could provide clean water to many of he planets needy areas.

Toward the end of the talks, the Presidio Graduate School's Academic Dean, Ed Quiedo, joined the conferees to discuss solar power. Ed, an attorney who has specialized in environmental issues for many years, fits in well with the Presidio's "green MBA" graduate program.

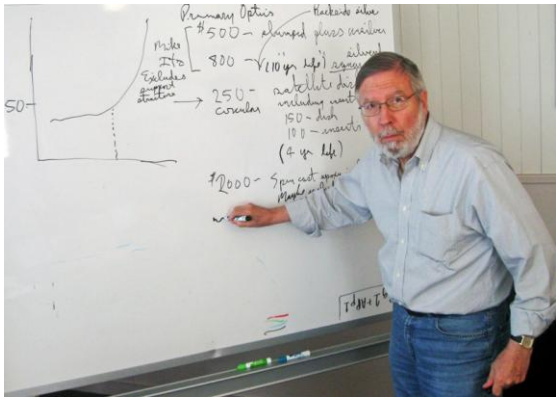
After the talks on Saturday, many of the conferees went to dinner at Capurro's in Ghirardelli Square. Left to right: Cheryl Genet, David Genet, Tom Joseph, Kiran Shaw, Russ Genet, and Dwight Collins.

On Sunday, Kiran, Dwight, Dave, and Russ met to rough out a “strawman” design, including a discussion of production issues and a rough stab at production costs.

Dwight and Dave work on some of the economic issues, using the whiteboard to sketch out ideas. Kiran modified his spreadsheet analysis system and took notes.



After a few hours of discussion, the working group finally came up with a rough production costs of $5,000 for a 2.4 meter diameter mirror system that would produce 1 KW of electricity with hot water (or clean water) as a byproduct.



Dwight, below, wraps up the cost estimate.

A Promising Future

As the price of fuel increases and the cost of triple-junction solar cells decrease, portable CPV solar power units could become increasingly attractive—especially as developments reduce the costs of mirrors and the support/tracking structures. It might be noted that portable CPV units get a developmental "free ride" on the coattails of firms producing CPV triple-junction solar cells in the millions for huge megawatt power plants. For instance, IBM is developing a solar cell that can handle a very high concentration factors. It has the liquid heat exchanger build right into the solar cell itself (Muller).

One of the features being pursued in the development of portable light bucket telescopes is the ability to assemble the telescope from a compact package, much as the mass produced furniture that requires "some assembly." We have purposely designed the structure as a series of planar trusses that lay flat when disassembled for ease of shipment or storage.

If costs are driven low enough, portable CPV solar power units could become very widespread, even seeing use as off grid, fixed-location power units. Ownership of these portable units could be decoupled from property ownership. Units could be rented or leased out by small business entrepreneurs. Governments or NGOs could loan units to off-grid villages for electric power and clean water. Families could purchase units for their own use and take with them when they moved.

It is even conceivable that portable CPV solar power units might become a major source of power for the planet. Not only would they avoid the costs of power distribution systems, but they would also avoid centralized control. Thus two of humanity's most pressing needs—electrical power and clean water—could, in a way, become democratic. Power for the people!