

IEA/SolarPACES Task I Meeting: Solar Thermal Electric Power Systems

September 25, 1994
Moscow, Russia

Meeting Summary

An IEA/SolarPACES Task I Meeting on Solar Thermal Electric Power Systems was held at the Uzkoe Hotel, Moscow, Russia on Saturday, September 25, 1994. The objectives of the meeting were to review the status of ongoing Task I activities and evaluate other activities of task participants as potential future task activities that would expand international cooperation within Task I. Other objectives included input on new sector leads and individual leads for specific activities. A meeting agenda, participants list, and presentation summaries (those submitted by authors) are attached.

Summary of Potential Task I Activities

The following table summarizes potential new Task I areas of cooperation, based on the detailed discussions summarized below. The name or organization listed with each activity is a potential lead. Each will be contacted by the Operating Agent to work out a plan for follow-up.

Parabolic Troughs

- DSG coordination (Ajona)
- Steam system comparisons (Meinecke)
- O&M - KJC consulting support for ST projects (Cohen)

Power Towers

- Solar Two (ongoing, info sharing)
- SOLGAS review (Blanco)
- PHOEBUS renewal (Grasse)
- Commercialization studies (Meinecke, Kolb)
- Aggregated Heliostat purchases (?)
- Heliostat system controls (Haegar)

Dish Systems

- CPG hardware test at PSA (Blezinger)
- CPG economic analyses, O&M evaluation, hybrid dev (Kubo)
- Brayton system development (ongoing) (Gallup, Buck)
- Tenant Creek review (W. Stein)
- Compendium/Evaluation guidelines (W. Stine)
- Russian Caucasus plant (Shadrin)

Detailed Meeting Minutes

Each of the agenda items was presented, with periods of discussion after each technology area to evaluate potential new activities.

Parabolic Trough Systems

In the parabolic trough system area, Gilbert Cohen presented the results of their KJC O&M contract work and later discussed KJC's role in potential future development of new trough systems in the U. S. He emphasized KJC's unmatched experience in SEGS plant operation and thus their position to lead a new trough system commercialization effort. He also discussed potential cooperation with others in the field and offered to make KJC's experience available to other solar thermal system developers on a consulting basis.

Amnon Yogev of WIS presented a brief status of the ongoing Solel efforts in Israel. The Sde Boquer work continues and cooperative discussions are underway between Solel, Flagsol, and CIEMAT. However, despite previous efforts to establish a cooperative effort for this work within Task I, Solel has determined that the Task I forum has not to date provided a fruitful forum for cooperation, primarily because of slow response in the area of intellectual property protection. Although previous efforts to improve this situation have not been successful, Wilfried Grasse of DLR stated that he felt it was now time for Wolf Von Kries and him to reestablish their efforts to develop a legal framework to resolve this situation. Because of the potential for international cooperation in this important area, we should continue to pursue options for making Task I a useful working medium for Solel.

Jose Ajona of CIEMAT discussed the status of trough system development testing in Europe, including ARDISS (advanced trough receiver development), DISS (direct steam generation activities), and STEM (Mediterranean area) activities. All of these activities relate to direct steam generation systems and involve many partners (CIEMAT, DLR, Solel, Siemens, U. Manchester, ZSW, INETI, Conphoebus, a number of utilities, etc.), although they are not coordinated through Task I. The suggestion was made that with so many DSG activities underway, Task I could provide a forum for collection and dissemination of information (if not coordination) for all DSG work by Task I participants. Although the form of this cooperation is not defined as yet, Jose Ajona offered to serve as a focal point for determining the need and practicality of formalizing a Task I activity on DSG coordination.

Finally, in the trough area, Craig Tyner presented material from Byron Washom on the ongoing efforts of Spencer Management to establish a World Bank/GEF supported trough commercialization effort with a first plant in Mexico. Washom's interest in cooperating through IEA/SolarPACES, in particular in the DSG area for future plants, was emphasized.

In the trough summary discussions, Grasse suggested meeting in 6 months to discuss interest in DSG cooperation and offered to begin again working with Von Kries to develop a legal document to satisfy Solel's concerns about working within the IEA/SolarPACES forum. Steven Kaneff of ANU suggested that waste heat use be moved out of Task III into a Task I effort. Finally, Wes Stein of Pacific Power in Australia discussed a number of opportunities in Australia, including a comparison of troughs and large dishes as means of steam generation. Further suggestions helped this idea evolve into a more general comparison of all solar thermal steam generation options. Manfred Becker of DLR later offered that Wolfgang Meinecke of DLR might be able to serve as a lead for this potential Task I activity. Greg Kolb of Sandia has since offered to participate.

Power Tower Systems

In the power tower area, Craig Tyner (in Pat DeLaquil's absence) summarized the on-schedule, on-budget status of the Solar Two project. Technical progress has been good, with the final design nearly complete and construction just beginning. All major hardware has been ordered, with delivery timed for installation throughout early 1995. The plant is scheduled to begin checkout in late summer of 1995. The one remaining uncertainty is meeting final funding levels, as the project is about \$1-2M underfunded at the moment. Although the decision has previously been made that the only foreign funding acceptable to the project would be from users (e.g., utilities), it was suggested that if an offer were made, it probably would be considered on its merits.

Mathias Haeger summarized the status of PHOEBUS. He emphasized the transition to Phase IC, which includes a design without storage and a second blower, but with fossil hybridization (parallel steam production) at the 40% level. This design will offer a lower risk, lower cost step into the marketplace. The plant would use 140m² membrane heliostats of German design and would cost about 190M DM for a 30MW plant. Energy cost would be reduced from 30pf/kWh to 22 pf (1st plant) and 19 pf (2nd plant). Construction could begin in 1998. Possible areas for cooperation within Task I include field control with dynamic aim point modification and cost comparisons within the steam generation cost study.

Manuel Blanco then presented the status of the Spanish SOLGAS project, a cooperative activity lead by SODEAN. The plant would be a combined cycle plant with natural gas firing of the gas turbine and saturated steam from the power tower combined with gas turbine waste heat firing the steam turbine. Waste heat from the steam turbine would be used as process heat by the chemical plant. (Except for the cogeneration/waste heat recovery, this plant looks much like the trough plant proposed by Washom.) SOLGAS would use only proven (conservative) technology; solar would provide 29% of the total thermal input. The EU ("APAS") has been asked to provide 412k ECU support to the next phase of the project. The objective is to break ground and build the first commercial

plant. Blanco expressed strong interest in securing Task I support for an international effort to review SOLGAS progress and to help assure a successful project.

Next, Amnon Yogev of WIS summarized the status of the Dead Sea Works (DSW) project in Israel. DSW now burns low grade oil, and, although public pressure is mounting to change, the costs are low and competition is difficult. Steam generation is thus not competitive and plans now center around competing with electricity by melting salt directly at about 700-800C. WIS is responsible for the solar and field design, which will include a dichroic secondary reflector atop the tower to direct the lower energy part of the solar spectrum to the ground to power a ground-level salt melter directly. Higher energy light passing through the dichroic mirror will be concentrated on PV cells atop the tower. Emphasis is on "maximum concentration." Public support is being pursued to help make the project cost-competitive.

Finally, Pat DeLaquil summarized the status of the so-called "Solar Enterprise Zone" in the U. S. SEZ will provide an environment supportive of solar thermal and PV development in Nevada and surrounding regions in the U. S. southwest. Plans are for about 1000MW of solar technology to be deployed for utility power applications. Although by no means a certainty, the project would offer a means of building plants required to begin reaping the benefits of economies of scale and really launching solar thermal technology. While direct subsidies are not likely, low cost financing, marketing support (perhaps through the agencies marketing hydropower the western U. S.), and facilitation of environmental hurdles and tax issues could offer solar the jump-start it needs. It clearly could be a location for early trough, power tower and dish/Stirling systems.

In the summary session, Blanco emphasized the international review of SOLGAS status; Grasse stressed the fact that PHOEBUS has all along been open to international participation, and he will pursue the willingness of partners to cooperate internationally; Haeger felt that heliostats could be a topic of international cooperation, including advanced control issues and aggregation of heliostat buys; the pending Israeli heliostat purchase for DSW was considered to have significant potential for cooperation; and a set of commercialization studies (marketing, financing, measures of comparison with other technologies) affecting all technologies was proposed.

Dish/Stirling

Heinz Blesinger (DLR/PSA) presented the status of the Schlaich Bergerman und Partner system testing at the PSA. Typical operating temperature is 740C; availability has been 67%; peak efficiency has been 19.5%, while daily efficiency has been 16%. Over 15000 operational hours have been logged on these systems. Options for future collaboration include comparative testing of a Cummins system at the PSA and a European marketing effort for dish systems.

Rocky Kubo of Cummins presented the status of CPG's system development efforts. The new Clever Fellows opposed engine is nearing solar test, and receiver systems have logged up to 2000 hours. Design level systems will be fielded in the next 2 or 3 months, and Phase 2 of the Joint Venture Program will be completed by year's end. Kubo indicated there were several areas where Cummins would welcome international cooperation in this area: economic analyses; O&M cost issues; joint hardware evaluation at PSA; and hybrid systems development.

Although Kelly Beninga of SAIC had prepared to discuss SAIC's Joint Venture Program for 25kW systems, he sustained an injury in route to Moscow and could not attend. Tom Mancini gave a very brief summary of SAIC's progress, including discussion of their dish and engine options.

Because of time limitations, there was limited discussion of the ongoing dish/Brayton cooperative program being undertaken by NREC, Sandia, and DLR. Progress continues to be made, however, with both the DLR VOBREC-4 receiver and the NREC engine. Hardware is being fabricated and testing is scheduled to begin at Sandia in early 1995.

Finally, Bill Stine of Cal Poly University summarized the status of his dish/Stirling compendium and his plans to develop design and evaluation guidelines for systems. He also expects to include information on Brayton-based systems in the update.

Potential Areas of Australian Cooperation

As a new member, time was allotted to Australia to summarize their programs and suggest areas for future cooperation. Wes Stein of Pacific Power and Steven Kaneff of ANU provided the summary. Stein stated that most of Australia's 35GW of capacity was from relatively inexpensive coal at about 3.5c/kWh, and thus likely to remain very tough competition for renewables in the foreseeable future. Nonetheless, a number of development and demonstration projects are underway.

The University of Sydney has a small trough system under investigation, while a 25kW system of 5m dishes has been under test at White Cliffs, NSW, for years. Some selective coating development and licensing is also underway, which could perhaps impact future trough development. The major activity, however, is the development and testing of a 400m² dish by ANU and their utility partners. A single dish is in operation at ANU and testing is underway.

A multi-dish system demonstration of this dish (steam generation for a central engine) is in the planning stages for the Tenant Creek region of northern Australia. The location is remote, with good solar insolation (2600 kWh/m²/yr). A feasibility study of the concept is scheduled to be completed by year's end. Stein request Task I support in reviewing and commenting on the proposed plan, including its economics. The 4MW power station is expected to cost \$16M (\$4000/kW vs. \$5500 for the first SEGS plant). A working system is the first priority, with refinements to come later. Kaneff discussed additional

details of the dish development and testing, including the use of standard building technology; 120-140 kph wind survival; and 50 kph wind operating limits.

The Tenant Creek review and participation in the solar steam generation cost study (bringing in the dish technology) seem obvious candidates for Task I cooperation.

Potential Areas of Russian and FSU Cooperation

Also a new IEA/SolarPACES member, Russia (with additional input from other former Soviet Union countries) discussed its ongoing activities and potential areas of cooperation.

Potential areas of cooperation identified at the meeting (and over the next few days) include:

- Development of a solar power plant based on a gas turbine from space applications (Koshelyev Institute for Thermal Processes, Moscow)
- The proposed solar plant in Kislovodsk (north Caucasus), a 1.5 MW PV and dish/Stirling plant (Shadrin SDA "Astrophysica", Moscow)
- Advanced technology for improving DSG process (Malysenko IVTAN, Moscow)
- Electrotechnical problem of solar power plants (Pavlovsky Institute of Direct Current, St. Petersburg)
- Dish/Stirling activities (Institute of Nuclear Energy, Obninsk)
- Dish/Stirling and solar hybrid plants (Physical and Energy Institute, Obninsk)

Action Items

Grasse	Work w/ von Kries to prepare legal input to Solel for addressing intellectual property issues preventing Task I cooperation
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IEA/SolarPACES Task I Meeting

Solar Thermal Electric Power Systems

Saturday, September 24, 1994

9:00 a.m.

Hotel Uzko

Moscow, Russia

Agenda (Post-Meeting Update)

Introduction and Objectives	Tyner (Sandia)	9:00
Trough System Status Reports		9:15
KJC/Sandia O&M Cost Reduction Study update	Cohen (KJC)	
Israeli trough development	Yogev (WIS)	
European trough development status (ARDISS, etc.)	Ajona (CIEMAT)	
U. S. trough development status	Cohen (KJC)/Tyner (for Washom)	
Discussion / Potential New Activities	All	
----- Break -----		
Power Tower System Status Reports		10:45
Solar Two update	Tyner for DeLaquil (Bechtel)	
PHOEBUS update	Haeger (DLR)	
Spanish power tower project (SOLGAS)	Blanco, Martín (SODEAN)	
Israeli power tower project	Yogev (WIS)	
U. S. Solar Enterprise Zone status	DeLaquil for Tyner (Sandia)	
Discussion / Potential New Activities	All	
----- Lunch -----		
Dish/Engine System Status Reports		13:30
SBP/Almeria systems update	Blezinger, DLR/PSA	
Cummins dish/Stirling joint venture update	Kubo (Cummins)	
SAIC dish/Stirling joint venture update	Beninga (SAIC)	
Dish/Brayton demonstration status	Buck (DLR), Karni (WIS), Tyner (Sandia)	
Dish/Stirling compendium/design and performance guidelines status	Tyner for Stine (Cal Poly)	
Discussion / Potential New Activities	All	
----- Break -----		
Potential Australian areas of cooperation	W. Stein (Pacific Pwr)	15:15
Potential Russian areas of cooperation	Shpilrain (IVTAN)	16:00
Discussion of Sector Leader roles and strategic planning needs	All	16:45
Action items, other	All	17:15
Adjourn		17:30