

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

9 October 1995  
DLR-Stuttgart, Stuttgart, Germany

## Meeting Summary

The primary topics for this meeting were detailed updates on most Sector 1 and 2 activities, with in addition an introduction of new topics of hybrid systems analysis, environmental issues, and World Bank Support.

## Detailed Meeting Minutes

The Task I meeting was chaired by Craig Tyner, as Operating Agent for Task I. After agreement on minor changes to the proposed meeting agenda (attached, as corrected), reports of ongoing Task I activities were presented.

### Sector 2. Distributed Generation Systems

US-Led Activities, Craig Tyner, SunLab. Tom Mancini, Sandia and Sector leader for Sector I.2, did not attend the meeting, and Tyner substituted for him. As a number of Sector 2 activities are US-led, Tyner presented status reports on the NREC/DLR Brayton project, the dish/Stirling compendium update by Bill Stine, and U. S. dish/Stirling JVPs, and also gave a brief description of SunLab. The DLR receiver for the Brayton system has been completed and was available for inspection during the meeting. It is a significantly more robust design than older receivers (ala CAESAR). The absorber is SiC, with extremely uniform web size and 90+% porosity. The receiver will be shipped within a few days for mating with NREC's engine and natural gas testing during November. The combined unit will be shipped to Sandia for TBC testing in December. Finally, opportunities for joint testing of a CPG system at PSA were discussed.

Tennant Creek and other Australian Activities, Wolfgang Meike, PAWA. Meike represented both the Australian Solar Thermal Working Group (pushing Australian technology and perhaps to be incorporated as Solar Thermal, Ltd.) and PAWA (with interest in other (e.g., foreign) technology). The two main Australian activities are the Scale-up Study (of how to get from a small system (Tennant Creek) to commercial systems) and Tennant Creek (TC) itself (whose implementation will depend on success of the scale-up study).

TC has 5000 population and a large copper mine. The project would include a 4MW system, with up to 2MW provided from ANU-dish-produced steam. 28 dishes (400m<sup>2</sup> each) would be required. Gas availability at the TC site can produce power at 12-16c/kWh; availability of new gas resources from Timor Gap (off-shore to the north)

would increase availability and reduce costs at TC. A follow-on would be a 20-40MW plant, probably in Queensland or NSW, while TC could eventually be converted to a test site.

The ANU dish has been operating with full automatic control capabilities since July, although essentially no data is yet available. The utility consortium (Pacific Power, Queensland Electric, PAWA) is taking control of the test program from ANUTech because of the slow progress to date. (Note that the utilities have recently been split into generation, transmission, and distribution companies (PAWA not yet complete). One issue with the dish - birds burrowing into the foam - has been a problem.

The scale-up study is nearing completion, and is required before proceeding to TC. The study still needs real data from the dish testing, and is still investigating boiler/steam turbine options, potential dish improvements, possible options to glass, and cleaning options. International support is not needed until the study is completed and test data is available.

SBP Dish/Stirling Systems, Wolfgang Schiel, Schlaich Bergerman und Partner. The three SBP systems at the PSA continue to operate 5 days/week (limited for personnel reasons), and they are still enlarging the data base of reliability and evaluating technical issues. There have been 19,300 total accumulated hours logged through August. A new receiver is being designed to eliminate fatigue failures. All tubes will be of equal length (equal flow) and designed to allow free expansion and reduced thermal stresses. The overall project is nearly finished, to be funded to the end of 1996.

A major new project will include 3 new systems incorporating new knowledge from the testing. The design is underway, and procurement has started. Cooperation with Steinmuller (new heliostat, 150m<sup>2</sup>, 14m diameter, turntable design - good beam quality and performance) will form the basis for the new dish, to utilize a similar design to allow benefit to each other. The turntable and other design features will be used in the new 8.5m diameter dish. The dish will be enlarged to allow full power operation over a larger range of times, with a 1.3 solar multiple, i.e., full power at 750W/m<sup>2</sup>. Somehow, it must survive at 1000W/m<sup>2</sup>. The dish manufacturing process is different, with the drum made on site. A new heat pipe receiver with hybridization is being developed by DLR and will be ready for test next year. It will allow solar/gas in combination; a prototype is in fabrication, with testing to begin in May 96.

The Stirling engine has been redesigned (from the SPS technology previously bought and conveyed to Solo); the new design will be from scratch, and both the solar and cogen units built entirely from German parts. Six engines will be built this year, followed by 14 next year for field test. Three are under test at this time, with 10 kW electric power and cost cut by half. Cost projections have been done. This new V-161, with power up from the V-160F (especially for part load), has an MTBF of 5000hr. The next step is to demonstrate cost-reduction technology and warranty issues, then to demonstrate to the public, perhaps via 3 demo plants - 100 units (date not yet set). The cost for the engine is

the largest part of the system (at 100's of units/year), thus the concentrator design doesn't drive the system. Expected cost of the system is down from 30kDM/kW to 30kDM (total) at 100 engines/yr; 20kDM at 1000 engines/year. Engine costs are driven by assembly and checkout labor. Market analyses show that cogen versions of the engines could enter the market today if they were cost effective, and 30kDM is deemed a cost effective engine. At the other extreme, 3kW is an ideal system for cogen (home) applications - millions of units, but there is no technology available today.

On a related note regarding applications, Wolfgang Meike described 40-50MW of remote generation with cost of \$0.30-1.20/kWh in Australia's Northwest Territories alone.

## **Sector 1. Central Generation Systems**

Sector 1 activities were chaired by Sector Head Michael Geyer, DLR/PSA.

O&M Cost Reduction, Gilbert Cohen, KJC. Gilbert discussed the status of KJC's cost-shared project between Sandia and KJC. Target for the activity was 30% cost-reduction - KJC is now near target but not quite there as yet. They have worked on over 50 tasks related to performance enhancement or O&M cost reduction; their focus has been on improving performance, upgrading control systems, increasing efficiency and life of the field, and improving effectiveness of the power block/solar field interface. Examples of improvements are the ball joints (vs. flex hoses) (pressure drop halved and catastrophic failures eliminated; costs lowered); replacement split glass covers; field status reporting system used to track broken facets, HCEs, etc.; centralized weather station; and total cost-savings analysis to date. 1995 data show a significant decrease in the amount of gas required to meet peaking requirements relative to 1993 and 1994. New replacement parts from Solel (HCEs) and Flagsol (mirrors) are now being installed to reduce lost energy. Estimated improvement in revenue on 9 key tasks will be at least \$50M (npv). Estimated improvements in O&M costs projected for future plants are 30% (troughs), 20% (towers), and 15% (dish/Stirling). Michael Geyer presented some studies about staffing in 3rd world countries, where number of staff may be very high, but costs low. We could then perhaps use solar to offset pollution technology on some fossil plants. We need also to recalculate capital costs based on local labor to fully minimize costs.

Steam System Comparison, Wolfgang Meinecke, DLR. Wolfgang discussed the early status of the study. Initial activities include the ANU dish studies (boundary conditions and explanatory materials transmitted, SOLERGY analyses underway, and project description transmitted to DLR); coordination activities and planning; discussion of PAWA analyses. Next activities will include continued analysis of the ANU systems; begin discussion on DSG systems on STEM and DISS; and initial discussions on tower systems. Geyer suggested that we use the new IEA standard LEC analyses methods, although this might be slightly different than the second generation studies basis being considered.

SOLGAS project, Michael Geyer for SODEAN. SODEAN (Manuel Blanco) was not represented. The European Union's (EU) DG17 is now requesting proposals for solar/fossil type of projects (like SOLGAS) from systems suppliers and utilities, which could signal a new program on these types of plants. Feasibility studies (funded by European Commission) remain on schedule, and participation will continue. There may be a call for proposals for a different plant (still called SOLGAS) with a different application (large combined cycle rather than a cogen plant).

Solar Two, Craig Tyner, SunLab. Tyner presented the current status of Solar Two. He also presented a detailed paper on Solar Two construction at the VDI conference. Despite the lack of joint cooperation (information exchange only), some possibilities apparently still exist for cooperation on the European equivalent, DISS.

PHOEBUS, Michael Geyer, for the consortium. There has been no recent activity on PHOEBUS, other than the Steinmuller heliostat and some additional TSA/heliostat controls strategy work. TSA is still operational for this purpose. The project was discussed at the VDI conference.

DISS Activities, Michael Geyer, DLR/PSA. Approval from the EU for Phase I, first row of troughs (2M ECU), has been officially received, and contracts are being finalized. Endesa's share of funding is secure, as well as some other partners' funding, including Siemens, Flachglas, and some Spanish participation. PSA has also purchased one-half of an LS3 collector for improvement of existing oil technology, to be available by early next spring. Improvements are in optics and receiver (through ARDISS - more even and tighter flux distribution).

### **New Business**

Optimal integration of fossil and solar, Michael Geyer, DLR/PSA. 2GW of new gas is being brought from Morocco to Spain. This gas can be tapped in Morocco for use with solar as Morocco triples its use in the near future. Also a new 600MW AC line across Gibraltar is being installed (to be upgraded to 2GW DC). Southern Med power needs will double by 2005. Potential is 3.5GW (with a 4% potential market share for solar) by 2005; 20GW (20% potential solar market share) by 2025. David Thatcher (British Gas) stated that world-wide demand will be up 40% by 2025, the equivalent of one new 1500MW plant per week. Egypt, Italy, Tunisia, and Turkey are all operating regions for British Gas. We need to look at the global potential of solar from a global perspective. We (the solar community) also need an analysis of what would or does attract British Gas into a new technology like this (e.g., how to make them think like an energy company, not just a gas company). The first step would seem to be showing them the synergies and how the two fuels can be used together. I think there are some opportunities in bringing BG skills to work on solar/gas hybrid systems (perhaps partload cycle efficiency analyses).

Development of tools for determining optimum use of hybridization could be a new task activity, benefiting from the work on Task III that has gone on over the last two years.

Hennecke suggested moving that work from III to I at this time to consolidate all the efforts into a systems view. Perhaps a conference focused on this topic could be held after a range of preliminary options are reviewed. Possible participants would be SNL, DLR, and the Spanish. Geyer suggested we could look to raise funds from EC, WB, etc., or go with a task shared route. Note that next meeting should focus on this topic rather than a complete set of status reports. See also note below regarding coordinating with Hennecke re Task III activities.

World Bank Status, M. Geyer, PSA, and C. Tyner, SunLab. Tyner described Greg Kolb's activities in India, his work to bring tools to the World Bank's Solar Initiative, the U. S. dish/Stirling briefing for the Bank and the Bank's request for large-scale ST briefing and consulting support, and the Mexico project. Geyer described the Seville meeting and proposed Solar Thermal descriptions and the use of WB "environmental manual" on a project for KFW that would standardize analyses of how life-cycle environmental benefits are taken advantage of and analyzed.

Environmental Issues, Michael Geyer, DLR/PSA. Because of the many new items already brought to the table at this meeting, the issue of how to accelerate the acceptance of environmental issues in reducing effective costs of solar was put off.

Based on all of the above and some additional input, potential Task I additions include an Australian market study; SWAT teams; hybrid systems analysis; DISS participation; and financial/political engineering (Kesselring).

### **Action Items Summary (all designated 9510-#)**

1. Tyner and Geyer - Get written communications to WB in conjunction with Kolb's meeting in early November.
2. Tyner - Put environmental issues on agenda for next meeting.

# IEA/SolarPACES Task I: Electric Power Systems

## Task I Meeting

DLR - Stuttgart, Pfaffenwaldring 38-40  
Gebäude (Building) A, Großer Hörsaal (Large Auditorium)  
Stuttgart, Germany  
8:30 am, Monday, October 9, 1995

### Agenda (Post-Meeting Update)

#### Sector I.2: Distributed Generation Systems

Tyner for Mancini

8:30 am Brief Status Updates

Cooperative I.2.A Dish/Brayton System

Tyner for Gallup

I.2.D Dish/Engine Compendium Update

Tyner for Stine

Comparative Dish/Stirling Test and Evaluation

(not covered)

Tennant Creek Evaluation Project (& other Australian activities)

Meike (PAWA)

Kislovodskya SPS Review

Tyner for Mancini

Information I.2.B Dish/Stirling Joint Venture Program

Tyner for Diver

I.2.C Utility-Scale Joint Venture Program

Tyner for  
Mancini, Gallup

Status of SBP Dish/Stirling Activities

Schiel

New Sector 2 Business

None

#### Sector I.1: Central Generation Systems

Geyer

1:00 pm Brief Status Updates

Cooperative I.1.A O&M Cost Reduction

Cohen

Steam System Comparisons

Meinecke

SOLGAS Project Review

Geyer for Blanco

Information I.1.B Solar Two

Tyner

I.1.C PHOEBUS/TSA

Geyer for Grasse

DISS Activities

Geyer

Status of Israeli Power Tower Activities

WIS, hardcopy only

New Sector 1 Business

World Bank/GEF Update

Tyner, Geyer

Optimum Integration of Solar into Fossil Systems

Geyer

Standards/Understanding of Environmental Benefits

(delayed)

Feasibility Study Supporting Egypt

(not covered)

Adjourn

