Trough Solar Field

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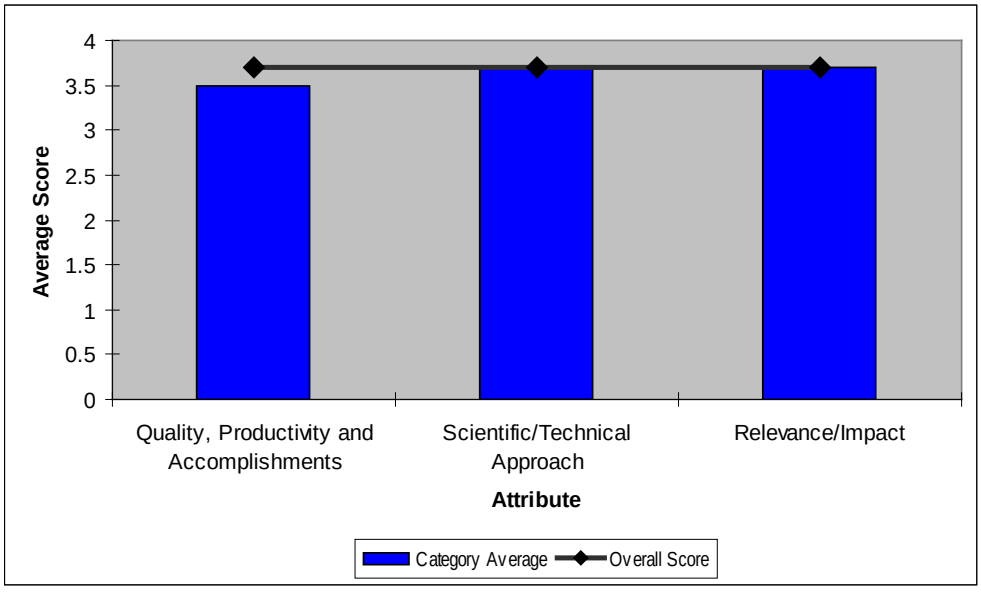

Review discusses NREL's work to support development of central station power generation through industry assistance in development, deployment and maintenance. Work is conducted with several federal funding awardees in the CSP industry.

Quality, Productivity and Accomplishments (Average Rating 3.5)

Rating	Comments
3.0	The results obtained in the project seem to be well balanced with the allocated resources. There is no doubt about the quality of the results. A precise assessment of team productivity is difficult, however, due to the lack of detailed information comparing planned versus carried out activities.
4.0	The project team consists of several members from NREL and SNL, representing many years of cumulative experience. They have strong expertise in the relevant field. The equipment, infrastructure and facilities engaged in this program are top quality and world class. The project developed, enhanced, and utilized sophisticated software and optical models and codes for optical and thermal measurement. It is a broad program that includes: • Optical measurement techniques – Mirrors – Overall collector – Overall field • Optical model development • Advanced absorber coating • Receiver heat loss measurement • Hydrogen mitigation The project made significant accomplishments in developing technologies, using them in field tests, and supporting the industry in their work of developing the parabolic trough technology for central station power plants. The Optical measurement techniques (VSHOT), Theoretical overlay photographic (TOP) alignment, Distant observer technique (DOT) have been demonstrated to be very useful tools for the CSP industry. The results are of immediate benefit to industry. All milestones are reported to have met on time and within budget. Suggestion for

improvement: The techniques are overly labor intensive to setup and use. It would be beneficial to put effort in reducing the time and human intervention required to use these tools, through automation wherever possible. This presentation included results from some of the other projects. It would have helped if a brief outline showing which other projects are covered under this presentation was presented in the beginning.

3.0 An appropriate number of people, with well recognized technical credentials have been engaged in this project. The members of the team and collaborators clearly demonstrate their ability to contribute to the project. The facilities deployed on the project appear to be adequate, but limited, for the task at hand. The work under way is producing an appropriate level of accomplishment relative to the costs incurred. The project team appears to be on schedule, but the project is clearly still in progress and not yet complete.

4.0 Key research in trough solar field is relevant to the needs of the solar industry. It supports the near term parabolic trough technology for central station power generation and advanced technologies for the next generation in accordance with the DOE long term goals. The use of VSHOT instrument to evaluate optical testing of mirrors and parabolic troughs provides a valuable capability to the industry. The use of TOP alignment tool is excellent insight and innovation demonstrated to align trough modules resulting in performance improvement.

The research work provides testing for Sunray, Skyfuel, Abengoa and Acciona resulting in close cooperation with the industry. The research results can be used immediately by the industry.
Optical testing of 2-axis tracking, Slope error detection improvements, Absorber coating, Sol Trace – Optical ray trace code
Advanced Absorber Coating – absorption >95%, Receiver testing, Receiver Heat loss surveys performed – technology transferred to industry.

Scientific/Technical Approach (Average Rating 3.7)

Rating	Comments
4.0	The technical approaches used in the execution of the different tasks are sound and effective, and take into consideration the effective use of available resources. They also seem to be well executed.
3.8	The parabolic trough R&D effort is broken into three areas: (1) trough solar field, (2) power cycle and balance-of-plant, and (3) industry support 1.1 Trough Solar Field The solar field technology agreement focuses on SunLab development of new parabolic trough solar technology and tools for evaluation of trough technology. The focus is on these areas: reflector optical measurement, TOP Alignment system, receiver heat loss, hydrogen mitigation, optical efficiency test loop, advanced trough materials, salt freeze/thaw experiments, and distant observer 1.2 Power Cycle and Balance of Plant The Power Cycle and Balance of Plant agreement focuses on improving overall parabolic plant performance. The work is focused on plant optimization and costing and heat rejection. 1.3 Systems Integration This activity focuses on general support for trough technologies and technical support to industry. Addressing barriers/needs: – Optical accuracy – Receiver thermal losses – Field performance degradation

– Cost
– Modeling capability
• Close collaboration with industry
• Optical testing, materials development, and analysis all aimed at providing near-term improvement in parabolic trough collectors
• Strong emphasis placed on experimental accuracy/uncertainty analysis
• Topnotch graduate student interns utilized to minimize cost, develop labor pool

3.0 The project team applied an appropriate technical approach in pursuit of project objectives. The design and execution of the approach are good. Most of the work is quite near term, not particularly long term. Close collaborations with industry, emerging international collaborations. Development of future staffing and personnel. The industry focus of the current project is commendable, and appropriate to foster success at overcoming technological hurdles that the CSP industry is likely to encounter as they ramp up in scale.

4.0 -The Distant Observer Technique to detect optical alignment problems in the solar field addresses a major industry need.
-Relevancy to the market place in near term
-Supporting Abengoa, Skyfuel, Reflectech, Glass Tech, Solar Systems
-Measure total efficiency of the collector
-Work closely with industry
-Addressing barriers:
-Explore receiver with inert gas instead of vacuum
-Distant observer to survey large field
-Low emissivity is R&D
-Way to prevent tube leakage
-Economies of scale and learning curve to reduce cost
-Close involvement for solar paces
-Absorber coating – midterm
-Mostly near term

Relevance/Impact (Average Rating 3.7)

Rating	Comments
4.0	The goals and activities defined within this project are targeted to provide solutions to short and mid-term needs of the CSP industry. The development of tools to provide QC and in-the-field optical and energy efficiency characterization and assessment capabilities is an urgent need of the industry. The development of advanced absorber coatings and of techniques for hydrogen production mitigation may also contribute to improve the efficiency of parabolic trough CSP plants and lower their LCOE.
3.9	The research areas under this program are highly relevant to the CSP industry's immediate needs. They are expected to accelerate development of CSP plants by reducing the costs and addressing technological barriers. The program has made significant progress towards DOE goals and objectives. However, based on the information presented it is difficult to quantify the benefits or assess the cost reduction of CSP (LCOE) linked to each topic. Some of the specific benefits and accomplishments include: • Optical mirror measurements, which will be of immediate benefit to Abengoa, SkyFuel, Reflectech, GlassTech, Saint-Gobain Flat Glass, Ashai Flat Glass, RioGlass Solar, Guardian, etc. • Transfer of VSHOT to industry which will benefit the industry partners • Overall collector measurements of immediate benefit to SkyFuel, and others • Improved SolTrace processing and input will enable industry to evaluate designs more efficiently and at lower cost • Field IR measurements of receivers led to FPL Energy replacing millions of dollars of receiver tubes

• New absorber coating for receivers under development with industry partnership will benefit many CSP technology providers
• Hydrogen mitigation technique will provide benefit to all trough installations using oil heat transfer fluid

3.0 This project has the potential for near term positive impact on the CSP industry through the reduction of technical barriers associated with installation, operation, and maintenance of CSP fields, particularly issues associated with receiver surface alignment, and hot spot mitigation. The primary impact of this project is expected to be at the field operations level. There is potential for this project to have positive impact on design and manufacturing of CSP receivers, with further development. This project is a core enabling technology, and is recommended for open access sharing with the public to promote high quality technical advances in receiver / reflector design in industry. This project has the potential to become useful as the basis for an acceptance test standard for large CSP installations, identified during the peer review panel discussion as a major hurdle to achieve private sector development financing of large future CSP projects. Assess the importance of achieving the project's objectives in terms of actual or potential contribution to broader program mission, goals, or strategy and to society.

4.0 Provided testing for Sunray, Skyfuel, Abengoa and Acciona – resulting in close cooperation with industry. This helps industry to use the results immediately. The technologies discussed are excellent and have performed very well. However, they are labor intensive, and needs to build in a lot more automation.

Overall (Average Rating 3.7)

Rating Comments

4.0 The project addresses relevant short and mid-term needs of the CSP industry. It uses sound and effective technical approaches. The technical personnel and the rest of the resources allocated to the project execution are appropriate. The results obtained are excellent.

3.9 It would have been nice to identify the other projects the results of which are presented in this presentation. Using SAM to quantify the results would have been helpful. Effort to some futuristic development of the technologies would be helpful, for example if some of the diagnostic technologies could be implemented in a way that the systems can use them for self diagnostics, and self correction (by way of a closed loop algorithm and mechanical action). General comment for all the projects: A clear list of tasks that was planned to be accomplished during the presorting period of this Peer Review (say 2007-2008) and what was accomplished during this period would have been helpful is evaluating the percentage or how much of the planned work was accomplished, i.e. the extent to which the accomplishments met the expected results for the reporting period. Some projects did that some did not.

Majority of the reported work, which is of very high quality and value, is short term focused, justifiably for good reason (to address the immediate industry need and help the technology developers). However, it would be valuable for both NREL and SNL to add intermediate and long term focus in their work. Both labs have suffered from lack of funding in the past. They are commended for maintaining sustained effort despite the budgetary hardship. Increased budget and additional resources is highly recommended to support the industry and accelerate the growth the CSP industry is beginning to see. It’s very important to help the industry gain momentum. It is surprising that despite efforts by DOE lab staff BrightSource has shared any information or asked for any help. It would be good to continue outreaching effort to get them engaged so that they can make use of the resources and expertise of both labs to make their contracts in California successful. The success of the CSP industry depends upon successful implementation of such contracts.

3.0 -1,130 k$
-H2 mitigation concerns
-VSHOT testing of collectors – slope error more imp than position error

-6m aperture width current industry trend
-Abengoa, Skyfuel, Reflectech, Glasstech solar systems
< 0.25 milliradian accuracy out of 3 mr desired
-79% optical performance for Acciona trough measured in mesa-top facility
-Distant observer field assessment tool – flyover
-Distant observer partners FPL Energy, sunray, skyfuel, abengoa, and acciona
-Simple blimp or RC planes for DO platform
-Modeling – Tim Wendelin NREL- SolTrace (troughnet tools web page), troughs, heliostats, solar advisory model
-Absorber emittance claimed at 7%
-HCE inert gas injection
-Directly measure mass flow with coriolis meter
-79% optical performance, trough misalignment over time, h2 leak over time, impact on optical performance? What is a reasonable upper limit on optical performance – where is the marginal return point? Comment on the difference between installation time alignment and maintenance alignment.

Efforts to collaborate internationally; Spain also working on distant observer technology; Acceptance test procedures, solar paces conference

4.0 The team has excellent hands on experience. The personnel, resources and lab facilities have been used efficiently. VSHOT and TOP are impressive tools, however, they are labor intensive and should be more automated to make them cost effective.