Mirrors and Receivers

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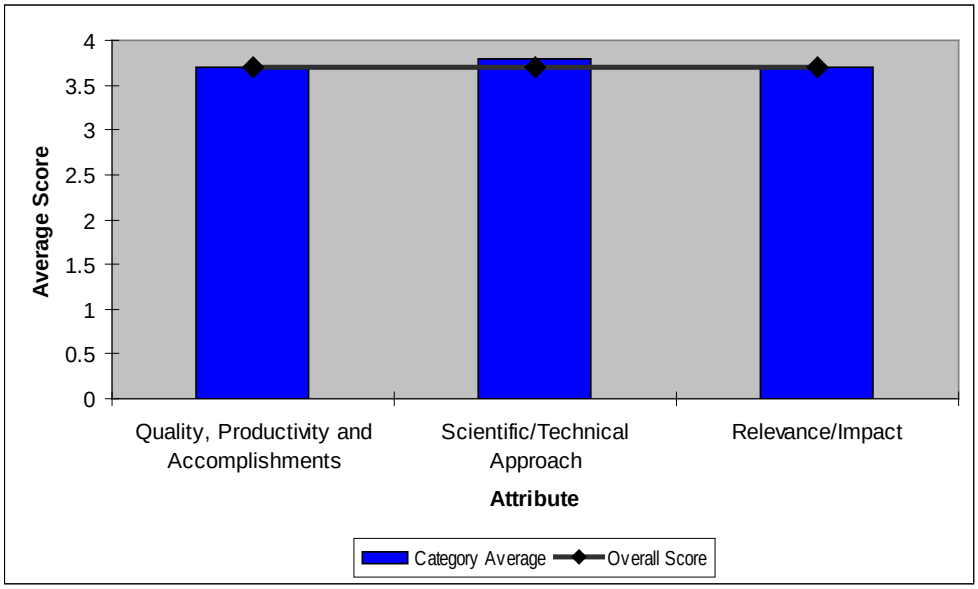

This project review details the work of NREL's CSP research team. Key activities include applied and advanced research in mirrors and receivers, with the goal of making CSP-generated power cost-competitive with fossil fuel power by 2015.

Quality, Productivity and Accomplishments (Average Rating 3.7)

Rating	Comments
4.0	The team is well qualified. The activity it has deployed and the quality of the research done is outstanding.
3.5	Very interesting and valuable work. PI has strong background. Depth of the NREL team is not as much as some of the other projects. Good NREL facilities, equipment and resources. PI needs more staff. Highly ambitious goals for mirror technology development includes: Develop new mirror technologies, reducing cost of mirrors by half by moving from heavy glass mirrors to lightweight front-surface reflectors that include surface coatings to reduce soiling, Develop advanced reflector materials that are low in cost (less than $2.50/ft2 or $26.90/m2) and maintain high specular reflectance (90%–95% into a 4-mrad cone angle) for long lifetimes (20 to 30 years) under severe outdoor environments. Test durability of optical materials to determine lifetime of solar reflector materials. Considerable work has been done on mirror characterization. Accomplishments seem to be strong. Results are supposed to be published in a paper. Team also seems to have provided extensive support to the FOA awardees. Ambitious targets for receiver work: Develop new, more-efficient advanced solar selective coatings for receivers with: High solar absorptance (α> 0.96), Low thermal emittance (ε< 0.07 @ 750°C), Thermally stable > 450ºC, Improved durability and manufacturability, Reduced cost. Encourage development of US &/or 3rd receiver manufacturer. Accomplishments include: Deposited modeled solar selective coating, developed demonstration prototype, filed for patent. To progress the technology an industry partner has been selected to

commercialize the NREL coating technology.

4.0 EXCELLENT PROJECT. One of the top three for the two days. 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.

-Reduce the cost of the concentrator by 50%
-Talk about mirror, receiver, advanced absorbers
-Looking for 95% reflectance
-Accelerated weathering chambers
-Don't silver the tin side – it delaminates
-Self cleaning coating is going to take the market
-Some equipment installations delayed, which in turn delayed experimental testing
-Rcvrs –advanced coatings
-The mirrors are about 40% the receivers about 25%
-Fast moving world right now – a bit of a culture shock
-TiO2 on front or tine side coating
-Lose 8-10% in one year – 2% cooked in, never get off
-Glass association standard of north America
-A wealth of knowledge in this person – this needs to be captured archivally

3.5 The objective is to reduce cost of concentrator by 50% so that the cost of solar electricity produced by CSP would be less than 10c/kWh and cost competitive with electricity produced by traditional means by 2015. In addition, reduce cost of mirrors by half by advancing mirror technologies, and develop low cost advanced reflector materials with high specular reflectance and long lifetimes under severe outdoor environments. Discussed >90% specular reflectance, Mirror characterization, Durability testing, Issues affecting glass mirror durability

The results are spectacular when considering available resources.

Scientific/Technical Approach (Average Rating 3.8)

Rating Comments

4.0 The technical approaches followed are very well thought out and well executed.

3.5 The technical approach is quite detailed, sharply focused and well designed. It includes identification of reflector materials based on their potential for low cost and high optical performance and durability. All candidate materials are optically characterized prior to exposure testing to assess optical durability. The mirrors are subjected to accelerated or outdoor weathering at a variety of geographically diverse outdoor exposure testing (OET) sites in Golden, Colorado (NREL); Miami, Florida (FLA); and Phoenix, Arizona (AZ). Accelerated exposure testing (AET) was performed at NREL in the Atlas Ci5000 (Ci5000) Weather-Ometers (WOM), and a BlueM damp heat oven (BlueM). The WOM's operates continuously at 60°C and 60% relative humidity (RH), with light levels about twice outdoor exposure.

A single day of testing (24 hours) is roughly equivalent to six times the outdoor exposure in terms of light intensity. The BlueM, which operates continuously at 85°C and 85% RH, does not have the same measured acceleration factor as the WOMs, as they are not exposed to the light.

However, based on other experiments the acceleration factor is believed to be as much as five times the Ci5000.

4.0 Excellent overall project. Keep up the great work.

3.5 40%-50% of funding is in glass
Tubes 20-25%
8-10% efficiency is lost without cleaning
2% efficiency is always lost

Relevance/Impact (Average Rating 3.7)

Rating	Comments
4.0	The project goals are of high importance to the CSP industry. The results obtained so far are of high interest, both in the area of mirror and receiver development.
3.0	The completed work represents good steps towards accomplishing the project goals, which in turn should help achieve the DOE goals and objectives. Not enough quantitative results or analyses have been presented to evaluate achievement of the specific targets of the projects. The work is very relevant to CSP industry needs.
4.0	Outstanding work. Potential for VERY large impacts in CSP adoption, acceptance, and long term success. Recommend strongly that this program be expanded relative to personnel, lab space, and equipment. Results of life cycle testing need to be shared widely to fullest extent possible. Critical for the industry to avoid past mistakes and be able to rely up on lessons learned. Recommend industry discussion on how to share testing results in a way that prevents repetition of mistakes, while protecting individual companies innovations. Disclose as many past lessons and mistakes as possible based on internal DOE work, so that these mistakes get out into the open before any company thinks they have proprietary access to knowledge you already know. Information content is highest in failures – you learn very little new information from a test that shows no failure modes. Critical to publish this data broadly and openly.
3.7	A large amount of work has been accomplished at outdoor exposure test sites and in several accelerated exposure test chambers during durability of solar materials testing as a function of exposure time. Upgrade optical characterization & durability testing is of high importance and will address significant technical and market barriers, These tasks will lead to lowering of the indicated barriers.

Overall (Average Rating 3.7)

Rating	Comments
4.0	The project goals and the results obtained are highly important to the CSP industry. The team executing the project is very well qualified. The activity carried out and the quality of the research done is outstanding.
3.3	[none]
4.0	Outstanding. Recommend recognition of Ms. Kennedy for her work.
3.7	NREL has performed durability testing and developed optical materials that will help in reducing levelized cost of CSP energy (LCOE). There has been broad collaboration with industry for glass and non-glass matrerials The work done so far is excellent. The scope of this work should be expanded.