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Solargenix Energy Advanced Parabolic Trough Development

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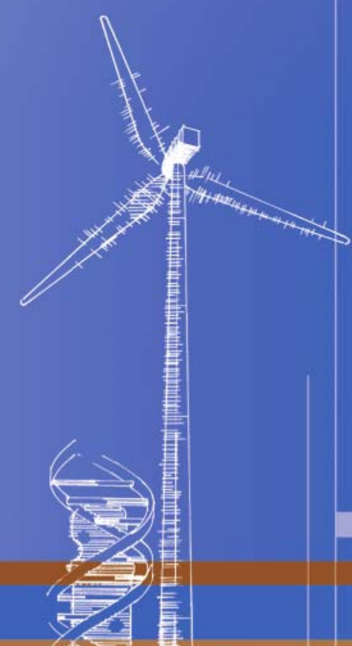

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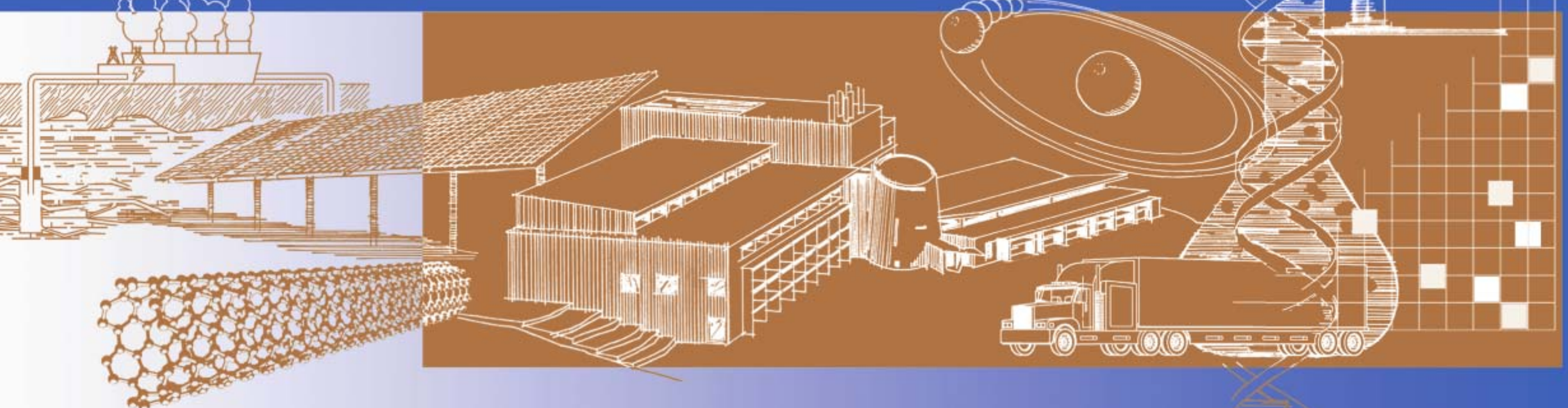

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Solargenix Energy Advanced Parabolic Trough Development

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ABSTRACT

The Solargenix Advanced Trough Development Project was initiated in the Year 2000 with the support of the DOE CSP Program and, more recently, with the added support of the Nevada Southwest Energy Partnership. Parabolic trough plants are the most mature solar power technology, but no large-scale plants have been built in over a decade. Given this lengthy lull in deployment, our first Project objective was development of improved trough technology for near-term deployment, closely patterned after the best of the prior-generation troughs. The second objective is to develop further improvements in next-generation trough technology that will lead to even larger reductions in the cost of the delivered energy. To date, this Project has successfully developed an advanced trough, which is being deployed on a 1-MW plant in Arizona and will soon be deployed in a 64-MW plant in Nevada. This advanced trough offers a 10% increase in performance and over an 20% decrease in cost, relative to prior-generation troughs.

1. Objectives

Solargenix Energy has committed to near-term deployment of an improved parabolic trough that is closely patterned after the best of the prior-generation troughs used at the SEGS plants, as well as further advancing the state of the art of parabolic troughs through R&D that will result in a next-generation trough with even lower installed costs. Accordingly, the Solargenix Energy Advanced Parabolic Trough Development Project has two primary objectives:

Objective 1: Development of an improved parabolic trough module that will be used in near-term SEGS plants.

Objective 2: R&D that will lead to the next-generation parabolic trough, with even further cost reductions.

All project work related to both of these objectives addresses the key technical barriers for trough technology as described in the CSP Subprogram's 2005 Multi-Year Plan: "improving the efficiency and reducing the installed capital cost of the solar field."

2. Technical Approach

The Solargenix Energy Advanced Parabolic Trough Development Project builds upon the basic knowledge and excellent operational history[1]of the SEGS plants that were constructed during the years 1984 to 1992. But since no large-scale SEGS projects have been built in over a decade, our general technical approach has been to build upon the most successful elements of these plants, but reduce collector costs and improve performance. The project's technical approach is also aligned with the CSP Subprogram's focus areas as outlined in the Multi-Year Plan: performance improvement, cost reduction, deployment support.

With a goal of near-term deployment (see Objective 1 above), we have first focused on the trough's prime targets for cost reduction (e.g. the trough structure) or where component development priorities (e.g. sun tracking controls). But we retained the same 8-m trough module length, and use the same glass mirrors successfully deployed at the SEGS plants. This approach reduces the time required to develop an advanced trough, and also reduces risks associated with the planned first-in-a-decade trough projects, a key consideration with the financial community that invests in these trough plants.

In addition to the R&D activities aimed at preparation for near-term trough deployment, we have also undertaken R&D that is somewhat longer term and/or that requires a somewhat larger technical departure from the parabolic troughs that have been operating at the SEGS plants. Here our goal is to develop a next-generation trough with even greater cost reductions (see Objective 2 above).

3. Results and Accomplishments

Prior Project work resulted in the definition of an advanced parabolic trough that uses a lightweight space frame structure, is twice the length of the prior-generation LS-2 collector and incorporates newly developed and improved subsystems (i.e. sun tracking controls, support pylons and drive units). Analysis and evaluation showed that the new Solargenix trough offers a 10% increase in performance and an 18% decrease in installed cost relative to the prior-generation[2]. Additional work during FY'05 has focused on further advancing this design through prototype deployment and testing, followed by optimization that incorporates "lessons learned" from prototype testing.

3.1 Field Deployment of Advanced Trough Structure

The design of an advanced 8-meter long parabolic trough structural framework, which supports the glass mirrors that concentrate sunlight onto the receiver tubes, was completed and successfully deployed for field-testing at the Eldorado Valley Test Site near Boulder City.

Fig.1 . Deployment of advanced trough structure.

The trough structure was designed to be field assembled (to reduce transportation costs from the factory to the project site), and to have reduced manufactured cost. This large emphasis on the structure of a parabolic trough is warranted because the structure has historically represented about 40% of the total collector cost, the highest single subsystem cost[3]. The new space frame was fitted with curved glass mirrors and readied for field-testing, as shown in Figure 1.

3.2 Space Frame Optimization

Since the Solargenix SCA uses a field-assembled space frame, the labor required for assembly of these frames is an important cost factor. Twenty-four space frames were assembled to determine how the process could be made more efficient. Three design improvements were identified[4] that have reduced assembly time nearly in half.

Further cost reductions were then identified by optimizing the frame structures for each module along the 100-m length of the collector (modules other than those adjacent to the drive, where lower torsional strength is required). Analysis shows this reduces the manufactured cost of the collector by another 8%. Two lighter weight space frames have been erected at the Eldorado Valley Test Site for field-testing.

3.3 Optical Testing at NREL

A Solargenix space frame has been assembled at NREL. The space frame is being used in NREL's Optical Laboratory to examine, characterize, and further evaluate the concentrator optics, with the objective of further improving the optical quality of the concentrator.

Fig. 2. Optical testing at NREL's optical lab

3.4 Sun Tracking and Solar Field Controls Development

Completely new sun tracking and solar field controls were a high-priority development need because the prior-generation SEGS controls are obsolete. To date, a new Advanced Local Controller (AdLoC) has been developed and readied for field deployment. The AdLoC controls the sun-tracking movements of the collector. Each AdLoC is connected through a network, to the Field Control Server (FCS), which has also been recently developed as part of this Project. The FCS monitors the AdLoCs in the field, collects real-time data and alarm conditions, and controls the overall operation of the AdLoC field. All bench testing has been completed and AdLoC and FCS controllers are ready for field-testing.

3.5. Full-Scale Wind Load Tests

Wind load experiments are underway using full-scale trough collectors to provide a comparison with loads predicted from wind tunnel tests. The results of these experiments will better quantify wind loads, which govern the structural design of a parabolic trough. All monitoring equipment is in place and data taking has commenced. Data taking will continue until enough data is obtained to allow comparison with the loads predicted from prior wind tunnel tests.

3.6 Development of a Next-Generation Space Frame

A new space frame structure has been developed that significantly reduces the number of parts needed for each trough module. Weight and cost reductions are currently being analyzed, but the design has been completed and a prototype space frame has just been erected at the Eldorado Valley Test Site for evaluation and field-testing.

4. Conclusions

The Solargenix Advanced Trough Development Project has successfully developed a new generation of parabolic troughs, with improved performance and significantly reduced cost compared to the best of the prior-generation troughs. This satisfies the need for an advanced trough ready for near-term deployment, and it is in fact currently being deployed in trough plants.

Next steps of this Project include: the construction of a thermal loop at the Eldorado Valley Test Site for extended field testing capabilities, and continuation of advanced component R&D leading to the next generation of parabolic troughs with even further increases in performance and further reductions in installed collector costs.

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