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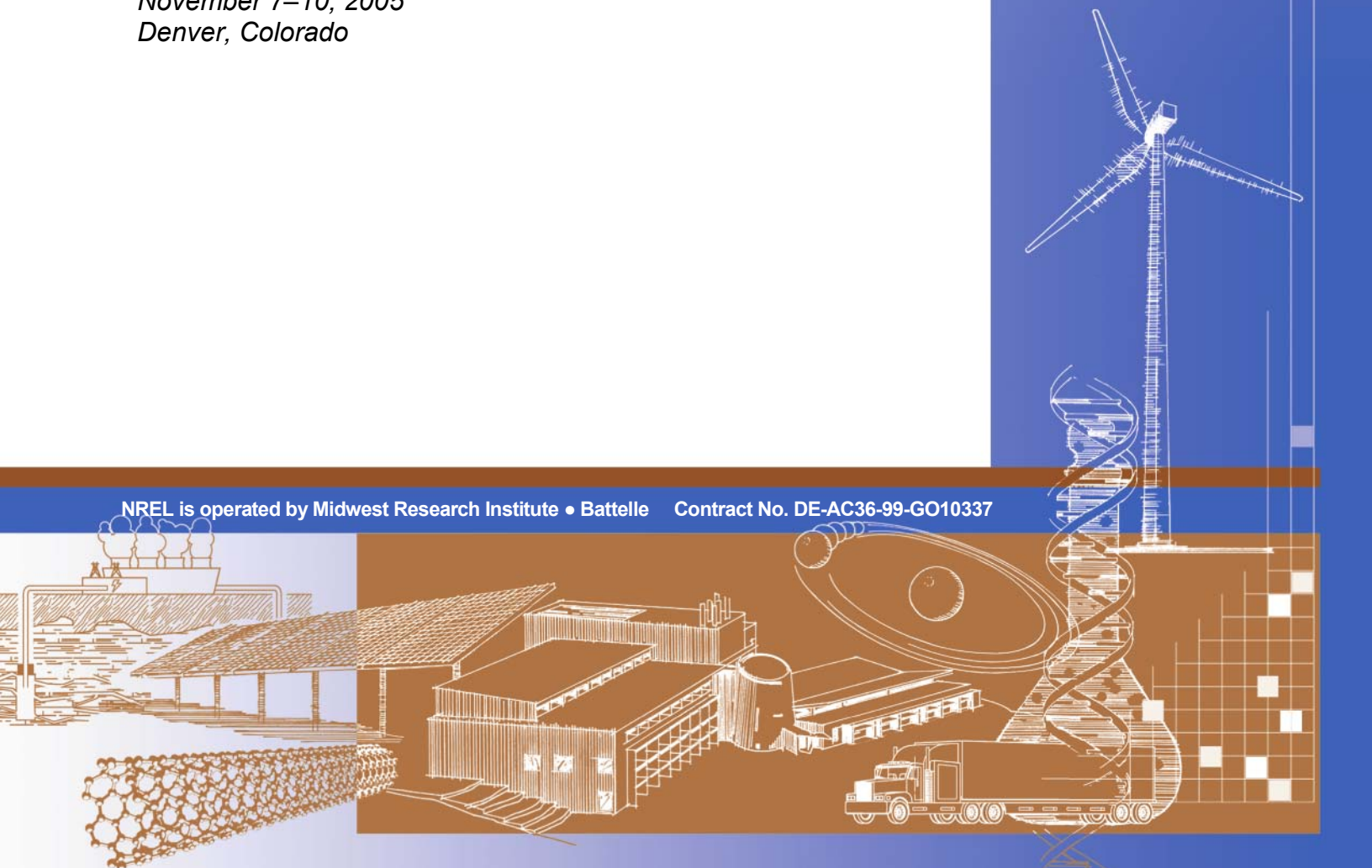

Status of APS 1-MWe Parabolic Trough Project

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ABSTRACT

Arizona Public Service (APS) is currently installing new power facilities to generate a portion of its electricity from solar resources that will satisfy its obligation under the Arizona Environmental Portfolio Standard (EPS). During FY04, APS began construction on a 1-MWe parabolic trough concentrating solar power plant. This plant represents the first parabolic trough plant to begin construction since 1991. Site preparation and construction activities continued throughout much of FY05, and startup activities are planned for Fall 2005 (with completion early in FY06).

The plant will be the first commercial deployment of the Solargenix parabolic trough collector technology developed under contract to the National Renewable Energy Laboratory. The plant will use an organic Rankine cycle (ORC) power plant, provided by Ormat. The ORC power plant is much simpler than the conventional steam Rankine cycle plant and allows unattended operation of the facility.

1. Objectives

The primary objective of the parabolic trough ORC plant is to generate electricity to satisfy the APS solar obligation under the Arizona EPS. However, a secondary objective is to evaluate the cost and performance of this technology in comparison to the other solar technologies that APS is implementing. The DOE Solar Technology Program's objective is to use this project to help baseline the cost and performance of the current generation of parabolic trough technology. A related objective may involve the design, installation, operation and performance evaluation of a thermal energy storage (TES) system. These objectives are addressed in Section 4.2 of the Solar Program Multi-Year Technical Plan (www.nrel.gov/docs/fy04osti/33875.pdf).

2. Technical Approach

Recent advances in parabolic trough solar technology and organic Rankine power cycle technology have made the possibility of a small parabolic trough plant economically feasible. Because of this, APS decided to competitively procure a 1-MWe parabolic trough plant. APS selected the team of Solargenix Energy, Inc., of Raleigh, North Carolina, and Ormat International of Reno, Nevada, to develop the plant. Solargenix is the system integrator and provider of the parabolic trough solar field and Ormat is the provider of the ORC power plant. APS has partnered with Sandia National Laboratories (SNL) and the National Renewable Energy Laboratory (NREL), collectively known as SunLab, for technical support and to offer the project as a potential test bed for evaluation of parabolic trough technologies and thermal energy storage designs.

3. Results and Accomplishments

The plant is located next to the existing APS Saguaro gas-fired power plant facility outside of Red Rock, Arizona approximately 30 miles northwest of Tucson, Arizona. The plant will initially have 10,340 square meters of parabolic trough solar field and the power plant will be nominally a 1-MWe ORC system with wet cooling. The plant was designed for possible expansion of the solar field and addition of thermal storage at some point in the future.

3.1 APS Site Activities

Construction began in June 2004 with grading of the site, installation of a security fence and installation of a water line from the existing Saguaro power plant. At the beginning of FY05, APS had a clear and level site prepared for construction. Foundation work began early in FY05 and construction of the solar field and installation of the power plant began in Winter 2004/05. Construction continued throughout much of 2005 and was nearing completion by November 2005. The FY05 goal was completion of construction, system checkout, startup, and automatic plant operation. By the end of FY05, there were some delays in the anticipated schedule, but the project picked up a great deal of steam. With completion of major construction, system testing should begin soon, with plant operation anticipated by early 2006.

APS also began a number of critical activities. The Saguaro substation will be upgraded to provide system and generator protection. The communication system will be installed, and Human Machine Interface and LAN will be installed to connect the control room at the solar site to the adjacent Saguaro power plant site. The main control building and blowdown pond will be completed late 2005.

3.2 Solar Field Fabrication and Installation

Solargenix worked closely with APS to coordinate all site construction activities. During FY05, all foundations were completed and underground electrical was installed. The site fabrication process was mobilized to assemble and install solar collector assemblies (Fig 1), pedestals, drive units, local controllers, mirrors, and the Schott heat collection elements (HCEs). Work began, and will continue late 2005, to complete electrical work (motor control centers), controls (programmable logic controls), the solar tracking system, and a new Maximo-based O&M tracking system. Finally, SunLab will support the alignment of the solar collectors.

3.3 ORC Power Plant and Balance of Plant

Ormat is responsible for the design and installation of the Ormat Energy Converter (OEC) power unit. Late in FY05, the OEC set was finished and shipped to the site (see Fig 2).

Figure 1 – Solargenix Solar Collector Assembly

During FY05, piping from the solar field to the power block area was completed and connections were made. The cooling tower and related equipment were set in place. Auxiliary power supply was arranged and 12.5 kV power was brought to the site. Work will continue late FY05 and early FY06 to install motor control cabinets, heat transfer pumps and tanks, cooling water pumps and controls, raw water treatment and storage provisions, and integrated control components.

3.4 SunLab Contributions

Early in FY05, SunLab and Nexant, Inc. documented a preliminary design for a thermocline-based TES for future implementation at the APS Saguaro plant. SunLab also began efforts to develop TRNSYS models of the plant that may determine whether the proposed thermocline storage system is technically and economically feasible for Saguaro and for future parabolic trough power plants.

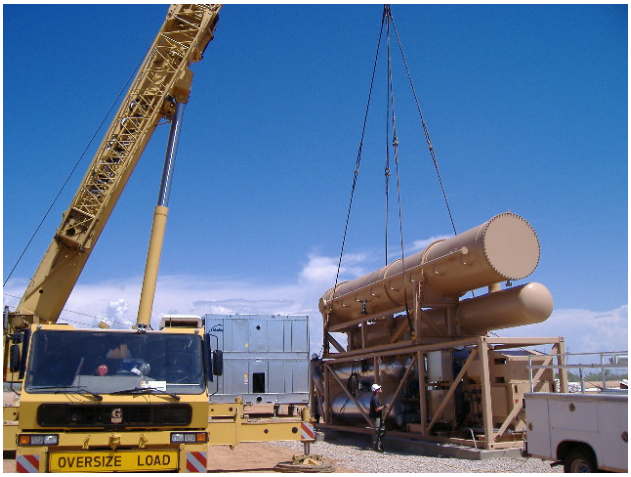

Figure 2 – Ormat OEC Placed On Site

SunLab also continued collaborative development of an O&M (operations & maintenance) database. Initial efforts involved adaptation of an existing database structure used to track O&M costs for photovoltaic (PV) facilities. A mid-year decision was made at a project meeting to develop the database using the Maximo system, software used by APS for their inventory, maintenance and O&M operations. Significant progress was made to define plant systems and components and failure modes, and to define and coordinate the activities needed for eventual implementation and integration with the current generating station at Saguaro.

3.5 Startup and Future Activities

Completion of all construction activities will occur early in FY06. Initial startup testing will include unit functional testing and utility testing (of relays and breakers), and then system integration of the power block and solar field, plus system testing of other balance of plant systems (cooling towers and cooling water, makeup water and treatment, fire protection, and the plant heat transfer fluid ullage control). Emergency operations will be defined and tested (loss of power, loss of critical systems, etc.). The communications systems and integration with the Saguaro power plant control room will be finalized and tested. During plant startup, performance testing and monitoring will begin, including initial optimization of integrated plant controls.

4. Conclusions

Significant construction and installation progress was made in FY05 on the APS 1-MWe Saguaro power plant. Plant startup should begin early in FY06. Overall, the APS perspective on this project has been favorable, gaining good experience with both the Solargenix solar technology and the OEC system. The OEC knowledge will help APS with test wells and geothermal exploratory activity in Arizona. APS has been able to break some internal barriers to trough plant technology. This new interest may lead to other opportunities with absorption chilling and heating as well as expanding the current site (to potentially include storage).

Both APS and Solargenix have benefited greatly from the project. APS knows much more about the project and will continue to learn as the operational phases begin. As for Solargenix, they have learned valuable construction and site fabrication lessons on a smaller project that will help them to prepare for and succeed on a larger project in Nevada.

There have been some lessons learned. The 1-MW plant is not the best size; from about 1 MW to 20 MW, many of the same permit and regulatory issues must be addressed. Furthermore, the effort required from engineering and management is about the same for this range of plant sizes. In the current regulatory environment, there is a significant drawback for smaller trough plants compared to the APS experience with PV systems. That is, it is an advantage to have the ability to grow a site over time and still get production as the building blocks are completed. Finally, strong and experienced construction professionals can mitigate the above issue by keeping schedules on time and budget. These professionals can also help mitigate the increases in material costs that were experienced if they are included very early in the design process.

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