Sun♦Lab SnapShot

Advanced Dish Development System for Remote Power Applications

Remote power applications provide an opportunity for high-value distributed power (50¢/kWh and higher for some remote applications) and many early opportunities for commercial deployment. The Advanced Dish Development System (ADDS) project is developing and testing 10-kW advanced dish/Stirling systems to address remote applications. One of the objectives is to fabricate, demonstrate, and field an advanced, stand-alone water-pumping system for use at Native American sites in the southwest United States.

System Description

The Advanced Dish Development System (ADDS) project started in October 1998 as a test bed for advanced components and systems-level testing of solar dish/Stirling technology to address the issues of the remote power market. Development activities have focused on incorporating advanced components, such as structural facets, heat pipe receivers, advanced controls and communications; improving reliability; and extending the application of dish/Stirling systems to water pumping. In 1999, a first-generation (Mod 1) 10-kW advanced dish/Stirling system in a grid-connected mode was successfully designed, built, and tested at the National Solar Thermal Test Facility in Albuquerque. The system is based on WGAssociates (WGA) concentrator and controls technology and the proven SOLO 161 kinematic Stirling engine. The WGA concentrator uses Sun♦Lab-developed structural facets, which are manufactured by Paneltec Corp. The structural facets are low-cost, high-performance parabolic structures that use industry-proven laminating techniques. The reflective surface is a thin-glass mirror manufactured by the Naugatuck Glass Co. The controls system, incorporating 20 years of development experience, is a complete solution, providing automated (unattended) control, fault detection, data acquisition, and communications. The SOLO engine has been developed for cogeneration and solar markets and has a proven track record of hundreds of thousands of hours of operation.

WGA provided detailed concentrator system design, controls integration, and managed fabrication and installation of the Mod 1 system. Initial testing of the Mod 1 system was started in the summer of 1999, and by November 1999 it was running automatically and unattended. By the end of 2001, the Mod 1 system had accumulated about 4000 on-sun operational hours and had exceeded all performance objectives for power and efficiency.

In 2000, development began on an upgraded, second-generation (Mod 2) system, which includes a range of system improvements based on Mod 1 test results and stand-alone water-pumping requirements. In July 2001, operational testing of the Mod 2 system was initiated. In the Mod 2 stand-alone system, a synchronous generator allows varying both voltage and frequency to directly drive a conventional three-phase 480-volt induction motor (in this case, a submersible water pump). Other features unique to the off-grid system are an advanced power management system (because the system only has battery power when not operating) and a standard 12-VDC automotive starter used to start the engine.

The Mod 1 (foreground) and Mod 2 (background) Remote Power Systems at Sandia's National Solar Thermal Test Facility in Albuquerque, NM.

Concentrating Solar Power Program

The SOLO 161 Power Conversion Unit on sun.

Testing of the ADDS evolved from concentrator testing early in the project to ongoing system operational, reliability, and performance testing. The systems operate automatically and unattended, including weekends and holidays. After the system detects that sunlight is available, it tracks to acquire the sun, starts the engine, and supplies power to the grid or water-pump motor. If high winds (greater than 35 mph) are detected, the system automatically drives to stow where it remains until wind speed returns to a safe level. When clouds are detected, the system drives off sun and continues to offset track. When the sun reappears, the system reacquires the sun and starts the engine. If the sun does not return within a specified time or by sunset, the concentrator stows. When a fault is detected, the system automatically sends the system to stow and notifies the operator through a pager. In many cases, the operator is able to resolve the problem and resume operation remotely.

Some highlights of the ADDS project include:

- A period of less than one year from concept to initial testing of the Mod 1 system,
- First demonstration of a stand-alone dish/Stirling water pumping system (Mod 2),
- A measured peak concentration ratio of more than 13,000 suns (Mod 2),
- Peak net system output of 11 kWe (Mod 1),
- Demonstrated net system efficiency of over 25% instantaneous and 24% daily (Mod 1),
- Fully unattended operation including weekends and holidays (Mod 1 and Mod 2), and
- An 89% availability (actual power generation time divided by available hours of sunlight) over the past nine months (Mod 1).

Native American Applications

WGA is considering the application of grid-connected systems at utility sites in the southwest U.S. However, the primary applications for the system are remote water pumping, village electrification, etc. While many of these applications are in developing countries, following a survey of Native American tribes in the southwest United States, remote water pumping was identified as an interesting domestic opportunity. In 2000, partnerships were initiated with four tribes (two each in Arizona and New Mexico) to develop a better understanding of their potential applications and the technical and cultural needs associated with those applications. The partnerships provided training for Native American operators and maintenance personnel, and in 2001, Laguna Pueblo was selected for the first system. Pending sufficient funding, fielding a system and testing over a multiyear period is anticipated for 2003, with improvements being implemented as they are identified and developed.

International Markets

The major markets for these systems are international. As reliable remote operation is demonstrated over the next couple of years, export opportunities for U.S. industry will be substantial. Previous marketing studies by U.S. industry have estimated markets for this type of remote system to be as much as several billion dollars per year. Achieving that level of market penetration will, of course, require continued development, testing, and field validation to reduce costs, improve reliability and lifetime, and decrease maintenance requirements. The overall system concept, as well as Sun♦Lab's research and development programs, will continue to target these needs.

For on-line information about **Sun♦Lab,** please visit **http://www.eren.doe.gov/sunlab.** Information about the U.S. Department of Energy's Concentrating Solar Power Program can be found at **http://www.eren.doe.gov/csp.**

For more information on renewable energy or for additional copies of this brochure, contact the Energy Efficiency and Renewable Energy Clearinghouse (EREC): **1-800-DOE-EREC (363-3732).**

Produced for the
U.S. Department of Energy (DOE)
1000 Independence Avenue, S.W.
Washington, DC 20585-0121

Produced by **Sun♦Lab**:
Bringing together solar energy expertise from Sandia National Laboratories and the National Renewable Energy Laboratory, DOE national laboratories.

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May 2002