Sun♦Lab SnapShot

The Boeing/SES DECC Project

The Dish Engine Critical Components (DECC) project is an industry/DOE, cost-shared program to establish the operation and reliability of the Stirling engine and to validate the performance of SES' next-generation dish-Stirling power generation system for emerging markets.

25-kWe Boeing/SES Dish-Stirling Systems on test in Huntington Beach, CA

In 1984, the McDonnell Douglas Corp. (now part of the Boeing Company) and United Stirling AB, a division of Kockums located in Malmo, Sweden, developed a Dish-Stirling solar power generation system. Stirling Energy Systems (SES) of Phoenix, AZ, acquired the patents for the Boeing concentrator design and a license to manufacture the Kockums 4-95 Stirling engine in 1996. At that time, SES initiated a commercialization program to build on the existing solar dish design by improving its manufacturability while continuing to operate the systems and improve the technology. The DECC Project was initiated in March of 1998 with the objective of developing a commercial Dish-Stirling system.

The Technology

The SES Dish-Stirling system is a power generation system that converts solar energy into electricity. It accomplishes this by collecting the solar energy on an array of tracking mirror facets formed into the shape of a "dish," which focuses the sun's rays to a small area on a thermal receiver. The receiver absorbs the solar energy and transfers it in the form of heat to the Stirling engine, where it is converted to the mechanical work that drives the electric generator. Because of the high solar concentration of the parabolic dish and the high efficiency of the Stirling engine, the Boeing/SES dish efficiently collects solar energy and converts it into electricity. This system routinely converts more than 29% of incident solar energy into electricity, the highest efficiency of any solar technology.

Concentrating Solar Power Program

Specifications and Performance Of the SES Solar Dish-Stirling System

Solar Concentrator

Type:	Faceted
No. of Facets:	82, 0.7mm thin glass (87.7 m^2 total)
Reflectivity:	0.91
Control:	Automatic Solar Tracking
Height:	11.6 m

Power Conversion Unit

Type:	Kinematic Stirling Engine Kockums 4-95 (SES)
Working Temp.:	720 °C
Size:	4 cylinders, 380 cc
Control:	Variable Pressure

Solar Dish-Stirling System

Electrical Output:	25 kW at 1000 W/m^2 solar input
Voltage:	480 v, 3 Phase, 50 or 60 hz

Performance

Peak Power:	24.9 kW
Peak Efficiency:	29.4 %
Annual Efficiency:	24%
Annual Output:	54,500 kWhrs at 7.1 kWhr/m^2/day

The Boeing DECC Project

The Boeing/SES DECC is a industry/DOE cost-shared project to commercialize the Dish-Stirling system for emerging markets. During Phase I of the project, which was completed in October of 1999, the focus was on operating and evaluating the performance of the Stirling engine, the "critical" system component. The main activities demonstrated performance and reliability of the engine with primary focus on the internal parts that operate at elevated temperatures. Phase II, which started in October of 2000, calls for building and testing two complete next-generation systems by Fall 2001. The third phase of the DECC project is planned to include deployment of enough Dish-Stirling systems to field-validate reliability of the technology. The location of this demonstration has not been determined, but Phase III could become part of a solar initiative being planned for the southwest U.S.

The main results from the Boeing/SES DECC Project so far include:

- More than 21,000 hours of operation on four Stirling engines (10,000 on sun and 11,000 in test cell)
- Average daily efficiency of 24% conversion of solar energy into electricity
- Solar System availability exceeding 96%
- Peak solar power generation of 24.9 kW

The Opportunity and the Challenge

The Boeing/SES Dish-Stirling system is being developed for use in emerging global markets for distributed generation, green power, remote power, and grid-connected applications. These systems have advantages over more conventional power generators in that they produce no emissions because they burn no fuel (when operating on solar energy) and operate quietly compared to diesel or gasoline engines. They start up and shut down automatically, and with projected low maintenance requirements, they will be capable of operating for long periods with little support. Individual units of 25 kilowatts can operate independent of power grids in remote sunny locations for pumping water or they can generate power for people living in remote villages. Largely because of their high efficiency and "conventional" construction, the cost of Dish-Stirling systems is expected to be competitive in distributed markets.

Opportunities are emerging to deploy Dish-Stirling systems in the Southwest U. S. Many states are adopting green power requirements in the form of "portfolio standards" and mandates. Being able to exploit these opportunities is critical to increasing production levels so that system capital costs can be reduced. Operating these systems for long periods of time is necessary to identify and correct issues important to reducing system operating and maintenance costs.

Fully one-third of the world's inhabitants, many in sunny, semiarid regions, live in homes without electricity. The payoff for successfully meeting the challenges ahead is the opening of this immense global market to Dish-Stirling technology.

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.**

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