Sun♦Lab SnapShot

Solar Dish-Engine Systems

Solar dish-engine systems are currently being developed for application in high-value remote power, distributed generation, green power, and other grid-connected markets.

The Boeing/Stirling Energy Systems DECC project will evaluate the performance of the "critical" parts of the Stirling engine and develop the next-generation of the 25 kW Dish-Stirling System.

This Science Application International Corporation/ STM Power Inc. 25 kW Dish-Stirling System is operating at a Salt River Project site in Phoenix, AZ.

What is a Solar Dish-Engine System?

A Solar Dish-Engine System is an electric generator that “burns” sunlight instead of gas or coal to produce electricity. The major parts of a system are the solar concentrator and the power conversion unit. Descriptions of these subsystems and how they operate are presented below.

THE DISH, which is more specifically referred to as a concentrator, is the primary solar component of the system. It collects the solar energy coming directly from the sun (the solar energy that causes you to cast a shadow) and concentrates or focuses it on a small area. The resultant solar beam has all of the power of the sunlight hitting the dish but is concentrated in a small area so that it can be more efficiently used. Glass mirrors reflect ~ 92% of the sunlight that hits them, are relatively inexpensive, can be cleaned, and last a long time in the outdoor environment, making them an excellent choice for the reflective surface of a solar concentrator. The dish structure must track the sun continuously to reflect the beam into the thermal receiver.

Solar dish-engine systems convert sunlight into electricity at very high efficiencies–higher than any other solar technology. The current record is held by a Solar Dish-Stirling system that converted 29.4% of the incident sunlight into electrical power.

THE POWER CONVERSION UNIT includes the thermal receiver and the engine/ generator. The thermal receiver is the interface between the dish and the engine/generator. It absorbs the concentrated beam of solar energy, converts it to heat, and transfers the heat to the engine/generator. A thermal receiver can be a bank of tubes with a cooling fluid, usually hydrogen or helium, which is the heat transfer medium and also the working fluid for an engine. Alternate thermal receivers are heat pipes wherein the boiling and condensing of an intermediate fluid is used to transfer the heat to the engine.

The engine/generator system is the subsystem that takes the heat from the thermal receiver and uses it to produce electricity. The most common type of heat engine used in dish-engine systems is the Stirling engine. A Stirling engine uses heat provided from an external source (like the sun) to move pistons and make mechanical power,

Concentrating Solar Power Program

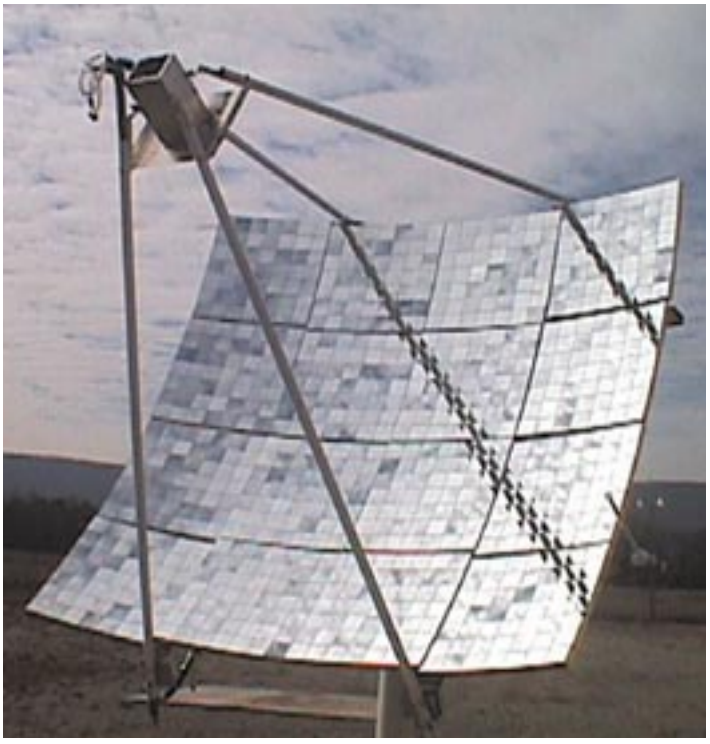
similar to the internal combustion engine in your car. The mechanical work, in the form of the rotation of the engine's crankshaft, is used to drive a generator and produce electrical power.

In addition to the Stirling engine, microturbines and concentrating photovoltaics are also being evaluated as possible future power conversion unit technologies. Microturbines are currently being manufactured for distributed generation systems and could potentially be used in dish-engine systems. These engines, which are similar to (but much smaller than) jet engines, would also be used to drive an electrical generator. A photovoltaic conversion system is not actually an engine, but a semi-conductor array, in which the sunlight is directly converted into electricity.

What are the markets for Solar Dish-Engine Systems?

Solar dish-engine systems are being developed for use in emerging global markets for distributed generation, green power, remote power, and grid-connected applications. Individual units, ranging in size from 9 to 25 kilowatts, can operate independent of power grids in remote sunny locations to pump water or to provide electricity for people living in remote areas. Largely because of their high efficiency and "conventional" construction, the cost of dish-engine systems is expected to compete in distributed markets.

Opportunities are emerging for the deployment of dish-engine systems in the Southwest U. S. Many states are adopting green power requirements in the form of



This small photovoltaic solar dish conversion system is being developed by Concentrating Technologies, LLC.

The Advanced Dish Development System is a 10 kW water pumping system developed by WG Associates for use by Native Americans in the southwest U. S.

"portfolio standards" and renewable energy mandates. While the potential markets in the U. S. are large, the size of developing worldwide markets is immense. The International Energy Agency projects an increased demand for electrical power worldwide more than doubling installed capacity. More than half of this is in developing countries and a large part is in areas with good solar resources, limited fossil fuel supplies, and no power distribution network. The potential payoff for dish-engine system developers is the opening of these immense global markets for the export of power generation systems.

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.**

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.

SAND2001-2534P
August 2001