# Concentrating Solar Power Program

## Technology Overview

**Concentrating solar power systems use the heat from the sun's rays to generate electricity. Reflective surfaces concentrate the sun's rays up to 10,000 times to heat a receiver filled with a heat-exchange fluid, such as oil. The heated fluid is then used to generate electricity in a steam turbine or heat engine. Mechanical drives slowly turn the reflective surfaces during the day to keep the solar radiation focused on the receiver.**

Three main types of concentrators are used in concentrating solar power systems. *Parabolic trough* systems concentrate solar rays onto a receiver pipe located along the focal line of a trough-shaped reflector. *Power Towers* use a field of sun-tracking mirrors (heliostats) to reflect solar radiation onto a receiver that sits on top of a tall tower. In both of these systems, the heated fluid is passed through a heat exchanger to boil water for a steam turbine that generates electricity. The third type of concentrator uses a *parabolic dish* to focus solar radiation onto a receiver mounted at the focal point of the dish. Instead of producing steam, most dish systems generate electricity by using the hot fluid to run a Stirling heat engine.

Warren Gretz, NREL/PIX06181

***The modularity of dish systems, such as this 25-kW model manufactured by Science Applications International Corporation, makes them ideally suited to a variety of distributed power applications at home and abroad, including village electrification projects in the developing world.***

## U.S. Department of Energy Program

**The U.S. Department of Energy (DOE) works with industry partners to develop concentrating solar power technologies. This collaboration has produced significant results. Parabolic troughs provide the cheapest solar electricity currently available, and utility-scale trough systems have been in operation since 1984. The ability of power towers to generate electricity around the clock has been established by Solar Two, a 10-megawatt (MW) demonstration project that used molten salt as the heat-exchange and -storage fluid. Finally, parabolic dish systems have now demonstrated thousands of hours of trouble-free operation in preparation for distributed energy applications.**

In response to the changes wrought by utility restructuring and the recent increase in the cost of energy, DOE's Concentrating Solar Power Program has stepped up its cooperative efforts with industry to lower the cost of the technology. This strategy will help industry compete in near-term renewable energy markets and further reduce costs through economies of scale, thereby improving the penetration of broader domestic and international energy markets in the long term.

The Concentrating Solar Power Program has three main thrusts:

- Distributed power – Improving the reliability of dish/engine systems for distributed and residential-sized applications in the U.S. Southwest.
- Dispatchable power – Reducing energy costs to bring power tower and trough technologies to near-term dispatchable power markets in the United States.
- Advanced component research – Addressing the research required to achieve energy costs in the range of 4 cents per kilowatt hour (¢/kWh) to 6 ¢/kWh. At this price, concentrating solar power technologies would be competitive in large-scale distributed and dispatchable power markets.

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## Solar Troughs: Proven Success

Parabolic trough systems have already proven themselves in the field, with nine power plants operating successfully in California, some since 1984. The plants, installed at three locations, have a combined capacity today of 354 MW. In 1997, five plants with 150 MW of combined capacity produced a record 2,071,000 kWh in a single day, enough to power more than 75,000 homes daily. They did this at a daily solar-to-electricity conversion efficiency of 18%.

Warren Gretz, NREL/PIX00033

***Nine trough power plants in California's Mojave Desert together provide the world's largest solar generating capacity, with a combined output of 354 MW.***

# Market Potential

**Like all solar generating technologies, electricity from concentrating solar power systems is currently too expensive to compete in U.S. bulk power markets. The levelized energy cost from trough plants (using natural gas as a backup power source) is currently 10 ¢/kWh to 12 ¢/kWh. The technology can, however, be competitive in certain peak (dispatchable) power applications and other high-value markets. In a deregulated domestic electricity market, for example, distributed power represents a significant niche for concentrating solar power systems. The use of concentrating solar power will provide an additional energy option for home owners and businesses as well as helping reduce greenhouse gas emissions in the United States.**

Concentrating solar power technology is best suited for the southwestern United States. This region is the fastest growing part of the country. As we enter the 21ST century, concentrating solar technology can be used to tap an underutilized domestic energy resource to help supply the needs of a growing population.

Parabolic troughs are particularly well suited to providing additional capacity to existing gas-turbine- and coal-based generating systems. Gas turbines, especially, can benefit from the additional solar capacity as they are adversely affected by high ambient temperatures – just when concentrating solar power is making its biggest contribution. In areas with an inadequate transmission and distribution infrastructure, the integration of dish systems with other renewables could provide an attractive alternative to diesel generator sets.

## For More Information:

DOE Concentrating Solar Power Program
Web: http://www.eren.doe.gov/csp/

Industry: Solar Energy Industries Association
Tel: (202) 383-2600
Web: http://www.seia.org/

General technology information: Energy Efficiency and Renewable Energy Clearinghouse
Tel: (800) DOE-EREC (363-3732)
Fax: (703) 893-0400
E-Mail: doe.erec@nciinc.com

Produced for the
U.S. Department of Energy
1000 Independence Avenue, SW
Washington, DC 20585
by the National Renewable Energy Laboratory
a DOE national laboratory

DOE/GO-102001-1179
April 2001

Printed with renewable-source ink on paper containing at least 50% wastepaper, including 20% post-consumer waste