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Renewable Energy Fact Sheet

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Concentrating Solar Power

Focusing the sun's energy with mirrors to produce electricity

Key Facts

- Concentrating solar power (CSP) technologies use mirrors to focus the sun's heat. This heat is used to boil water, and the resulting steam turns a turbine to generate electricity.
- Concentrating solar power plants provide the lowest cost power of any solar technology. They can produce electricity for $0.09 to $0.12 per kilowatt-hour (kWh), which can be competitive with peak power prices.
- About 500 megawatts (MW) of concentrating solar power capacity will be installed worldwide by the end of 2005, according to the US Department of Energy. The world's largest solar facility, a 345 MW CSP trough system, has been operating in the Mojave Desert in California since 1984.
- The United States has enormous solar energy potential. For example, a 100 mile by 100 mile plot of land in Nevada, fitted with CSP trough systems, could provide enough electricity for the entire United States, according to the National Renewable Energy Laboratory.

Concentrating Solar Technology

- *Trough systems:* Using long, curved mirrors, trough systems concentrate solar energy onto oil-filled pipes, heating the oil. This hot oil is used to boil water, creating steam to turn a turbine. Heat can be stored in the oil, so trough systems can continue to generate power for several hours after dark or in cloudy weather. Trough systems range in size from 10 MW (sufficient for a small town) to 150 MW (utility-scale). Since peak energy demand occurs during the day and corresponds to peak solar energy supply, trough systems can generally provide peak-load power.
- *Power tower systems:* In a power tower system, a field of flat mirrors focuses the sun's energy onto a receiver located on a central tower. Molten salt flows through this receiver and is heated by the concentrated solar energy. The heat stored in this salt is later used to generate steam to power a turbine. Molten salt can retain heat for several hours, allowing electricity to be generated at night or at times when demand is higher. Existing power tower plants, such as Solar Two in the Mojave Desert, have between 10 MW and 30 MW of electrical capacity, and plants with capacities of 50 MW to 200 MW are currently in development.
- *Dish systems:* A mirrored dish, similar to a very large satellite dish, tracks the sun throughout the day. The solar power dish focuses the sun's energy onto a photovoltaic module, or a heat pump called a Stirling engine. These systems provide intermittent and peak load power. Each dish generates from 2 to 25 kW, making this technology ideal for distributed electrical generation. A 250-kW plant composed of ten 25-kW dishes requires less than an acre of land.

Benefits

- *Added land value:* Much of the land with the best solar resources is inadequate for farming, grazing, or habitation. Solar power generation adds considerably to this land's financial value.
- *Central generation and storage capability:* Concentrating solar power can be generated centrally and distributed through the electricity grid, so this technology can easily be integrated into the existing power distribution network. Since concentrating solar power plants can store solar energy, they may be able to match power production with energy demand better than other solar energy technologies.
- *Pollution prevention:* Using solar energy does not release greenhouse gases or other pollutants.
- *Jobs and security:* Electricity from concentrating solar power is produced domestically, providing manufacturing and installation jobs for Americans and helping to reduce energy security concerns associated with depending on foreign countries for oil and natural gas.

Cost

- Concentrating solar power technologies provide the lowest cost electricity of any solar technology. Concentrating solar power plants with capacities of over 10 MW currently can produce electricity for $0.09 to $0.12 per kilowatt-hour (kWh). This price is higher than other commercial electricity sources, but it can be competitive with peak power prices. Operation and maintenance costs have decreased by 40 percent since concentrating solar power was first developed.
- A review by the National Research Council concluded technological innovation and large-scale deployment of the technology will allow concentrating solar power to become economically competitive, and the US Department of Energy projects the cost of concentrating solar power will fall to $0.04 to $0.05 per kWh within the next few decades.

Issues

- *Direct sunlight:* These systems require direct sunlight and are, therefore, not suitable for all locations. The best locations for collecting solar energy in the United States are in the Southwest, which also have high peak electrical demand (for air conditioning), coinciding with all those sunny days.
- *High capital costs:* Most concentrating solar power systems in the United States are utility-scale installations in the southwestern United States. These systems were installed under favorable power purchase rates that are not generally available anymore. Several southwestern states are currently investigating policies to foster concentrating solar power development.
- *Ongoing research:* Prototypes of new trough and dish systems have been installed in Spain, Egypt, Morocco, Italy, and the United States over the past few years. Researchers are testing the systems' durability and expanding their capacity to store solar energy. They are also investigating hybrid systems, where solar power generation is combined with wind, natural gas, or coal systems, to increase power production and reduce the overall cost of power production.

For More Information

American Solar Energy Society http://www.ases.org/
National Renewable Energy Laboratory http://www.nrel.gov/clean_energy/concentratingsolar.html
National Research Council http://www.nap.edu/catalog/10587.html
Solar Energy Industries Association http://www.seia.org/
DOE Office of Energy Efficiency and Renewable Energy http://www.eere.energy.gov/solar/csp.html

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