Solar Thermal Electric Technologies

Using the sun's heat to generate electricity

Commercial prospects for solar thermal electric technologies recently got brighter when the nation's two leading resources for solar thermal research—the National Renewable Energy Laboratory and Sandia National Laboratory in Albuquerque, N.M.—joined together to form a single, unified research laboratory called SunLab.

SunLab, which combines the expertise and experience of the two laboratories, works with solar thermal manufacturers and users to develop reliable and efficient solar thermal systems, increase acceptance of the systems and help the systems penetrate growing domestic and international energy markets.

Solar Thermal Electric Power

Solar thermal electric technologies convert solar energy into electricity by using reflectors (or concentrators) such as mirrors to focus concentrated sunlight onto a receiver. The receiver transfers the heat to a conventional engine-generator—such as a steam turbine—that generates electricity. There are three types of solar thermal systems: power towers (central receivers), solar dish generators and parabolic troughs.

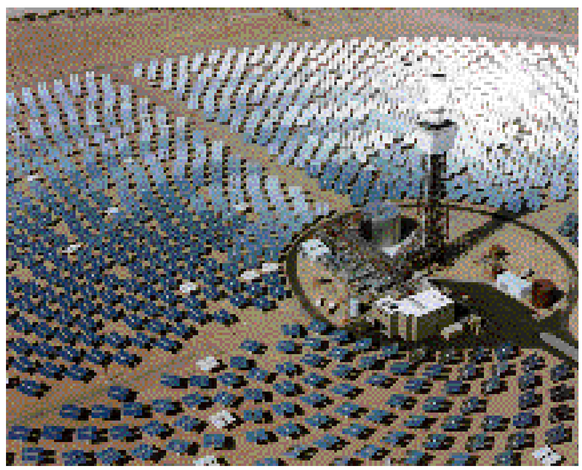
More than 350 megawatts (mWe) of solar thermal electric systems have been installed in the U.S. This power meets the needs of over 350,000 people and annually displaces the energy equivalent of 2.3 million barrels of oil.

Technology Development

To reduce costs and improve performance and reliability of solar thermal systems, SunLab researchers are developing lower cost solar concentrators, high-efficiency engine/generators and high-performance receivers.

Advanced concentrator technology— Research efforts focus on developing new, innovative designs for solar concentrators that will lead to less expensive, higher-performance heliostats (reflectors) and dishes.

Optical materials—Researchers are developing new reflective materials, such as polymer films, to replace expensive glass mirrors. Optical materials are used to concentrate sunlight. The goal is to develop reflective materials with excellent optical and wear-resistant properties that can be produced at a fraction of the cost of glass mirrors.



Power tower technology—To improve power tower (central receiver) technologies, SunLab and Rockwell International are developing an advanced receiver that is smaller and more efficient than current designs. Researchers also are working with several utilities to examine the feasibility of building hybrid power towers that run on both solar energy and natural gas. Hybrid power towers run continuously throughout the day and night.

Dish receiver technology—Researchers are developing an advanced heat pipe receiver for hybrid operation of dish/engine systems. The solar/fossil hybrid design will operate regardless of time of day or weather conditions.

Systems Development

SunLab works in partnership with industry on cost-shared projects aimed at developing and demonstrating solar thermal electric technologies. Major projects include:

Solar Two—Aconsortium of utility and industry partners, DOE and SunLab converted the existing 10-mWe Solar One Pilot Plant near Barstow, Calif. into an advanced molten-salt receiver and thermal storage system. The new storage system enables the power plant to operate three hours after sunset. The added operating time generates electricity during peak demand periods, greatly enhancing the technology's cost effectiveness. The project was cost-shared between DOE and the industry partners

Dish/Stirling joint venture programs— Through cost-shared subcontracts, Cummins Power Generation, Inc. is developing a commercial 7.5-kilowatt (kWe) dish/Stirling system for remote applications. Cummins and Science Applications International Corporation are each developing commercial 25-kWe dish/Stirling systems for utilities. The projects are cost-shared between DOE and the industry partners.

Operation and Maintenance Cost Reduction—SunLab researchers are helping plant owners reduce operation and maintenance costs at the Solar Electric Generating System (SEGS) III-VII power plants in Southern California. The power plants have an existing capacity of 150 mWe, and are the only utility-scale solar thermal power plants currently operating in the world. Plant operators expect to reduce costs by 30 percent.

SolMaT—The Solar Thermal Manufacturing Technology (SolMaT) initiative was established to reduce the cost of solar thermal technologies. SolMaT efforts include identifying common manufacturing barriers, evaluating processes for manufacturing solar components and testing components to ensure they meet performance and durability goals.

Benefits

Solar thermal power systems provide an environmentally benign source of energy, produce virtually no emissions and consume no fuel other than sunlight. The systems also have low operating costs, produce power during peak demand periods and provide a secure source of energy. Energy storage allows the plants to operate in cloudy weather and after sunset, and solar/fossil hybrid systems operate around the clock regardless of weather. Solar thermal power plants also create two and a half times as many skilled jobs than do fossil fuel plants.

Challenges

Solar thermal power plants are still in the early stages of commercial development and are currently more expensive than fossil fuel plants. Costs can be reduced through economies of scale, as well as through improved component design and advanced systems. Also, because solar thermal systems are capital intensive, they pay much higher taxes over their lifetime than do power plants that have higher operating costs, such as fossil fuel plants. Solar thermal is appropriate only in regions that receive abundant sunlight.

Potential

During the next decade, worldwide demand for electricity is expected to create markets for hundreds of mWe of new solar thermal power systems. U.S. government experts speculate that by the year 2010, more than 5,000 mWe of solar thermal power systems could be installed throughout the world.

8/96