Concentrating Solar Power

Concentrating Solar Power (CSP) offers a utility-scale, firm, dispatchable renewable energy option that can help meet the nation's demand for electricity. Worldwide, CSP activity is rapidly scaling, with approximately 14,500 megawatts (MW) in various stages of development in 20 countries. In the United States alone, more than 400 MW of CSP are currently in operation, with another 75 MW under construction and more than 10,000 MW under development.

Credit: Pat Corkery/PIX 16142

The SkyTrough solar concentrator was developed with highly-reflective, silver-metalized film that is lighter and less expensive than the glass mirrors that are traditionally used.

CSP Technology Basics

There are four primary types of CSP systems. *Parabolic trough* systems use mirrors that reflect and focus sunlight onto a linear receiver tube. The receiver contains a fluid that is heated by the sunlight and then used to create superheated steam, which spins a turbine and drives a generator to produce electricity. *Linear Fresnel* systems approximate the parabolic shape of a traditional trough collector with long, ground-level rows of flat or slightly curved mirrors that reflect the solar rays onto an overhead, downward-facing linear receiver. *Dish-engine* systems use a parabolic dish of mirrors to direct and concentrate sunlight onto a central engine that produces electricity. *Power tower* systems use numerous tracking mirrors, called heliostats, which reflect the sun's rays to a receiver located on top of a centrally located tower. A heat transfer fluid heated in the receiver is used to generate steam, which is used in a conventional turbine generator to produce electricity.

Collaborating Among Industry, Universities, and National Labs

The goals of the U.S. Department of Energy's (DOE's) Solar Energy Technologies Program (SETP) CSP Subprogram include lowering costs and advancing technology to the point that CSP is competitive in the intermediate power market by 2015-2017 and in the baseload power market by 2020-2022. Research and Development (R&D) is conducted through cost-shared contracts with industry, universities, and national laboratories. In addition, the CSP subprogram develops partnerships with federal and state agencies, as well as throughout the solar industry, to encourage the deployment of CSP technologies by addressing land and transmission issues.

Offering Financial Opportunities

Since 2007, the CSP subprogram has established 40 ongoing partnerships through competitive solicitations with companies and universities by giving financial and technical assistance to each awardee. The 12 contracts awarded in 2007 focus on advanced CSP components and manufacturing concepts; the 15 contracts awarded in 2008 emphasize novel thermal energy storage concepts and improved heat transfer fluids. All of these projects represent important steps toward making CSP a cost-competitive source of power.

In May 2010, the CSP subprogram added 13 new contracts that will develop CSP components and systems capable of providing low-cost, baseload power. The grantees, receiving up to $62 million in DOE funding, will seek to improve CSP designs to extend plant operation to an average of about 18 hours per day, a level of production that would make it possible for these plants to displace traditional coal-burning power plants.

Credit: NREL/PIX 02385

Concentrating solar power (CSP) technologies, such as power towers, are potential demonstration projects for the Solar Demonstration Zone in Nevada.

Supporting Industry

National laboratories, primarily the National Renewable Energy Laboratory (NREL) and Sandia National Laboratories (SNL), support the CSP industry with critical R&D to meet cost, reliability, performance, and manufacturability challenges.

One of the most important avenues of support is through optical tool development, including the Video Scanning Hartmann Optical Test (VSHOT) and Theoretical Overlay Photographic Collector Alignment Technique (TOPCAT). Industry partners have used both to characterize and align reflectors. Another area of industry support is resource assessment, in which accurate weather and solar insolation data are captured through improved satellite imaging, additional ground data sites, and forecasting. Other research topics include materials; thermal storage and heat transfer concepts; reflector and absorber concepts; trough, tower, and dish-engine component and system R&D; and CSP systems analysis.

Moving CSP into the Market

CSP technology continues to mature and develop at a rapid pace, but several nontechnology hurdles (primarily issues related to land and transmission access) stand in the way of large-scale CSP deployment in the United States. In terms of land use, CSP plants require a relatively large plot of land; for example, a 100-MW project requires almost one square mile of land. Furthermore, land must be selected in a way that minimizes environmental and ecological effects.

To help address these concerns, the CSP subprogram is co-leading a Programmatic Environmental Impact Statement with the U.S. Department of the Interior's Bureau of Land Management (BLM). A significant number of acres administered by BLM in desert areas of the Southwest USA register the necessary levels of solar radiation for CSP development. The purpose of the environmental impact statement is to identify suitable federal land for utility-scale solar project development. Others participating in this effort include the California Energy Commission, the California Public Utilities Commission, the Department of Defense, and Argonne National Laboratory (ANL). Thus far, 24 solar energy study areas have been identified, totaling 677,000 acres of land.

As a corresponding activity to the establishment of the solar energy study areas, DOE and the U.S. Department of Interior (DOI) announced in July 2010 that they will collaborate on establishing a "Solar Demonstration Zone" to demonstrate cutting-edge CSP technologies. The 25 square-mile demonstration zone will serve as a proving ground for new solar technologies, providing a critical link between DOE and industry's advanced technology development activities and full-scale commercialization efforts.

CSP and the Recovery Act

Through the utilization of funds from the American Recovery and Reinvestment Act of 2009 (ARRA), the CSP subprogram received $22.7 million to upgrade SNL and NREL facilities: SNL for thermal storage and advanced systems testing, and NREL for a materials research laboratory and advanced thermal storage facility.

In addition, the CSP subprogram issued a $4.7 million CSP National Laboratory Call through ARRA funds, under which advanced thermal energy storage (TES) and heat transfer fluids research will be conducted through awards to ANL, NREL, Oak Ridge National Laboratory, Los Alamos National Laboratory, Pacific Northwest National Laboratory, and Savannah River National Laboratory. These contracts complement and support the ongoing private sector work.

Solar Program Priorities

Concentrating Solar Power is one of four subprograms in the DOE Solar Energy Technologies Program (SETP), along with Photovoltaics, Systems Integration, and Market Acceleration. The SETP subprograms focus on accelerating the advancement of solar energy technologies to make solar electricity cost competitive with conventional forms of electricity by 2015. To learn more about SETP activities, visit www.solar.energy.gov.

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