Concentrating Solar Power

Concentrating solar power (CSP) is a reliable and well-known form of solar power. Nine solar trough plants producing more than 400 megawatts (MW) of electricity have been operating reliably in the California Mojave Desert since the 1980s. With a renewed sense of urgency to commercialize renewable energy sources, the U.S. Department of Energy (DOE) is ramping up its CSP research, development, and deployment efforts. These efforts, which are leveraging both industry partners and the national laboratories, are directed toward the development of parabolic trough, dish/engine, and power tower CSP systems.

DOE national labs assist industry in improving dish-Stirling engine systems. Early in 2008, a 25-kilowatt (kW) Stirling Energy System dish set a new solar-to-grid system conversion efficiency record of 31.25%, generating a net electrical output of 26.75 kW.

Reaching Its Goals

DOE's goals include increasing the use of CSP in the United States, making CSP competitive in the intermediate power market by 2015, and developing advanced technologies that will reduce systems and storage costs, enabling CSP to be competitive in the baseload power market by 2020.

DOE plans to achieve these goals through cost-shared contracts with industry, advanced research at its national laboratories, and working with other government agencies to remove barriers to the deployment of the technology.

Refining the Technology with Industry

In 2008, DOE established a dozen contracts with industry through a competitive solicitation. The objectives of these contracts include the development of storage solutions, manufacturing approaches, and new system concepts for large-scale CSP plants. Each contract requires a minimum 25% cost share.

To continue its support and development of CSP systems, DOE released a solicitation in 2008 that will lead to additional innovations in advanced high-temperature heat-transfer fluids (HTFs) and thermal storage systems. Improved HTFs will lead to increased system efficiency and lower life-cycle costs for solar trough systems. Development of thermal storage systems will improve the value of CSP systems by extending the system electrical output to better coincide with peak usage periods. Thermal storage can also be used to address periods of intermittency. These development areas are important steps for CSP to become competitive in both the intermediate and baseload power markets. DOE is providing as much as $35 million over several years under this effort, which will be augmented with at least a 25% cost share from industry.

Refining the Technology with National Labs

In alignment with industry efforts, a critical focus of research at the national labs is the study and development of advanced storage materials. One project identifies non-nitrate salts and other inorganic salt formulations that possess improved physical properties but are not highly corrosive. Another study focuses on a new class of nanofluids having enhanced properties in the areas of thermal conductivity, heat capacity, freezing and boiling points, and high-temperature thermal stability.

In addition, advanced optical materials help to lower cost, improve performance, and increase the reliability of CSP systems. The DOE labs are working with industry

to characterize advanced absorber and reflector materials, as well as developing advanced selective absorbers and conducting research on advanced reflector hardcoats and antisoiling coatings.

Labs have also teamed with industry on improving dish/Stirling engine systems, with particular emphasis on increasing the reliability and improving the design and manufacturability of these solar technologies. In January 2008, a 25-kilowatt (kW) Stirling Energy System dish set a new solar-to-grid system conversion efficiency record of 31.25%, generating a net electrical output of 26.75 kW.

Two optical tools developed by DOE labs help the CSP industry design solar collectors and align collectors operating in the field. The Theoretical Overlay Photographic system is a rapid, effective optical approach to evaluate and correct mirror alignment in parabolic trough systems. The Video Scanning Hartmann Optical Test rapidly characterizes optical performance of point-focus and line-focus concentrators and heliostats.

Partners in CSP Success

DOE national labs helped develop a trough that was used in the largest CSP trough facility to be built in nearly 2 decades. Acciona Energy's Nevada Solar One, a 64-MW plant near Boulder City, Nevada, came online in June 2007. This installation, the largest of its type to be built in the world since 1991, consists of 47 miles of parabolic mirrors arranged in a grid. Nevada Solar One will produce enough power to supply 15,000 average U.S. homes. DOE invested $3 million in developing the new trough design, including testing and evaluating collector designs and pilot models.

Credit: Acciona

Site Selection and Streamlined Permitting

CSP solar power plants require large tracts of land with good solar resources. For example, a 250-MW plant with 6 hours of storage would require nearly 3 square miles of land. To help identify optimal solar sites, DOE is working with the Department of Interior's Bureau of Land Management (BLM) to conduct a Programmatic Environmental Impact Statement (PEIS). Under the PEIS, potential sites will be examined in California, Arizona, New Mexico, Nevada, Colorado, and Utah.

In addition to identifying the best sites for solar projects on the 119 million acres of BLM-managed land, this effort will explore the need for new transmission to access these sites. The PEIS will also allow for modifications in the BLM solar application process. These modifications will reduce the time required for project developers to navigate the permitting process for large utility-scale solar projects. The California Energy Commission and the California Public Utility Commission, among others, are expected to become cooperating agencies in this activity. DOE and BLM expect the PEIS process to take about 22 months. Visit http://solareis.anl.gov/ for more information.

DOE supports ongoing solar resource assessment at its national labs, which continue to update and refine the satellite-derived, direct-normal incident (DNI) data sets. DNI tools, including a geospatial toolkit and an Internet map server, are developed to provide power plant developers and utilities with easier access to solar resource data.

Solar Program Priorities

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

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