Concentrating Solar Power

Concentrating solar power (CSP) is a reliable and well-known form of solar power. Since the 1980s, nine solar trough plants producing more than 400 megawatts (MW) of electricity have been operating reliably in the California Mojave Desert. Purchase power agreements for CSP projects representing more than 7 gigawatts of electricity have been signed in the southwestern United States. Internationally, more than 800 MW of CSP technologies will be deployed in Spain and North Africa over the next 2 years, starting with the deployment of the PS10 and Andasol 1 plants—the first power tower and parabolic trough power plants in Europe. A list of projects in operation, under construction, or under development is available at *www.nrel.gov/csp/solarpaces.*

To speed the commercialization of renewable energy sources, the U.S. Department of Energy (DOE) is increasing its efforts toward development of parabolic trough, dish/engine, power tower, and linear Fresnel CSP systems. Industry partners and the national laboratories are closely involved in these efforts.

Reaching DOE Goals

DOE goals include increasing the use of CSP in the United States, making CSP competitive with natural gas in the intermediate power market by 2015, and developing advanced technologies that will reduce systems and storage costs. These will enable CSP to be competitive with coal in the baseload power market by 2020. The relatively lower cost of coal and the CSP system storage capacity required for the baseload power market pose a challenge. The benefit, however, would be a solar option to reduce the carbon dioxide released by coal-fired power plants.

Refining the Technology with Industry

In the near term, DOE's focus is on enabling the deployment of projects through research and development (R&D) support contracts and laboratory support, and by addressing market barriers where possible.

Credit: Acciona/PIX 16603

DOE national laboratories helped develop a new trough design used at Acciona Energy's Nevada Solar One facility in Boulder City, Nevada. The 64-MW plant came online in 2007 and produces enough power to supply 15,000 average U.S. homes.

In 2007, DOE established 12 contracts with industry through a competitive solicitation. The objectives are to develop storage solutions, manufacturing approaches, and new system concepts for high capacity-factor CSP plants. Each contract requires a minimum 25% cost share.

In 2008, DOE released a solicitation that led to 15 additional contracts supporting 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 trough systems. 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 developments are important steps for CSP to become cost competitive. DOE is providing as much as $35 million over several years, augmented with at least a 25% cost share from industry.

A third solicitation aimed at developing baseload CSP systems with higher efficiencies and longer-term energy storage was released in July 2009.

Refining the Technology with National Laboratories

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

The laboratories have teamed with industry to develop new components, emphasizing cost-effective designs and improving the reliability and manufacturability of dish/Stirling engine systems.

Innovation Recognized

DOE-supported collaboration between the solar industry and national laboratories resulted in a ground-breaking, low-cost system for utility-scale power generation: the SkyTrough™ Parabolic Trough Solar Concentrating Collector. The system overcomes the cost barriers of traditional solar concentrators by using a new weather-proof, low-cost, high-reflectance polymeric film instead of the traditional heavy, glass-based mirror. The system, developed by SkyFuel Inc. in Albuquerque, New Mexico, was honored with a 2009 R&D 100 award by *R&D Magazine*.

Credit: SkyFuel Inc./PIX 16604

In addition, advanced optical materials help to lower costs, improve performance, and increase the reliability of CSP systems. The DOE laboratories are working with industry to characterize advanced absorber and reflector materials, develop advanced selective absorbers, and conduct research on advanced reflector hardcoats and antisoiling coatings.

Optical tools developed by DOE laboratories help the CSP industry design solar collectors and align collectors operating in the field. The Theoretical Overlay Photographic System evaluates and corrects mirror alignment in trough systems. The Video Scanning Hartmann Optical Test rapidly characterizes optical performance of point-focus and line-focus concentrators and heliostats, and the Optical Fringe Analysis Slope Tool characterizes optical facets online during the fabrication process. Lastly, a full field assessment tool is being developed that will characterize entire fields of collectors rapidly so that the more specialized tools can be used more efficiently.

Selecting Sites and Streamlining Permits

CSP solar power plants require large tracts of land with good solar resources. To help identify optimal solar sites, DOE is working with the U.S. 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 Arizona, California, Colorado, Nevada, New Mexico, and Utah. In June 2009, BLM released for public comment maps of the six states showing 24 potential solar zones that total 676,000 acres of BLM-managed land.

The PEIS effort will also explore the need for new transmission to access these sites and allow for modifications in the BLM solar application process. These will reduce the time required for the permitting process for utility-scale solar projects. The California Energy Commission and the California Public Utility Commission, among others, are cooperating agencies in this activity. DOE and BLM expect the PEIS process to be completed in September 2011. Visit *http://solareis.anl.gov/* for more information.

DOE supports ongoing solar resource assessment at its national laboratories, 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, provide power plant developers and utilities with easier access to solar resource data.

Solar Program Priorities

CSP is one of four subprograms in the DOE Solar Energy Technologies Program (SETP), along with Photovoltaics, System Integration, and Market Transformation. 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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