Systems Integration

With solar energy technologies supplying more electricity in the United States, integrating solar seamlessly into the nation's electric power grid becomes increasingly important. Technologies for generation planning, interconnection, communication and control, and energy management are needed to allow solar electricity to feed into the grid simply, safely, and reliably. The Systems Integration (SI) subprogram works with industry, universities, and the national laboratories to overcome technical barriers to the large-scale deployment of solar technologies on the grid. The subprogram is investing primarily in four areas: grid integration, technology validation, solar resource assessment, and balance of system development.

Credit: Tom Stoffel/PIX 15558

The Alamosa Photovoltaic Plant in Alamosa, Colorado, uses Suntech solar modules to generate 8.2 MW of power.

While this subprogram covers a variety of subject areas, it is primarily addressing research and development necessary for wide-scale demonstration and deployment. Within the balance of systems and grid integration areas, the U.S. Department of Energy (DOE) is investing in new advanced inverter, controller, and energy management technologies. To help better predict solar's impact on the grid, DOE is developing advanced technical and economic modeling, simulation, and analysis capabilities that will give utility personnel a better understanding of photovoltaics (PV) and concentrating solar power (CSP) system power production. In addition, new ground- and satellite-based methods are being investigated for measuring, modeling, and forecasting solar radiation. Finally, DOE is supporting the development of consistent solar interconnection codes and standards, and transparent regulatory implementation practices. Collaborators in this work include the Solar America Board of Codes and Standards, the national laboratories, the National Institute of Standards and Technology (NIST), and the Institute of Electrical and Electronics Engineers (IEEE).

Clearing the Way for Solar

To help ensure the "bankability" of PV systems, the SI subprogram tests and evaluates new technologies to determine their impact on system performance and the levelized cost of energy (LCOE). Since component and system reliability are so important to reaching LCOE commensurate with conventional generation, the national laboratories are working diligently with the industry and code-making bodies to develop test protocols to find failure mechanisms early so they do not affect the legitimacy of solar as a proven technology. These testing and evaluation activities are then used to enhance the development of models like the Solar Advisor Model (SAM), allowing validation of component/system models, and to integrate various modeling platforms for collaborative development and use.

Collaborating with Stakeholders

The SI subprogram is working with NIST to develop new standards, including additions to the distributed energy interconnection standard IEEE 1547. The subprogram is also collaborating with the Electric Power Research Institute (EPRI) to develop new communications standards so utilities can communicate with and potentially control solar systems on the grid. The national laboratories are collaborating with the National Oceanic and Atmospheric Administration (NOAA) to collect high-quality solar radiation data from ground- and satellite-based measurements, meeting the needs for

Utility and Lab Collaboration in Colorado

The Systems Integration team is also collecting performance data on a large PV plant in Alamosa, Colorado. Sitting on 82 acres, the Alamosa Photovoltaic Plant uses Suntech solar modules to generate about 8.2 megawatts (MW) of power. SunEdison built, owns, and will maintain the Alamosa plant under a Solar Power Services Agreement. Xcel Energy will buy renewable energy credits and the solar power generated by the plant for 20 years. The solar power plant near the substation is unique because it consists of three types of solar technologies: single-axis tracking arrays, fixed-mount arrays, and a dual-axis tracking array with PV concentrator technology.

Making the Most of Hawaii's Sunshine

The Systems Integration team is supporting several solar projects in Hawaii. Since the Hawaii Clean Energy Initiative was launched in 2008, state officials have partnered with DOE to help the state obtain 70% of its energy from renewables by 2030.

One of projects involved engineering support to the island of Lanai for installing a 1.2-MW PV system with energy storage. This solar farm covers 10 acres and includes 12 arrays of more than 7,000 panels and a tracker system, representing a very high penetration of PV onto the Lanai grid. Other projects include developing road maps for renewables on each island and integration of several grid-tied PV projects.

improved atmospheric models, and developing solar radiation forecasts. Finally, the Solar Program is collaborating with utility organizations like the Solar Electric Power Association (SEPA) and the Utility Wind Interest Group (UWIG), particularly because of the interest from utilities in integrating variable generation (like solar and wind) into the electric distribution and transmission systems.

National laboratories such as the National Renewable Energy Laboratory (NREL) and Sandia National Laboratory (SNL) supply a range of technical and analytical assistance to industry partners in all four areas of the subprogram. They were instrumental in tackling the first step, which was to identify the scope of challenges for solar technologies to integrate into the grid by conducting a comprehensive analysis. In recent years the national labs, in collaboration with DOE, completed the Renewable Systems Interconnection (RSI) study, which consists of 14 reports, along with an executive summary, that address a range of grid-integration issues.

Investing in the Smart Grid

The Systems Integration subprogram has awarded $24 million from the Recovery Act for a three-year Solar Energy Grid Integration Systems (SEGIS) Program. SEGIS funds companies working on innovative technologies that will allow more PV systems to be integrated on the distribution system safely and reliably. These smart grid projects focus on developing three types of PV systems, which (1) communicate with an interactive utility grid and allow for bidirectional communications, fully controllable features, power and reactive power control, and grid stability; (2) work with energy storage devices and smart appliances that support the grid and respond to utility price signals; and (3) interact with building energy management systems.

In addition, DOE has awarded $37.5 million through the 2009 Funding Opportunity Announcement for High-Penetration Solar Deployment projects. This funding opportunity solicited industry-led projects to address topics in improved modeling tools, field verification of high-penetration PV use cases, modular power architecture, and demonstration of PV and energy storage for smart grids (which use digital technology to improve reliability, security, and efficiency).

Systems Integration Highlights

- Awarded funds to 12 industry teams through the SEGIS program to develop new inverters and controllers with interfaces for smart grid technology
- Developed a PV Working Group that includes utilities, industry, and universities to develop analysis to understand PV variability and collect data for large-scale systems
- Began monitoring large-scale PV performance at high-penetration sites in California, Colorado, and Hawaii to better understand how high levels of PV affect the grid and to reduce installation costs

Solar Program Priorities

Systems Integration is one of four subprograms in the DOE Solar Energy Technologies Program (SETP), along with Photovoltaics, Concentrating Solar Power, 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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