SunShot
U.S. Department of Energy

The DOE SunShot Initiative is a collaborative national initiative to make solar energy technologies cost-competitive with other forms of energy by reducing the cost of solar energy systems by about 75% by the end of the decade. Reducing the total installed cost for utility-scale solar electricity to roughly 6 cents per kilowatt hour without subsidies will result in rapid, large-scale adoption of solar electricity across the United States. Reaching this goal will re-establish American technological leadership, improve the nation's energy security, and strengthen U.S. economic competitiveness in the global clean energy race.

SunShot will work to bring down the full cost of solar – including the costs of solar cells and installation by focusing on four main pillars:

1. Technologies for solar cells and arrays that convert sunlight to energy;
2. Electronics that optimize the performance of the installation;
3. Improvements in the efficiency of solar manufacturing processes; and
4. Installation, design, and permitting for solar energy systems.

SCE's plan to install 500 MW represents the highest level of distributed PV in the U.S.
Photo Courtesy of Southern California Edison

Systems Integration

The Systems Integration (SI) subprogram works closely with industry, universities, and the national laboratories to overcome technical barriers to the large-scale deployment of solar technologies by:

- Reducing the costs of power electronics and balance of system hardware,
- Reducing the risk associated with the use of new technologies (bankability), and
- Establishing a timely process for integrating high penetrations of solar technologies into the grid in a safe, reliable, and cost-effective manner while providing value to the system owner and the utility grid.

To support these goals, the subprogram invests primarily in four areas: grid integration, technology validation, solar resource assessment, and balance of system development.

Balance of Systems Cost Reduction

To reduce the cost associated with power electronics and other balance of system hardware, the SunShot Initiative announced the **Solar Energy Grid Integration Systems – Advanced Concepts (SEGIS-AC)** and **Extreme Balance of Systems (BOS-X)** funding opportunities in March 2011. The awardees are listed below:

SEGIS-AC (Power Electronics)

1. **SolarBridge** will develop an innovative photovoltaic AC module.
2. **General Electric** will demonstrate a plug and play system design for residential systems.
3. **Alencon** will develop, centralized inverter using a high-voltage energy harvesting network.
4. **Delphi** will develop and demonstrate a modular cascaded multilevel PV inverter architecture.

BOS-X (Balance of System)

1. **The Dow Chemical Company** will develop a residential application that includes high power density and integrated designs for both heat management and power electronics.

2. **Carlisle Construction Materials Incorporated** will develop a low-cost, high-efficiency, flexible BIPV system integrated with roofing membranes.
3. **Solexel and Owens Corning** will develop a BIPV roofing shingle and installation accessories for residential sloped-roof applications.
4. **GE Global Research** will develop prewired, mechanically interconnected, foldable, strings of PV modules and electrical distribution busways for commercial buildings.
5. **Raymond Tinnerman** will develop an innovative bracket system for commercial rooftop installations.
6. **Zep Solar** will develop innovative structural components for ground-mount applications.
7. **Cascade Engineering** will develop an innovative racking system.
8. **Georgia Tech** will develop whole system designs to include the module mounting, integration, materials, and wire management.
9. **Amonix** will develop optimized installation approaches for concentrating photovoltaics (CPV) systems.

Grid Integration

To address the solar integration issues with the distribution system, the SI team focuses on technical areas such as variability, voltage regulation, power quality, protection, and unintentional islanding. The approaches include developing advanced grid-friendly PV interconnection technologies, validating inverter and system models, proactively engaging with external stakeholders, and updating standards and codes.

As part of the **SEGIS-AC** funding opportunity in the area of power electronics, four recipients are developing technologies to better integrate PV systems with the smart grid. The awardees include:

1. **University of Hawaii** will develop and demonstrate utility-controlled, smart grid-enabled PV inverters at two widely different utilities – on the island of Maui and at Oklahoma Gas and Electric.
2. **EPRI** will leverage ongoing investments in smart grid and related standards to develop smart-grid ready PV inverters with grid-support functionality, utility communication, and control link.
3. **Advanced Energy** will develop and commercialize ramp control by using energy storage, islanding detection, and synchrophasor technologies to reduce impacts of distributed PV systems.
4. **SatCon** will develop a PV inverter control architecture to eliminate voltage variation impacts due to PV generation variability while providing voltage support.

To address the issues with the transmission system, the SI team focuses on a mission to integrate high penetrations of solar in a reliable and cost-effective manner by measuring the variability and uncertainty of the solar energy system output (e.g. field data collection) and developing solutions (e.g. short-term and long-term forecasting, curtailment, storage) to minimize their impact on system operations. SI executes this in a variety of ways, including working with the DOE Wind Program and the Office of Electricity and Reliability to update the Western Wind and Solar Integration Study. The Solar Resource Assessment team also works closely with the National Oceanic and Atmospheric Association (NOAA), under a memorandum of understanding (MOU), to provide better solar resource data for system performance monitoring and forecasting.

Technology Validation (Bankability)

In the course of bringing new technologies to scale, manufacturers demonstrate "bankability" by validating their new technology to potential investors, potential customers, or insurance companies. To support these manufacturers in this effort, the DOE is developing Regional Test Centers, which will be located in three targeted climates: 1) hot-humid, 2) high thermal cycle and UV, 3) hot-dry. These centers will provide space required to install at least 2 MW of PV on their facility. PV module manufacturers will be able to use these sites to demonstrate a bankable product from an unbiased, technically competent source.

Making the Most of Hawaii's Sunshine

The Systems Integration team supports 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 project 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.

High Penetration Solar Deployment

Systems Integration has funded six High Penetration Solar Deployment Projects that focus on three research and development areas: development of improved modeling tools, field verification of high-penetration levels of PV into the distribution grid, and demonstration of PV and energy storage for smart grids. For more information visit the High Penetration Solar Portal webpage at solarhighpen.energy.gov/.

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