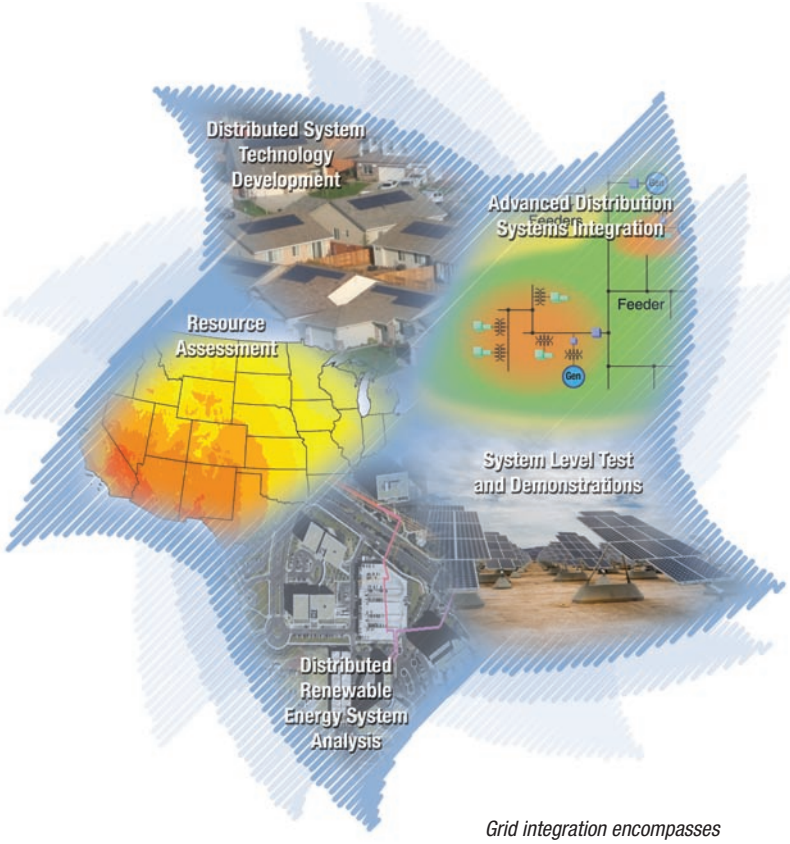
Grid Integration

As solar technologies provide an increasingly larger part of the U.S. electricity supply, it is becoming increasingly important that they be integrated seamlessly into the nation's electric power grid. This will require new ways of thinking about how we generate and distribute electricity and new technologies that make it simple, safe, and reliable for solar electricity to feed into the grid. The U.S. Department of Energy (DOE) is making significant investments in these grid-integration technologies and is coordinating with all stakeholders to accelerate the integration of renewable technologies.



Grid integration encompasses these five research areas.

The Challenges

Breaking down the regulatory, technical, and economic barriers to integrating solar electricity into the electric grid is a priority for DOE. Specific barriers to the proliferation of distributed solar electric systems vary from place to place.

Instituting net metering rules and simple, consistent interconnection standards is critical to all developing solar markets. Technology and equipment (e.g., advanced inverter and controllers) that allow real-time monitoring of the output of the solar system will also benefit both owners and utilities.

Historically, interconnection standards have applied largely to centralized power plants, and the requirements of connecting many small generators to the grid are significantly different. Interconnection standards that make this process easy, inexpensive, and safe are an important part of growing a healthy solar industry.

Other key technical issues will need to be addressed within the transmission and distribution systems, such as the need to accommodate bidirectional power flow and high penetrations of nondispatchable variable generation. Advancements in energy storage may be required to address many of these issues. Systems that can intelligently manage residential photovoltaic (PV) systems with other advanced home energy devices may also offer further enhancements. Tackling all of these concerns will allow tomorrow's utilities, businesses, and consumers to realize the maximum value from PV systems.

Responding to the Challenges

DOE is working with utilities and the solar industry to develop technologies and strategies that encourage the widespread market penetration of distributed PV technologies. DOE, working closely with industry, is responding to these challenges.

In early 2008, the Renewable Systems Interconnection (RSI) study, which comprises 14 individual reports focused on the various challenges of integrating small PV systems into the electric grid, was published. The RSI study identified the R&D initiatives required to accelerate the pace of distributed PV installations and to modernize the existing electricity grid to accommodate renewable energy. It covers topics ranging from PV systems design and technology to business models to market-penetration scenarios. The reports and executive summary are available at www.solar.energy.gov/solar_america/rsi.html.

Based on the results of the RSI study, the DOE grid-integration team initiated the Solar Energy Grid Integration Systems (SEGIS) activities to develop new PV inverters, controllers, and energy-management systems for distributed PV systems. Because this initial RSI study focused only on distributed PV, the team also drafted

the Critical Renewable Energy Storage (CREST) study plan to address transmission, distribution, and storage issues for PV as well as for concentrating solar power, wind, and "stranded" renewable resources.

In many ways, storage adds value to a renewable energy installation. For the owner, the system can function as an uninterruptible power source and a potential revenue source, because electricity can be sold during high-priced peak periods. For the utility, a system with storage can become a demand-response or load-management tool that can be used for load-shifting, peak-shaving, and to improve dispatchability.

R&D efforts that focus on simplifying and automating metering also benefit both utilities and solar system owners. For example, both groups benefit from metering that acknowledges time-of-use pricing on hot, sunny summer afternoons when the utility grid is strained and PV systems are working at capacity.

Bright Spots in Hawaii

DOE is supporting three projects in the Hawaii Clean Energy Initiative to help the state achieve its goal of obtaining 70% of its energy from renewables by 2030. In the first project, DOE is providing engineering support to the island of Lanai for the installation of a 1.5-megawatt PV system with energy storage. The second involves helping the island of Kauai develop a roadmap to accelerate the integration of renewables, with particular emphasis on a high penetration of PV installations. Finally, DOE is providing engineering support to Forest City Military Communities for the installation of both a PV array and rooftop PV systems. This project demonstrates the benefits of combining a high penetration of renewables with maximized energy efficiency in a residential community.

Credit: Will Boudra

Investing in Projects

DOE plans to invest as much as $24 million over a number of years to develop products that connect solar power systems with the electrical grid in an interactive way. Twelve industry teams were selected to receive $2.9 million in current fiscal year funding to develop conceptual designs and market analyses for such SEGIS projects. The projects will focus on PV systems and will involve such efforts as developing systems that can communicate with an interactive utility grid and advanced power meters to respond to power price changes over the course of a day, systems that can work with energy storage devices and "smart" appliances to respond to utility price signals, and systems that can interact with building energy-management systems.

The goal is to maximize the value of PV systems and offer consumers greater control over their electric consumption and costs. In the future, additional funding will be provided for the projects that achieve the most promising technological advancements while demonstrating a high likelihood of commercial success.

Grid Integration Projects at a Glance

DOE is supporting several grid-integration projects around the country. At Nellis Air Force Base in Nevada, DOE will be collecting solar energy performance data at the 15-megawatt (MW) PV installation. In Alamosa, Colorado, performance data is collected on an 8-MW PV plant. DOE will also collect data at the Anatolia subdivision of 600 energy-efficient homes equipped with PV systems in Sacramento, California. At Mesa del Sol in Albuquerque, New Mexico, data-monitoring systems will collect PV-performance data as this new sustainable community evolves to its capacity of 38,000 homes. And in Hawaii, DOE is working to help that state meet its ambitious renewable energy goals *(see **Bright Spots in Hawaii** sidebar)*.

Solar Program Priorities

Grid Integration is one of the four subprograms within the DOE Solar Energy Technology Program (SETP), along with Photovoltaics, Concentrating Solar Power, 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. To learn more about SETP activities, visit ww.solar.energy.gov.

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