U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Solar Energy Technologies Program

High Penetration Solar Deployment Awards

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October 26, 2009

Outline

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High Penetration Solar Deployment

- Topic 1: Improved Modeling Tools Development
- Topic 2: Field Verification of High-Penetration Levels of PV into the Distribution Grid
- Topic 3: Modular Power Architecture
- Topic 4: Demonstration of PV and Energy Storage for Smart Grids

Awardees

- Arizona Public Service Company
- Commonwealth Edison Company
- Florida State University
- National Renewable Energy Laboratory
- Sacramento Municipal Utility District
- University of California San Diego
- Virginia Polytechnic Institute and State University

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- One goal of the Systems Integration subprogram is to address challenges facing high penetration solar electricity generation into the electric power system.
- Examples of high penetration photovoltaic systems exist today in the United States
  - Anatolia III subdivision in Rancho Cordova - 91 Solar Smart homes having a 2 kW PV installation each (3% penetration)
  - Alamosa, Colorado - an 8 MW PV power plant (260% penetration)
  - Nellis Air Force Base - 14 MW PV plant with 70,000 PV panels, which supplies over 25% of the power used by 12,000 military personnel and civilians.

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- A better understanding of the effects of PV penetration levels on grid operations with respect to different distribution circuit characteristics (circuit designs, load and generation mixes, etc.) is needed for broad acceptance of high-penetration PV levels in distribution systems throughout the country.

The objectives of this funding opportunity were the following:

- 1) To gain experience with high penetration scenarios of photovoltaic systems on distribution systems and develop the tools needed to model their performance,
- 2) To develop the necessary monitoring, control and integration systems to enable cost-effective widespread deployment of small modular PV systems, and
- 3) To demonstrate the integration of PV and energy storage into Smart Grid applications.

Topic 1:
Improved Modeling Tools Development

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- Topic 1: Projects were required to demonstrate an improved ability to model the effects of high penetration solar electricity generation on the electric distribution system. The modeling tools must address the following:
  - The dynamic performance of PV systems associated with resource variability
  - Interactions with other distributed resources, loads, demand response, and storage on a distribution feeder
  - The effect of high penetrations on grid reliability and stability indices
- The fidelity of modeling results must be validated using simulations and field data.

Topic 2: Field Verification of High-Penetration Levels of PV into the Distribution Grid

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- Topic 2: Projects addressed approaches for field testing and validation of high-penetration levels of PV on typical distribution circuits and on new circuit configurations (including microgrids) for optimized technical and economic performance. Issues to be addressed include
  - voltage regulation schemes,
  - unintentional islanding prevention,
  - Intentional islanding/microgrid operation,
  - false inverter trips due to utility line transients,
  - reverse power flow in secondary network distribution systems,
  - reactive power (VAr) control schemes for multiple inverters,
  - fault contribution,
  - coordinated protection and operations with other protection equipment, and
  - effects of variable cloud cover on system stability.

Topic 3:
Modular Power Architecture

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- Projects were to demonstrate how high levels of small, modular PV systems (200-500 watt) can be integrated into the electrical distribution network.
  - PV systems should be low-cost, easy-to-install, modular and have a scalable power architecture.
  - Only technologies that have been previously demonstrated in utility test systems were eligible.

Topic 4: Demonstration of PV and Energy Storage for Smart Grids

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- Applications were sought to integrate PV and energy storage into Advanced Metering Infrastructure (AMI) pilot programs
- PV with energy storage can be integrated into homes or small businesses with an existing AMI.
- Applicants should address how this will enable real-time pricing and billing.

Awards

- ***Arizona Public Service Company***
- **Area**: Topic 2
- **Partners**: Arizona State University, the National Renewable Energy Laboratory, and General Electric
- **DOE Funding**: $3,328,000
- **Description**
  - This project will study the impacts of 1.5 MW of photovoltaic (PV) generation connected to a typical residential feeder.
  - The 1.5 MW of PV generation will include residential, commercial, and a 500 kW utility system.
  - Modeling and evaluation will be completed in accordance with utility standard practice.

Awards

- ***Commonwealth Edison Company***
- **Area**: Topic 4
- **Partners**: Gridpoint, Argonne National Laboratories, the Illinois Sustainable Energy Center
- **DOE Funding**: $5,000,000
- **Description**
  - This one-year project will evaluate consumer reactions when a utility provides advanced metering and price signals for electric power with PV, without PV, and with both PV and energy storage.
  - The impact will be measured on a utility-based understanding of market response for photovoltaics.

Awards

- ***Florida State University***
- **Area**: Topic 2
- **Partners**: The Florida Regional Coordinating Council, Florida Power and Light, Gainesville Regional Utility, JEA, Orlando Utilities Commission, Lakeland Electric, Florida Municipal Power Authority, Tampa Electric Company, the University of Central Florida, the University of South Florida, SunPower, SatCon, AMEC
- **DOE Funding**: $3,599,957
- **Description**
  - This project will identify the need for technical solutions to address any issues identified with high-penetration levels of grid-connected photovoltaics including
    - Protection, control strategies, and technologies
    - Converter, converter controls, and PV system technologies

Awards

- ***National Renewable Energy Laboratory***
- **Area*:*** Topic 2
- **Partners**: Southern California Edison, Clean Power Research, Electrical Distribution Design
- **DOE Funding**: $3,600,000
- **Description**
  - This project will utilize *modeling and simulation, laboratory testing, and field demonstrations* to determine the effect of high penetrations of up to 500 MW of mostly commercial scale rooftop PV systems on electrical distribution systems. This includes both typical distribution circuits and those with SmartGrid functionality.

Awards

- ***The Sacramento Municipal Utility District***
- **Area**: Topic 2
- **Partners**: The National Renewable Energy Laboratory, Navigant Consulting
- **DOE Funding**: $4,300,971
- **Description**
  - This one-year project will determine the value of advanced metering infrastructure, PV, and the additional value of storage by studying systems with:
    - No storage
    - Home-based storage, and
    - Community based storage.
  - Actual utility data will be available to assess the performance and market impacts of these options.

Awards

- ***University of California San Diego***
- **Area**: Topic 1
- **Partners**: EDSA Micro Corporation, San Diego Gas and Electric
- **DOE Funding**: $1,750,000
- **Description**
  - This project will develop *advanced modeling tools* and *electric power control strategies* to optimize electric power value and to mitigate the impact of PV-sourced electricity on existing microgrids and the SmartGrid.
  - Factors to be modeled and evaluated include monitoring of micro-climate effects by sky imaging systems to enable one-hour energy forecasting of PV systems in conjunction with utility dynamic price signals.

Awards

- ***Virginia Polytechnic Institute and State University***
- **Area**: Topic 2
- **Partners**: The Electric Power Research Institute (EPRI)
- **DOE Funding**: $3,206,108
- **Description**
  - This project will evaluate both existing and prototype power conditioners designed at Virginia Tech to identify cost-effective approaches to address issues associated with high-penetration PV systems including
    - Voltage regulation
    - Reverse power flow
    - Unintentional islanding
    - False inverter trips
    - Reactive power control
    - Intentional islanding operation.

Thank You

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