



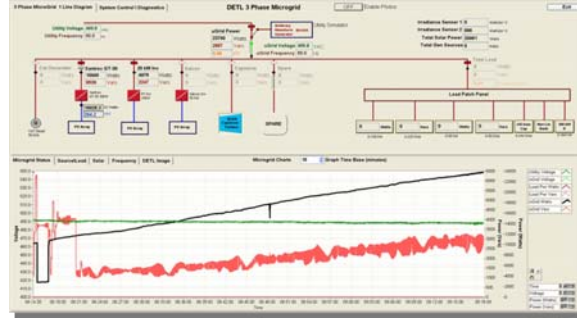
# PV System Evaluations for High Penetration Deployment

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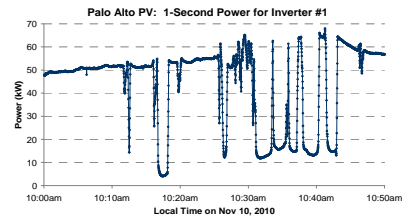
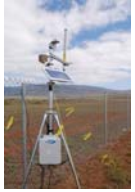
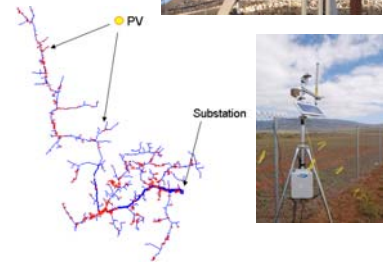
## Abstract

Utility planners and operators are concerned with power system performance and reliability as the penetration of variable generation increases. There is also high interest in understanding the interactions and inter-operability of smart grid technologies, including energy storage and demand response, with large-scale deployments of solar photovoltaic (PV) systems. The Distributed Energy Technologies Laboratory (DETL) at Sandia National Laboratories and the Distributed Generation (DG) laboratory at Electric Power Research Institute (EPRI) are conducting research, development, and demonstration to better understand and address issues associated with high penetration PV into the power system.



## PV Resource Modeling

- Collecting high-resolution (~ 1-sec) ac energy generation, solar radiance, and panel temperature data from different regions and sizes of PV plants
- PV resource model development using measured data
- Distribution feeder simulation to study effects of different PV penetrations



## Cooperative Research and Development Agreement (CRADA)

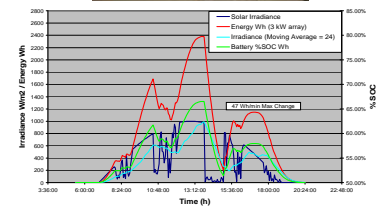
(Agreement pending final Review and Approval)

Sandia and EPRI are collaborating to address technical barriers to large-scale deployment of PV systems on the grid:

- Facilitate industry development and validate effective inverter-utility communication for distributed PV and storage
- Statistical characterization of PV output including high resolution data collection and geographical modeling
- Further development of OpenDSS distribution modeling tool and analysis of high penetration PV cases including representation of storage

## PV System Energy Smoothing

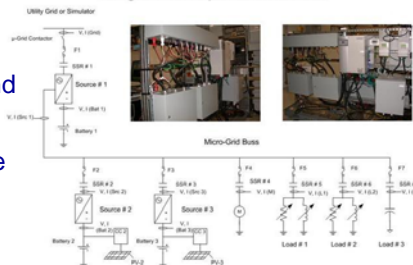
- Evaluating battery technologies and developing control algorithms for PV energy smoothing solutions
- Biggest obstacle could be the integration of energy control algorithms into inverters and battery management for the energy smoothing system



## Grid-Tied PV Resource Test Facilities

IEEE 1547 compliance tests for grid-tied inverters include:

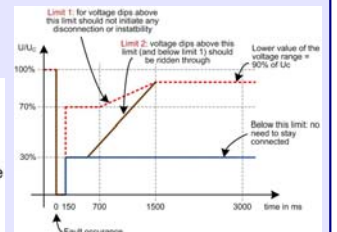
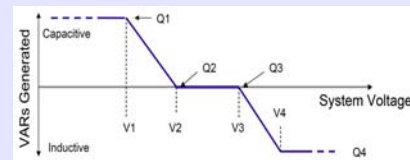
- energy capture
- dynamic event response (sag, swell, surge)
- response to conditions of over and under voltage and frequency
- anti-islanding performance
- intentional islanding mode



## Advanced Grid Support Inverter Research

Developing performance criteria and test setup for PV inverters with advanced grid support features:

- Low/Zero voltage ride through (L/ZRT)
- Volt-VAR voltage regulation control
- Active power curtailment
- Ramp-rate control



## Technical Contacts

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