NREL
NATIONAL RENEWABLE ENERGY LABORATORY



SunEdison Photovoltaic Grid Integration Evaluation

Cooperative Research and Development Final Report

CRADA Number: CRD-08-302

NREL Technical Contact: Ben Kroposki

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Cooperative Research and Development Final Report

In accordance with Requirements set forth in Article XI.A(3) of the CRADA document, this document is the final CRADA report, including a list of Subject Inventions, to be forwarded to the Office of Science and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

CRADA Number: CRD-08-302

CRADA Title: SunEdison Photovoltaic Grid Integration Evaluation

Parties to the Agreement: SunEdison

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources
Year 1	$ 50,000.00
Year 2	$ 50,000.00
Year 3	$ 50,000.00
TOTALS	$ 150,000.00

Abstract of CRADA work:

Under this Agreement, NREL will work with SunEdison to monitor and analyze the performance of photovoltaic (PV) systems as they relate to grid integration. Initially this project will examine the performance of PV systems with respect to evaluating the benefits and impacts on the electric power grid.

Summary of Research Results:

SunEdison installed and activated a 8.22-megawatt system in Alamosa, Colorado on December 17, 2007. At the time, this plant was the largest PV plant in the United States supporting substation loads for a major public utility. The solar plant was financed and built and will be maintained by SunEdison, under a Solar Power Services Agreement (SPSA). Under the SPSA, Xcel Energy will buy renewable energy credits and the solar power generated by the Alamosa plant for 20 years. The PV system will help meet a Colorado utility mandate of deriving 10% energy from renewable sources by the year 2015.

The solar power plant near the substation is unique in that it consists of three distinct types of solar technologies: single-axis tracking array, fixed-mount array, and a dual-axis tracking array with PV concentrator technology. The PV system is connected to the grid with Xantrex inverters. Two types of inverters are used: 12 x GT 500 kW inverters for the fixed-mount and single axis tracking array, and 288 x GT3.8 kW inverters for the dual-axis tracking systems. The Alamosa solar plant is on roughly 80 acres of land near the substation in Alamosa and the San Luis Valley in Colorado. The Alamosa system

interconnects through a dedicated circuit to a substation that has only one other circuit. The other circuit contains normal rural agricultural loads and has a peak of approximately 3MW.

The objectives of the Xcel Energy monitoring project are to determine the impact of a large PV system on the electrical distribution system. This includes the effects of voltage rise from the PV system, variable plant production due to intermittent clouds, and effect on voltage regulation equipment at the substation. Data collection is accomplished through the inverters (Xantrex GT500E) for the single-axis tracking system. The utility meter (ION 8600) monitors system operation and can be accessed remotely. Substation SCADA data are also accessible and provide total current, voltage, real power, and reactive power for the system.

With the data collected from the Alamosa system, the first objective was to examine the ramp rates of a large PV system due to intermittent cloud cover. Several days were analyzed and demonstrated that the PV system does have numerous time periods of high output fluctuations. This system represents approximately a 260% penetration scenario, where PV penetration is equal to the PV output divided by the load. Data showed that there can be large changes in power output, with the largest being -81% reduction in power output over a five-minute period due to clouds. The effect of these variations will continue to be analyzed and their impact on the electrical distribution system has been negligible so far. To date there have been no adverse effects on the electrical distribution circuit.

Subject Inventions Listing: No inventions were developed under this CRADA.

Report Date: July 25, 2012 **Responsible Technical Contact at Alliance/NREL**: Ben Kroposki

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