Public Service Co. of New Mexico (PNM) -PV Plus Storage for Simultaneous Voltage Smoothing and Peak Shifting



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Project Goals – Develop an even more Beneficial Renewable Resource – Transferable Nationwide

•Created a dispatchable, renewables-based peaking resource

•Combined PV and storage at a substation targeting 15% peak-load reduction

•Demonstrating a combination that can simultaneously mitigate voltage-level fluctuations as well as enable load shifting

•Developed power system models (baseline and projected), and cost/benefit economic models

•Generating, collecting, analyzing and sharing resultant data

•Enabling distributed solutions that reduce GHG emissions through the expanded use of renewables

Project Partners

Sandia National Labs: assistance in battery control algorithm development
Northern New Mexico College: field data acquisition, manipulation and analysis
University of New Mexico: grid modeling, development of control schemes
Ecoult/East Penn Manufacturing: advanced lead acid battery vendor



Project Schedule Update

- Five of six major milestones have been achieved on time and on budget.
 - 1. Negotiate Final Award (completed 10/2010)
 - 2. Revise PMP (completed 11/2010)
 - 3. Manufacture Battery System (completed 05/2011)
 - 4. Create system computer models and calibrate (Completed 05/2011)
 - 5. Install and commission system (completed 09/2011)
 - 6. Demonstration of the system is on track for early 2014 completion
 - 5 Test Plans Total
 - Test Plan 1 (smoothing) underway
 - Test Plan 2 (shifting) underway
 - Test Plan 3 SCADA data porting effort underway effort to start in Oct.







Smoothing Results

Test Plan 1 •Variety of control inputs

•Variety of gains on input – tests different capacities of battery use

•Question is: how much smoothing is enough?





Shifting Results Test Plan 2

•Advancing Automation and Sophistication

•Automated cloud forecast retrieval

•Automated PV energy calculation

Algorithm will get more and more complex







Simultaneous Smoothing and Shifting Results



Both storage systems interact well – some tuning remaining on the Smoothing side to optimize spiking during cloudy periods



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Key Findings

- Dead Band Implemented in Shifting Algorithm
 - Eliminated spikes induced by algorithm looking at SoC too quickly
- Firming with Clouds Simultaneous Smoothing and Shifting
 - Tuning needed on smoothing to prevent spikes during shifting discharge
- Ramp Rate Analysis HVAC Noise Filtering Need
 - May be impacting ramp rate statistical analysis HVAC meter signal available if needed to be introduced to smoothing algorithm
- Ramp Rates Definition and Mitigation Analysis
 - No clear definition (until now) on how to treat non uniform time stamped data - on line real time Savitsky Golay filter will be utilized
- Smoothing Adequacy How much is enough?
 - Optimization analysis will be needed to determine best amount of smoothing vis-a-vis status quo solutions (i.e., what are we preventing and what's the lowest cost way to prevent it?)



Key Findings

Lack of Correlation with Current Forecast Used for Shifting

- % cloud cover prediction doesn't work well on cloudy days No surprise as % cloud cover is not tuned to PV, may try forward forecasts or persistence forecasting
- Need for Hour Ahead PV forecasts
 - Required for forward forecasting/smoothing may come through parallel efforts could incorporate a simple smart camera key to forward moving average approach
- Need for Day or 2 Day Ahead Accurate Cloud Forecast
 - Required for optimized shifting may come through parallel efforts
- PV Meter vs Irradiance Sensor
 - Irradiance sensor can mislead smoothing batteries because of no upper limit PV meter is upward bounded by inverter size – also MPPT is ignored.
- Latency Issues in Smoothing response 3 computers involved that have to react sub second - pretty much solved
- Sensitivity of PV System Ramp Rates Measured
 - 500kW PolySi Field is extremely sensitive ramp of 135kW/sec measured



Next Steps - Continue Test Plans Implementation

Algorithm Development

- Smoothing–will continue to test various inputs and filters throughout test period
 - Forward Moving Average (with forecast)
 - Low Pass Filter instead of Moving Average
 - Adding other external signals (adjacent PV farm, PNM ACE)
- Shifting data structure assembled to align next day forecast with historical load/price history
 - Adding price forecast (ICE Palo Verde) combined with hourly price shaping model
 - Peak Shaving to commence when SCADA signal import is completed to PI
- First of five test plans being initiated
 - Smoothing Oct through Dec 2013
 - Peak Shaving winter and summer peaking period 2012-2013
 - Firming summer 2012 on going
 - Arbitrage Shoulder periods throughout test period
 - All of the above summer 2013



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PNM Prosperity Energy Storage Online Batteries Smoothing Live (updates every second) Contact PNM | About PNM | PNM News SOLAR PANELS COLLECTING Google" Custon Search Search POWER FROM THE SUN ty Bill | My I **PNM Prosperity Energy Storage Project** ine in the Total Power Output 200 200 200 200 200 Energy storage has long been a barrier to produced by the Solar realizing the potential benefits of renewable deres deres deres deres deres Panels in kW energy. The sun doesn't always shine and the wind doesn't always blow, which creates reliability issues without fossil fuel sources to back कर कर कर कर कर कर कर कर them up. <-260 The PNM Prosperity Energy Storage Project, near Albuquerque, helps to address that 900 900 900 and 900 900 900 900 900 900 900 900 challenge. *negative value is a sign convention meaning power is being provided into the PNM Utility grid* The project features one of the largest nations of battery storage and System is producing enough to power photovoltaic energy in the nation. During the next two years (2011-13), PNM and its research partners will test and demonstrate *calcuation is based on a 5kw residential home the numerous benefits of a solar battery-storage system . Visit PNM Prospenty Energy Storage Project web site to learn more Solar is producing Tweet 0 in Share Battery is Smoothing LEGEND charging discharging

See how the battery operates in three different scenarios below

- Real Time Data
 Presentation
- **Project Description**
- Publications/Press
- Education & Outreach Focus – being embedded in College Curriculum at UNM and NNMC as well as local high schols

www.pnm.com/solarstorage

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POWER Levels

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