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

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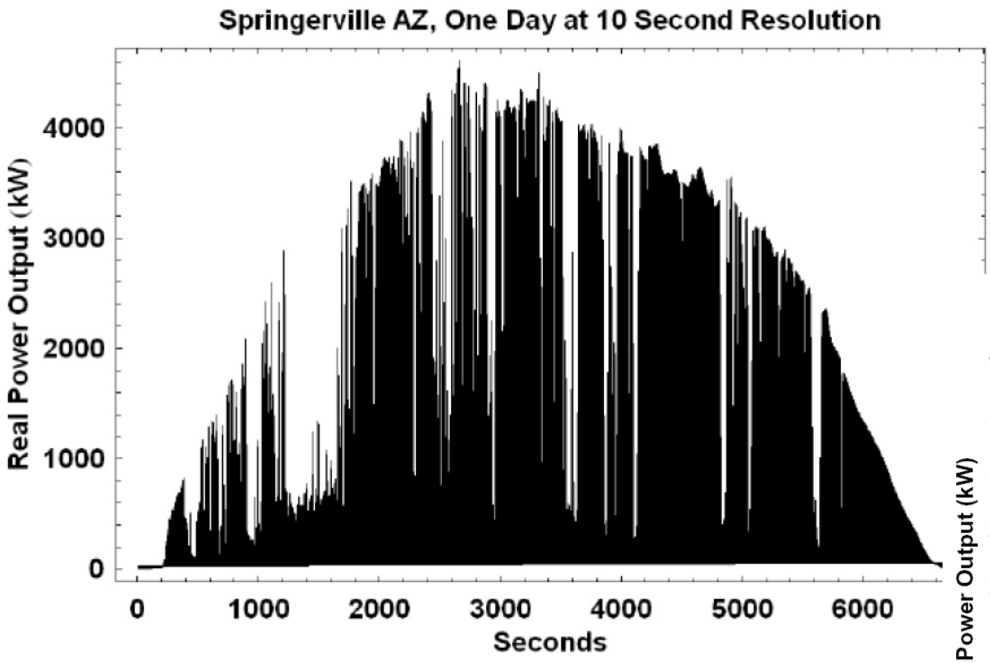
PNM/DOE SGDP Battery + PV Objectives

- **Project will co-locate a 2 - 4 MWh Advanced Lead Acid battery with a separately installed 500kW solar PV plant at a utility-owned site to create a firm, dispatchable distributed generation resource.**
- **The project will develop broadly applicable modeling tools. These tools are being developed and used during the project to optimize the battery-system control algorithms, and ultimately will help characterize and further the understanding of feeders with storage and distributed generation. Models are based on GridLAB-D and EPRi's OpenDSS**
- **Project risk mitigated by incorporation of front end modeling of PV impacts and optimized control algorithms**
- **The system can switch between two configurations – the end of a feeder versus the beginning of a feeder to demonstrate smoothing and shifting in both cases**
- **High resolution data collection and analysis will produce commercially useful information for a wide range of applications including grid upgrade deferral.**

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

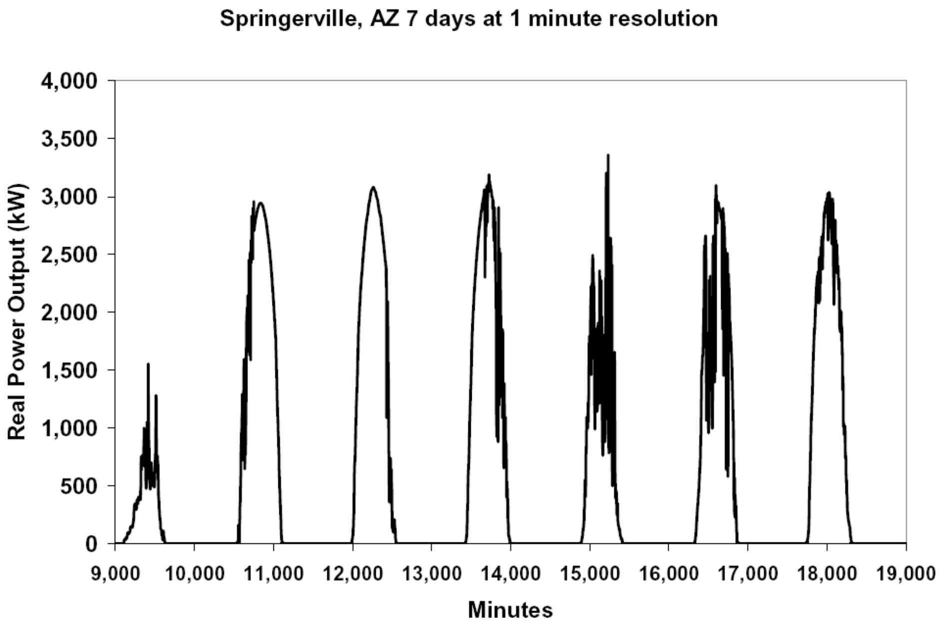
- Create a dispatchable, renewables-based peaking resource
- Combine PV and storage at a substation to achieve a minimum of 15% peak-load reduction on a distribution feeder
- Demonstrate that this combination can simultaneously mitigate voltage-level fluctuations as well as enable load shifting
- Quantify and refine the associated power system models (baseline and projected), operating practices, and cost/benefit economic models
- Generate, collect, analyze and share resultant data
- Enable distributed solutions that reduce GHG emissions through the expanded use of renewables

Driver – Engineering Side/Intermittency and Impact of High Penetration PV



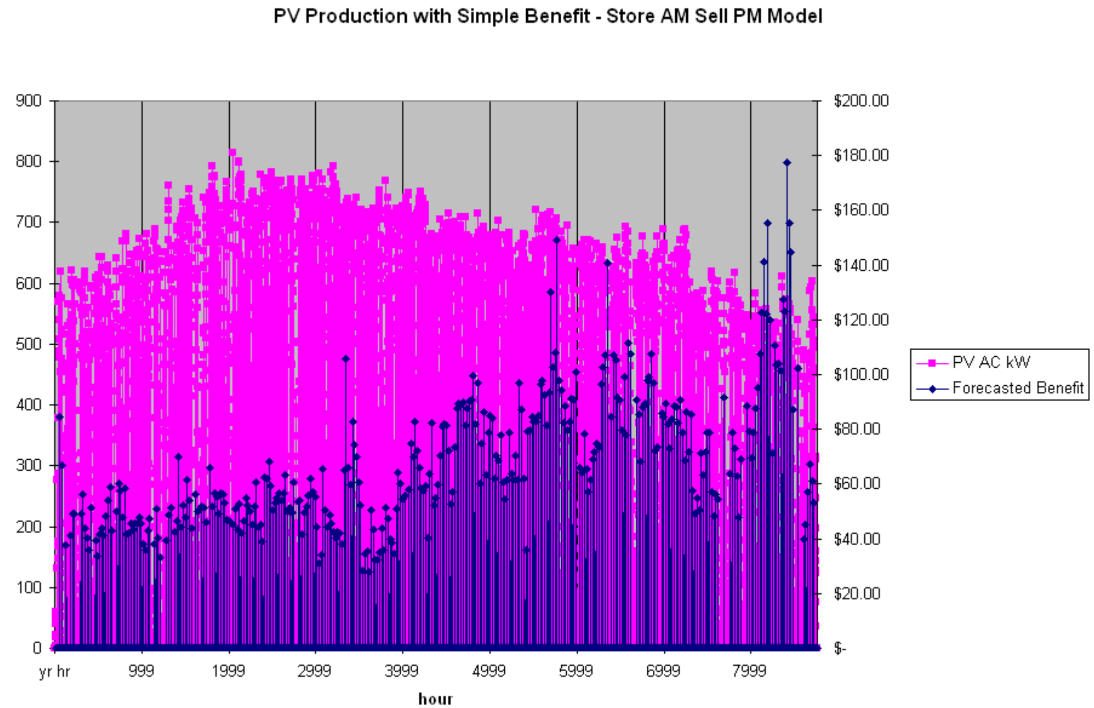
A single 1MW PV resource (distributed generation) can push a feeder into high penetration

"High penetration" - Installed PV amounts to 15-20% of feeder peak load – issues are already being experienced – even at 5%



Driver – Economic Side/ Results from Front End Benefit Modeling – need for simultaneous benefits is obvious

- Can simple arbitrage won't create a large enough benefit stream?
- How do wholesale prices transfer down to the grid?
- What are the best dispatch algorithms?
- Need to Monetize other benefits
- We also need to look at other forms of storage and smoothing



A successful demonstration will yield a renewable resource with a high capacity value that can predictably offset fossil peaking resources

Project SOPO - Phasing/Tasks

Phase I – Design/Engineer Solution & Establish/Develop Control Strategy

Specification of data acquisition equipment; baseline data acquisition; Refinement of the PV integration test plan;

Definition of the engineering scope and requirements including design, testing and control; and battery manufacture.

Significant modeling efforts, Confirm and test the cyber security and interoperability standards.

Phase II – Construct and Commission Demonstration

Develop the performance site - oversee installation of the PV and battery system, integrate the PV, storage, data, communication and control

Phase III – Demonstrate, Evaluate and Report

Test, operate and optimize the solution per SGDP objectives;

Collect data toward a cost-benefit analysis; and analyze all technical, economic and operational data produced by the demonstration.

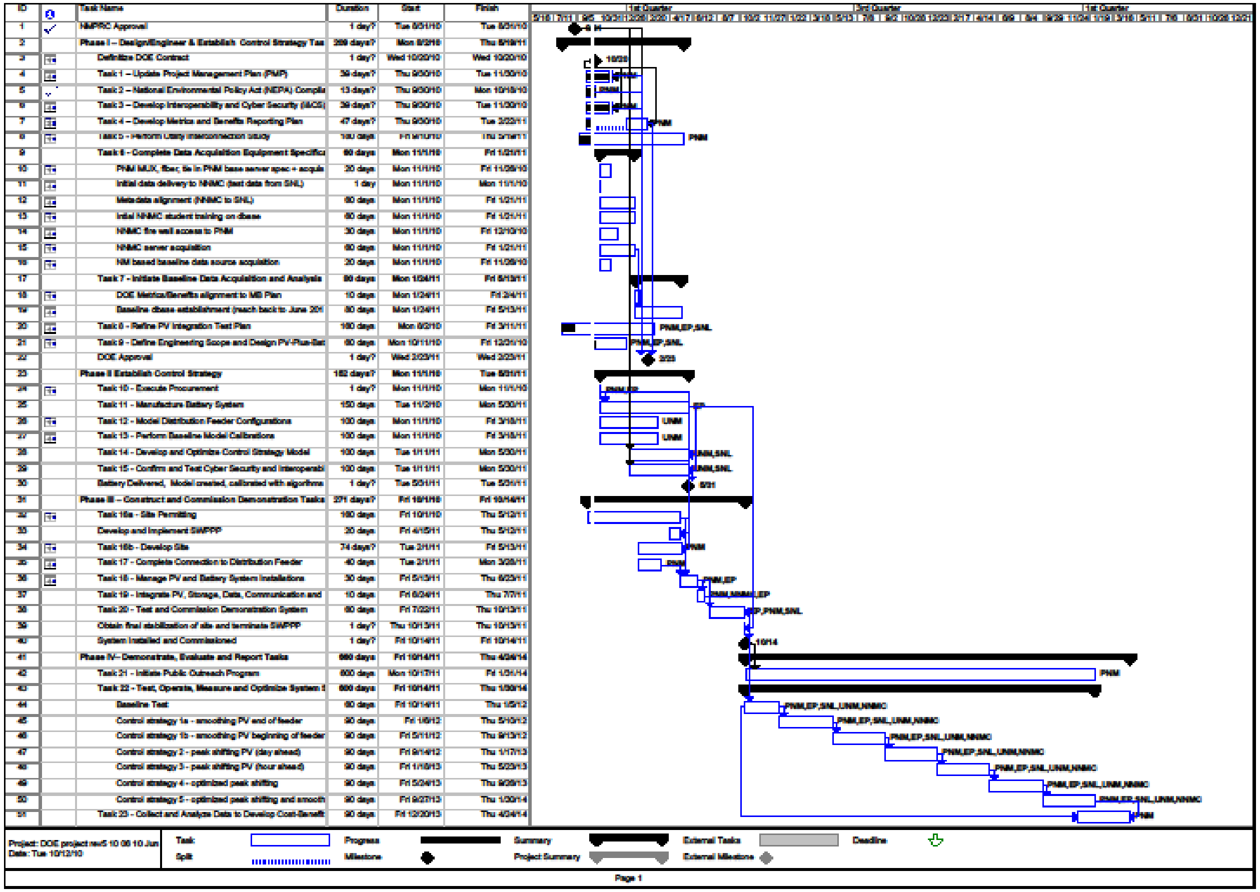
Perform public outreach, transfer knowledge DOE Smart Grid Information Clearinghouse,

Supplemental analyses through the EPRI

Project Schedule

Project Tasks aligned to EVM reporting requirements

- More detailed subset charts required for day to day reporting
- Program Management through Daptiv© with weekly meetings
- Task updates flow to EVM tool



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PNM

PNM/DOE SGDP Battery + PV - Project Partners

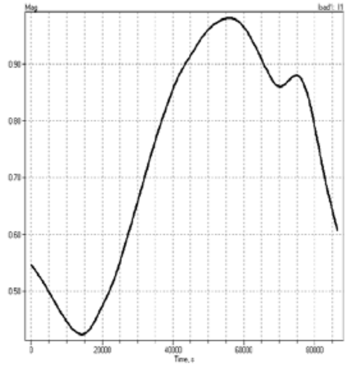
Project performed in collaboration with

- Sandia Labs: acceptance testing of the battery with PV panels integrated – at their DETL facility
- Northern New Mexico College: field data acquisition, manipulation and analysis
- University of New Mexico: grid modeling, development of control schemes
- Advanced Lead Acid Battery Vendor

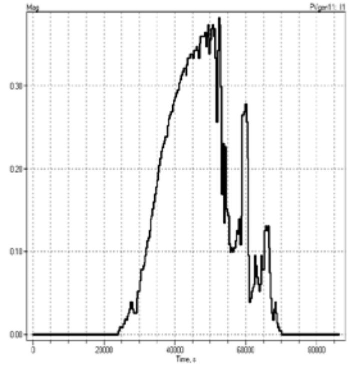
- **Aligning with PNM/EPRI Smart Grid Demonstration Project**
  - Incorporating modeling results from OpenDSS and GridLAB-D models currently underway by Univ. of New Mexico
  - Algorithm development in alignment with UNM and Sandia National Labs – initial target for smoothing algorithm

Results to date -

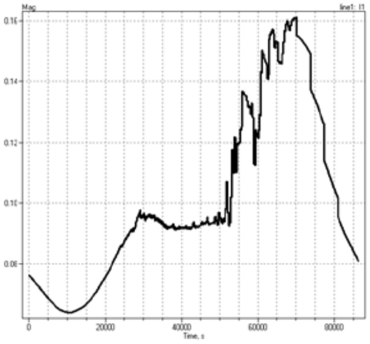
- Front End Economic analyses
- Identification of SNL smoothing algorithm
- Data Mapping – 103 points – high resolution (1sec)
- Feed in from PNM/EPRI Smart Grid Demonstration Program
    - Initial model calibration to actual feeders – both in EPRI OpenDSS and GridLAB-D



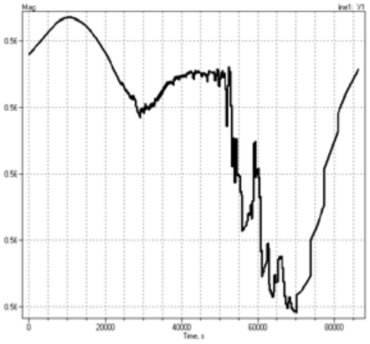
Typical load current profile (PU)



PV current profile (PU)



Line voltage profile (PU)



Line current profile (PU)

Gap Analysis - Utility Based Storage - A Growing List is emerging in the interface arena

- Who owns distributed resources? Merchant, Transmission Ops, Wholesale Ops, or Distribution Ops? Vertical and ISO models differ but both need to be addressed.
- Who controls distributed resources? Distribution or Power Operations?
- What makes up a "real time price signal"? ISO answer is more evident but still needs to incorporate distribution loading in order to attack deferral benefits and high penetration.
- How do we control distributed resources? EPRI DMS specs currently being developed – need to target PV shifting and firming of resource

Next Steps - risk analysis focusing on specific features and the required specifications

- Modbus vs DNP3 vs IEC61850 - Offering from inverter manufacturer is forcing Modbus
- Architecture pointing to Ethernet output for DAQ, IP addressable link for host controls and some SCADA monitoring/controls
- Cyber security tie in the above based on latest NIST/PAPs
- MetaData – what format for storage (suggest similar to NREL/SNL – developed for high resolution PV)
- Potential Additions to project
  - SNL request for PMU system (of scope) – extremely high resolution view of power flow
  - Further define SNL/EPRI Use Case Analysis for DMS interaction