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

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DOE Peer Review

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PNM

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 targeting 15% peak-load reduction
- Demonstrate combination can simultaneously mitigate voltage-level fluctuations as well as enable load shifting
- Develop power system models (baseline and projected), 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

Project Partners

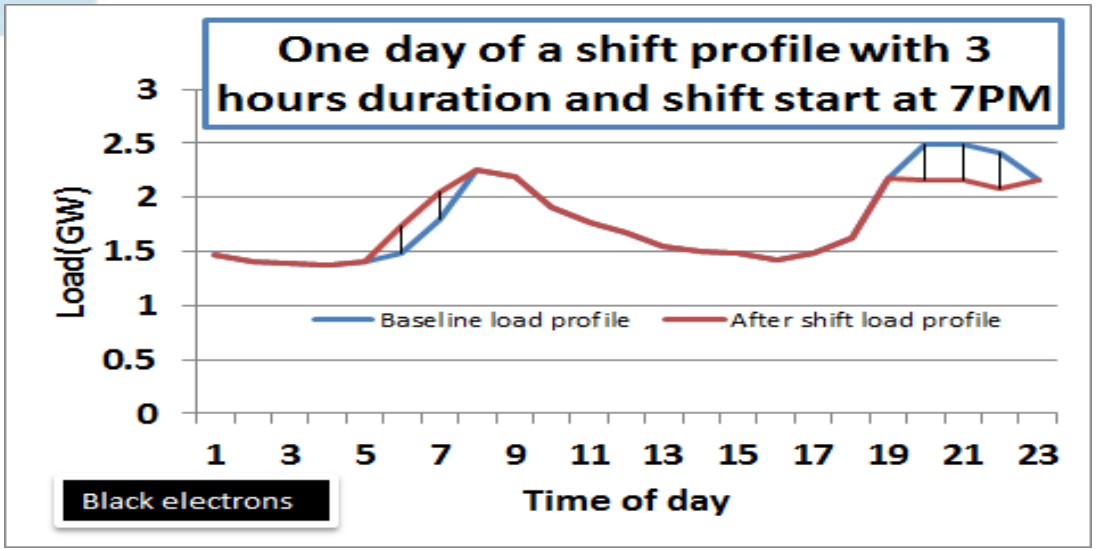
- Sandia Labs: assistance in battery control algorithm development
- Northern New Mexico College: field data acquisition, manipulation and analysis
- University of New Mexico: grid modeling, development of control schemes
- East Penn Manufacturing -advanced lead acid battery vendor

Project Objectives/Update

- Project has co-located a 1MWh/250kW 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 has developed broadly applicable modeling tools. These tools are being used 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
- PV System went on line August 17, 2011, Battery System September 15, 2011
- 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 is underway and will produce commercially useful information for a wide range of applications including PV variability and battery/PV interaction
  - Additional PMUs from SNL were installed with the data collection system
  - Integrated control with PNM Distribution Operations established
  - Sophisticated PI database collecting data – Sharepoint Portal displaying

Modeling Results – Synopsys of UNM/PNM EESAT Presentation

GridLAB –D and OpenDSS models completed and calibrated for specific PNM Circuits

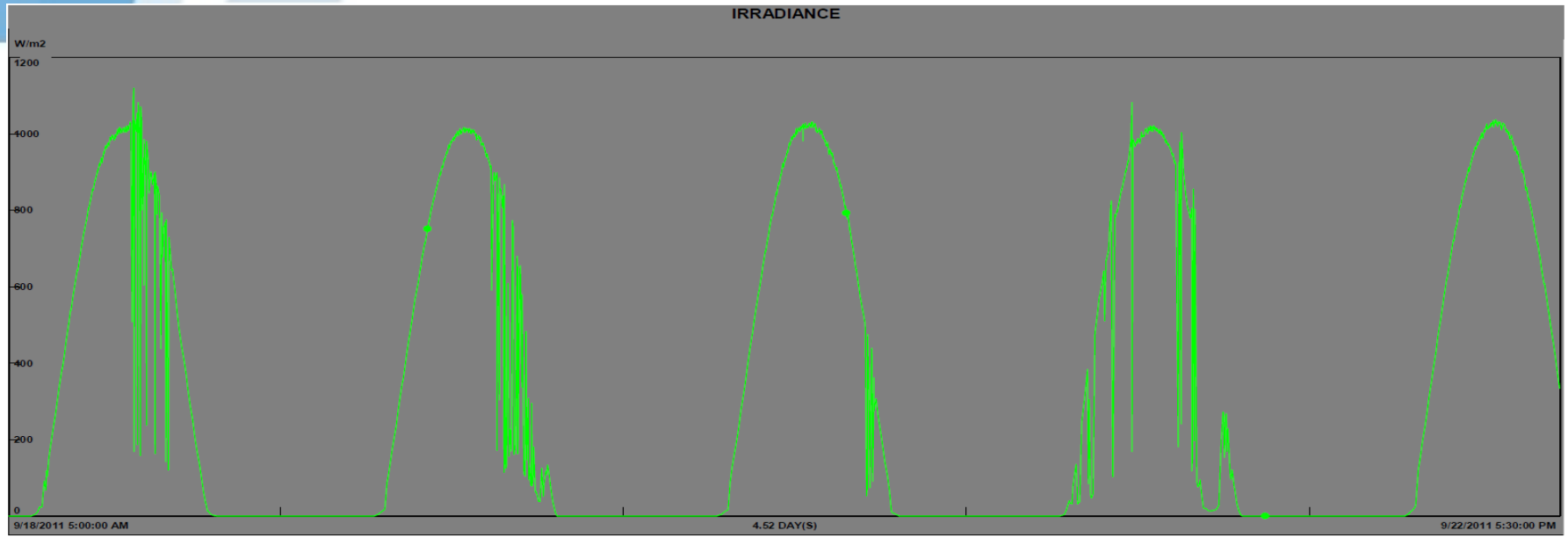


Challenges associated with modeling inverters

Results feed directly to control algorithm development and ensuing benefits analysis

Key Driver – Intermittency and Impact of High Penetration PV – Baseline Data

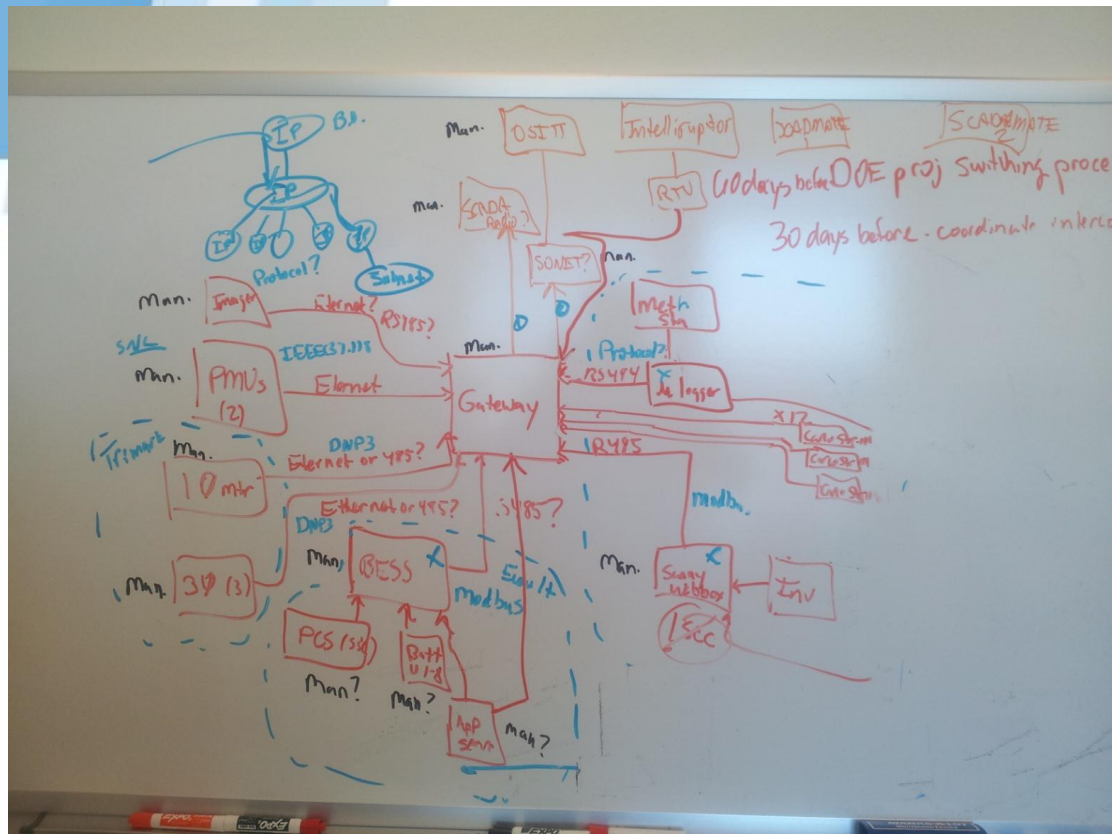
- PNM experiencing effects of numerous large scale PV plants
- Data from Project Site - Sept 18, 2011 – serving as baseline data



Deep Dive – Data Acquisition System/ Back Office Specification

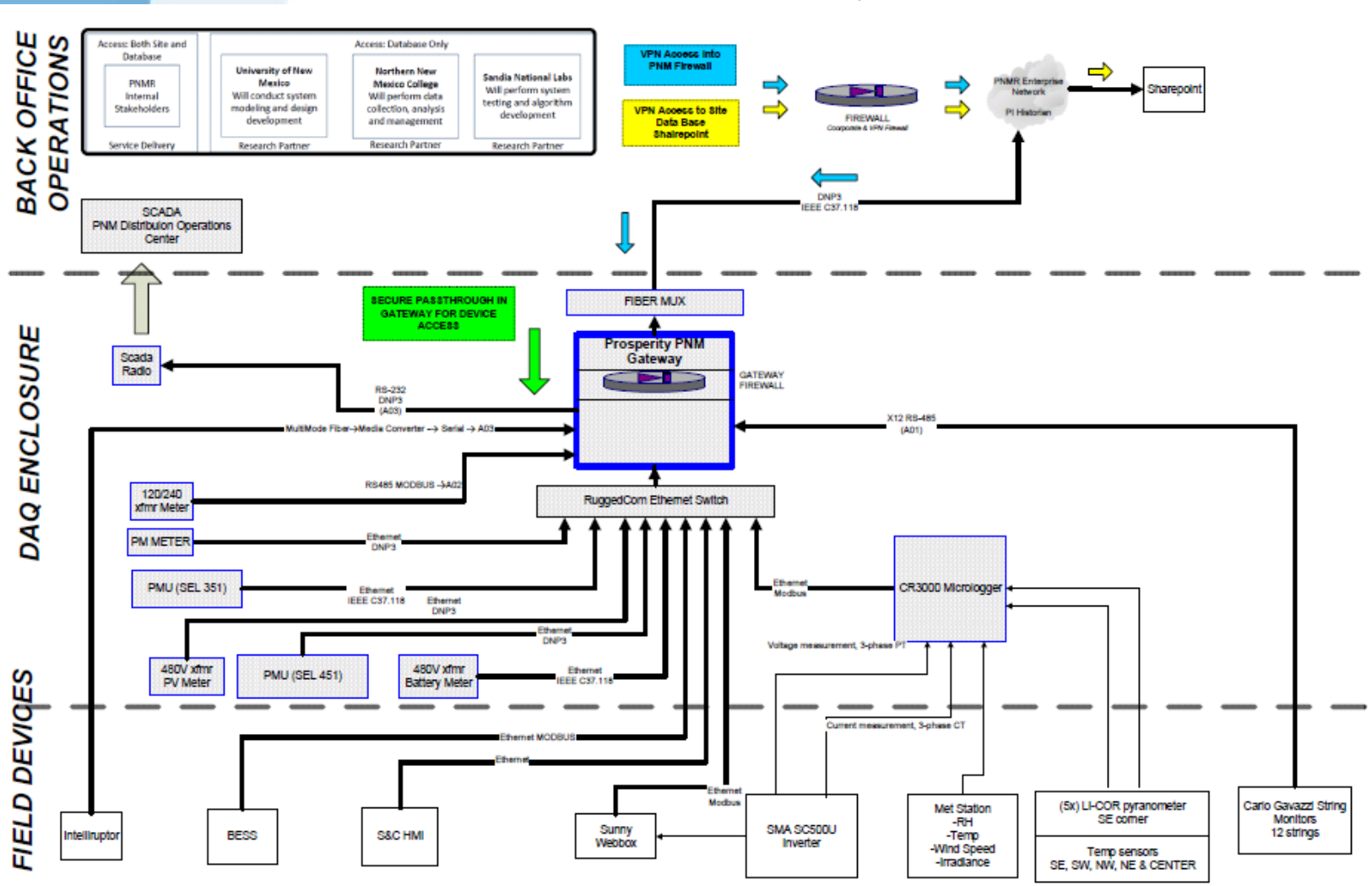
- **Objectives – Based on User Definition Requirements:**
  - The Information and Collaboration Portal exposes analytics and visualizations for collaboration of real time and historical information with project stakeholders
  - The Information and Collaboration Portal is architectured for scalability and supports secure connectivity to multiple data sources
- **Benefits:**
  - Optimizing asset visualizations and information analytics
  - Context sensitive and situational awareness roles
  - Collaboration regardless of device or location
- **Current Features:**
  - Real-time monitoring, Real-time situation detection, Real-time dashboards for different user roles
  - Correlation of events, Dashboards., Multidimensional analysis
  - Root cause analysis
  - Time Series and trending analysis

Starting from Scratch – No “Off the Shelf” Solution



- Vision of common station communication bus
- Design factors
  - Physical connections
  - Protocols
  - Communication rates (new requirement around PMUs)
  - Protocol translation needed

Details – Data Acquisition System Specification/Engineering Architecture Diagram



Details – Data Acquisition System Specification/ Engineering Effort

- **Drivers**
  - 1 second data (or less) capture due to PV Ramp Rate
  - Evolving Standards
    - Cyber security
    - NIST Interoperability
  - Storage Use Cases Developed with EPRI
  - Need to Integrate to PNM Distribution Ops (via secure SCADA radio) and PNM Data Center (via secure fiber).
  - Need to acquire data and control field devices for non PNM entities via secure virtual connection
- **Scope/Spec Issues**
  - MODBUS/DNP3 – requirement to keep MODBUS on field side of fire wall due to NIST concerns
  - Limited devices talking IEC61850 yet
  - No mature packaged systems for high resolution data gathering
  - Few integrators with experience with Utility Grade Metering/ Modbus based data acquisition and DNP3 SCADA interface
  - Need to accommodate IEEE C37.118 protocol for PMUs

Cyber Security Plan

- Designed with NISTR 7628 as guidance
- Revised at each step of the system lifecycle
  - Initiation to Concept
  - Planning to Requirements Analysis
  - Design to Development
  - Security Test to Implementation
  - Operations and Maintenance
  - Disposition/Retirement
- Risk Assessments, System Security Plan, Contingency Plan, Configuration management plan, and Change management documentation part of the cyber security plan

Details – Data Acquisition System Specification/Engineering Effort - Targets Met

Cybersecurity Requirements met – DOE Plan being revised to reflect

Talks to PNM Distribution Operations – Control functionality enabled to protective devices through DNP3

Direct Fiber link to secure utility data center

Enables pass thru virtual connection access to partners

Incorporates IEEE c37.118 for PMU communication

Enable High Resolution data capture in PI Database

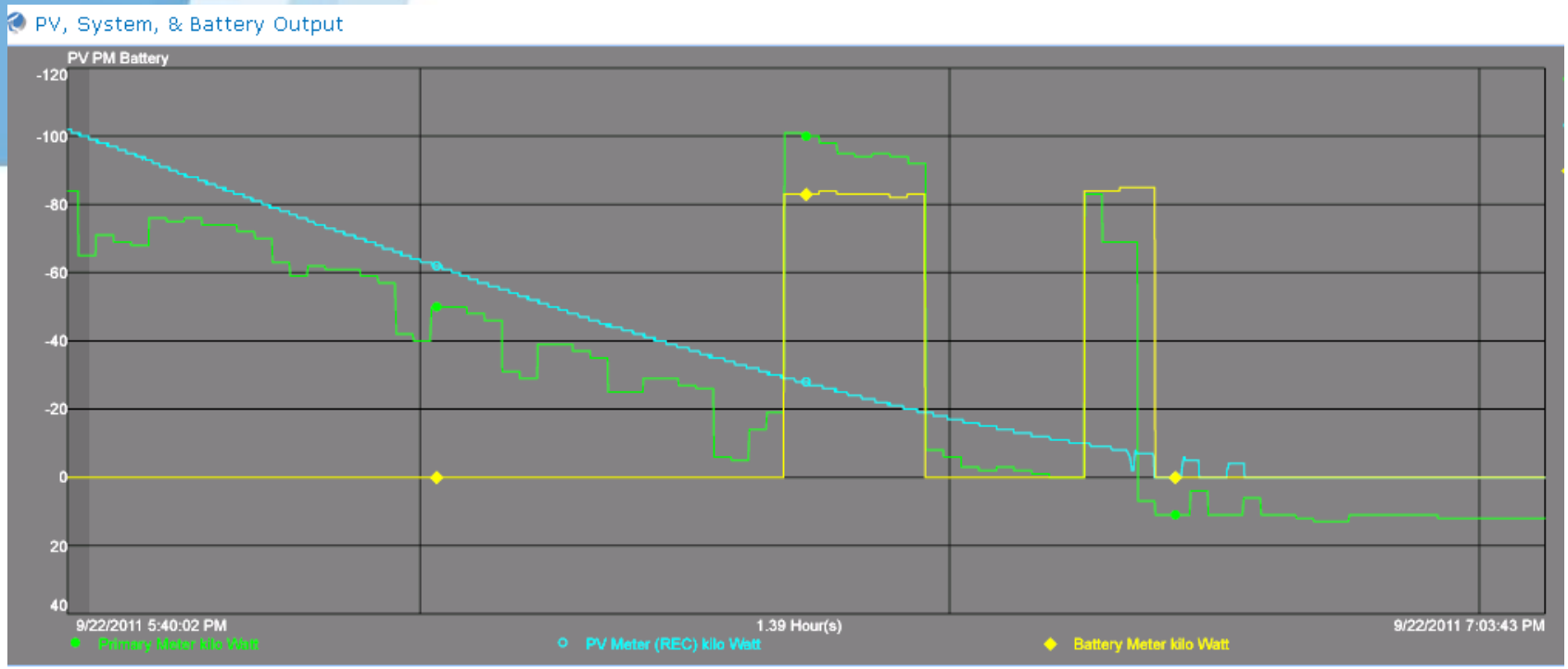
- 1 second for most points
- 30 samples/second for PMUs

Prosperity Architectural structure enabled our organization to embrace emerging technologies.

Details – Data Acquisition System Specification/ Engineering Effort

- System Field Commissioned – August 2011
- Back Office Commissioned through September 2011

Data Acquistion System – Proven and Flexible Ability to Acquire High Value Data Streams for Test Plans



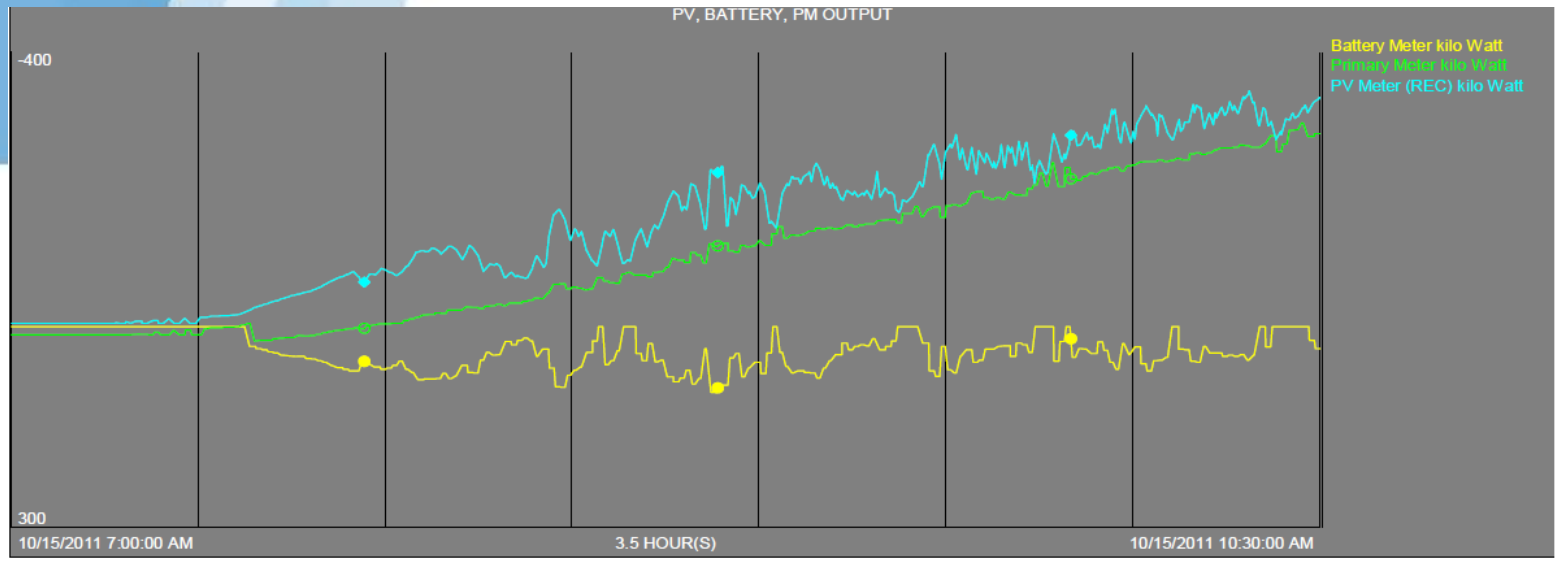
- **Data from Battery commissioning showing afternoon drop of PV and Shifting Storage Dispatch 9/22/11**

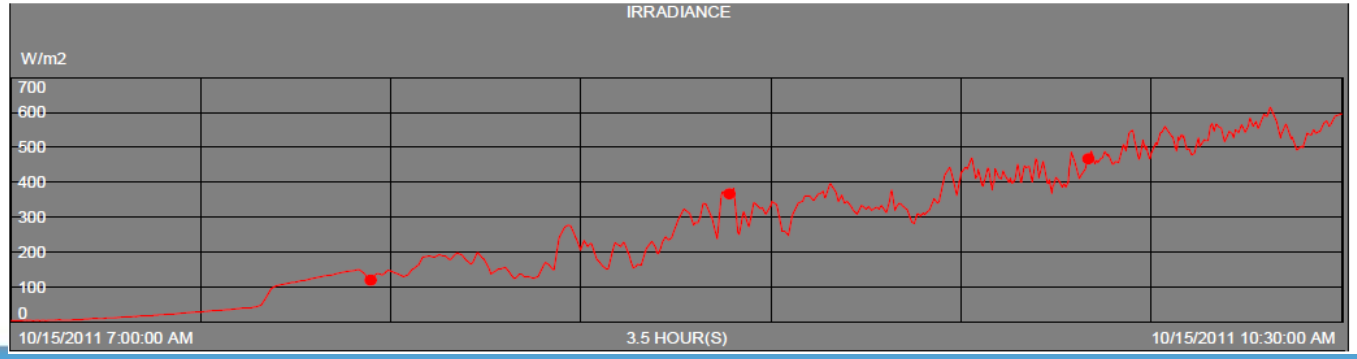
Data Acquistion System – Proven and Flexible Ability to Acquire High Value Data Streams for Test Plans

- **User defined timeline selection of all non proprietary variables**
- **Flexible display and graphics enabled by SharePoint Portal**
- **Access through strict security parameters to project partners for algorithm diagnostics**
- **Separate public access portal to selected data being enable**
- **Key element is alignment of data extraction to Project MBRP and PMP based Test Plans**

Applying Storage – Commissioning Data

Shifting and Smoothing Batteries Commissioned and dispatching to grid - data from Saturday 10/15/11





Lesson Learned to Date

- Front End and Continual Risk Evaluation is Key
- Project Management Tools Ensure Success
- Smoothing algorithm – very sensitive to input signal
  - Irradiance
  - Primary meter
  - ACE
- Shifting algorithm – underlying (historical) price and load data is key
  - Not being in an ISO is an issue – no market for regulation

Next Steps - Implementing Test Plans

- **Algorithm Development**
  - **Shifting – coded V1 in place – will test various inputs and filters throughout test period**
  - **Smoothing – data structure assembled to align next day forecast with historical load/price history**
    - **extensive data correlation of historical price/load history completed**
    - **Result forecasted to be multi-variant /optimization based algorithm – extensive effort – start simple and grow in complexity**
- **Test Plans Aligned to seasonal load and PV output**
- **First of five test plans being initiated**
  - **Smoothing – Oct through Dec 2013**
  - **Peak Shaving – winter and summer peaking period 2012-2013**
  - **Firming – summer 2012**
  - **Arbitrage – Shoulder periods throughout test period**
  - **All of the above – summer 2013**

Acknowledgements

- DOE – Dr Imre Gyuk
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- East Penn/Ecoult
- Sandia National Labs
- UNM
- Northern NM College