Pacific Gas and Electric
EPIC Workshop: DER Integration

AUGUST 18, 2015

PG&E's EPIC-1 In-Progress Projects

Project Name	Project Phase
Energy Storage for Market Operations	Build / Test
Energy Storage for Distribution Operations	Planning
New Forecast Methods for Improved Storm Damage Modeling	Staging
Distribution System Safety and Reliability through New Data Analytics Techniques	Build / Test
Close Proximity Switching	Design
Network Condition-Based Maintenance	Planning
Discrete Reactors	Design
Next Generation SmartMeter Telecom Network Functionalities	Design
Grid Operations Situational Intelligence	Build / Test
Vehicle-to-Grid Operational Integration	Design
Appliance-Level Load Disaggregation	Build / Test
Enhanced Data Techniques and Capabilities via the SmartMeter Platform	Design
Automatic Identification of Distributed Photovoltaic Resources	Design
Electric Vehicle Submetering	Build / Test
Photovoltaic Submetering	Planning
Demand-Side Management for Transmission and Distribution Cost Reduction	Build / Test
Direct Current Fast Charging Mapping	Planning

Project Phases: Initiation -> Planning -> Design -> Staging -> Build / Test -> Closeout

EPIC-2 Potential Projects

Renewables and Distributed Energy Resources Integration

- *Evaluate storage on the distribution grid*
- *Pilot Distributed Energy Management Systems (DERMS)*
- *Test Smart Inverter enhanced capabilities*
- *DG monitoring & voltage tracking*
- *Inertia response emulation for DG impact improvement*
- *Intelligent Universal Transformer (IUT)*

Grid Modernization and Optimization

- *Real time loading data for distribution operations and planning*
- *"Smart" monitoring and analysis Tools*
- *Distributed Series Impedance (DSI)*
- *Emergency preparedness modeling*
- *New mobile technology & visualization applications*
- *Emergency management mobile applications*
- *Digital substation/substation automation*
- *Automatically map phasing information*
- *Synchrophasor applications for generator dynamic model validation*
- *Enhanced Synchrophasor analytics & applications*
- *Geomagnetic Disturbance (GMD) evaluation*
- *Optical sensors for protection and control systems*

Customer Focused Products and Services

- *Enable distributed demand-side strategies & technologies*
- *Real-time energy usage feedback to customers*
- *Home Area Network (HAN) for commercial customers*
- *Demand reduction through targeted data analytics*
- *Integrate demand side approaches into utility planning*
- *Appliance level bill disaggregation for non-residential customers*

Cross-Cutting / Foundational Strategies & Technologies

- *Enhanced Smart Grid Communications*
- *Customer & distribution automation open architecture devices*
- *Next generation integrated Smart Grid communications network management*
- *Smart Grid communications path monitoring*
- *Mobile meter applications*
- *Leverage EPIC funds to participate in industry-wide RD&D programs*

PG&E: EPIC 1 Highlighted DER Projects

Highlighted EPIC 1 DER Related Projects*
01 – Energy Storage for Market Operations
02 – Energy Storage for Distribution Operations
15 – Grid Operations Situational Intelligence
16 – Vehicle-to-Grid Operational Integration
21 – Automatic Identification of Distributed PV Resources
23 – PV Submetering
24 – Demand Side Management for T&D Cost Reduction

Today's Presentations:

- Energy Storage for Market Operations
- Automatic Identification of Distributed PV Resources

** EPIC 2 will include additional DER related projects*

EPIC 1 Project #01:
Energy Storage for Market Operations

Presented By: Steven Ng
Electric Distribution Planning

EPIC Project Overview

Objectives:

- Gain operational experience bidding battery energy storage in CAISO markets
- Develop and demonstrate automation capabilities to enable efficient market operations of battery resources

Concern, Gap, or Problem to be Addressed

Decision 12-08-016 identified “Lack of Commercial Operating Experience” as one of the barriers to entry for energy storage.

This project aims to improve the understanding of market participation end uses.

PG&E's Battery Energy Storage System (BESS) Pilots

Vaca-Dixon (VD) BESS
2 MW / 14 MWh NAS Battery
Vaca-Dixon Substation, Vacaville

Operational Date: August, 2012
Commenced daily CAISO market operations: Aug 2014

Current Uses:
- 100% dedicated to CAISO wholesale market participation

Yerba Buena (YB) BESS
4 MW / 28 MWh NAS Battery
Customer R&D Facility, San Jose

Operational Date: May, 2013
Completed islanding commissioning: Sep 2013

Current Uses:
- Daily peak shaving, with half energy reserved for islanding/ backup for adjacent customer facility.
- Will begin CAISO market participation in Fall 2015.

CAISO Market Participation

Vaca Dixon Battery Energy Storage System

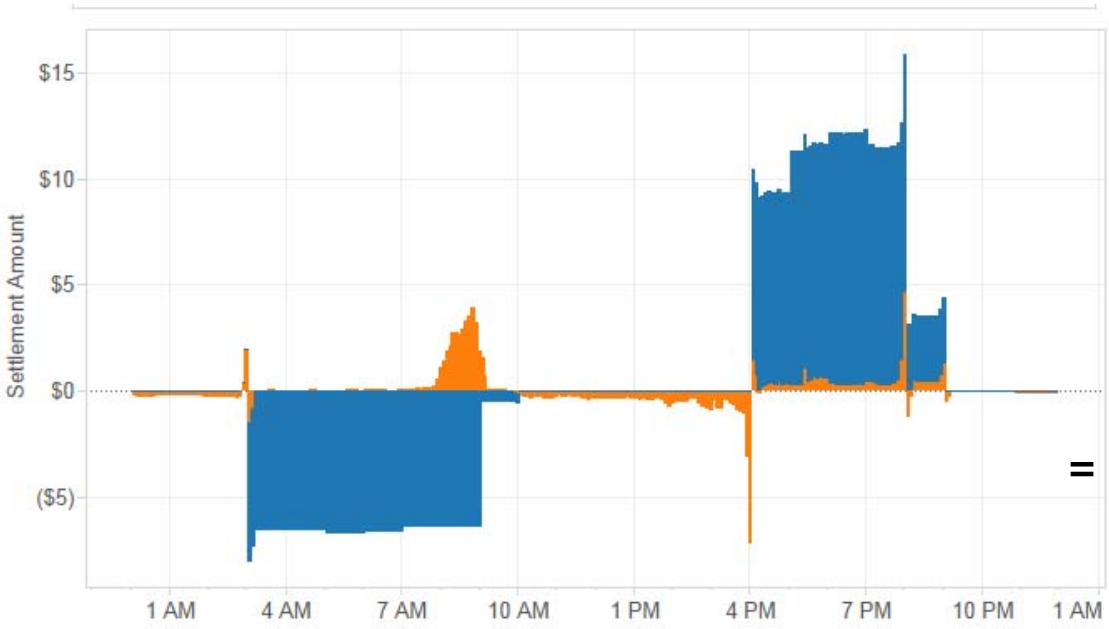
Storage Technology: Sodium Sulfur
Energy available for market: 13.2 MWh
Pmax: +1.9 MW
Pmin: -2.1 MW

- Began CAISO NGR Market Operations: August 19, 2014
- **Only resource commercial in CAISO NGR market**
- Bidding in for **Day-Ahead Energy**, Real-Time Energy (limited), and **Regulation**

Current goal is understanding market dynamics, setting operational protocols, working with CAISO to resolve NGR implementation issues…

…not necessarily optimizing for revenues

Day Ahead Energy Example: 10/5/2014



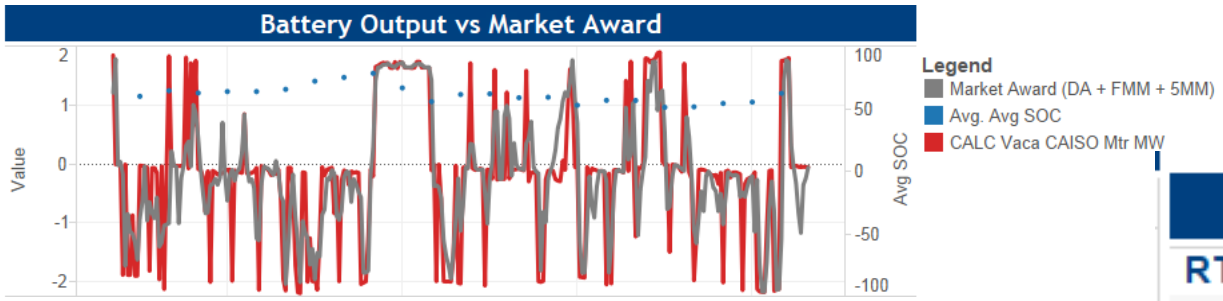
=

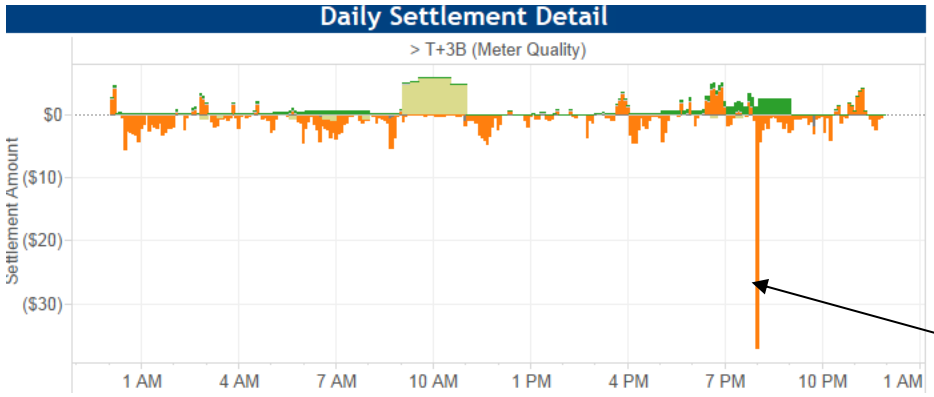
Net Daily Revenues

Daily Totals	
Day Ahead Energy	$79
Real Time Energy	$10
Grand Total	**$88**

In this case, the deviation from schedule due to battery curtailment ended up being revenue positive because charge curtailment essentially shows up as additional energy supply in the Real-Time market.

Regulation Example: 5/18/15





Daily Totals	
RT Energy - 15 min	$115
RT Energy - 5 min IE	($228)
RT Energy - 5 min UIE	($5)
DA Reg Up - Capacity	$122
DA Reg Down - Capacity	$191
Reg Up - Mileage	$52
Reg Down - Mileage	$6
Reg Down N/P	($1)
RT Reg Down - Capacity	$9
RT Reg Up - Capacity	$1
Grand Total	$261

Key Caveat: The focus of the project is demonstrating how regulation market works.

Price spikes can hurt you if you get called for Reg Dn during the spike, as we did on this day.

General Observations and Next Steps

Observations

- Market revenues for Day-Ahead Energy participation are at best break-even due to flat prices and efficiency losses of battery
- Real-time energy participation also represents only limited revenue opportunity due to flat real time prices.
- Regulation has represented the best opportunity for market revenues
- Predicting State Of Charge (SOC) once unit has been on AGC for extended period is a challenge. Exposure to real-time price spikes during regulation are a concern, especially when resource is used extensively for Reg Down.
- We have had to work through numerous issues with software at CAISO that has generated anomalous awards. Several fixes have been implemented, but some issues still remain.

Next Steps

- Completed Proof of Concept testing of CAISO ADS automation system that will enable more dynamic real-time market participation.
- Plan to declare Yerba Buena BESS commercial in CAISO market to demonstrate pilot market operations in Fall 2015

EPIC 1 Project #21: Automatic Identification of Distributed PV Resources

Presented By: Fabio Mantovani
Distributed Generation Policy

What is a solar unauthorized interconnection (UI)?

A UI occurs when a photovoltaic system connected in parallel to the PG&E Distribution System does not have a permission to operate (PTO) from the utility and therefore violates (PG&E) Electric Tariff Rule 21.

Photo of a UI from PG&E rep in the field

Why is Unauthorized Connection A Problem?

A PV system that is not authorized to operate connected to the grid has the potential to negatively impact reliability of the Distribution System and to be a safety concern for customers and employees.

PV installation for a UI customer; photos by PG&E Field Metering Personnel

Risk items:

- Non-UL listed equipment means can charge line when crews at work.
- Not NEC-compliant installation means no building permit and can lead to structural issues.
- Larger system than the circuit can accommodate (impact on voltage, transformers, etc.)

Customer View

What incentive do solar customers have to set up a grid-tied PV system without authorization from the utility?

At times customer/contractor may think it's a good idea to interconnect without permission for one or more of the following reasons:

- Inability to get building permit from the City / County
- Upgrading to larger system
- Unlicensed contractors
- Desire to turn on the solar system while PTO in process
- Potential Cost

The typical customer does not benefit

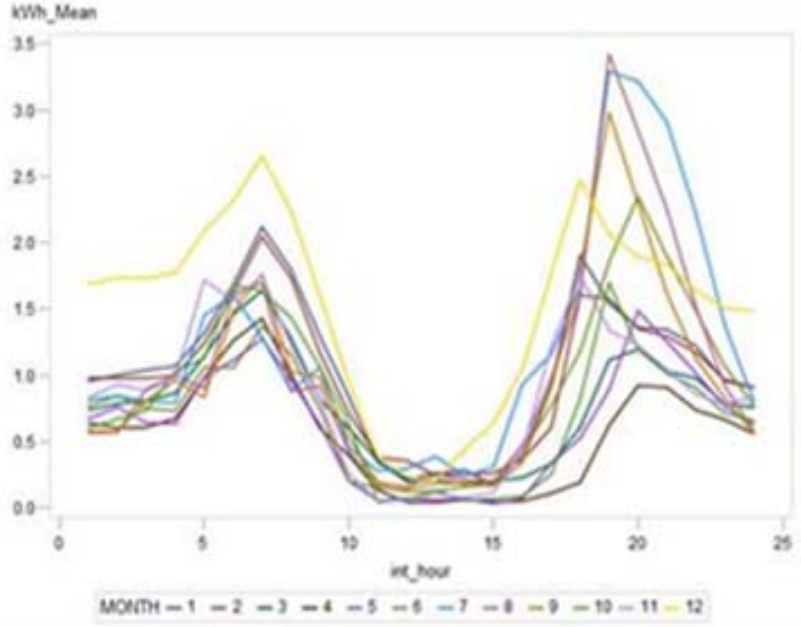
Inability to participate in NEM

Safety & Structural Risks

Objective of this EPIC Project

- Leverage smart meter data to develop and demonstrate an algorithm to automatically identify PV Unauthorized Interconnections
- Develop automated process to track UIs, develop an automatic protocol to communicate with customers and resolve the interconnection
- Leverage learnings and methodology for other potential use cases

Hourly load shape (monthly average) of a customer with a grid-tied solar system. This customer dos not have a permission to operate on file



Benefits

Customer and Employees Safety:

- Ensure compliance of equipment (e.g. UL listed inverter) so that PV can operate safely for the for PG&E employees and PG&E customers.

Reliability:

- Mitigate risks that inappropriate equipment is installed on the grid
- Mitigate the risk of PV systems larger than hosting capacity of the feeder
- Accurately track the amount of DERs for each distribution circuit - important to understand voltage fluctuations and ultimately ensure grid reliability

Efficient and Scalable Customer Interactions:

- Automate the low-touch customer interactions that are today performed in a ad-hoc fashion by staff (in person and/or over the phone).

Current Status and Outlook

Progress to Date

- Developed first draft of algorithm focused on detecting gross exporters (>12kWh exported / 10 days)
- Identified suspected residential rate unauthorized interconnections, conducted sample survey to test accuracy and assist customers with appropriate connection if verified
    - Primary reason for false positives were water pumps and other load that can act as generators in some situations
    - Learnings will be applied to next revision of algorithm

Future Potential Beyond this EPIC Project

- Algorithm's capabilities could go Beyond Unauthorized PV:
    - Detecting unauthorized behind the meter storage paired with PV
    - Detecting EV charging patterns to cost effectively promote EV programs
    - Notification of PV system degradation
    - Identification of other specific load signatures could allow targeted marketing of load control programs