Status Update on the NYSERDA/DOE Joint Energy Storage Initiative Projects

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This project is part of the Joint Energy Storage Initiative between the New York State Energy Research and Development Authority (NYSERDA) and the Energy Storage Systems Program of the U.S. Department of Energy (DOE/ESS), and managed by Sandia National Laboratories (SNL).

Acknowledgements

- The Data Acquisition and Analysis for these demonstration projects is funded by the U.S. Department of Energy.
  - Project Manager - Georgianne Peek, Sandia National Lab

Acknowledgements - cont

- Joe Sayer – NYSERDA
- Mark Schneider – DCEC
- Ib Olsen – Gaia Power Technologies
- Jim Arseneaux – Beacon Power

Project Statement

- Core Requirements – PON 846
  - The proposed Energy Storage System (ESS) must include a Data Acquisition System (DAS) for the purpose of providing system operating data to be used for evaluation and generation of reports on the overall performance of the EES.

Approach

- Transport to monitoring center via secure communications link over Internet
- Convert data from vendor systems into standard formats
  - IEEE 1159.3 PQDIF
  - IEC 61850 data models for metering
- Expose via dynamically generated tables, graphs on demand on project web site
- Provide project information, archived data and real-time data on open project web site
  - www.storagemonitoring.com

Projects

- Gaia Power Technologies/Delaware Valley Electric Cooperative
- Beacon Power
- New York Power Authority/ABB
- Gaia Power/Princeton Power

Site 1

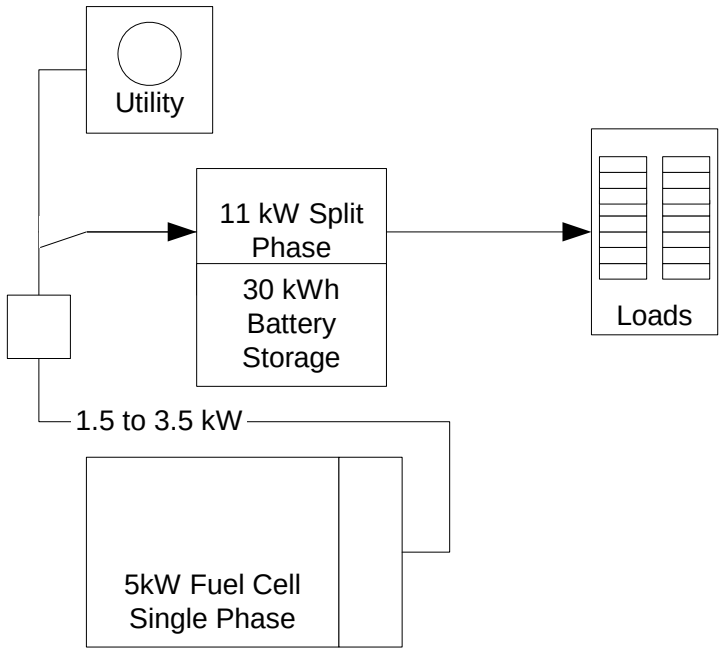
- Gaia Power Technologies/Delaware County Electric Cooperative, Inc. – Edge of grid residential application that includes an 11 kW Power Tower battery-based energy storage and delivery system fed by a Plug Power 5 kW fuel cell in Delhi, NY

Timeline

- Gaia Power Tower and Plug Power Fuel Cell installed in June, 2005
- System operational in July 2005
- Fuel cell shut down in June, 2006, removed July, 2006
- System restarted in September, 2006 with grid supplying Power Tower
- Briggs 15 kW generator installed in March, 2007
- Monitoring continued until April, 2007

Operation

- Fuel cell supplied about 2kW to the Power Tower on a continuous basis
- Power Tower continuously supplied house load unless either leg went above 5.5kW or 45 amps
- If load went above, load shedding relaying operated, followed by full load transfer back to grid



Project Summary

Month	System Mode
July, 2005	Fuel Cell ON (But new stack was installed during the last week of month)
August	Fuel Cell ON (Net metering but back to full mode on Aug 30th)
September	Fuel Cell ON
October	Fuel Cell ON (Until Oct 26th when outage occurred)
November	Fuel Cell ON (Primarily netmetering then set to OFF position followed by brief operation on Nov 22nd)
December	Fuel Cell OFF
January, 2006	Fuel Cell OFF (Set back to ON position on Jan 15th)
February	Fuel Cell ON (Net metering)
March	Fuel Cell ON (Net metering, Power Tower switched ON March 23rd)
April	Fuel Cell ON (Net metering)
May	Fuel Cell ON (May 20th, switched to Bypass)
June	Fuel Cell OFF (June 5th), Bypass
July	Fuel Cell Removed (July 27th), Bypass
August	Bypass
September	Grid Feeding Power Tower, Power Tower Feeding Loads
March, 2007	15kW Generator ON
May	Equipment Removed

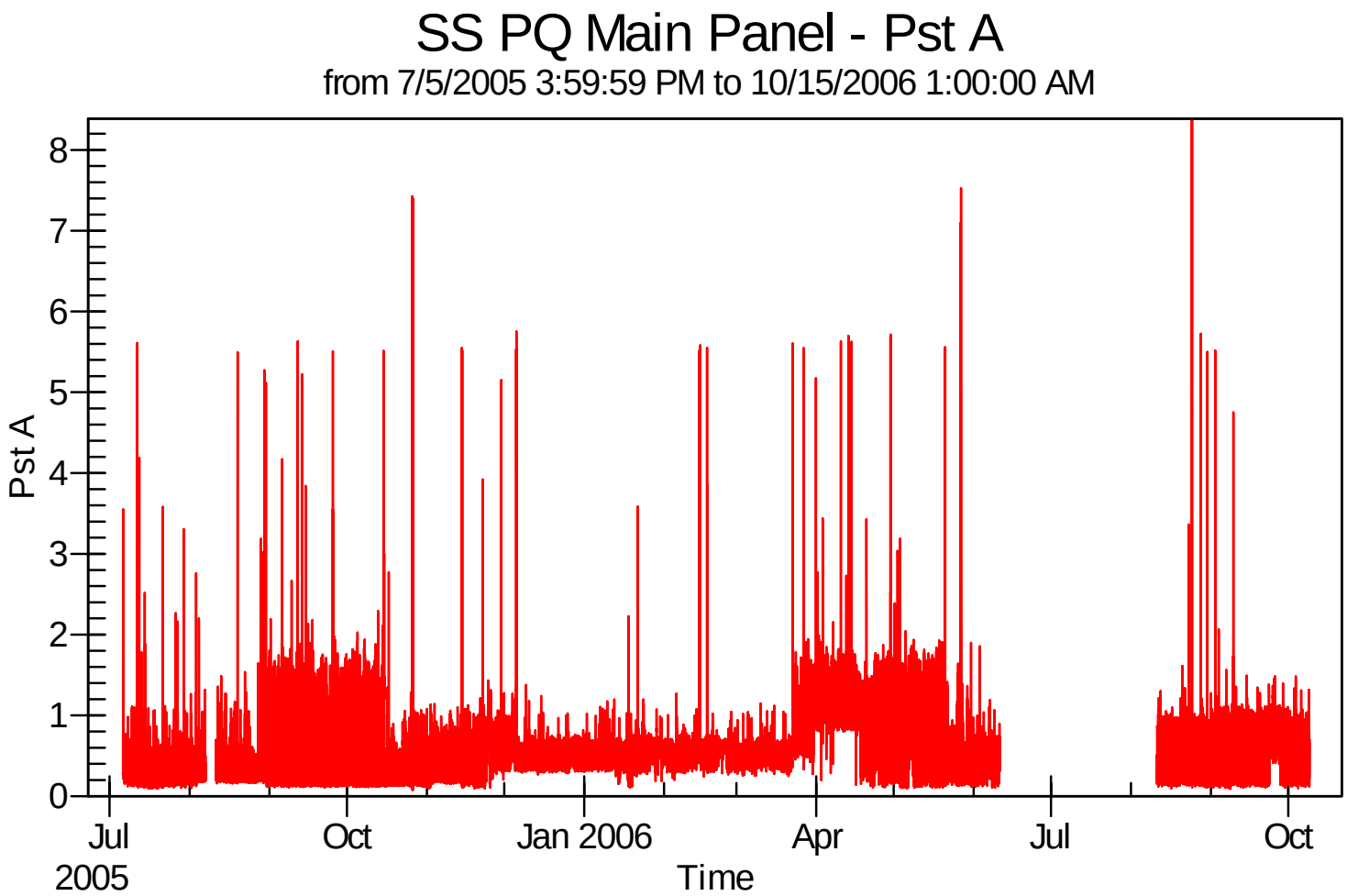
Lessons Learned

- Edge of grid residential application successfully proven
- Battery energy storage system worked as designed
  - Round trip efficiency of approximately 39%
- However, several power quality issues emerged
  - Load shedding relay caused 2 cycle interruptions
  - Inverter operation of Power Tower in combination with a weak grid caused severe voltage flicker that caused homeowner to put system into bypass on numerous occasions

Flicker Problem

- After operating for a while the house owner started to complain about flicker in his light sources
  - Local project manager could not see any flicker
  - Lead project manager could not see any flicker
  - Gaia technical service engineer could see flicker
- Anecdotally the flicker was worse when energy storage was powered by fuel cell, but still present when energy storage powered by utility
  - House owner did not see any flicker when energy storage was bypassed

Flicker Measurements

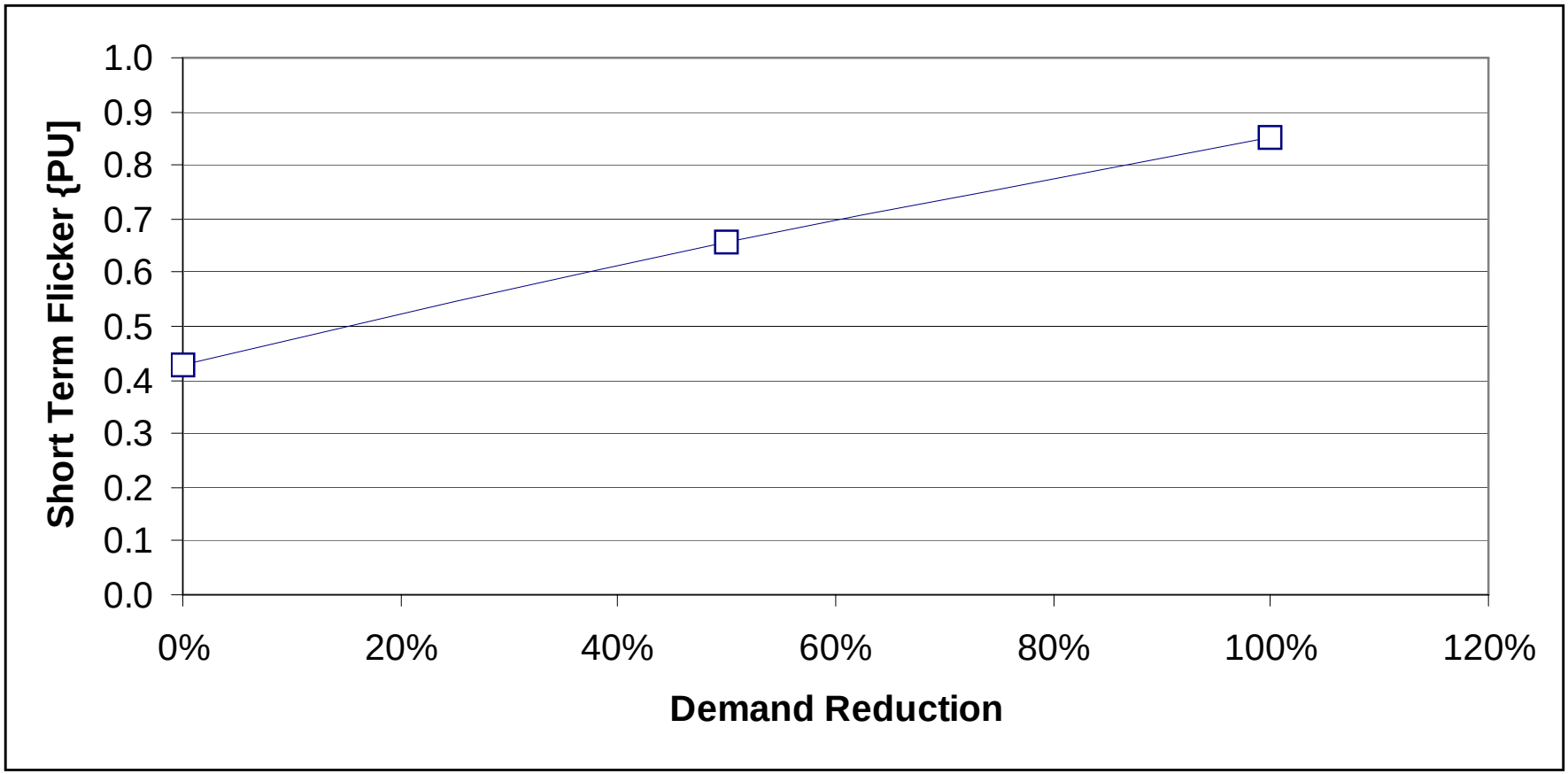


Gaia Test Results

- The grid at the test side was measured to have a short term flicker around 0.5
- Introducing the energy storage device increased the flicker with more than 80% on the input side and an additional 3% on the output side
- Using the fuel cell as source increased the flicker with 13%

Energy Source	Energy Storage	Short Term Flicker	
		Before Energy Storage	After Energy Storage
Weak Grid	No	0.47	Not Active
Weak Grid	Yes - Demand Reduction	0.87	0.90
Fuel Cell	Yes - Demand Reduction	0.95	0.97

Gaia Test Results - cont



Conclusions

- Introduction of an energy storage device used for demand reduction (current source) increased the short term flicker at a residence
- The magnitude of the short term flicker was a function of the “strength” of the source and of the level of demand reduction
  - A weak source increased the flicker
  - Increased demand reduction increased the flicker
- When used as voltage source the energy storage device had short term flicker values significant lower than the grid
  - Using the fuel cell as a DC source rather than an AC source would most likely have solved the flicker issue

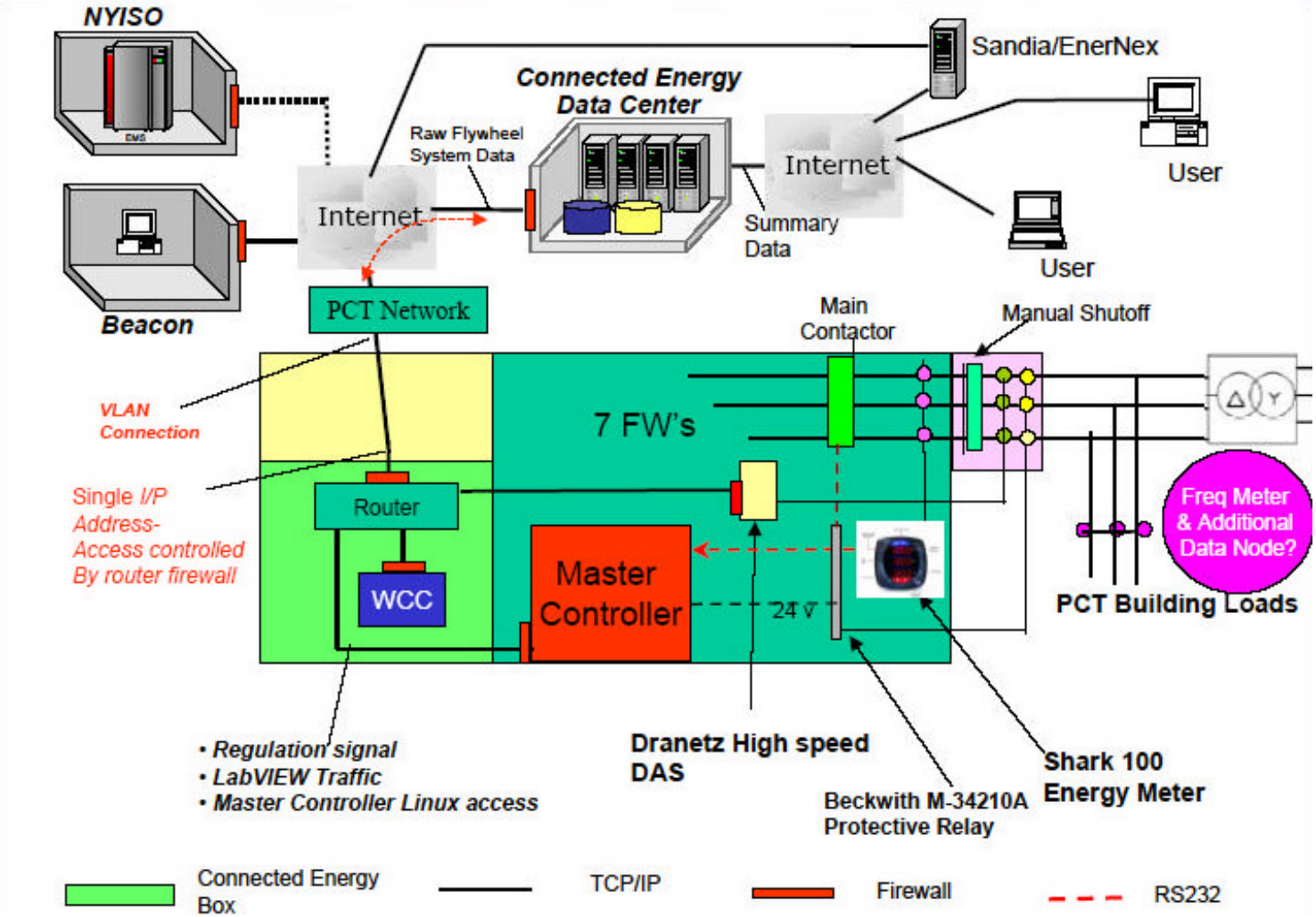
Site 2

- Beacon Power – Grid frequency regulation demonstration at an industrial facility in Amsterdam, NY, using 7 flywheels producing 100 kW for 15 minutes

Timeline

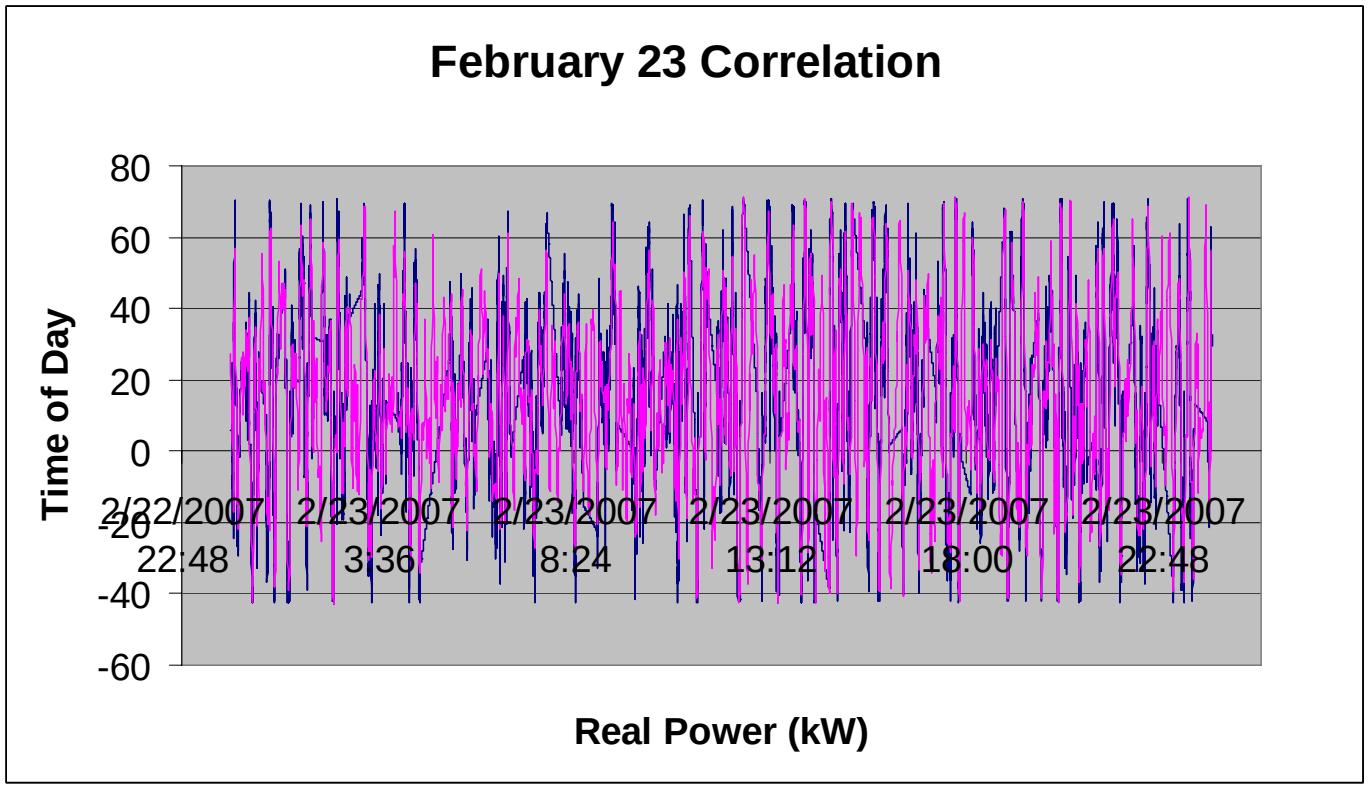
- Service entrance monitored at PCT, Amsterdam, NY from Feb – June, 2006
- Smart Energy Matrix (EM) flywheel system installed in June
- Approximately 1 month of system commissioning and testing
- Monitoring continued through March, 2007 when it was agreed enough data had been collected

DAS Block Diagram



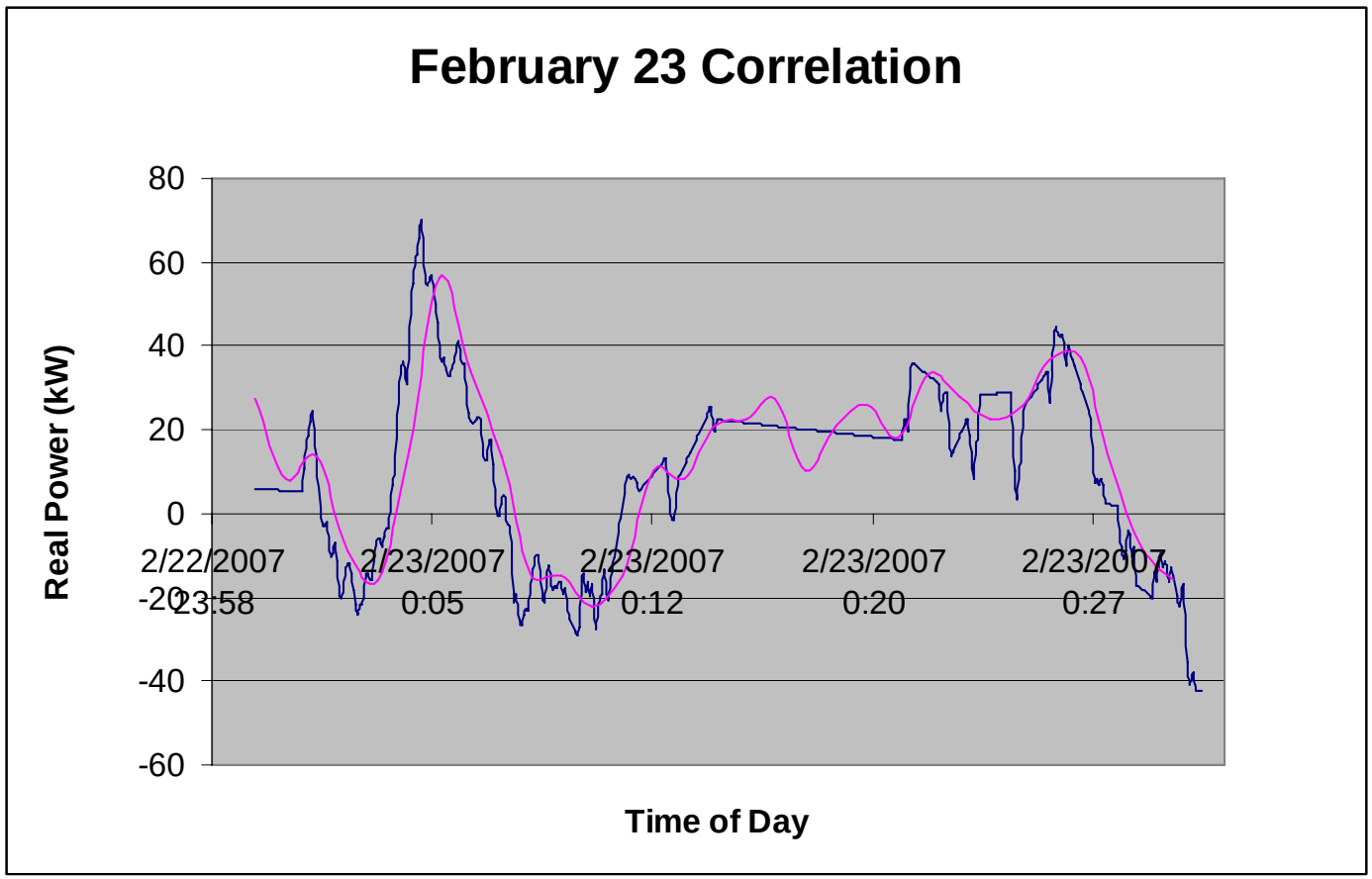
Status

- Dranetz was used to verify extensive on board DAS supplied by Beacon Power



Status - Cont

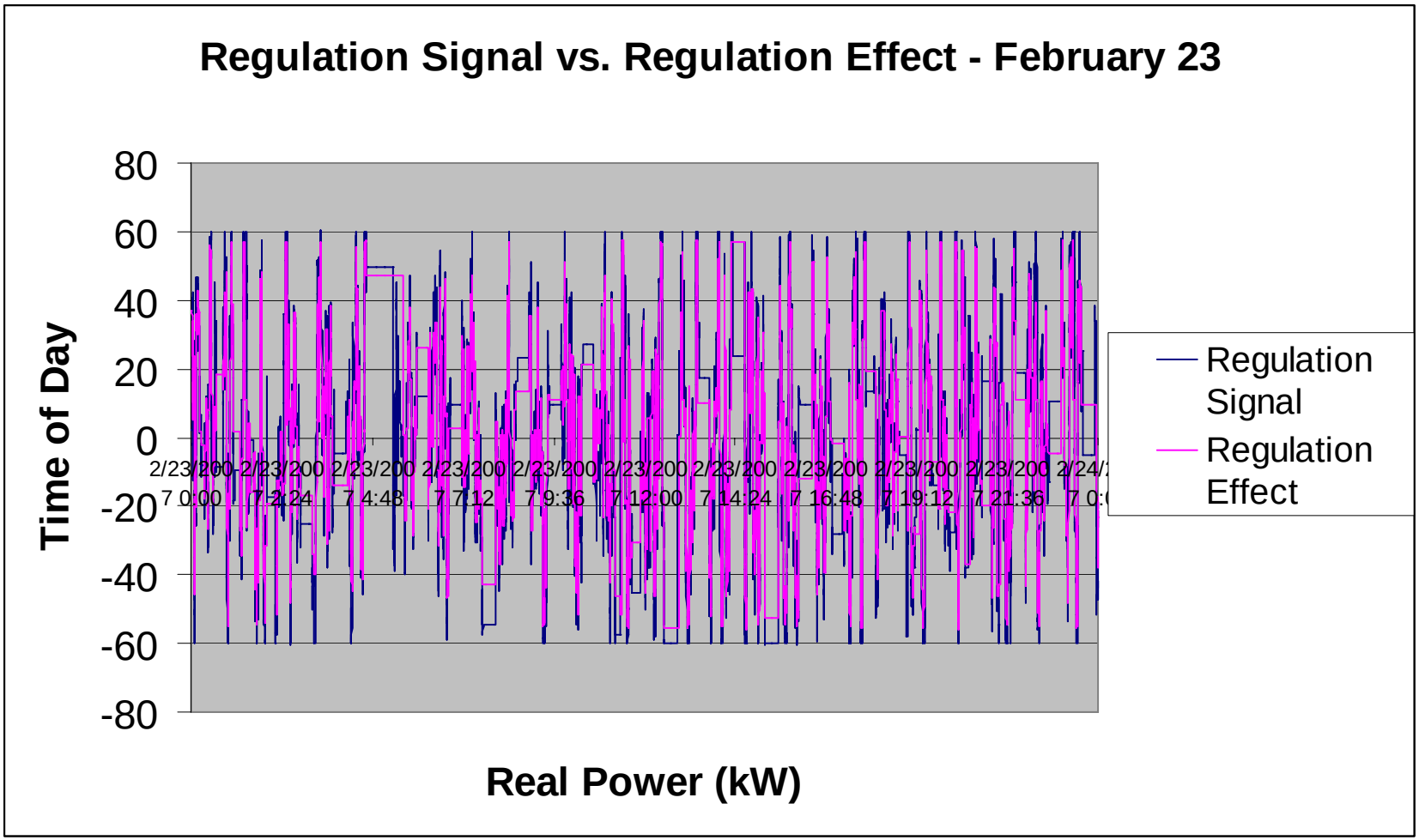
- February 23 verification correlation



Lessons Learned

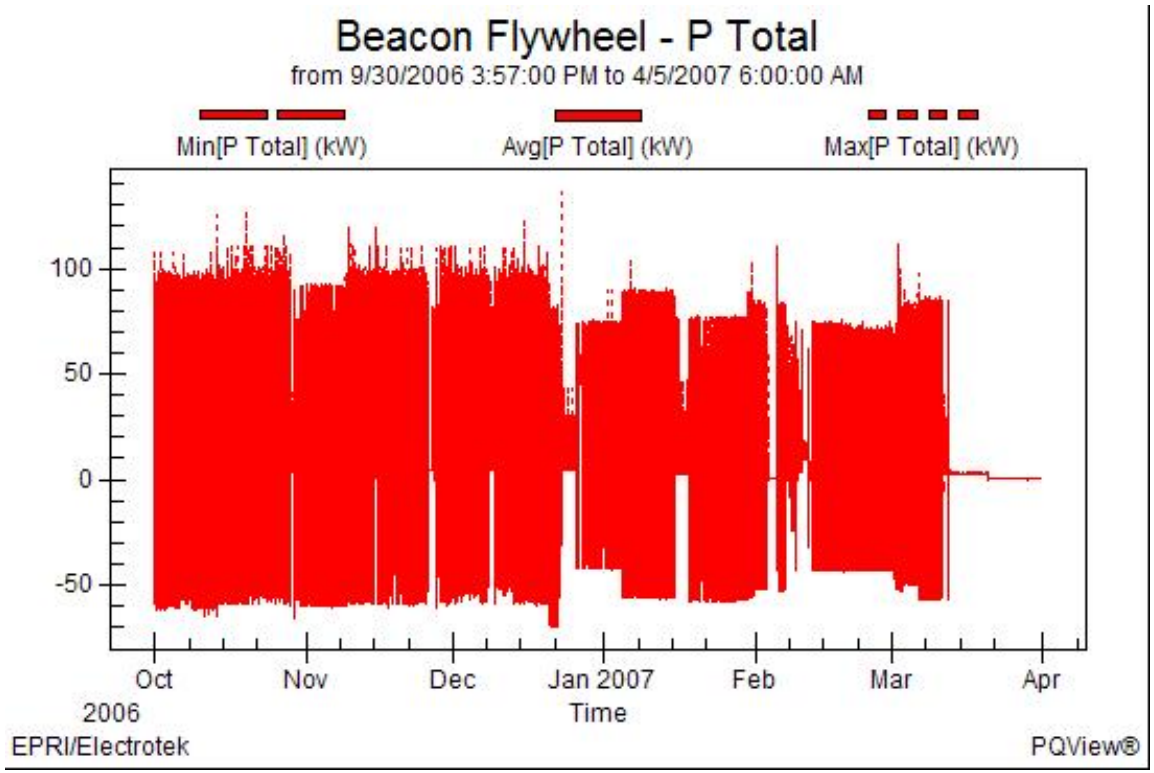
- Beacon Power has successfully shown that the EM flywheel system can react to a frequency signal and inject or absorb power as needed assuming energy is available from storage system

Lessons Learned - cont



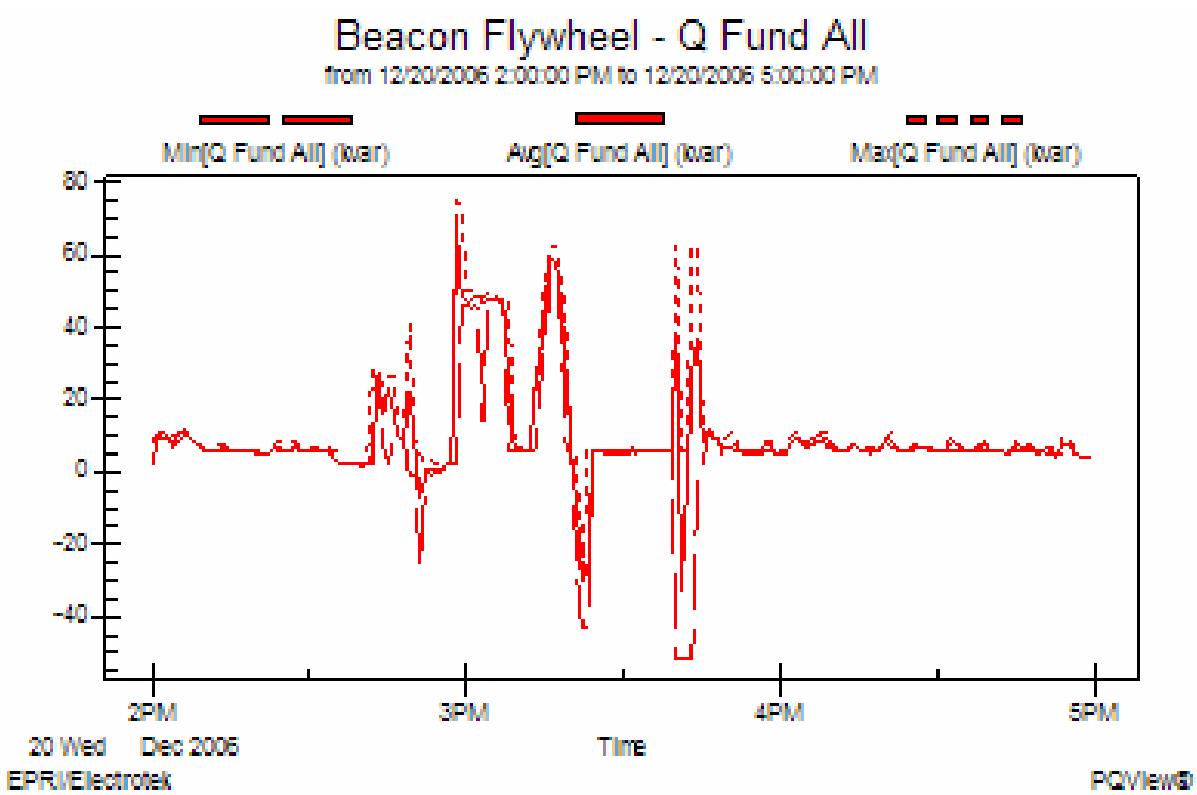
Lessons Learned - cont

- One thing to note is that for example on February 23, only 4 of the 7 flywheels were in operation limiting the output power to 60 kW.



Lesson Learned - cont

- As an additional benefit, Beacon Power was able to show that the flywheel system could be used as a reactive power compensation device.



Site 3

- New York Power Authority/ABB – Peak-shaving and emergency backup application utilizing a 1 MW/7.2 MWh commercial-scale sodium-sulfur (NAS) battery system at a Long Island Bus facility

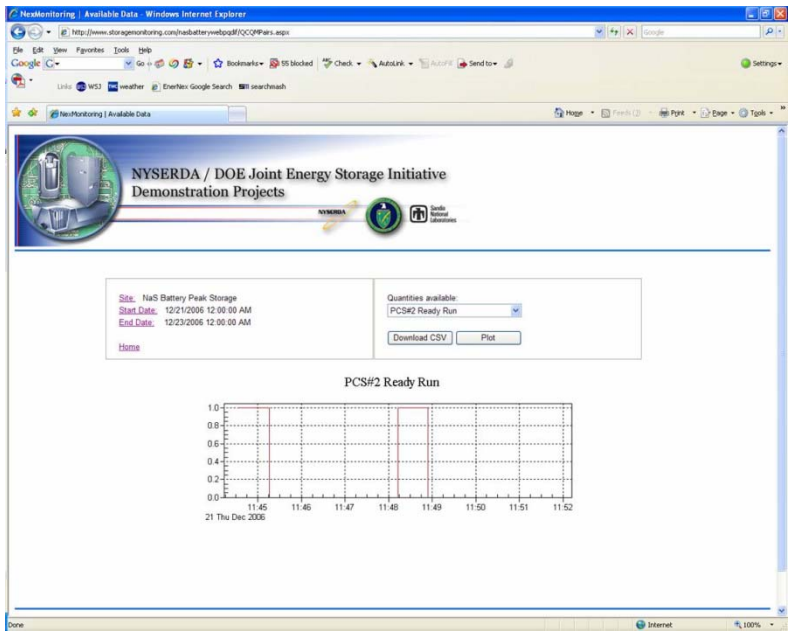
Status

- Signal points list finalized in July, 2006

Signal
Grid RMS Voltage
Grid RMS Current
Grid Real Power
Grid Reactive Power
Grid Apparent Power
PCS Real Power
PCS Reactive Power
PCS Apparent Power
Load Real Power
Load Reactive Power
Load Apparent Power
PCS Real Energy Accumulated – Absorbed Real Energy
PCS Reactive Energy Accumulated – Absorbed Reactive Energy (Inductive)
PCS Real Energy Accumulated – Discharged Real Energy
PCS Reactive Energy Accumulated – Discharged Reactive Energy (Capacative)
System Charge / Discharge Cycle Counter
System Operational Mode

Status - cont

- The process for retrieving, converting and posting the data is complete.
- We are waiting for input on what data is restricted.
- We are ready to go as soon as data becomes available.



Site 4

- Gaia and Princeton Power are in production for four 75kW/225kWh Power Tower units.
- The project will demonstrate peak shaving at an industrial customer in the DCEC territory.
- Kickoff meeting was held on June 26.
- DAS configuration is expected to be similar to the NYPA/ABB project at LIBUS.

Thank You