Data Management for CEC/DOE Energy Storage Demonstration Project

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Project funded by the US DOE ESS Program
Dr. Imre Gyuk, Program Manager

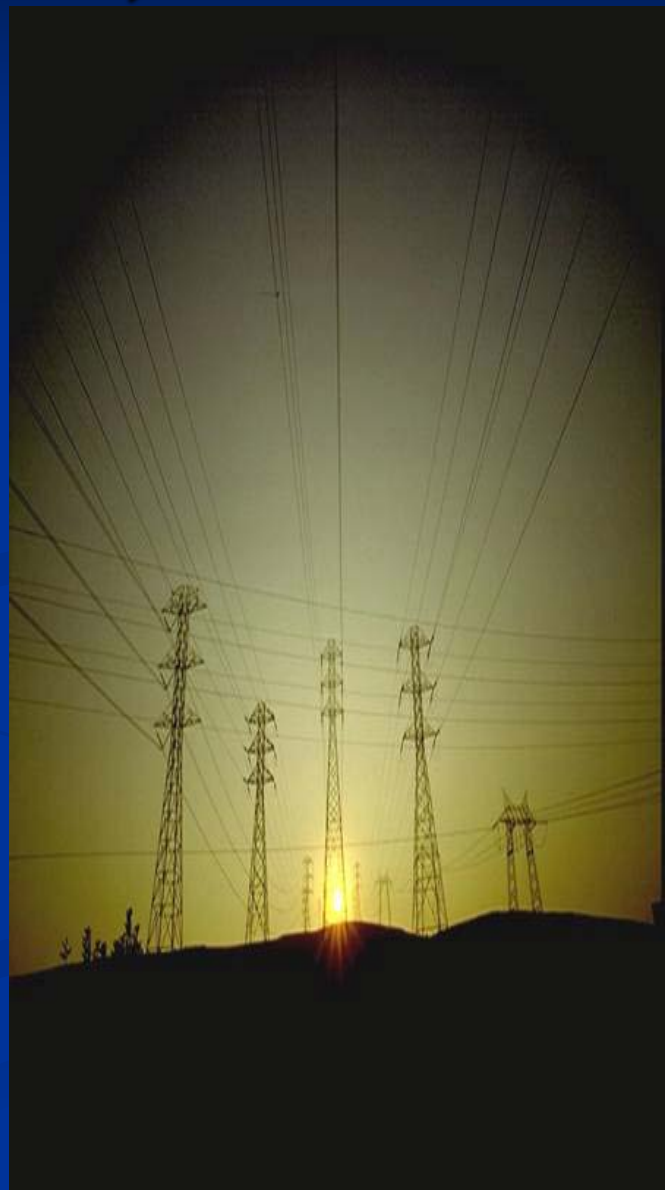
Work performed under contract with Sandia National Labs
Garth Corey Project Manager

Presentation Outline

- Project Overview and Objectives
- Data acquisition status for the demonstration projects
- Updates to the Energy Storage Initiative Website
- Examples of Website Data Analysis

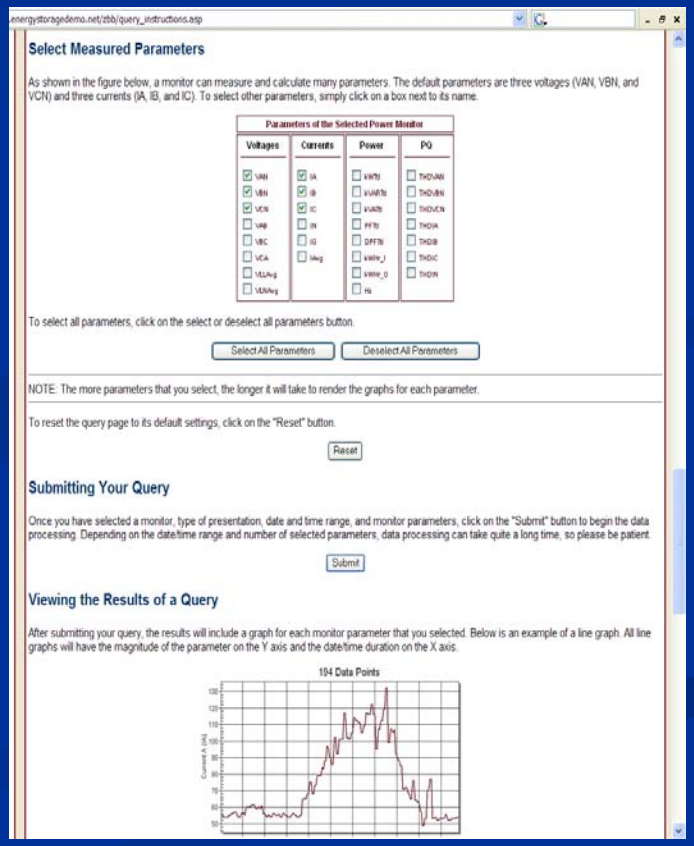
Project Overview and Objectives

- Promote New Energy Storage Technologies that can achieve California's long range energy goals:
  - Increased energy utilization efficiency
  - Reduced demand for out of state energy procurement
  - Reduced overall energy costs to consumers
  - Total emissions reductions



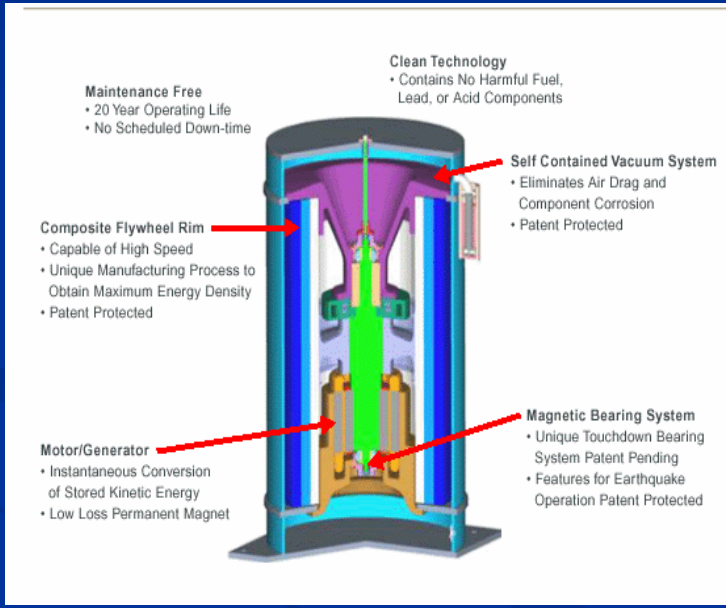
Data Acquisition Objectives

- Develop customized design specifications associated with the DAS for each demonstration
- Provide a safe and secure means of data transmittal, storage, and backup for each demonstration
- Supply a web interface to display system info and provide query-able electric parameter and operational information



FESS Demo Custom DAS Needs

- For the FESS demo key elements of success include:
- Availability
- (% available capacity)
- Electrical response time to a change of state signal
- Overlays of desired power profile vs actual response

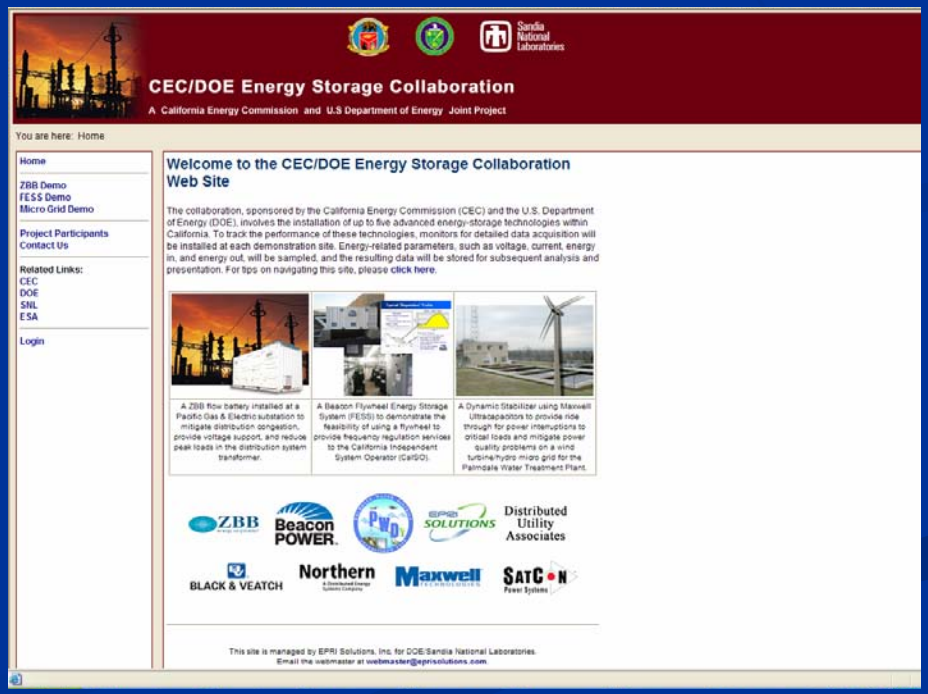


Palmdale Custom DAS Needs

- For the Palmdale demo – key elements of success will include:
- Ultracapacitor System Availability 1 (online ready to discharge/offline for repair)
- Availability 2 Charge state (% available capacity)
- Power Quality 1 – During power variations did the system continue to support the critical load?
- Power Quality 2 – Was the ultracapacitor system able to improve overall power system interactions between the wind, hydro and other distributed resources

Energy Storage Demo Website

- Homepage detailing the project and the project objectives
- Separate main-page for each demonstration project
- Electrical configuration information (one line diagrams) detailing each application
- Summary status pages
- Password protected area
  - Analytical Tools
  - Query Help Instructions
  - Saved and Pre-Defined Charts and Graphs



CEC/DOE Energy Storage Collaboration

A California Energy Commission and U.S Department of Energy Joint Project

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Welcome to the CEC/DOE Energy Storage Collaboration Web Site

The collaboration, sponsored by the California Energy Commission (CEC) and the U.S. Department of Energy (DOE), involves the installation of up to five advanced energy-storage technologies within California. To track the performance of these technologies, monitors for detailed data acquisition will be installed at each demonstration site. Energy-related parameters, such as voltage, current, energy in, and energy out, will be sampled, and the resulting data will be stored for subsequent analysis and presentation. For tips on navigating this site, please click here.

A ZBB flow battery installed at a Pacific Gas & Electric substation to mitigate distribution congestion, provide voltage support, and reduce peak loads in the distribution system transformer.

A Beacon Flywheel Energy Storage System (FESS) to demonstrate the feasibility of using a flywheel to provide frequency regulation services to the California Independent System Operator (CalSO).

A Dynamic Stabilizer using Maxwell Ultracapacitors to provide ride through for power interruptions to critical loads and mitigate power quality problems on a wind turbine/hydro micro grid for the Palmdale Water Treatment Plant.

ZBB energy corporation
Beacon POWER
PWD
EPRI SOLUTIONS
Distributed Utility Associates
BLACK & VEATCH
Northern A Distributed Energy Systems Company
Maxwell TECHNOLOGIES
SATCON Power Systems

This site is managed by EPRI Solutions, Inc, for DOE/Sandia National Laboratories.
Email the webmaster at webmaster@eprisolutions.com.

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Demonstration of a Flywheel Energy Storage System for Frequency Regulation Services

Project Overview

This project demonstrates a flywheel energy storage system designed to respond to a regional transmission operator signal to quickly add or subtract power from the grid in a frequency regulation support mode. Using this concept, the flywheel recycles energy (store energy when generation exceeds loads; discharge energy when load exceeds generation) instead of trying to constantly adjust generator output.

The California Energy Commission is supplying project implementation funding and the US Department of Energy ESS program is sponsoring and funding the data management, collection and analysis activities. The data management activities are directed by Sandia National Laboratories through contracts with EPRI Solutions Inc and Distributed Utility Associates.

Why is CEC/DOE Sponsoring This Project

This project is being sponsored to determine the relative benefits of having faster responding generation resources. Additionally, understanding the response time of a flywheel storage system as compared to traditional generator response time will provide a better determination of the required sizing for flywheel and other fast response systems.

When aggregated to reach appropriate output/input levels there are many benefits that a flywheel energy storage system (FESS) can offer to the electric grid. The primary benefits are:

- Increased Available energy: Because present day generators need to be operated below their maximum capability to provide regulation, they are not available to provide their maximum power. Typically generators need to be below their maximum capacity by 2 times the amount of regulation in order to provide headroom for safe operation. If all regulation were accomplished by FESS, then there would be an additional 2-4 % generation capacity without adding new generators.
- Support Distributed Generation with Local Voltage Support: Several Projects have already shown the benefits of using flywheels for local voltage support. This includes a project on the NY City transit system, where ten 1.6 KWh flywheels provide support between train stations. As flywheel storage increases, as will be demonstrated by this project, the

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Login to the Energy Storage Demonstration Project

Notice:

To view data on the Energy Storage Demonstration site, you must have authorization from one of the Project Managers below.

To request authorization, send an email to the appropriate Project Manager. If you are approved, you will receive an email message with additional instructions.

Garth Corey - Sandia National Laboratories

Matthew Knudson - Palmdale Water District

Jim Arseneaux - Beacon Power

Peter Lex - ZBB Energy

Registered users login here:

User Name

Password

Submit

Forgot your password?

Beacon POWER

Go To | Go Do | Help | Welcome: General User

CEC Demo Flywheel Matrix

FW	RPM	Status
1	18154	Online
2	18122	Online
3	0	OFFLINE
4	18149	Online
5	18124	Online
6	18237	Online
7	18167	Online

Regulation (kW)
27.60 Signal
27.01 Effect

Operating Mode
Live Signal

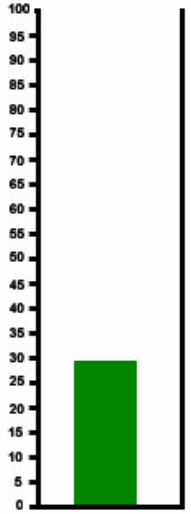
Matrix Energy
29.18 %

-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90 100
Absorbing Injecting

Load Bank Status
OFF

Connected

Grid
488.98 Volts
59.99553 Hz



Local Date
10/25/2006

Local Time
8:10

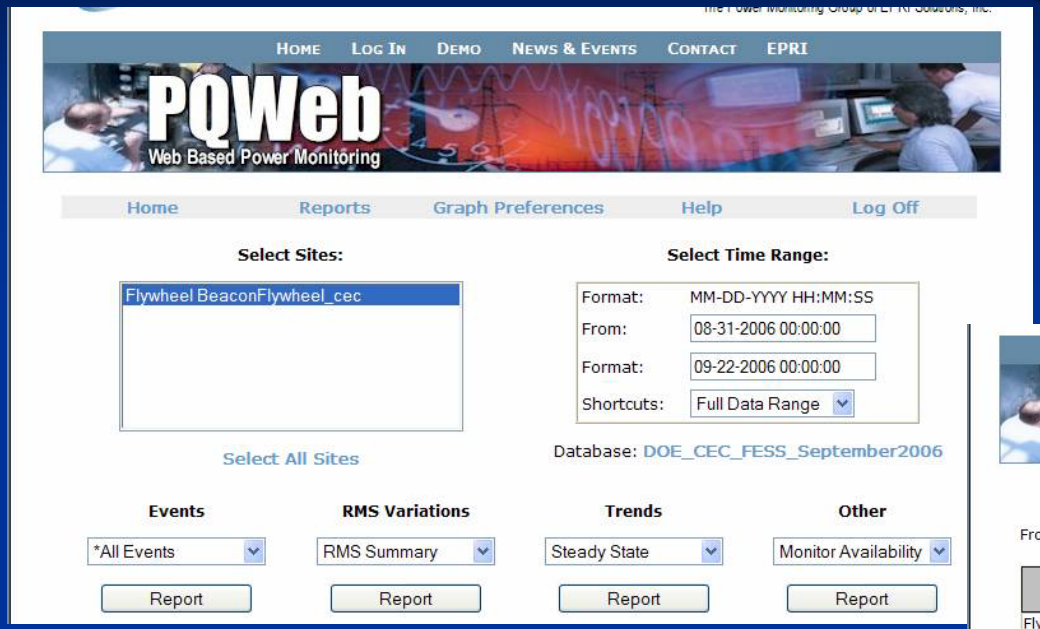
Data Last Updated
8:06 on 10/25/2006

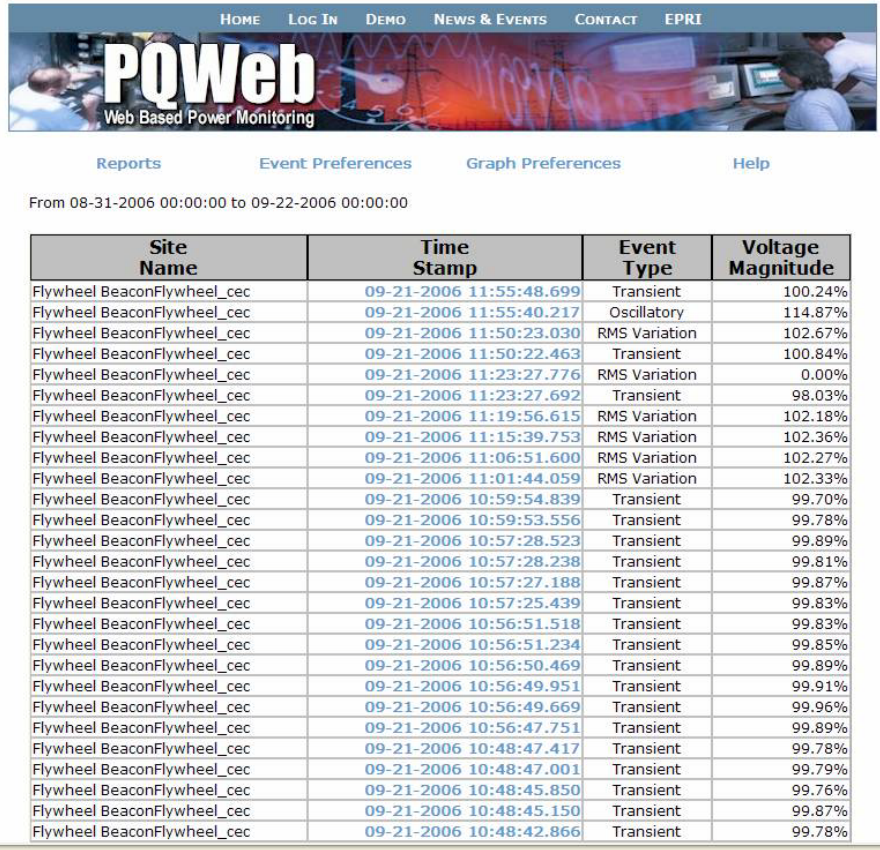
Real Time Flywheel Status "Hyperlink"

Done

Archival Data From the FESS Demo

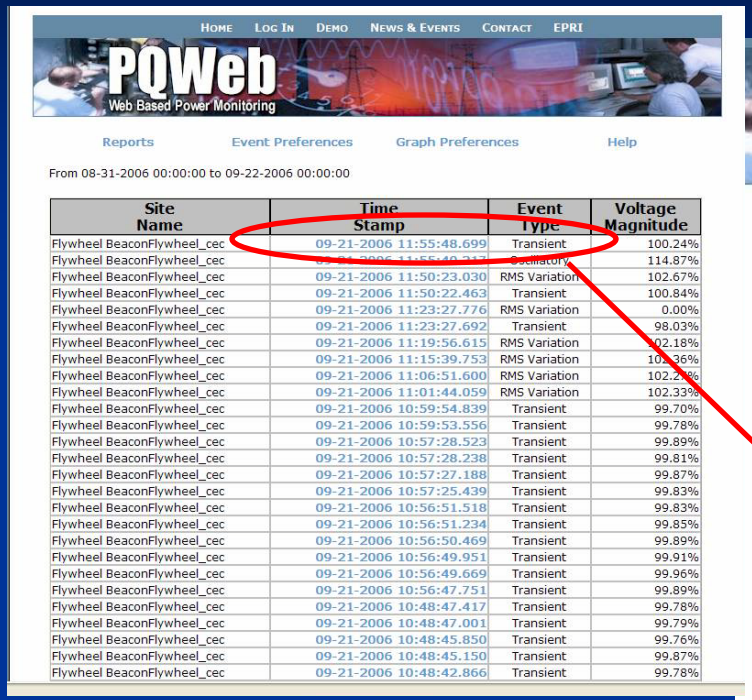
Data From the Flywheel Demo





Site Name	Time Stamp	Event Type	Voltage Magnitude
Flywheel BeaconFlywheel_cec	09-21-2006 11:55:48.699	Transient	100.24%
Flywheel BeaconFlywheel_cec	09-21-2006 11:55:40.217	Oscillatory	114.87%
Flywheel BeaconFlywheel_cec	09-21-2006 11:50:23.030	RMS Variation	102.67%
Flywheel BeaconFlywheel_cec	09-21-2006 11:50:22.463	Transient	100.84%
Flywheel BeaconFlywheel_cec	09-21-2006 11:23:27.776	RMS Variation	0.00%
Flywheel BeaconFlywheel_cec	09-21-2006 11:23:27.692	Transient	98.03%
Flywheel BeaconFlywheel_cec	09-21-2006 11:19:56.615	RMS Variation	102.18%
Flywheel BeaconFlywheel_cec	09-21-2006 11:15:39.753	RMS Variation	102.36%
Flywheel BeaconFlywheel_cec	09-21-2006 11:06:51.600	RMS Variation	102.27%
Flywheel BeaconFlywheel_cec	09-21-2006 11:01:44.059	RMS Variation	102.33%
Flywheel BeaconFlywheel_cec	09-21-2006 10:59:54.839	Transient	99.70%
Flywheel BeaconFlywheel_cec	09-21-2006 10:59:53.556	Transient	99.78%
Flywheel BeaconFlywheel_cec	09-21-2006 10:57:28.523	Transient	99.89%
Flywheel BeaconFlywheel_cec	09-21-2006 10:57:28.238	Transient	99.81%
Flywheel BeaconFlywheel_cec	09-21-2006 10:57:27.188	Transient	99.87%
Flywheel BeaconFlywheel_cec	09-21-2006 10:57:25.439	Transient	99.83%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:51.518	Transient	99.83%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:51.234	Transient	99.85%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:50.469	Transient	99.89%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:49.951	Transient	99.91%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:49.669	Transient	99.96%
Flywheel BeaconFlywheel_cec	09-21-2006 10:56:47.751	Transient	99.89%
Flywheel BeaconFlywheel_cec	09-21-2006 10:48:47.417	Transient	99.78%
Flywheel BeaconFlywheel_cec	09-21-2006 10:48:47.001	Transient	99.79%
Flywheel BeaconFlywheel_cec	09-21-2006 10:48:45.850	Transient	99.76%
Flywheel BeaconFlywheel_cec	09-21-2006 10:48:45.150	Transient	99.87%
Flywheel BeaconFlywheel_cec	09-21-2006 10:48:42.866	Transient	99.78%

Real Time Data From the FESS Demo



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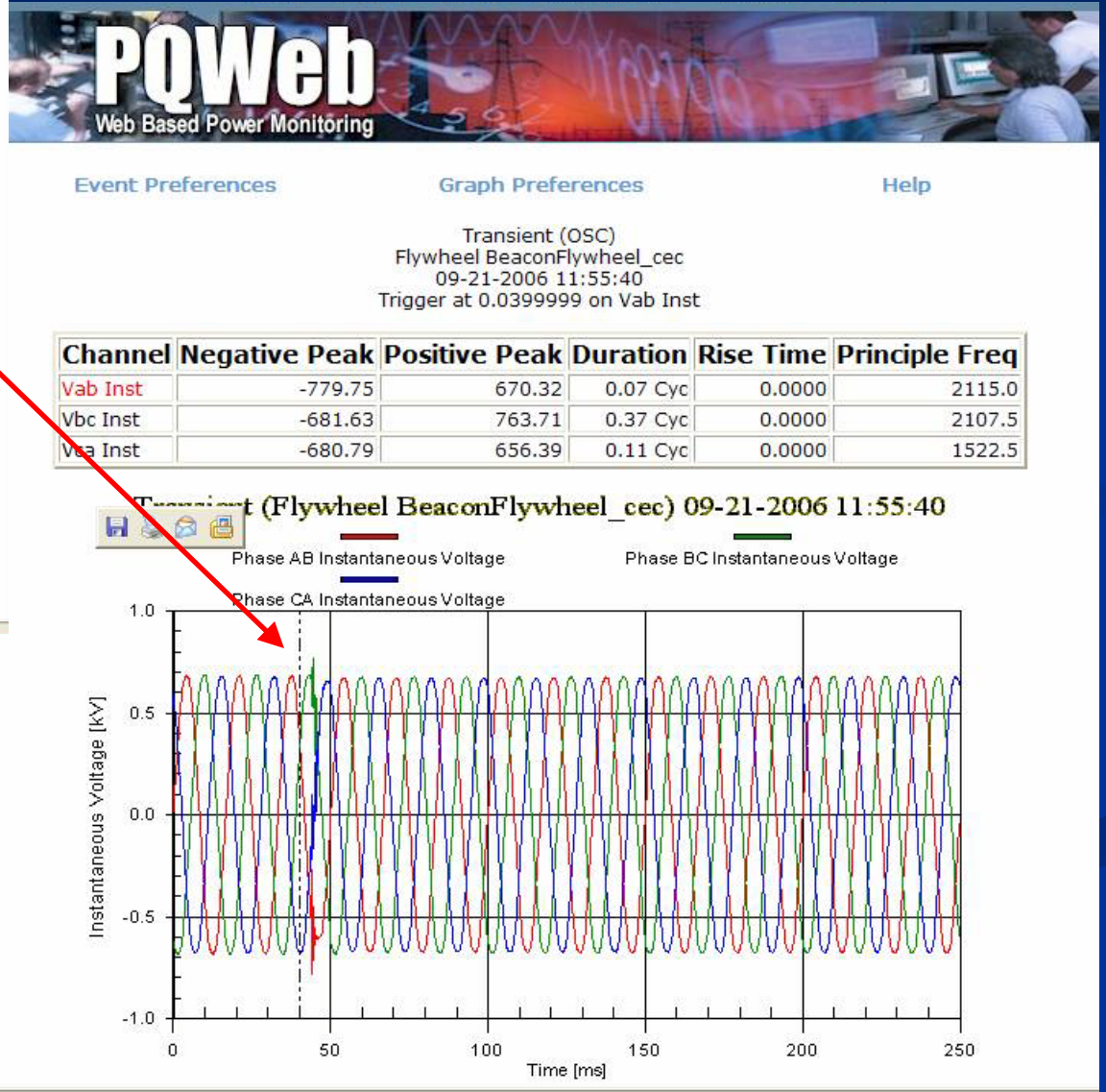
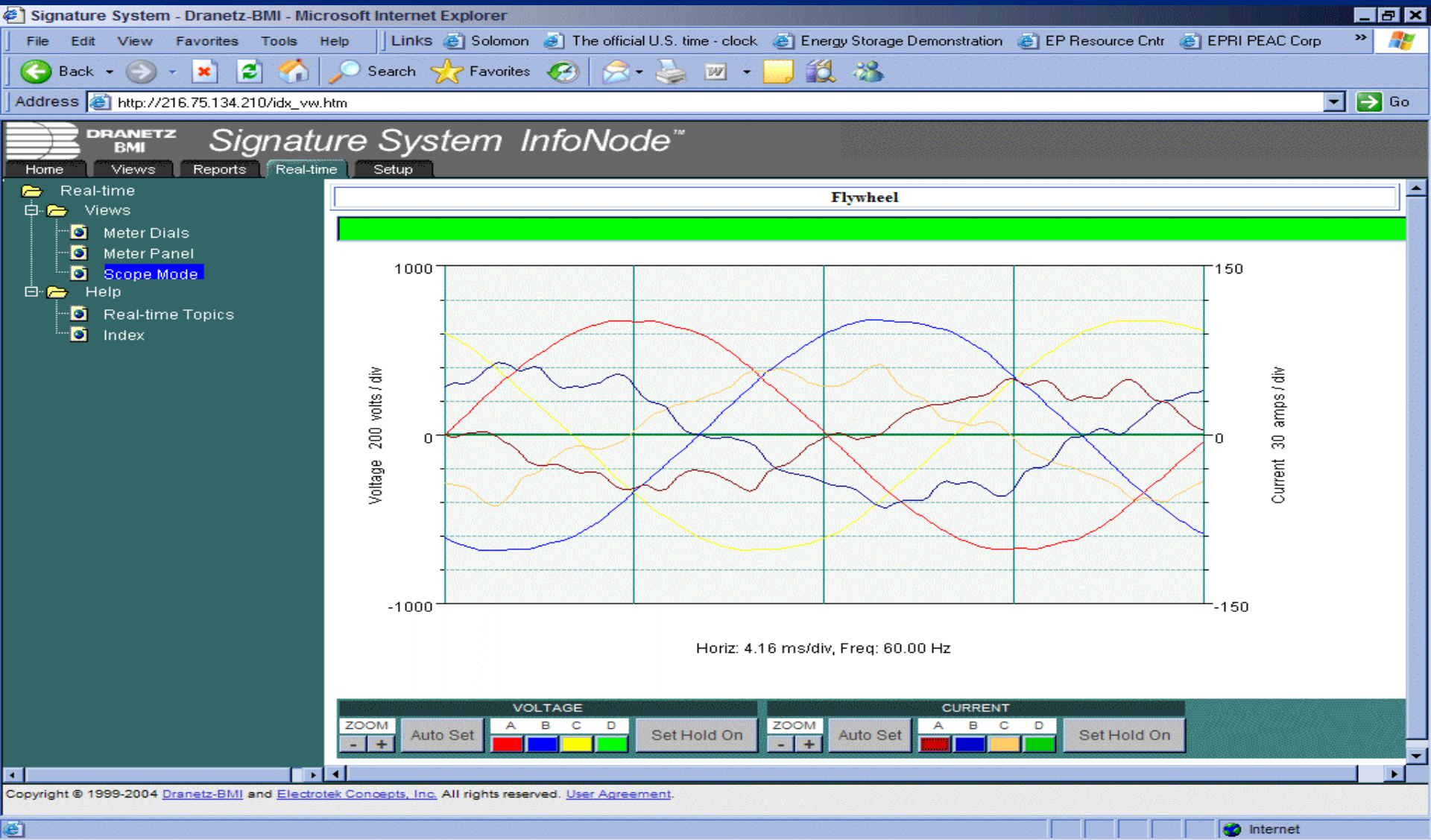
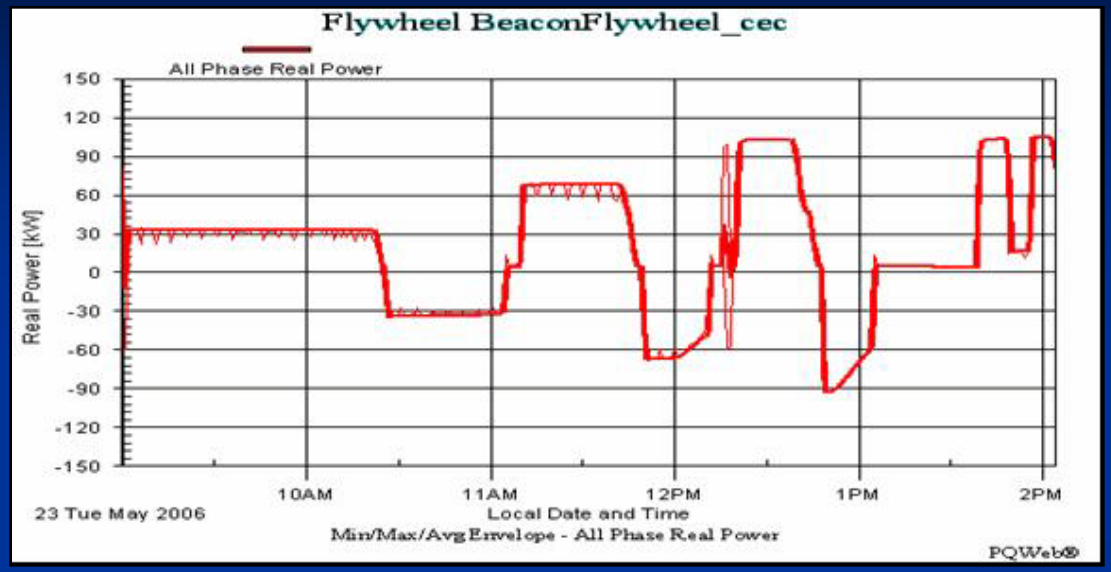


Channel	Negative Peak	Positive Peak	Duration	Rise Time	Principle Freq
Vab Inst	-779.75	670.32	0.07 Cyc	0.0000	2115.0
Vbc Inst	-681.63	763.71	0.37 Cyc	0.0000	2107.5
Vca Inst	-680.79	656.39	0.11 Cyc	0.0000	1522.5

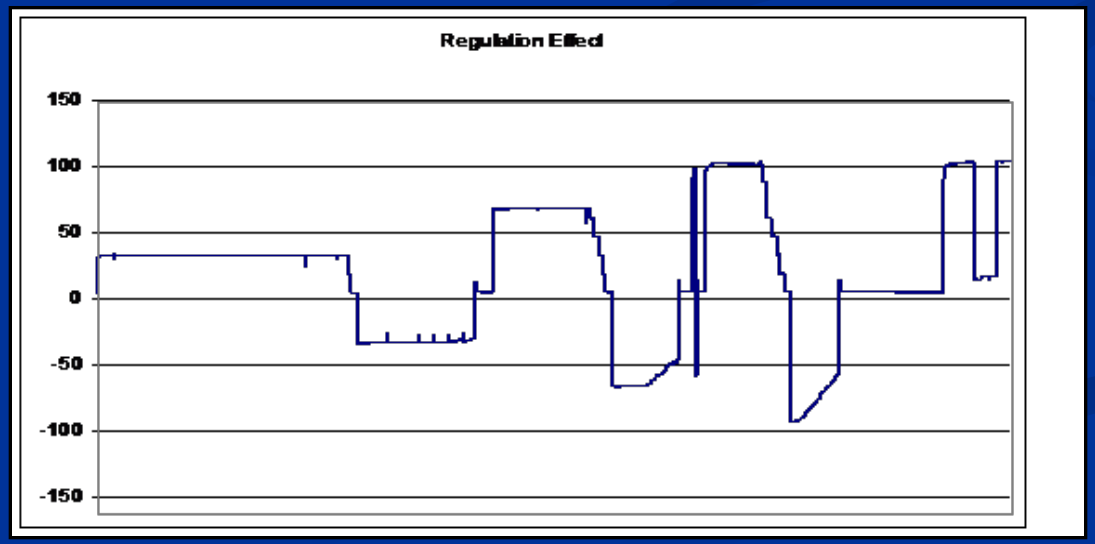
FESS Demo Three-Phase Voltage and Current "Oscilloscope Mode"



Independent Confirmation of Beacon Data



Power Delivered and Absorbed by the Flywheel Over a 5 hour Test Period as Reported by Dranetz Signature System Energy Meter



Power Delivered and Absorbed by the Flywheel Over a 5 hour Test Period as Reported by The Shark Energy Meter

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Micro Grid Energy Storage Demonstration

Project Overview

This project will demonstrate the use of ultracapacitor energy storage module in support of a selection of distributed energy resources that could potentially be configured as an electric microgrid. To support the demonstration, Palmdale Water District (Palmdale) in California has installed a variety of new distributed energy resources to supply facility power in an environmentally friendly way. These resources include a 950 kilowatt wind turbine, a 200 kilowatt natural gas generator, and a 250 kilowatt water turbine generator. It is expected that with these new distributed generation sources, the facility will be able to supply the majority of its electric power needs for the near future.

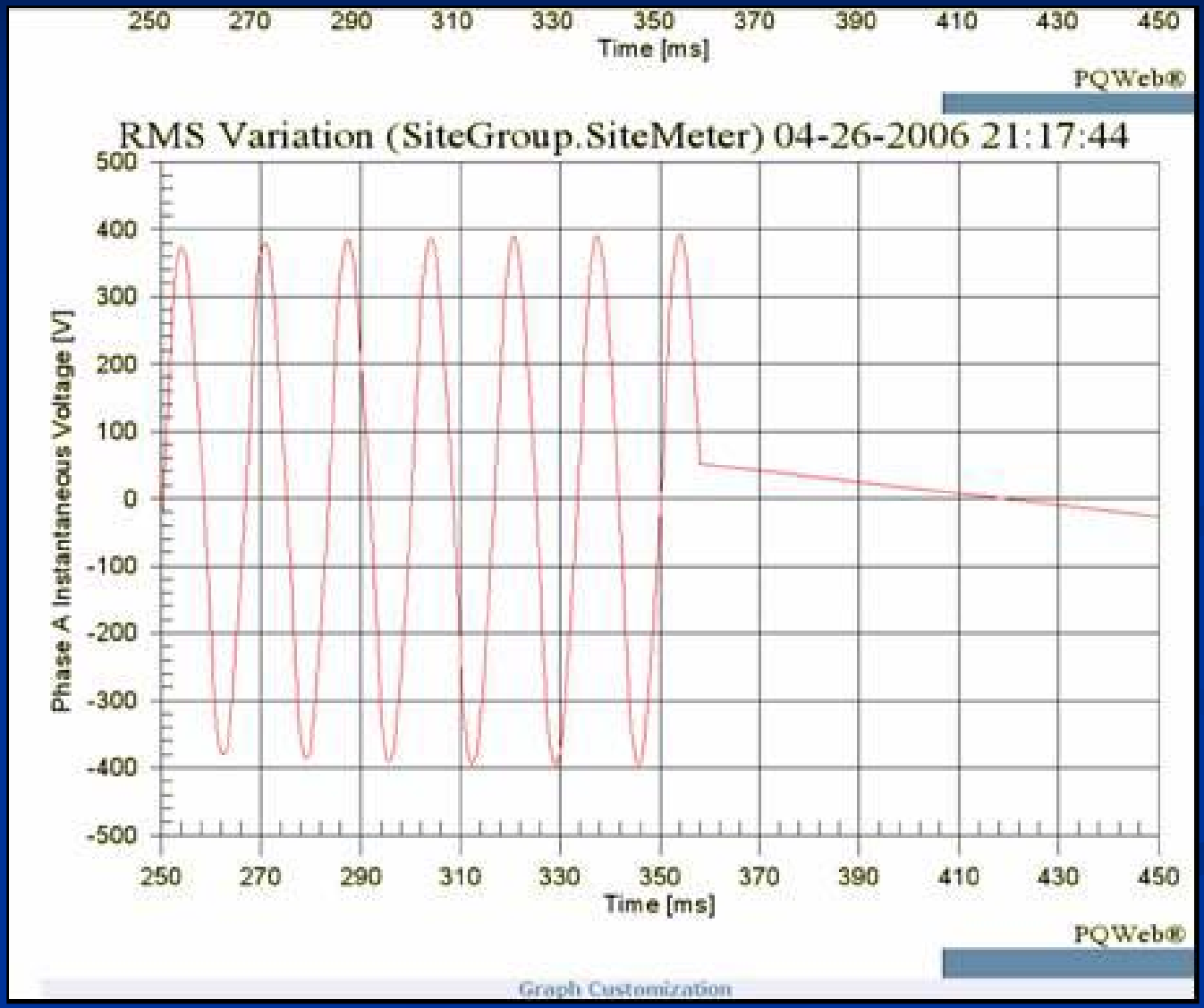
To supplement the electrical performance of these technologies, Northern Power Systems will develop and demonstrate a 450 kilowatt storage system called the electric energy storage system. Data collection and management for this system demonstration is being funded by the U.S. Department of Energy (DOE). The system will be installed at Palmdale's Clearwell Pumping Station (Clearwell). The energy storage system utilizes ultracapacitors coupled with advanced power electronics and controls to maintain electric grid stability even during brief power system variations and momentary power interruptions.

The California Energy Commission is supplying project implementation funding and the US Department of Energy ESS program is sponsoring and funding the data management, collection and analysis activities. The data management activities are directed by Sandia National Laboratories through contracts with EPRI Solutions Inc and Distributed Utility Associates.

Why is CEC/DOE sponsoring this project?

This project offers a unique opportunity to demonstrate and better understand the capabilities of a zinc bromine battery based storage system and compare the economics and lifecycle costs to some of the

Data From the Micro Grid Demo



Summary and Conclusions

- Website is operational – data is being collected for the Palmdale Site and the for the FESS Demo – http://www.energystoragedemo.net/cec
- Web based data acquisition system is structured for security, redundancy, availability and expandability
- Data acquisition cost are running less than 5% of the overall project costs
- Archival value of the data will most likely have an inverse relationship to the project costs….. i.e. 95% of the value will be the archived data