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

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Sandia is a multi-program laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

ACKNOWLEDGMENTS

- This project is part of the Joint 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) through Sandia National Laboratories (SNL).

Acknowledgements

The Data Acquisition and Analysis for these demonstration projects is funded by the U.S. Department of Energy.

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Core Requirements – PON 846

- The proposed EES 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.
- Data acquisition rates must be adequate to monitor the application that the system is designed to perform. For example, power quality operations require high-speed data acquisition, on the order of micro-seconds, to adequately capture power quality or system stability events.
- In contrast, energy management operations such as peak shaving or arbitrage applications, require sampling on the order of milli-seconds to seconds with 15 minute averages.
- In the event that the demonstration system performs multiple activities, the DAS must provide for the collection of data for all activities.
- DAS hardware and software plans, flowcharts, and operating manuals must be provided to the NYSERDA and DOE Project Managers by the proposer at the demonstration project final design review prior to the initiation of system DAS hardware procurement.

System Operational Summary – Minimum Requirements

- A written summary of the economic benefit derived;
- A written summary of all operations and maintenance activities;
- System dispatch information and use patterns associated with the project;
- Energy consumption breakdown of parasitic loads introduced by the demonstration system;
- System performance under typical utility fault conditions, e.g. lightning strikes, primary phase to ground faults, voltage sags/spikes, electric outages, etc.;
- System performance under user fault conditions, e.g. fault in customer plant;
- System reliability, failure rates, and performance summary;
- Utility system operational data after installation of the demonstration system.

Minimum System Recorded Parameters

- At a minimum, the following demonstration system parameters must be measured, recorded, and transmitted to the Data Management Contractor for all system operations;
  - Events that result in a change of demonstration system operational mode;
  - Demonstration system response times to changes in operating conditions;
  - Energy and power into and out of the EES for each AC phase in the system;
  - EES System load;
  - EES System duty cycle count;
  - EES failures and problems;
  - Electrical performance of the Power Conditioning System.
  - All data must be time-stamped with resolution to 1 milli-second.

Key Data Requirements

- Standards based power, energy, and quality measurements
  - IEEE 1459 standard for power measurements in non-sinusoidal and unbalanced situations
  - IEEE 1159, IEC 61000-4-7, 4-15, 4-30
- “millisecond level” data
  - Mainly related to short term system impact analysis
  - Single PQ metering device should suffice – preferably same device used for other DOE-NYSERDA project sites
  - Flicker, harmonics, unbalance, transients, voltage sags/swells

Measurements and Impact Assessments

- Input control signals used to dispatch the system
- System operating characteristics and status
  - Available capacity
  - Current control mode (e.g. local, remote, other)
- Local voltage, frequency, flicker, THD, etc.
- System current, power flow, harmonic injection
- Impact on local power quality
  - Transition impact (RMS and transient domains)
  - Harmonic impact
  - Flicker impact
  - Voltage regulation

Approach

- Convert data from vendor systems into standard formats
  - IEEE 1159.3 PQDIF
  - IEC 61850 data models for metering
- Merge with data from high resolution monitoring system in EnerNex gateway
- Transport to EnerNex monitoring center via secure communications link over Internet
- Expose via dynamically generated tables, graphs on demand on project web site
- Expose raw data via web services (at site gateway and at collection center) using IEC 61850 ACSI service model

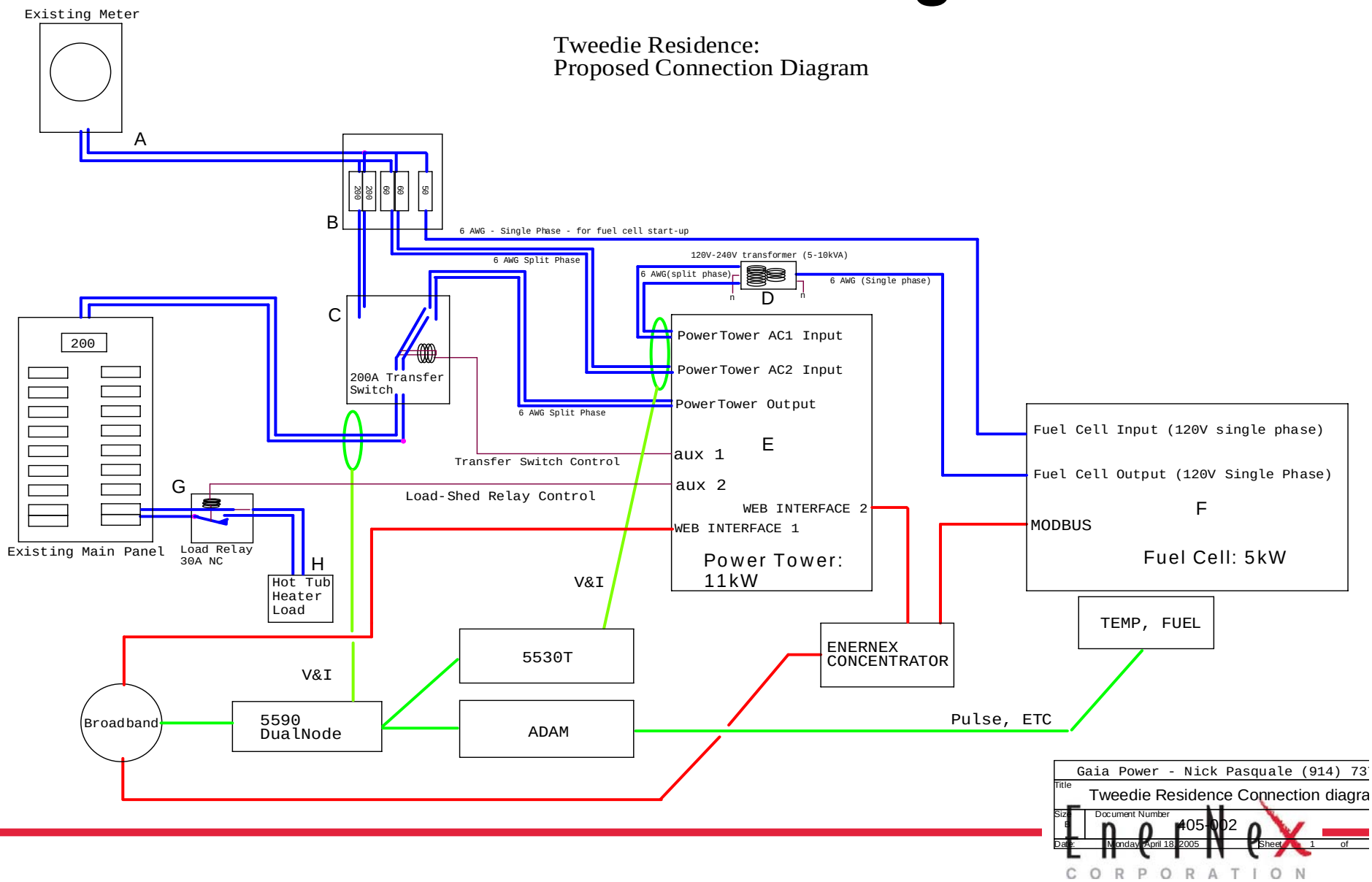
DAS Design Steps

- Identify data points available from vendor system
- Compare available data with DOE-NYSERDA requirements
- Determine if any missing parameters can be obtained from high speed monitoring device.
- Determine method of getting data from vendor system into EnerNex gateway
- Select high speed measurement device
  - Prefer to use same system as other DOE-NYSERDA sites to reduce system integration and recurring costs
  - Install ASAP to meet baseline requirements
- Identify means of network connection
  - Cable, DSL or Satellite
  - Install to coordinate with HS measurement device

Site 1

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

Site 1 – DAS Block Diagram



Site 1 – DAS Equipment

- Drantez-BMI Signature System DualNode (Combination InfoNode (data concentrator) and DataNode) at Service Entrance collecting power quality and steady-state values
- Additional DataNode on Power Tower Input (also Fuel Cell Output)
- Advantech ADAM modules for environment (temperature, humidty) and flow (gas and water) data from thermocouple and pulse counter meters
- EnerNex Data Concentrator (ETRAX 100LX MCM 2+8 chip and device server) to download Power Tower currently and Fuel Cell Operational Data (future)
- On board DAS systems on Power Tower and Fuel Cell
- Communications through secure VPN to VPN satellite link provided by Skycasters, LLC

Downloading and Display

- Essentially two data concentrators are collecting data continuously
- EnerNex data center downloads concentrators every hour through the satellite link
- Data publicly available at (http://www.storagemonitoring.com/nyserda-doe/CriteriaSelection.aspx)

Steady-State Quantities

- Service Entrance and Power Tower Input
  - RMS Voltage
  - RMS Current
  - Active Power
  - Fundamental Reactive Power
  - Apparent Power
  - Frequency
  - Voltage THD
  - Voltage TID
  - RMS Harmonic Current
  - Interharmonic RMS Current
  - Voltage Crest Factor
  - Harmonic Group Voltage
  - Harmonic Group Current
  - True Power Factor
  - Displacement Power Factor
  - Frequency
  - Watthours
  - Varhours
  - Short Tem Flicker
  - Sliding PLT
  - Long Term Flicker

Steady-State Quantities - cont

- ADAM Modules
  - Environment
    - » Outside Temperature
    - » Outside Humidity
  - Thermocouples (Temperature)
    - » CHP From Fuel Cell
    - » CHP Return to Fuel Cell
    - » From Outdoor Boiler
    - » Return to Outdoor Boiler
  - Flow Counters
    - » LP Gas Flow (Cubic Feet)
    - » CHP Loop Flow (Gallons)
    - » Outdoor Boiler Flow (Gallons)

Steady-State Quantities - cont

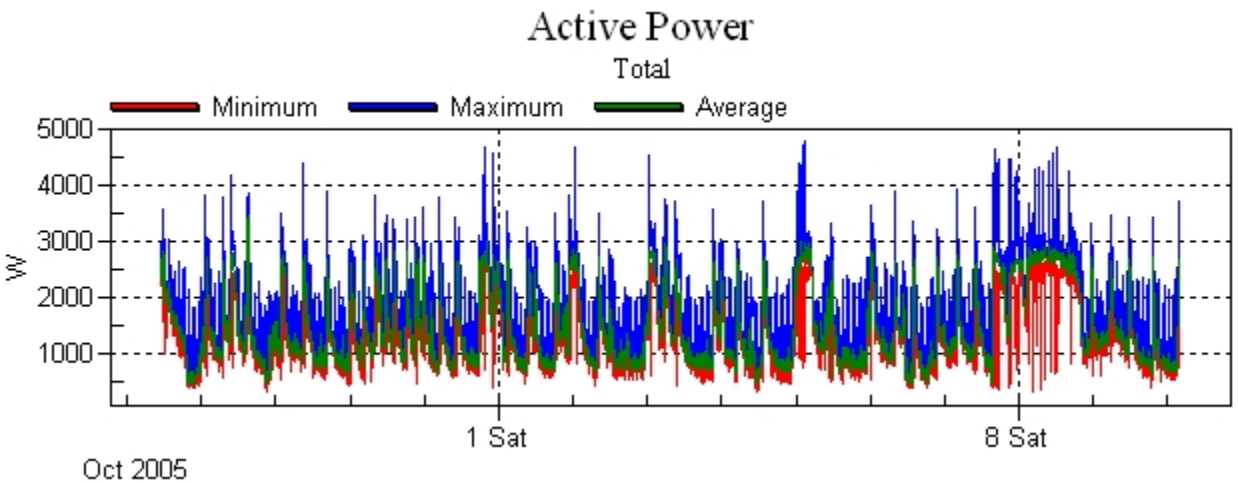
- Power Tower
  - PowerTower Input and Output ("Elkors 1" and "Elkors 2" in XML file):
    - » RMS Voltage
    - » RMS Current
    - » Apparent Power (V * I) (calculated quantity not in XML file)
    - » Frequencey
  - Battery Monitor ("EMeter" in XML file):
    - » Energy Shift
    - » DC Volts
    - » DC Amps
    - » Capacity Shift
    - » SOC Level
  - Inverter Leg 1 and 2:
    - » Battery Actual Volts DC
    - » Inverter / Charger Current
    - » Input Current
    - » Load Current
    - » Inverter Voltage
    - » Fuel Cell Voltage
    - » Grid Voltage
    - » Fuel Cell Current Limit
    - » Grid Current

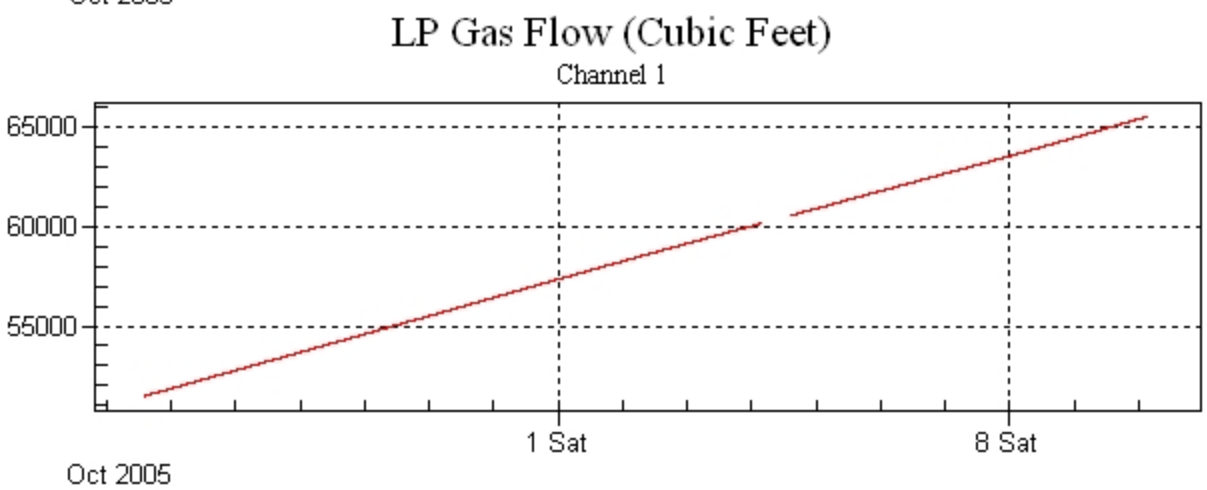
Steady-State Quantities - cont

- Fuel Cell
  - Lifetime System Run Hours
  - Lifetime Stack Run Hours
  - Lifetime kW Hours
  - Lifetime fuel consumption
  - FC Voltage
  - FC Current
  - Line1 RMS Current
  - Line2 RMS Current
  - Line1 RMS Voltage
  - Line2 RMS Voltage
  - Grid Voltage
  - Grid Frequency
  - Last Event Code
  - SYSTEM_POWER_SETTING

Current Operation

- Fuel cell is supplying about 2kW to the Power Tower on a continuous basis





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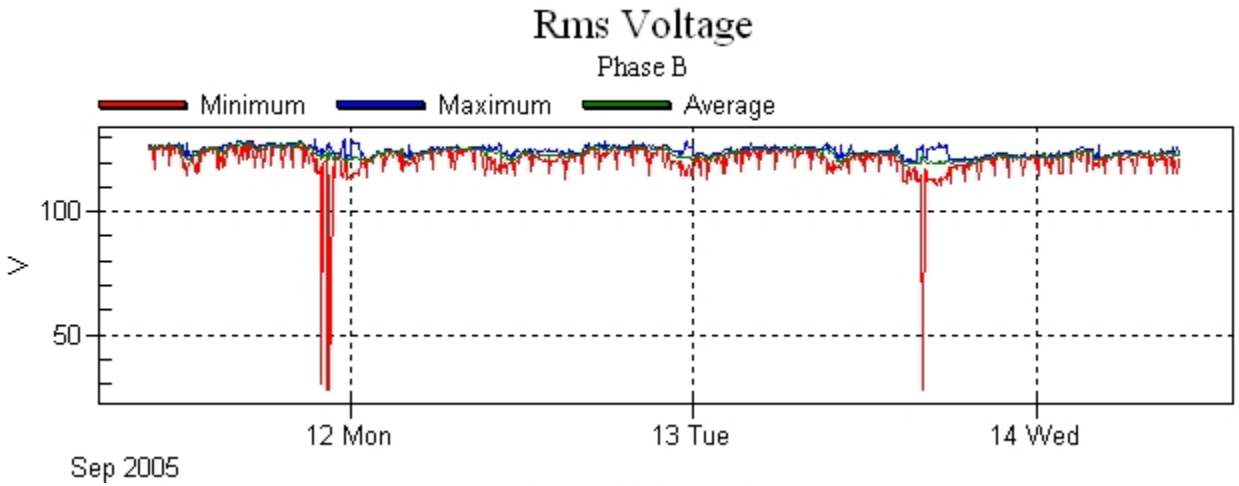
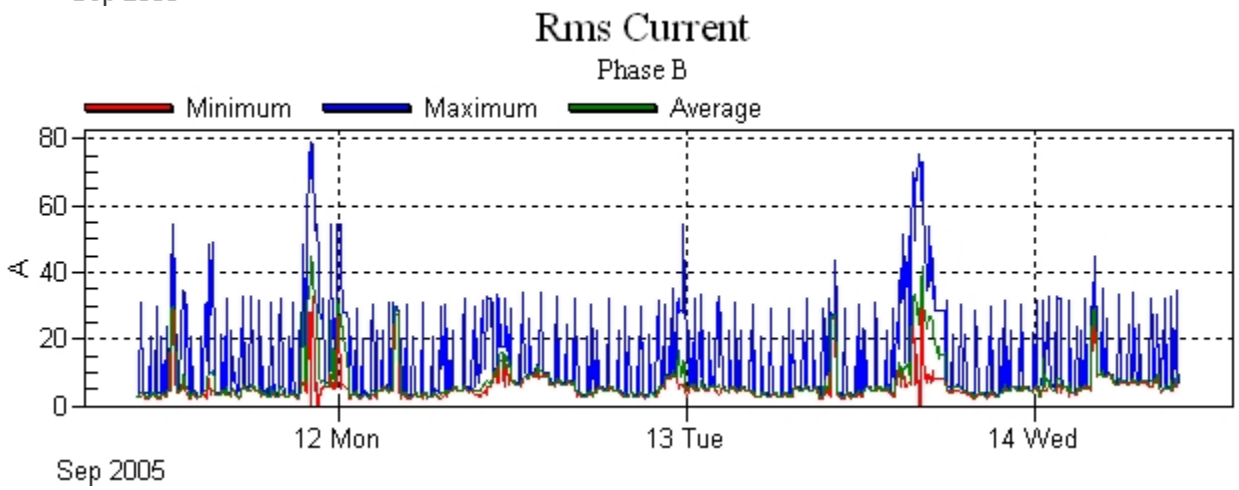
Current Operation - cont

- Power Tower continuously supplies house load unless either leg goes above 5.5kW or 45 amps
- If load goes above, load shedding relaying operates, followed by full load transfer back to grid
- Recently this has occurred on
  - 8/29, 9/5, 9/11 (twice), 9/13

Current Operation - cont

- Voltage and Current Trend from 9/11 through 9/14





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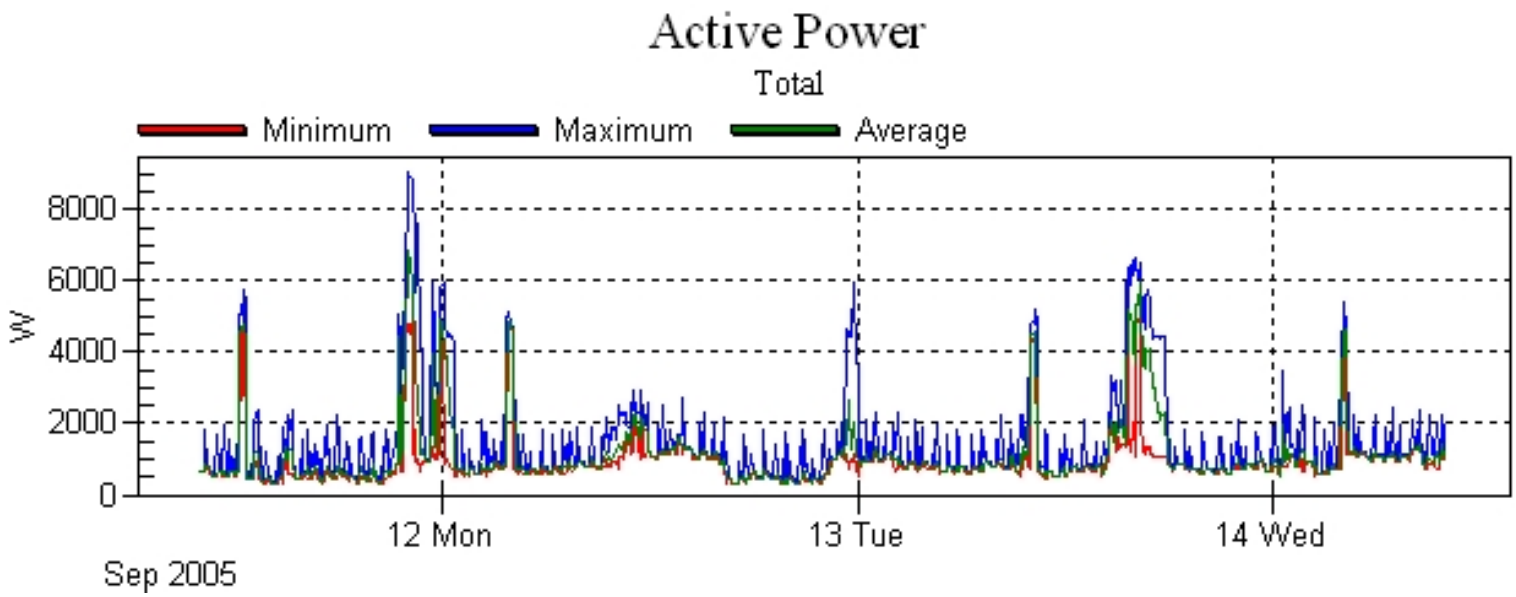
Current Operation - cont

- Active Power out of Power Tower

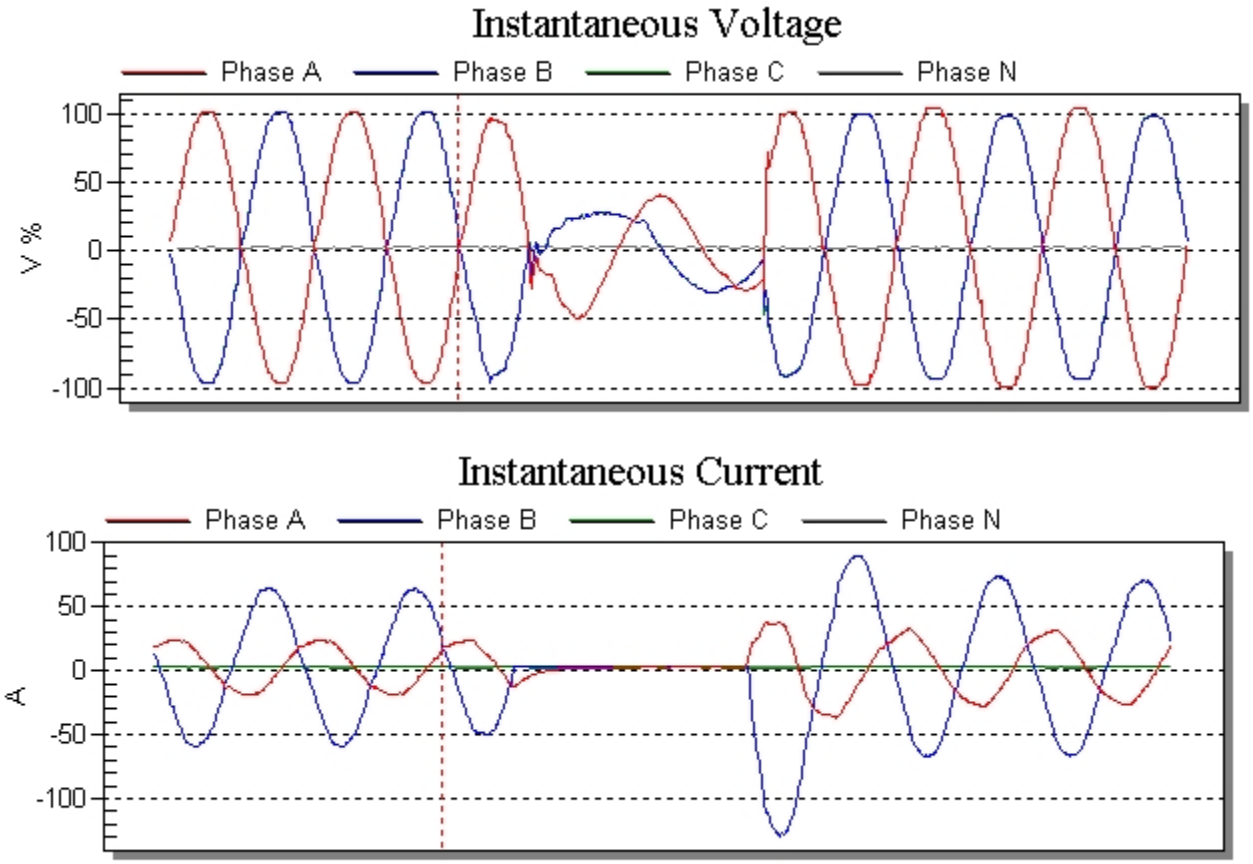


Current Operation - cont

- Full load transfer actually result in a pair of events, transfer over, transfer back
  - 9/11 09:58.55 pm GMT
  - 9/11 10:24:25 pm GMT
  - 9/11 10:31:12 pm GMT
  - 9/11 10:37:08 pm GMT
  - 9/13 03:55:46 pm GMT
  - 9/13 04:01:42 pm GMT

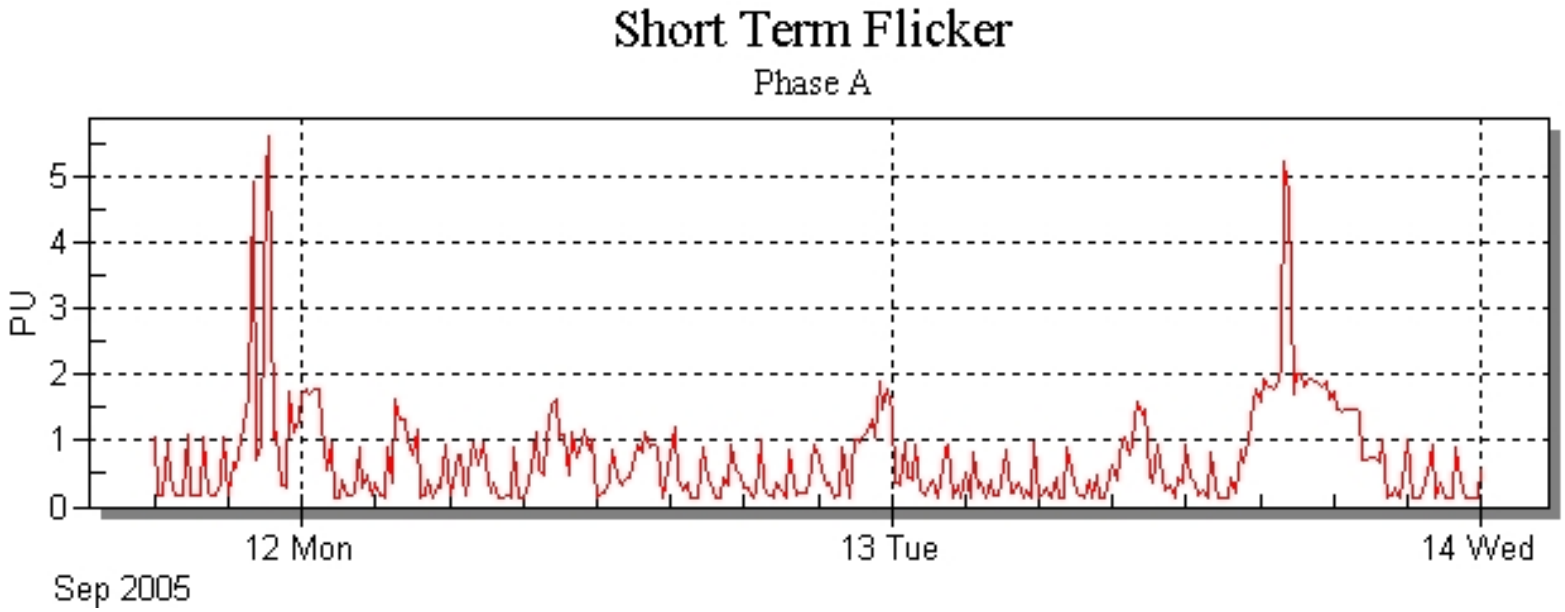
Current Operation - cont

- Transfers result in 2 cycle very deep events



Current Operation - cont

- We are investigating why lights in house are blinking periodically
  - Probably hot tub load



Site 2

- Beacon Power – Grid frequency regulation demonstration at an industrial facility in Amsterdam, NY, using 7 flywheels producing 100 kW for 15 minutes
  - Will use same instrument as other Beacon Power site, Dranetz-BMI Singature System

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
  - Still working out the detail of the DAS system

Questions

- Any questions?