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300kW Energy Storage Demonstration Project

Technical Overview

Presented at:

Annual Doe Peer Review Meeting – 2008

DOE Energy Storage & Power Electronics Research Programs

By

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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). 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

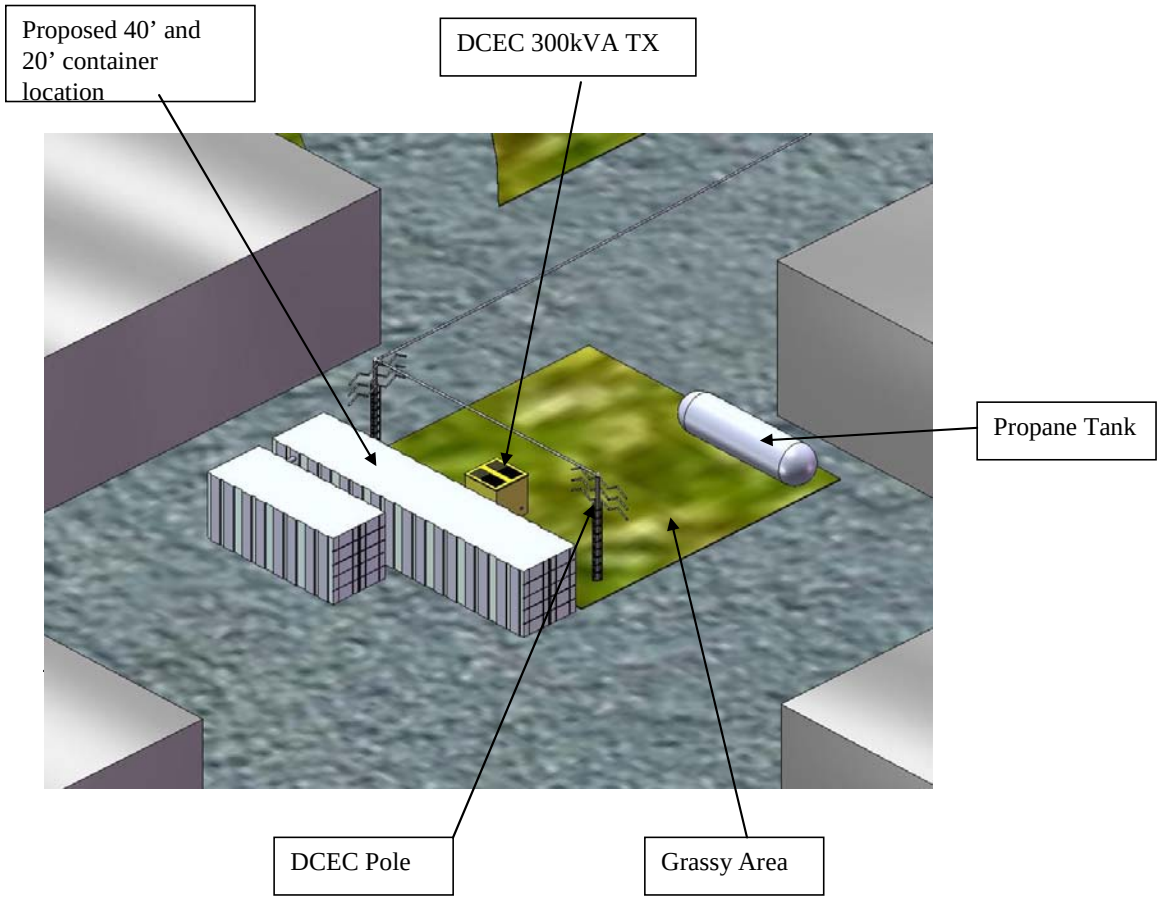
Project Scope

- 300 kW / 900 kWh utility controlled battery energy storage partially funded by NYSERDA and CEATI
  - Primary function: Daily or seasonal demand reduction
  - Secondary function: Back-up power for major industrial customer
- Deliveries for NYSERDA and CEATI
  - Technical feasibility of battery technologies
    - Comparison between Zebra and advanced lead acid carbon battery technologies
    - Feasibility of combined demand reduction and back-up
  - Analysis of business case
    - Utility value / savings (reduced demand charges, deferred cap-ex) versus capital investment and operational cost
    - Industrial customer tangible or non-tangible benefits

Project Status

- BESS specifications almost finished
- Received the four 75kW inverters
  - Testing in progress
- Received half of the Zebra batteries
  - Integration has started
- PbC batteries manufactured and ready to be installed
- Third party Environmental, Health, and Safety assessment has just begun
  - Dr. Sanjoy Banerjee from City University in New York will perform the assessment
  - The outcome may impact BESS specifications and / or final location
- We expect to install BESS in 1st half 2009 and commissioning in 2nd half.
  - Testing will include two winter peak seasons

Proposed Test Site

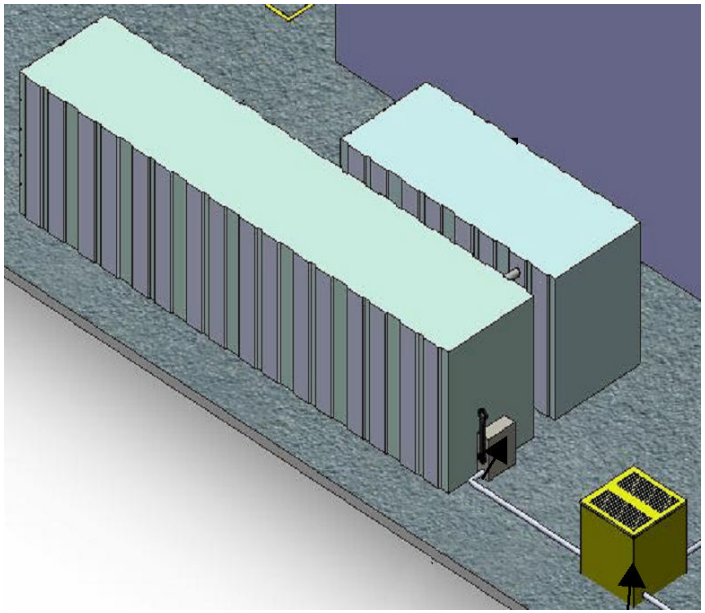


The proposed test site is in the middle of an industrial complex, which is also the recipient for the backup power from the BESS in case of loss of utility power

As the installation involves “new” battery technology, the project has decided to perform an Environmental, Health, and Safety assessment prior to installing the BESS

BESS Enclosure

- Standard enclosure
  - One 40ft shipping container
    - All power electronics, Zebra and lead acid batteries, and control equipment
  - One 20ft shipping container
    - Advanced lead acid carbon batteries
  - Can either be placed on pavement / concrete pillars or for temporary installation stay on trailer
  - Connects directly to user side of utility transformer



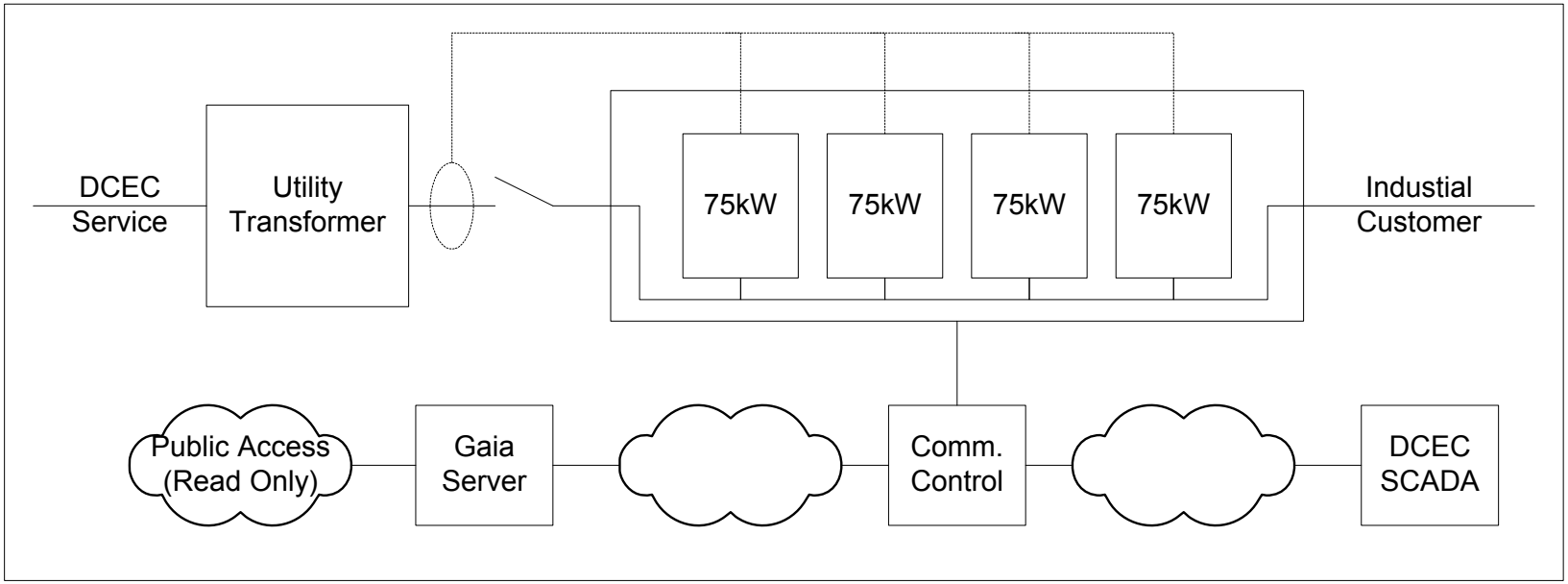
BESS Building Blocks

- Energy storage unit made up of four individual commercial grade 75kW / 225kWh PowerTowers operating in parallel
- Two “new” battery technologies will be tested
  - NaNiCl (Zebra) battery technology from MES-DEA in Switzerland
    - Potential alternative to Sodium Sulphur (NaS), which is used in several recent utility demonstrations
  - Carbon modified lead acid (PbC) battery technology from Axion Power in Pennsylvania
    - High cycle, high power competitor to NiMH, NiCd and Li-ion for several applications

BESS Specifications

- Rated input voltage: 480VAC 3-phase
- Rated input current: 600A RMS
- Rated output voltage: 480VAC 3-phase
- Rated output current: 600A RMS
- Rated output power: 300kW (100kW per phase)
- Rated energy storage: 900kWh
- Line frequency: 60 Hz nominal
- Harmonics: <5% Current THD

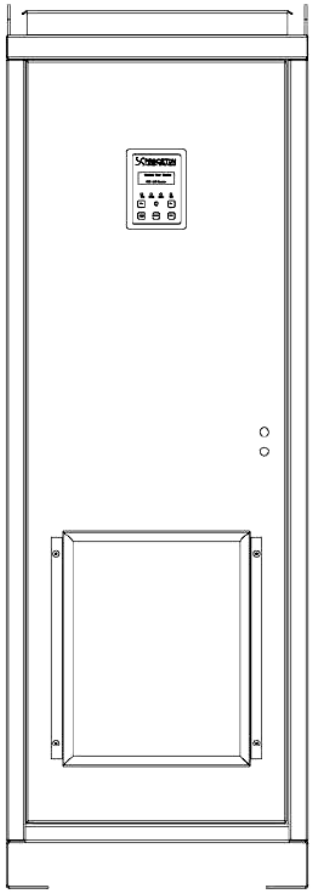
Electrical and Communication Connection Diagram



DOE is providing 3rd party performance monitoring and data acquisition

75kW Inverter Chargers

- 75kW Inverter charger is manufactured by Princeton Power
  - Technology based on IP out of Princeton University and first commercialized for US Navy
  - Used in both large motor controllers and grid-tied solar inverters
- The inverters are currently being certified to UL1741
- Can operate either as current source for demand reduction or voltage source for back-up
  - Each inverter will work as voltage source eliminating some of the power quality issues seen with master / slave configurations



75kW Inverter Chargers Specifications

• Rated input voltage:	600VDC Nominal / 480VAC
• Rated output voltage:	480VAC 3-phase
• Rated output current:	150A RMS
• Rated output power:	75kW (25kW per phase)
• Line frequency:	60 Hz nominal
• Harmonics:	<5% Current THD
• Fault protection:	Over/under voltage, over current, over/under Frequency, ground fault
• Safety features:	Anti-islanding (grid fault detection, isolation, & auto-reconnect), fused ground fault interrupter
• Reliability:	Oversized IGBT and non-electrolytic capacitors to reduce failure rate and increase lifetime

ZEBRA Batteries

- Chemistry based on Sodium Nickel Chloride
- Today ZEBRA® batteries are produced by MES-DEA, in Switzerland
- The cell and battery are operated at temperatures between 270°C and 350 °C
- ZEBRA® batteries can be used for any mobile or stationary energy storage application which requires more than 2kWh of stored energy and a discharge time between 1 ½ and 6 hours
- Can be kept in the discharged state for extended time
  - Distinct advantage over NaS batteries

ZEBRA Battery Specifications

- Type: Z37-620-ML3C-32
- Nominal voltage: 620VDC
- Nominal capacity: 19.8 kWh
- Rated cycle life: >2,000 to 100% DOD
- Operating temperature: 270°C to 350°C
- Surface temperature: <40°C
- Heating: Primary system AC power. Secondary system DC power. Some heating or cooling may be needed to transition from discharge to charge

  Batteries can be heated individually to avoid initial large power demand
- Control: On-board computer

Modified Lead Acid Batteries

- The carbon modified lead acid battery (PbC) is based on traditional valve regulated lead acid (VRLA) technology but substituting the lead anode with either an activated carbon or an lead / activated carbon electrode
- The principles of the asymmetric supercapacitor technology were developed in the 1980s
- Axion Power has developed the PbC for six years and is currently commercializing the first products

Modified Lead Acid Battery Specifications

• Type:	BCI Group 27 Type
• Nominal voltage:	12VDC
• Nominal capacity:	50Ah
• Rated cycle life:	>2,000 to 90% DOD
• Operating temperature:	<35°C
• Control:	Active equalizing and monitoring circuit on each battery

Conclusion

- Project delayed partly due to the decision of performing an EHS assessment
  - EHS assessment is driven by:
    1. We have not found prior formal EHS assessments for BESS installations
    2. Proposed site is in the middle of an industrial complex in order to fulfill secondary goal of providing backup power
- All major components have been manufactured and are either ready for shipment to Gaia or already at Gaia for testing and integration