

Demonstration of a 2-MWh Peak Shaving Z-BESS

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Abstract

ZBB Energy Corporation manufactures transportable, turnkey zinc/bromine battery energy storage systems (Z-BESS) for utility-scale storage applications. In May 2004, ZBB was awarded a multi-year, cost-shared contract with the California Energy Commission (CEC) Public Interest Research Program (PIER) to demonstrate a 2-MW/2-MWh Z-BESS as a utility peak shaving resource. This paper discusses the design and integration of the Z-BESS and the peak shaving benefits of the system.

Introduction

The objective of the CEC program is to demonstrate the benefits of utilizing battery energy storage for distribution system upgrade deferral. Four trailer-mounted 500-kW/500-kWh units will be installed at a Pacific Gas and Electric Company (PG&E) distribution substation that is experiencing overload peaks of 1 to 1.5 MW during the summer months. Each 500-kWh unit, consisting of a 20-foot battery shipping container and a Power Conversion System (PCS) mounted on a flatbed trailer, will be connected to a pad-mount isolation transformer.

Phase 1 of the program involves manufacturing the first 500-kW/500-kWh Z-BESS and delivering the unit to the Distributed Utility Integration Test (DUIT) site in San Ramon, California. The Z-BESS unit will be tested for 6 months under controlled conditions to establish response characteristics, controls protocols and data acquisition requirements. During Phase 2, the three additional units will be delivered along with the initial test unit to the designated PG&E utility demonstration site(s) to verify the overall system performance of the 2-MW/2-MWh Z-BESS.

50-kWh Battery Module Description

The Z-BESS utilizes a flowing battery technology, in which the electrolyte is stored in external tanks and circulated to and from the battery stacks where the electrochemical reaction occurs. The building block for the Z-BESS technology is a 50-kWh battery module, consisting of three battery stacks connected electrically in parallel, a control system, a pair of electrolyte storage tanks and electrolyte circulation equipment. Each module is rated at 50kWh (dc) for a 4-hour discharge and has an open circuit voltage of 108 volts.

Recent efforts have focused on reducing the footprint of the battery module, which has allowed 500-kWh of energy storage to be packaged into the same container that formerly housed 400-kWh. Previous designs placed the battery stacks between a set of electrolyte storage tanks in a horizontal arrangement. By redesigning the module into a vertical configuration, the footprint has been reduced from 28 ft² to 12.8 ft². This modification has eliminated the necessity for a racking system to support a second level of battery modules. Figure 1 shows the sectional design of a 50-kWh battery module. The bottom section contains the electrolyte storage tanks, the middle section consists of the pumps and electrical control box and the upper section holds the battery stacks.



Figure 1. 50-kWh Z-BESS module.

500-kWh Battery System Description

A 500-kWh Z-BESS provides a meaningful amount of energy storage for utility applications. To achieve this, ten 50-kWh battery modules are aligned in two independent strings on each side of a standard 20 foot Military cargo container. The shipping container has full side opening, bi-fold doors on both long sides to allow the battery modules to be easily loaded into the container and to allow future access to the battery modules. A string of five modules aligned on one side of a shipping container is shown in Figure 2. The shipping container, PCS and cooling equipment are mounted on a 45-foot flatbed trailer for operation and transportation to site. The Z-BESS unit is rated at 500 kWh of energy storage with a peak power output of 500 kW (250 kWh / 250 kW per string).



Figure 2. A 250-kWh string of five modules in a standard shipping container.

A 500 kW/625 kVA PCS, supplied by Satcon Power Systems, is mounted to the back end of the trailer. The two-stage unit, comprised of choppers and inverter/converter, enables the bi-directional flow of power from the battery to the electrical grid. The inverter was designed for three-phase output connection of 480Vac, 60Hz operation.

The output of the four trailer mounted 500-kWh systems will be connected to the utility at a substation location designated by PG&E. The system will either remain at one utility site for the entire demonstration period, or may be moved to a second demonstration site for the latter half of the demonstration period. The Z-BESS will be tested at the utility demonstration site(s) for duration of 18 months.

Benefits of the Z-BESS

The Z-BESS will be used to demonstrate the benefits of distribution system upgrade deferral at a PG&E substation that is experiencing peak overloads during the summer months. To accomplish this, the battery will provide the necessary peak capacity and energy to reduce the substation peaks in the electrical load.

The ultimate goal of the CEC demonstration program is to determine the benefits of utilizing the Z-BESS for a utility peak shaving application. This includes evaluating the economic benefits of the system and monitoring the operation and performance of the Z-BESS. The key information needed to for this type of evaluation is historical data from the demonstration test site as well as the availability and performance of the Z-BESS. Data will be collected to verify that the storage system operates when necessary and that it is able to provide the necessary power required by end user.

Conclusion

The construction of the initial 500-kWh Z-BESS will be completed in early September 2005, followed immediately by factory acceptance testing. The first 500 kWh Z-BESS is scheduled for delivery to the DUIT facility in early October 2005.