Sandia National Laboratories

Energy, Climate, & Infrastructure Security

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The Energy Storage Test Pad at Sandia's Distributed Energy Technologies Laboratory

Commissioned in April 2011, the Energy Storage Test Pad (ESTP) provides trusted, independent, third-party testing and validation of up to 1 MW AC electrical energy storage (EES) systems.

Vision

To enhance the nation's security and prosperity through sustainable, transformative approaches to our most challenging energy, climate, and infrastructure problems.

Sandia's energy systems research spans renewable generation, power electronics, energy storage, and load management. Distributed Energy Technologies laboratory (DETL) researchers work to develop and integrate emerging energy technologies into the nation's electricity grid to accommodate the increasing demands for clean, secure, reliable energy.

Our new ESTP is equipped with a 1 MW grid-tied transformer, a 1 MW resistive/1 MW reactive load bank, and high-performance metering and protection. The ESTP also enhances Sandia's existing capabilities to test the various components of energy storage systems.

Utilities and other electricity/transmission providers and regulators often require that equipment be proven safe and reliable before it is permitted on the grid, but energy storage manufacturers and integrators are unable to afford/provide the logistics necessary for this long-term testing and monitoring. Sandia's ESTP can provide the venue for this testing in a simulated grid environment accompanied by detailed diagnostics that can provide proof of a component's reliability.

The ESTP was built to serve the needs of a wide variety of EES customers including

- EES system manufacturers;
- utilities including independent system operators, independent power producers, and regional transmission operators;
- end users: commercial, industrial, government agencies, & renewable project developers; and
- R&D activities including independent and government R&D labs and universities.

Frequency Regulation & Energy Shifting

In cases where a utility acquires energy storage to improve regulation and/or perform energy time shifting, the storage is directly connected to the power grid via a high-voltage transformer. In this configuration, we can send an ESTP control signal to the system to test its ability to perform in an assortment of applications (see the box on the following page, under *Testing Capability*). The control signal is normally updated every four seconds

U.S. DEPARTMENT OF ENERGY

Energy Storage Test Pad (ESTP) Overview

System Capacity/Capability

- 1.5 MVA, 12470 V to 480 VAC 3-phase transformer capable of testing up to 1 MW energy storage systems.
- 2500 amp switchboard with motor operated main breaker.
- Five feeder breakers capable of a 1600 amp single point of EES connection or multiple feed connections through a 1200 amp branch panel.
- 1 MW/1 MVAR loadbank.
- Subcycle metering feeder breakers for transient analysis.

Testing Capability

- Can test for both power and energy applications including energy time shift, capacity, load following, area regulation, voltage support, T&D deferral, demand charge management, and power quality and reliability.
- Test duration can range from one day to multiple months.
- Scalable from 5 KW to 1 MW, 480 VAC, 3 phase.

Data Monitoring

- All breakers are equipped with subcycle wave capture meters.
- Can capture voltage, current, KVA, KW, KVAR, PF, frequency, harmonics and transients.
- Provides fiber optic or Ethernet connectivity to monitor parameters (will soon implement National Instruments' LabView software).

Data Analysis & Reporting

- Evaluate system parameters including but not limited to
  - system efficiency including balance of plant,
  - ramp rate,
  - system operating temperature,
  - performance to specifications,
  - system reliability, and
  - power electronic and balance of plant operation.
- Analyze system performance relative to standards & applications.
- Develop new testing procedures.
- Support developing new energy storage standards.
- Issue reports of findings.

to simulate frequency regulation or it can be put on a daily cycle to simulate energy shifting. The control signal can also be updated in response to peaks in a simulated load profile to evaluate peak shaving. This configuration is most valuable for assessing the business cases for grid-scale energy storage in nominal day-to-day operations.

(Note that a bidirectional inverter or other controller should be built into the energy storage system under test. The system designers must supply this equipment. If an AC energy storage system [such as a flywheel] is tested, then the system designers must supply other power electronics.)

Grid-Tied Reactive Power Support

In the case where there is a local load associated with the energy storage, the voltage may sag without proper reactive power support. In this configuration, we can switch the reactive portion of the load bank in/out to evaluate system capability to dynamically adjust its power angle when necessary. Also, the connection to the grid can be severed under load to test the system's ability to perform islanding and uninteruptable power supply (UPS) functions.

Islanded Load Following & Power Quality

Once the connection to the grid has been severed, we can test the system for its ability to follow changes in the local load. In this configuration, we can assess the power quality and voltage response to changes in demand and power output. This assessment can be extremely valuable in improving reliability in a microgrid application.

For more information, please contact:

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