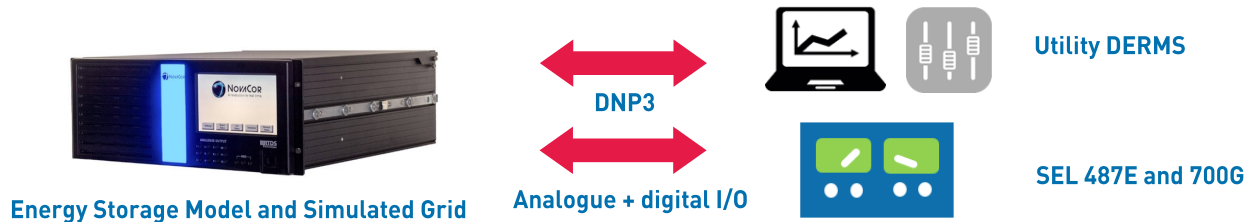




Utility test bed for standardizing the integration of new battery storage with Distributed Energy Resource Management System

Project Focus: Testing controller operations and interactions prior to deployment

Distributed energy resources offer great potential for improving power quality and resiliency. Leading utilities who seek to take advantage of this potential are recognizing a major barrier: lack of standardization in DER operation and control. Addressing this, a major utility in the United States developed an operational standard for Battery Energy Storage Systems (BESS). To implement the standard, they developed a test bed that allows them to comprehensively validate the operation of their DERMS controller before deploying new resources in the system. BESS behavior during various operational modes (including islanded), as well as effects on the operation of the system’s protection devices, can be evaluated.

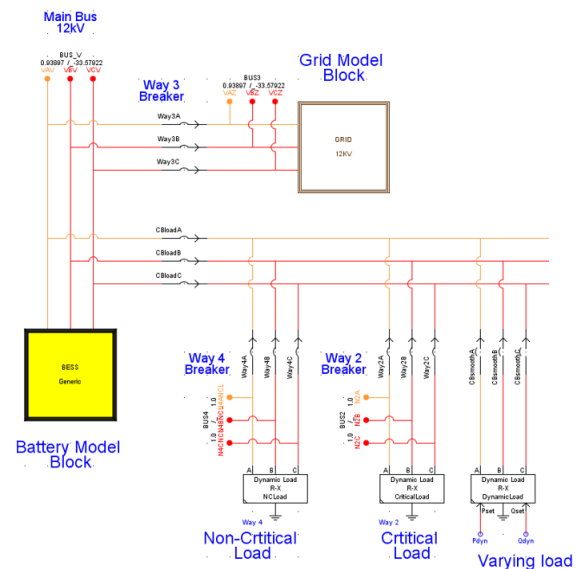


Real Time Simulation: A flexible model enabling closed-loop testing

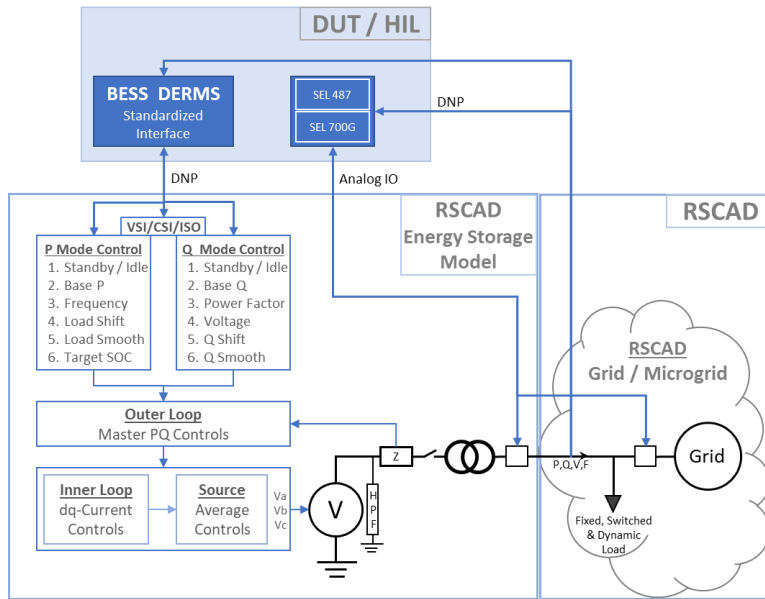
The RTDS® Simulator provides a detailed model representing the behavior of the battery system, surrounding power system, and control loops. Simulation timesteps in the 50 microsecond range allow the representation of high frequency transients. The model runs in real time, allowing for fast and efficient simulation of many scenarios and the interfacing of external software or hardware to the simulated environment in a closed loop.

The simulation case includes the following components:

- Li-ion battery (Min/Rincon-Mora)
- Inverter (average value and fully switched)
- Critical, non-critical, and varying loads
- Grid model (fully scalable)
- Breakers and transformers
- dq-Current converter control and other calculation blocks
- Input/output blocks for interfacing external devices



Software and Hardware Interface: Test devices from any vendor



The complete functionality of the BESS model can be tested either using a Software in the Loop approach, in which the control points are specified locally by the user within the simulation, or using a remote approach, which would see the utility's DERMS interfaced to the simulation via DNP3 protocol.

The operation of breakers and other control logic during islanding or reconnection can also be tested using real physical protective relays. In this case, the SEL 480E and 700G relays were interfaced to the simulation using analog and digital input and output. These relays are responsible for monitoring and operating the battery-side and main-side breakers.

▶ A Software- and Hardware in the Loop interface connects the utility's DERMS system and protective devices to the simulated BESS model.

Testing Standards: Defining required modes of operation for a specific grid

Based on the characteristics and needs of their system, the utility defined many different modes which controllers must include in their functionality in order to comply with the new operational standard. Various real and reactive power functions, as well as islanding mode, are required. The set point, limits and permissions for these modes of operation are provided either locally in the simulation via user interaction, or remotely from the DERMS through DNP3.

Constant P or Q support

Islanded operation and grid reconnection

Frequency regulation (P)

Target State of Charge (P)

Power factor correction (Q)

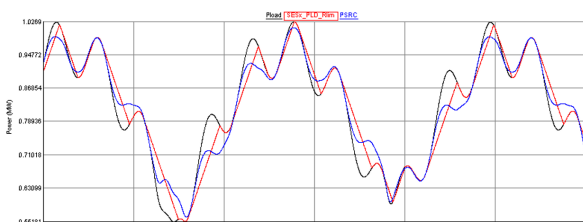
Reactive power load shift or smoothing (Q)

Voltage regulation (Q)

Outcomes and Looking Ahead: Installing with confidence

More than a hundred unique simulations led to the successful completion of Software in the Loop testing for this project. Furthermore, on-site testing with remote (DERMS-provided) control and hardware relays was performed to satisfactory results.

Moving forward, with the implementation of the new operational standard, suppliers of BESS and their control systems will perform standardized tests on equipment prior to commissioning it on the utility's network.



▶ In the event of sudden changes in demand, the battery is charged/discharged for a gradual change in grid power. This behavior was confirmed via testing.

■ Load power (MW)

■ Grid power (MW)

■ Smoothing reference (MW)

Learn more

Project supported by Nayak Corporation: power system simulation specialists at www.nayakcorp.com

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