Doosan GridTech®

LADWP BEACON SOLAR PLANT
BATTERY ENERGY STORAGE SYSTEM

20MW / 25MVA / 10MWh

Case Study

DOOSAN

EXECUTIVE SUMMARY

When Doosan GridTech® installed a 20 MW/25 MVA/ 10 MWh battery energy storage system (BESS) for the Los Angeles Department of Water & Power (LADWP) at its Beacon Solar Plant site in California's Mojave Desert, the firm introduced mission-critical design elements that would enable the system to operate reliably in one of the most inhospitable places on the planet while meeting the utility's rapid-response and high-performance requirements on this transmission asset.

PROJECT HISTORY & COMMITMENT TO RENEWABLE ENERGY

LADWP, one of the United States' largest publicly owned utilities, has long operated a fleet of large, natural gas combined cycle generation facilities. But LADWP was forced to curtail its gas-fired units after problems surfaced in late 2015 with the Aliso Canyon natural gas storage facility located near Los Angeles.

The curtailment of Aliso Canyon and the limited availability of cost-effective alternatives threatened LADWP's electrical grid operations. This meant that the utility accelerated its search for dispatchable resources that could be rapidly developed and placed into service as a transmission asset.

LADWP's Renewable Portfolio Standards (RPS) program exceeded 2,500 MW of renewable generating capacity in mid-2017, putting it just short of its 33-percent by 2020 goal. While proud of reaching this milestone ahead of schedule, LADWP intends to remain ahead of the state's goals by setting its own, more aggressive, RPS targets of 50-percent by 2025, 55-percent by 2030, and 65-percent by 2036.

LADWP's commitment to renewable energy is embodied in the utility's mission: Providing clean, reliable water and power, and excellent customer service, in a safe, environmentally responsible and cost-effective manner.

LADWP turned to Doosan GridTech for its first battery energy storage system (BESS) as a cost-effective and rapidly deployable transmission asset to support a variety of applications for stabilizing the utility grid, especially during periods of peak renewable generation. As the utility continues plans to add more solar, wind, and geothermal power to its portfolio, LADWP also wants to make more efficient use of renewable generation.

The Beacon BESS is the first of several energy storage projects that LADWP is undertaking to instal 178 MW of new storage by 2021 as mandated by the California state legislature.

THE PROJECT

The $19M Beacon BESS is LADWP's first utility-scale battery energy storage project. It has been installed alongside new solar photovoltaic (PV) power plants totaling 590 MW in the Mojave Desert about 112 miles northeast of downtown Los Angeles.

Doosan was LADWP's engineering, procurement & construction (EPC) partner and software systems integrator for the Beacon BESS project. The project finished construction in April 2018 and was placed into grid operation for performance testing. The project met all of LADWP's contractual performance requirements by October 2018.

The Beacon BESS is located within the boundaries of LADWP's 250 MW Beacon Solar PV plant, which sits on 2,400 acres of recovered alfalfa farmland. The system is connected to LADWP's 230-kV transmission lines through the new Beacon Collector Station and the Barren Ridge Switching Station.

The 20 MW/25 MVA/10 MWh lithium-ion BESS connects to a dedicated 34.5-kV breaker in the Beacon Collector Station. In addition to stabilizing local solar PV, the direct connection to the substation allows LADWP, operating as its own balancing authority, to manage the BESS in accordance with the daily needs of the grid.

Batteries, Modules, and Racks

- Chemistry: Lithium-ion/NMC (Nickel Manganese Cobalt Oxide)
- 22 cells per module
- 13 modules, 1 switchgear and “rack controller” per rack
- 19 racks per container

Total Scale

- 247 Racks
- 3,211 Samsung SDI Mega P3 modules
- 70,642 Battery Cells

This new BESS provides frequency control, voltage support, and power smoothing to assist LADWP in complying with its NERC/FERC Balancing Authority requirements as well as its transmission grid and line stability responsibilities. These grid services benefit all solar PV as well as the 135 MW wind farm connected to the Barren Ridge Switching Station which is connected to Beacon and is in close proximity. The BESS also will enable LADWP’s 490 MW solar PV expansion in the area.

The grid services provided by the BESS allow higher utilization of the electricity generated by the solar PV by reducing curtailment, smoothing fast ramps from passing clouds, and stabilizing voltage after grid events that can trip the solar inverters.

DESIGN CHALLENGE & METHODOLOGY

Design Challenge

LADWP’s Beacon Solar Project is located in one of the most inhospitable places on earth, where summertime temperatures can exceed 120°F. Doosan GridTech designed the Beacon Energy Storage project to have over 99 percent availability for ten years. That performance is warranted for a full decade.

Due to the two-hour driving distance from downtown Los Angeles, the Beacon BESS also needed to be designed to minimize maintenance in an extreme weather environment.

Design Methodology

Doosan's modular turnkey design includes thirteen pairs of power conversion systems (PCS) and lithium-ion battery containers equipped with preventative maintenance that can occur without sacrificing availability. The nameplate capacity of the PCS and battery container pairs total 35.75 MVA and over 20 MWh to deliver a consistent 25 MVA and 10 MWh in extreme temperatures with 99.9 percent availability over ten years.

N+1 design: The project is designed to meet the performance capabilities for the full 10-year period of service even if any major piece of equipment is out of service for any reason. This means that routine maintenance and other downtimes can occur without losing system functionality.

Designed for weather extremes: The battery system included special considerations for the unique temperature extremes in the Mojave Desert. Oversized equipment allows for both N+1 design and extreme temperature considerations while still delivering 25 MVA/10 MWh. Highly insulated battery containers were installed to improve HVAC efficiency. Hardened control systems can handle temperatures above 160°F. An on-site backup generator can power the HVAC and monitoring systems for up to seven days to ensure battery temperature conditions stay within warranty requirements.

Redundancy: Several critical components have 100% redundancy to enable full BESS availability in the event a component is offline. Complete redundancy is provided for the battery HVAC system. The 10-ton design requirement for cooling each container was doubled, providing 100% redundancy for a total of 20-tons of cooling and utilizing multiple stages for efficient operation.

A redundant fiber-optic network loop between all BESS components eliminates any single point of communication failure.

High Seismic Zone Consideration: An on-site backup diesel generator was installed that can power the HVAC and monitoring systems for up to seven days, keeping battery temperature conditions within warranty requirements. Due to the high likelihood of a major earthquake in California, enough fuel for seven days of generator operations was required so that LADWP could focus on higher-priority recovery efforts. If this project had not been built in a high seismic zone, less fuel, or a non-permanent solution such as portable generator connections might have been acceptable. The foundations and structures of the facility were designed to the stringent requirements of the high seismic zone.

Maintenance & Safety: Two auxiliary power transformers were installed to provide redundancy of auxiliary power distribution. This allows one transformer to be taken out of service for maintenance while the other is available to continue running the HVAC and cooling the batteries.

Two on-site control systems were created in a hot standby configuration so that if one fails, the other will automatically take over and continue to manage the system.
As an additional safety measure, oversized door hinges, door bolts, and door latches were installed on each container to protect against high winds in the area.

Other critical design features and functionalities: 16 operating modes with user-defined prioritization — targeting both real and reactive power use cases.

Lithium-ion batteries sized to have a uniform performance with no perceived degradation over the 10-year design life. Flexible performance warranty allows for the customer to operate system well outside of initial use cases and still have the yearly guaranteed capacity.

Multiple means of control — local, remote, and automatic — with user-configurable access to ensure every stakeholder has the proper level of access.

CONTROL SYSTEM

To ensure broad interoperability in future systemwide expansion, the BESS is controlled by Doosan GridTech's Intelligent Controller® (DG-IC®) — one of the first software control systems built using the Modular Energy Storage Architecture (MESA) open standard.

The DG-IC is the "brains" within each system. Inside the BESS, the DG-IC coordinates the activities of the PCS, the batteries and the BESS auxiliary systems (e.g., thermal management). Externally, the DG-IC responds to local signals and sends communication to and from power meters, relays and breakers, and the backup generator on site. The DG-IC also coordinates schedules and operating mode activation between the site and the utility network through LADWP's existing SCADA system.

The software is highly scalable, enabling LADWP to expand the Beacon site to as much as 50 MW of capacity without the need for additional control software.

PUT TO THE TEST

The battery energy storage business is a fast-growing, rapidly evolving sector within electricity generation and distribution. But some aspects of the technology and some use cases are still in an early stage of development. The stakes were high for LADWP's $19 million Beacon BESS, and we wanted to ensure that the technology would prove itself under extreme operational conditions and extreme weather conditions.

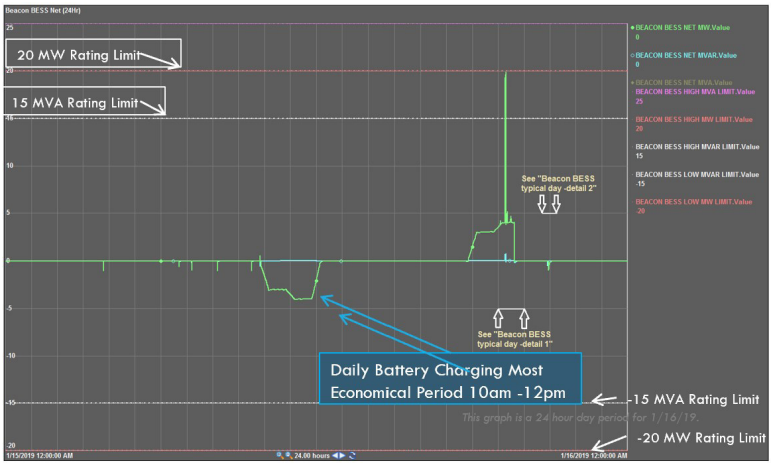
The system was put through 90 days of Performance Acceptance Testing to prove the N+1 design methodology and meet the 100% redundancy requirement.

The first five days of testing took three hours and included a 30-minute/20-MW charge cycle and a 30-minute/20-MW discharge cycle followed by a 60-minute/10-MW charge cycle and a 60-minute/10-MW discharge cycle, while simultaneously producing and consuming 15 MVAR of reactive power. That was followed by 85 days of 15-MVAR production and consumption of reactive power to support the voltage at the 230-kV transmission line.

The system successfully obtained 99.9% availability for the 90 days of testing, exceeding expectations. The only downtime that occurred was a few hours to optimize the feedback control loop to improve performance when transitioning between scheduled setpoints.

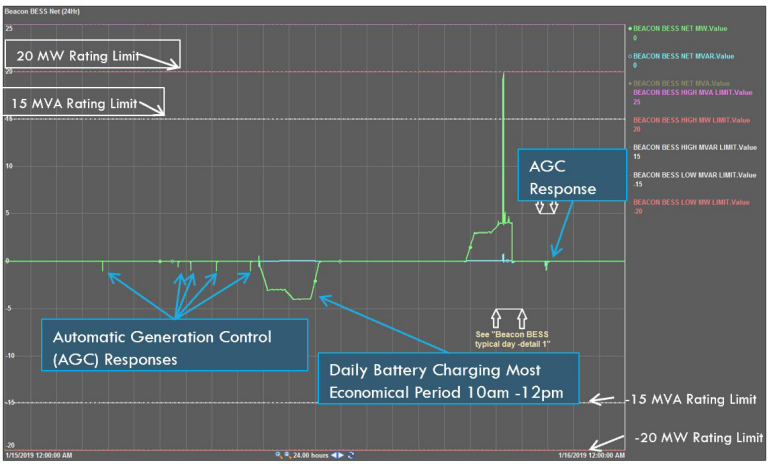
As determined by the Grid Operations Marketing group, the Daily Battery Charging Most Economical Period was between10am-12pm.

ECC OATI scheduling software (economic schedules) and schedule import process was used.

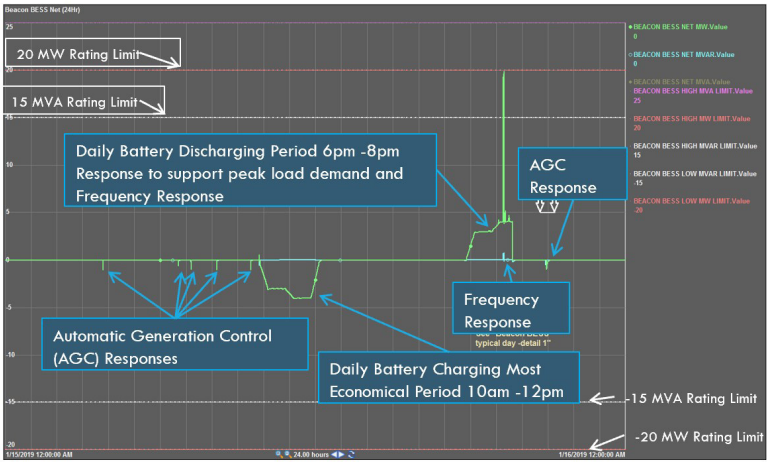


Automatic generation control (AGC) adjusts the power output of the multiple BESS Units in response to changes in load.

The AGC operating mode enables the system to participate in AGC.



Frequency Response – The Beacon Station reports the frequency of the grid to the BESS. The BESS compares the reported frequency with response values on a pre-specified Curve. This frequency determines the corresponding real power output that is used to compensate for the deviation. The Beacon BESS outputs real power to adjust frequency to the normal cycle (60Hz).



SUMMARY

Commencing commercial operation in early October 2018, Doosan's Beacon BESS is handling the harsh climate of the Mojave Desert while increasing utilization of solar PV, having been constructed alongside new solar photovoltaic (PV) power plants totaling 590 MW, and providing grid reliability services in the wake of the Aliso Canyon natural gas supply disruption.

The Beacon BESS positions LADWP as a leader in the fast-moving battery energy storage market, where prices are declining, deployments are rising, and regulatory pressures are mounting. It also enables additional development in one of the best solar PV locations in the United States.

PROJECT PHOTOS

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At Doosan GridTech®, we believe that enduring economic growth and environmental healing start with a resilient, low-carbon power grid. We are a multi-disciplined team of power system engineers, software developers, and turnkey energy storage specialists. We help utility-scale power producers evaluate, procure, integrate, control, and optimize energy storage, solar power, and other renewable power resources. Our battery storage experts in Seattle, Melbourne, and Seoul have designed and built over 35 installations in the Americas and Asian-Pacific regions – representing over 453MW of capacity.