SRP battery storage and AVEVA™ PI System™

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Salt River Project

• US Bureau of Reclamation Project

• Supply water & power to the Salt River Valley in Arizona and large portions of the Phoenix Metropolitan area

• SRP facts per end of FY23
  • 1,135,988 electric customers
  • Peak system load: 7620 MW
  • Available MW resources: >8800 MW

• Generation Resources
  • Gas, coal, nuclear, hydro, solar, battery storage, wind, biomass & geothermal
Solar and battery storage at SRP

• SRP currently has over 500 MW of solar resources available
• SRP is adding 2,025 MW of solar by 2025
  • Sonoran Energy Center: 250 MW solar + 1,000 MWh battery
  • Others as well, with consideration for when the sun sets
• SRP has Li-ion batteries already (180 MWh worth)
• Bolster Substation Battery System, Peoria, AZ

Challenge
SRP demand for solar power is growing fast. Battery storage is required to support the intermittent nature of solar and wind power. In order for SRP to incorporate battery storage into our system, we will need to better understand the capabilities, limitations and other characteristics of battery storage.
Quick Bolster background

100 MWh storage capacity

25 MWh  25 MWh

25 MW max connection to the grid*

25 MWh  25 MWh

*during normal operation

- Bolster is connected to SRP’s 69 kV system, and is charged during low-cost, low-load hours to be used during high-cost, high-load hours.
- Bolster is warrantied for 20 years if SRP operates it per specifications.
- Max energy storage capacity decreases every year, but max power level connection to the grid will remain the same.
- Bolster is a 25 MW/4-hour battery meaning a max energy capacity of 100 MWHr (25 MW x 4 Hours).
Bolster scheduling and operating practice

• Look at average electricity market prices each month.
• Optimize with ~88% efficiency (means charging is 88% efficient so it takes more than 4 hours to charge from 0% to 100%. Discharging is about 100% efficient as it takes 4 hours to go from 100% to 0%).
• Send monthly schedule to SRP’s internal optimizer (PCI).
• SRP PCI > CAISO EIM > SRP Energy Dispatch System.
• SRP’s dispatch system receives 5-minute dispatch targets to follow a monthly optimized schedule.
• Both the dispatch targets and actual charge/dispatch values are saved in the AVEVA™ PI System™.
Tracking State of Charge and Battery Dispatch

EMS Ramped DOT
Bolster Available Energy in MWHrs (State of Charge)
Bolster Actual Output
Bolster Base Schedule
Solar and Battery Operations Display

- Site Net MW
- Solar Output
- Battery Output
Battery Performance Monitoring Data

Site Level Points

- SUB_BOR.TSC Loss of Battery Meter Communication
- SUB_BOR.TSC Battery Controller to Inverter Communication
- SUB_BOR.TSC Battery Fault
- SUB_BOR.TSC Status_Command_Source
- SUB_BOR.TSC RealPower_Command_SC_to_Batteries
- SUB_BOR.TSC ReactivePower_Command_SC_to_Batteries
- SUB_BOR.TSC Status_Full_Charge_Energy
- SUB_BOR.TSC Status_Remaining_Energy
- SUB_BOR.TSC Status_Maximum_Charge_Power
- SUB_BOR.TSC Status_Maximum_Discharge_Power
- SUB_BOR.TSC BatteryMeter_3PH_ReactivePower
- SUB_BOR.TSC BatteryMeter_3PH_ApparentPower
- SUB_BOR.TSC BatteryMeter_3PH_ACVoltage
- SUB_BOR.TSC BatteryMeter_3PH_ACCurrent
- SUB_BOR.TSC BatteryMeter_3PH_ACFrequency
- SUB_BOR.TSC BatteryMeter_3PH_RealEnergyExported
- SUB_BOR.TSC BatteryMeter_3PH_RealEnergyImported

Megapack Level Points

- Analog Points
  - MP1.1_real_power_target
  - MP1.1_real_power_output
  - MP1.1_reactive_power_target
  - MP1.1_reactive_power_output
  - MP1.1_state_of_energy
  - MP1.1_usable_energy_remaining
  - MP1.1_usable_energy_to_be_charged
  - MP1.1_usable_full_pack_energy
  - MP1.1_nominal_full_pack_energy
  - MP1.1_frequency
  - MP1.1_ac_voltage_average
  - MP1.1_ac_voltage_phaseA
  - MP1.1_ac_voltage_phaseB
  - MP1.1_ac_voltage_phaseC
  - MP1.1_inverter_phased_current
  - MP1.1_inverter_phaseA_current
  - MP1.1_inverter_phaseB_current
  - MP1.1_inverter_phaseC_current
  - MP1.1_dc_voltage
  - MP1.1_max_battery_temperature
  - MP1.1_ambient_temperature
  - MP1.1_available_charge_power
  - MP1.1_available_discharge_power
  - MP1.1_nominal_charge_power
  - MP1.1_nominal_discharge_power

- Digital Points
  - MP3.1_megapack_loss_of_comms
  - MP3.1_megapack_iso_failure
  - MP3.1_inverter_fault
  - MP3.1_hv_interlock_broken
  - MP3.1_keylock_open
  - MP3.1_door_switch_open
  - MP3.1_ac_breaker_open
  - MP3.1_bus_controller_prolonged_fault
  - MP3.1_remote_shutdown
  - MP3.1_coolant_low
  - MP3.1_battery_overtemperature_warning
  - MP3.1_thermal_event_active
  - MP3.1_grid_uncompliant
  - MP3.1_low_state_of_energy

x1

x34
Bolster Site Level Dashboard

- Total battery output data including:
  - Auxiliary load
  - Full charge energy (amount of MWhr energy capacity available)
  - Real and reactive power setpoint commands from the site controller to the battery.

- Bolster is made up of 34 "Megapacks", each delivering 700kW

- Right side has Megapack overview alarms for:
  - General alarms
  - Critical battery thermal event active (potential fire)
Bolster Megapack Level Dashboard

- Digital statuses
  - 480V AC breaker
  - Internal fault detection
- Numeric data
  - Available power
  - Nominal power
  - Nominal energy
  - Real and Reactive Power command targets
- Trending analog data
  - 480V AC voltage
  - 480V AC current
  - DC voltage
Battery maintenance semi-live dashboard

Tesla Maintenance performed on 4 Megapacks. Notice the PI Point notifications that changed state in the green boxes.
Bolster PI Data value

- Current Notifications and Alarms value:
  - Megapack outage/dropouts – Identify when capacity is impacted.
  - Ramping MW plateauing – Identify abnormal ramping behavior.
  - High state of charge – Identify possible battery self-curtailment and resultant EMS control issues.

- What we think could provide some value to real-time operations:
  - Advanced knowledge of potential battery failure.
  - Reduction in energy availability.

- What we think could provide some value for performance:
  - Idle Degradation
  - Battery site level analysis via EPRI Foresight project
Real-time value of PI Data

- Alarm trigger: Current State of Charge has reached to 95% of current available energy for greater than 10 seconds.

- Power output (MW) has changed by 600kW in less than 2 seconds. One Megapack is 700kW.
Value realized and actions taken

Unexpected power output shift alarm
- Megapack dropout
- Ramped operation plateau ACE effect.

Megapack dropout – Action: Submit a service ticket to Tesla to investigate.

ACE Effect – Action: Contact SRP EMS teams or check ACE PI Vision display to investigate ACE action for verification of ramping commands interruption and prevent aggravating system balancing issues.
Bolster Testing Project - Regulation

How it works
ACE (Area Control Error) is a measure of SRPs generation to load balance. Specific generation units can be selected to aid with regulating ACE.

Test Results
Bolster successfully provided ACE Regulation particularly as the SOLE SRP system regulation generator.
Future

- Full energy capacity degradation monitoring – Identified battery Megapack reduction of available energy capacity.

- EPRI Research Project - Megapack level analytics (EPRI Foresight) – Battery education into battery module behavior.

- Use EMS and Meteorological data from PPA sites to further our understanding in BESS operations.
SRP uses AVEVA PI system to manage solar generation and energy storage.

**Challenge**
- SRP demand for solar power is growing fast. Battery storage is required to support the intermittent nature of solar and wind power. In order for SRP to incorporate battery storage into our system, we will need to better understand the capabilities, limitations and other characteristics of battery storage.

**Solution**
- SRP has acquired and installed a 100 MWh Tesla battery storage system, Bolster
- Data from the battery site and the individual Megapacks are brought into SRP’s centralized enterprise AVEVA™ PI System™ to streamline data collection, access, analysis, and reporting.

**Results**
- The system is already providing a better understanding of how SRP will deploy large-scale batteries in the future.
- By utilizing SRP’s centralized, enterprise AVEVA™ PI System™, battery storage operations data is made available across the enterprise in order to make intelligent operational and planning decisions.
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