Case Study

Jinko ESS's BESS Application for Peak Shaving and Frequency Regulation

2MW/8MWh Li-ion BESS Project in Japan

Project Overview

This case study describes a Japan-specific utility-scale Battery Energy Storage System (BESS) adopting an AC-coupled architecture which connected to grid system.

This project located in Toyohashi-city, Japan, and connected to Japan 6.6kV distribution grid with the following characteristics:

- Strict grid codes and utility specific acceptance criteria (JEAC 9701, utility test guidelines)
- Mandatory grid connection and commissioning tests, including load break and voltagetransient tests.
- It is applicable not only to Japan's energy market for peak shaving, but also to the frequency regulation market (such as primary frequency regulation).

The AC-coupled configuration was selected to enable

independent operation of PV and BESS, provide high system redundancy, and ensure flexibility in meeting evolving grid requirements.

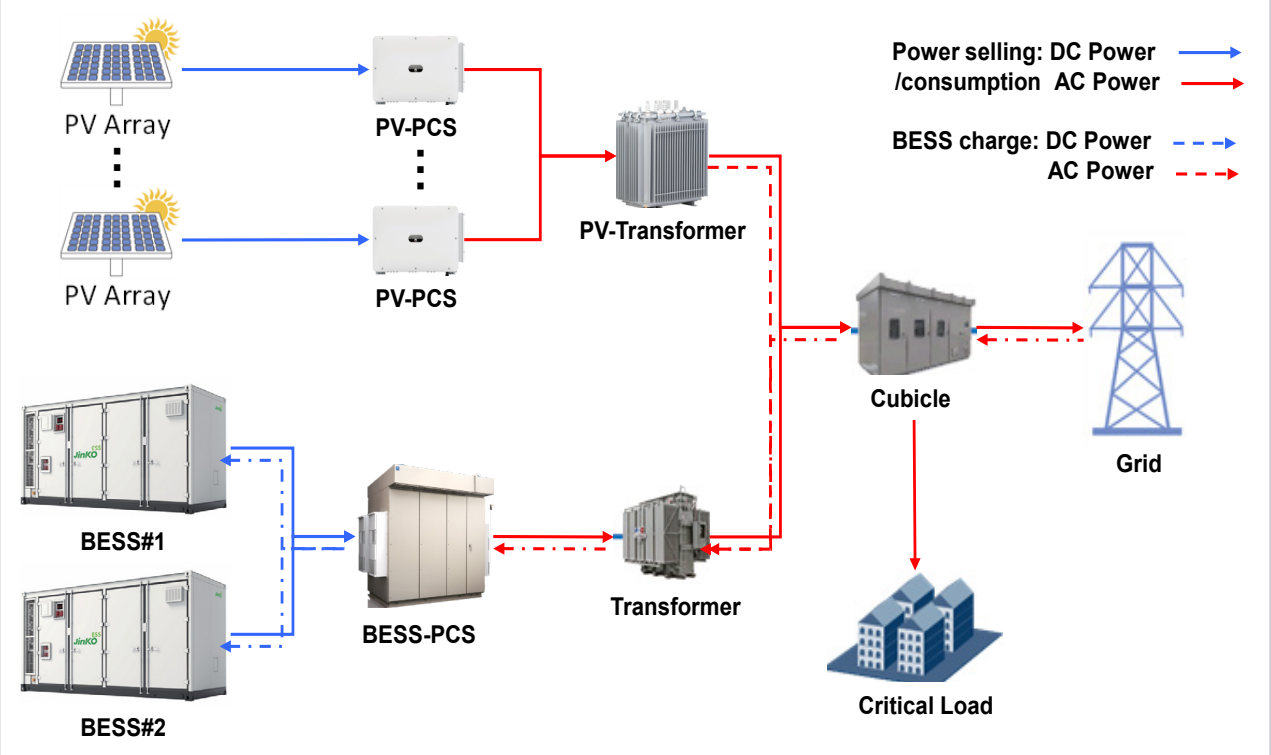

Fig. 1 System Diagram of 2MW/8MWh AC-coupled Project

The Solution

System Architecture

The project applied a conventional AC-coupled configuration as follows:

- An existing FIT system which configuration with PV panels connected to the grid through a dedicated PV-PCS.
- New BESS system connected to the same AC bus via a dedicated BESS-PCS.
- AC power from PV step-up transformer and BESS step-up transformer, integrated to cubicle then connected to POI (Point of interface) of grid.
- Centralized EMS can coordinate PV and BESS operation.

Key Equipment

- 7.52MWh Lithium-ion battery (LFP) system sized for 4-hour rated charge/discharge power.
- 2.75MW dedicated BESS-PCS with four-quadrant operation. (limited to 1990KW output)
- 2300kVA step-up transformer which can convert PCS 690Vac output to 6600Vac.
- Using the cubicle which adopted in Japan, the whole system can be disconnected from grid once emergency or abnormal.
- EMS/SCADA system Connected to all devices required for power plant through Modbus-TCP, and made the whole system run optimally and coordinately.

Grid Compliance Measures

- Configurable power factor control (fixed PF, cosφ(P))
- Q–V droop control aligned with utility requirements
- Rate limits on active and reactive power (dP/dt, dQ/dt)
- Coordination logic between PV-PCS and BESS-PCS

Operation Logic

The EMS is responsible for ensuring compliance with both energy market operation and grid frequency supporting.

Energy Market Operation

- During charging periods, PV panels exported AC power to the AC bus and absorbed by the BESS via the BESS-PCS, at the meanwhile insufficient energy can be charged from grid until BESS fully charged.
- During discharge periods, the BESS supplies scheduled active power to the grid, of course PV panels also can generate before sun set.
- PV and BESS operate independently by EMS control, PCS can also prevent reverse power or overload at the POI.

Grid Frequency Supporting

- BESS maintains a controlled SOC range and P-rate to ensure long-duration availability.
- With the EMS monitoring function, BESS-PCS remains synchronized with the grid, capable of immediate P/Q response.
- Reactive power support is continuously available even when active power output is zero.
- Reactive power response is coordinated to prevent over-voltage.
- EMS prioritizes BESS-PCS for voltage control while curtailing PV output if necessary.
- EMS monitoring grid frequency timely, and BESS-PCS can respond to primary frequency regulation ms level with EMS command.

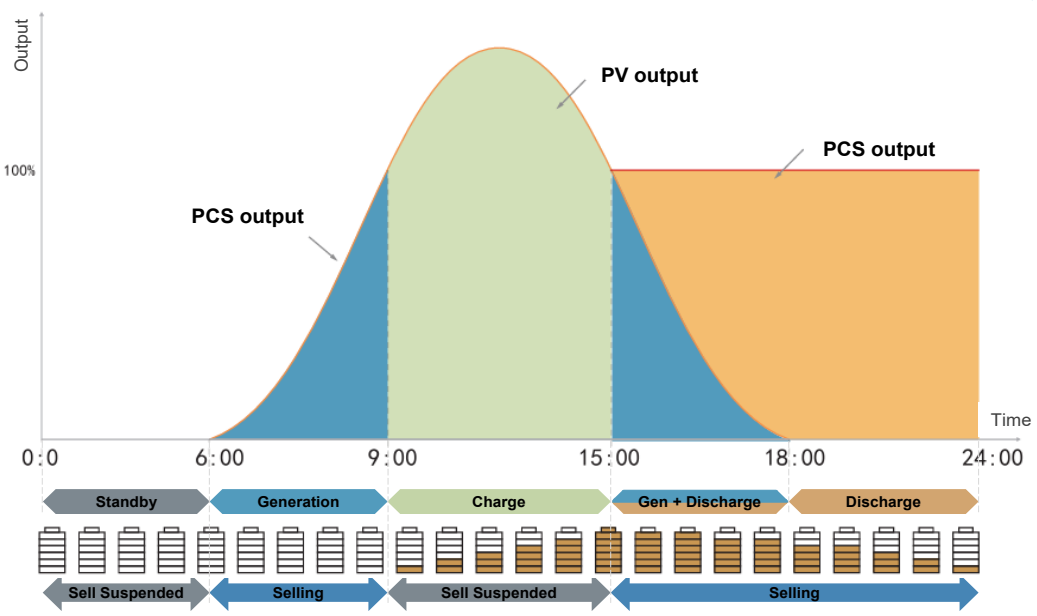

Fig. 2 Jinko ESS Energy Storage Active Power Diagram

Critical grid code results

Grid Connection and Commissioning Tests

- Load Break Test

  - With local EMS coordination logic, transient voltage didn't change significantly due to the prevention of aggressive Q injection.

  - Test results showed voltage maintained within acceptable limits.

- Voltage and Frequency Performance

  - Stable voltage regulation observed under varying grid strength conditions

  - No unintended tripping during frequency or voltage excursions.

Customer Benefits

High Compatibility with Existing PV Plant

- Ideal for projects which PV panels ware already installed.
- Minimum modification required for PV plant devices.

Enhanced Redundancy and Reliability

- Separate PCS units reduce single points of failure.
- PV and BESS can operate independently during faults or maintenance.
- Clear separation of responsibilities between PV and BESS systems.

Operational and Business Flexibility

- EMS-based coordination enables participation in multiple services and markets.
- Flexible response to future grid code updates or market changes.
- Can participate in the primary frequency regulation market stably in Japan and achieve higher returns.

時刻	積入計画 (kW)	自家発消費 (kW)	積入量 (kWh)	売却量 (kWh)	スポット入札計画 量 (kW)	スポット入札計画 価格 (円/MWh)	時間帯入札計画 量 (kW)	時間帯入札計画 価格 (円/kWh)	電源調整市場 計画 量 (ΔkW)	電源調整市場 計画 価格 (円/kW)	電源調整市場 計画 商品	3OC計画 (kW)	収支 (万円)
0:00	-350	-350	0	0	7.11	7.11	750	750	0	-	-400	72	-98.10
1.00	-330	-330	-90	0	7.11	7.15	750	750	0	0	-4①	72	-918.10
1.00	-400	-400	800	0	7.11	7.15	750	790	0	0	-9①	72	318.40
2.00	800	800	800	250	7.11	7.15	790	790	0	0	-3①	81	15.90
3.00	700	700	800	700	730	7.15	750	800	0	0	-3①	81	167.90
4.00	800	800	800	700	730	7.15	760	800	0	0	-3①	81	111.00

Fig. 3 EMS Operation UI Image

www.jinkosolar.com

Jinko Solar Co.,Ltd.

No.1, Lane 1466, Shenchang Road,Minhang District, Shanghai, China

Tel +86 400 860 8878