Case Study

Jinko ESS's BESS Application of DC-Coupled AIS Project

20.06MW/66.33MWh Li-ion BESS Project in Germany

Project Overview

As Germany's energy transition accelerates, energy storage has become essential for projects that must simultaneously participate in grid services and maximize the value of renewable generation.

The AIS projects—located in Grünberg, Grünhainichen and Marbach—are part of agrivoltaics developments, combining agriculture, photovoltaic generation and battery energy storage at the same sites. These projects are developed against the backdrop of increasing price volatility in the German electricity market, particularly the significant price drops—and even negative pricing—during midday hours, driven by high photovoltaic penetration.

In this context, energy storage plays a critical role in stabilizing energy revenues while ensuring that renewable generation can be fully utilized without curtailment. Jinko ESS delivered more than 66 MWh of containerized battery energy storage systems, enabling the projects to stabilize revenues, respond to market price signals and support grid operation under Germany's highly regulated energy framework.

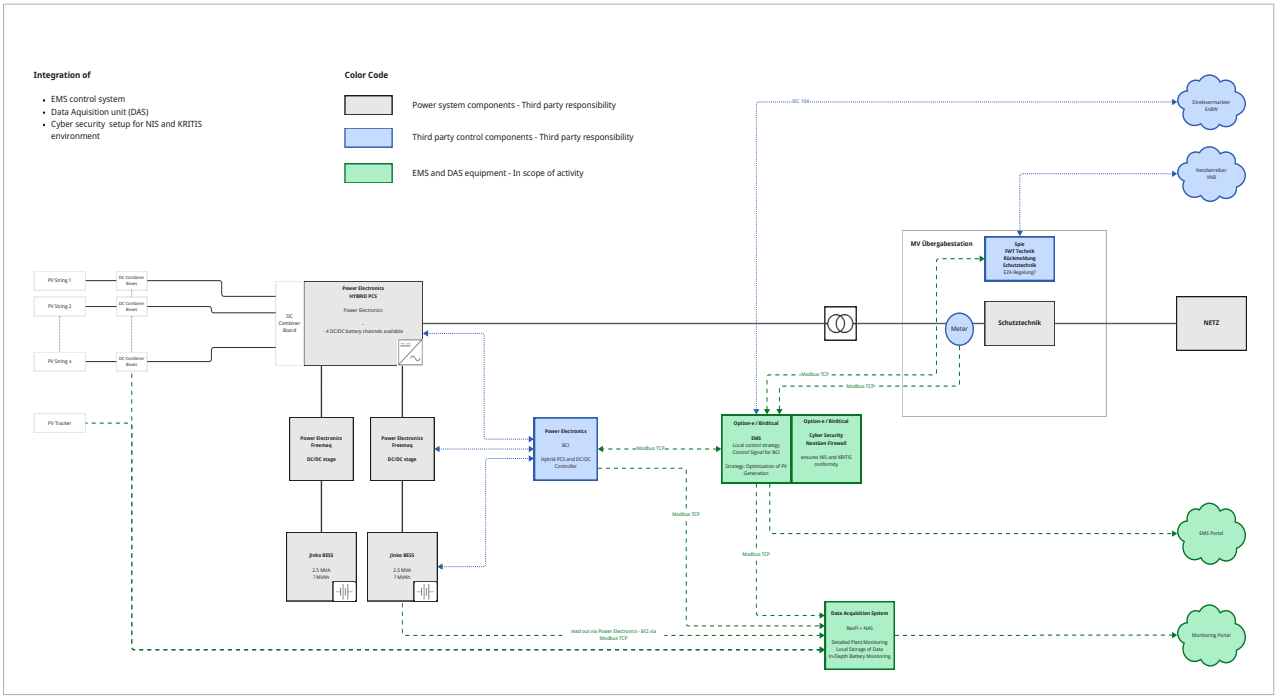

Fig. 1 System Diagram of the AC-coupled Project

Key Challenges

The AIS projects faced a combination of regulatory, economic and technical challenges.

From the customer's perspective, these challenges required an energy storage solution capable of going beyond standardized configurations to address market volatility, regulatory complexity and site-specific capacity requirements across multiple locations.

Severe price volatility and negative pricing risk

High PV penetration in Germany leads to significant price drops—and at times negative electricity prices—during midday hours, directly impacting project economics.

Strict environmental and safety requirements

The systems were required to comply with Germany's stringent safety regulations. In addition, due to their proximity to residential areas, operational noise levels had to remain below 75 dB (@1 m), placing further constraints on system design and operation.

Multi-site deployment with differentiated

Different AIS sites have distinct power and energy requirements, driven by variations in PV capacity, grid connection limits and local operating conditions. A conventional "one-size-fits-all" container configuration would either oversize capacity—leading to unnecessary CAPEX—or constrain operational flexibility, undermining project economics across multiple sites.

System compatibility and reliability

With the PCS supplier specified by the customer, the energy storage system had to achieve seamless compatibility for long-term reliable operation.

The Solution

To address the regulatory, economic and site-specific challenges of the AIS projects, Jinko ESS delivered a turnkey, modular DC-coupled system architecture, aligned with the customer's economic objectives and operating requirements:

System architecture aligned with market-driven operation

To mitigate negative pricing risks and maximize arbitrage value, Jinko ESS proposed and implemented a DC-coupled system architecture. In this configuration, photovoltaic generation and battery systems are connected on the DC side of the PCS, enabling surplus solar energy to be stored directly during low- or negative-price periods.

By reducing unnecessary power conversion stages compared to AC-coupled solutions, this architecture improves overall system efficiency and directly supports the customer's market-driven operating logic.

Modular capacity configuration for multi-site deployment

The AIS projects involve multiple sites with different power and energy requirements, due to the variations in PV capacity, grid constraints and local operating conditions.

Rather than relying on fixed container configurations, Jinko ESS implemented a modular, cluster-level capacity configuration within standardized container platforms. This approach enabled precise capacity matching for each site—such as 10 MW / 40 MWh, 3.06 MW / 12.53 MWh and 4 MW / 13.8 MWh—while maintaining a unified hardware platform.

As a result, capacity waste was avoided, CAPEX was optimized, and the solution remained scalable and repeatable across sites.

Compliance-ready design for environmental and safety requirements

To operate within Germany's demanding regulatory environment, the energy storage systems were designed to meet stringent safety regulations and environmental constraints, including strict operational noise limits for residential proximity.

A comprehensive safety architecture was integrated at the system level, incorporating multi-layer sensing and monitoring for temperature, voltage, current, gas detection and system status. This ensured safe, stable operation under frequent daily cycling and dynamic grid conditions.

Seamless system integration with designated PCS suppliers

With the PCS supplier specified by the customer, system compatibility and integration reliability were critical success factors.

Jinko ESS proactively conducted joint system integration and validation with the designated PCS supplier prior to delivery. Electrical interfaces, control logic and communication performance were verified under simulated operating conditions, minimizing on-site integration risk and enabling rapid commissioning.

Operating Logic

The storage systems follow a clear, market-driven operating strategy aligned with German electricity price dynamics:

· Midday charging (approximately 10:00–15:00): During periods of high PV output and low or even negative electricity prices, surplus solar energy is absorbed by the battery system, avoiding curtailment and negative pricing exposure.

· Evening discharge (e.g., 18:00–19:00 and other peak periods): Stored energy is discharged during high-demand, higher-tariff windows, maximizing arbitrage revenue while supporting grid stability.

Through this operating logic, the energy storage systems act as a flexible buffer between renewable generation and volatile market prices, significantly improving the overall economics of the agrivoltaics project

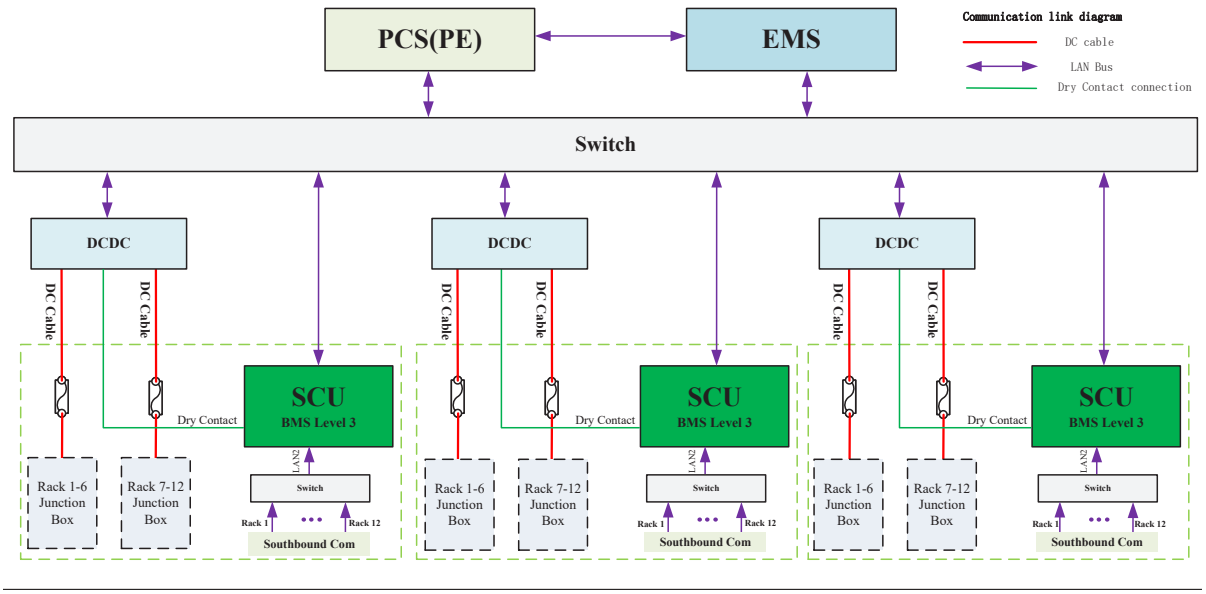

Fig. 2 Communication Topology

Customer Benefits

Improved project economics

Negative pricing risks are mitigated, PV utilization is maximized and energy is shifted to higher-value time periods, enhancing overall ROI.

Operational reliability

The DC-coupled architecture and comprehensive safety systems support stable, unattended operation suitable for daily cycling and grid service participation.

Regulatory confidence

Compliance with grid requirements and proactive technical coordination reduced approval and integration risks in a challenging regulatory environment.

Future-ready solution

The standardized yet flexible system design enables replication across multiple sites, supporting long-term expansion of agrivoltaics and storage deployments.

Fig. 3 On-site Photo

Fig. 4 On-site Photo

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