Case Study

Jinko ESS Solution of Micro-grid DC-coupled System

250kW/945kWh Li-ion BESS Project in Madagascar

Project Overview

The project is in Chifunde District, Tete Province, Mozambique. Mozambique's electricity access stands at a national average of 31.1% due to the unfavorable market conditions and distribution networks. The location of the project has less than 1% of the population with electricity access. The majority electricity power generation in the country is from Hydropower sources. However, the country's vast landscape and sparse population makes the power transmission and distribution from the hydropower sources expensive and costly. With these challenges off-grid solar solutions have become a go to option to ensure distributed energy access.

Jinko ESS micro-grid solution was deployed to provide power to the households of the location by harnessing the solar power from the photovoltaic (PV) system to directly supply the loads and be stored by the energy storage system to bridge the gap of the intermittent nature of solar.

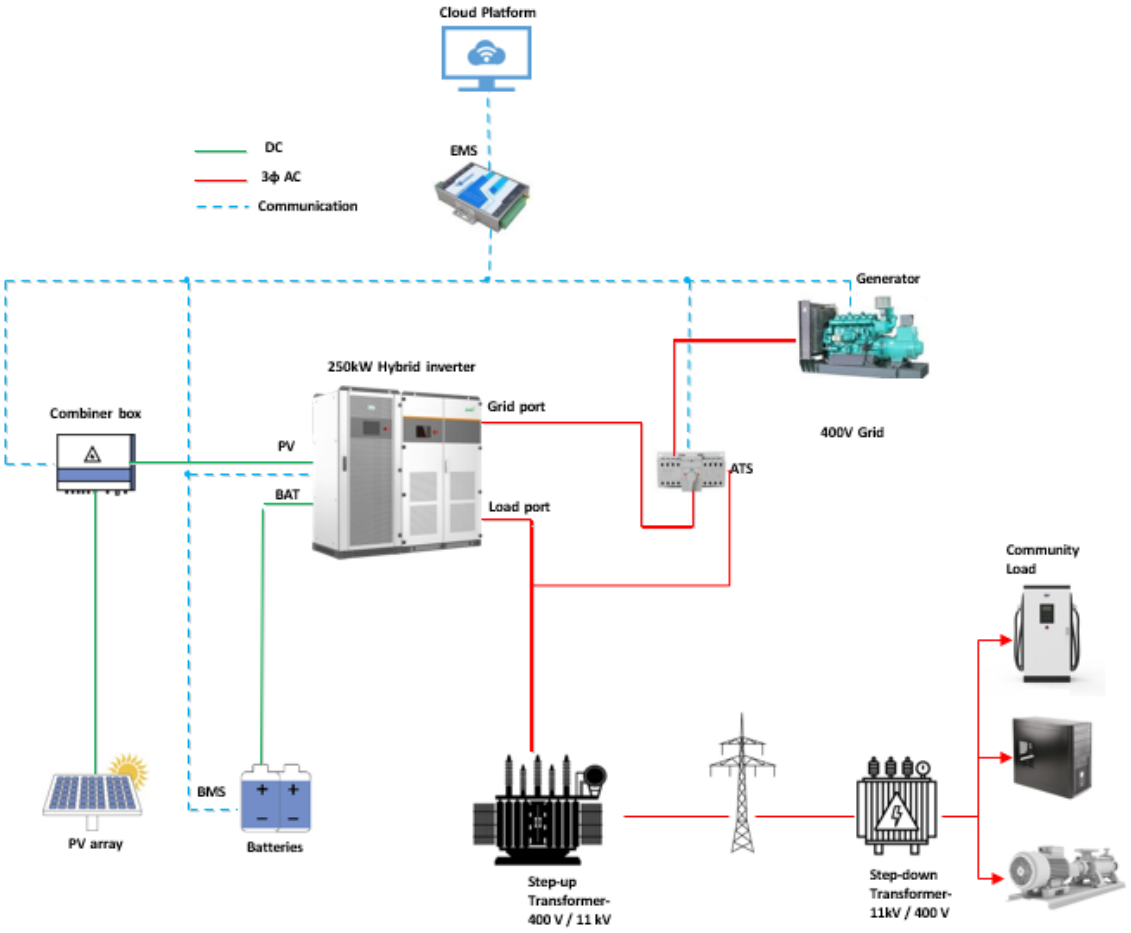

Fig. 1 Single Line Diagram of Micro-grid DC-Coupled System

The Solution

Featuring a 945kWh LFP battery, a 250kW hybrid PCS with a 250kW DC-DC converter, 200kWp PV system, a 100 kVA DG, and an Energy Management System (EMS), this project has emerged as a successful modern hybrid micro-grid solution in Sub-Sahara Africa boasting the following features:

a. High-efficient DC-coupled Solution

During the day, the PV system directly supports the community's load and charges the battery via a DC-DC converter, without the need for additional PV inverters. This setup enhances overall efficiency and reduces capital expenditure (CAPEX). At night, the battery powers the community, significantly reducing fuel consumption. When the battery is depleted, the EMS activates the DG to provide power, automatically transitioning the power supply.

b. Grid-forming PCS

The implementation of Grid-forming (GFM) PCS in this project ensures continuous power supply. Similar to a synchronous generator, GFM PCS can operate and serve the load both with and without the other synchronous machines. As a result, it can operate in synchrony with other synchronous machines, such as DGs, maintain stable operation when they are disconnected, and seamlessly stabilize when those machines are re-connected.

c. Smart Static Transfer Switch

Static Transfer Switch (STS) is an automatic static switching equipment designed to transfer critical loads between two independent AC power sources. By incorporating a smart STS and a real-time monitor of the micro-grid, the transfer time is maintained unsensible in less than a cycle (20ms).

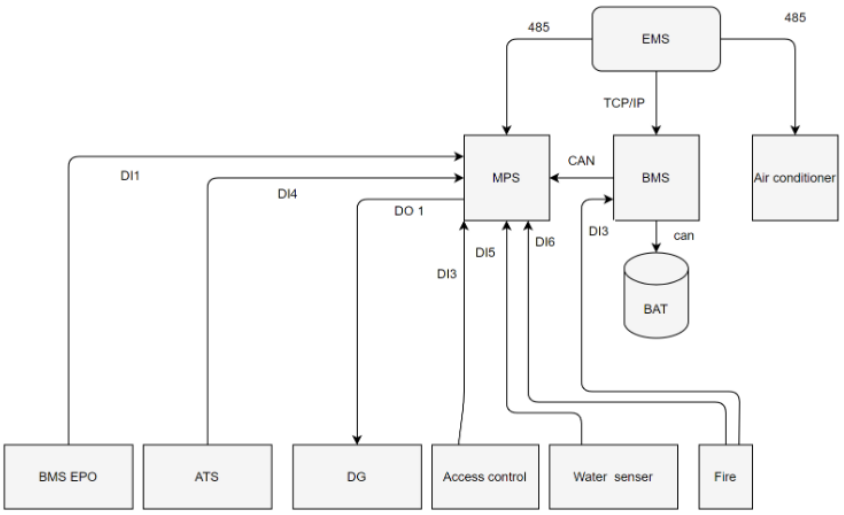

Fig. 2 Topological Graph of Microgrid DC Coupling System

Operation Logic

In this project, the objective of the Energy Storage System (ESS) is to maximize the utilization of photovoltaic (PV) power while minimizing the reliance on the genset. Hence the battery will be charged from the PV generated power and will discharge within the permissible DoD.

During daylight hours, the PV system supplies the load's power needs and uses excess energy to charge the battery. The EMS monitors the energy flow and regulates the PCS to maintain a balanced energy flow and charging process.

Should the PV output decrease, the PCS will automatically increase its power output to satisfy the load demand.

At night, the battery supports the load with the stored energy. When the battery's SoC reaches its minimum threshold, the EMS activates the genset to assume the load, thereby ensuring uninterrupted power supply.

An example of typical energy flow and daily generation data is shown below:

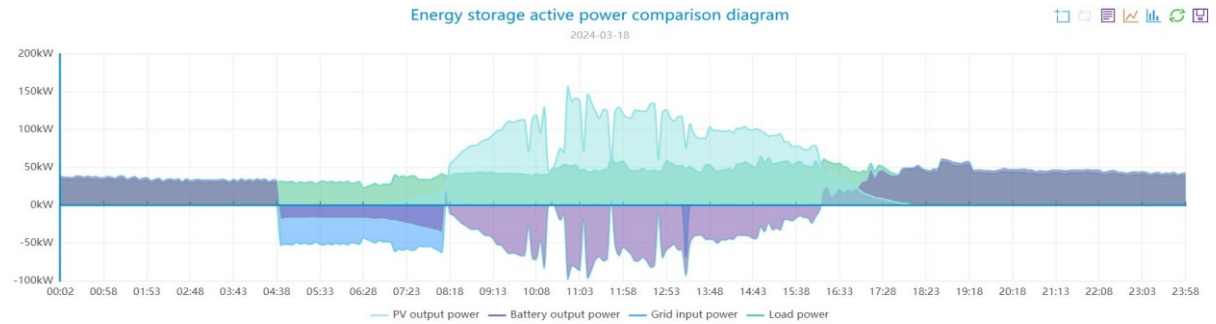

Fig. 3 Jinko ESS Cloud Energy Storage Active Power Comparison Diagram

Customer Benefits

Micro-grids are localized grids that can disconnect from the traditional grid to operate isolated and autonomously and are designed to provide power to a small-scale community or specific location, such as a university campus, hospital, or business complex. When considering a DC-coupled Photovoltaic (PV) Energy Storage System (ESS) micro-grid, below are the key features to stress on

I. Enhanced Energy Efficiency and Reliability and Simplified Infrastructure

a. Energy Efficiency

The DC-coupled PV-ESS's remarkable efficiency is particularly beneficial in a micro-grid, where optimizing the use of generated renewable energy is crucial for energy independence and reducing reliance on diesel generators or grid imports during operation.

b. Reliability and Resilience

The ability to store excess solar energy directly into batteries without DC/AC conversion losses plays a vital role in maintaining a reliable power supply, where fewer components are introduced with less possibility of failure. The high-efficient DC/DC converter are designed with compatibility of easy relacing and future expansion.

c. Infrastructure Simplification

A micro-grid often requires a carefully designed mix of energy sources, storage, and control systems. The simplicity of a DC-coupled system, with fewer components and conversions, can lead to easier integration and operation within the micro-grid. Jinko provides overall solution of PV+ESS including commissioning, which only involves limited on-site civil work, benefiting the client with easy installation.

II. Flexibility in Energy Management

a. Adaptive Energy Storage and Release

DC-coupled system allows micro-grid to manage when and how stored energy is used in a more effective way via built-in DC/DC converter compared to stand-alone PV inverter.

b. Voltage and Power Management

Careful design is considered to manage voltage levels and maintain compatibility between the PV array and storage, ensuring the system operates within safe and efficient parameters.

In a micro-grid, a DC-coupled PV-ESS offers significant benefits in terms of efficiency, cost savings, and flexibility, enhancing the micro-grid's resilience and sustainability. This integration approach supports the overarching goals of micro-grids: to provide reliable, sustainable, and efficient energy solutions on this community

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