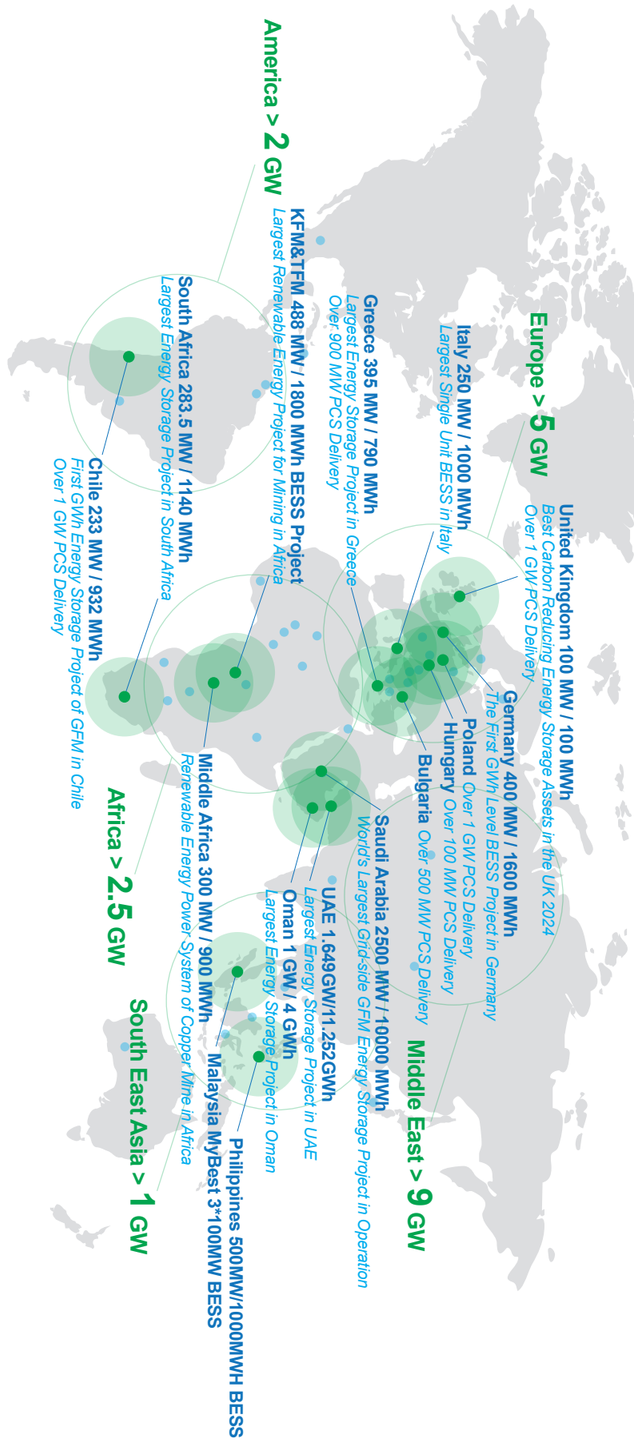
Global References





LaGuoCuo Off-grid Project

An Integrated Solution of "source-grid-load-storage"

Case Study

NR-iSGrid

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Version 2026.02

Background

On March 29th , 2024, the success of black start testing marks Laguocuo off-grid project phase I formally put into operation, it is a typical off-grid integrated solution of "source-grid-load-storage" variable renewable energy dominated electric power system, which has no electrical connection to main power grid.

Project Overview

The Laguocuo project locates in Xizang province with an altitude of 4,700 meters. The backbone is grid-forming energy storage system provided by NR Electric, 155 sets of grid-forming PCS work in parallel, establishing stable voltage and frequency as synchronous generators. The main power source is solar and diesel generators work as backup ones. The main load is Salt Lake lithium mining equipment.

For phase I, it consists of 125MWp photovotaic, 67.5MW/135MWh grid-forming(GFM) energy storage, 32.4MW DG, 35MW impact lithium extraction load and 30MW adjustable electric boiler load.

Thanks to the cutting-edge technology, average daily saving of diesel power generation costs is about 300,000 USD, achieving reliable, clean, economic and high-quality power supply for mining industry load.

After 5 months of operation of phase I, phase II put into service in August, 2024, with capacity of 75MW solar, 126.25MW/405MWh GFM BESS.



Fig 1 PCS container

Contemporary Challenges

As a high renewable penetration off-grid network, faces challenges like insufficient system voltage support, lack of rotational inertia, weak damping and complicated power dispatch.

The Proposed Resolution

1. With the aim of reliable, safe and economic operation, based on "Three-Defense-Line" principle, NR Electric has devised a comprehensive wide area microgrid solution. This encompassing solution comprises the power stability control function, the coordinated control function, the energy management function, and a grid-forming battery storage system (BESS). A state-of-the-art grid-forming Battery Energy Storage System (BESS) station has been successfully erected. This endeavor includes the installation of a novel power stability control system, a sophisticated coordinate control system, and an advanced energy management system, all integrated into a unified control framework.

2. The BESS comprises a 193.75MW/540MWh grid-forming BESS system that is outdoor installed. The BESS connects to 35kV busbars.

With NR-ISGRID technology, All PCS operate continuously as ideal synchronous voltage source during both stable and fault processes.

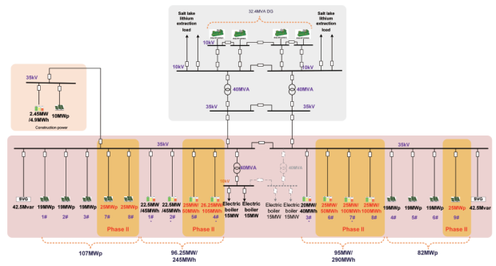

Fig 2 System architecture

NR Electric's grid-forming Battery Energy Storage System (BESS) not only encompasses conventional energy storage functions such as peak valley shifting, renewable power smoothing, black start capability, and power backup, but also attains self-synchronization control through precise manipulation of internal electric potential amplitude and phase angle. This results in the manifestation of distinct voltage source characteristics.

The BESS system realizes instantaneous frequency regulation, inertia providing, etc., it effectively improves the system inertia and short circuit capacity, improves the damping characteristics of the off-grid network, and can provide fast dynamic reactive power compensation, enhance the voltage support for it. Undoubtedly, it serves as a pivotal cornerstone, ensuring the stable operation of the "source-grid-load-storage" network.

The power stability control function, coordinate control function and energy management function collectively serve as the cognitive core. In addition to the conventional operation & monitoring functions, it has the decision-making ability to ensure stable operation of the power grid under various operating modes.

The Assessment of Performance

Dynamic response

The integrated emergency stability control and fast power control, achieves continuous closed-loop control of voltage and frequency in 100 ms level based on a fast control network, provides high-quality voltage frequency for off grid systems

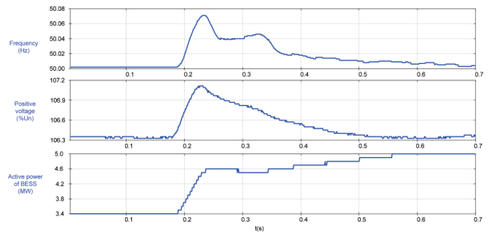

Fig 3 Large capacity load impact

One-button black start

NR Electric developed one-button black start function achieving sequential black start within 10 minutes from cold standby to completion of black start, and tested during phase I site commissioning, including:

- Start key equipment automatically, like UPS, BMS, PCS, etc
- Automatic status self-diagnosis for each device
- Automatic DC side pre charging control
- Voltage raising from Zero automatically by 52 units of grid-forming PCS operates in parallel

NR Electric's GFM BESS can expand to a scale of 1000 units of PCS in parallel operation, covering all sizes microgrid demand.

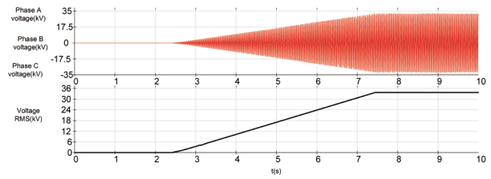

Fig 4 Waveform of black start

Fault ride-through

At 7:20:14 on April 3rd 2024, a single-phase-to-ground fault occurred on Phase A of the 35kV busbar 2 of the photovoltaic system. The grid-forming energy storage system successfully achieved fault ride-through, which fully verifies that the grid-forming energy storage system can fully function as an ideal synchronous voltage source for grid support.

Perfect power quality

Since commissioning, under any proportion of renewable energy penetration, the voltage and frequency qualification rate has been 100%, ensuring high-quality power supply for loads. Take the daily voltage and frequency curve on October 19th, 2024 for example, the frequency and voltage operated within 50.058Hz~49.984Hz and 1.0055pu~0.9925pu respectively.

Unveiling the Project Value

NR Electric keeps on stepping forward in the field of "source-grid-load-storage technology", innovatively realizes the technical breakthroughs like charging the idle-load transformers, voltage and frequency fast recovery within hundred milliseconds, one-button start/stop, one-button black start, intelligent power dispatch, etc, which enhances the power security and quality of the off-grid system effectively. It also reduces the system operation and maintenance workload significantly.

The successful operation of the Laguocuo project proves again the good performance and big value of "source-grid-load-storage technology" solution which provides economic, high quality, reliable power supply to industry.

Compared to conventional DG based grid, the GFM BESS based one is very environment-friendly and cost-effective. It brings a good alternative solution for such demands, like power supply to rural places, power security enhancement and industries, etc.