



Case Study

## MERALCO Cagbalete Island Microgrid Project

Provides a safe, stable and reliable solution

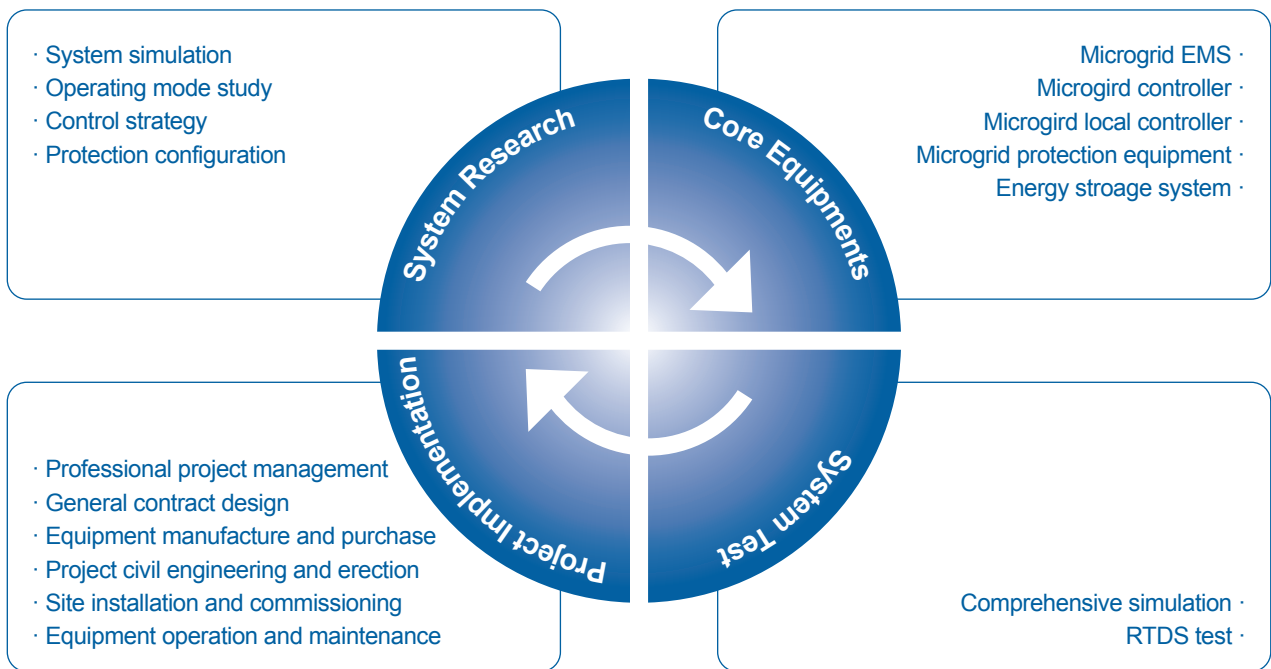
# Project Overview

Cagbalete Island Microgrid project is a pilot project which owned by MERALCO. There will be 2 new 30kVA Diesel generators and will have 60kW PV system, 30kW\*150kWh battery storage system and controllable loads in future that can be coordinated way either while connected to the main power network or while islanded. With its autonomous protection, control & management, it provides multiple advantages including higher energy utilization rate, better power supply safety & reliability, minimum power transmission losses and low environmental impact.

The permanently islanded Microgrid is an off-grid power network and implemented in the several villages in Cagbalete Island uncovered by the large power grids. It operates independently to meet the load demand within Microgrid.

NR delivered all-in-one Microgrid solution including the overall system simulation, design, equipment manufacturing, system simulation and site implementation for this project.

NR all-in-one Solution for Microgrid Project

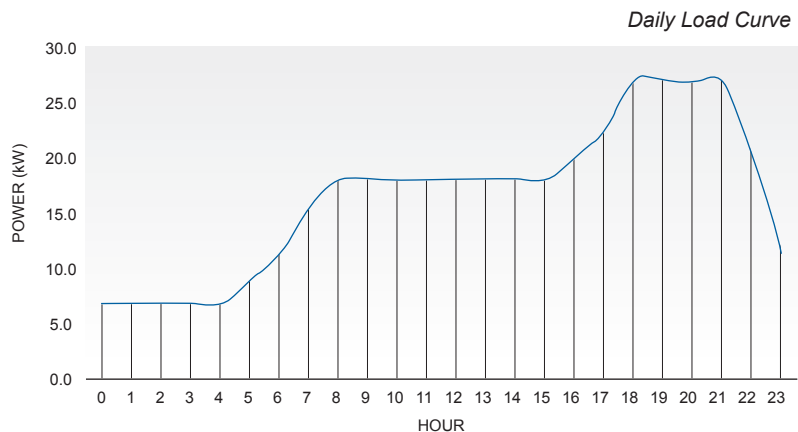


# NR Solution

## Introduction

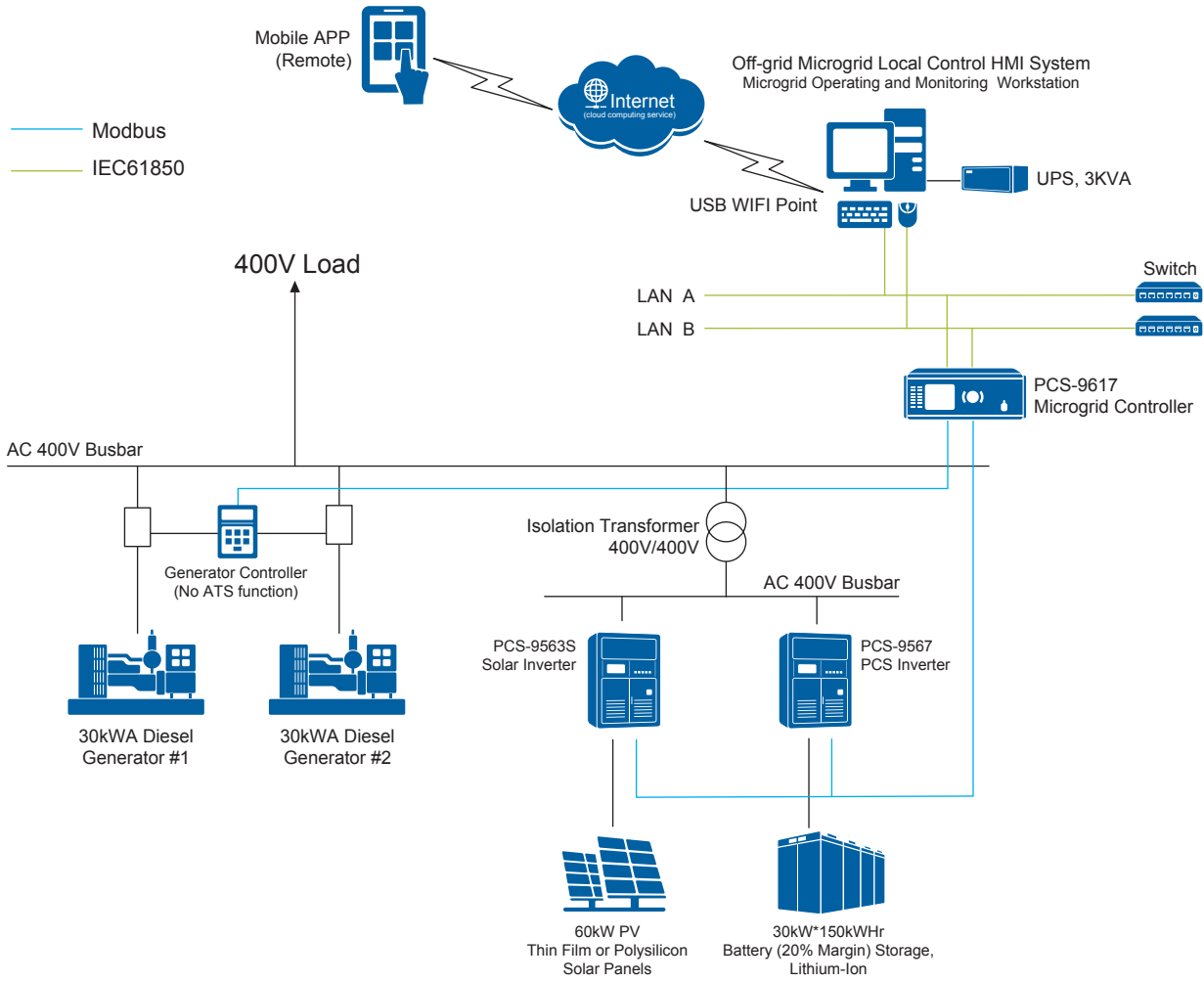
The system contains PV (photovoltaic, 60kWp), BESS (Battery energy storage system, 30kW\*5h) and DG (Diesel generator, 30kW\*2). It functions in the islanding mode, when the SOC (state of charge) is high, the battery supplies power to the system, when the SOC is low and the DG supplies power to the system.

*The maximum load of this system is 30kW and the load curve is shown in the following figure:*



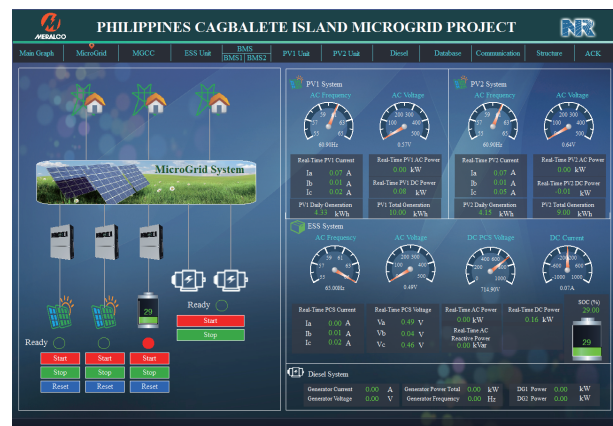
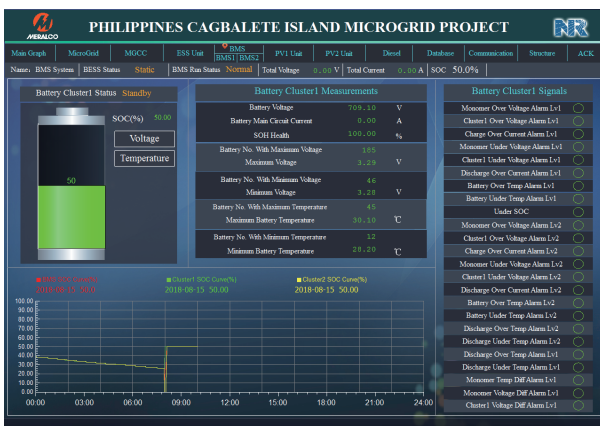
## Control Structure

The proposed off-grid Microgrid system architecture is shown as follows and mobile APP functionality can be provided as an option.



The MGCS (microgrid control system) consists of two parts: Local control HMI system and microgrid controller. Local control HMI system sends information to the internet and provide a user-friendly HMI. The HMI of Thailand microgrid is shown as an example:

Microgrid controller communicates with the PV, BESS, DG, and samples the system voltage and frequency. It maintains the stability of the system by controlling the power sources above.



## Control Strategy Description

Adjust the maximum output value of the PV ( $P_{max}$ ) to 45kW (The maximum cannot exceed 50kW), to avoid the danger of PV output greater than energy storage + load situation.

As the maximum load is 30kW, to improve the economic efficiency, only one DG is allowed to run and the other is used as spare.

This control strategy considers three cases:

1. parallel operation of PV, DG and BESS.
2. PV failure, parallel operation of DG and BESS.
3. BESS failure, parallel operation of DG and PV.

Since the DG has two units, DG failure is not considered. In order to describe the different SOC, this control strategy defines the following variables: SOC high, SOC middle1, SOC middle 2, SOC low, and meets SOC high > SOC middle 1 > SOC middle 2 > SOC low

- Parallel operation of PV, DG and BESS

When the SOC is greater than SOC high, the power of BESS is limited to 0 to make sure the BESS is no longer charging, avoid the BESS working in the current limiting mode as the high SOC and prevent system collapse.

When the SOC is less than SOC middle1, the PV output is limited to  $P_{max}$ .

When the SOC is greater than SOC middle2, the BESS is charging and limiting the DG output to 0.

When the DG is under operation, the BESS output power is limited to the PV power which prevent the DG power from charging the BESS.

- PV failure, parallel operation of DG and BESS

When the SOC is greater than SOC low, BESS provides power to the load and when the SOC is less than SOC low, BESS will stop.

- BESS failure, parallel operation of DG and PV

In order to avoid the PV output power greater than the load, the maximum output value of the PV is limited to 15kW

## Simulation

With the benefit of NR RTDS technology, the simulation analysis is carried out with the parallel operation of PV, DG and BESS during the factory test, rather than site test. The data of the PV original output in the simulation are all the actual data for both sunny and cloudy days.

This site simulation will make great contribution to the project commissioning in the future and will highly guarantee the success operation of this microgrid system at once.

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## Contribution of NR

### Functional Analysis

- Economic analysis

1. Avoiding battery charged by DG
2. Maximum reduction of PV output power

- Stability analysis

1. Maintaining the Voltage and frequency stability
2. Ensuring the SOC in a certain range and avoiding the battery working in the current limiting mode because of the battery's abnormal SOC.

NR Electric, as a power stability expert, is a leading power system solution provider across the world. Base on its strong technical background and vast professional experience, NR Electric has the ability to supply all around solution for Microgrid, ranging from EMS, Microgrid controller, BESS, to renewable generation system. NR Electric will provide best performance, competitive cost and most reliable solutions to our clients.

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