# Technical Proposal

# 22MW/55MWh @ 33kV

# BESS Project

**Issue: 01**

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## Prepared By

BYD Battery Storage and Energy Gate

# Content

# 1. Project Background and Requirements

This document aims to provide Powealthy and BYD's Battery Energy Storage System (hereinafter referred to as "BESS") solutions for the MEY Energy project with a total capacity of **55MWh@33kV**. The ESS will operate in **On-Grid** mode. The warranty period of this ESS project is **20 years**.

This solution includes the design, manufacturing, procurement, and delivery of ESS. We only provide the equipment listed in this proposal. The buyer or the buyer's contractor shall be responsible for all other equipment and engineering, such as on-site infrastructure preparation, installation, etc.

# 2. Terms and Definitions

### (1) BOL & EOL

BOL stands for Beginning of Life, which refers to the initial state of the battery cell or module.

EOL stands for End of Life, which refers to the state in which a battery can no longer deliver its expected performance.

### (2) Battery cell

The battery cell is a single sealed units made of aluminum using BYD's $LiFePO_4$ technology. These cells can be connected in series or parallel to form a battery module and then packaged in a housing.

### (3) Battery string

A battery string is a combination of multiple battery cells connected in series. The system also includes electronic circuit devices such as monitoring and protection circuits, electrical and communication interfaces, etc.

### (4) Battery rack/unit

A battery rack/unit is a system of multiple battery cells connected in series on the DC side of the inverter/PCS.

### (5) Enclosure/MC Cube BESS/Battery System

Enclosure/ MC Cube BESS consists of multiple battery racks/units and auxiliary systems. For example, the 10+1 MC Cube ESS consists of 10 battery racks and auxiliary systems.

**(6) Total cell energy**

Total cell energy = Cell nominal voltage × Cell number × Cell capacity.

**(7) Nominal energy (Also known as The Usable Energy)**

Nominal energy refers to the target value set by the buyer, which is also the target value of the system SAT. The ESS will undergo Factory Acceptance testing (FAT) before shipment and be transported to the project site. On arrival, the system will be installed, commissioned and subjected to Site Acceptance Testing (SAT). The supplier requires testing of the ESS system from FAT to SAT within 3 calendar months.

**(8) Battery Management System (BMS)**

BMS is a real-time monitoring system composed of electronic circuit apparatus. It effectively monitors the status of the battery, manages the charging and discharging process, and alerts and protects the battery in the event of failure. In addition, it optimizes the operation of battery cells and modules to ensure their safety, reliability and stability.

**(9) Energy Storage System (ESS)**

ESS consists of the battery, BMS, other auxiliary systems, PCS & MV Skid and EMS.

**(10) MC Cube nominal working condition**

Battery system under conditions of the ambient temperature shall be -30~55°C, the average SOC of battery shall be about 50% when in operation, the suggested SOC long term storage range of battery is 20% to 60%, RH 5% ~ 100%, altitude is less than 3000 meters (when the altitude is between 2000-3000m, the output of the system will be de-rated).

The system should meet two conditions:

Condition 1: The battery is charged at nominal charging power of 2147kW and is discharged at nominal discharging power of 2147kW. On average 1 cycle per day, 365 cycles per year. (maximum 2 cycles in a single day)

Condition 2: Testing condition only once a year, following the standard test condition in 11) of section 2.

**(11) Battery energy Standard Test Conditions and round-trip efficiency**

Each ESS unit Battery system under conditions of RH 5% ~ 95%, altitude is less than 3000 meters (when the altitude is between 2000-3000m, the output of the system will be de-rated):

1) The initial temperature of the battery cell shall be 20～28°C.
2) Pre-charge and pre-discharge before Energy and round-trip efficiency test.
3) Measured at the DC side of the 10+1 System BESS output, excluding the auxiliary consumption.
4) The battery is discharged until any battery cell reaches the discharging cut-off voltage, then stop discharging.
5) The battery is charged at nominal charging power until any battery cell reaches the charging cut-off voltage (which should correspond to up to 100% SOC), then stop charging and record the cumulative data (Q1) of the measuring equipment. System should then standby for 60 min.
6) The battery is discharged at nominal discharging power until any battery cell reaches the discharging cut-off voltage (which should correspond to down to 0% SOC), then stop discharging and record the cumulative data (Q2) of the measuring equipment.
7) Calculate the recorded measurement data.
8) Round Trip Efficiency(η), the calculation formula is: $\eta = Q2/Q1 \times 100\%$

**(12) SOC**

SOC is the ratio of the battery's current capacity to its current maximum available capacity, expressed as a percentage.

## 3. Standards Compliance

The system design is based on the codes and regulation listed below. Any subsequent amendments or revisions to the dated citation standards will not apply to this specification. However, the latest version of the undated standards shall apply.

- **Battery standards:**

UN3536

UN38.3

UL1973

UL9540A

UL9540

- **Other standards:**

ISO9001:2015

ISO14001:2015

- **PCS Standard:**

IEC 62271-212

IEC 62271-200

IEC 60076

IEC 61439-1

# 4. Scope of Supply

## 4.1 Battery System

Table 4-1 The Product of supply of the battery system

| Item | Description | Qty (Pcs) | Remarks |
|---|---|---|---|
| 10+1 MC Cube System | 4.659MWh Battery Capacity (BOL) | 14 | Each 10+1 MC Cube System includes 10 MC Cube and 1 distribution junction unit. The system integrates batteries, BMS, HVAC, fire detection systems, etc. |
| Connection Cables | All the cables in the container | 14 set | Exclude cables from the battery system to the PCS system, the PCS system to the buyer's equipment, and any grounding cables from the ESS system |

## 4.2 PCS System

Table 4-2 The Product of supply of the PCS system

| Item | Description | Qty (Pcs) | Remarks |
|---|---|---|---|
| 6.3MW PCS SKID | PCS – 9567 6.3MW Integrated MV Skid | 4 | Includes 4 pcs of 1.575W PCS, 6300kVA Transformer, RMU, Auxiliary transformer, Communication Cabinet |

## 4.3 Warranty period of supplied equipment

The warranty of the equipment supplied are listed in the table below.

Table 4-3 Warranty Period

| No. | Items | Warranty Period/years | Remarks |
|---|---|---|---|
| 1 | MC Cube ESS | 18 | Prices will be listed in the commercial offer |
| 2 | PCS/MV Skid | 18 | Prices will be listed in the commercial offer |

# 5. ESS Technical Proposal

## 5.1 Energy Capacity Configuration and Energy Retention of BESS

### 5.1.1 Energy Configuration

This project proposes using BYD 10+1 MC Cube BESS product. For the 10+1 system, the initial nominal energy@33kVac is calculated using the parameters in the table below.

Table 5-1 The Usable Power and Energy@33kVac for the 10+1 MC Cube ESS

| Item | Initial solution | Remark |
|---|---|---|
| Battery model | LFP | |
| Battery cell rated voltage(V) | 3.2 | |
| Number of battery cell per string | 416 | |
| Number of battery strings per enclosure | 10 | |
| Cell energy per enclosure(MWh) | 4.659 | |
| Number of enclosures | 14 | |
| Total cell energy(MWh) | 65.226 | |
| DC side usable energy(MWh) | 60.130 | @SAT (Within 3 calendar months from FAT to SAT) |
| AC side @33kV energy (MWh) | 56.623 | @SAT (Excluding the aux. power consumption) |
| AC side energy requirements (MWh) | 22.282 | |

### 5.1.2 The Capacity Retention of BESS

Battery system under conditions of the ambient temperature shall be -30~55°C, the average SOC of battery shall be about 50% when in operation, the suggested SOC long term storage range of battery is 20% to 60%, RH 5% ~ 100%, altitude is less than 3000 meters (when the altitude is between 2000-3000m, the output of the system will be de-rated).

The system should meet two conditions:

Condition 1: the battery is charged at nominal charging power of 2147kW, and is discharged at nominal discharging power of 2147kW. On average 1 cycle per day, 365 cycles per year. (maximum 2 cycles in a single day)

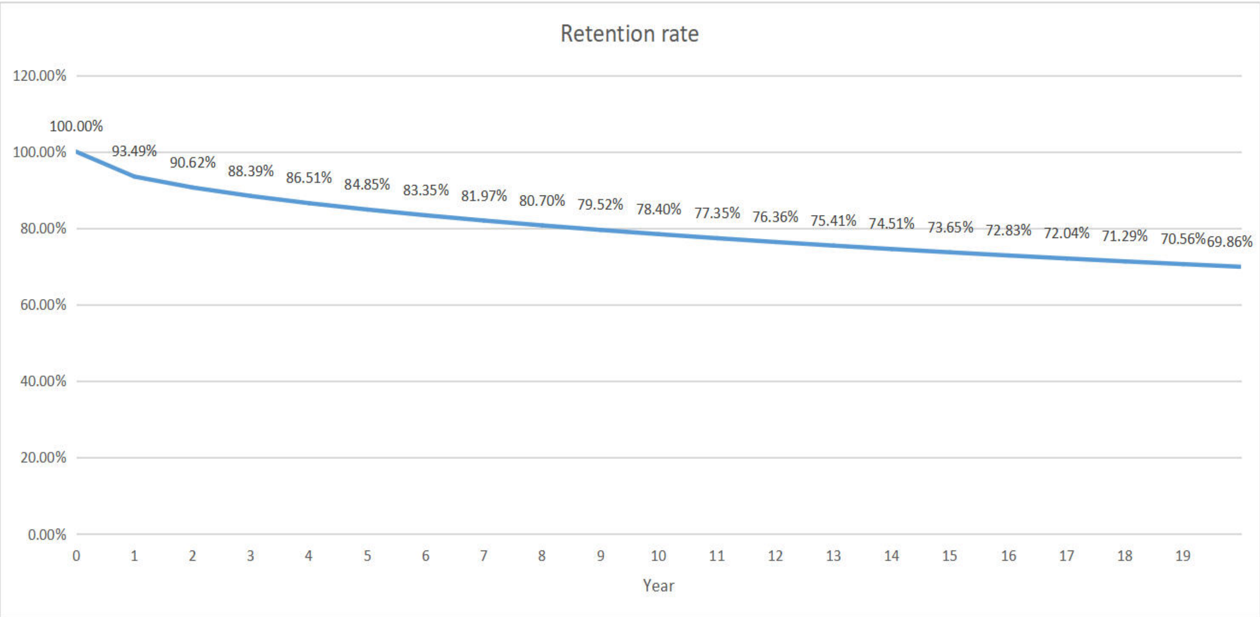
Condition 2: Testing condition only once a year, following the standard test condition in 11) of section 2.

If there are any changes to the system working condition, the energy retention need to be reevaluated.

Table 5-2 The Degradation Curve of Battery System

| **Year** | **0** | **1** | **2** | **3** | **4** | **5** | **6** |
|---|---|---|---|---|---|---|---|
| Retention | 100.00% | 93.49% | 90.62% | 88.39% | 86.51% | 84.85% | 83.35% |
| **Year** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| Retention | 81.97% | 80.70% | 79.52% | 78.40% | 77.35% | 76.36% | 75.41% |
| **Year** | **14** | **15** | **16** | **17** | **18** | **19** | **20** |
| Retention | 74.51% | 73.65% | 72.83% | 72.04% | 71.29% | 70.56% | 69.86% |

Figure 5-1 The Battery Degradation Curve




### 5.1.3 The Limited Power of System

The charge and discharge limits of a battery unit depend on the cell temperature and the battery's SOC. The battery unit shall have charge and discharge capabilities as shown in the diagram below. The battery temperature - SOC graph below represents battery system performance and is used to indicate battery system performance under different conditions.

During the operation of the battery unit, when the battery operating temperature is higher than 40°C, the battery unit will automatically reduce its output; thereafter, when the temperature reaches 35°C, it will resume full power operation.

Within a certain temperature and SOC range, considering the PCS efficiency of 98%, the maximum charging power is the nominal charging power at the single PCS DC side, see Table 5-2. T The charging limit table and map of the ESS unit on DC side are shown below.

Figure 5-2 Cell Temperature - SOC maps (charge)

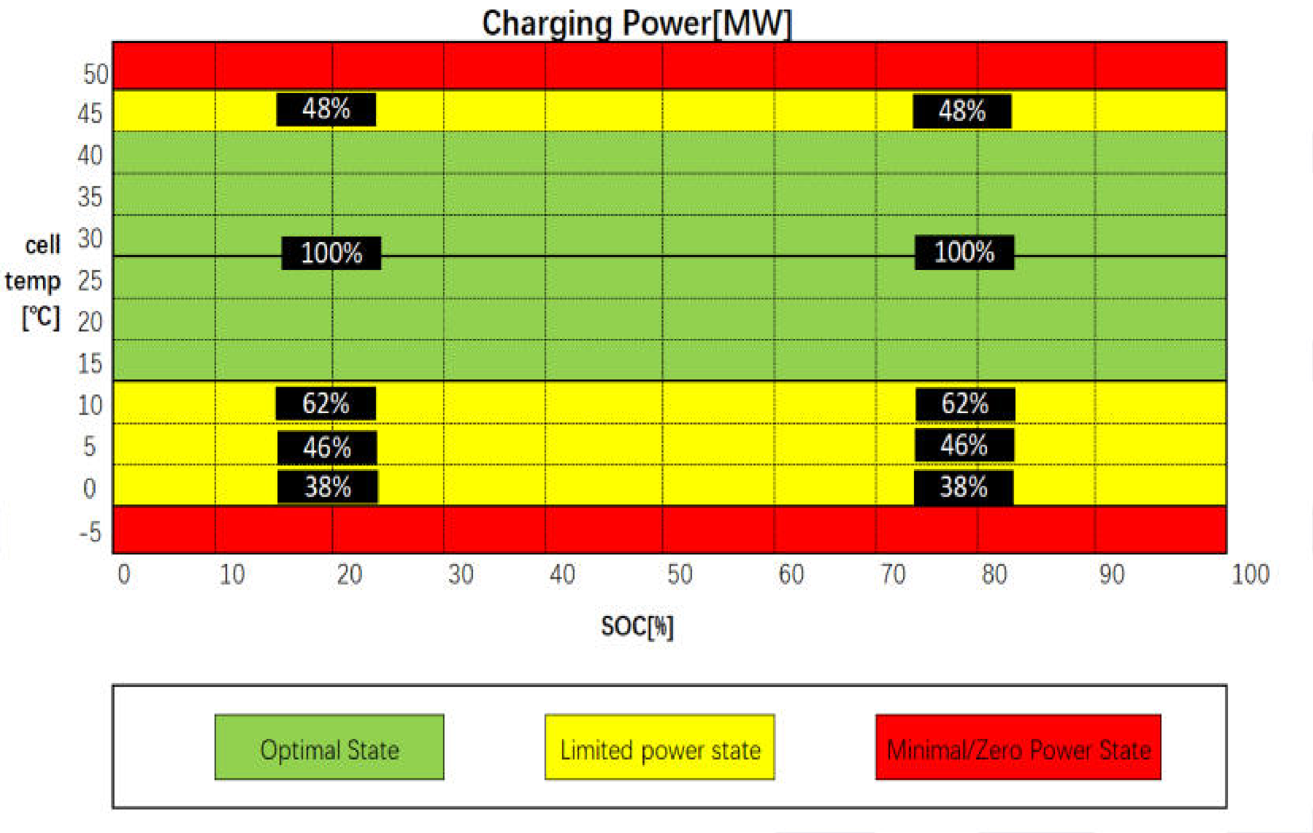
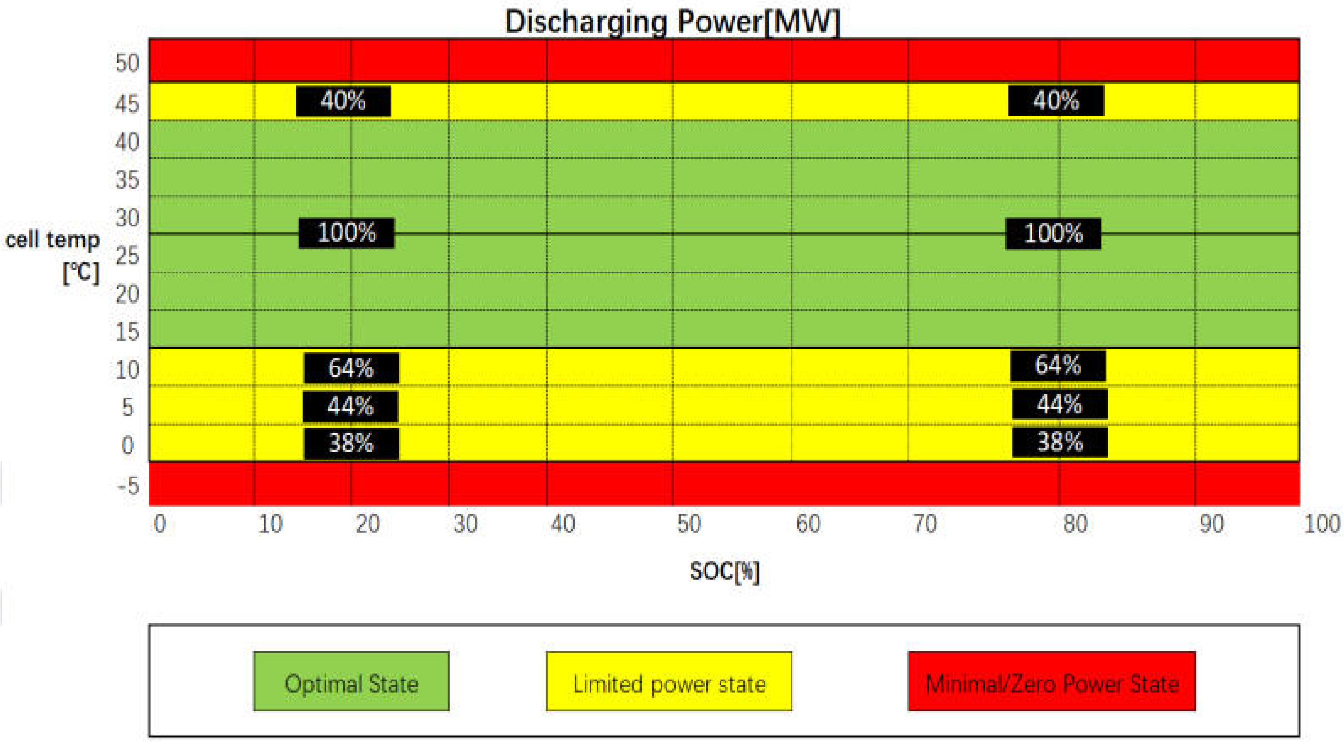



Figure 5-3 Cell Temperature - SOC maps (discharge)

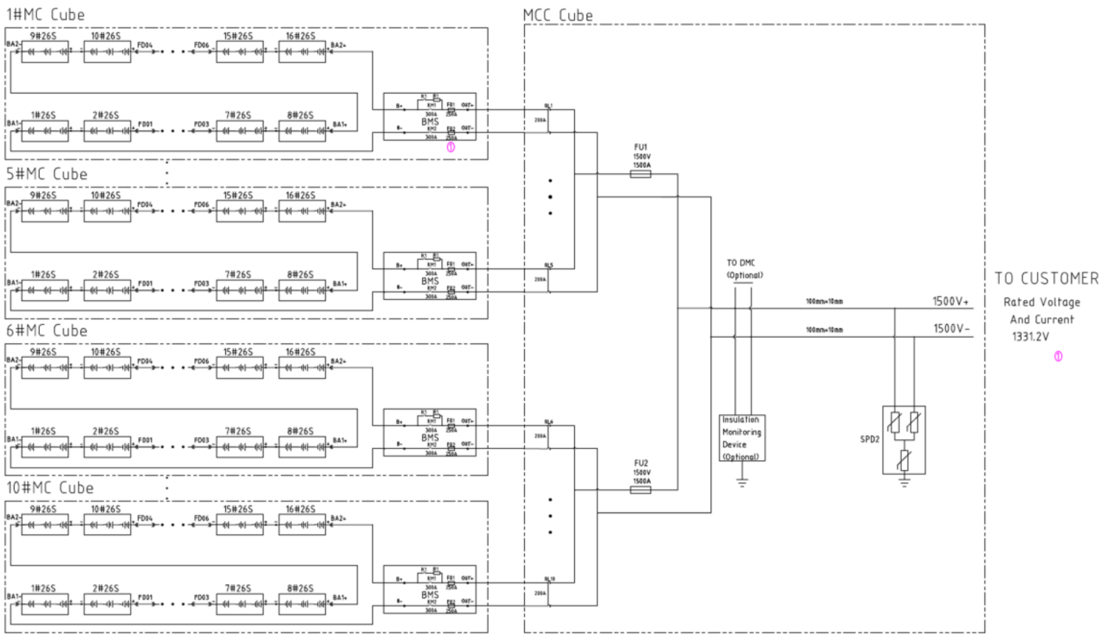



The battery unit shall be capable of charging/discharging at nominal power in the optimal state. It shall be capable of charging/discharging at a power lower than nominal power in the limited power state. Reduced power levels are represented as contour lines in the indicative temperature -SOC maps.

## 5.2 The Electrical Topology of ESS

The electrical topology of 10+1 MC Cube BESS is illustrated in figure below.

Figure 5-4 Electrical Topology of 10+1 MC Cube BESS

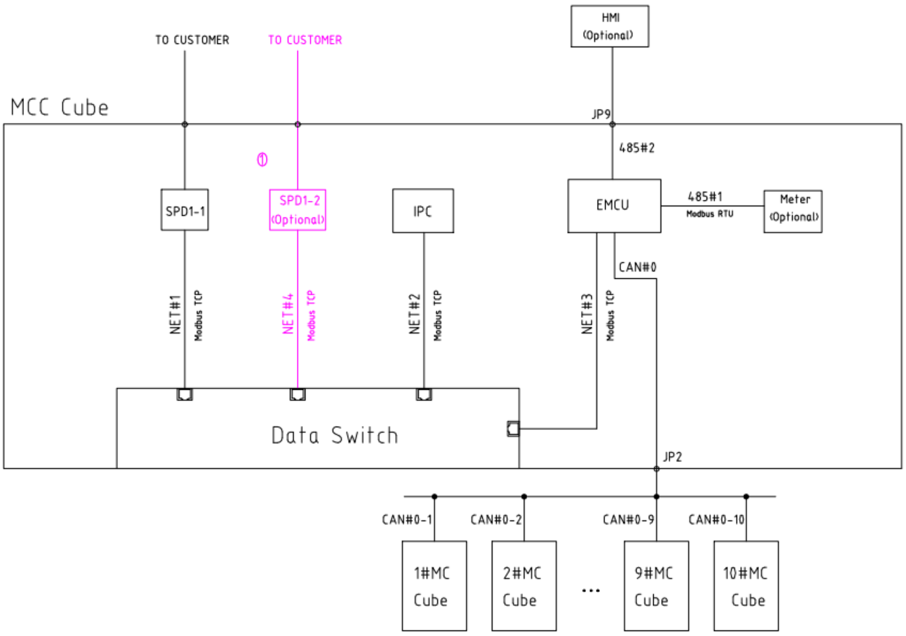



## 5.3 The Communication Topology of ESS

In this specification, the system provides communication interface for buyer side

SCADA system. The communication protocol of the communication interface is Modbus TCP/IP.

Figure 5-5 Single battery energy storage system unit communication topology




## 5.4 The Installation Area for ESS

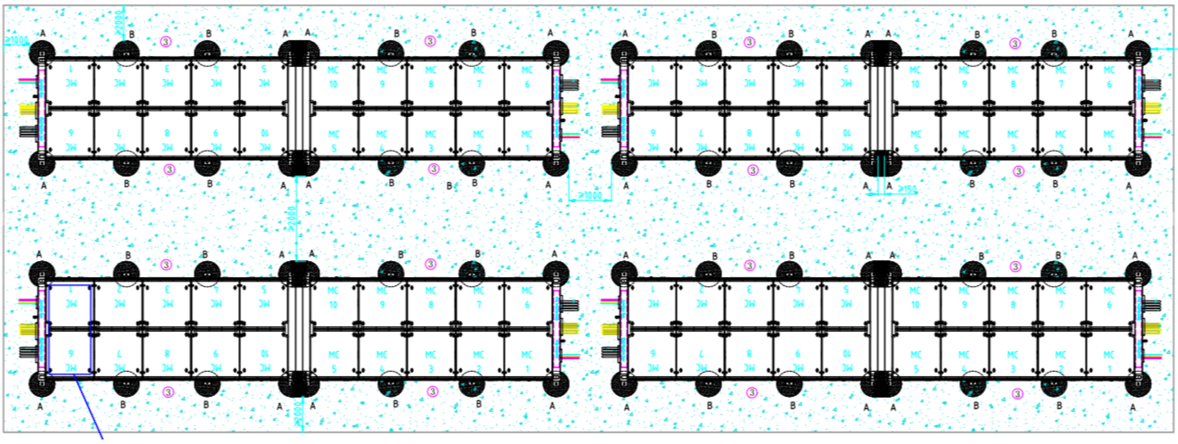
The MC Cube BESS is specifically designed to meet UL1973 standards, including an integrated battery, battery management system, protection circuit, temperature control system and fire protection unit.

Figure 5-6 The Appearance of a 10+1 MC Cube BESS (for reference only)

The 10+1 System BESS can be used in large-scale power station, small-scale power station, and can be installed in the narrow and long area of the site.

The installation layout is shown in the following figure.

Figure 5-7 Installation layout for MC Cube ESS



## 5.5 Battery System Design

### 5.5.1 The Design of Battery Cell

Lithium iron phosphate batteries (LiFePO4) are commonly used in large battery storage systems and electrified transportation. BYD produces lithium iron phosphate batteries of different capacities.

The technical parameters of the battery cells of this project are shown in the table below.

Table 5-3 The Technical Parameters of Battery Cell

| No. | Items | Parameters | Remarks |
|---|---|---|---|
| 1 | Cell type | LFP | |
| 2 | Nominal voltage (V) | 3.2 | |
| 3 | Cell charge cut-off voltage (V) | 3.6 | |
| 4 | Cell discharge cut-off voltage (V) | 2.6 | |
| 5 | Cell nameplate capacity (Ah) | 350 | |
| 6 | Cell nameplate energy (Wh) | 1120 | |

### 5.5.2 The Design of MC Cube BESS

The technical parameters of 10+1 MC Cube BESS are shown in the table below.

Table 5-4 The Technical Parameters of 10+1 MC Cube BESS

| NO. | Item | Parameter | Remark |
|---|---|---|---|
| 1 | Max charge and discharge power (kW) | 2147 | DC |

| | | | | |
|---|---|---|---|---|
| 2 | DC usable energy (kWh) | | 4295 | @SAT(The duration time from FAT to SAT is no more than 3 calendar months) |
| 3 | DC full power usable energy (kWh) | | 4295 | Full power usable SOC range is 100% |
| 4 | Nominal output voltage (V) | | 1331.2 | DC |
| 5 | Output voltage range (V) | | 1081.6～1497.6 | |
| 6 | Max output current (A) | | 2456 | |
| 7 | Working mode | | On-grid | |
| Operation environment | | | | |
| 8 | Permissible ambient temperature of enclosure (℃) | | -30～+55 | Operation above +55℃ may result in reduced power and capacity |
| 9 | Best operation temperature for battery (℃) | | +10～+25 | Best ambient temperature |
| 10 | Permissible relative humidity (%) | | 5～100 | |
| 11 | Permissible altitude (m) | | ＜3000 | |
| Other parameter | | | | |
| 12 | Noise (dBA) | | ≤75 | 1 meter distance outside enclosure |
| 13 | Ingress rating | | IP55 | |
| 14 | Communication mode | | Ethernet | |
| 15 | Dimension (D×W×H, mm) | | 2438*6058*2896mm | |
| 16 | Weight of 10+1 System BESS (tons) | | Around 41.385 | |
| 17 | External interface | DC1500V interface (pcs) | 1 | |
| | | Auxiliary power supply interface (pcs) | 1 | AC400V/50Hz, 3 phase 4 wire , about 60kVA for each enclosure |
| | | Communication interface (pcs) | 2 | Ethernet |
| | | Grounding interface (pcs) | 1 | 1 for each MC Cube |
| 18 | Fire Protection System | | 10 | 1 Fire detection system for each single MC Cube |
| | | | 1 | 1 Fire control cabinet for entire MC Cube system |

### 5.5.3 BMS Design

The proposed solution adopts BYD self-developed battery management system for the LiFePO4 battery, and each battery management system includes:

- Battery management unit (BMU)
- Battery electrical controlling unit (BECU)

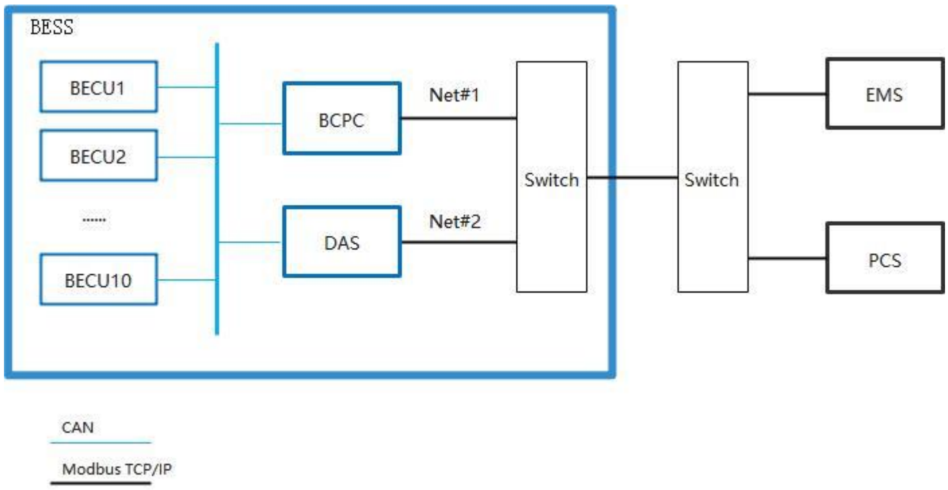
The BMS performs the following functions to ensure the normal, stable, and reliable operation of the batteries:

- Battery status monitor
- Operation control
- Online balancing management
- Protection alarm
- Communication

**BMS principle and characteristics:**

The BMS monitors the voltage, temperature of the single cell, the current of the battery pack, as well as the temperature and humidity in the box, the concentration of combustible gas, the concentration of smoke and the gas pressure in real time. It also calculates the state of charge (SOC) of the battery string, and communicates with the upper equipment, sends alarm information, conducts protection action, balances cells and etc.

Figure 5-8 The Schematic Diagram of BMS Structure




## 5.6 Auxiliary System Design

The auxiliary system should be powered by auxiliary power transformer. The MC Cube BESS provides interface connection to auxiliary power distribution panel or transformer.

### 5.6.1 Thermal Management System

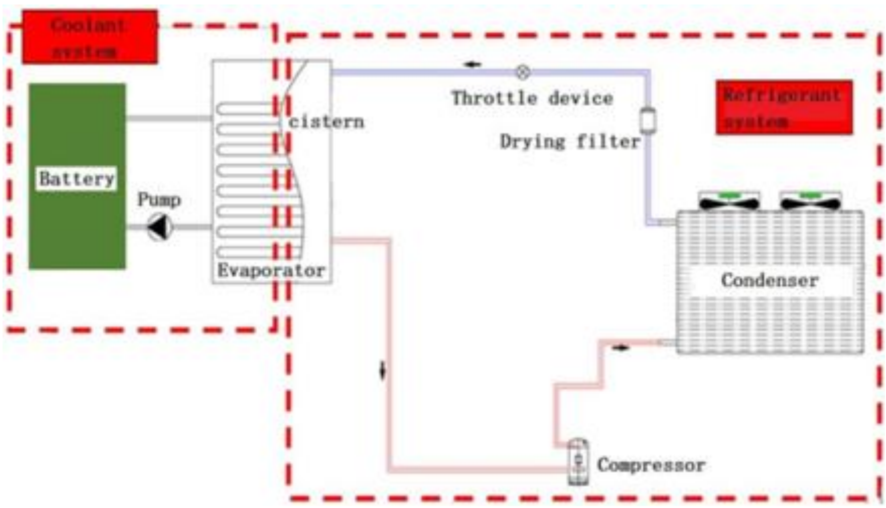
The thermal management system in the battery unit is a liquid cooling system for the batteries.

The liquid cooling system is divided into a HVAC system and Liquid cooled pipe system. The HVAC system mainly generates cold liquid, and the Liquid cooled pipe system transmits the cold liquid to the batteries through the pipe.

The liquid cooling design principle used in MC Cube System is as follows:

The whole cooling system is divided into Refrigerant system and Coolant system. The refrigerant system mainly generates cold water, and the Coolant system transmits the cooling capacity or heat to the battery module through the refrigerant. Refrigerant system mainly includes compressor, condenser, throttle device and cistern. The compressor provides power, the condenser dissipates heat into the air, and the cooling capacity is exchanged between the Refrigerant system and the Coolant system through the cistern.The Coolant system then evenly distributes the cooling capacity to the liquid-cooling plates within each battery layers through the water pump.

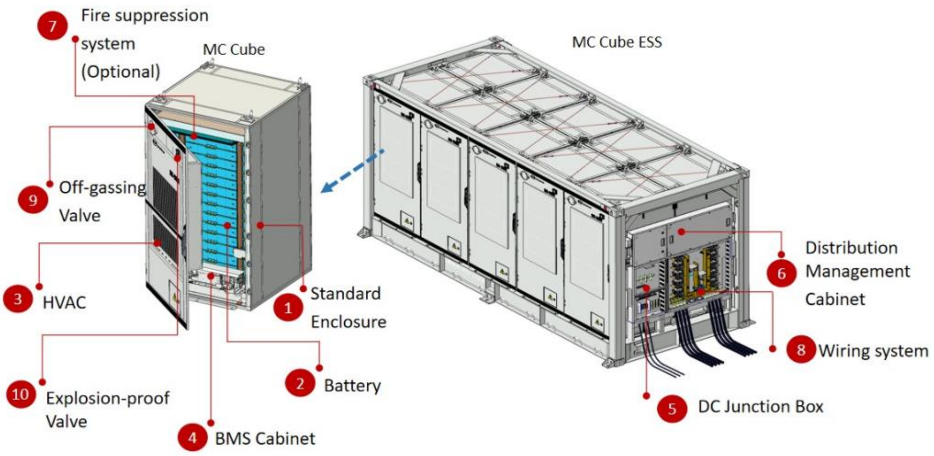
Figure 5-9 Liquid Cooling System Working Principle (for reference)




### 5.6.2 Fire Detection System

Each battery unit of the BESS is installed with flammable gas detection and ventilation valve, as shown below.

Figure 5-10 Fire Detection System




The MC Cube incorporates heat and smoke detection. The below alarm sequence will be programmed into the MC Cube ESS.

**Level 1 Alarm:** If a gas detector is triggered, the exterior mounted alarm bell will ring and the MC Cube ESS will communicate the level 1 alarm condition to the site EMS, notifying on-site personnel that there is a potential risk within the MC Cube ESS.

**Level 2 Alarm:** If the heat and smoke detector are triggered at the same time, the exterior mounted alarm strobe will active and the MC Cube ESS will communicate the level 2 alarm condition to the site EMS, notifying on-site personnel that there is a potential risk within the MC Cube ESS.

If an alarm is triggered, do not open any of the MC Cube ESS access doors-explosive gases may be present. If safe to do so, stop the system via E-stop, evacuate the site, and notify emergency response authorities.

## 5.7 Communication and Control

### 5.7.1 Project Communication Protocol and Interface

In this project, the system provides communication interface for buyer side SCADA or EMS system. The communication protocol of the communication interface is Modbus TCP/IP.

The ESS system reserves the communication interface and receives the instructions from the buyer SCADA or EMS to charge and discharge.

The buyer should set up the Internet at the site of the project so that the supplier can obtain the ESS running data remotely and facilitate the after-sales maintenance.

The buyer should provide one Ethernet interface for every 10+1 BESS.

### 5.7.2 System Upload Data

ESS will upload the following data via internet, including but not limited to the item listed in the following table.

Table 5-5 System Upload Data

| Item | Remote access （Y/N） | Local display （Y/N） | Unit |
|---|---|---|---|
| Allow Active Power Discharge Limit | Y | Y | kW |
| Allow Active Power Charge Limit | Y | Y | kW |
| DC Power | Y | Y | kW |
| DC Voltage | Y | Y | V |
| DC Current | Y | Y | A |
| Battery String SOC | Y | Y | 1% |
| Battery String Currents | Y | Y | A |
| Battery String Max Cell Temp | Y | Y | ℃ |
| Battery String Min Cell Temp | Y | Y | ℃ |
| Battery String Max Cell Voltage | Y | Y | V |
| Battery String Min Cell Voltage | Y | Y | V |
| Battery String Warning | Y | Y | |
| Work State | Y | Y | |
| Battery String Work State | Y | Y | |

# 6. PCS Technical Proposal

## 6.1 PCS/Skid Selection

Based on the design of the ESS system, we propose to use NR PCS-9567TU-1575 on the AC side. The advantages of this PCS are:

High efficiency and low loss

Air-cooled heat dissipation, low system loss;

PCS three-level topology, maximum efficiency 99%

Grid friendly

PQ, network and other control modes are suitable for various application scenarios;

Supports IEC 61850 protocol and fast communication interface, millisecond response

Safe and reliable

IP65 high protection level, reliable in harsh environments

Figure 6-1 NR 1500V Outdoor PCS

Figure 6-2 Schematic Diagram of NR PCS-9567TU-1575

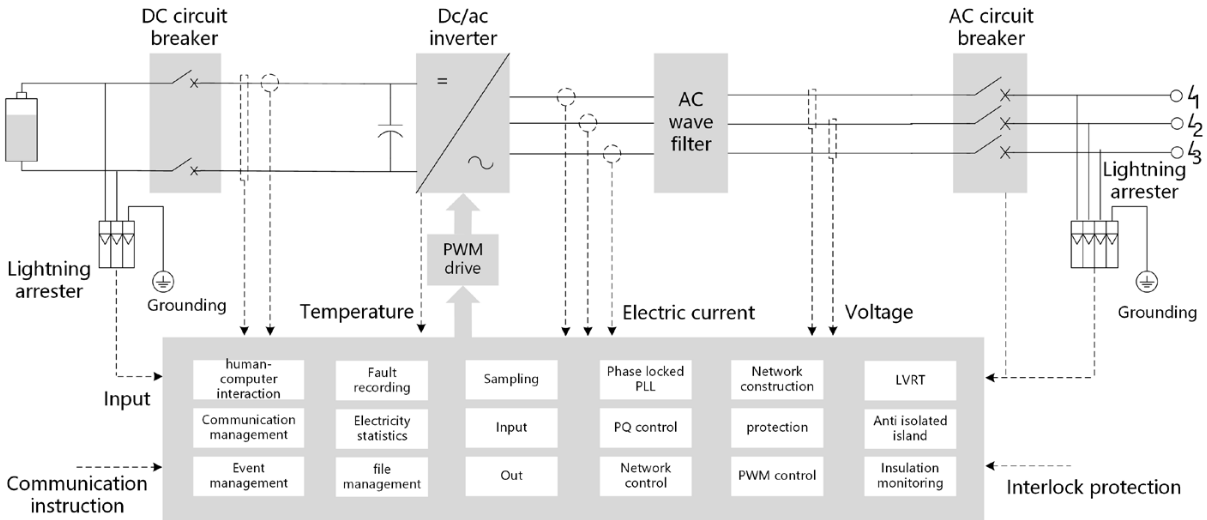



Figure 6-3 PCS/MV Skid

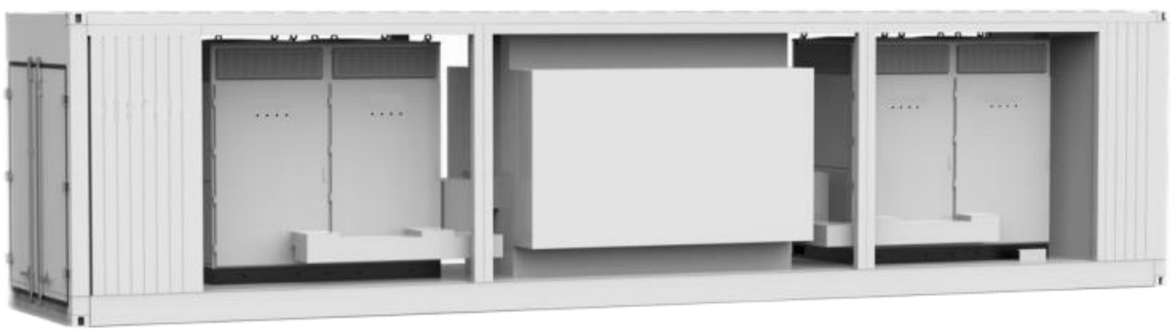


Table 6-1 PCS/MV Skid Main Parameters

| Technical Parameter | PCS-9567-6300 (40ft) | PCS-9567-2500 (20ft) |
|---|---|---|
| **DC Side** | | |
| DC Voltage Range | 780~1500V | |
| Maximum DC input current | 1833A*4 | 1833A*2 |
| DC Voltage Ripple | <1% | |
| DC Current Ripple | <3% | |
| **AC Side** | | |
| Nominal Output Power | 6300kW | 2500kW |
| Maximum AC Power | 6930kVA | 2750kVA |
| Maximum AC Output Current | 1588A*4 | 1588A*2 |
| Nominal Operating Frequency | 50/60Hz | |
| Operating Frequency Range | 45~55 / 55~65Hz | |
| Maximum THD of Current | < 3% | |
| Nominal Power Factor | >0.99 | |
| Adjustable Power Factor | 0.9(leading)~ 0.9(lagging) | |
| AC Connection | Three Phase Three Wire | |
| Cooling method | Forced Air Cooled | |
| Operating temperature range | -35~60℃ (>50℃ derating) | |
| Relative Humidity | 0~95%, No condensation | |
| IP Rating | IP65 | |
| Communication Interface | CAN / RS-485 / RJ45 / Optical Fiber Port | |
| Communication Protocol | CAN / Modbus / IEC60870-103 / IEC61850 | |
| Compliance | UL1741 | |
| **Transformer** | | |
| Transformer Model | Oil type | |
| Transformer Vector | Dy11 | |
| Nominal Output Power | 6300kVA | 2500kVA |
| **Skid General** | | |
| Dimensions (L*H*W)(mm) | 12192*2896*2438 mm | 6058*2896*2438 mm |

## 6.2 Configuration of PCS/MV Skid

As the AC side grid-connected voltage is 33kV, for the power conversion system, we plan to use the container, which consists of PCS, transformer, Ring main unit(RMU), protection control system, etc., and is connected to the battery container on the DC side.

The combined configuration of the PCS/MV Skid and battery container is as follows

Table 6-2 Configuration of PCS/MV Skid

| Project site | Configuration of BYD Battery System | Total Battery Container | Configuration of PCS/MV Skid | Total PCS/MV Skid Qty | Total Power of PCS (kW) |
|---|---|---|---|---|---|
| Madedonia | 10+1 | 14 | One **6.3MW PCS/MV Skid** (1575kW*4) is connected to Two BYD 10+1 battery systems, a total of 16 6.3MW PCS/LV Skids are needed; | 4 | 23,200 |

## 6.3 PCS Function

As a flexible interface between energy storage devices and power grid, NR PCS-9567TU-1575 uses high-reliability intelligent power module and the integration design of charging and discharging, for realizing the bi-directional flow of energy between AC system and DC system.

- Accurate and flexible charging & discharging control modes

PCS-9567 provides CAN, Ethernet and RS485 interface for real-time communication with battery management system (BMS). It can accurately monitor current battery operation information, not only control the charging and discharging status of converter, but also switch to constant current, constant voltage or constant power and other charging & discharging modes conveniently, so as to achieve the optimal strategy for the battery charge and discharge control. It supports various types of energy storage batteries.

Free switchover between grid-connected operation mode.

PCS-9567 can realize bi-directional exchange of energy with the grid in grid-connected mode.

Soft grid-connected control and power quality control

The control system can accurately control the output voltage of the converter in real time according to the monitored on-line grid voltage information. It can eliminate the static and dynamic errors and realize the impact-free grid-connection. The optimized filter and harmonic suppression algorithm can realize the optimal control of grid-connected power and ensure the power quality.

- Respond to EMS instructions for load leveling

Under the dispatching of EMS (Energy Management System), it can store electric energy during load valley and release electric energy during load peak, reducing peak-valley difference of power grid and improving load characteristics of power grid.

- Grid frequency and reactive power regulation

In grid-connected operation, the converter can realize primary and secondary frequency regulation in coordination with AGC (Automatic Generation Control) or power management system, it can realize steady-state reactive power control in coordination with AVC (Automatic Voltage Control), and it can realize transient voltage control in coordination with power management system.

- Complete self-supervision and protection functions

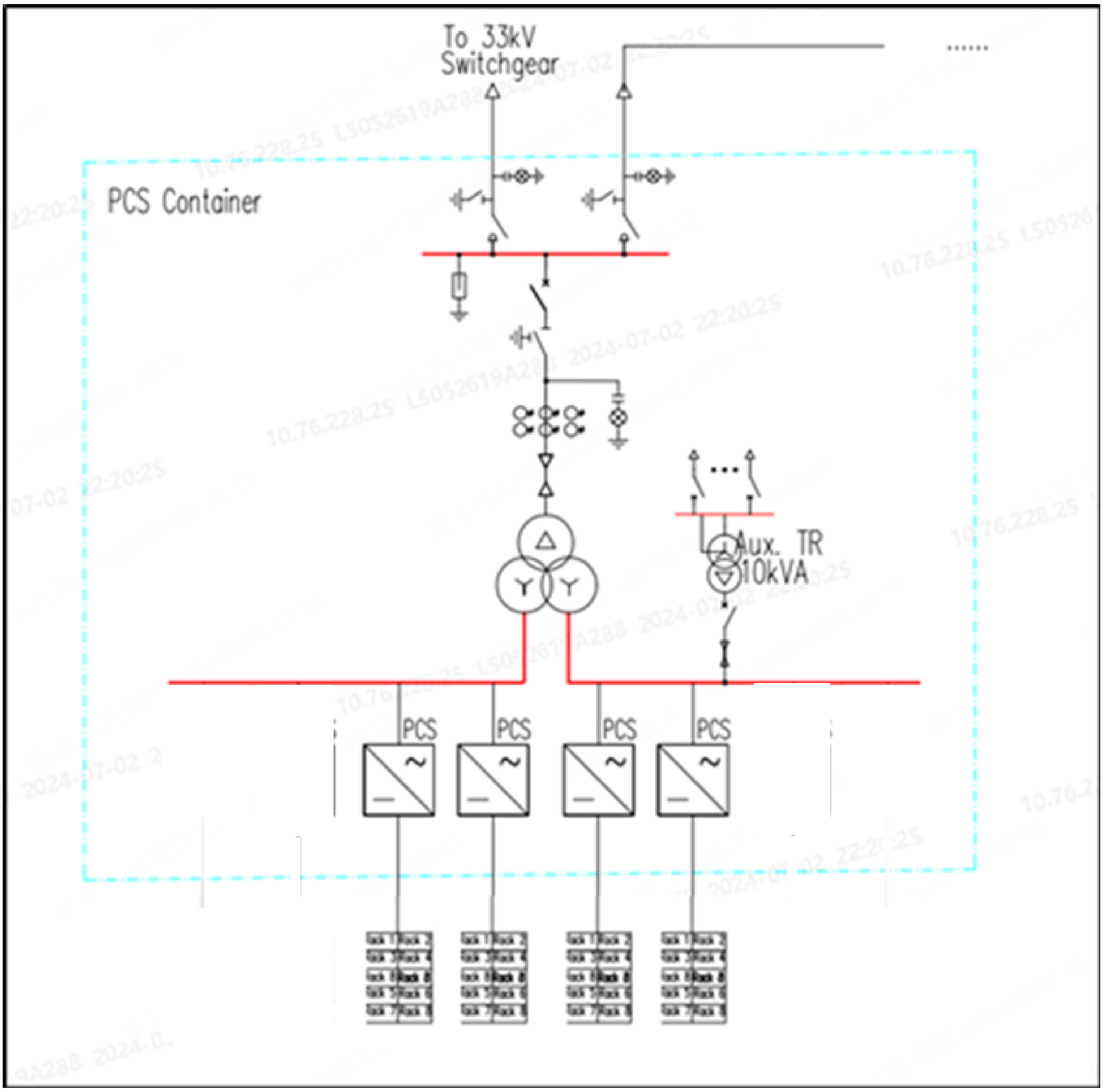
The scope of self-supervision covers the control systems, IO units, converter power modules, buses and other related equipment. The system fault can be detected within 1ms and the corresponding blocking pulse or trip signal will be issued if detecting the fault. The complete protections ensure the normal operation of the converter.

- Powerful communication function

The device is equipped with multiple optical interfaces and RJ45 interfaces, and supports high-speed communication protocols such as GOOSE and IEC 60044-8, its communication delay less than 2ms, and it can meet the fast control response requirement of some applications, such as frequency regulation, voltage regulation, smooth fluctuation, and micro-grid control.

- Transient fault recording function

The system can continuously record the signals before and after the fault. The recorded data files are stored in the shared directory of the operator workstation and can be used for fault analysis.


To 33kV
Switchgear
PCS Container
Aux. TR
10kVA
PCS
PCS
PCS
PCS

# Appendix

## 1. Projects References

BYD has a large experience in Battery Energy Storage Systems using LFP Lithium-Ion technology, more than 10 GWH in operation in North America, over 24.6 GWh in the whole world. Some of the main references of projects executed by BYD are:

Table A-1 Successful Cases

| Projects | Power | Capacity | Country | Time |
|---|---|---|---|---|
| Chevron 2MW/4MWh Containerized ESS | 2MW | 4MWh | USA | 2011 |
| Chevron 250kW/500kWh Containerized ESS | 250kW | 500kWh | Qatar | 2012 |
| Duke 200kW/500kWh Containerized ESS | 200kW | 500kWh | USA | 2012 |
| Ontario, Canada 4MW/2MWh Containerized ESS | 4MW | 2MWh | Canada | 2014 |
| Sicily, Italy 1MW/1MWh Containerized ESS Project | 1MW | 1MWh | Italy | 2014 |
| Ohio, USA RES 4MW/2MWh Containerized ESS | 4MW | 2MWh | USA | 2015 |
| South Africa 200kW/1.2MWh Containerized ESS | 200kW | 1.2MWh | Africa | 2015 |
| Illinois, USA Invenergy 31.5MW-12MWh ESS | 31.5MW | 12MWh | USA | 2015 |
| Joliet, USA 19.8MW/7.865MWh ESS | 19.8MW | 7.865MWh | USA | 2015 |
| WV, USA Invenergy 31.5MW-12MWh ESS | 31.5MW | 12MWh | USA | 2015 |
| West Chicago, USA 19.8MW/7.865MWh ESS | 19.8MW | 7.865MWh | USA | 2015 |
| Sardinia, Italy 1MW/1MWh Containerized ESS Project | 1MW | 1MWh | Italy | 2015 |
| NY, USA 400kW/1.187MWh Containerized ESS | 400kW | 1.187MWh | USA | 2015 |
| UK 250kW/250kWh Containerized ESS Project | 250kW | 250kWh | UK | 2015 |
| Australia CSIRO 132kW/150kWh ESS | 132kW | 150kWh | Australia | 2015 |
| Glacier, USA 2MW/4.4MWh ESS Project | 2MW | 4.4MWh | USA | 2016 |
| UK 24MW/24MWh Containerized ESS Project | 24MW | 24MWh | UK | 2016 |
| Chicago, USA 19.8MW/7.865MWh ESS | 19.8MW | 7.865MWh | USA | 2016 |
| UCSD Campus, 2.5MW/5MWh Micro-grid ESS | 2.5MW | 5MWh | USA | 2016 |
| NY, USA 2MW/12MWh Containerized ESS | 2MW | 12MWh | USA | 2016 |
| UK 310kW/668kWh Containerized ESS Project | 310kW | 668kWh | UK | 2016 |
| UK 4MW/5.5MWh Containerized ESS Project | 4MW | 5.5MWh | UK | 2016 |
| UK 10MW/12MWh Containerized ESS Project | 10MW | 12MWh | UK | 2017 |
| LA, USA 1MW/2.6MWh Containerized ESS | 1MW | 2.6MWh | USA | 2017 |
| UK 9.6MW/9.6MWh Containerized ESS Project | 9.6MW | 9.6MWh | UK | 2017 |
| UK 3.75MW/3.75MWh Containerized ESS | 3.75MW | 3.75MWh | UK | 2018 |
| UK 29MW/29MWh Containerized ESS | 29MW | 29MWh | UK | 2018 |
| UK 20MW/20MWh Containerized ESS | 20MW | 20MWh | UK | 2018 |
| UK 7MW/7MWh Containerized ESS | 7MW | 7MWh | UK | 2018 |
| UK 20MW/20MWh Containerized ESS | 20MW | 20MWh | UK | 2018 |
| UK 19.5MW/19.5MWh Containerized ESS | 19.5MW | 19.5MWh | UK | 2018 |
| Poland 1.26MW/2.52MWh Containerized ESS | 1.26MW | 2.52MWh | Poland | 2018 |
| MA, USA 3MW/6MWh Containerized ESS | 3MW | 6MWh | USA | 2018 |
| Belgium, 1.26MW/1.34MWh Containerized ESS | 1.26MW | 1.34MWh | Belgium | 2018 |
| Japan 0.63MW/1.366MWh Containerized ESS | 0.63MW | 1.366MWh | Japan | 2018 |
| UK 53MW/57MWh Containerized ESS | 53MW | 57MWh | UK | 2018 |

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|---|---|---|---|---|
| US 1.5MW/3MWh Containerized ESS | 1.5MW | 3MWh | US | 2019 |
| UK 44MW/44MWh Containerized ESS | 44MW | 44MWh | UK | 2020 |
| AU 1MW/2MWh Containerized ESS | 1MW | 2MWh | AU | 2020 |
| JP 600kW/1.2MWh CHESS | 0.6MW | 1.2MWh | Japan | 2020 |
| US 28MW/56MWh ESS | 28MW | 56MWh | US | 2020 |
| US 75MW/300MWh ESS | 75MW | 300MWh | US | 2021 |
| US 140MW/560MWh ESS | 140MW | 560MWh | US | 2022 |
| US 200MW/1700MWh ESS | 200MW | 1700MWh | US | 2022 |
| Chile 225MW/1100MWh ESS | 225MW | 1100MWh | Chile | 2023 |
| US 1000M/4204MWh ESS | 1000MW | 4204MWh | US | 2023 |