0.6MW/1.548MWh Energy Storage System

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CL258pro Energy Storage System Solution

This technical document describes the solution of Shandong Jieyuan's energy storage system (ESS). The solutions include the design, manufacturing, delivery and after-sales of the battery energy storage system equipment. Shandong Jieyuan will only supply the equipment listed in this program, as well as the associated services (such as training, consultation, installation guide, etc). The customer or the customer's contractor shall be responsible for all other works and equipment, such as site infrastructure and preparation, installation, etc.

1. Design Background

The requirement of this ESS station is 0.6MW/1.548Wh, and the voltage is to be boosted to 20KV. It also requires the storage battery cabin (liquid cooling), medium voltage inverter, EMS, air conditioning, fire protection and other auxiliary systems.

Upon the requirement, Jieyuan will provide CL258pro-125 ESS solution. The 0.6MW/1.548MWh energy storage system is composed of the following energy storage units: The system is composed of 6 CL258pro-125 energy storage battery cabinets and 6 125kW PCS medium voltage inverter integrated machine, for a total of 0.75MW/1.548MWh ESS unit; The total power configuration of 0.75MW is overcapacity, we will derate it to 0.6MW for the normal operation.

CL258pro-125 can meet the application needs of various industrial and commercial and energy storage power stations, and can match/integrate with new energy systems such as photovoltaic and wind power

For energy transfer, frequency modulation services, peak shaving and valley filling, peak regulation applications, and other larger scaled power stations can realize power expansion by configuring more units. The modular design is easy for scalability.

2. Meeting Standards

The system design refers to the following standards. All subsequent modifications (excluding errata) or revisions of dated references shall not apply to this Specification, nor shall the most recent undated version of the standard apply to this Specification.

- Battery standard: GB/T 36276-2018
- BMS standard: GB/T 34131-2017
- PCS standard: GB/T 34120-2017; GB/T 36547-2018

Others:

- ISO 9001:2015
- ISO 14001:2015
- ISO 45001:2018

3. Definition

- Life start & end of life

Life start: BOL

End of life: EOL

- CL258pro-125 (ESS Unit/System)

The ESS system includes several CL258pro-125 units (battery packs), a battery monitoring circuit, a battery balancing circuit, communication interfaces, thermal management equipment, and fire protection equipment. Also, it has electrical connection components, power distribution master control unit, bus junction unit, power cable, communication cable and other related supporting facilities in the system.

- Medium voltage inverter system

The medium voltage inverter system includes PCS, medium voltage transformer, high voltage cable cabinet, communication power cabinet, equipment tray, power cable, communication cable and other related supporting facilities.

- PCS (Power Control System, Converter)

Power Control System (PCS) : An AC-DC two-way power conversion system, often called an inverter, couples a battery system (DC power) to the grid (AC power). PCS can consist of one or more units, depending on the size of the system.

- Monomer

The monomer is a single aluminum-sealed cell with LiFePO4 lithium iron phosphate. The cells can be connected in series or parallel to form a package in the battery cabinet.

- Total CELL energy (installed energy)

Total Cell energy = rated voltage x number of cells x capacity of cells.

- Rated energy

The rated energy is the buyer's target value and also the target value of the system SAT (Site Acceptance Test). Typically, the energy storage system is loaded after FAT (Factory Acceptance Test) and needs to be transported to the project site. Then the system will be installed, debugged, accepted, which generally includes handover test and performance acceptance test (the purpose of the performance acceptance test is to check whether all the performance of the contract equipment meets the requirements of the technical specifications) and grid-connected acceptance test/grid-involved test. The SAT acceptance test defined by our company is handover test/performance acceptance test, and the measured energy can be used. The required energy storage system does not take more than 1 calendar month from FAT to SAT.

- Rated operating condition

The CL258pro-125 is applied to the environment where the ambient temperature in the box is 10~40℃, the humidity is 5%~100%, and the

altitude is < 2000m. The SOC for normal operation is 50%, the SOC for storage is 30%~60%, and the rated operating condition is 1 100% DOD cycle per day.

- STC

Standard Test Conditions (STC) for each energy storage unit under the conditions of ambient humidity 5%~100% and altitude < 2000m are defined as:

(i) The internal temperature of the battery storage container should be 10~25℃;

(ii) The initial temperature of the battery should be 23~27℃;

(iii) precharge and predischarge prior to capacity and cycle efficiency tests;

(iv) Measurement on the DC1500V side, no measurement of secondary power consumption;

(v) Discharge the battery at 0.5C until any cell reaches the discharge cutoff voltage, and then stop discharging;

(vi) The battery is charged at rated power until any battery unit reaches the charging cutoff voltage, and then stop charging, record the accumulated energy data of the measuring device (Q1), and stand by for 60 minutes;

(vii) The battery discharges at rated power until any cell reaches the discharge cutoff voltage, then stops discharging and records the accumulated energy data of the measuring device (Q2);

(viii) Calculation of recorded measurement data;

(ix) Cycle efficiency (η), calculated as: η= Q2 / Q1× 100%.

- SOC

SOC (State Of Charge) is the ratio of a battery's current capacity to its current maximum available capacity, often expressed as a percentage.

- Cycle efficiency (%)

The cycle energy efficiency should be measured at the DC side, and the test procedure is consistent with the definition in the STC.

4. Energy Storage System Integration Scheme

4.1 Energy Storage System Design

The scheme is designed according to the following operating conditions: the average SOC during operation is required to be 50%, the battery temperature is maintained at 10~ 25℃, and the altitude is less than 2000 meters; When the battery is not in use, it is recommended to store 30% to 60% SOC. This technical solution adopts 1000V battery system, and the required quantity of CL258pro-125 will be configured according to the actual demand of the project. The configuration of a single set of CL258pro-125 is as follows:

Table 4.1-1 Energy configuration table of the CL258pro-125

item	0.6MW/1.548MWh scheme	remark
Battery type	LFP	
Cooling mode	Liquid cooling	
CL258pro-125 string configuration	1P288S	
CL258pro-125 Configuration Energy (MWh)	0.258	
Number of CL258pro-125 units	6	
Single CL258pro-125 Energy (MWh)	0.258	
Single CL258pro-125 DC Available Energy (MWh)	0.258	FAT to SAT within 1 month, without auxiliary power consumption
Total Cell Allocation Energy (MWh)	1.548	

4.2 Features of Energy Storage System

CL258pro-125 is a new generation of LFP battery energy storage system solutions, with high energy density, safety, maintainability, flexibility, service life and efficiency that all have been greatly improved, while auxiliary energy consumption, cost, footprint and so on have been reduced. The product with its ultimate cell strength, long life to provide customers with peace of mind energy storage solutions.

4.3 System Parameters of a Single battery Energy storage Unit

The main system parameters of a single CL258pro-125 are as follows:

Table 4.3-1 Technical specifications of a container

Serial number	Project description	0.6MW/1.548MWh scheme	remark
Performance parameter			
1	Charging power	0.6MW	@AC20kV allows maximum daily operating conditions
2	Discharge power	0.6MW	@AC20kV allows maximum daily operating conditions
3	CEll capacity	1.548 MWh	
4	Accuracy error of SOC and SOE	8% or less	

	estimation		
5	SOH estimation accuracy error	8% or less	
6	Electrical energy calculation error	3% or less	
7	Temperature detection accuracy	± 1	
8	Timing function	NTP network time	
Working environment			
9	Allowable ambient temperature	- 30 ℃ ~ + 55 ℃	The derating occurs when the ambient temperature is lower than -15 ° C or higher than 45 ° C
10	Optimum operating environment temperature for batteries	+ 10 ℃ ~ + 40 ℃	
11	Allowable relative humidity	5% ~ 100%	non-condensing
12	Allowable altitude	≤2000m	The value above 2000m is optional
13	Class of corrosion and rust removal for cabin body	Sa3	
14	Cabin application environment category	C4	
Other parameters			
15	noise	< 75dBA	Sound pressure level measured at 1 meter

16	Dc system cycle efficiency @BOL	93% or higher	@ Test condition, once a year, according to the STC in the technical scheme, does not include self-use electrical auxiliary loss
17	Class of protection	IP55	
18	Cooling mode	Liquid cooling	
19	Fire protection system	Gas fire/water fire	
20	External communication mode	Ethernet	IEC61850 protocol
21	Single set MC Cube ESS inches (Width × depth × height)	(1130*1203*2104mm) *5	Final size is subject to actual delivery
22	The weight of a single MC Cube ESS	≤3906kg*5	

Serial number	Project description		1MW/2.33MWh scheme	remark
	The amount			
23	Default color		RAL7035	
24	Each element is connected to the external interface	Dc power interface	Route 1	DC port on the battery unit. Each port contains positive and negative terminals
		Auxiliary power interface	Route 1	Each MC Cube ESS auxiliary power supply is three-phase AC380V/50Hz,

				peak power rate ≥46kVA@45℃, PF=0.8
		External communication port of the energy storage unit	Route 1	2 lines per CL258pro-125
		Ground connection	Route 1	2 lines per CL258pro-125

4.4 Recommended Electrical Topology of the Energy Storage System

The topology of the energy storage unit system is shown in the following figure:

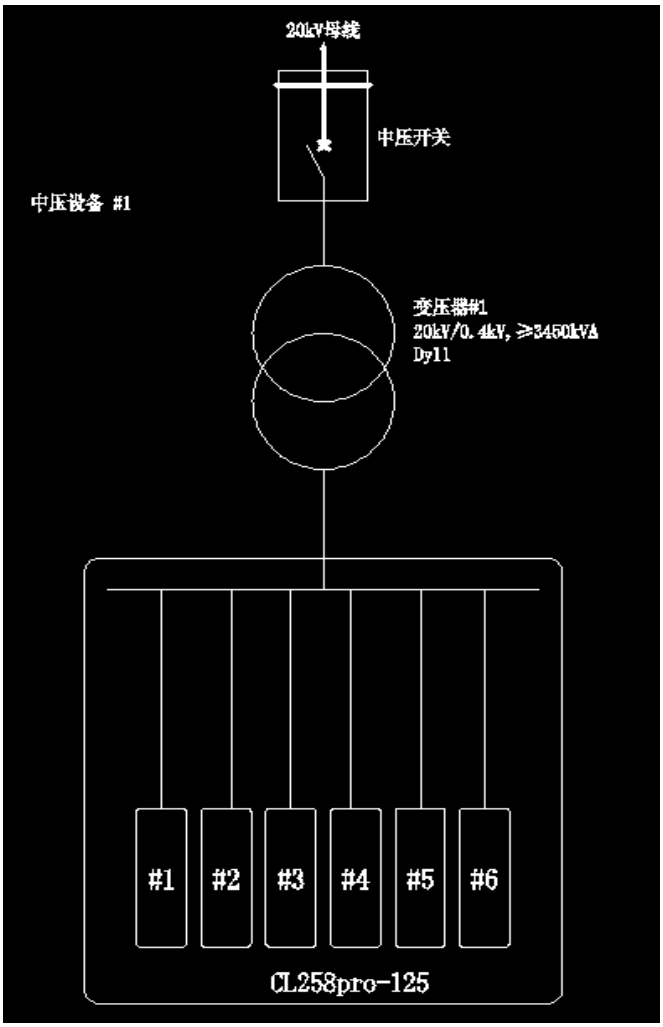

Figure 4.4-1 Topology of 0.6MW/1.548MWh energy storage unit system (schematic)

4.5 Recommended Communication Topology of the Energy storage System

The battery energy storage container can monitor the ambient temperature and humidity of CL258pro products and the door status, and the relevant information is uploaded to the customer monitoring system /PCS system. The communication topology of the entire energy storage system is shown in the following figure:

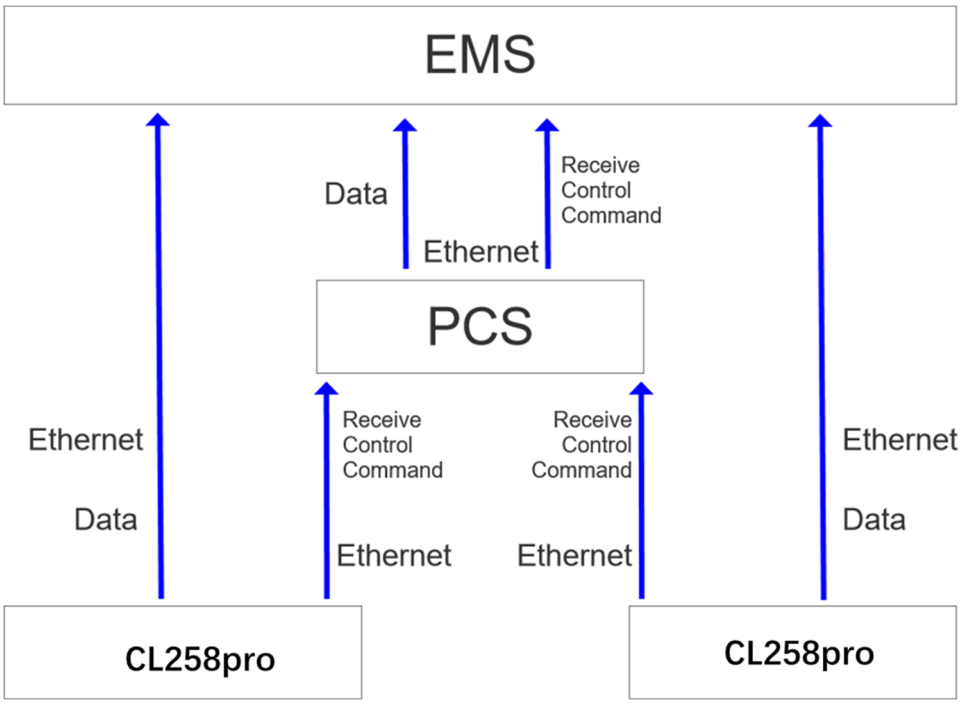

Figure 4.5-1 Communication topology of the energy storage unit monitoring system (for reference)

4.6 Recommended Device Layout Diagram of the energy storage system

The overall layout of the energy storage unit system equipment covers an area of about 150 square meters (the actual area is subject to the size of the Design Institute)

5. Configuration of the Battery System

5.1 CL258pro-125 Configuration

Each CL258pro-125 consists of 1*288 single batteries and 1 BMS control box. Battery strings are installed in the BMS control box

Management of the power distribution system, the CL258pro specs are as follows:

Table 5.1-1 Technical specifications of the CL258pro-125

Serial	item	argument	remark

number			
1	Number of cells	1*48*6=288	
2	Rated operating voltage (V)	921.6	
3	Operating voltage range (V)	720~1051.2	
4	CELL Capacity (MWh)	0.258	
5	Dimensions (W * D * H) (mm)	(1588±10)×(1380±10)× (2450±10)mm	
6	Weight (kg)	3100	
7	Operating temperature range (℃)	- 30 ~ + 55	When the ambient temperature is lower than -15 ° C or When the temperature is higher than 45 ° C, the derating is derated
8	Relative humidity	5%~100%RH	non-condensing
9	Altitude	< 2000m	When the altitude is in the range of 2000-3000m, the system output will be derated (to protect)
10	Cooling mode	Liquid cooling	

5.2 Battery Management System (BMS)

This solution adopts the battery management system (BMS) independently developed for the lithium iron phosphate battery matching management, adopts the harness free design, and has high reliability. Meanwhile, the battery management system meets the standard requirements of GB/T 34131.

It mainly includes the following four levels of management units, which are:

- Battery management unit BIC;
- Battery string management module, BECU;
- CL258pro Unit Management module, EMCU (for 2 or more batteries in parallel)
- Energy storage unit management module (for more than 2 sets of CL258pro units in parallel)

The battery management system can realize the functions of battery status monitoring, operation control, balance management, protection alarm and communication, etc. Through real-time detection of the battery status, the stable and safe operation of the system is guaranteed. Its communication structure is shown as follows:

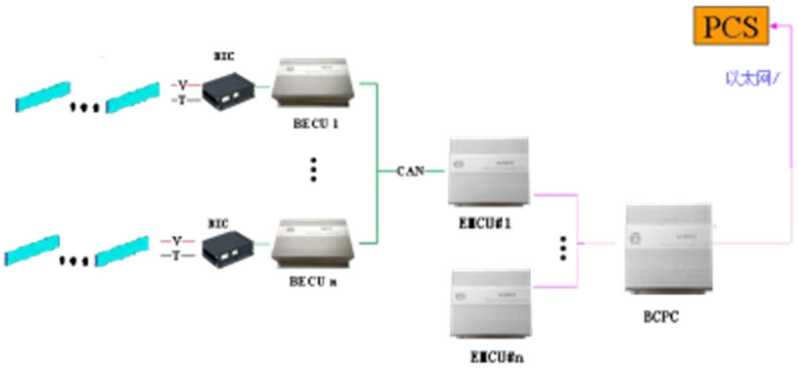

Figure 5.2-1 Topology diagram of multiple CL258pro battery management systems (actual objects prevail)

5.3 Battery Auxiliary System

The CL258pro is equipped with a power distribution main control unit, which is used to power the internal devices of the System. The power supply mode is: from the external market power supply or PCS (if any); The power supply system is three-phase four-wire AC380V/50Hz, peak power ≥ 46kVA@45℃, PF=0.8.

The CL258pro is equipped with a convergence unit for the convergence of multiple CL258pro inside the System. The entire CL258pro uses busbar

output after the convergence unit, reducing the use of external cables and reducing construction costs.

Each set of CL258pro is equipped with a temperature control system for the temperature control of the battery system inside System. The vehicle gauge liquid cooling method is adopted to ensure that the battery in each set of CL258pro operates at the best working temperature and escorts the life of the battery during its life cycle.

CL258pro uses an automatic fire extinguishing system with perfluorhexanone as the main material. Once a fire is detected, it can disconnect the electrical connection with the external equipment in time, start the fire extinguishing device, and upload the alarm information to the background monitoring system.

6. PCS Medium Voltage Inverter (all-in-one machine)

6.1 Configuration

- PCS: 1 unit
- Booster transformer, 1 set
- Communication power cabinet, 1

6.2 Electrical Topology and Primary Diagram

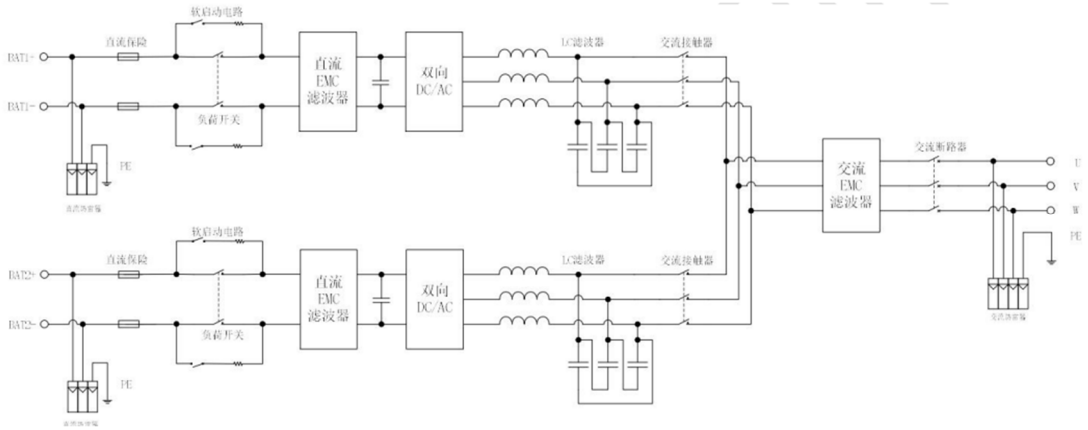

Figure 6.2-1 Unit topology

6.3 Product Features

(1) Three-level topology, maximum 99% conversion efficiency, better power quality;

(2) Support two groups of battery access, can be independent charge and discharge management, more friendly to the battery;

(3) Intelligent multi-stage fan speed regulation, wide temperature operation capability, 50℃ without derating;

(4) Highly integrated, small footprint, transportation, lifting, installation, operation and maintenance more convenient and efficient;

(5) With PQ, VF, SVG, VSG and other functions, support high/low voltage crossing;

(6) Islanding detection, black start

(7) UPS switch (optional)

6.4 PCS Specifications

Table 6.4-1 Specifications of PCS medium voltage inverters

Name	**0.6MW PCS medium voltage inverter**
DC side parameter	
Maximum input voltage	1000V
Maximum direct current	208A
Battery voltage range	1000~ 1500V
Number of battery strings that can be connected	1/2
Grid side parameter	
Rated AC power	125kW

Maximum AC power	150kW
Rated network frequency	50/60Hz
THD(Rated power)	< 1.5%
Power factor	>0.99 (> 20% load)
Power factor adjustable range	1 (lead) ~1 (lag)
System characteristic	
Isolation mode	Dry transformer
Maximum efficiency	98%
Class of protection	IP65 (Converter) /IP54 (other)
Operating ambient temperature	- 30 ~ + 60 ℃
Permissible humidity range	0 to 100% no condensation
Altitude without derating	3000m
Cooling mode	Forced air cooling
Communication interface	RS485/CAN/Ethernet
Overall dimensions (W * H * D)	(1588±10)×(1380±10)× (2450±10)x6 (reference size)
Weight	3100x6kg

7. EMS Energy Management System

7.1 EMS Functions

In this project, an in-station EMS energy management system is configured to interconnect with each hardware device in the station, collect and

display the operation data of the equipment, and provide staff in the station with management, operation and maintenance of the power station. At the same time, part of the data is uploaded to the superior scheduling monitoring platform, so that the superior system can formulate scheduling policies, receive scheduling from the superior system, and deliver commands and process control to all devices in the station according to scheduling orders. It can improve the quality of power generation and move power within time dimension.

7.2 Hierarchy of the EMS system

EMS system includes energy storage station control layer and energy storage basic unit layer, as shown in the following figure:

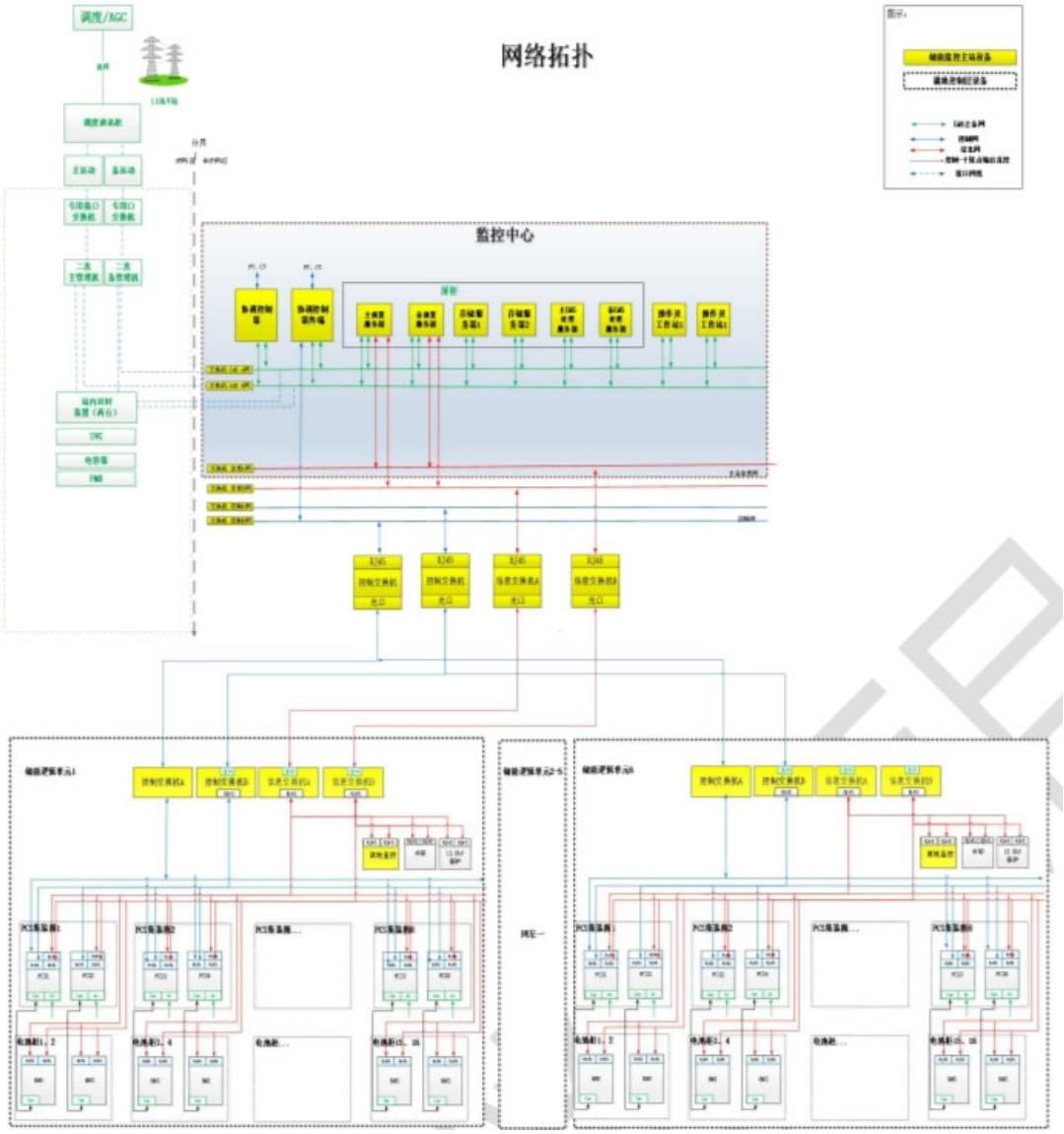

Figure 7.2-1 Architecture diagram of the energy storage control area (for reference only)

7.3 EMS System Access and Communication Solutions

On the one hand, the energy storage EMS energy management system obtains the information in the power station through the station control layer network of the access power station; on the other hand, it obtains the relevant information such as PCS, BMS, and battery operating status in each unit of the energy storage through the communication equipment, and then issues instructions according to the scheduling, and carries out charge and discharge and power control for the system through the relevant strategies. The platform provides a rich library of communication

regulations, supporting all international and domestic standard protocols such as IEC61850, IEC60870-5-101, IEC60870-5-104, MODBUS-TCP, MODBUS-RTU, DL/T 645, DNP3.0, and also supports custom protocols. For authorized users, the convention library can also be extended through the API functions provided by the system.

8. Project Scope

8.1 Device List of the Energy Storage System

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Table 8 1 1 MC Cube ESS equipment list

equipment	specification	quantity	unit	remark
CL258pro-125 Energy storage unit	(1588±10)×(1380±10)×(2450±10)mm	6	Set	Each ESS consists of 6 CL258pro (including battery, battery management, air conditioning), power distribution master control unit, bus unit, fire protection system, etc.

equipment	specification	quantity	unit	remark
PCS medium voltage inverter one body machine	0.6MW @AC20kV	1	Set	
EMS	custom	1	Set	
Connect cables	Internal connection cable	1		The cable between the battery box and the PCS medium voltage inverter appliance, the cable between the PCS medium voltage inverter appliance and the customer's network connection point, and the ground cable of the energy storage system are not included.

Table 8.1-2 Warranty of the energy storage system

Serial number	name	Warranty period	remark
1	CL258pro-125 ESS	Five years	Optional extended warranty, according to the warranty purchase period determined
2	PCS medium voltage inverter	Five years	

8.2 Seller's Scope of Work

The specific scope of work of the seller is shown in the table below.

Table 8.2-1 Seller's scope of work

Serial number	type	Description	unit	remark
1	CL258pro-125 ESS Energy storage unit	- LFP battery - Power distribution main control unit - Bus unit - Cables connecting devices inside the box - Factory FAT	6	
2	PCS medium voltage inverter one body machine	- 0.6MW@AC20kV	A set	
3	EMS	- Custom	A set	
4	Project site service	- On-site installation guide - On-site commissioning guidance - Live SAT guidance	1 item	

		- On-site training		
5	Quality assurance service	- Equipment warranty	1 item	
6	transport	- See the agreement in the commercial quotation	1 item	

8.3 Buyer's Scope of Work

The main work contents of the buyer's project site are shown in the following table (including but not limited to the following work), and the seller is present in the project

The field provides technical guidance only.

Table 8.3-1 Buyer's field work scope

Serial number	type	Description	unit	remark
1	Design and engineering	- Project approval - Civil drawing package - Field mechanical drawing package - Field electrical drawing package - Construction specifications, etc.	1 item	
2	Manufacturing and supply	- High and low voltage switchboard - AC power cables and DC power cables and AC, DC conduits or cable ducts - Communication cables and cable ducts - Grounding system design and manufacture	1 item	
3	Site construction	- Concrete foundation/cushion/pier, etc	1 item	

		- Conduit wire		
4	Field installation	- Unpacking or unloading of energy storage equipment (lifting, etc.) - The device is physically installed and secured - Installation of overweight battery cabinet (if applicable) - Electrical, building, environmental, etc - Power line connection of CL258pro-125 the bus unit - Connect DC and AC power cables - Auxiliary power cable connection - Communication cable connection - Connect the ground cable of the energy storage device - Installation of station general lighting and emergency lighting - Ground grid, lightning protection, grid-connected switchgear, MV cabinet	1 item	
5	Debug	- All power supplies for commissioning - System debugging, etc	1 item	
6	SAT (Performance Acceptance/Handover Test)	- Complete the SAT according to the agreed acceptance plan.	1 item	
7	Operation and daily maintenance		1 item	