Storion ESS 2750

Battery Energy Storage System
Standard Production Specification

The current product appearance is for reference only and may be subject to change as the product undergoes further iterations and improvements.

Scope of Specifications

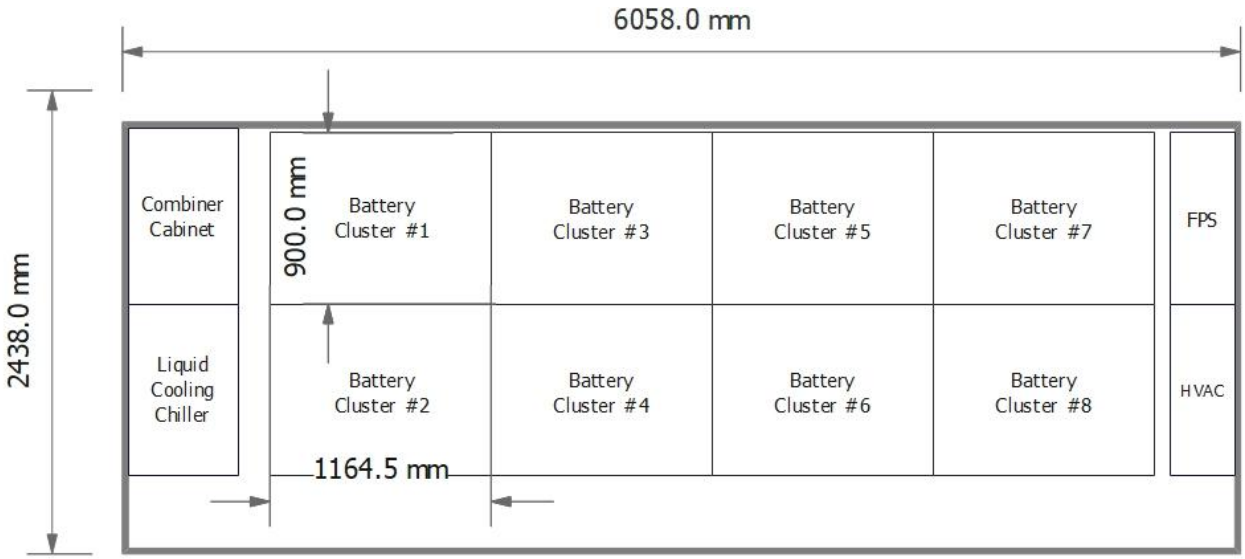
This specification provides a comprehensive description of the performance indicators, parameter thresholds, operating conditions, and risk warnings for **280Ah rechargeable lithium iron phosphate (LFP) aluminum shell battery cells**, battery modules, battery clusters, battery system liquid cooling units, Battery Management Systems (BMS). These products are specifically designed for use in large-scale containerized energy storage systems.

The **280Ah LFP battery cell** selected for the **Storion** energy storage system has been extensively verified in the market, demonstrating **excellent performance**, **high stability**, and **reliable quality**. It offers a **cycle life of up to 8,000 cycles**, making it ideal for long-term energy storage applications where durability and operational efficiency are critical.

Containerized Energy Storage System Design

Based on the standard battery module, Ganfeng has designed a **standard 20-foot container energy storage system** with the following specifications:

- **Dimensions**: 6058 mm (L) × 2438 mm (W) × 2896 mm (H)
- **Energy Capacity**: 2.75 MWh



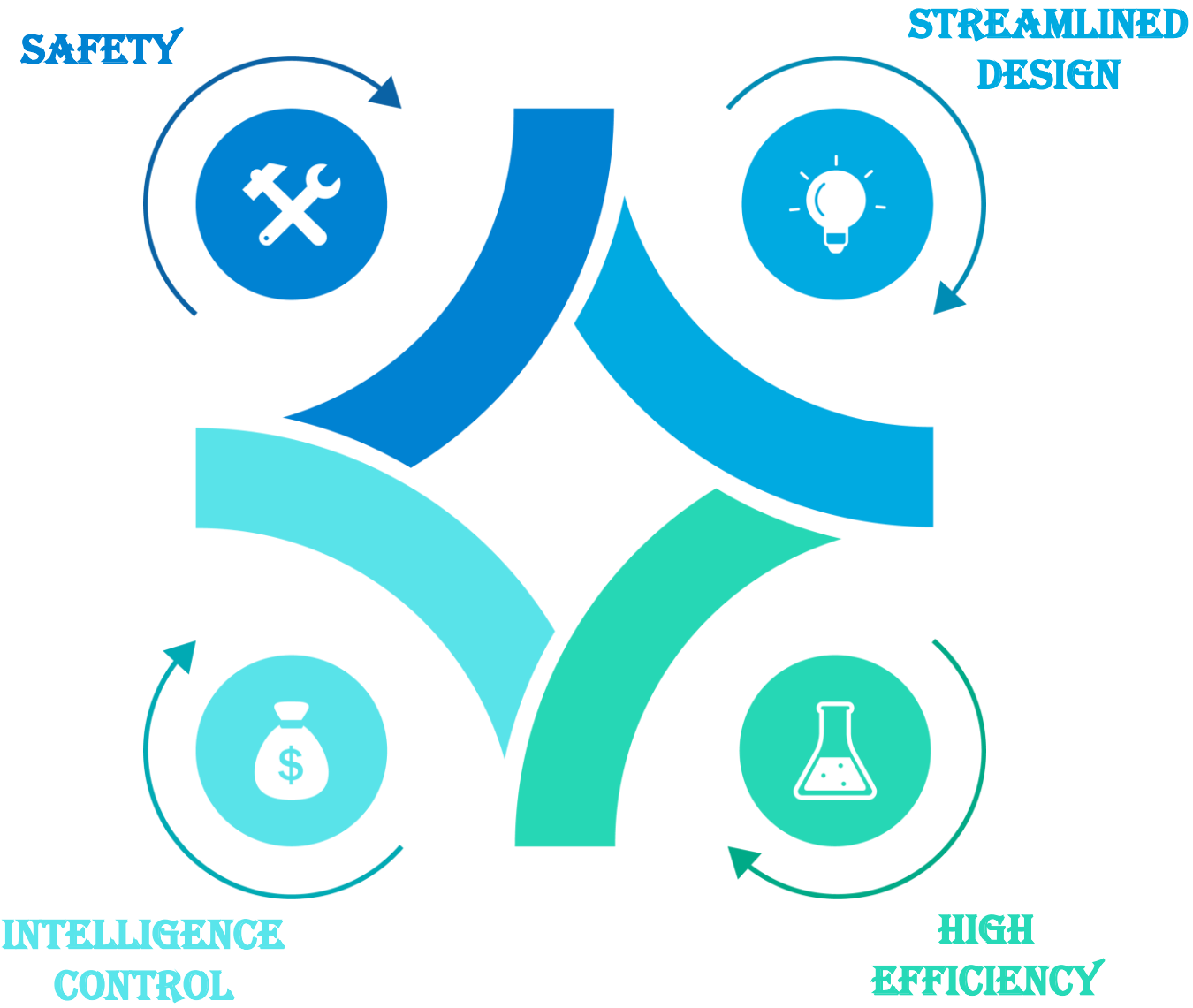
A 20-foot container: it includes 8 sets of 1P384S battery clusters, 1 combiner cabinet, 1 water-cooling unit, 1 fire protection system, 1 environmental control air conditioner, 1 temperature and humidity monitoring system, 1 lighting system, and 1 ventilation system.

Product Specification

Parameter	Specification
Total Energy Capacity	2.75 MWh
Cell Type	LFP 280Ah Aluminum Shell
Cell Capacity	>=280 Ah
Total Number of Cells	3,072
Module Configuration	1P384S * 8 clusters
Nominal System Voltage	1228.8 V
Voltage Range	1075.2 V -1344.0 V
Rated Charge/Discharge Power	0.5C (approx. 1,375 kW)
Cooling Method	Liquid Cooling
Container Dimensions	6058 * 2438 * 2896 mm (20-ft container)
System Weight	Approx. 25 tons
Protection Grade (PACK)	IP67
Protection Grade (Container)	IP55
Operating Temperature Range (Discharge)	-20°C to +55°C
Max Continuous Current per Cluster	154 A
Communication Protocol	RS485, CAN, Ethernet
Fire Suppression	Dual-level: PACK & Cabin, Gas-based
Water Cooling System	Air-cooled chiller + glycol loop
Automatic Refill Function	Yes (>=8L)
System Voltage Output (DC side)	1500 VDC (input to PCS)
System Output Voltage (AC side, via PCS)	10 kV or 35 kV (via transformer)
PCS Rated Power	2 * 1375 kW PCS
PCS Efficiency	Up to 99% (SiC-based)
Black Start Support	Yes

Product Features

The Storion Smart 2.75 MWh Containerized Energy Storage System is designed with a focus on **safety**, **streamlined design**, **intelligent control**, and **high efficiency**, tailored to meet the demanding requirements of industrial and commercial energy applications.



1. Safety

Advanced Intelligent Liquid Cooling
Equipped with a precision liquid cooling system that maintains cell-to-cell temperature variance within ±2.5°C, effectively extending battery lifespan by up to 15%.

Verified System Safety
Tested and validated against industry safety standards, including protections against short-circuiting, overcharging, and thermal stress.

Multi-dimensional Electrical Protection
Integrated fault detection and protection leveraging comprehensive electrical fusion sensing, ensuring system-wide safety in real time.

Proactive Thermal Runaway Mitigation
A layered safety design including:

•Early-stage thermal runaway detection

•Targeted PACK-level fire suppression

•Combustible gas sensing

•Smoke containment

•Pressure relief mechanisms
All coordinated via real-time BMS/EMS linkage for rapid, intelligent response.

Sealed & Flush-Mounted Design
Fully enclosed with no exposed critical components, minimizing damage risk and improving system robustness.

High Protection Ratings

•Battery PACK: IP67

•Container system: IP55
Resistant to dust, water, and harsh environmental conditions.

Optional AI-driven Diagnostics
Optional AI modules offer predictive fault analytics, leveraging cell-level models to support preventive maintenance and early alerts.

2. Streamlined design

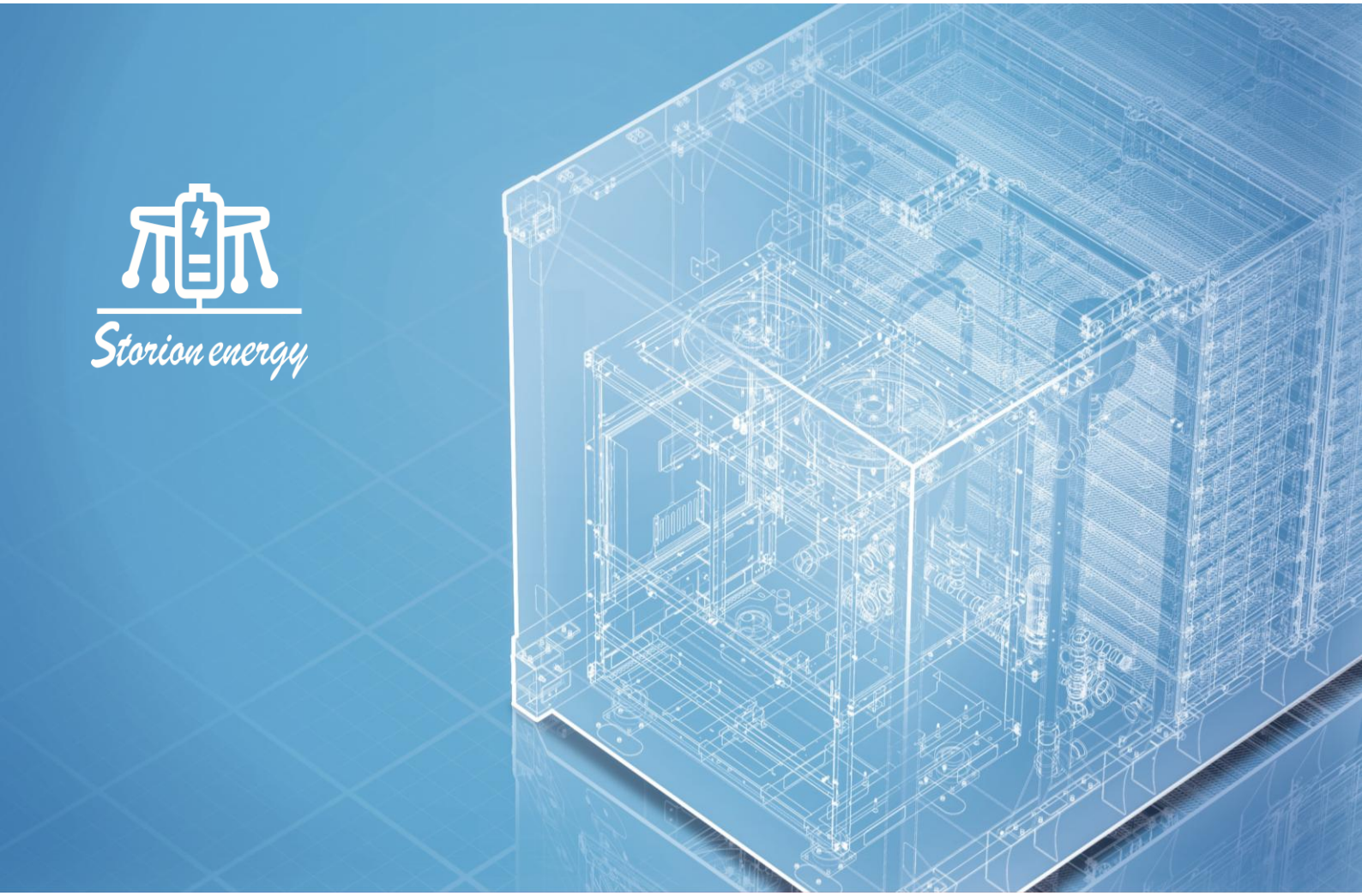
Integrated Modular Architecture
Compact layout with an all-in-one design; each system preassembled within a single 20-ft container occupying minimal ground space.

High Compatibility & Flexibility
Seamlessly integrates into various commercial setups with grid-friendly operations and scalable capacity (125 kW to 1.25 MW).

Fail-Safe Installation
Built-in anti-reversal and short-circuit protection enhances safety and simplifies field operations.

Plug-and-Play Expandability
Aviation-grade connectors support parallel expansion with minimal onsite engineering.

Rapid Deployment
Factory-prefabricated and fully tested before delivery, reducing on-site deployment time and costs by up to 15%.



3. Intelligence

Smart Liquid Management
Real-time liquid leakage monitoring and auto-refill reduce maintenance needs and enhance system uptime.

Cloud-based O&M Platform
Supports local and remote monitoring, powered by AI-driven diagnostics and centralized fleet management—no on-site technician required.

AI-enhanced Lifecycle Optimization
Adaptive balancing strategies and predictive alerts preserve battery consistency throughout its full lifecycle.

Black Start Support
Enables autonomous restart in off-grid or microgrid scenarios, ensuring continuity during power outages.

Flexible Operating Modes
Supports:

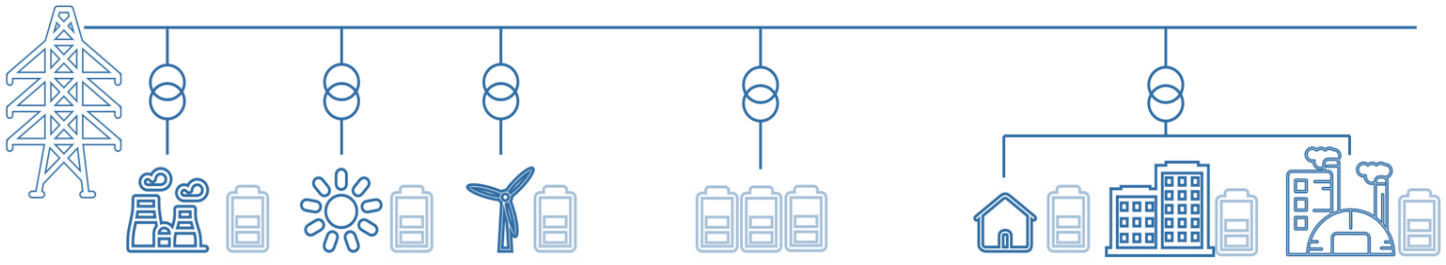
- Virtual Power Plant (VPP) aggregation
- Grid-connected operation
- Off-grid/islanded modes

Maximizing both flexibility and revenue generation potential.

4. High Efficiency

- **Next-generation Power Conversion System (PCS)**

  Built on third-generation semiconductor technology using silicon carbide (SiC) devices, achieving conversion efficiency of up to **99%**, ensuring minimal energy loss and superior system performance.



Warranty Statement

Storion Energy d.o.o. hereby provides the following warranty for the 2.75MWh energy storage system:

1. Warranty Coverage

•The entire system is covered by a **5-year** warranty.

•The warranty includes both **performance** and **materials/workmanship**, ensuring that the product meets the stated capacity and functional safety during the warranty period.

•In the event of a defect caused by manufacturing, materials, or normal use within the warranty scope, Storion Energy will repair or replace the affected components at no cost to the customer.

2. Service Commitment

•Storion Energy d.o.o. has a dedicated engineering support team operating in **Croatia, Slovenia, and Hungary**.

•For any issues reported during the warranty period, **on-site or remote response will be initiated within 24 hours**.

•A responsible and transparent warranty policy ensures smooth communication and rapid issue resolution.

3. Exclusions

•The warranty does not cover damages caused by:

- Improper installation or operation not in accordance with the technical manual.
- Unauthorized repairs or modifications.
- External events such as fire, flooding, or other force majeure.

4. Extended Services

•Extended warranty options and operation & maintenance (O&M) packages are available upon request.

The Storion EMS ensures secure and intelligent energy management with real-time monitoring, scheduling, and remote control capabilities.
All operational data is securely stored on dedicated servers located in Zagreb, ensuring full data sovereignty and compliance with EU data protection regulations.
Our EMS is designed with cybersecurity in mind, providing reliable and encrypted data communication between all system components.

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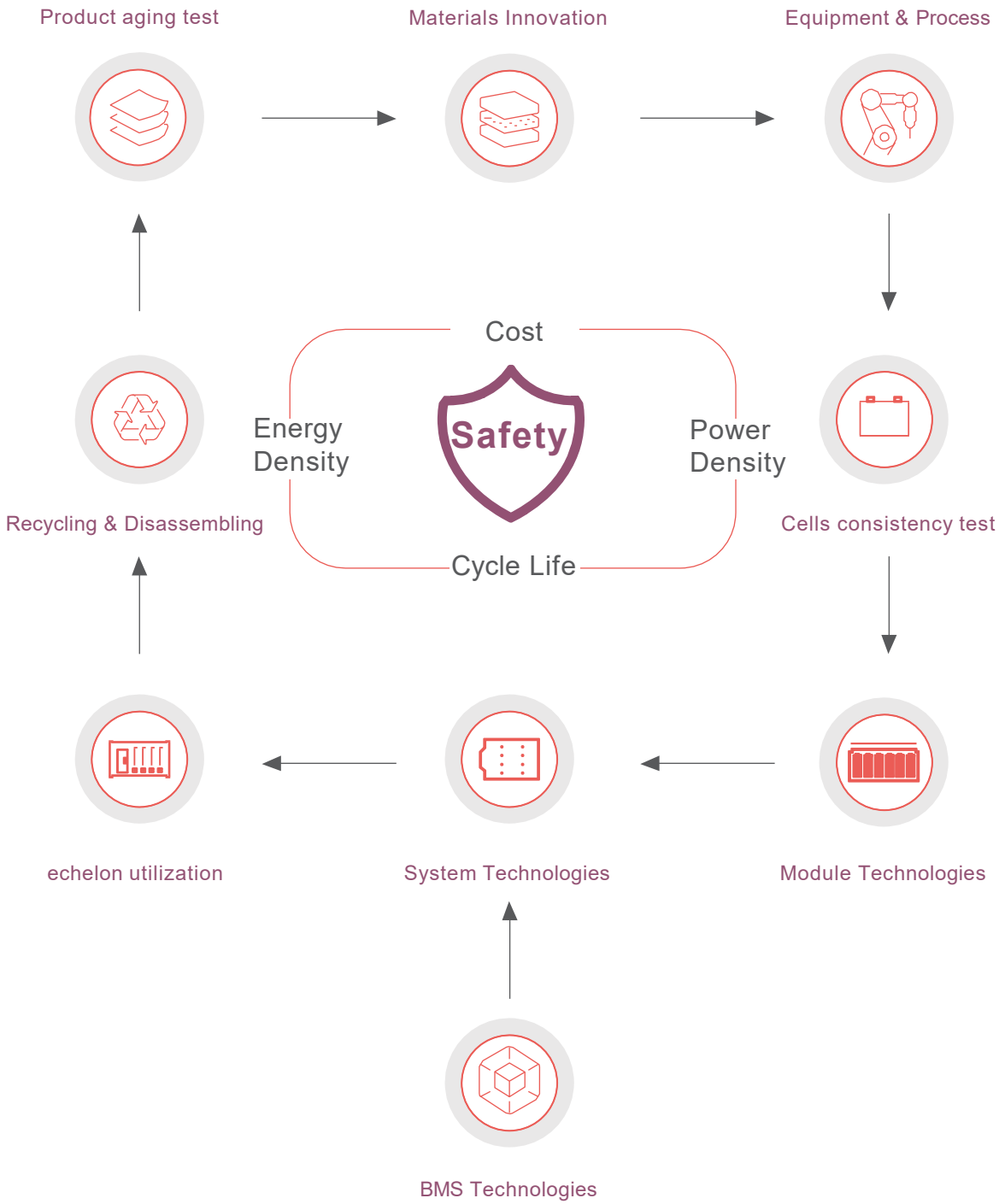
Quality
Policy

Providing clients with the perfect quality beyond expectations is our unremitting pursuit.

IATF16949 ISO9001


Product aging test
Materials Innovation
Equipment & Process
Recycling & Disassembling
Cells consistency test
Cost
Energy Density
Safety
Power Density
Cycle Life
echelon utilization
System Technologies
Module Technologies
BMS Technologies

5 Technology Highlights

Substantial Safety

Aircraft-grade safety and reliability

Storion Energy ensures safety and reliability in real scenarios with well selected and designed raw materials, multi-level protective structures, automated manufacturing processes, comprehensive testing and verification, 24-h monitoring, and big data-based early warning.

Long Service Life

Life up to 12,000 cycles

Storion Energy has upgraded key components such as the cathodes, anodes, electrolytes, and pole pieces of the battery to slow down the battery capacity loss, extend the battery life, and reduce LCOS throughout the battery life cycle.

Smarter Decisions

Based on AI and quantitative trading technology

Storion Energy has developed an Energy Management System that analyzes weather patterns, social events, and power generation data to predict hourly energy prices. This allows their energy storage solutions to deliver up to 30% higher returns compared to industry peers by optimizing energy cost savings.

Intelligent Temperature Control

Automatic temperature adjustment to cope with cold and heat

The intelligent thermal management system effectively avoids the bucket effect caused by the series connection of cells, guarantees the attenuation of life consistent of each cell to the greatest extent, ensures a temperature difference of cells in the container within 5℃, and improves the discharge capacity of the battery system. The integrated liquid-cooled units selected are featured in adaptive adjustment of the operating state, reducing the auxiliary loss by 30%.

Intelligent Management

24/7 protection

The BMS monitors the battery health status and identifies unhealthy batteries in advance. Intelligent internal short-circuit detection with early warning of battery fire hazards can reduce the probability of relevant fires by more than 90%. The online early warning system ensures the safe operation of battery throughout the life cycle.

System Configuration

The system utilizes **3.2V/280Ah lithium iron phosphate prismatic aluminum shell battery cells**. The battery system is configured as follows:

•**Battery System Topology**:

- **8 Clusters**, each configured as **1P384S**.
- Each cluster contains **8 battery modules**, configured as **1P48S**.
- Each module further contains **4 sub-modules**, configured as **1P12S**.

•**Battery Management System (BMS)**:

- The system is equipped with a high-precision BMS for real-time data acquisition and monitoring of the battery packs.
- The BMS supports external communication and is compatible with the Power Conversion System (PCS), Human-Machine Interface (HMI), Energy Management System (EMS), liquid cooling units, and fire protection systems.
- The system ensures long-term stable and safe operation.

•**Fire Safety and Protection**:

- In compliance with **TCEC373-2020**, the fire separation distance between prefabricated cabins should be greater than **3 meters**.
- If a firewall is installed, this distance requirement is waived.
- Each energy storage unit should be equipped with a dedicated water storage tank, serving as the water intake point for the fire protection system.
- Lightning protection towers should be installed around the site based on coverage requirements, with all grounding points, including those of the prefabricated cabins, connected to the underground grounding network.

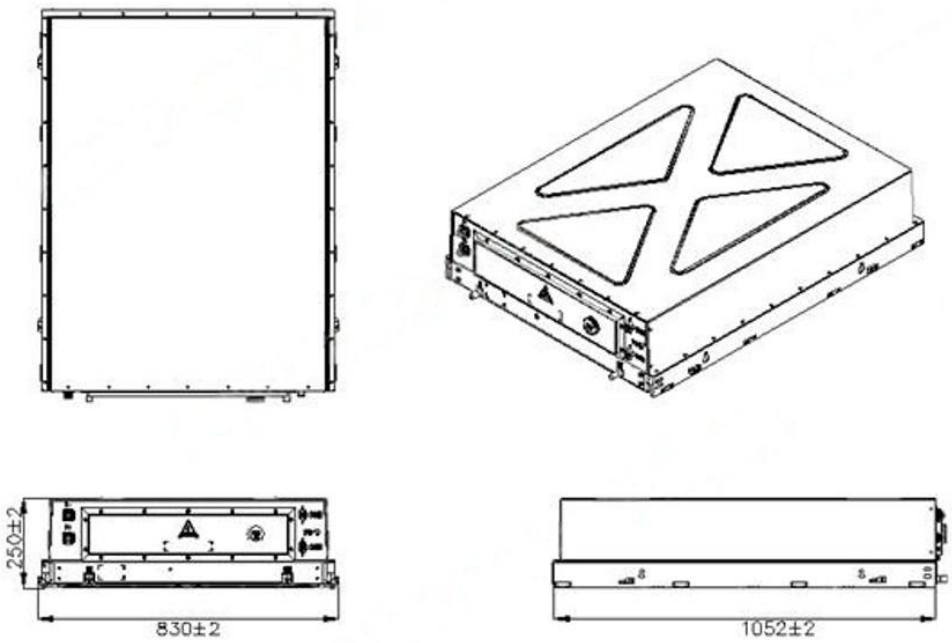
•**Power Conversion and Electrical Configuration**:

- Each system uses a **single boost inverter with a capacity of 2750 kW**.
- This includes **two PCS units rated at 1375 kW each** and **one 2750 kVA dry-type transformer**.
- The output voltage is configurable at **10 kV** or **35 kV**.
- Each boost inverter is connected to one battery compartment, and the system operates at a charge/discharge rate of **0.5C**.

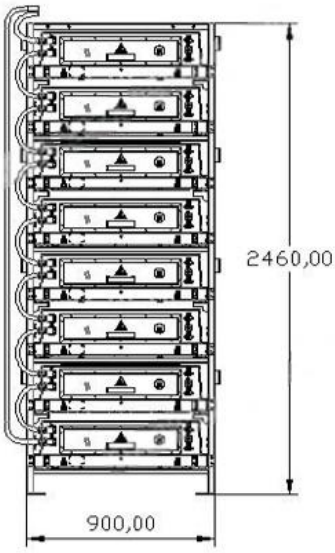
Battery Energy Storage System 2.75MWh						
Type	Model	Voltage Min	Voltage Max	Voltage Rated	Energy	Quantity
cell	280Ah	2.8	3.5	3.2	896	3072
Pack	1P48S	134.4	168	153.6	43008	64
cluster	1P384S	1075.2	1344	1228.8	344064	8
System	8P384S	1075.2	1344	1228.8	2752512	1

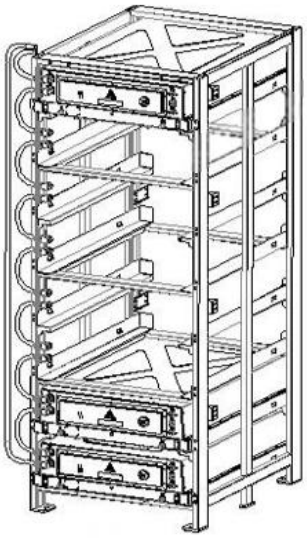
Specification of 280Ah Single Battery Cell		
Item	**Product Specification**	**Condition**
Cell Capacity	≥280Ah	2.8 ~ 3.55V, 25±2℃, 0.5C discharge current, new
Chemical system	LFP/C	N/A
Charging & discharging rate	0.5C	
Energy density (Wh/kg)	160	
Cycle Life (Number of Cycles)	8000	
Working voltage	2.80~3.50V	
Internal resistance （1kHz）	≤0.25mΩ	Refer to the specification of Battery Cells for details
Operating temperature (charging)	0~55℃	
Operating temperature (Discharging)	-20~55℃	
Standard operating current	280A	25 ± 2 ℃ ambient temperature
Max. sustainable operating current	280A	
Storage temperature (1 Months)	-30℃-45℃	SOC: 25% -40% Storage environment humidity ≤ 85% RH, no condensation
Storage temperature (6 Months)	-20℃-35℃	
Monthly self discharge rate	≤3.5%/month	25℃, 50% SOC, after 3 months of new battery storage
Weight	5.56±0.2kg	N/A
Dimension	71.8*207.1*174.2 (±0.8mm)	
Clamp Force	300±20 kgf	

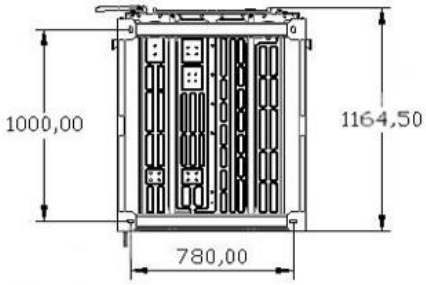
Specification of Battery Pack		
Item	**Product Specification**	**Condition**
Assembly Method	1P48S	N/A
Nominal Voltage	153.6V	Monomer protection 2.80 to 3.50V
Nominal energy	43.008kWh	25℃±2
Standard operating current	140A	N/A
MAX. operating current	154A	25℃±2
Installation mode	Plug-In Drawer Type	N/A
Charging temperature	0~55℃	
Discharging temperature	-20~55℃	
Cooling mode	Liquid Cooling	
Pack dimension	250*1052*830 (±2mm)	
Pack weight	≤340kg	
Ingress Protection Rating	IP65	



Specification of Battery Cluster		
Item	**Product Specification**	**Condition**
Assembly Method	1P384S	N/A
Nominal Voltage	1228.8V	Monomer protection 2.80 to 3.50V
Voltage Range	1075.2~1344V	N/A
Nominal energy	344.067kWh	25℃±2
Standard operating current	140A	N/A
MAX. operating current	154A	25℃±2
Charging temperature	0~55℃	N/A
Discharging temperature	-20~55℃	
Cooling mode	Liquid Cooling	
Pack dimension	900*1164.5*2460 (mm)	
Pack weight	≤3100kg	
Ingress Protection Rating	IP65	







High-voltage box

Each battery cluster contains one high-voltage box, which is primarily responsible for voltage and current acquisition of the battery cluster, summarizing the voltage and temperature information of individual battery cells within the cluster, calculating the battery cluster's SOC (State of Charge) and SOH (State of Health), executing balancing strategy decisions, performing battery fault diagnosis, and providing local protection and relay control based on battery fault information.

The high-voltage box is equipped with communication interfaces, enabling data communication with the Battery Management Unit (BAU) and the Energy Management System (EMS). The BMS also features insulation monitoring and calculation of cell-level SOC/SOH and other status indicators.

Specification of High-Voltage Box	
Main components	BCU, relay, fuse, shunt, etc
Panel Devices	Air switch, circuit breaker, 220 V AC interface, etc
Protection Function	System protection, insulation / total voltage detection, etc
Ingress Protection Rating	IP2X
Installation mode	Plug-In Drawer Type
Weight	≤25kg
High voltage input positive	BAT+
High voltage input negative	BAT-
AC input	220V
Inter box communication	BCU-BMU
External communication	BCU-BAU
High voltage output positive	PCS+
High voltage output negative	PCS-
Grounding Point	M6 screw

Human-Machine Interface (HMI)

Each energy storage system is equipped with a 10-inch display screen, used to show the operating status, alarm information, and other key parameters of all battery clusters under the main control..

Specification of HMI	
Screen Dimensions and specifications	10-Inch Color Display with Touchscreen Control
Screen Power supply mode	DC24V
Screen Communication mode	RS485
Display System Status	Stop, Standby, Charging, Discharging, Fault, Emergency Stop
Alarms	Overcharge, over discharge, over current, over temperature, insulation fault, communication fault, self check fault, etc
Display main parameters	SOC, total voltage, total current, maximum and minimum cell voltage, maximum and minimum temperature, etc
Other displays	Use the **Battery Pack Details** button to open the corresponding detailed information page. The battery pack details display the operating status, alarm information, SOC (State of Charge), total voltage, total current, insulation resistance value, maximum cell voltage difference, highest temperature, all cell voltages, and all temperature measurements. Special markings are applied to the maximum cell voltage, minimum cell voltage, temperature measurements, highest temperature, and other key parameters.
Data storage	Historical data can be stored and read by SD card.
Location of Screen	Combiner cabinet

Liquid cooling system

The containerized battery system utilizes an **air-cooled liquid chiller**. The external unit dissipates heat to the air using fans, while the internal compressor-based refrigeration system performs heat exchange with a glycol-water solution (coolant) via a heat exchanger. A computer-controlled system regulates the outlet temperature based on feedback signals from the upper control system, as well as water temperature and pressure sensors. The water circulation system is configured with pumps according to the main pipeline design and the internal resistance of battery modules, ensuring proper coolant (glycol solution) flow in and out of the modules.

Each prefabricated battery cabin is equipped with one liquid cooling unit. The chiller features advanced designs for **condensation prevention**, **leak prevention**, and **automatic coolant replenishment**.

Condensation Protection:

All liquid cooling pipes are wrapped with anti-condensation foam insulation to effectively prevent water droplets and condensation from damaging the battery modules.

Leak Detection and Pressure Monitoring:

After installation, the liquid cooling pipes undergo airtightness testing. Only after passing this test is coolant injected and the system commissioned. Pressure gauges are installed at both the inlet and outlet of the chiller to monitor pressure during both operation and idle states. If abnormal pressure values are detected, the system immediately triggers an alarm and sends alerts to the monitoring platform.

Leakage Alarm System:

Two sets of adjustable-sensitivity water leakage sensors with RS485 communication are installed at the bottom of each prefabricated cabin. In the event of coolant leakage, the system can quickly detect and report the leakage status along with an alarm signal to the monitoring platform.

Structural Protection:

The entire prefabricated cabin has a protection rating of **IP54**. The only cable routing holes are located at the bottom near the combiner cabinet, and after cable installation, these openings are sealed with fireproof material. This design prevents small animals from entering and ensures that any coolant leakage is contained internally, avoiding environmental contamination.

Automatic Coolant Replenishment:

The system is equipped with an automatic coolant replenishment function. An auxiliary coolant storage tank is connected to the main pipeline through a water-stop valve. When the system detects a coolant leak via pressure monitoring, the valve automatically opens, allowing the main pipeline to draw coolant from the storage tank until the pressure returns to normal. This reduces the frequency of maintenance required by operators.

Liquid cooling system

Specification of Liquid Cooling System	
Item	Descriptions
Working Voltage	380V
Power	40kW
Cryogen	R134A/R410A
Refrigerant Carrier	50% Pure Water + 50% Ethylene Glycol
Automatic Fluid Replenishment	≥8L
Communication Protocol	≤78dB
Ingress Protection Ranking	IPX5
Anti-corrosion ranking	C3
Operating ambient temperature	-30~55℃
Weight	≤590kg

Combiner Cabinet Configuration

The container is equipped with **one combiner cabinet**, which is divided into two functional sections:

Upper Section – AC Distribution and Communication

This section provides AC power distribution and communication functionalities, and is equipped with:

- Auxiliary power switches
- HMI (Human-Machine Interface)
- UPS and backup battery (30-minute runtime)
- Data network switch
- Video switch
- Fiber optic terminal box and patch cords
- Auxiliary power energy metering device (installed at the 380Vac combiner cabinet input)
- BMS equipment
- Switching power supply
- Emergency stop button and status indicator lights

Lower Section – DC Bus and Combiner Function

This section handles the DC combiner functionality, where **every four battery clusters are combined into one group, with a total of two groups connected to the main DC busbar**. After passing through a circuit breaker, the system connects directly to the PCS (Power Conversion System).

Battery Management System (BMS)

The battery management system (BMS) adopts a **three-level hierarchical architecture**, enabling functional division across control layers to ensure precise management and reliable, stable system operation.

BMU (Battery Management Unit):

Responsible for collecting detailed data from individual battery cells, including **voltage** and **temperature**. The BMU calculates and analyzes the **State of Charge (SOC)** and **State of Health (SOH)** of each cell, performs **cell balancing**, and reports any abnormal conditions to the Battery Cluster Management Unit (BCU).

BCU (Battery Cluster Unit):

Gathers all individual cell data from the BMUs and monitors key parameters of the battery cluster, such as **total voltage**, **cluster temperature**, and **charging/discharging current**. The BCU also calculates and analyzes the SOC and SOH at the cluster level and transmits this information to the Battery Array Unit (BAU).

BAU (Battery Array Unit):

Serves as the top-level control unit, collecting comprehensive data from all BCUs. Based on real-time operating conditions and the battery system status, the BAU manages and controls **charging and discharging operations**, and transmits all relevant information to the **PCS (Power Conversion System)** and **EMS (Energy Management System)** for higher-level monitoring and battery state management. The BAU also supports communication with external devices to ensure seamless system integration.

This hierarchical control structure enables accurate battery monitoring, precise balancing, and efficient operation, thereby extending the battery system's service life and improving overall safety.

BMS parameters

Item	Descriptions
Working Voltage	24V
Equilibrium mode	Active equilibrium
Voltage Measurement Accuracy	±0.3%
Current Measurement Accuracy	±0.2%
Temperature Measurement Accuracy	±2°C
SOC Deviation	≤8%
Voltage Sampling Interval	≤200ms
Current Sampling Interval	≤50ms
Temperature Sampling Interval	≤5s
Protection and Alarms	Overcharge / Over-discharge / Over-temperature / Short Circuit
Communication Method	CAN、RS485、Ethernet
Communication Protocol	CAN2.0B/modbus-RTU/IP

BMS System Overview

The **Battery Management System (BMS)** consists of the **Battery Management Unit (BMU)** for individual cells, the **Battery Cluster Unit (BCU)**, the **Battery Array Unit (BAU)**, and dedicated modules for current, voltage, and temperature measurement.

The BMS offers a comprehensive range of advanced functions, including:

❖ High-precision acquisition and reporting of analog signals

❖ Fault detection, alarm notification, data logging, and storage

❖ Battery protection and parameter configuration

❖ Active balancing of battery cells

❖ SOC calibration for battery groups

❖ Data exchange and communication with external devices

This intelligent management system ensures optimal battery performance, safety, and seamless integration with other system components.

BMS Functional Description

The **Battery Management System (BMS)** is an electronic monitoring and control system designed for real-time supervision of battery operation. It plays a critical role in ensuring the **safe, reliable, and stable performance** of the battery system.

Key functions of the BMS include:

•**Real-time Monitoring**: Continuously monitors critical battery parameters such as **voltage**, **current**, **cluster insulation status**, and **State of Charge (SOC)**.

•**Safety Management**: Manages and controls the charging and discharging processes to ensure they operate within safe limits.

•**Fault Detection and Protection**: Identifies potential faults in the system, triggers **alarm notifications**, and initiates **emergency protection measures** to prevent system failures or accidents.

•**Battery System Optimization**: Actively manages and optimizes battery operation to extend service life and improve system efficiency.

Through these comprehensive functions, the BMS ensures that the battery system operates safely, reliably, and efficiently under all working conditions.

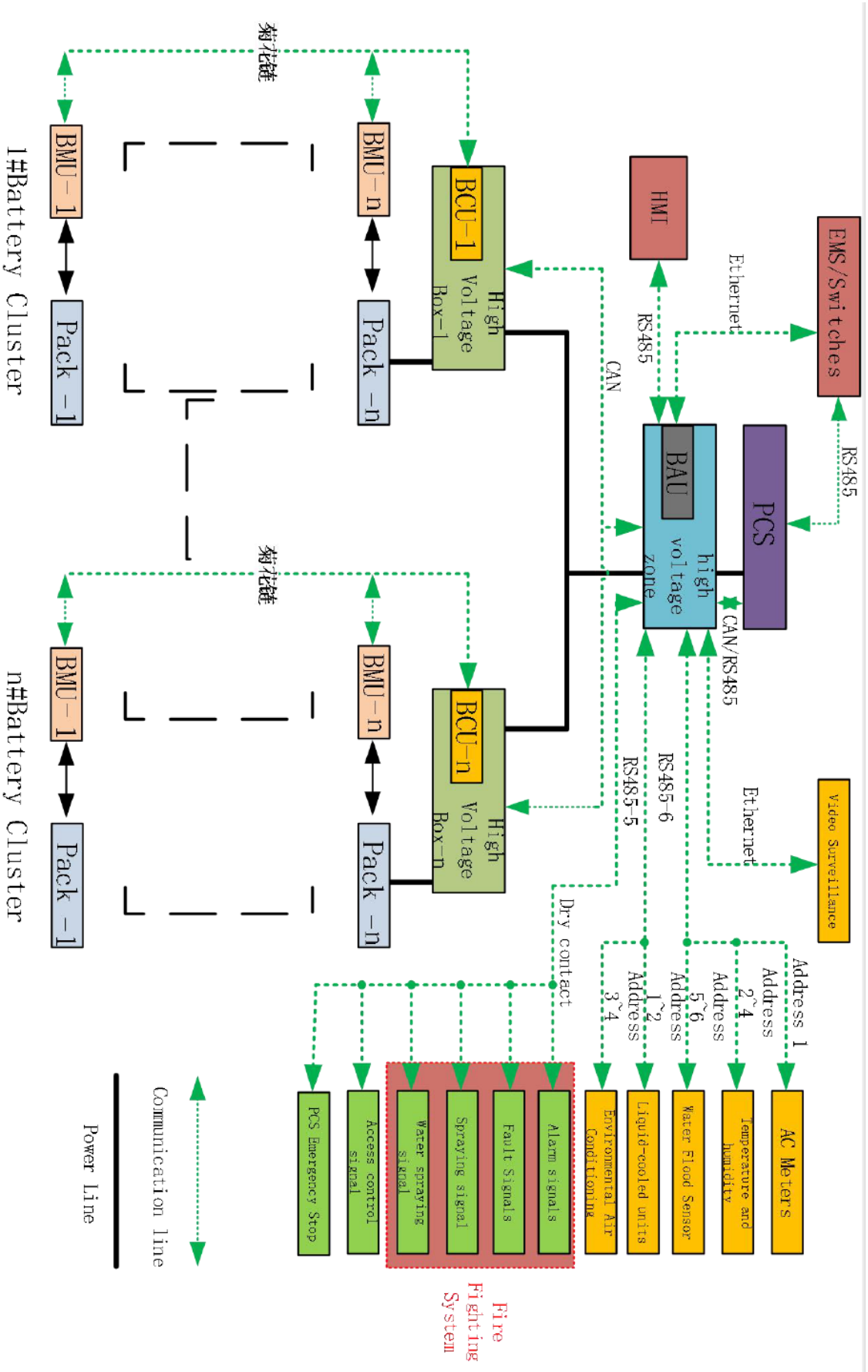


Fig. topological diagram of BMS system

BMS Alarm and Protection Levels

Level 1 Alarm (Power Reduction Request)

- Cell Overcharge/Over-discharge Warning
- Large Voltage Deviation Between Cells
- Cell High/Low Temperature During Charging or Discharging
- Excessive Temperature Difference Warning
- High/Low Total Voltage Warning
- High Charging/Discharging Current Warning
- Low Insulation Resistance Warning

Level 2 Alarm (PCS Standby Mode)

- Cell Overcharge/Over-discharge
- Large Voltage Deviation Between Cells
- Cell High/Low Temperature During Charging or Discharging
- Excessive Temperature Difference
- High/Low Total Voltage
- High Charging/Discharging Current
- Low Insulation Resistance

Level 3 Protection (Relay Cut-off)

- Cell Overcharge/Over-discharge Protection
- Large Voltage Deviation Between Cells
- Cell High/Low Temperature During Charging or Discharging
- Excessive Temperature Difference Protection
- Total Voltage Overvoltage/Undervoltage Protection
- Charging/Discharging Overcurrent Protection
- Low Insulation Resistance, Communication Timeout, Cell Fault, NTC Sensor Fault, and Other Critical Errors

Power Distribution Function

The container's power distribution system adopts a **three-phase five-wire configuration**, providing independent control and **220V single-phase AC power** for internal devices such as lighting, UPS, switching power supplies, fire protection systems, temperature and humidity sensors, and power outlets.

Electrical Interfaces (Including but Not Limited To):

- **Main Control Power Circuit Breaker (3P5W)**
- **Water Cooling Unit Power Supply**: 380VAC three-phase, 1 circuit (3L+PE)
- **Socket Power Supply**: Multiple 220VAC outputs
- **UPS Input Power Supply**: 220VAC
- **BMS Auxiliary Power Supply**: 220VAC (provided by UPS)
- **Fire Protection Auxiliary Power Supply**: 220VAC (provided by UPS)
- **Switching Power Supply Input**: 220VAC (provided by UPS)
- **Explosion-Proof Fan Power Supply**: 220VAC (provided by UPS)
- **Control Board Power Supply**: Provided by the switching power supply
- **Relay Control Power Supply**: Provided by the switching power supply
- **Touchscreen Power Supply**: Provided by the switching power supply
- **24V DC Power Supply for Auxiliary Systems**: Includes electric louvers, temperature and humidity sensors, smoke detectors, temperature sensors, combustible gas detectors, and water leakage sensors
- **Auxiliary Power Switch**: Equipped with a shunt trip feature and controlled by the BAU

Fire Protection

Overview

During the operation or storage of battery systems, thermal runaway may occur due to internal heat generated by chemical reactions or exposure to external heat sources. This poses significant safety risks to the energy storage system. To address these risks and meet the stringent fire protection requirements of battery energy storage systems, a fully automatic and highly efficient fire suppression system has been designed. This system implements a dual-level suppression strategy—targeting both the battery PACK and compartment levels—to ensure rapid and reliable fire mitigation by promptly flooding the ignition zone with extinguishing agents.

System Composition

The fire protection system comprises the following components:

- Fire detectors
- Control unit
- Extinguishing agent storage cylinders
- Piping network
- Nozzles
- Pressure relief valves
- Audible and visual alarm systems
- Gas release indicator lights
- Emergency start/stop buttons
- Manual/automatic mode selectors
- The system is structured around a centralized control center with a bus-based architecture, supplemented by limited multi-wire control. It prioritizes automatic alarm and suppression control, with manual override capabilities for redundancy.

Fire Protection

1. Control Section

Fire Alarm Controller

The system includes a fire alarm control panel with integrated linkage functions. It receives input from detectors and system devices (e.g., exhaust fans, fire suppression modules), and executes control commands accordingly.

Upon fire detection, the controller can:

- Automatically activate extinguishing and ventilation systems based on pre-set logic
- Allow manual activation via the control panel interface
- Display operational status of all linked equipment
- Introduce an adjustable delay (30–60 seconds) before activation, enabling operator intervention
- Switch between manual and automatic modes

2. Detection Section

(1) Functional Modules

- **Input Module**: Connects binary signal devices such as detectors and pressure switches to the controller, allowing for real-time status monitoring.
- **Output Module**: Interfaces with external devices like audible/visual alarms for automated or manual control.

(2) Detectors

The system deploys various detectors tailored to specific risk areas:

- Point-type photoelectric smoke detectors
- Point-type thermal detectors

These devices promptly detect smoke or abnormal temperature rises and transmit alarm signals to the controller.

(3) Manual Call Points

Manual alarm buttons are installed inside the energy storage cabin. These allow on-site personnel to trigger fire alerts when hazards are visually confirmed.

(4) Audible & Visual Alarms

Installed externally, these units are activated upon fire detection to emit both sound and light alerts, ensuring timely warning.

Fire Protection

3. Fire Suppression Section

Gas Fire Extinguishing System

The system supports three activation modes:

•**Automatic**: Dual-trigger logic from smoke and/or heat detectors initiates fire confirmation. After a delay (adjustable 30–60s), the controller activates the extinguishing system.

•**Manual**: Emergency activation via control panel or local emergency start button.

•**Mechanical Emergency**: Manual actuation directly from the cylinder room in case of system failure.

Sequence of events during automatic activation:

1.Single detector activation triggers preliminary alert (no suppression).

2.Dual detection (smoke + heat or two detectors) confirms fire, activates the alarm and suppression system.

3.Within 10 seconds, extinguishing gas floods the protected enclosure.

4.Pressure relief valves engage to prevent overpressure.

5.System suppression continues for 10 minutes to prevent re-ignition.

4. Ventilation System

Two explosion-proof exhaust fans (with motorized louvers) are installed at one end of the container, and two intake fans with similar specifications are placed at the opposite end. This configuration ensures adequate ventilation before fire suppression activation. All components comply with T/CEC 373-2020 standards.

5. Key Features

- Utilizes high-efficiency, colorless, odorless, non-toxic extinguishing agents that do not damage battery systems
- Fully automated operation prevents false activations
- Quick response time (≤10 seconds) for rapid and precise intervention
- Firefighting system cables (power, control, communication) are independently routed in galvanized steel conduits or metal ducts
- Integrated smoke, temperature, and nozzle-based suppression targeting both electrical and battery modules
- Automatic disconnection of HVAC and DC systems upon fire detection and prior to extinguishing gas release

Fire Protection

6. Operating Principle

When combustible gas levels exceed the low alarm threshold:

•Exhaust fans activate to purge gases

•If the high alarm threshold is exceeded:

- Fans are shut off
- BMS is alerted to shut down HVAC and disconnect high-voltage circuits

Upon simultaneous smoke and heat detection:

•Fire controller activates, uploads alarm to BMS and escalates to energy station and grid-level fire control

•Triggers alarm systems, gas release indicators, and extinguishing sequence

•Suppression duration ensures no combustion or explosion for 2 minutes and no reignition for 10 minutes

7. Delayed Activation for Personnel Safety

To allow safe evacuation:

•A delay timer (default 30s, adjustable) is initiated after fire detection or manual trigger

•Sound-light alarms activate before agent discharge

8. PACK-Level Fire Protection

If thermal runaway is detected in a battery PACK:

•BMS initiates emergency shutdown of busbar and contactors

•Fire suppressant is routed via flexible metal hose to directly reach the ignition source

•Rapid inerting suppresses propagation and prevents re-ignition

9. Water-Based Fire Protection

The container includes reserved water pipe interfaces connected above battery racks. In case of emergency, water can be applied to:

•Reduce ambient temperature

•Supplement gas suppression

•Further mitigate fire risk and prevent reignition

Fire Protection