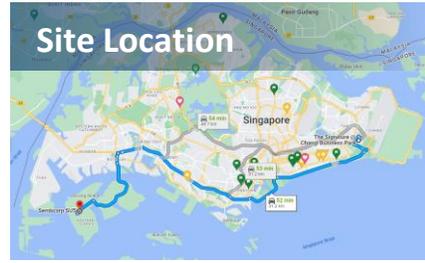
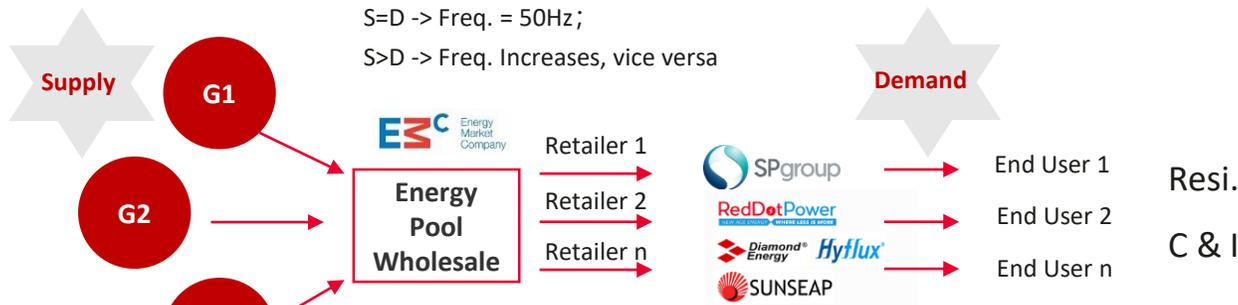


**Singapore BESS Sharing
BANYAN ENERGY STORAGE SYSTEM**

Sembcorp JI BESS Project Background

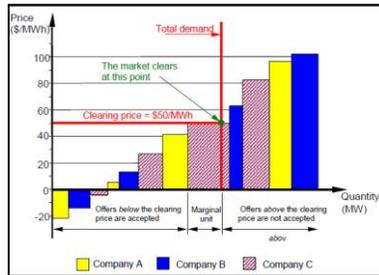


Singapore Electricity Market



Half-an hour Bidding

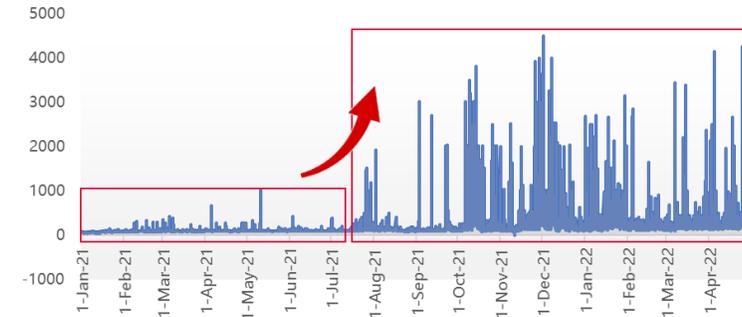
Supply & Demand -> Prices (Arbitrage)



FR & Reserve Prices (Ancillary)

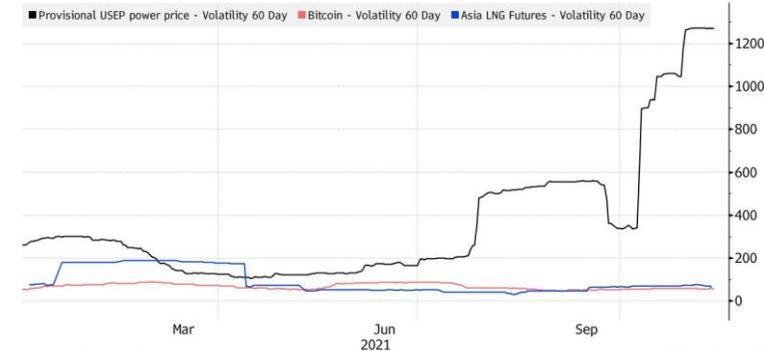
Year	FR Average (\$/MWh)	Reserve Price Average (\$/MWh)
2018	20.76	10.08
2020	10.22	6.84
2022	49.30	25.6

Wholesale Electricity Price - USEP (\$\$/MWh)



- **Lowest:**
11 Nov 2021:
US\$ -0.0036/kWh
- **Highest:**
2 Dec 2021:
US\$ 3.2/kWh

Singapore Swing Volatility in Singapore's power market outpaces Bitcoin or natural gas



Source: Singapore's EMC, Nymex

Bloomberg



1. Initial Engagement - Authority clearance

NFPA 855

Reference

4.8 Maximum Stored Energy.

4.8.2

Where approved by the AHJ, outdoor ESS installations, ESS installations in open parking garages and on rooftops of buildings, and mobile ESS equipment that exceed the amounts in [Table 4.8](#) shall be permitted based on a hazardous mitigation analysis in accordance with [4.1.4](#) and large-scale fire testing in accordance with [4.1.5](#).

Table 4.8 Maximum Stored Energy

ESS Type	Maximum Stored Energy ^a (kWh)
Lead-acid batteries, all types	Unlimited
Nickel batteries ^b	Unlimited
Lithium-ion batteries, all types	600
Sodium nickel chloride batteries	600
Flow batteries ^c	600
Other battery technologies	200
Storage capacitors	20

4.1.4 Hazard Mitigation Analysis.

4.1.4.1 *

A hazard mitigation analysis shall be provided to the AHJ for review and approval when any of the following conditions are present:

- (1) When technologies not specifically addressed in [Table 1.3](#) are provided.
- (2) More than one ESS technology is provided in a room or indoor area where adverse interaction between the technologies is possible.
- (3) When allowed as a basis for increasing maximum stored energy as specified in [4.8.1](#) and [4.8.2](#).

A.4.1.4.1

One form of hazard mitigation analysis (HMA) is a failure mode and effects analysis (FMEA), which is a systematic technique for failure analysis. An FMEA is often the first step of a system reliability study and involves reviewing as many components, assemblies, and subsystems as possible to identify failure modes and their causes and effects. For each component, the failure modes and their resulting effects on the rest of the system are recorded. Other formal methodologies for conducting the analysis can also be used depending on the complexity and type of the system being assessed. Guidance for analysis can be found in the following standards:

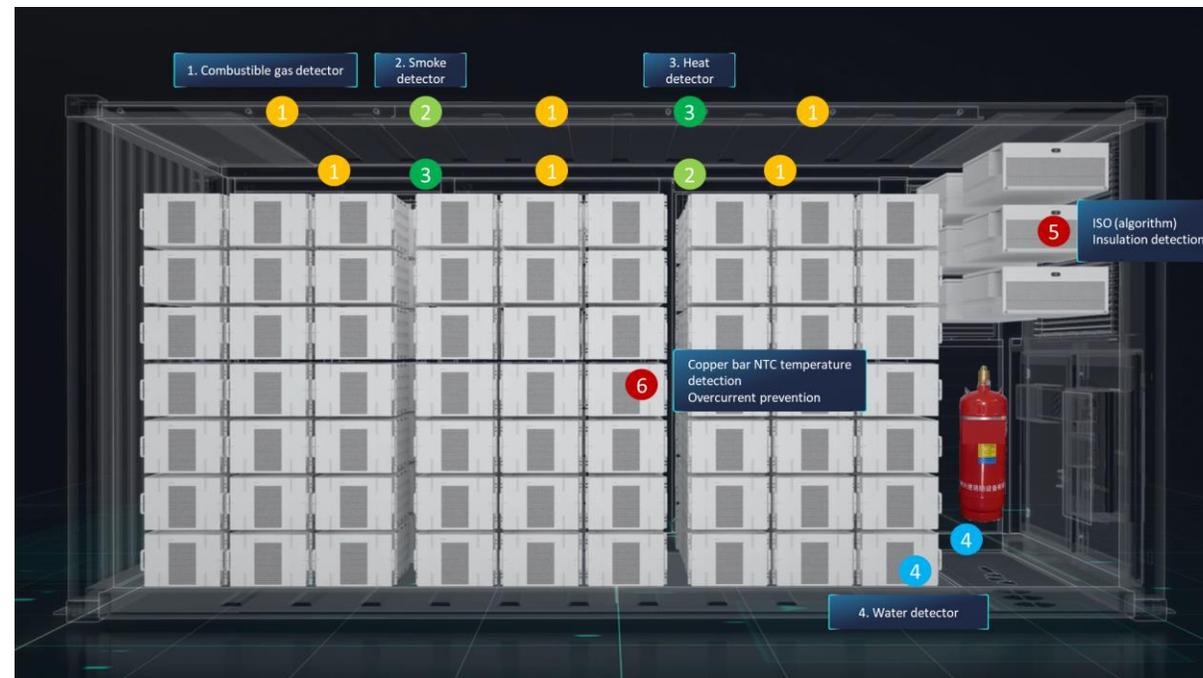
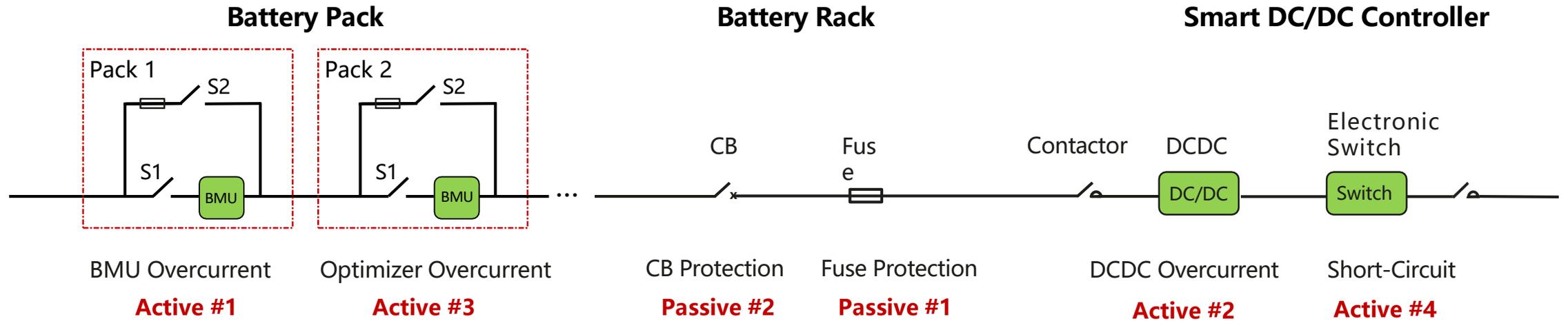
- (1) IEC 60812, Analysis techniques for system reliability — Procedure for failure mode and effects analysis (FMEA)
- (2) IEC 61025, Fault tree analysis (FTA)
- (3) MIL-STD-1629A, Procedures for Performing a Failure Mode, Effects and Criticality Analysis

4.1.5 Large-Scale Fire Test.

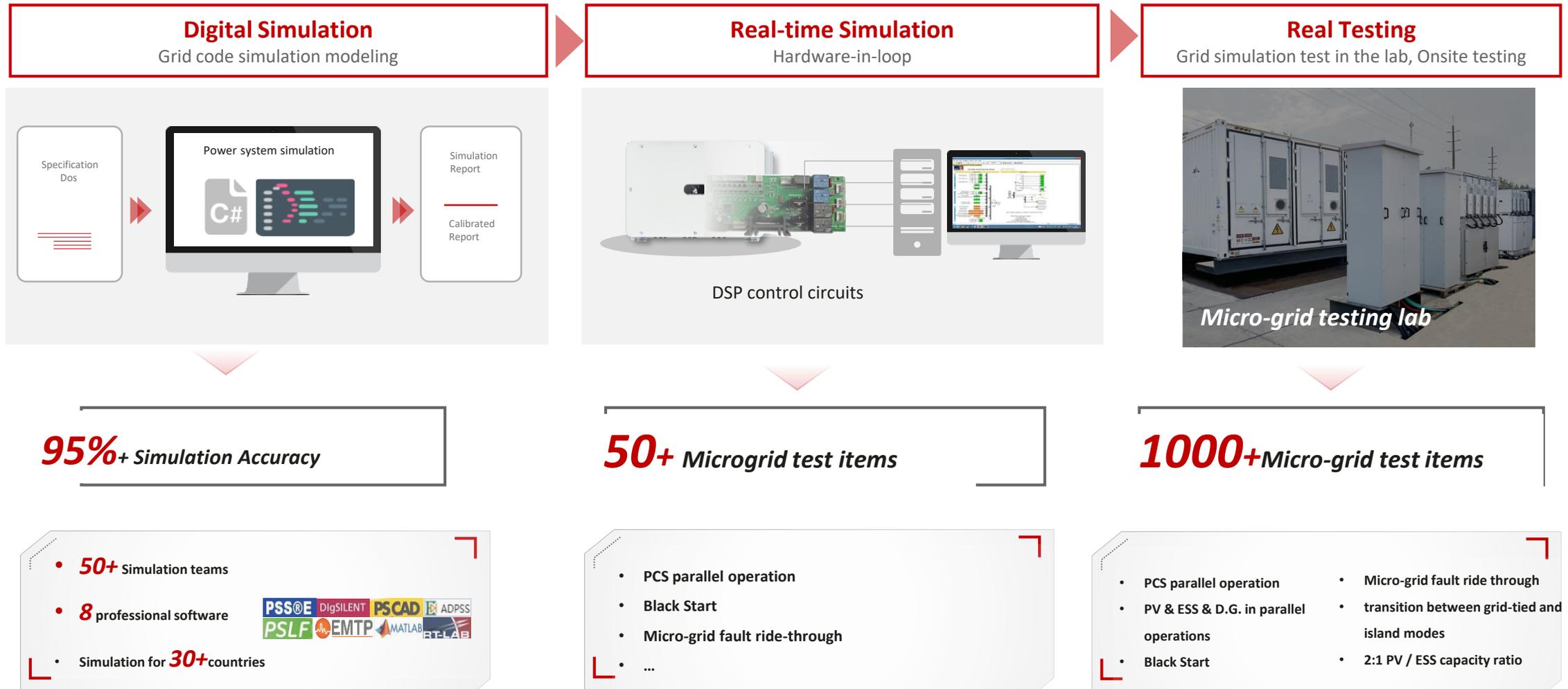
4.1.5.1 *

Where required elsewhere in this standard, large-scale fire testing in accordance with [4.1.5](#) shall be conducted on a representative ESS in accordance with UL 9540A or equivalent test standard.

Addressing the Safety Concern



2. Delivery - From digital, semi-physical simulation to real testing



Delivery – Standardization

From Planning, Simulation, Delivery, FAT, SAT, HMA, Commissioning, to training, processes are standardized and optimized to ensure reliable delivery.



Item	Quantity	Unit
...

Item	Quantity	Unit
...



Item	Quantity	Unit
...

Item	Quantity	Unit
...

HUAWEI BESS INITIAL CONFIGURATION FOR SEMBCORP JI BESS PROJECT

HUAWEI FAT PROCEDURES FOR SEMBCORP JI BESS PROJECT (DC LV Panel)

HUAWEI FAT PROCEDURES FOR SEMBCORP JI BESS PROJECT (Smart String ESS)

HUAWEI FAT PROCEDURES FOR SEMBCORP JI BESS PROJECT (Smart Transformer Station)

HUAWEI FAT PROCEDURES FOR SEMBCORP JI BESS PROJECT (Power Control System)

Ji-BESS Overall System Commissioning Test Plan Banyan

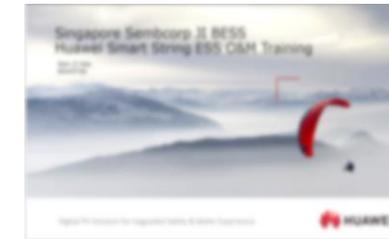
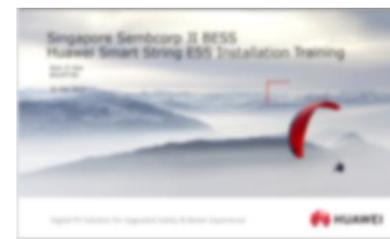
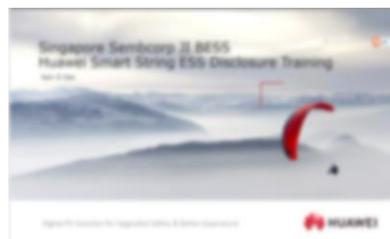
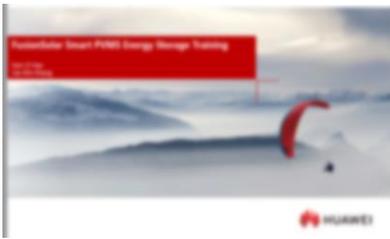
Item	Quantity	Unit
...

Item	Quantity	Unit
...

Item	Quantity	Unit
...

Item	Quantity	Unit
...

Item	Quantity	Unit
...



3. O&M - Asset Digitalization

Abnormal battery packs in a rack coloring alert

Real-time data of a battery rack

2D&3D battery rack data display available

Running Status

- Discharging: -62.31 kW Power
- Device Status: 39 % SOC
- Fire Suppression Status
- Fire Suppression System Fault Status
- Fire Suppression Gas Discharge Status
- Fire Alarm Status
- Water sensor status in the battery cabin
- Water sensor status in the control unit cabin

Realtime Data

68.72 kWh	9132.92 kWh
Daily auxiliary power	Total auxiliary power
23.6 °C	20.6 °C
Battery cabin dew point	Control unit cabin de...
874.255 kWh	1143.267 kWh
Chargeable capacity	Dischargeable capacity
1526.88 kWh	841.14 kWh
Daily charge energy	Daily discharge energy

Current Data

1092.7 V	70.5 A
Voltage	Electric current
77 kWh	30.1 %
charge/discharge power	SOC
220 kWh	88 kWh
Daily charge energy	Daily discharge energy

Realtime Data

56.42 kWh	8721.65 kWh
Daily auxiliary power	Total auxiliary power
20.7 °C	16.0 °C
Battery cabin dew point	Control unit cabin de...
1247.456 kWh	770.016 kWh
Chargeable capacity	Dischargeable capacity
1255.71 kWh	1226.19 kWh
Daily charge energy	Daily discharge energy
97664.970 kWh	90748.030 kWh
Total charge energy	Total discharge energy

Change/Discharge power

Graph showing power over time with a legend for 'The per/charge power(kWh)'.

Device-level Monitoring: Visualized Real-time Data

PCS

HVAC

Meter

STS

The screenshot displays a comprehensive monitoring dashboard. At the top, there's a 'HVAC' section with a temperature gauge showing 22.6°C. Below it, a 'Meter' section provides detailed real-time device data for various components like active power, reactive power, and phase voltages. At the bottom, an 'STS' section shows a schematic diagram of a transformer and medium-voltage room, along with their respective status indicators and parameters.

This screenshot shows the 'PCS-1' monitoring page. A callout bubble labeled 'Real-time device data' points to the 'DC Side' section, which displays 19.9 V DC Voltage. The 'PCS' section shows 'Grid connected' status with 0.72 kW active power and 44.4°C internal temperature. The 'AC Side' section provides detailed power and voltage data for all three phases. A 'Basic Information' table lists device details like model, software version, and location.

Battery Pack

This screenshot displays the 'Battery Pack' monitoring interface. A callout bubble labeled 'Real-time data of a battery cell' points to the 'Current Data of battery cell' section, which shows SOC (State of Charge) and SOH (State of Health) for individual cells. Below this is a bar chart showing SOC, SOH, and Voltage for 12 cells. The 'Basic Information' table at the bottom provides details for the selected battery cell, including its name, plant, and model.



Thank you.

Bring digital to every person, home, and organization for a fully connected, intelligent world.

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