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开启您的能量自由时代

Together for the Energy Freedom

CATL Path to BESS Lifecycle Durability



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17th Oct 2024

Contemporary Amperex Technology Co., Limited



CATL
Abbreviation

2011
Establishment

Ningde, Fujian
Headquarters

300750
Stock Code

Main Business

Provide EV battery systems & services for green transportation
Market Share 2023: **37%**

Cell → Module → Pack

Provide solutions and services for clean energy storage
Market Share 2023: **40%**

Rack → Container → Power Station

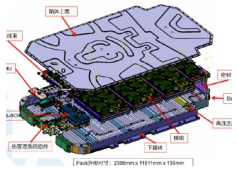
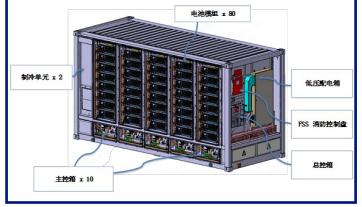
Why is the Durability of BESS Difficult?

- Large-scale energy storage system is a new application scenario of lithium-ion batteries, which has the characteristics of ① **high voltage,** ② **multiple parallel strings,** ③ **large capacity,** ④ **long life,** ⑤ **complex environment and working conditions**, etc., Which puts forward higher safety requirements for battery application and system design.

Contrast item	Consumer lithium-ion battery	Vehicle lithium-ion battery	Energy storage lithium-ion battery	Difficulty coefficient (compared to Vehicle Battery)
Number of cells	1 ~ 6	~ 100	> 1 million/whole station	X 10000 times
Average capacity	3 ~ 15Ah	~ 150Ah	> 280Ah	X 2 times
Application requirements	500 cycles @ 2 years	1500 cycles @ 8 years	> 8000 cycles/20 years	X 5 times
System voltage	< 5V	400 ~ 800V	800 ~ 1500V	X 2 times
Parallel & series number of battery	1S	1P108S ~ 1P216S	10P250S ~ 20P416S	X 5 ~ 10 times
Application environment and requirements	Comfortable environment	Low temperature + high temperature + waterproof + vibration	Low temperature + high temperature + waterproof + snow + anticorrosion, etc.	X 2 times
Safety requirements	1PPM (part per million)	1PPB (part per billion)	1PPB (part per billion)	equally

BESS *vs* EV Battery

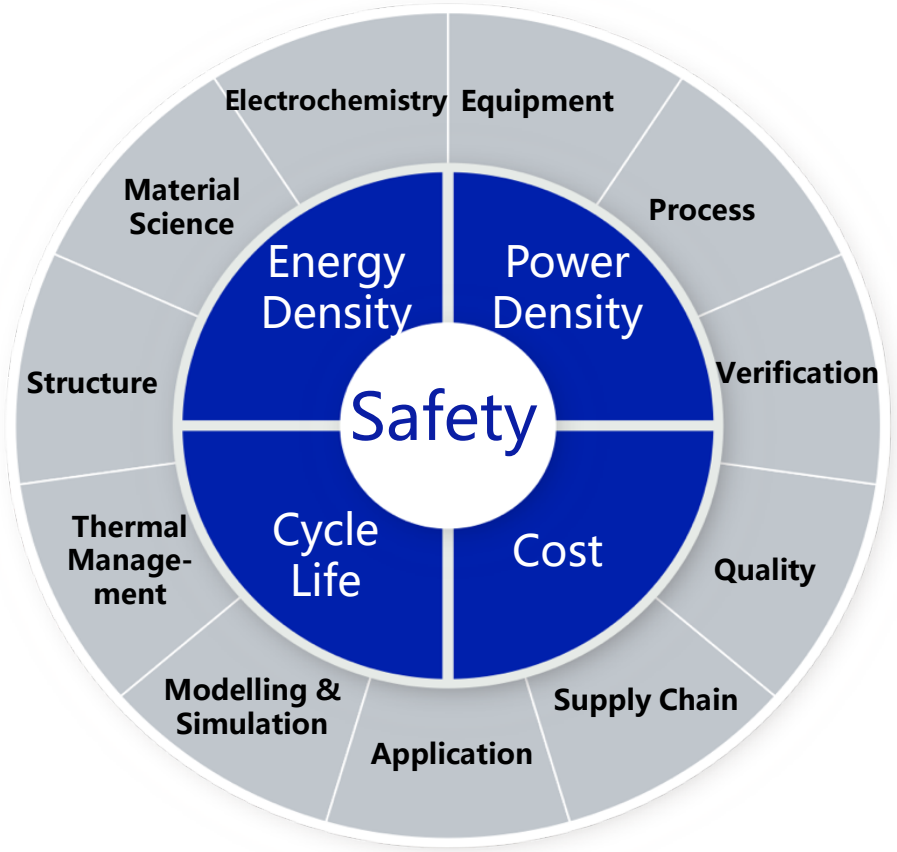
- Compared with passenger vehicles, the development **characteristics of BESS** are as follows: ① **multiple subsystems,** ② **new application scenarios,** ③ **less distinct customer requirements,** ④ **short development cycle,** ⑤ **less test and verification,** ⑥ **no station-level system joint commissioning in the process.**

	System characteristics	Requirements Analysis	Design and development	Material preparation production	Test & verification	Client verification
EV	• **System energy: ~ 100kWh** • System weight: ~ 500kg • **Number of cells: 108pcs** 	• More specific requirements (RFQ 100 + pages) • **Comprehensive product standards, PDP, quality management system & tolls, test cases, etc.**	• **BOM list: 400 +** • Top5 Complex Subparts: ✓ Bottom plate ✓ **Liquid cooling plate** ✓ **CCS** ✓ End plate ✓ Upper cover • Small number of parts	• Core components: ✓ BMS ✓ bottom plate (aluminum, steel) ✓ Liquid-cooled plate (aluminum) ✓ CCS (plastic, aluminium) ✓ Top cover (plastic).	• **Test item: 100 +** • Top5 Complex testing: ✓ **Vibration shock** ✓ Thermal runaway ✓ **PTCE** ✓ EMC ✓ Thermal management	• Complete vehicle DV/PV test • System joint commissioning runs through the whole development process of A, B and C samples • Market Verification of Million Passenger Cars
BESS	• **System energy: 4000kWh** • System weight: 35000kg • **Number of cells: 4160pcs** 	• Less specific requirements • Lack of application scenarios accumulation, product standards, test cases, etc. • Local environments， laws and regulations are complex and diverse	• **BOM Parts Number: 4000 +** • Top5 Complex Subsystem: ✓ **Liquid cooling unit** ✓ **Fire suppression system** ✓ Electrical control system ✓ Communication control system ✓ Container structure system • Larger number of parts and less experience of complex parts	• Core components: ✓ Water cooling unit (chip) ✓ Fire suppression system (chip, certification) ✓ UPS (Chip, Certification) ✓ Communication module	• **Test item: 50 +** • Top5 Complex testing: ✓ **Fire test** ✓ UL950A test ✓ **Thermal management strategy** ✓ **Fault simulation test** ✓ Condensed water	• No test control node in the middle of the integrated system level • **Direct on-site joint commissioning test and acceptance** • Most BESS manufacturers lack of experiences

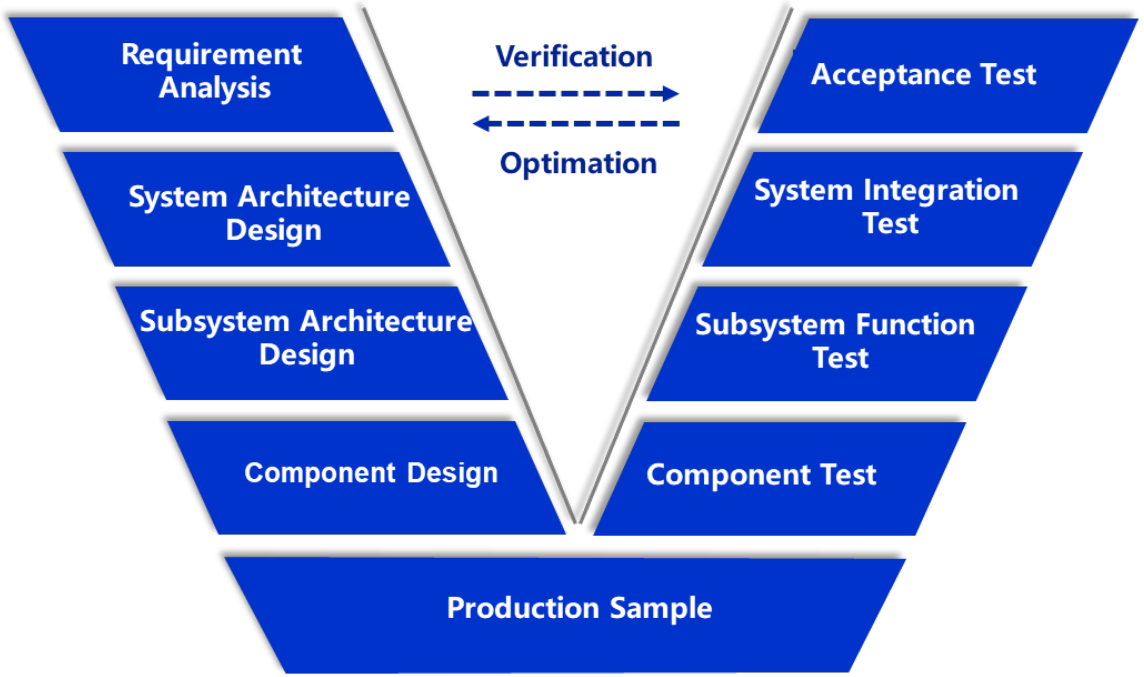
How to make BESS Products with Good Durability?

- Product safety design concept runs through cell design, system integration and application performance, and strictly follow the “V” model of PDP development.
- CATL carry over best practice from automotive (V model) and defined PDP for BESS.

Battery Safety Design



CATL PDP for BESS

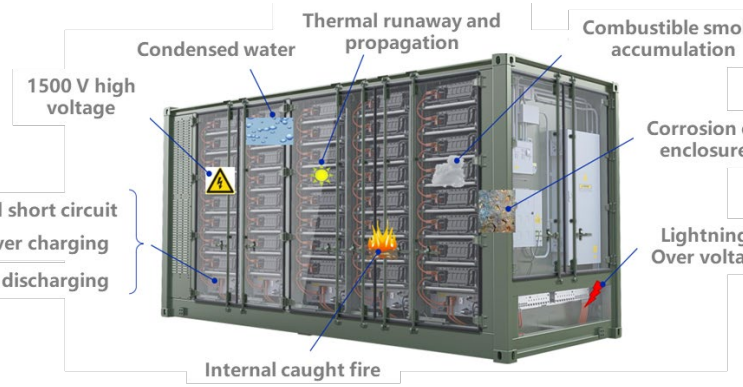


Safety is Core for long-term Durability

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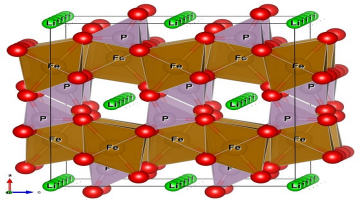
- According to the “V” model, the whole life cycle scenarios of energy storage battery system and subsystems are analyzed through QFD, and the failure mode analysis and safety protection designs are carried out for safety scenarios, such as high voltage insulation, condensed water, thermal propagation, electrothermal coupling etc.

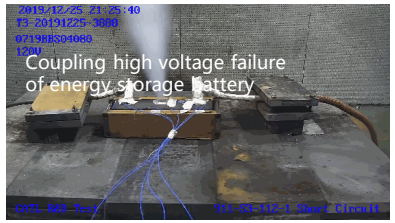


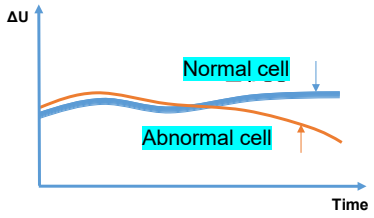


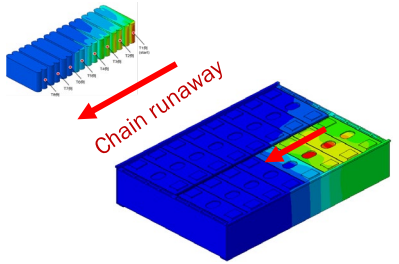
Chemical safety of battery → Electro-thermal coupling Protective design → Intelligence Early warning of TR → TR Prevention → Smoke explosion and combustion control design → Safety event insulation and fire protection design

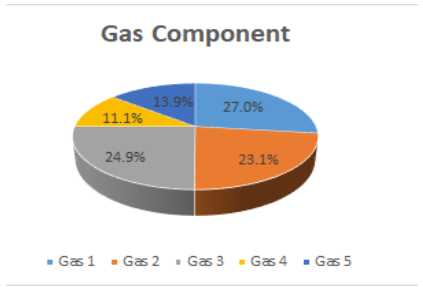
1 2 3 4 5 6

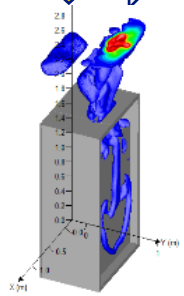












Dedicated PDP Process for BESS

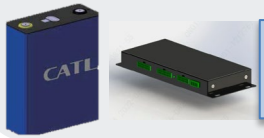
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FSS, Control box



Requirements | Tooling sample | Product certification and testing | SOP

Cell, BMS



Requirements | A-sample | B-sample | C-sample/D-sample | SOP

Module, TMS



Requirements | A-sample | B-sample | C-sample/D-sample | SOP

Containers, Racks



Requirements	Sample development		System joint optimization		Installation and commissioning	SAT	Lifecycle Operation
	Scheme design	Sample verification	Scheme optimization	Verification of optimization scheme			

- Identify demand
- Integration demand
- Initial scheme
- Risk analysis
- Cost decomposition
- Overall scheme
- Overall process scheme
- Test/certification scheme

- Scheme verification determination function
- Safety design
- Detailed design
- Function/performance implementation
- Safety verification
- Reliability design
- Design freezing

- Process verification
- Safety and reliability verification
- Process design freezing

- Pilot production
- PPAP
- Transfer to SOP

- Site acceptance Test

Test and Validation for BESS Level Durability

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Cell

Comprehensive electrical performance, safety, and life boundary evaluations



Battery system

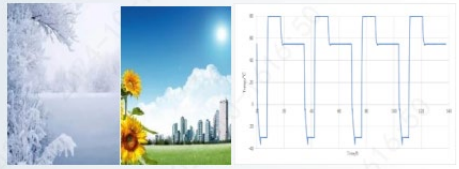
Multi-scenario verification and evaluation of real-world application conditions



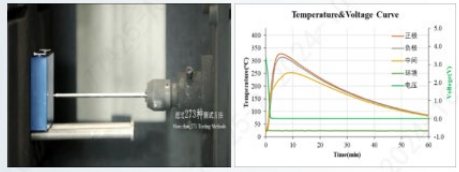
Energy Storage System

Systematic assessment of the whole chain and multiple dimensions

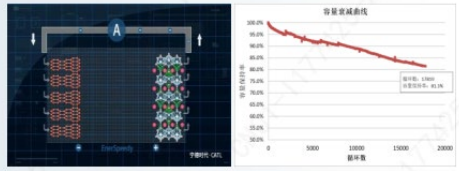
Performance test under extreme temperature



Safety boundaries under conditions of abuse test



Ultra-long lifetime evaluation





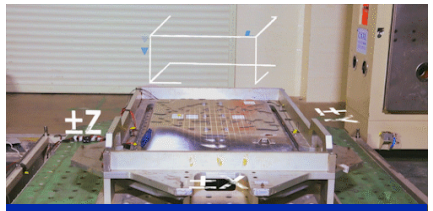
IP Test



Mechanical Shock Test



External Fire Test



Integrated vibration



6 MW Charging & Discharging Test



11000 m² Testing Clusters



330 m² & 70 t Temperature Test System



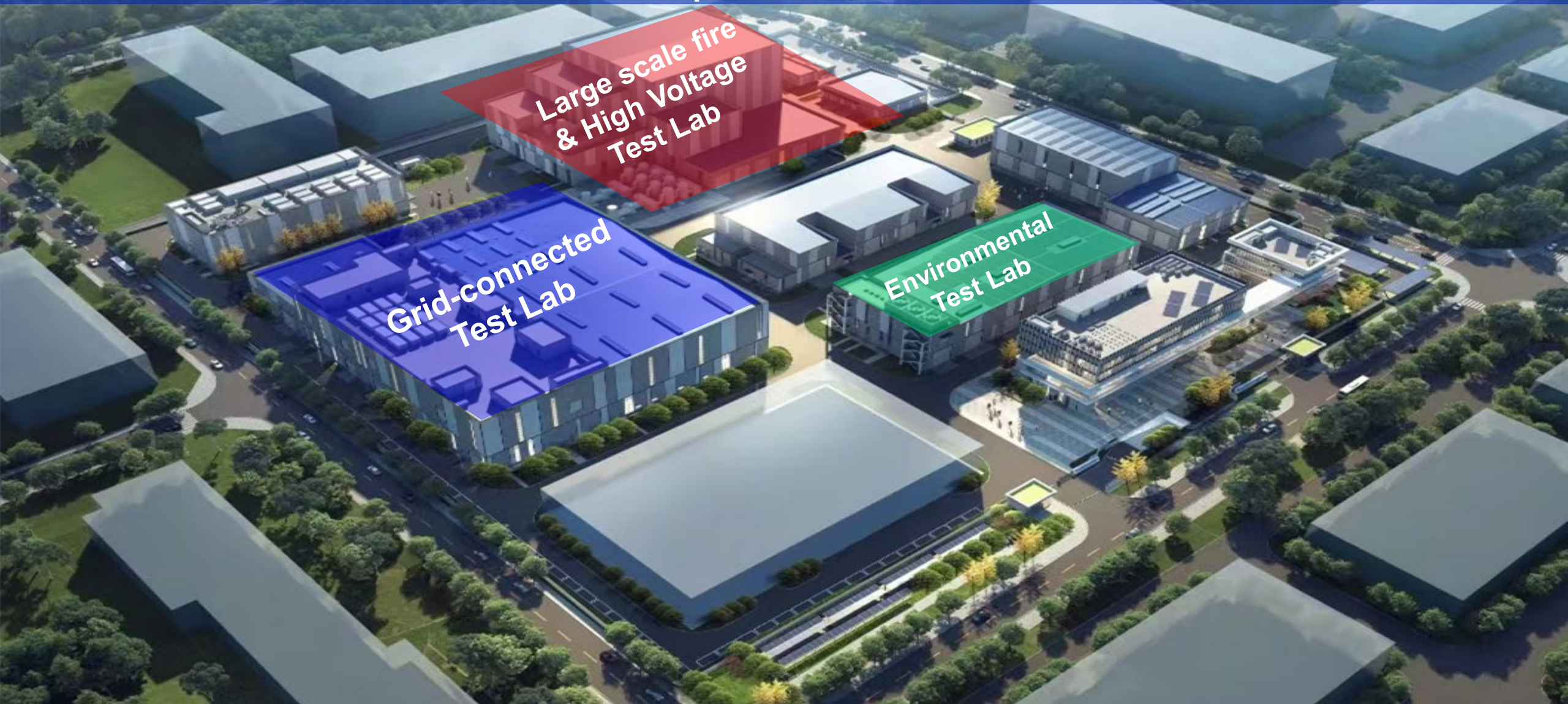
Grid Connection Test

Cell	Module	Subsystem	System (Rack & Container)
☐ Vibration test	☐ Vibration test	☐ Vibration test (Masterbox)	☐ Condensed water test
☐ Mechanical impact test	☐ Mechanical impact test	☐ Connector Connection Strength Test(Cooling unit)	☐ Temperature shock test
☐ Cycle performance test	☐ Cyclic test	☐ Test of plug-in and unplug times of electrical plug-in	☐ IP level test
☐ Expansion force test	☐ Expansion force test	☐ Temperature shock test (UPS/Cooling System)	☐ Hygrothermal cycle test
☐ Storage performance test	☐ High temperature storage test	☐ High temperature aging test (UPS/Cooling System)	☐ Salt spray test
☐ Temperature shock test	☐ IP level test	☐ High temperature floating charge test (UPS)	☐ High temperature charge/discharge test(55/45/35℃)
☐ Overcharge and overdischarge test	☐ Temperature shock test	☐ etc.	☐ Low temperature charge/discharge test(0 /-10/-35 ℃)
☐ **etc.**	☐ etc.		☐ etc.

Test and Validation for Grid Level Durability

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World first High Voltage(35KV-50MW) Grid Connection Test Lab (Xiamen, China)
Start Operation from 2025



CATL BESS Test & Validation Video

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