

Huawei FusionSolar Utility Solution Introduction

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34+ GWh 600+ GW FusionSolar Smart String Grid Forming ESS & PV Solution

Company Introduction

Gained Worldwide Recognition

1+ GWh
RO BESS Projects by 2025

34+ GWh
BESS Shipment by 2024

600+ GW
Inverter Shipment by 2024

40+ GW
STS Shipment by 2024

4.2+ GWh
EU BESS Shipment

3.5GW_{Solar} + 4.5GWh_{BESS}
Largest On-grid Hybrid Plant

400MW_{Solar} + 1.3GWh_{BESS}
Largest Microgrid Plant



HUAWEI Smart String Grid Forming PV & ESS Solution Panorama

All-architecture safety

ESS: Proactive safety from cell to grid
PV: Three-level safety on the DC side

All-scenario Grid Forming

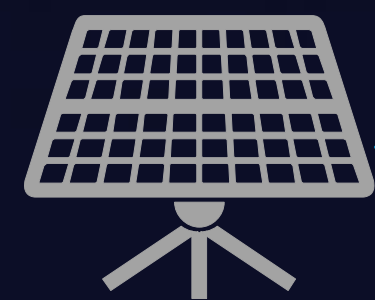
ESS: Increasing the proportion of
new energy access by 40%+

All-lifecycle cost-effectiveness

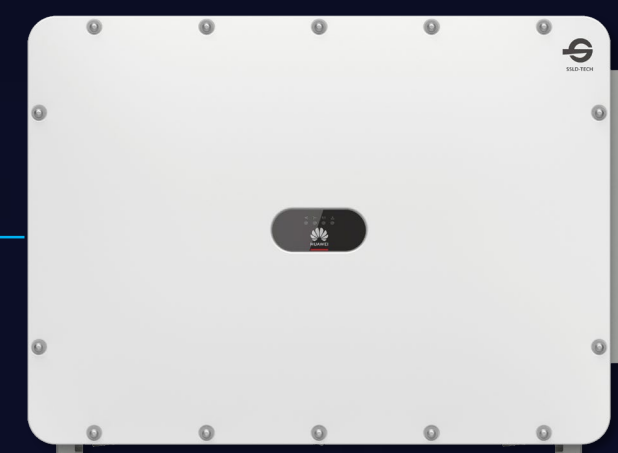
ESS: Better investment, ROI increased by 3% to 8%
PV: High availability, high efficiency, low failure rate,
energy yield increased by 1%+

All-rounder Smart O&M

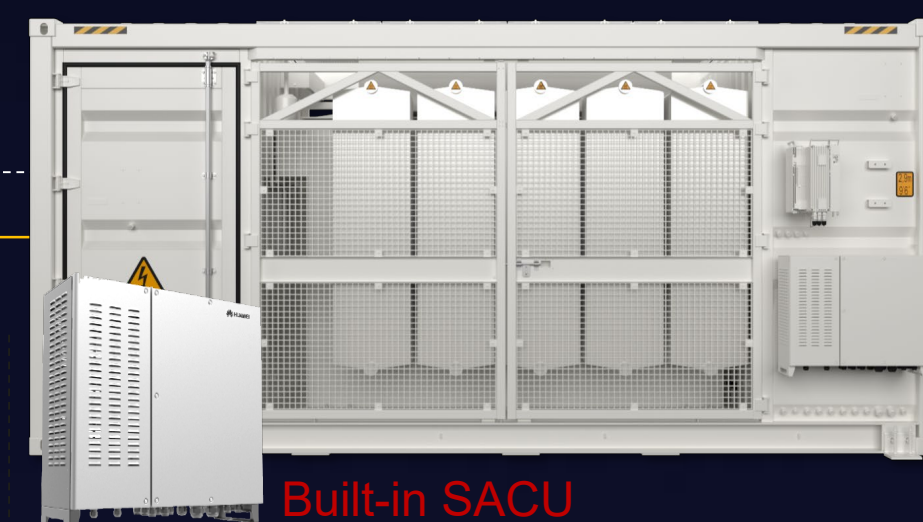
PV & ESS: O&M efficiency increased by > 50%



PV module



Smart String Inverter
SUN2000-330KTL-H1



Built-in SACU
Smart Transformer Station (STS)
JUPITER-9000/6000/3000K-H1



Smart Power Plant Controller (SPPC)
SPPC2000-A01/A02



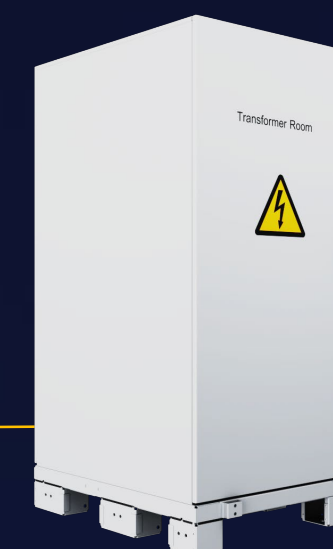
Smart Plant Management System
SPMS2000



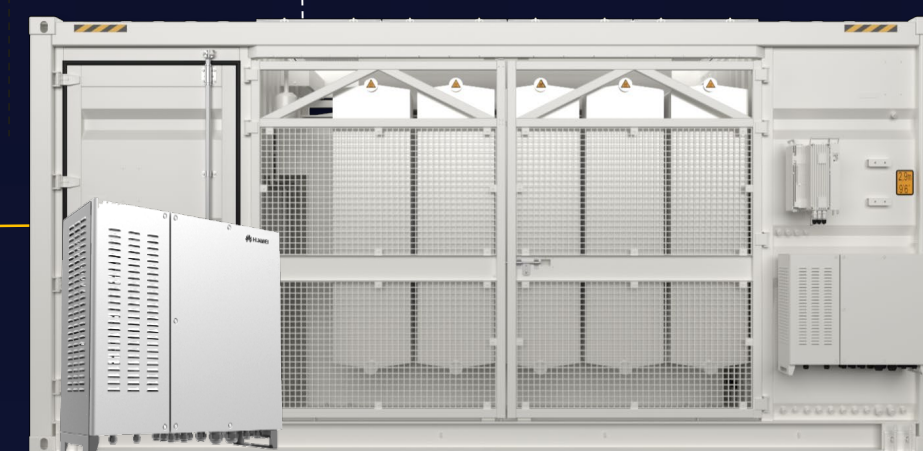
Smart String Grid Forming ESS 2.0
LUNA2000-4472-2S
LUNA2000-5015-2S
LUNA2000-2236-1S
LUNA2000-2507-2S



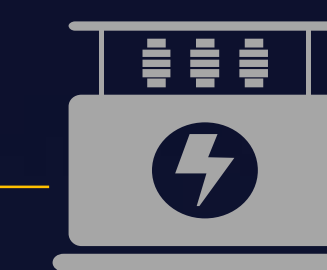
Smart Power Control System(PCS)
LUNA2000-213KTL-H0



Distribution Transformer
DTS-200K-D0



Smart Transformer Station (STS)
STS-3000/6000K-H1, Jupiter-9000K-H0
JUPITER-9000/6000/3000K-H1 built-in SACU



Step-up transformer



Grid

— DC power cable
— AC power cable
- - - Communications cable

BESS C2G (cell to grid), Solar M2G (module to grid), building end-to-end safety architecture from component level to system level

BESS safety: Enhancing ESS plant safety from cells to grids to ensure long-term product reliability from design to application



1

Higher cell test standard

Needle no catch fire
Drop no leak liquid



2

Battery pack thermal runaway non-diffusion

Metal shell withstand temperature
1500°C +



3

Rack-level directional smoke exhaust

Transportation, commissioning,
smoke exhaust ensure safety



4

Container-level directional explosion

2m above the ground
No injury



5

System-level seismic reliability

5000 km multi-section transportation +
random vibration

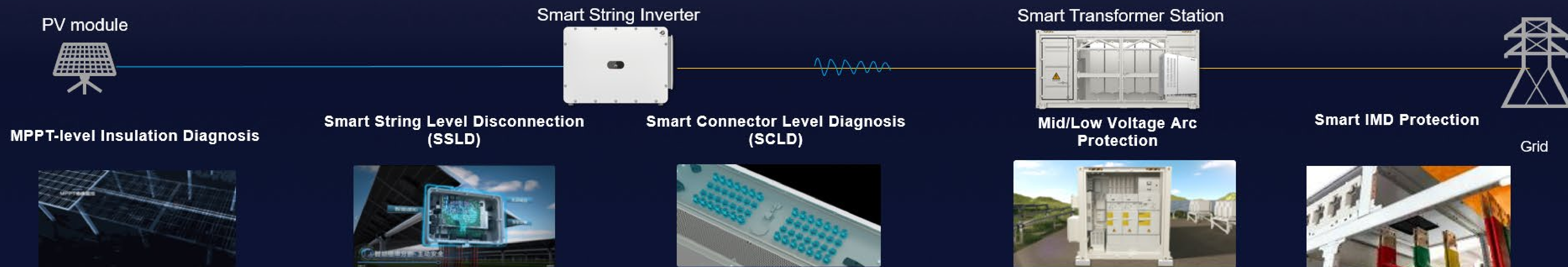


6

String dual-level architecture

High-through active power no
derate, No current backfeed

Solar safety: Enhancing Solar plant safety from modules to grids to ensure effective response to extreme environments

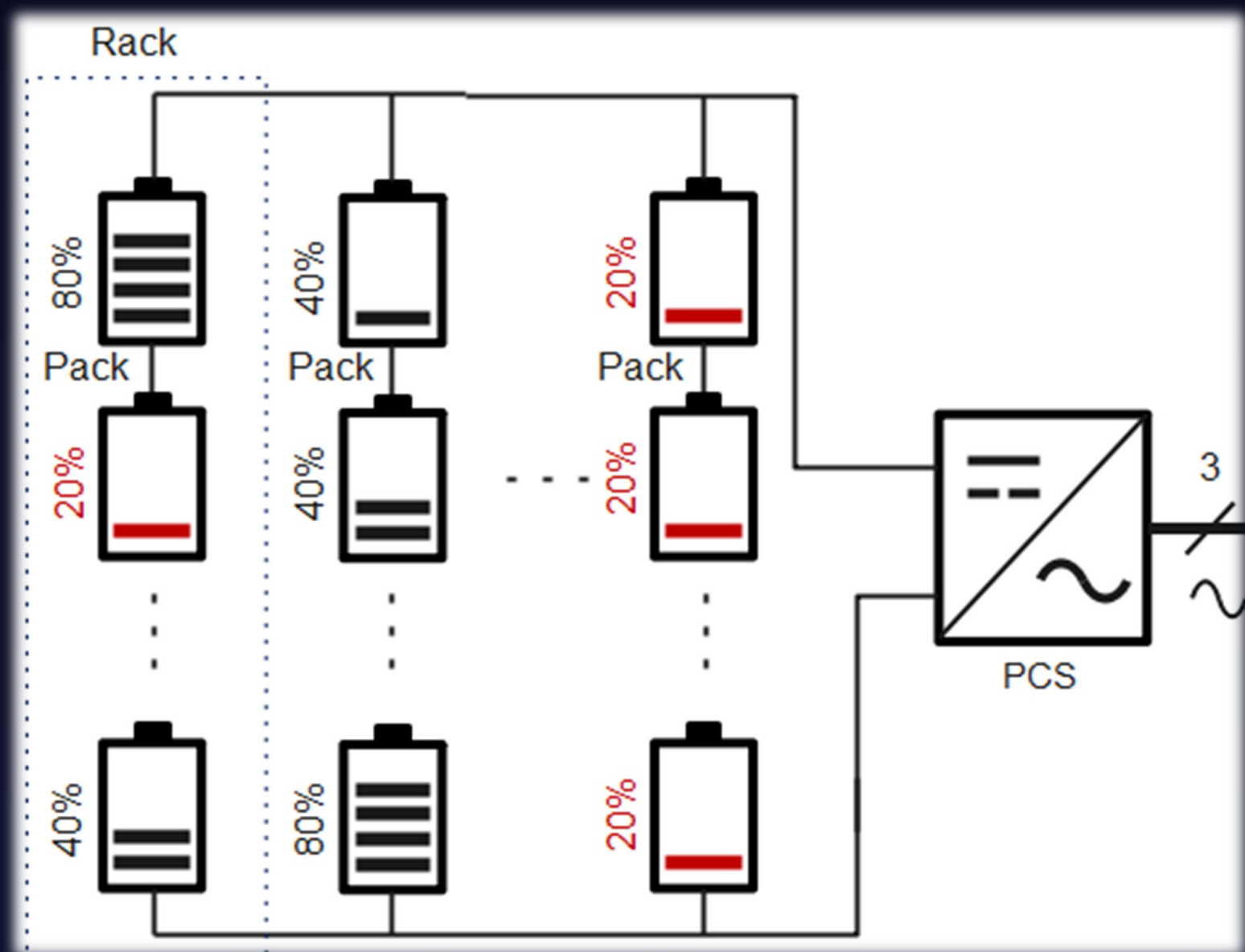




Unique Pack-level Optimization, Rack-level Optimization, improving the energy yield of the entire life cycle by 8.9%+

Higher discharging
capacity

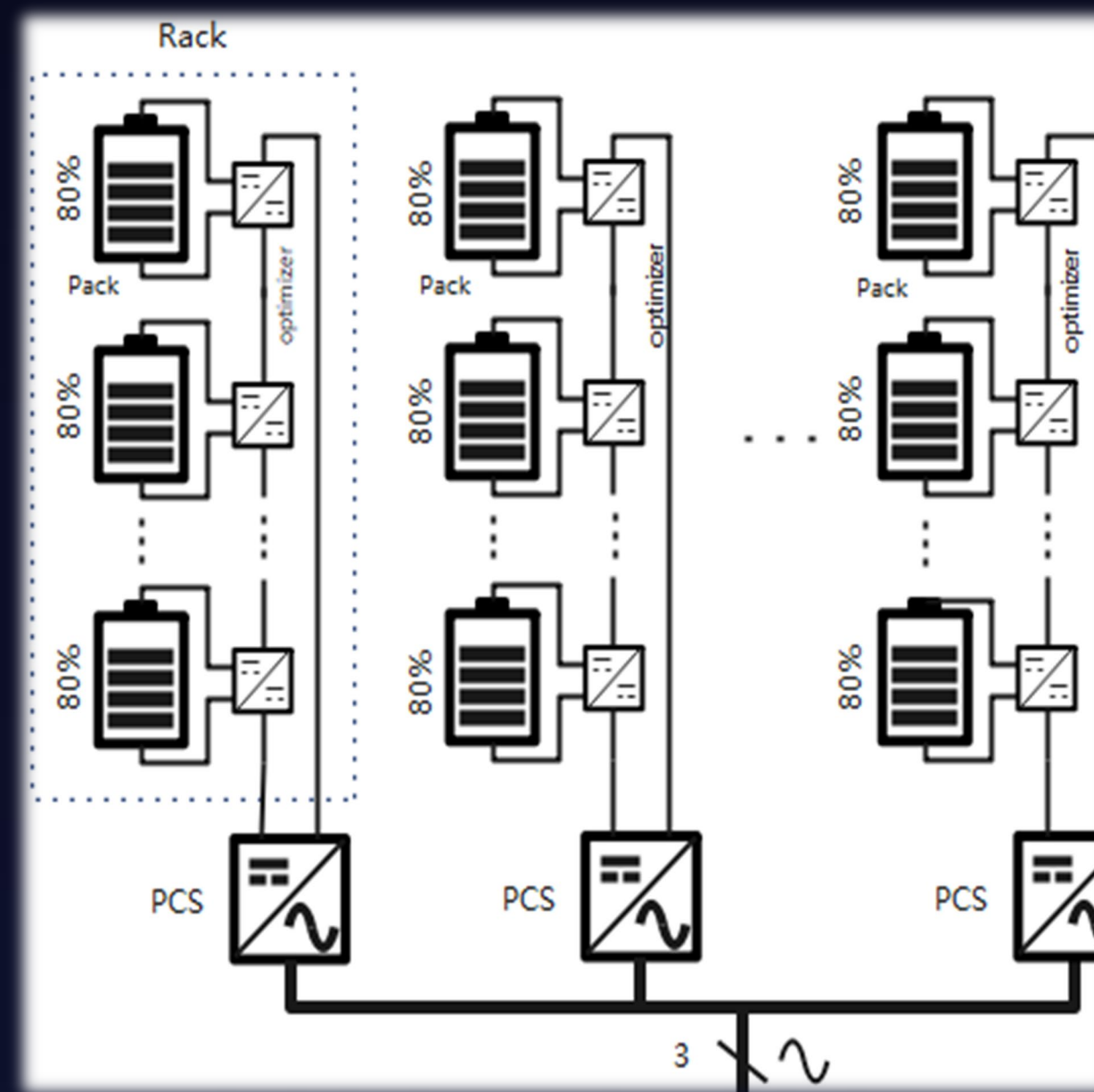
Traditional Solution



- No Pack Optimizer
- No Rack Optimizer

SOC inconsistency is obvious and cannot be fully discharged

Huawei Solution



•Pack-level Optimization

Life cycle increased discharge capacity > 1.7%

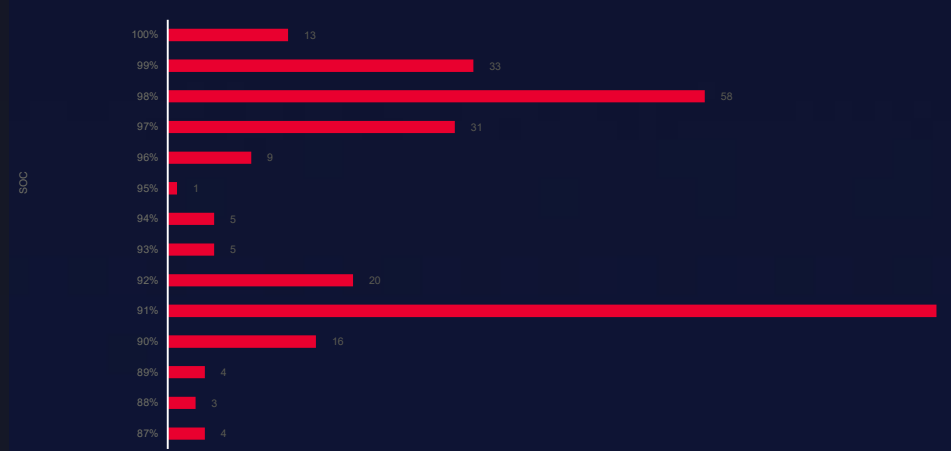
•Rack-level Optimization

Life cycle increased discharge capacity > 7.2%

High SOC consistency, and 6.37% more discharge capacity in the first year

50MW/100MWh
Operate for one
year @Hubei

Charging cut-off SOC-
Inconsistency



Discharging cut-off SOC-
Inconsistency

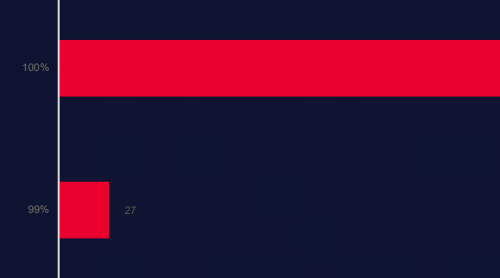


DOD = Average charging SOC – Average discharging SOC = 87.97%

* The preset charge and discharge range is 5% to 100%.

50MW/100MWh
Operate for one
year @Hubei

Charging cut-off SOC-
Almost 100%



Discharging cut-off SOC-
Almost 5%



DOD = Average charging SOC – Average discharging SOC = 94.34%

* The preset charge and discharge range is 5% to 100%.



The industry's highest RTE of 91.5%, increasing the discharged energy by 1%+ at the same initial configuration

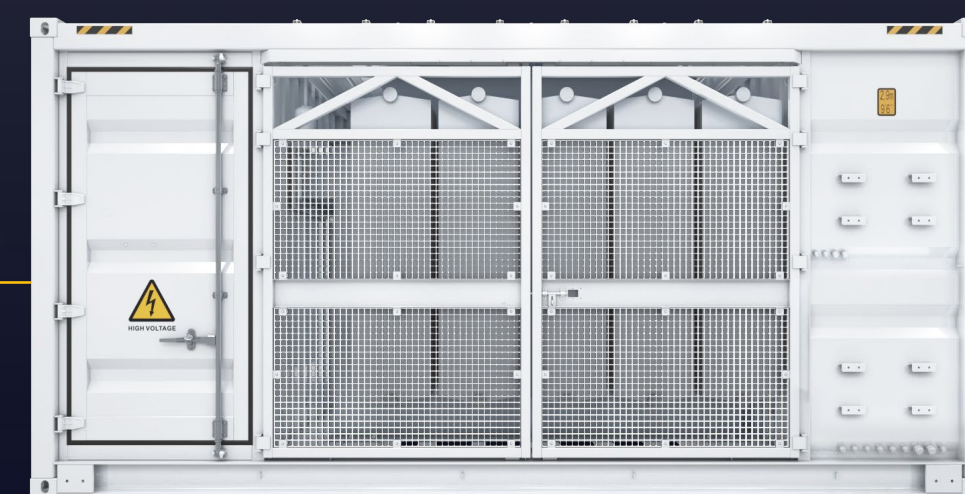
Higher RTE



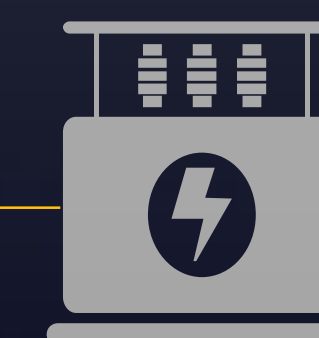
Smart String Grid Forming ESS
LUNA2000-4472-5015-2S



Smart PCS
LUNA2000-213KTL



Smart Transformer Station
JUPITER-3000/6000/9000K-H1



Step-up station



Grid

Conventional solutions

89.5%

On the low-voltage AC side,
including auxiliary power loss

Single-stage PCS, 690 V AC output,
higher loss at the same power level



Huawei's solution

91.5%

Higher RTE
System configuration reduced by
1%+
with same discharged energy

@0.25C, low-voltage AC side,
including auxiliary power loss
800 V AC PCS, flexible switching between single-
stage and two-stage architectures
Smaller current, voltage difference, and loss

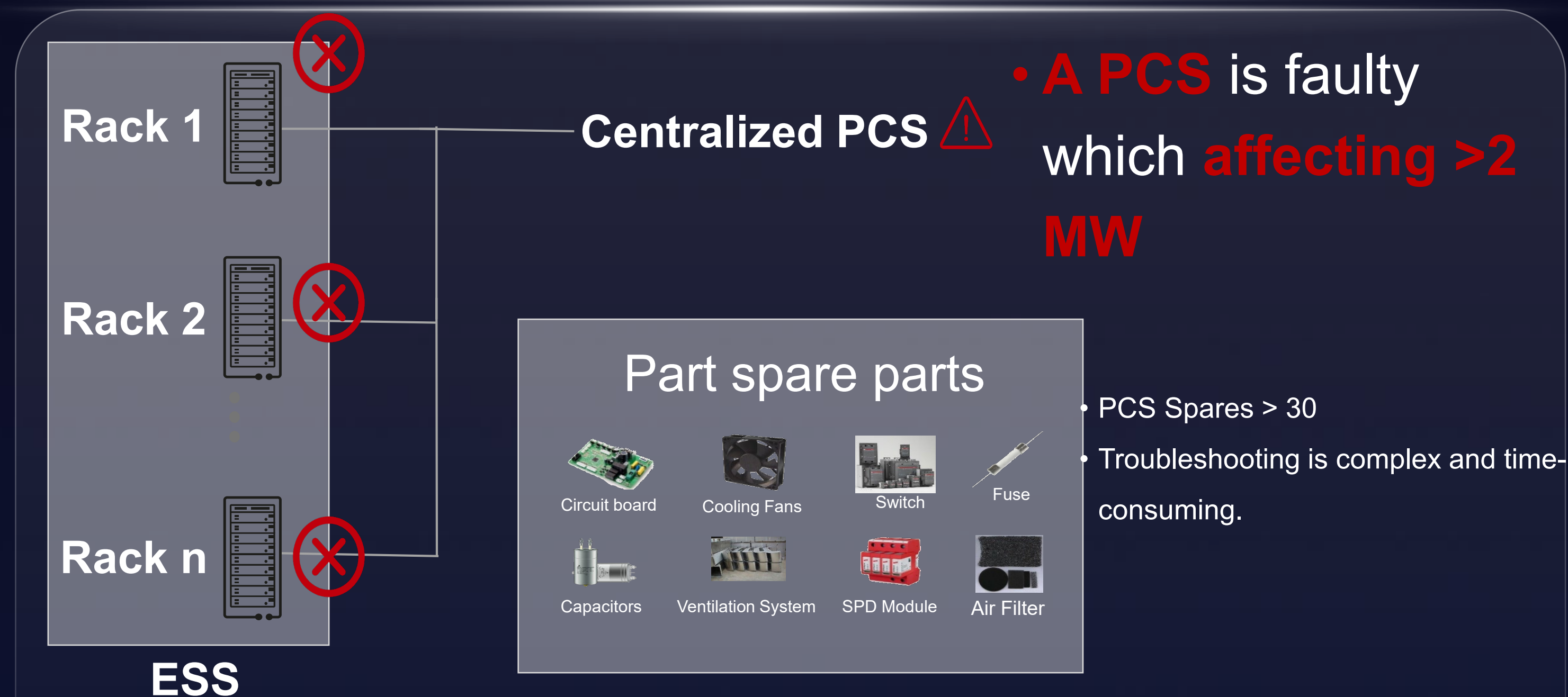


Modular design, fewer vulnerable parts, 99.9% system availability, ensure reliable power supply

Higher Availability

Traditional ESS

A single PCS manages the entire ESS



Low availability and long maintenance time

100MW/150MWh

Singapore

Statistic Period :

2022.12 - 2023.07

113

Hazardous Faults

92

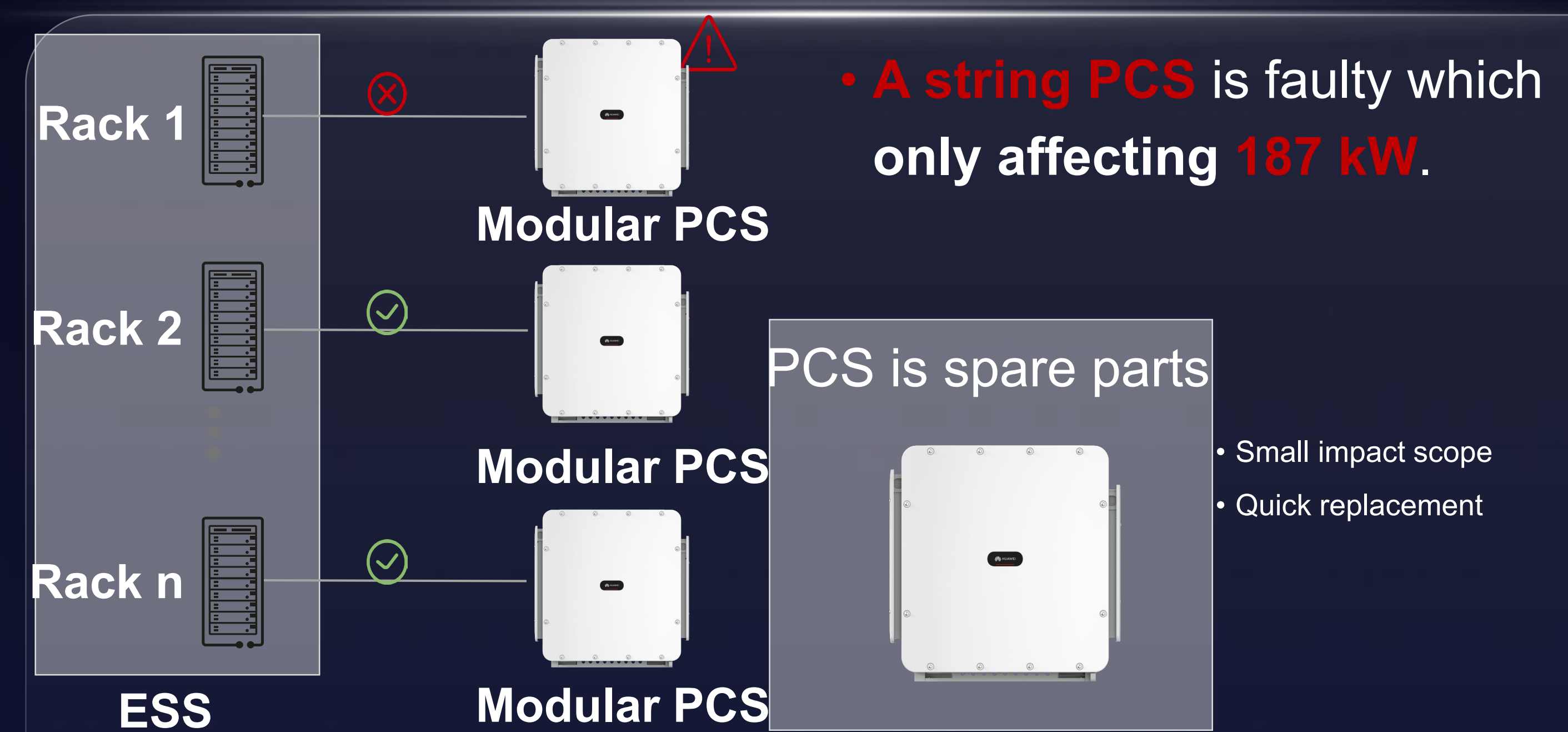
Critical Faults

Average Availability

98.8%

Huawei Solution

A single PCS manages the one battery rack



High availability and reliable power supply, ensuring revenue

115MW/146MWh

Singapore

Statistic Period :

2022.12 - 2023.07

0 Fault

Average Availability

100 %

* 100 MW @ 1C, revenue difference of about \$3.65 million / 10 years



Quadruple SOC active balanced, Constant Power Output @100 ~ 0% SOC, Increases the constant power discharge duration by 6%

100% Constant Power
Output

Traditional Solution

Constant output power: **100% ~ 6% SOC**

Power/MW



6% more ESS
configuration
when constant output
needed



Batteries are not managed in a refined manner
Output capability depends on the worst performing battery



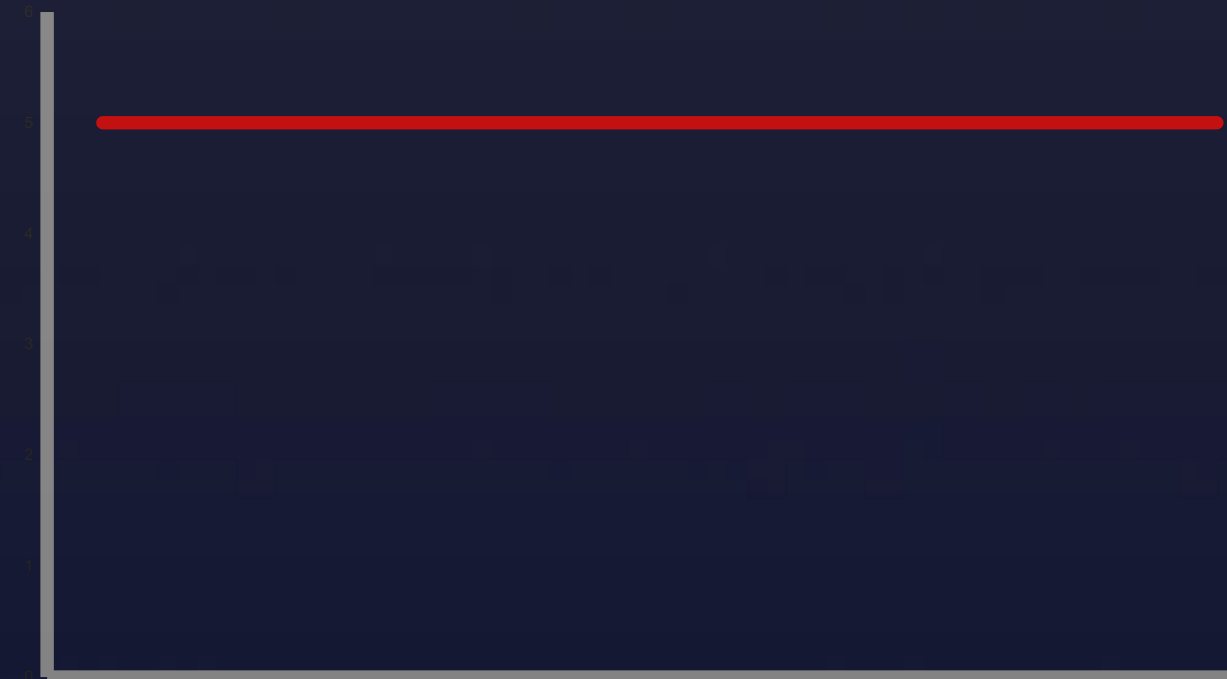
Insufficient overload capacity of electrical equipment

*Conditions: ambient temperature 25°C, 0.5C

Huawei Solution

Constant output power: **100~ 0% SOC**

Power/MW



No need for extra
ESS Reducing CAPEX
by **6%**

Quadruple SOC balanced, maximizing the discharging capability

Pack-level
SOC balance
(BCU)

Rack-level
SOC balance
(CMU)

System-level
SOC balance
(SACU)

Array-level
SOC balance
(SPPC)



Pack-level high-precision SOC: More accurate and safer charge and discharge, 2%+ energy discharged

Stronger SOC Calibration
Capability

Conventional solutions: SOC precision > 5%

Low voltage/current sampling precision

Voltage sampling precision: ± 10 mV;
current sampling precision: ± 0.25 A

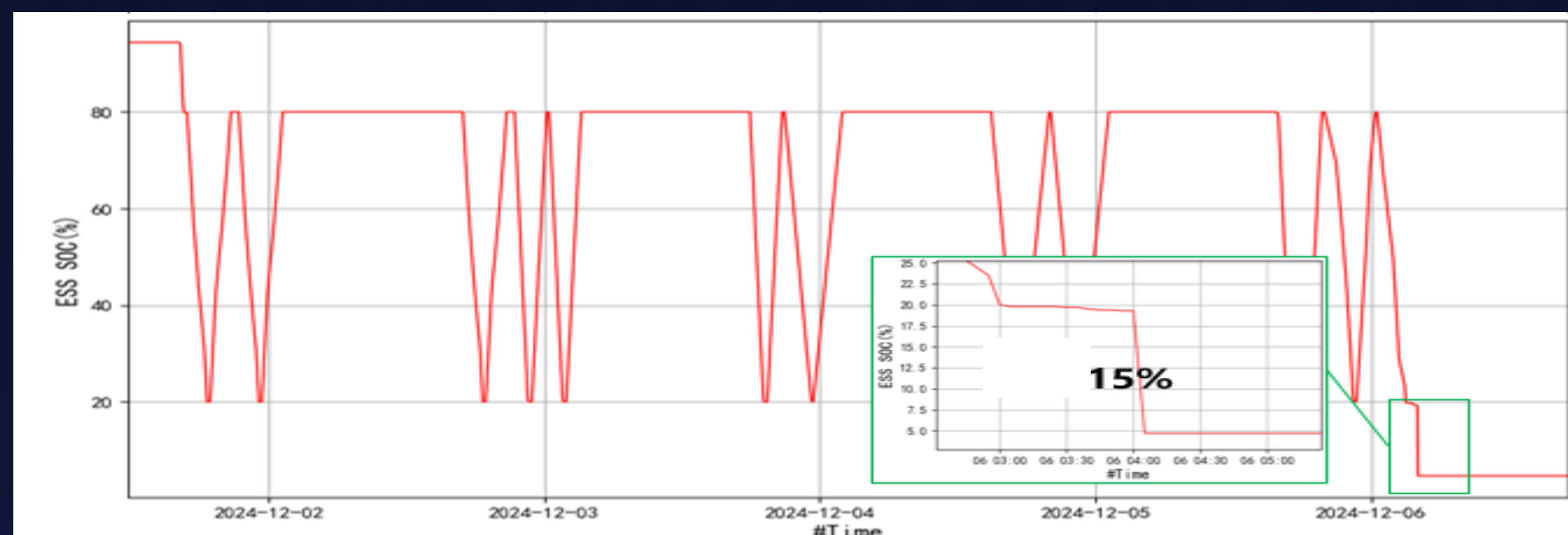
Conventional management chips

Low computing power, slow speed,
slow transmission, and low precision

Device-free cloud big data platform

Algorithms without self-learning capabilities, and no
minimum guarantee available in complex working conditions

SOC fluctuation by 15% at the start and end of charging in a project



Huawei's solution: SOC precision < 3%

High-precision voltage/current sampling

Voltage sampling precision: ± 3 mV,
current sampling precision: ± 0.1 A

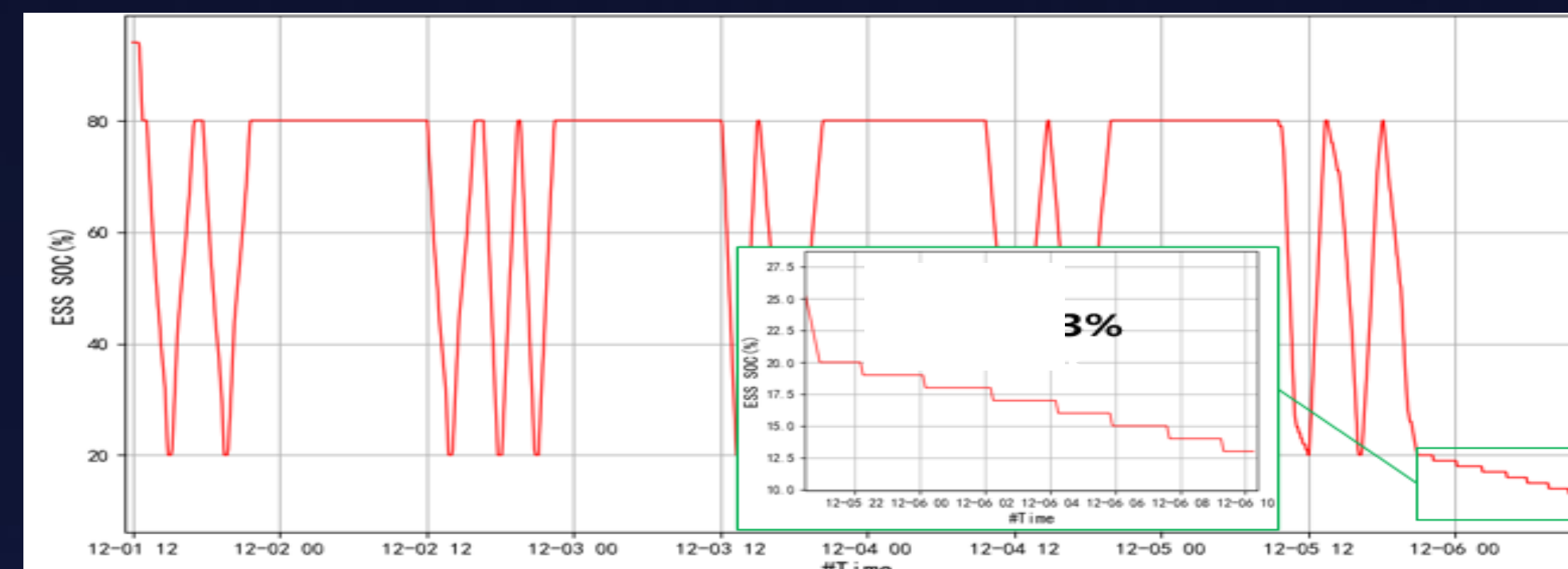
Dedicated high-precision BMIC chip

Dedicated battery management chip: higher
precision, and cell-level automatic balancing

Self-learning algorithm

High-precision battery modeling, parameter
identification, and feature extraction

SOC precision < 3% in a project



The nameplate capacity is not equal to the available capacity, Huawei target is to achieves the best return of investment within the whole lifecycle

$$\text{IRR} = \frac{\text{Safety factor (C2G safety)} \times \text{System availability} \times \text{Revenue in different markets}}{\text{Lifecycle investment (CAPEX+OPEX)}}$$

IRR: internal rate of return

Capacity Market

(government subsidy)

Lifecycle revenue increased by **5-7%**

⑤

Forward/Futures Market

Lifecycle revenue increased by **10-15%**

②③⑤

Spot Market

Lifecycle revenue increased by **15-20%**

①②③④⑤

Ancillary Services Market

(or Balancing Market)

Lifecycle revenue increased by **25-30%**

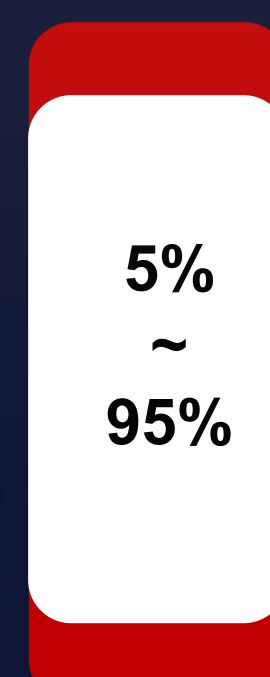
①②③④⑤

1

Operation within a wider SOC range



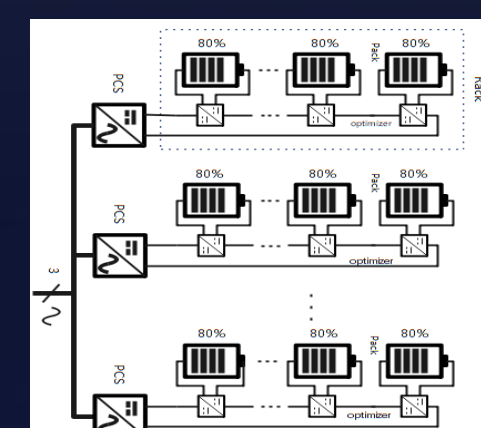
VS.



2

Higher discharge efficiency

Pack optimization improves discharged energy by **2%**.
Rack optimization improves discharged energy by **4%**.



3

Higher efficiency

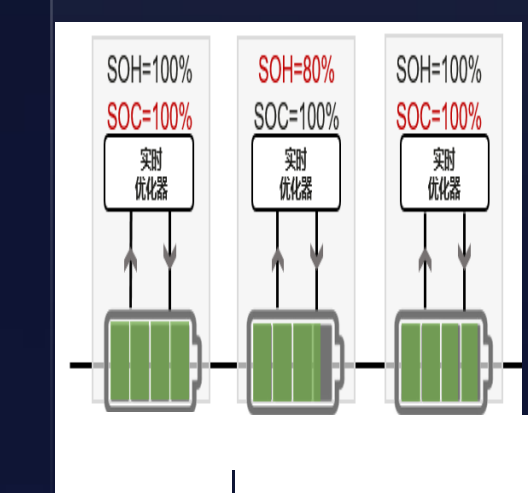
800 V AC PCS vs. 690 V AC PCS
(less AC cable loss)

RTE: **91.5%** vs. 89.5%
On the low-voltage AC side,
including auxiliary power loss

4

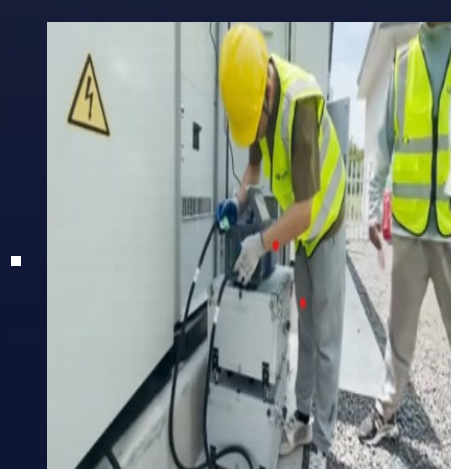
Higher SOC control precision

SOC precision **< 3%**



< 3%

VS.

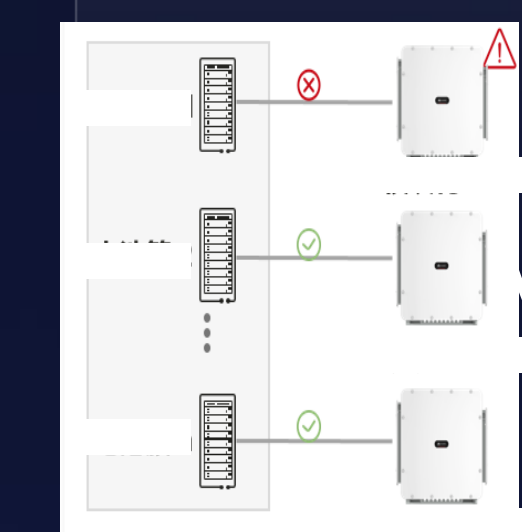


< 5%

5

Higher availability

Availability 1% higher than the central PCS



VS.

