Huawei Digital Power, Your Sustainable Partner for Building a Low Carbon Smart Society

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1 Huawei Overview

Huawei: Leading provider of ICT infrastructure and smart devices

195,000
employees

170+
countries and regions

No. 96
on Fortune Global 500

No. 2
in R&D investment

54.8%
of employees are in R&D

Vision & mission

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

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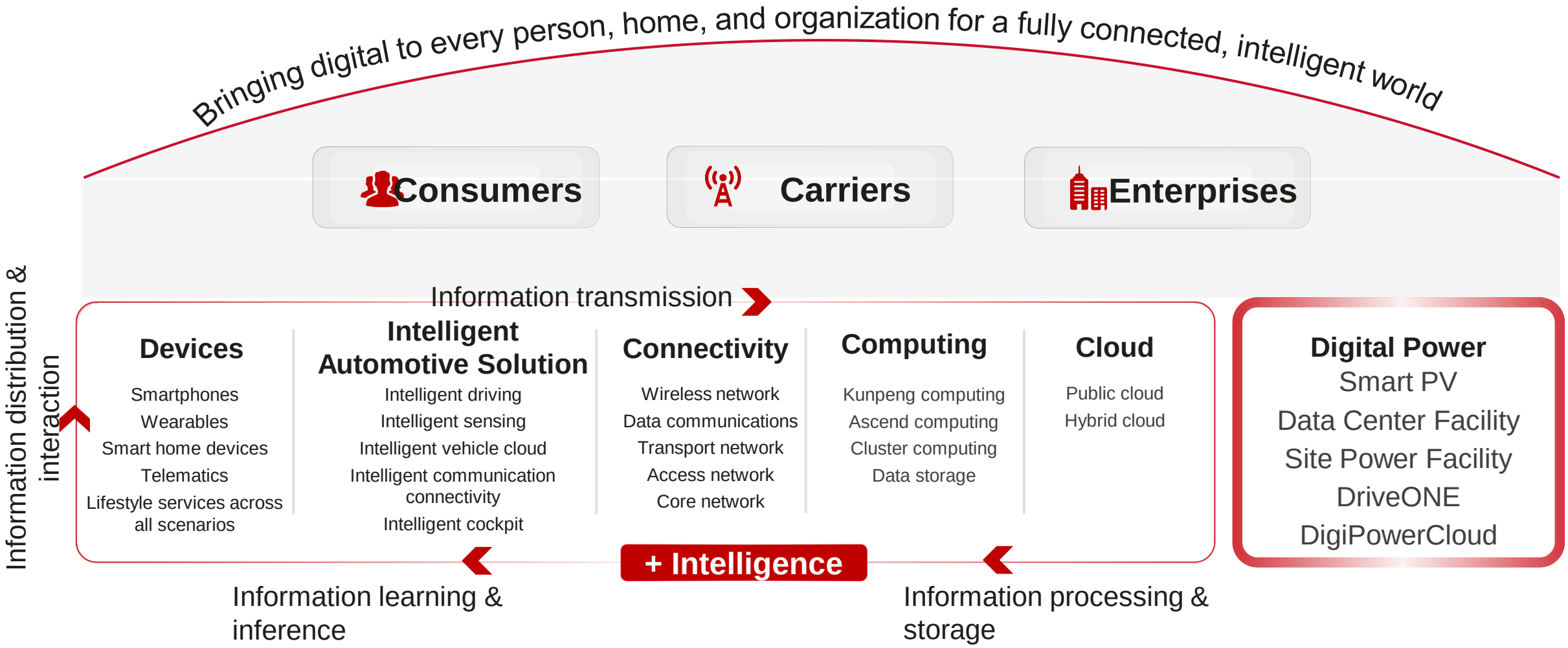
Focusing on ICT to provide products, solutions, and services to three customer groups



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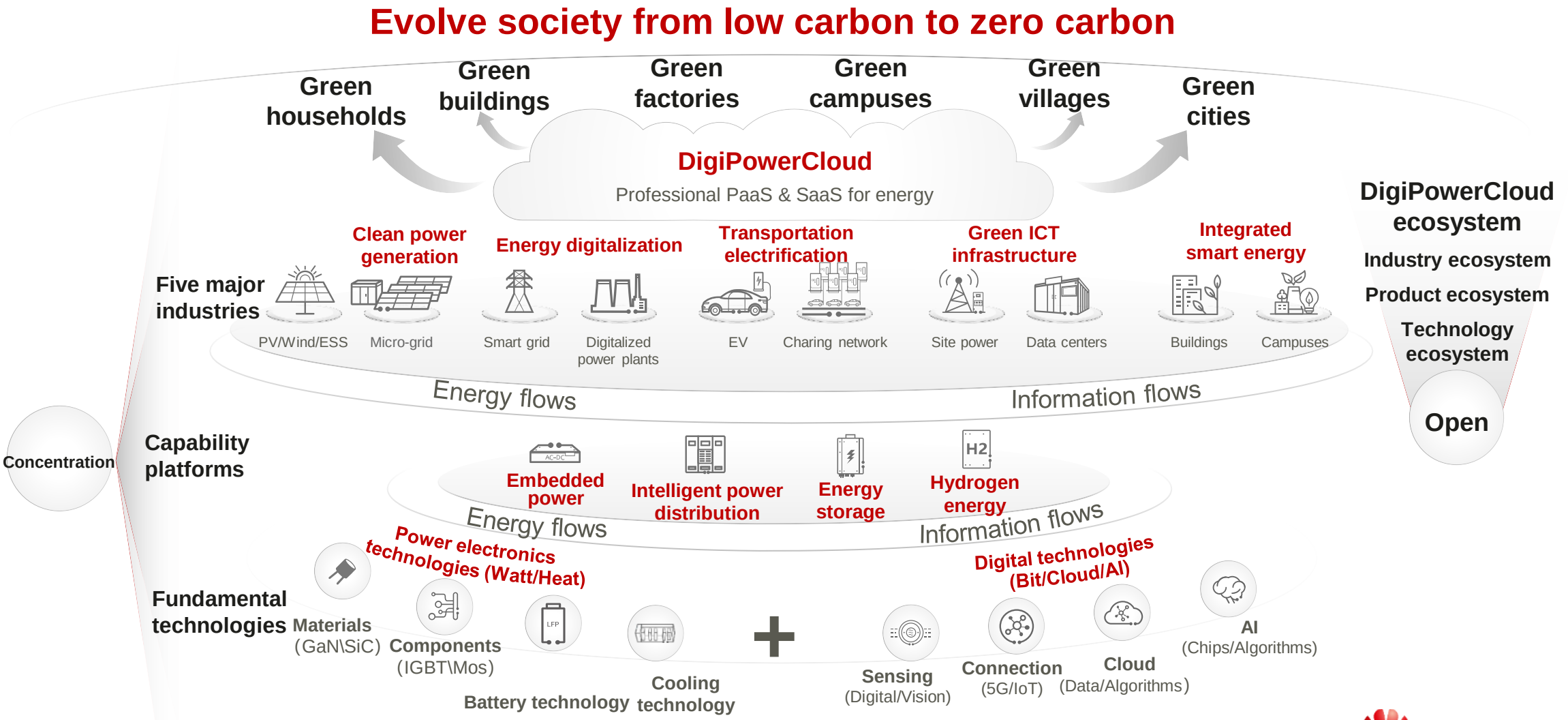
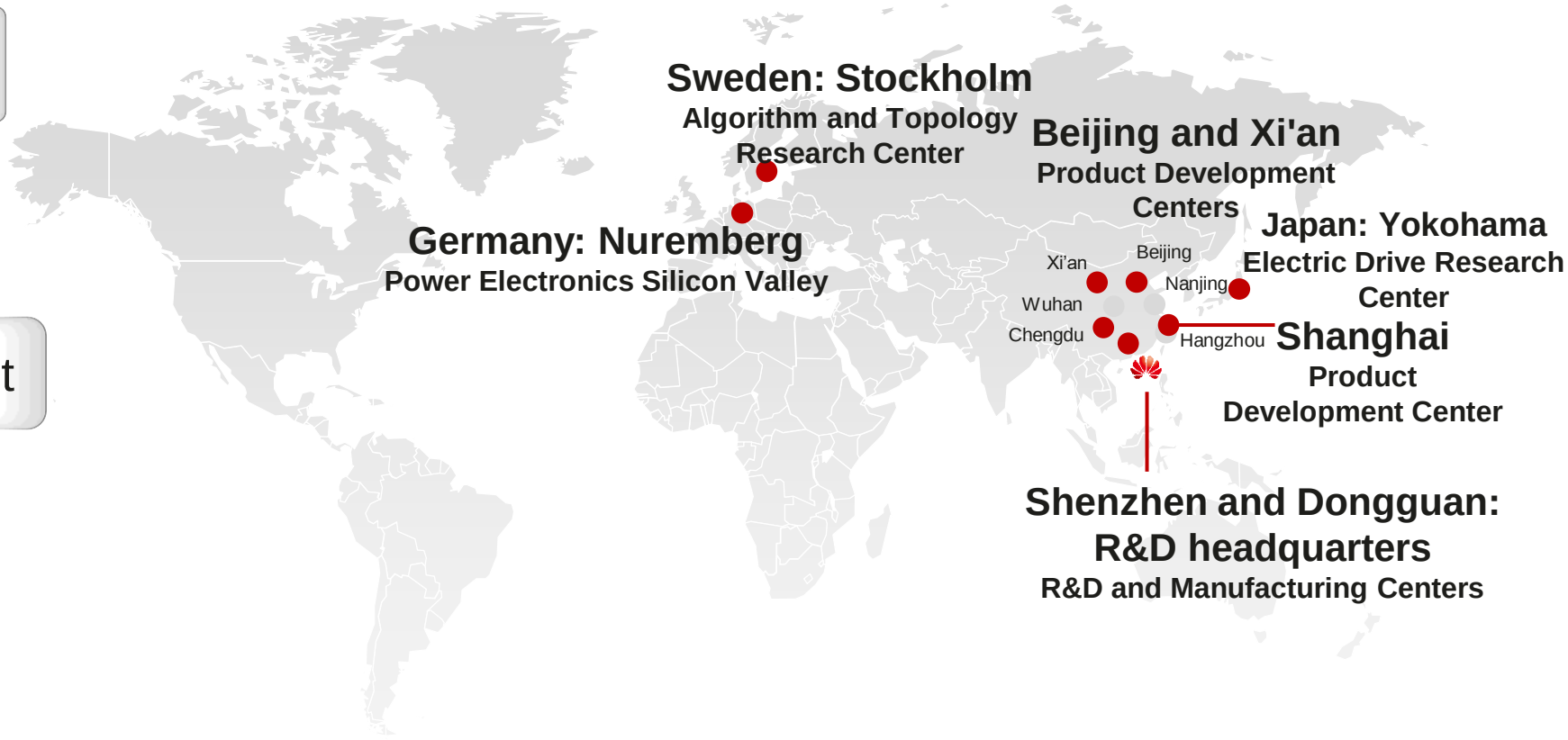
Digital Power strategy overview

Developing clean energy, promoting the digitalization of traditional energy, integrating digital and power electronics technologies, and converging information and energy flows to drive energy revolution for a better, greener future



Digital Power Global Platforms: Leveraging the domain specific advantages globally to keep leading

- 6000+ employees
  60% R&D
- 12 R&D centers
- 10%+ R&D investment
- 1300+ patents

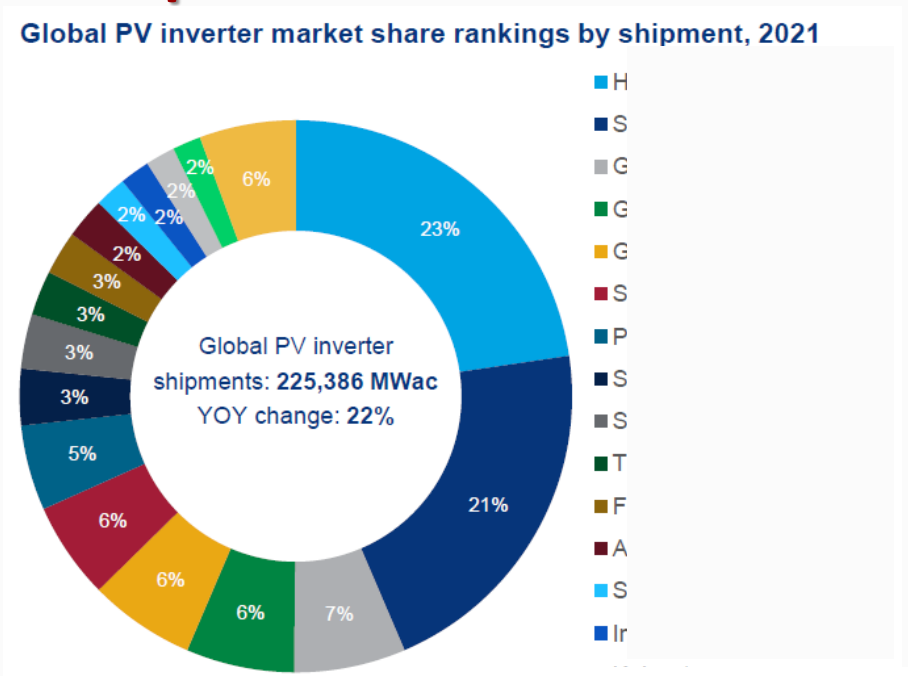


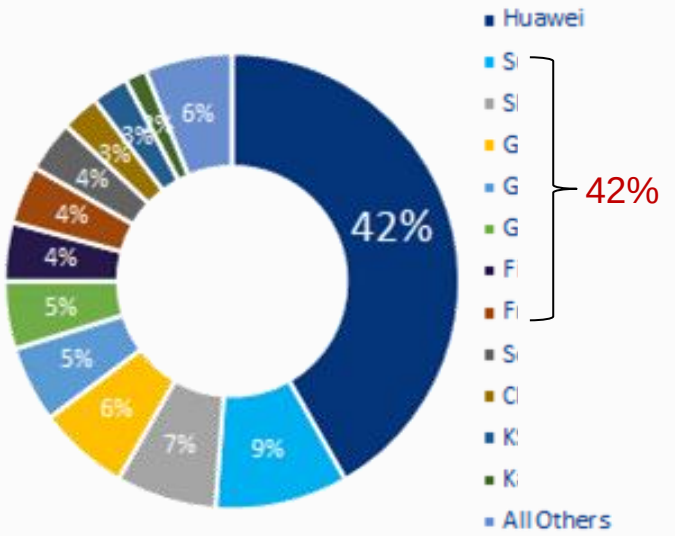
Huawei Inverter Shipment Is Leading in the World

No.1 Global Inverter Shipment since 2015 to 2021

Global Market Share ~23%

Leading Market Share Globally

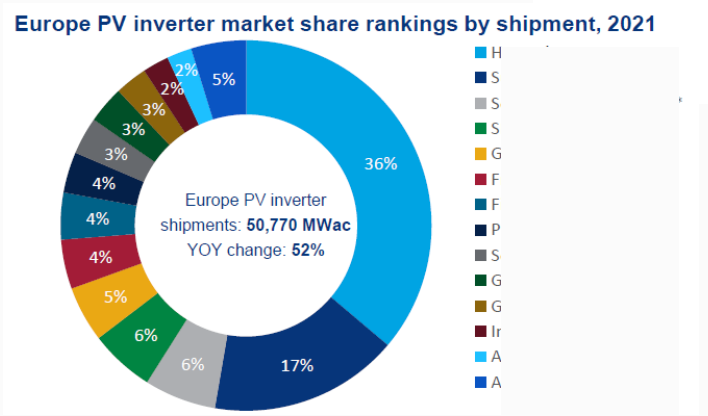


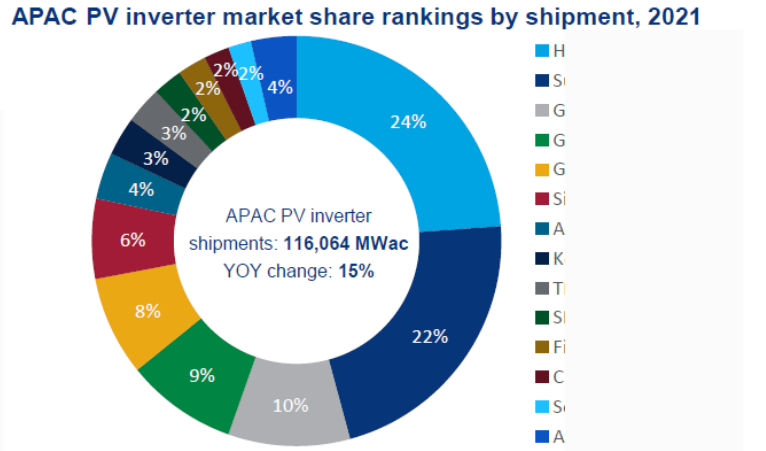


HUAWEI String inverter market share >

Total market Share of the 2nd to 8th

String inverter market share ~42%





Source: Wood Mackenzie

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Huawei Supporting Global Customers Success with Optimal LCOE (cost/kWh)

*– **X**-Elio, Spain*
***Capacity** - 800 MW*
***COD** - Dec. 2019*
4.06 ***cents/kWh***

***Location** – Shaanxi, China*
***Capacity** – 250MW*
***COD** - Sep. 2019*
Solution** - **Bifacial PV Modules
+ SUN2000-175KTL-H0

Europe
Ukraine 69MW
Netherlands 40MW
Spain 800MW

China
>72% MKT share
in Sihong Top Runner
67% MKT share
In Qinghai UHV project

Japan
大崎市147MW investor from Thailand *(Smart I-V Curve Diagnosis)*
岩手県 55MW
福島県 29MW
茨城県 23MW

Mexico
Jalisco 270MW
Tlaxcala 220MW
Sonora 220MW
Chihuahua 120MW
Durango 117MW

Saudi Arabia
SAKAKA 300MW
Auction 2.4 cents/kWh

Bangladesh
58MW

Thailand 2021
DG & Residential 970MW
Utility 110MW

Vietnam
inh Thuan 58MW
inh Thuận 50MW
aklak 800MW

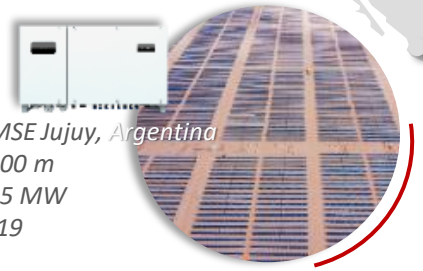
Indi
Bhadla 300MW
PPA 3.4 cents/kWh
Pavagada 275MW
Bikanner 250MW
Binega 180MW
Tamilnadu 100MW

Pursat & Kampong Chhnang 230MW
Banteay Meanchey 39MW

Malaysia
Johor 65MW
Kedah 50MW
Perak 49MW

Africa
Zambia 54MW
Kenya 50MW
Malawi 26MW
Ghana 20MW
Uganda 10MW

Argentina
Cauchari 315MW
Cordillera 90MW



***Location** - JEMSE Jujuy, Argentina*
***Altitude** – 4,200 m*
***Capacity** – 315 MW*
***COD** – Q3. 2019*

***Location** - Perak, Malaysia*
***COD** - Oct. 2019*
***Solution** - SUN2000-185KTL-H1*

The Global Leading Inverter Brand

Smart PV Deployed ***225.3GW+***

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Quick Response by Local Service Team and Local Warehouses

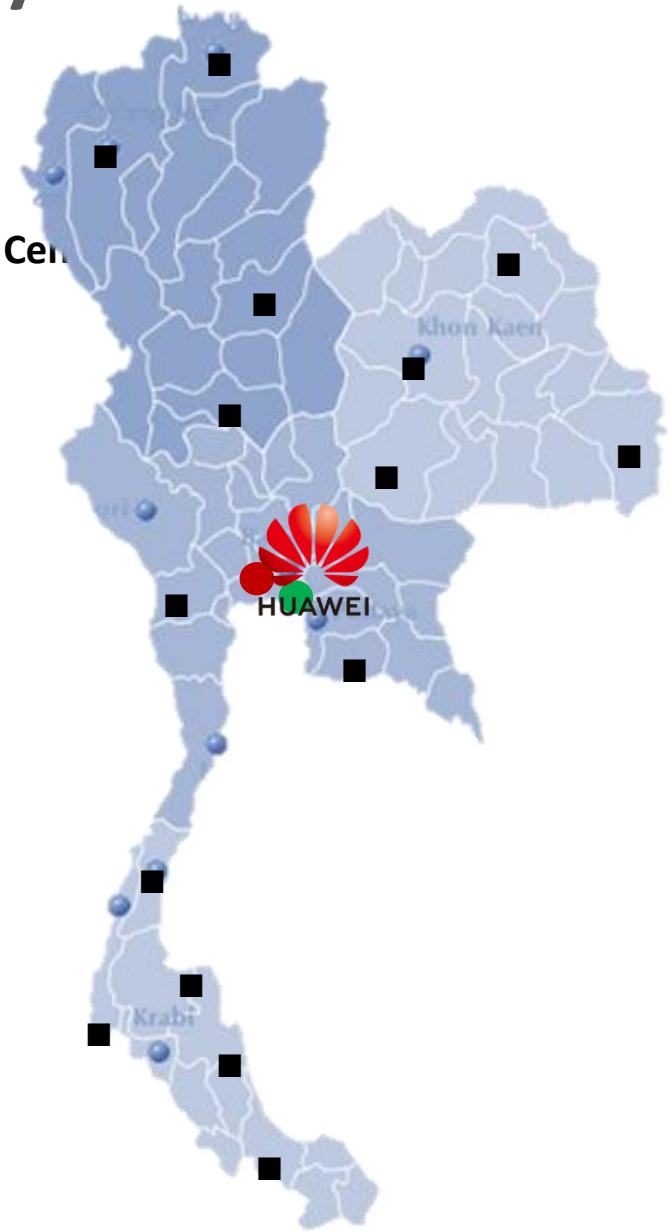
1 Country Technical Assistance Ce

1 Country Warehouse

15 City Warehouses

2 Training Centre's

2 Business day - shipment



Country Technical Assistance

Centre

Country Warehouse

City Warehouse

City Name of W/H Location	Supported project	Management model
Chiangmai Chiangrai Chumporn KhonKhaen Nakornratchasima Nakornsawan Nakornsrithammarat Phuket Pitsanuloke Ratchaburi Rayong Sakonnakorn Songkhla Surathani Ubonratchathani	All projects	SPMS (Spare Parts Management Service)

Smart PV: All-scenario PV & storage solution, accelerating the shift to zero carbon generation

PV & storage Utility solution

Challenges: High PV LCOE and weak grid problem

Trend: **PV & storage coordinated solution,creating the smart PV generator and accelerating the shift to zero carbon generation**

C&I solution

Challenges: High electricity cost and low system safety

Trend: **Green C&I power solution with integrated PV & storage architecture, entering thousands of C&I fields and adapting to different scenarios**

Residential solution

Challenges: High safety risks and low system safety

Trend: **"1+3+X" architecture, increasing the self-consumption ratio and reducing the electricity cost**

Microgrid solution

Challenges: High diesel generators cost and pollution

Trend: **Comprehensive off-grid fuel removal PV & storage solution, helping bridge the energy divide**

Utility-scale PV plant

The largest single-site PV project, Qinghai, 2.2 GW

Commercial & industrial PV rooftop

Longyang road metro station PV project, Shanghai, 3.66MW

Residential PV rooftop

X

Family green power PV & ESS project, Dongguan, 30kW

Island off-grid PV power station

Maritime bureau PV & off-grid energy supply project, Zhuhai, 24kW

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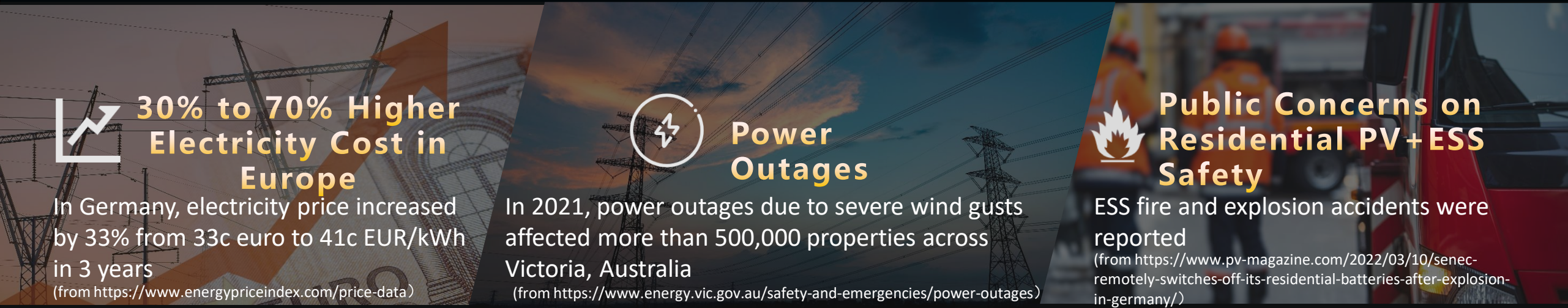
Smart Residential and C&I PV Solution for Better LCOE

The Requirement of New Solution for Residential Scenario is Urgent



30% to 70% Higher Electricity Cost in Europe

In Germany, electricity price increased by 33% from 33c euro to 41c EUR/kWh in 3 years

(from https://www.energypriceindex.com/price-data）

Power Outages

In 2021, power outages due to severe wind gusts affected more than 500,000 properties across Victoria, Australia

(from https://www.energy.vic.gov.au/safety-and-emergencies/power-outages）

Public Concerns on Residential PV+ESS Safety

ESS fire and explosion accidents were reported

(from https://www.pv-magazine.com/2022/03/10/senec-remotely-switches-off-its-residential-batteries-after-explosion-in-germany/）

Residential Solution 3.0: Green Life Reimagined

Optimal Electricity Cost

- Optimizer increase 5-30% yield
- 10% more usable ESS energy

Active Safety

- Module voltage shutdown, RSD
- AFCI, < 0.5 shutdown

Better Experience

- One-Fits-All solution
- <5s auto physical layout mapping

1 + 4 + X

Smart Energy Controller

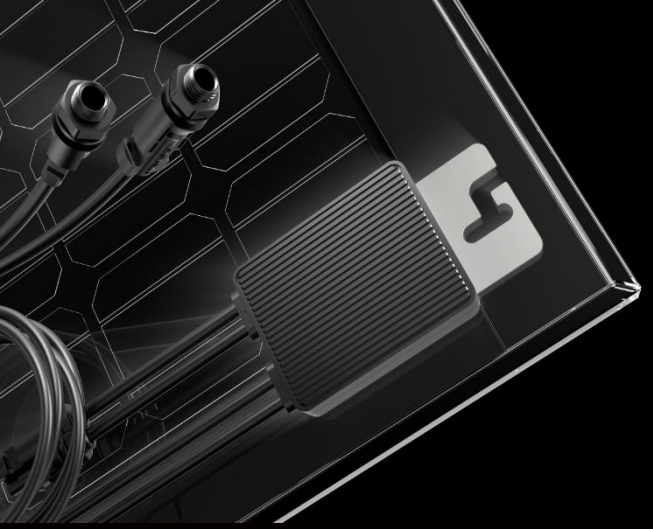
NEW Smart Module Controller

Smart String ESS

NEW Smart EV Charger

FusionSolar Smart PV Management

Smart Energy Home Ecosystem



Smart Module Controller

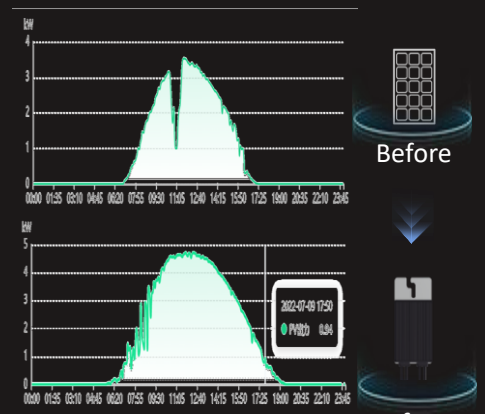
The Wonderful Option for Your Life

SUN2000-600W-P

Available now

Module-Level Optimization

5%-30% More Energy Output



Case from Japan

9.84% higher yields
with full configuration of optimizers

Maximized Rooftop Usage

Without optimizer

14kW

With optimizers

24kW

10% to 30% higher
PV capacity

Module-Level Shutdown

Safe Rooftop Voltage

Conventional VS Optimizer

NEC 2020
690.12

20V Voltage

10s Shutdown time

Ensure Installer & Firefighter Safety

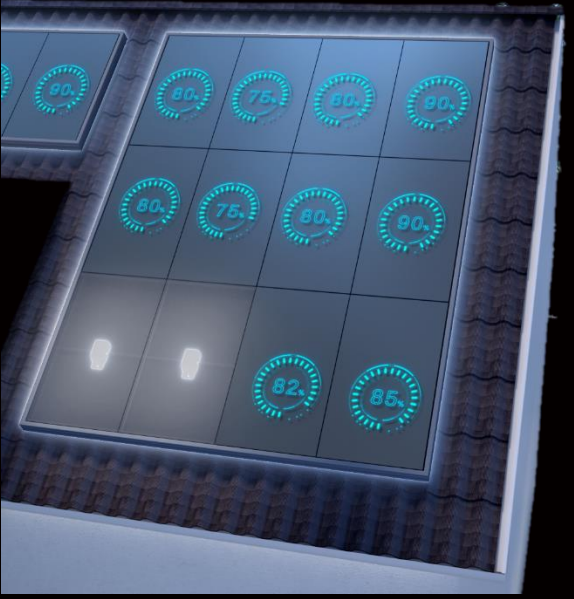
Two Main application scenarios

No Optimizer

+

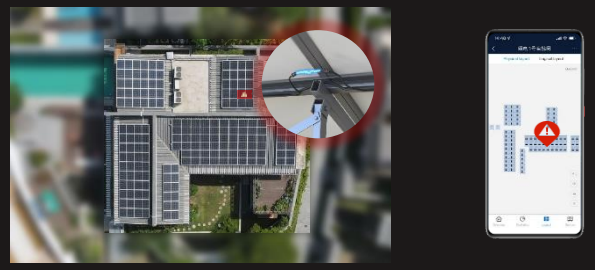
Full Optimizer

Cover more scenarios



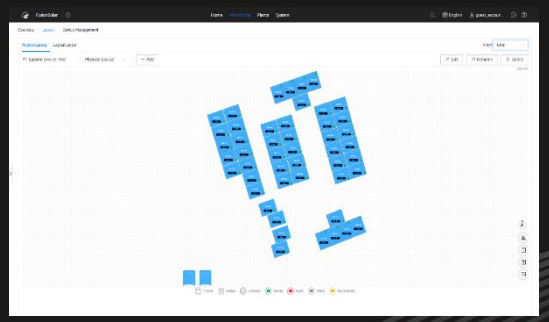
Digital Features for Better Experience

< 5min Troubleshooting



Pinpoint module disconnection on the APP

Multi-Physical Layout



Building 1

Building 2

Building 3

Building 4

Support up to 20 physical layouts for a system

Performance Detection

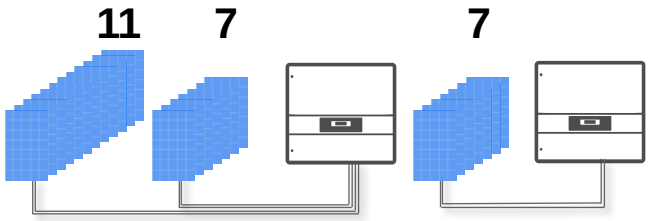
Identify modules in different colors

More Modules

with Long & Flexible String Design

Comparison Case

Other Solution



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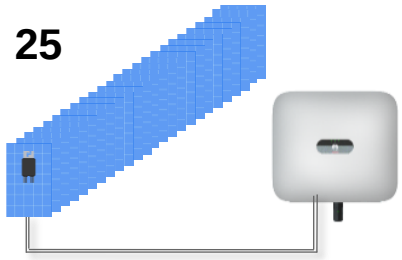


·Max. **200%** DC/AC oversizing for SUN2000-5KTL-L1 & 10KTL-M1

	SUN2000-3/5KTL-L1	SUN2000-5/10KTL-M1
Maximum DC power per string	5,000 W	10,000 W

PID Can Severely Reduce PV System Output by 30% or More

What is it?

- Potential Induced Degradation, a phenomenon that negatively affects power output of PV modules

What causes PID?

- Due to potential difference, anode ion (eg. Na+ ion) flows from the glass plate into the semiconductor material of the solar cell and affect the cell performance

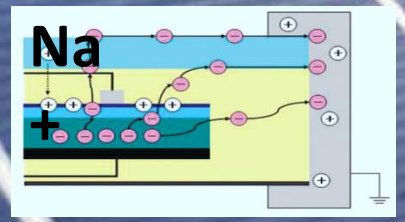
What is the negative impact?

- High humidity, high temperature and contamination

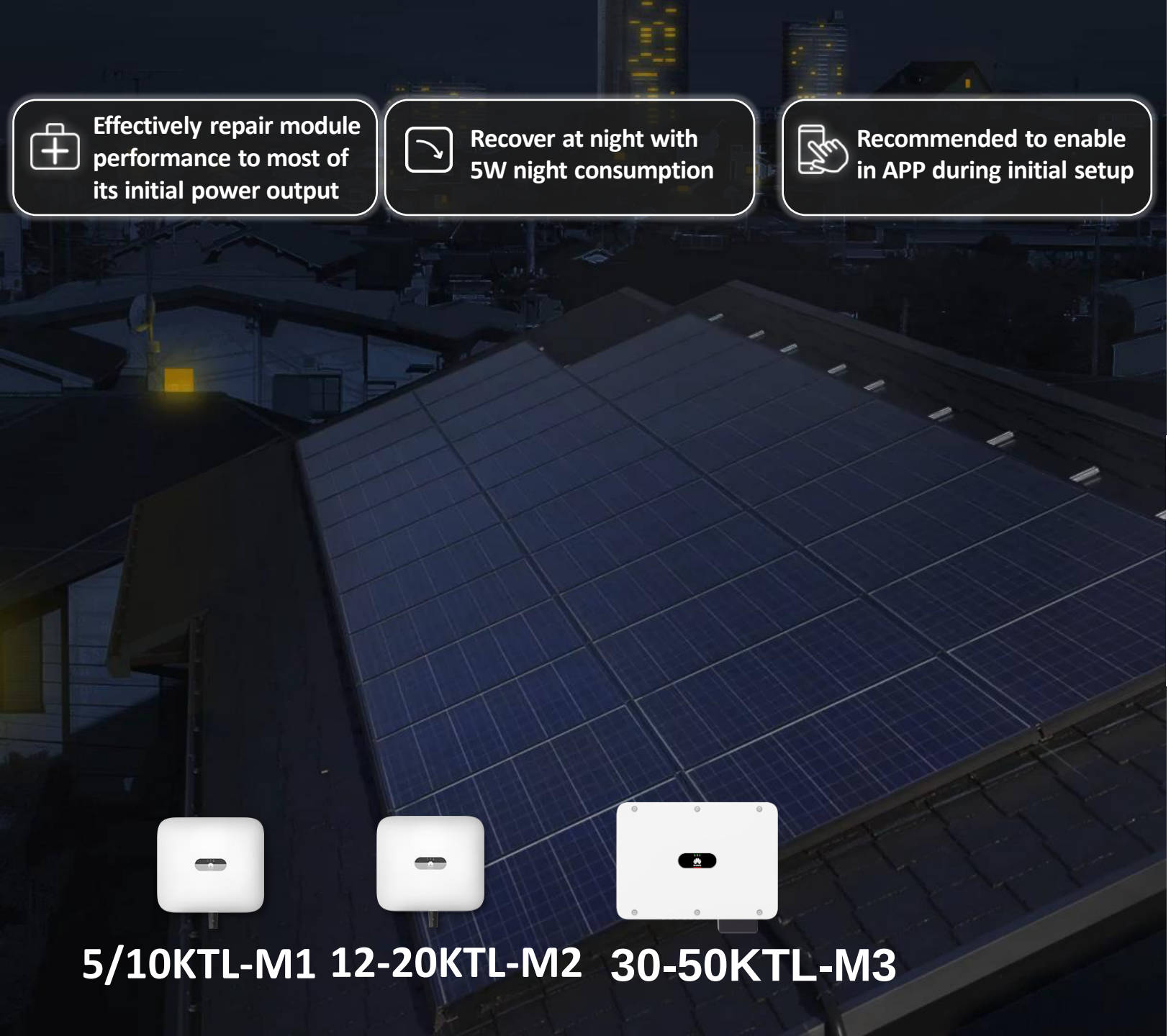
PID can significantly reduce the power output of a PV module by 30% or more

High Temperature

High Humidity



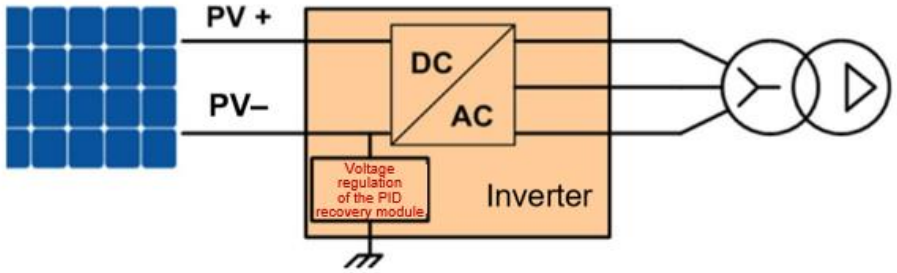
Negative ions migrate away while positive ions migrate toward cells



PID Recovery

Built-in to Secure Better Module Performance

When the inverters are off-grid at night, an offset DC voltage is applied between the inverter PV- and Ground. This effectively increases the voltage of the PV- string with respect to Ground



	Huawei Inverters	Vendor A
Built-in PID Recovery Module	✓	✗
Lower Capex & No Retrofit Required	✓	✗

Electric Arcing Is Threatening the Safety of PV System & Underlying Buildings

What is it?

- electrical breakdown of air that produces an prolonged electrical discharge

What causes Electric Arcing?

- Unreliable soldered joints within modules
- Broken PV cables
- Loosen PV connectors

What is the harm?

Can reach temperature of over 3000°C & easily start a fire

Arc Detection Challenges

Arc noise is generally weak and only accounts for 0.1% of the normal current signal, it is difficult to detect and often leads to missing detection

Inverter/Loads/Grid interference signals, as well as spectral overlay with normal current signal leads to faulty detection

AI Powered

Active Arcing Protection

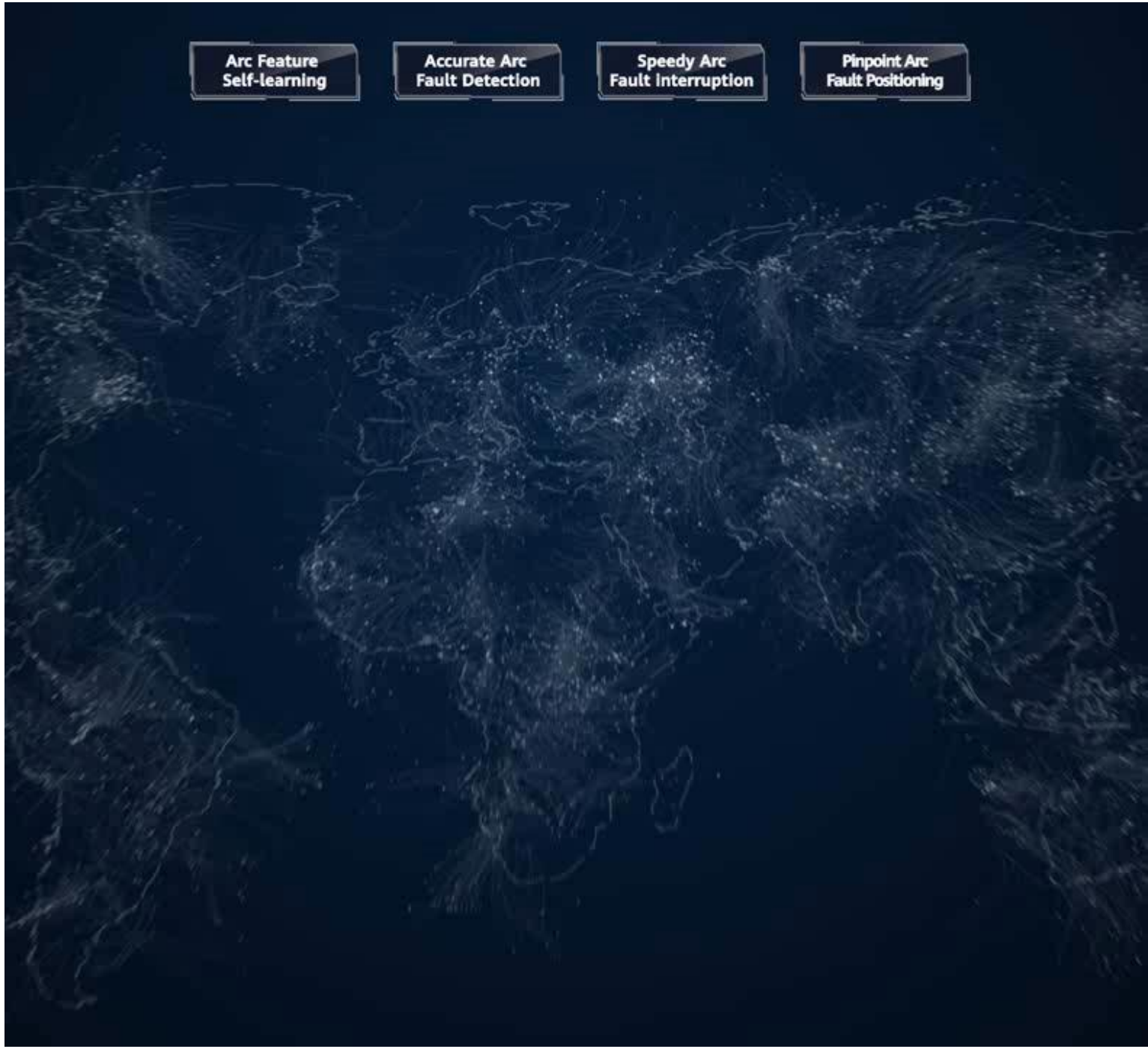
What is AI Powered AFCI?

- HUAWEI inverter keeps self-learning new arc feature to accurately protect system from arc fault, even under complex noise

Self-learning new arc features with AI model

Accurate arc fault detection via local neural network algorithm

Speedy arc fault protection by inverter shutdown in 0.5s



AI BOOST

AFCI disabled, arcing continuously posing fire risks

VS

AFCI function enabled, arcing extinguished in < 0.5sec

PV Arcing with/without AFCI Comparison

No Fuse or Other Quick-wear Parts, Inverter Touch Free

No Fuse No LCD No Button

Natural Cooling Verified by Telecom & Solar Application*

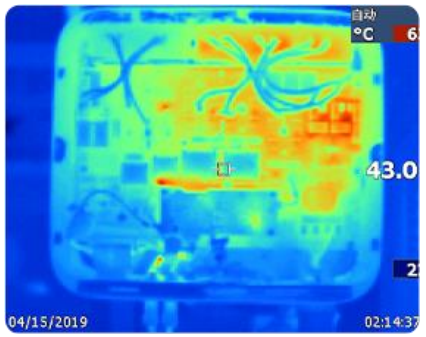
* For 3–10KTL inverter models

TUV verified: annual failure rate < 0.5%

Station Phase Ⅱ,
200 units, 963 running days
Failure Rate:
0.189%

Station Phase Ⅲ,
4939 units, 583 running days
Failure Rate:
0.252%

Station Phase IV,
1790 units, 207 running days
Failure Rate:
0.390%



High efficient thermal design to ensure low temperature within enclosure

Smart String Energy Storage System

Beyond+ Modular Design

5kWh 10kWh 15kWh

1~3 Optional Modules

Flexible module capacity configuration

1P/3P Inverters Supported

High voltage DC couple Solution

Up to 2 ESS

Operates in Parallel in 1 System

-25℃ ~ 55℃

Smart Thermal Management For Low Temperature Environment

LUNA2000-5/10/15-S0

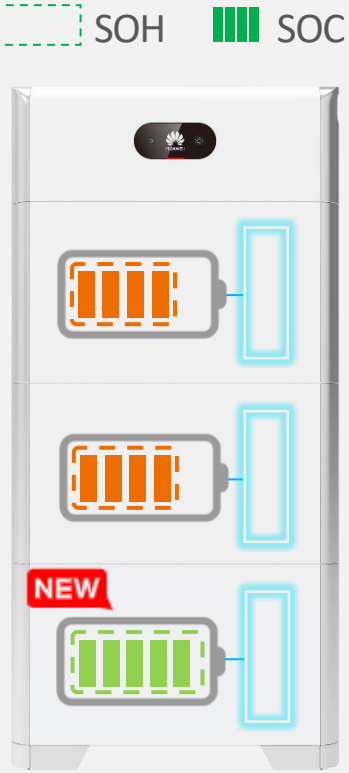
Modular + Energy Optimizer

New Installation Scenario

@100% @100%

Auto SOC Adjustment

Within 1 charging/discharging cycle



Expansion Scenario

Old Mixed with New

Easily Expand Your Capacity

New Battery pack could charge/discharge independently, avoid the influence from the old battery pack

No Pre-charge Needed When Apply New Battery Pack In System

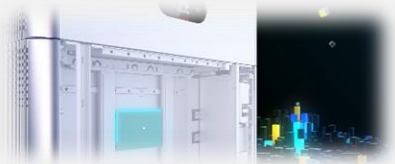
TÜVRheinland®

Modular +4 Level Safety Protection

LiFePO4 (LFP) cell

Cell Level Monitoring

0V at Ports



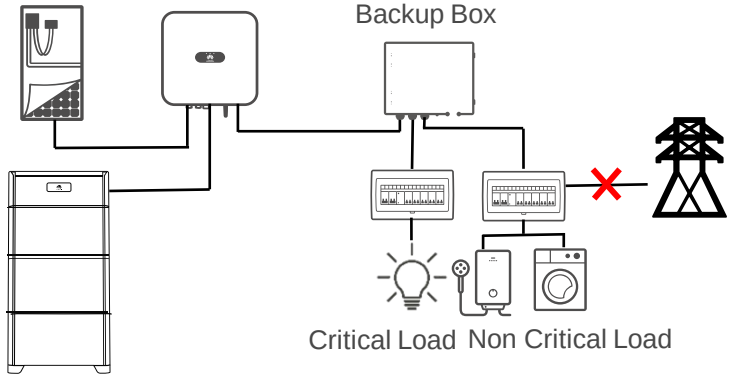
Extinguish Bag

No Worry About Power Outage

With Backup Power

System switches to backup mode to supply emergent power to critical load automatically when power outage

Smart string ESS supports black start from blackout to restore system operating



FusionCharge AC

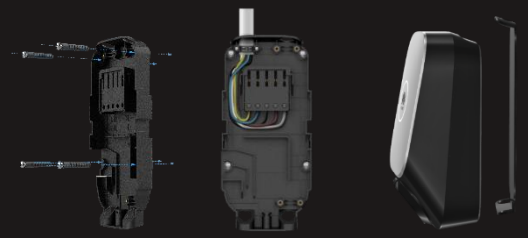
Charge Smarter

AP07N-EU/AP22N-EU

roughly 85% of charging will be done at home according to estimate

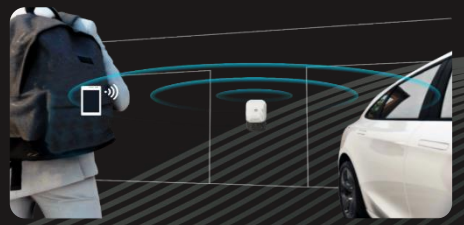
Install in 3 Steps

Installation in 16 min, replacement in 4 min



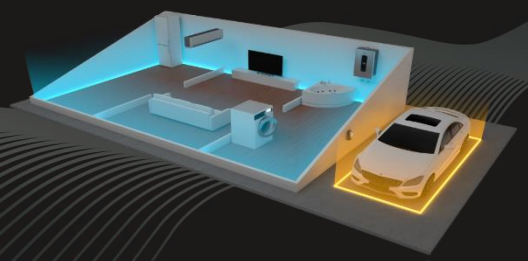
5m Close to Access

Bluetooth automatic authentication



Load Balancing

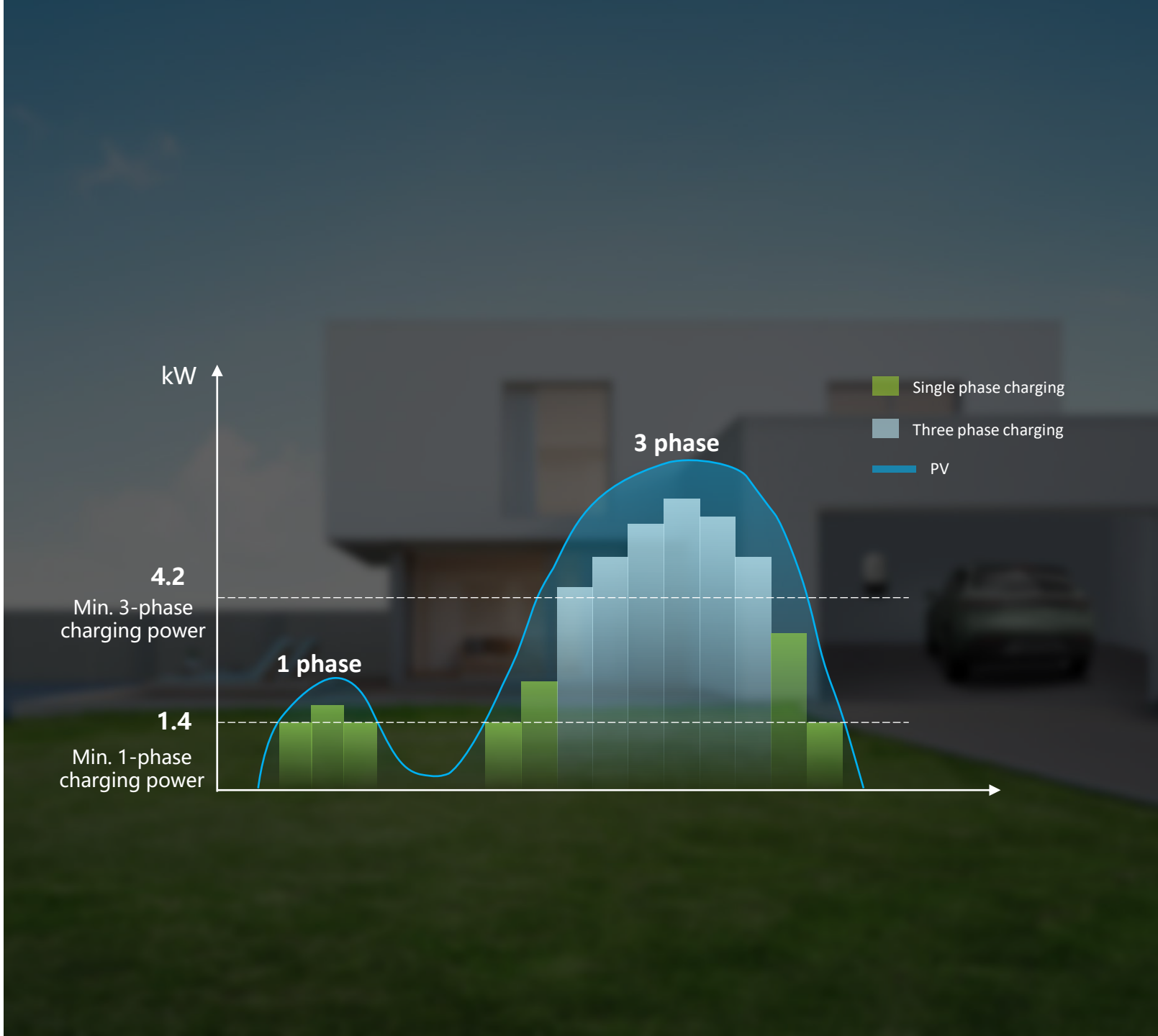
Dynamic charging power, no fuse tripping



PV Power Preferred for optimal Electricity Cost

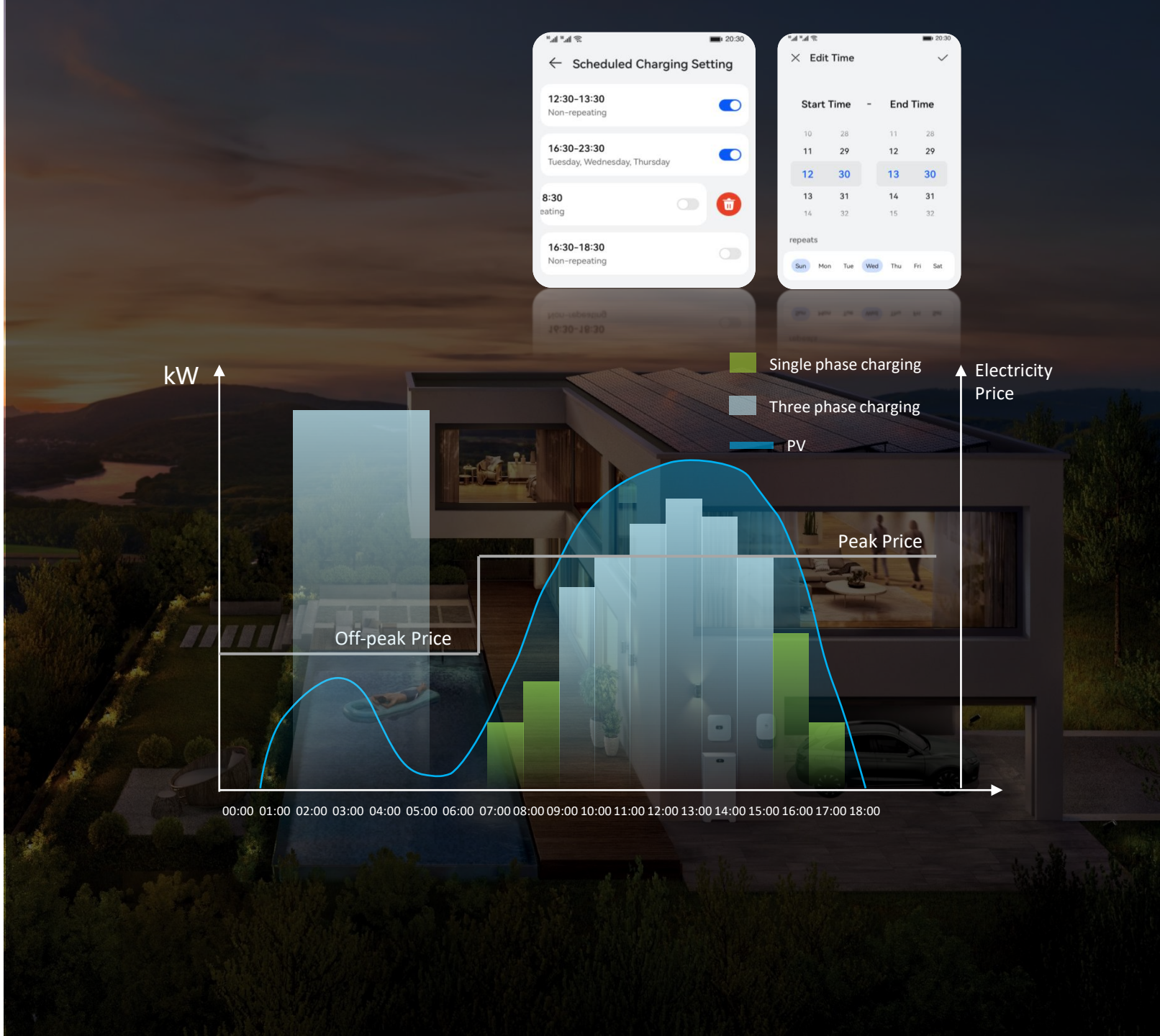
Green power adaptive charging
Minimize extras electricity cost

Automatic phase switchover
Maximize power utilization at 1.4–4.3 kW



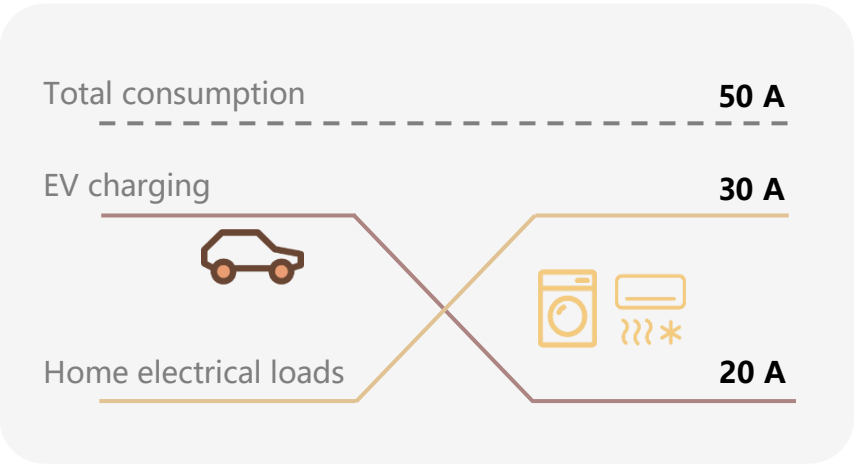
Scheduled Charging for flexible Configuration

- Scheduled charging at off-peak hours
  Lowering electricity bills
- Max. 28 Time Periods Setting by APP
  Make Charging schedule flexible

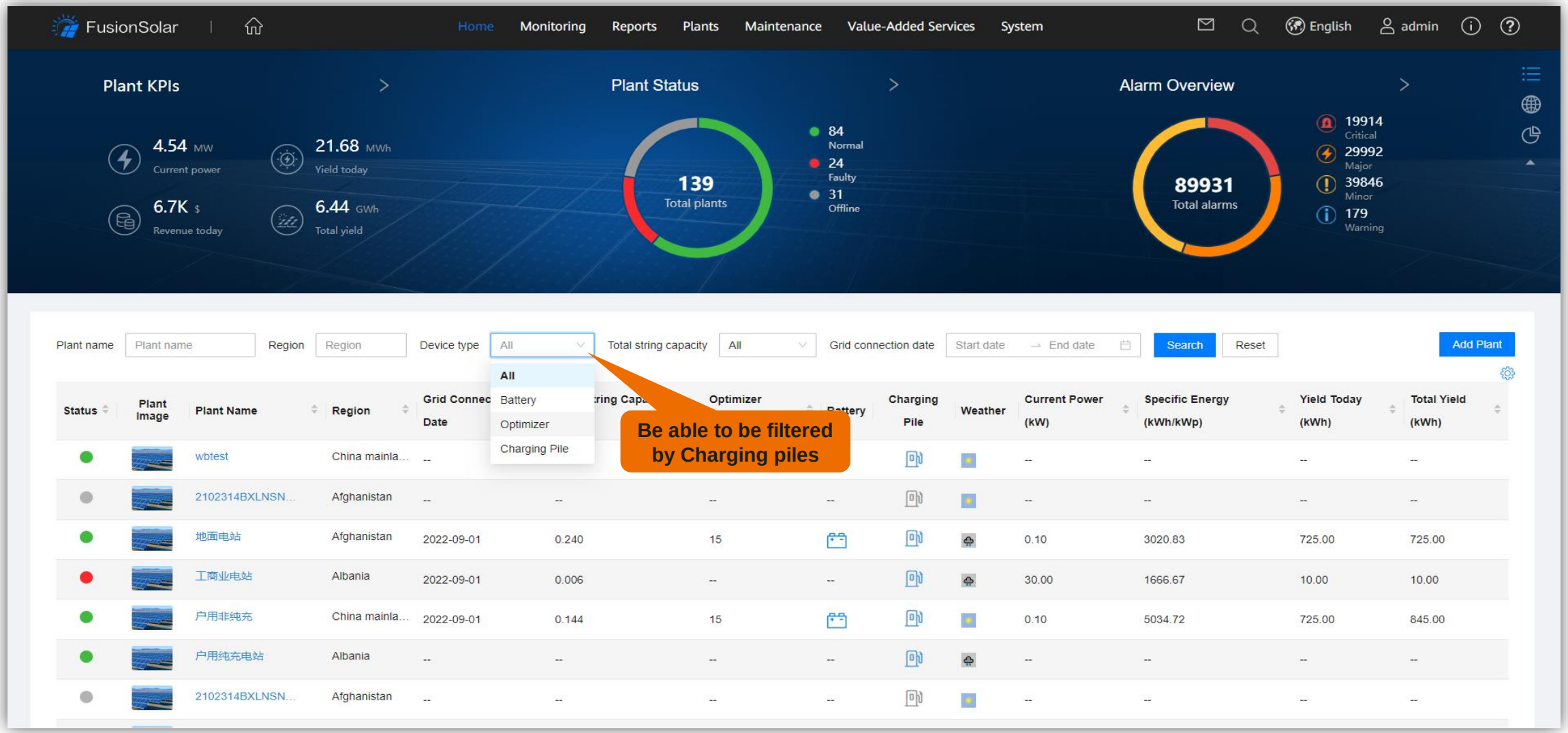


Dynamic Charging Power No Overload, No Fuse tripping

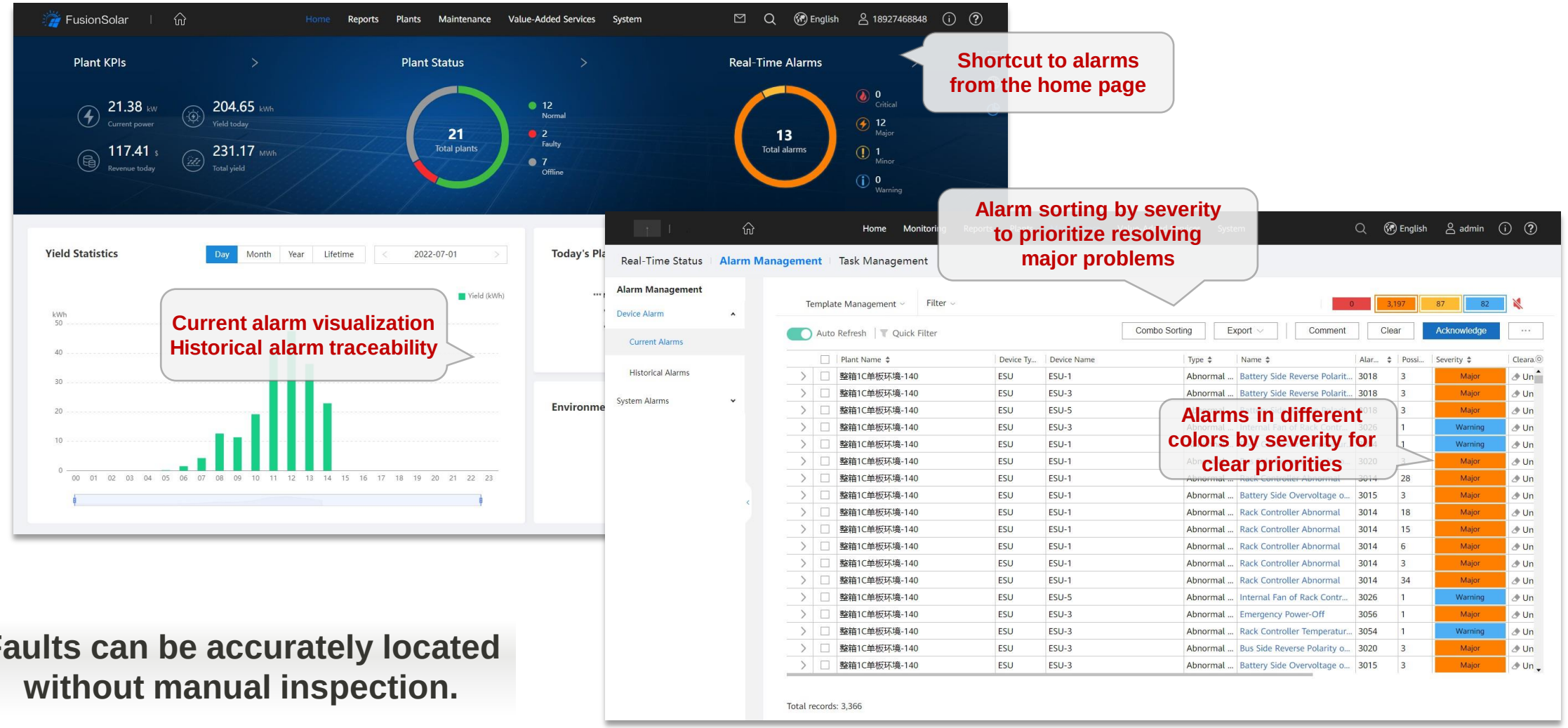
Dynamically adjusts charging power to ensure total consumption at safe levels



Adding Charging Piles for Device Type Filtering on the Home Page



Real-Time Alarm Reporting, Accurate Fault Locating, and Shorter Service Interruption Duration



Faults can be accurately located without manual inspection.

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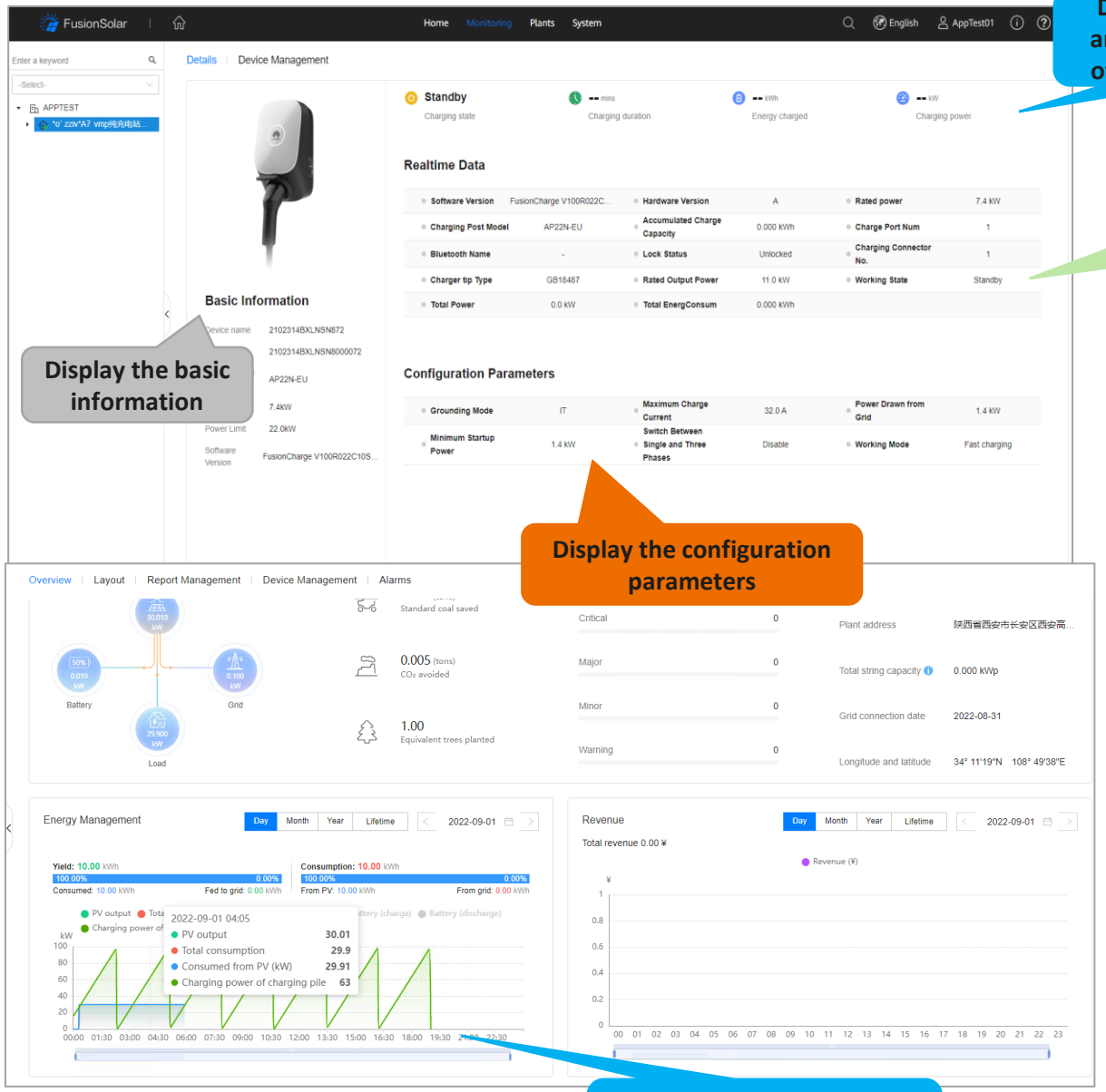
Viewing Charging Pile Details on the FusionSolar SmartPVMS Web



Scenario	Plant Components	Chang
Charging-only	Only charging piles	The plant overview page is removed. The charging pile details information is added. **Device Management** page. The charging pile details information is added.
PV+Storage+Charging	PV + energy storage + charging pile	The charging power curves are added to the **Energy Management** section. Charging piles are added to the **Device Management** page. The charging pile details information is added.
PV+Charging	PV + charging pile	The charging power curves are added to the **Energy Management** section. Charging piles are added to the **Device Management** page. The charging pile details information is added.

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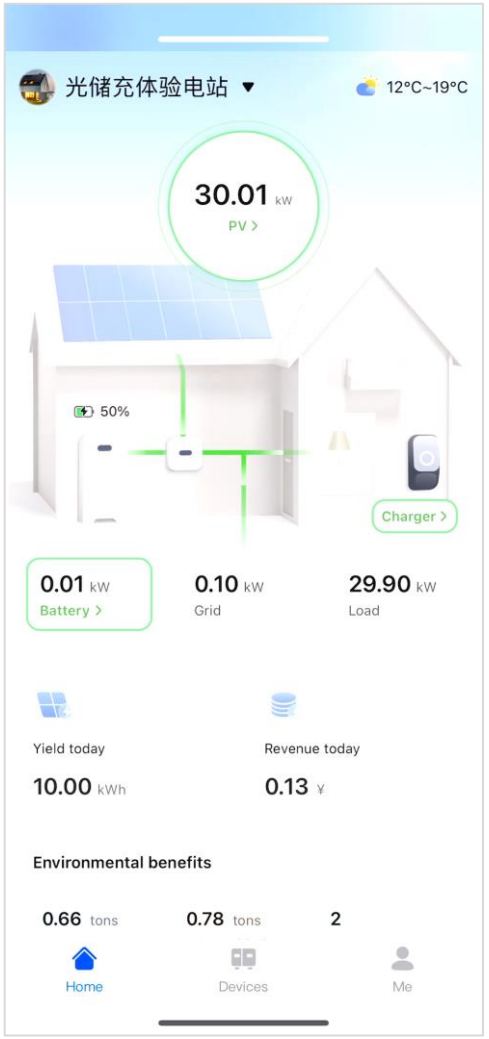
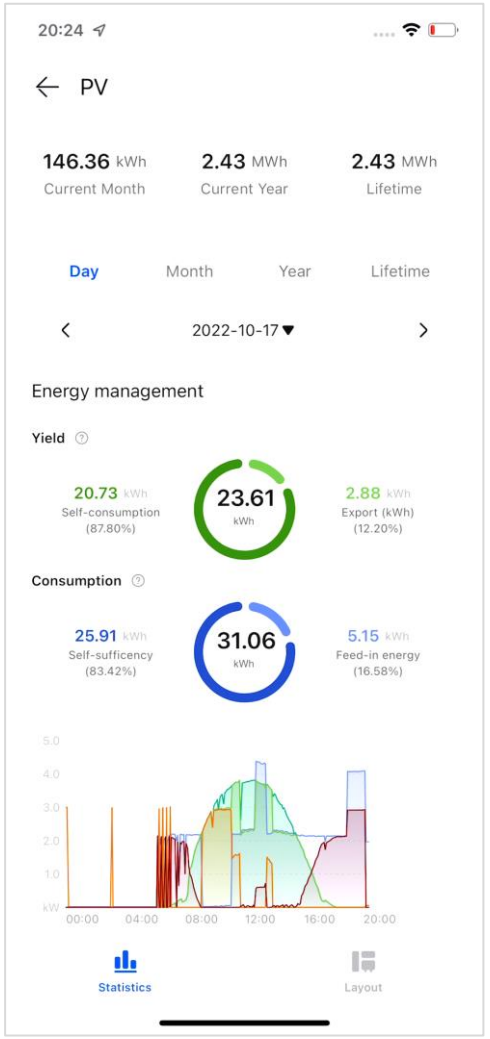
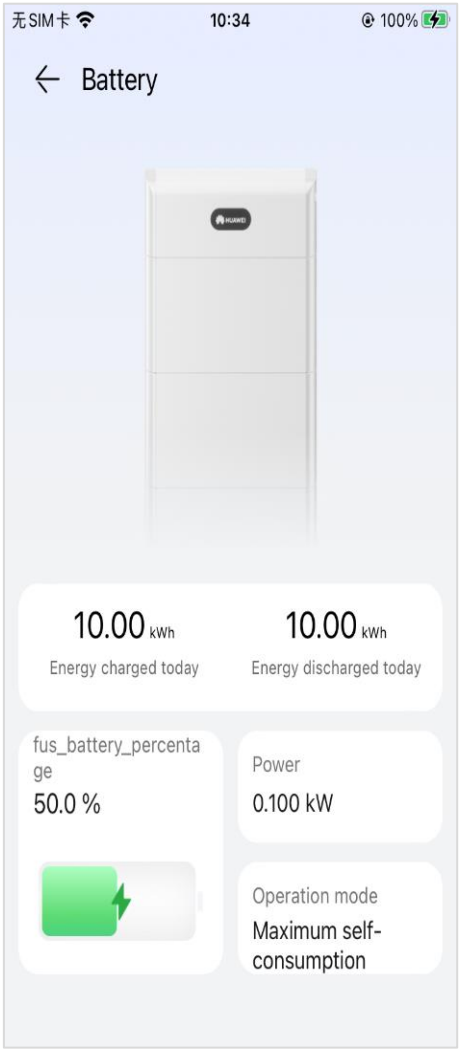
Remote APP owner login home page



Residential PV + Storage + EV Scenario Owner homepage



Optimized energy management for easier understanding



Click Energy Storage Device on the home page to view the key KPIs of the energy storage device.

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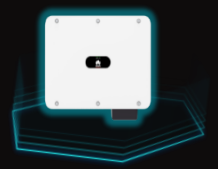
FusionSolar Smart PV

C&I Solution 2.0

Optimal Electricity Cost | Active Safety | Smart O&M

"1+3"

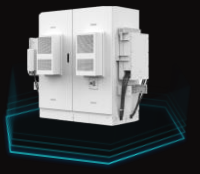
One-Fits-All Solution



1-1:
Smart PV Controller

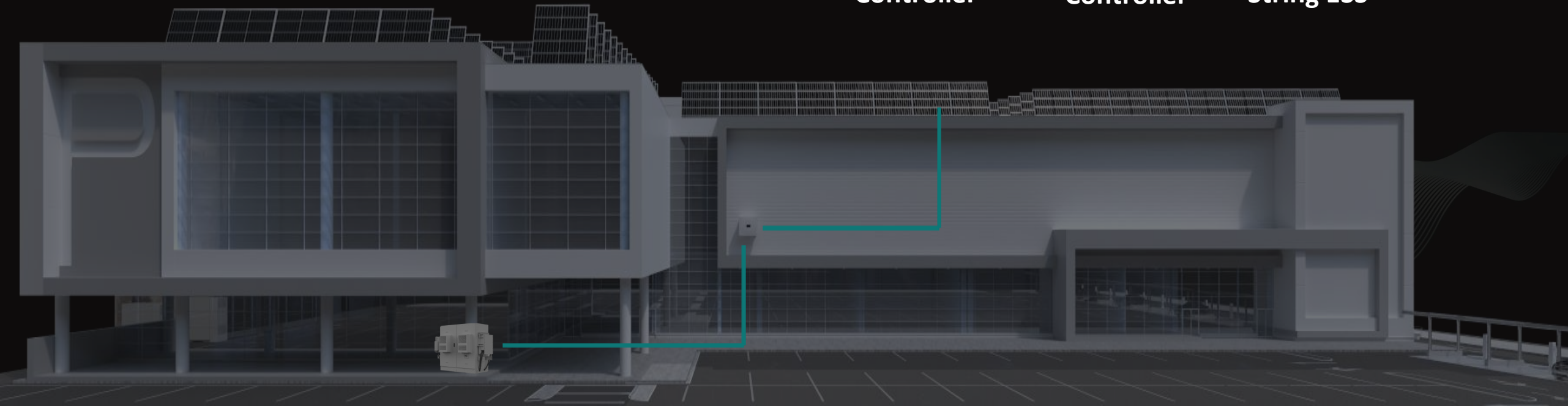
+

3-1:
Smart Module Controller



3-2:
Smart String ESS

3-3:
SmartPVMS

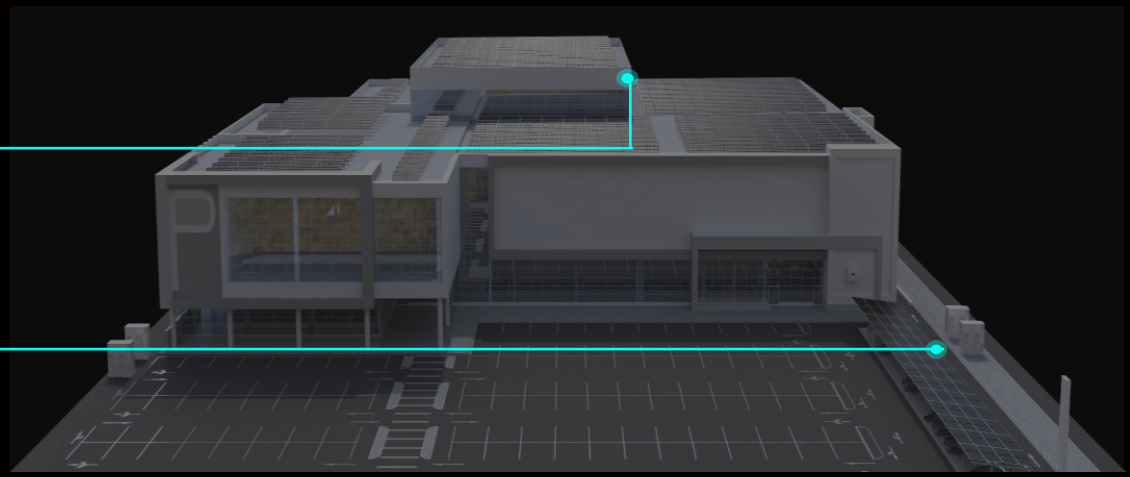


Taking the Business Safety to the New Heights via System-level Safety

System-level Safety

PV Safety

ESS Safety



Industrial-leading Rapid Shutdown

Shutdown Time: 30s → 10s

Final Voltage: 80V → 20V

MERC-1100/1300W-P

SUN2000-50KTL-M3 SUN2000-12-20KTL-M5

Best-in-Industry

L4 Smart Arc Protection

UL1699B HW

Arcing Detection Range: 80M → 200M

Input Current: 13A → 30A

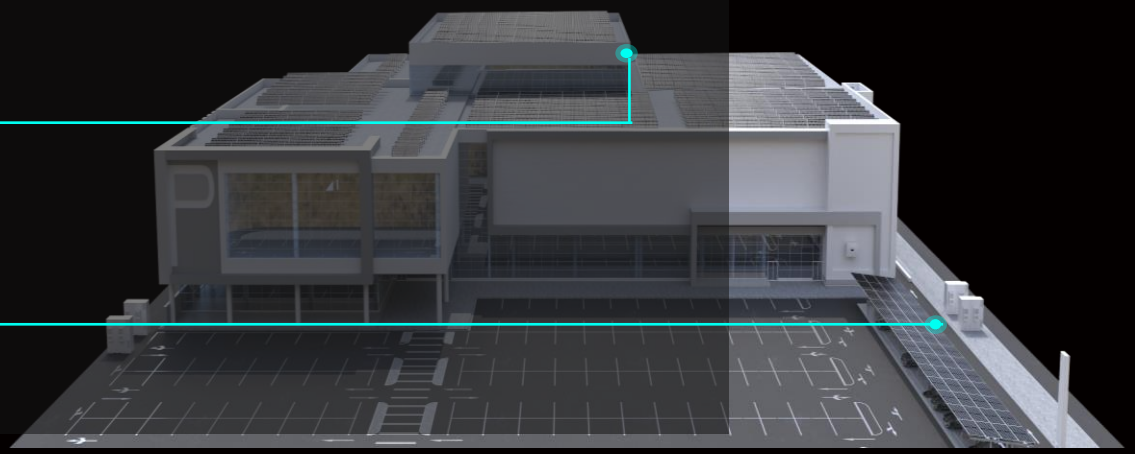
Shutdown Time: 2.5s → 0.5s

Industry’s 1st Smarter Energy Storage System with Module+ Design

System-level Safety

PV Safety

ESS Safety



LUNA2000-200kWh-2H0/2H1

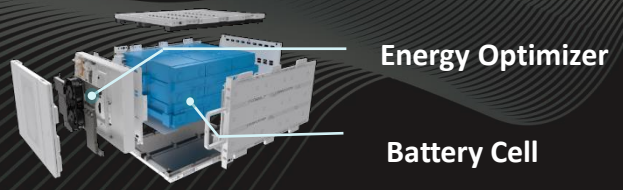
4-Layer Safety Protection

From Battery Pack To System

Pack-level Rack-level System-level Cloud BMS

Industry’s 1st Pack Level Safety

with Energy Optimizer

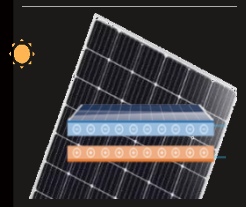


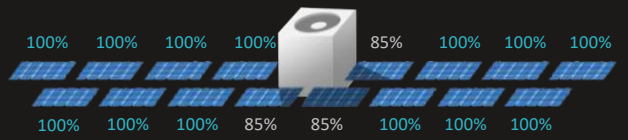
System-level Optimization to Energize More Earnings

System-level Optimization

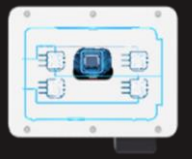
Module-level | String-level

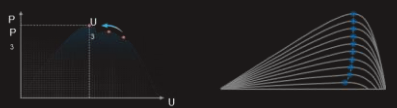
Solar to DC Power

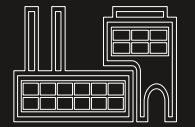




DC Power to AC Power







Full Chain Optimization

Shanghai DURR with 4.80% Higher Yields

thanks to optimizer module-level optimization

Vietnam Site with 1.56% Higher Yields

thanks to inverter smart MPP tracking algorithm

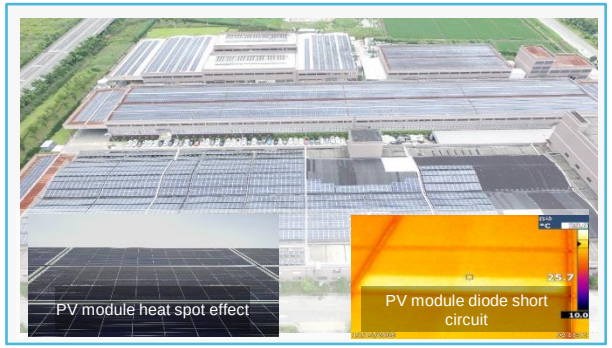
Smart I-V Curve Diagnosis 4.0: Online and Full Detection, Reducing O&M Costs

Authentication: L4 - highest level in the industry

Performance Level	I-V Curve Scanning		Abnormality Identification			Fault Diagnosis
	Measurement Precision	Scanning Precision Rate	Recognition Rate[1]		Recurrence Rate[2]	Root Cause Analysis Accuracy[3]
			Class I defect	Class II defect		
L1	Voltage and current ≤ 1.0%	≥ 70%	≥ 75%	≥ 70%	≥ 70%	≥ 70%
L2	Voltage and current ≤ 1.0%	≥ 80%	≥ 85%	≥ 80%	≥ 80%	≥ 80%
L3	Voltage and current ≤ 0.5%	≥ 85%	≥ 90%	≥ 85%	≥ 85%	≥ 85%
L4	**Voltage and current ≤ 0.5%**	**≥ 95%**	**≥ 95%**	**≥ 90%**	**≥ 90%**	**≥ 90%**
Actual test result	**≤ 0.5%**	**97.5%**	**100%**	**96.4%**	**96.2%**	**96.8%**

Widely used in plants around the world (> 15 GW) to improve plant O&M efficiency

Project: XX rooftop PV plant in Ningbo, Zhejiang



528 Diagnosed strings | **62** Faulty strings | **11.7%** String failure rate

Project: XX PV plant in a coal mining subsidence area of Yangquan, Shanxi

3960 Diagnosed strings | **188** Faulty strings | **4.7%** String failure rate

Huawei Smart I-V Curve Diagnosis VS **I-V curve scanning of other vendors**

Multi-scenario adaptability

- Applicable to large-scale ground-mounted and mountainous scenarios
- Compatible with mainstream modules: half-cell/shingled/166/182/210 mm

Limited adaptability

- PV string-based diagnosis
- Hard to apply in various scenarios

Energy yield loss assessment

- Quantifying the energy yield loss of faulty strings
- Precise guidance for PV plant O&M

No energy yield loss assessment

- Not supported

Scheduled scanning

- Periodic diagnosis and email notification ensuring user experience

No scheduled scanning

- Not supported

ISV integration

- Supporting northbound interfaces
- Can be integrated by ISV

No ISV integration

- Not supported

Refined data management

- The inverter automatically obtains irradiance data.
- Parameters of PV strings can be configured.

Obtaining unrefined data from the EMIs

- Obtaining data from the EMIs
- Parameters can be configured only for inverters.

High availability of diagnostic reports

- Provide diagnosis overview report, diagnosis report, and fault O&M report.
- Provide raw data for the customer.

Poor availability of diagnostic reports

- No fault cause analysis and low availability
- Raw data cannot be exported.

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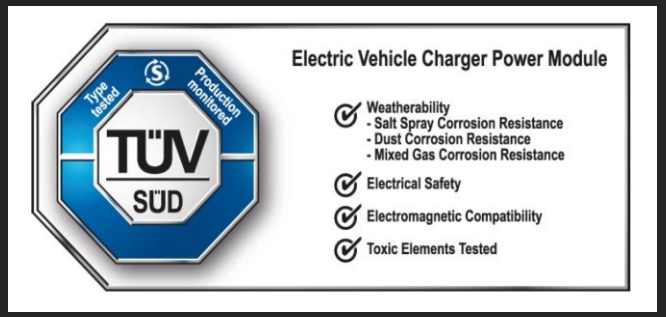
Huawei HiCharger DC Charging Module ——Helping Operators Robust Operation

Huawei HiCharger DC charging module

The first charging module that award TÜV reliability certification



High reliability

Annual failure rate from 2% to 0.2%

High efficiency

Efficiency from 95% to 97%

Low noise

Silent mode 55 dBA

High density

The power density is 1.5 times compare with the industry

High-voltage fast charging

Voltage from 750V to 1000V

15min charging SOC from 30% - 80%

Optimal TCO

Annual O&M cost saving

0.1THB/W

Annual Electricity Fee Saving

0.08THB/W

High-density cabinet cost saving

0.025THB/W

Charging power module: global total shipment 300,000, covering 8 regions, serving 30 CPOs

Application Cases

taxi charging station

Bus charging station

Special vehicle charging station

Heavy truck charging station

HUAWEI

Huawei Inside – mPower DC Charging Module

Cases in Thailand

	Customer	Quantity	Type of Chargers
1	PTT-OR	450	120/160kW
2	BMW	12	60/160kW
3	Mobility One	2	160kW
4	CP-Lotus	4	160kW
	……		

EV Charger brand - Power Core

HUAWEI

Thank you.

把数字世界带入每个人、每个家庭、
每个组织，构建万物互联的智能世界。

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

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