



Building a fully connected, intelligent world

# Huawei's C&I Solution 3.0 Helps Businesses Achieve Green and Low-Carbon Transformation





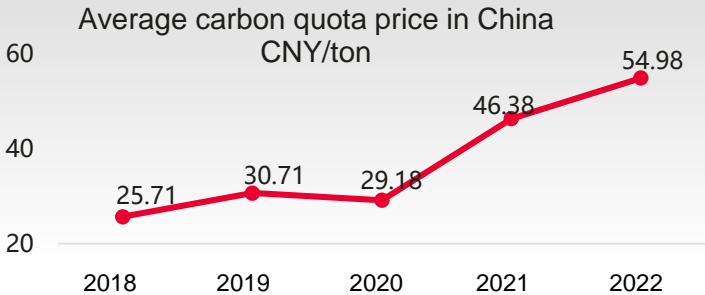
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# Trends and Challenges

# Policy: Under the Trend of Carbon Neutrality and Pressure on Social Responsibility and Marketing, Enterprises Are Seeking an Optimal Way to Reduce Carbon Emissions



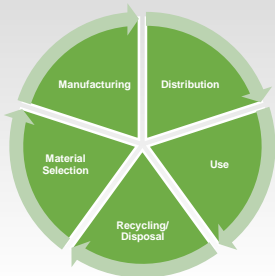
- Apple reiterated in October that it will assess and track partners annually to check whether they are decarbonized in production and operations.
- At the ESG Forum in April, Mercedes-Benz said carbon neutrality commitments and measures will be a mandatory criterion for supplier selection.



- China's carbon trading price keeps increasing, and so does the carbon emission cost of enterprises.
- Carbon trading gradually extends from 8 major industries to other industries.



## Carbon Footprint

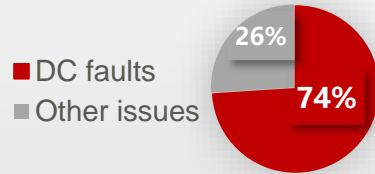


- Enterprises directly or indirectly (upstream and downstream partners) participate in global trade. Facing carbon tariffs, low-carbon products are more competitive.
- The EU's carbon tariff has been put into trial operation in October 2023, which will increase the operating costs of enterprises in China and weaken their international competitiveness.

# Challenges: Challenges in C&I PV Construction

## DC high-voltage safety risks

Root causes of inverter failures: 74% faults are on the DC side



## Complex environment



- The rooftop environment is complex, and the rooftop usage is low due to shading.

## Complex O&M



- C&I PV plants are geographically dispersed and difficult to manage in a unified manner.
- Onsite O&M is required, resulting in high costs.

## Safety challenges

DC arcing

DC short circuit

DC high voltage

Terminal overtemperature

## Benefit challenges

Shading

Less area for PV installation

Lower yield

## Operation challenges

Unable to achieve unified and visualized management

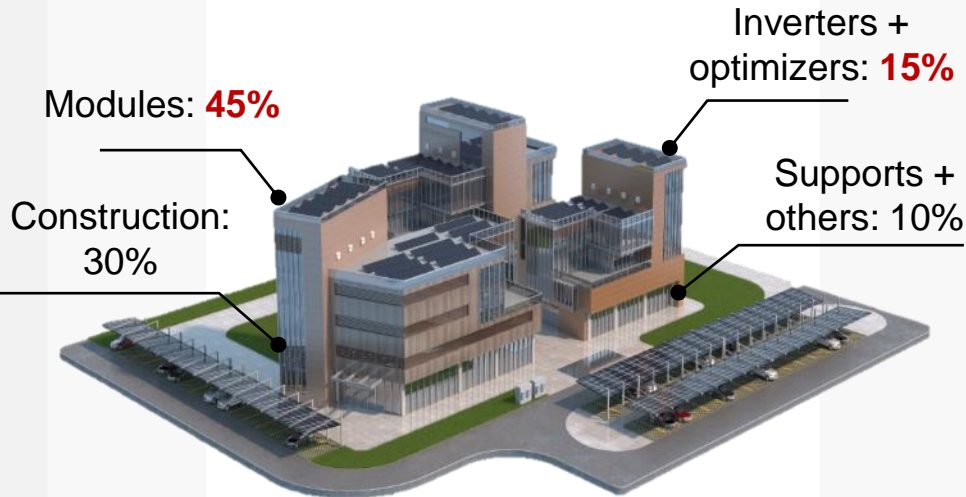
Difficult and inefficient fault locating



# Solution: Inverter is the Core of PV System. Small Investment Brings Huge Benefits

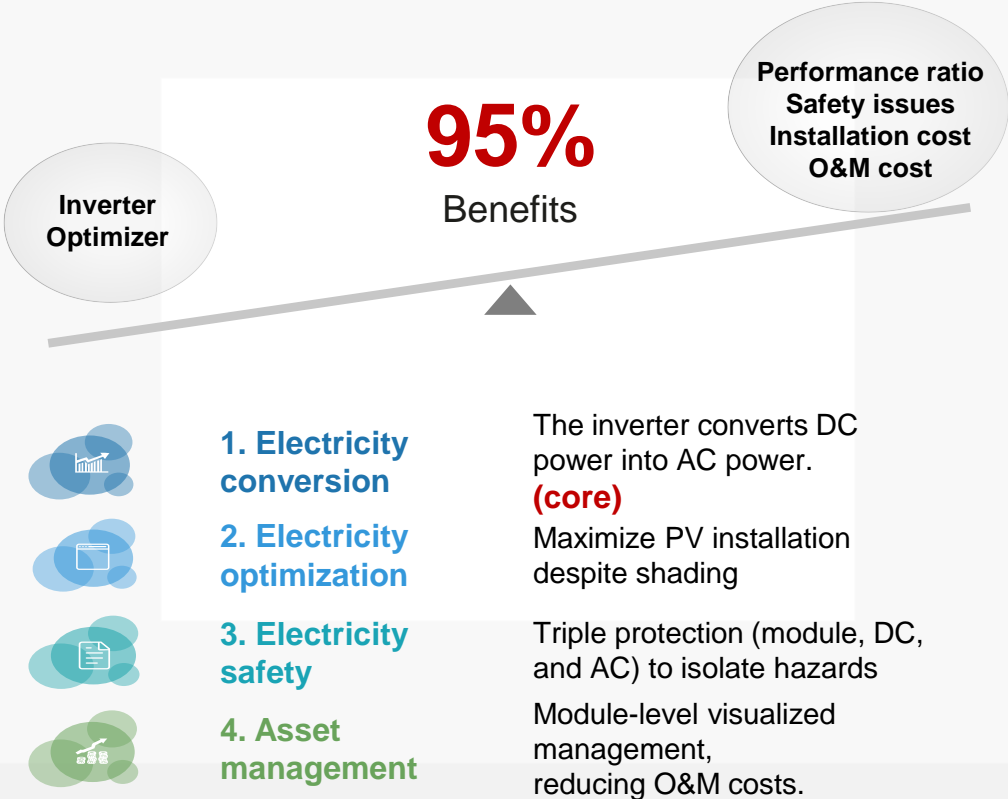
## Optimizers and Inverters Account for Only a Small Portion of the Investment

Optimizers and inverters account for only **15%** of the investment.



## Inverters and optimizers are the **core of a PV system**.

Determining factors in terms of current conversion, system benefits, and reliability











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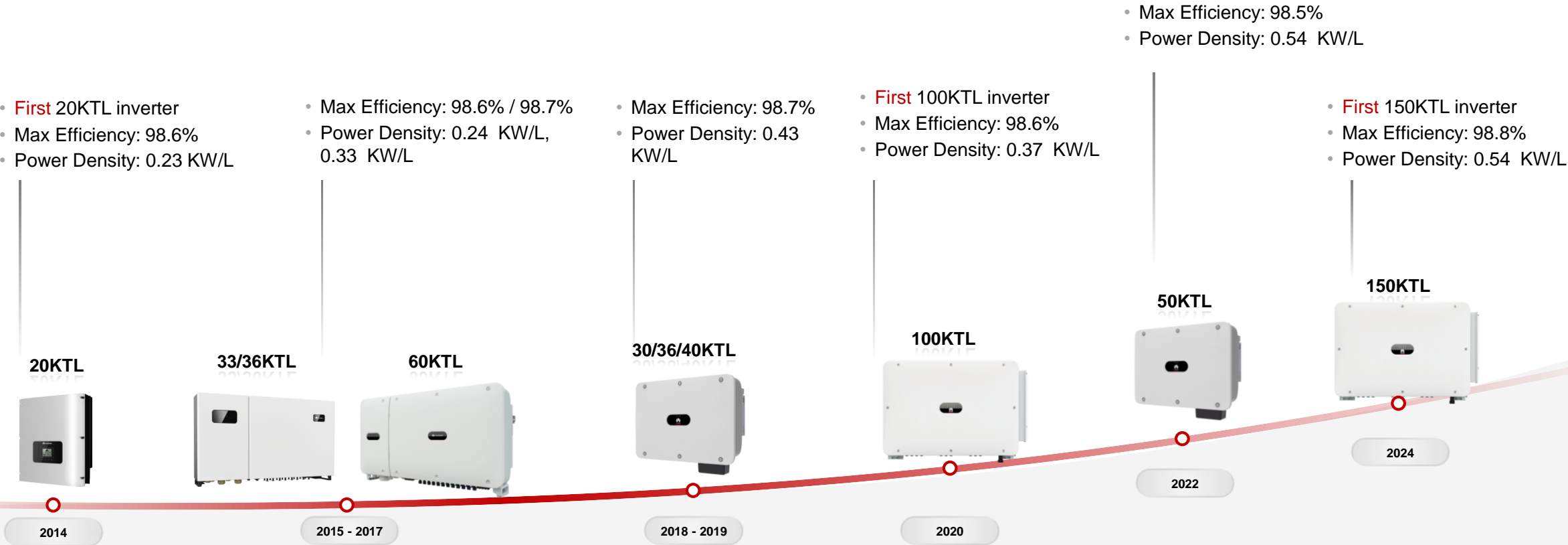
## Huawei Fusionsolar C&I Solution



# Market Strategies - SUN2000 only PV and SUN5000 must with Optimizer

Only PV - SUN2000			PV + Optimizer - SUN5000		
M3	V5+	V6 (not configured)	Optimizer + M3 or V6 (mandatory)		
					
SUN2000-30-40-KTL-M3 SUN2000-50KTL-M3	SUN2000-100KTL-M2 SUN2000-115KTL-M2	SUN2000-150KTL-MG0	MERC-1100W-P MERC-1300W-P	SUN2000-30-40-KTL-M3 SUN2000-50KTL-M3	SUN5000-150KTL-MG0
<ul style="list-style-type: none"><li>30-50KTL</li><li>Module-level insulation impedance test</li><li>Standard AFCI &amp; PID Repair</li></ul>	<ul style="list-style-type: none"><li>Maximum current of each MPPT: 30 A</li><li>100KTL-M2 standard AFCI</li><li>Standard smart PV string break</li><li>Supply assurance to support sales in the first half of the year</li></ul>	<ul style="list-style-type: none"><li>DC-to-ground protection</li><li>Module-level insulation impedance test</li><li>Standard smart string disconnection</li><li>Supports AC MBUS communication</li><li>Standard AFCI &amp; PID Repair</li></ul>	<ul style="list-style-type: none"><li>Module-level optimization, multiple installation and yield</li><li>Module-level management, timely identification of low-efficiency components</li><li>RSD at the component level, ensuring roof safety</li></ul>	<ul style="list-style-type: none"><li>30–50 KTL (mandatory optimizer)</li><li>Module-level insulation impedance test</li><li>Standard AFCI &amp; PID Repair</li></ul>	<ul style="list-style-type: none"><li>Industry's only 100 kW or higher-matching optimizer</li><li>Separate documentation and certification for the SUN5000</li><li>Commercial and sales of the SUN5000</li><li>Provides all the features and functions of the premium version.</li></ul>
Launched	Launched	TR5-2 2024.04.10 GA 2024.05.30	Launched	Launched	TR5 2024.04.10 GA 2024.05.30 Europe after July.

# Leading the Way in Power Electronics Innovation Throughout Decade





# Never Stop Innovating on Safety Throughout Decade

## Higher Density & Efficiency

### Material upgrading

The 3rd. generation semiconductor application



### Technological innovation

Key of digital power technologies fusion

Heat  
Dissipation

Integrated  
driven

High Speed  
Computing Chips

Advanced  
Packaging

### Higher Energy Density in Same Volume

**50%+**

- 100 -> 150kw, same volume but higher density
- Reach to the largest power in C&I voltage

### Higher Inverter Efficiency and better yield

**98.8%**

- Worry-free Conversion Losses
- Make each inverter more efficient

# More Secure and Reliable Inverter Solution



SUN2000-150K-MG0

# 150 kW



# C&I All-Rounder



SUN2000-150K-MG0

## Grid Friendly

Intelligent harmonic algorithm  
Intelligent reactive power compensation

## Higher Yield

Maximum efficiency: 98.8%  
PID repair improves yield by 3%.

## Optimal BOS

Better BOS for 1 MW  
PV plants



## Active Safety

Device safety  
Asset safety  
Personal safety

## Simplified O&M

Module-level  
insulation resistance  
detection

## High Reliability

Product availability:  
99.999%

## Value 1: Increase energy yield and achieve optimal energy efficiency

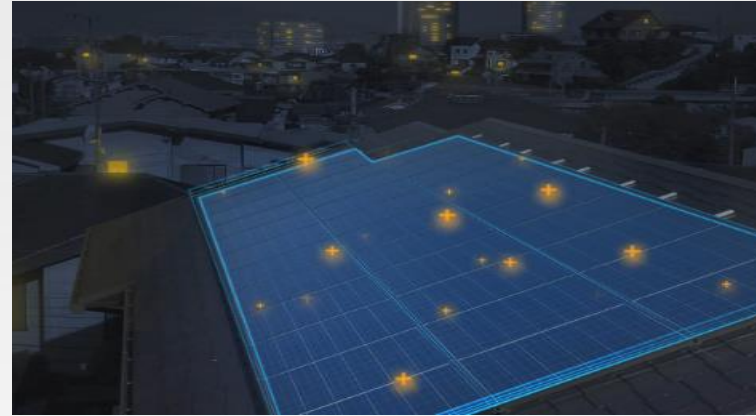
No worries about conversion loss  
Optimal energy performance ratio



**Unique inverter tracking algorithm**

Industry higher inverter maximum efficiency: **98.8%**  
Industry highest dynamic MPPT efficiency: **99.8%**

No worries about PID  
Support PV installation in extreme environments



**Leading PID repair technology**

**3%** higher system yield  
**0.1%** higher efficiency for the same configuration



# 98.8% Efficiency + Intelligent MPPT Tracking Algorithm, Improving Yield by 1.5%

## 98.8% efficiency

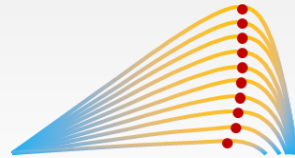
Focus on the three core elements of inverter efficiency  
Improve inverter efficiency with three steps



- Three steps: Simulation in the early stage, test and verification, and long-term optimization
- 0.2% higher efficiency than industry average

## High dynamic MPPT efficiency

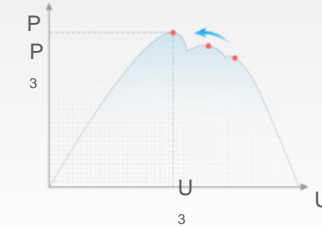
With Huawei's intelligent algorithm, the MPPT tracking efficiency reaches 99.839%.



- Dynamic MPPT efficiency: 99.839%
- Faster tracking of MPP when irradiance changes

## MPPT multi-peak scanning

Conventional algorithms cannot accurately track the maximum power point. Huawei multi-peak MPPT scanning accurately locates the maximum power point.



- Automatic identification of multiple peaks
- Full-range MPP scanning < 200ms

## Rooftop PV Plant of a factory in Vietnam: Huawei's 100 kVA inverters outperform those of the competitor by 1.71%.



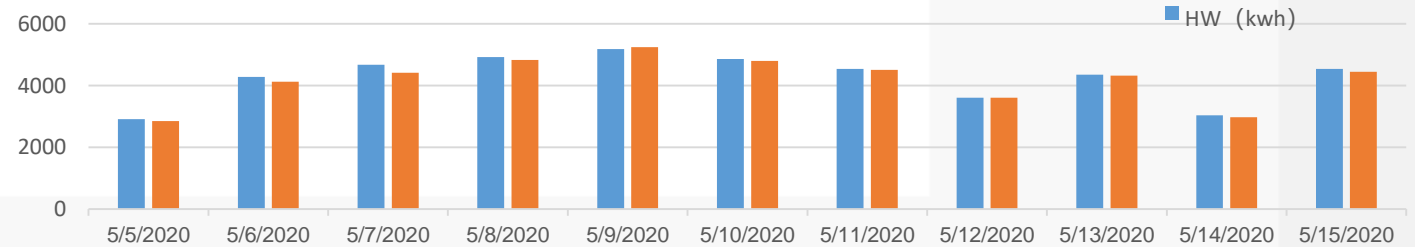
- Location: Vietnam
- Huawei: 9 x SUN2000-100KTL-M0
- Competitor: 9 x XX-100-CX
- Comparison test duration: 1 month

### Huawei's intelligent MPPT tracking

vs

### Competitor's MPPT tracking

In the 900 kW comparison test, the monthly energy yield of Huawei inverters is 1.71% higher than that of the competitor.

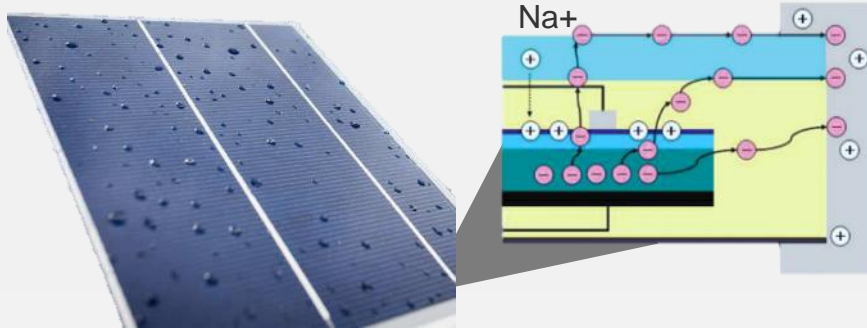


# Industry-leading PID repair improves the energy yield by 3%.

## Industry Leading

Industry: PID is one of the most frequent problems in PV systems

PID reduces the energy yield by more than 5% throughout the lifecycle.



The modules work at a high voltage for a long time, and leakage current exists between the cover glass, packaging material, and frame.

The direct harm of PID is that a large number of electric charges accumulate on the surface of the cell, which downgrades the passivation effect on the surface, causing power attenuation.

**PID is more severe in high-temperature and high-humidity areas.**

PID is most likely to occur in high-temperature and high-humidity environments, or on modules with damaged packaging. The severity is related to the humidity.



High temperature



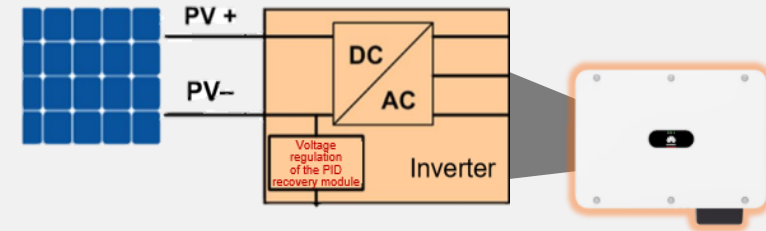
High humidity



Damaged module

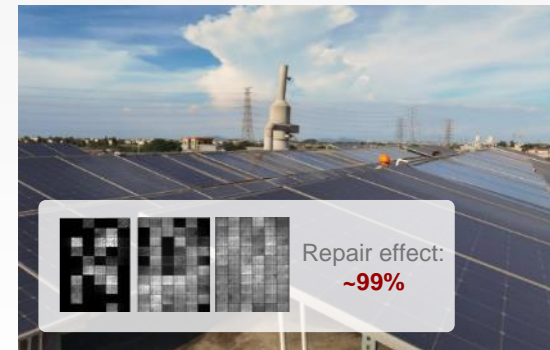
**Huawei PID repair solution effectively avoids the PID effect and ensures energy yield.**

Built-in PID repair function of Huawei inverters



**A rooftop project in Zhongshan City, Guangdong Province**

**TÜV's empirical tests prove that Huawei's PID repair function can improve energy yield by 3%.**



## Value 2: System-Level Safety Solution, Ensuring Device and Asset Safety

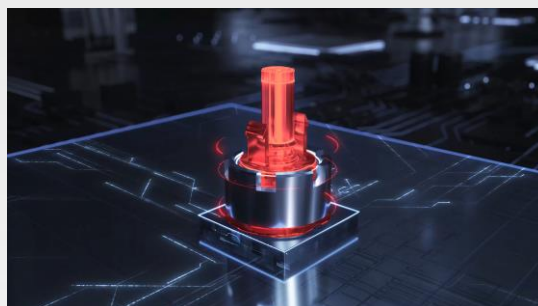
### Device Safety PV Ground-Fault Protection



#### Industry's First

cutting off ground faults within 15 ms during grid connection, ensuring inverter safety

### Device Safety Smart Connector Temperature Detection



#### DC & AC Side

Real-time Detection of Connector Temperature

### Asset Safety Active arc extinguishing for fire prevention



#### Industry Highest L4 AFCI

Arc protection covering the entire roof  
Active arc extinguishing for fire prevention

### Device Safety Active disconnection for device protection



#### Industry-unique Smart String-Level Disconnect

Intelligent and fast disconnection  
Ensure the safety of the DC side



# Industry's first PV Ground-Fault Protection, cutting off ground faults within 15 ms during grid connection, ensuring inverter safety

Industry First

## PV Ground-Fault Caused Highest Failures



Cable damaged



Cables not firm connected



Long-term stress cause by disordered cabling

**75%**

PV Ground Fault @ PV Side Problem

Inverter damage

Fire risk

## Rapid Shutdown and Protect Inverters Effectively

**15ms** overcurrent automatic shutdown

More than **75%** short-circuits protected



# Smart Connector Temperature Detection, Real-time Detection of Connector Temperature, Improving DC Connector Reliability

DC & AC Side

## Over Temperature May Cause Fires



**Metal core improperly crimped**



**Connectors loosen or not qualified installation**

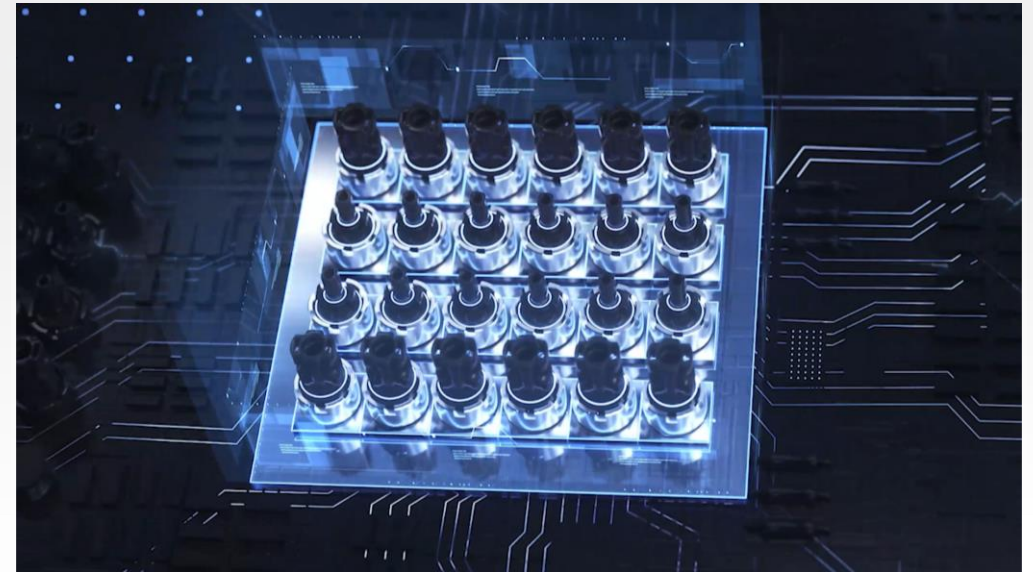


**Poor contact by external forces**

## Accurate Over Temperature Detection

Both DC connector and temperature sensor onboard

**0.5s** Shutdown when Over temperature Happens



# Leading AFCI Solution, Larger Detection Range, Ensuring Asset Safety

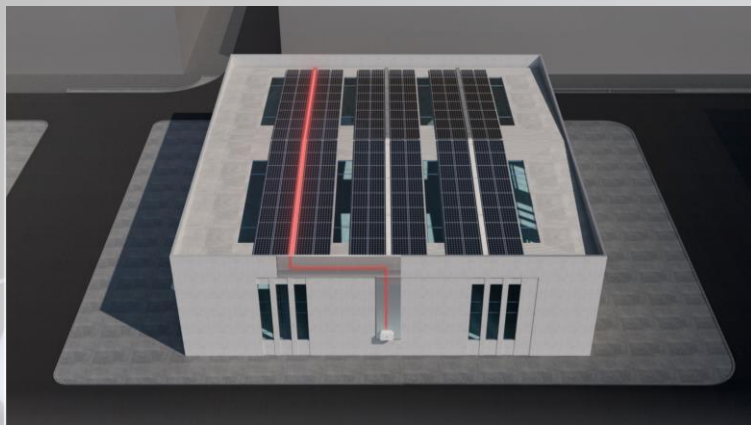
Industry Leading



TUV certification  
IEC 63027 standard

**200m Detection Range Only fit  
Small/Middle Scale Rooftop**

Unable to Detect Longer range Arc fault



**200m**

**450m Can Cover Larger Scale  
of C&I Application**

Especially for MW rooftop

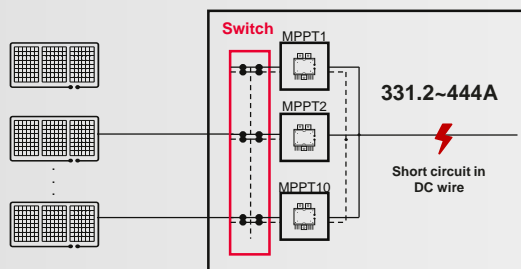


**450m**



# C&I's 1st Smart String Disconnection Function, Rapid disconnection of DC-side faults within 15ms ensures DC-side safety

## Traditional: DC short circuit



- **Manually enabled**, causing high safety risks
- **Equipment damage**: inverter, MCCB& transformer
- **Secondary damage**: fire hazard etc

VS

## Huawei: **Smart String Disconnection Function**



- **Intelligent enabled**, free of site visit
- **15ms rapid shutdown**, ensuring device safety
- **Real-time monitoring**, quickly cut off the fault current circuit



Reverse connection of PV strings



DC input back feed



Internal short circuit



## HW Industry-leading SSLD

Passed CGC's first intelligent segmentation certification

## Value 3: Long-Term High Reliability Assurance, With 99.999% Product Availability

### Unique

- The development of Huawei inverters strictly comply with the **IPD process** to ensure reliability from concept, planning, development, verification, to launch.
- Huawei conducts special simulation design and joint component customization for high-power inverters, 100% of which have undergone vigorous tests **higher than industry standards** before delivery.
- **High reliability** is a key factor to ensure that Huawei inverters are reliable in harsh environments and can be used for a long time.



- Joint design by aesthetic research centers globally
- Simulation design for **high-power** inverters



- **Mature components:**  
Components are carefully selected and have been proven in large shipments.
- **Customized components:**  
Components are customized for **high-power** inverters to reduce the size and loss.



- **Rigorous tests** on high-power inverters:
  - Low-temperature freezing test
  - High-temperature and high-humidity test
  - Salt spray corrosion test
  - Dust test
  - **Lightning test**
  - **Limit test**



- **100% aging test** before delivery
- Huawei-unique **ongoing reliability testing (ORT)**



**How does Huawei build up  
its reliable high power inverter?**

How does Huawei build up its reliable high power inverter?



# Module-level Isolation Fault Detection, High Precision to Ensure Safety and Reduce O&M Cost

## Isolation Fault is a Very Common Problem and Hard To Locate



More MPPTs and longer cables

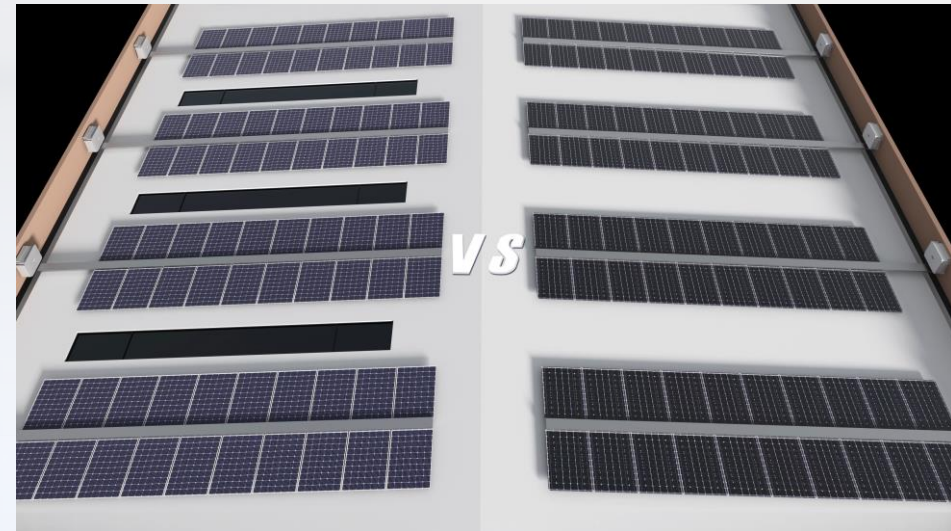


Small or tiny fault points



More false alarm in rainy seasons

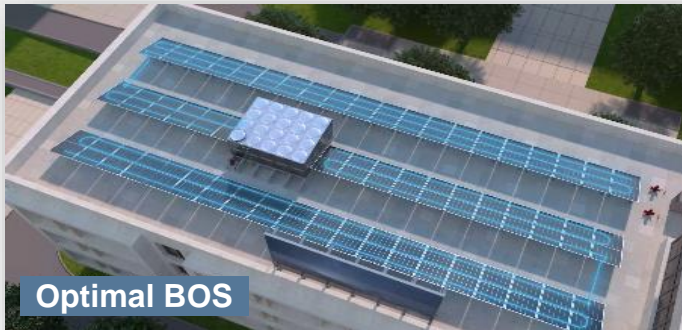
## Precise Location Reduces Installation Duration Module-level Isolation Fault Detection



## Value 5: Optimal BOS, SmartDesign Brings Simplified Design Experience

### Optimal BOS

**Lower cable costs  
Lower installation costs**



- The output power is increased by 50% (compared with 100K products).
- Reduce the required number of inverters and AC&DC cables.

### Simplified design

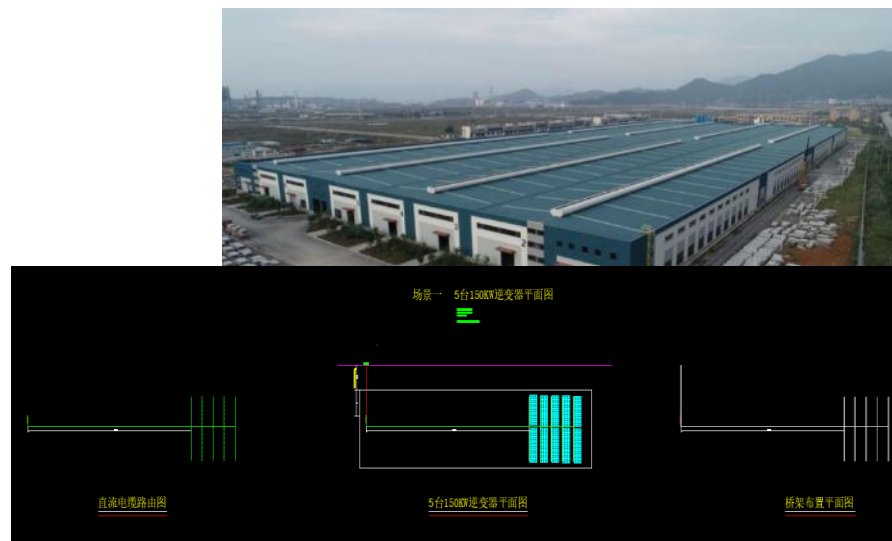
**PV design tool (SmartDesign)**



- Satellite positioning, automatic layout, and one-click connection
- Comprehensive analysis and comparison for optimal design

# For C&I Projects With a Higher Power, the BOS Is 0.03\$/W Lower Than that of Competitors to Provide Better ROI

**For a 1 MW typical PV plant, the BOS is 0.03\$/W lower than that of competitors.**



**Rooftop picture of an industrial campus in Guangdong + Emulated module layout**

- Area: 10 km<sup>2</sup>
- Installed capacity: 1 MW
- Inverter layout: Mounted near the edge of the rooftop and close to the power distribution room
- Cable routing: overhead cable tray

125 KW	VS	150 kW
Total number of inverters	<b>6pcs</b>	<b>5pcs</b> ↓
Total length of AC power cables	<b>393m</b>	<b>333m</b> ↓
	VS	
Total length of AC power cables	<b>47454m</b>	<b>47286m</b> ↓
Installation costs	<b>340\$</b>	<b>270\$</b> ↓

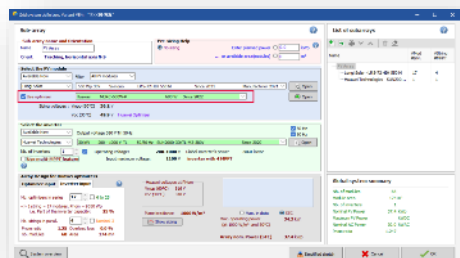
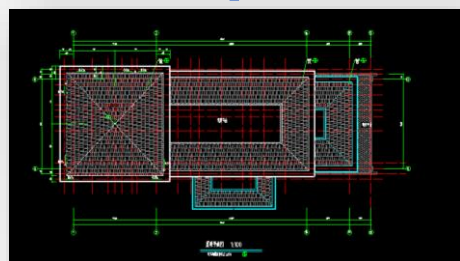
- The BOS calculation is based on 575 W modules, with a ratio of 1, connected with copper cables.
- The calculation is based on the average price of copper cables in 2023.



# SmartDesign Uses Satellite Positioning to Eliminate the Need for Site Visits and Supports One-Stop Automatic Design to Provide Better Solutions

Industry-Leading

Conventional solution: Multiple software applications are required, only one solution can be generated, and the UI is not user-friendly.



## Manual site survey

- **High labor costs** due to rooftop survey for large projects

## CAD simulation

- Rooftop modeling based on survey data, which is **time-consuming**

## Pvsyst calculation

- A **single** solution is generated based on the input.
- Parameters are too technical, and the UI is **not user-friendly**.

VS

**SmartDesign:** One-stop simplified design, providing the comprehensively optimal solution



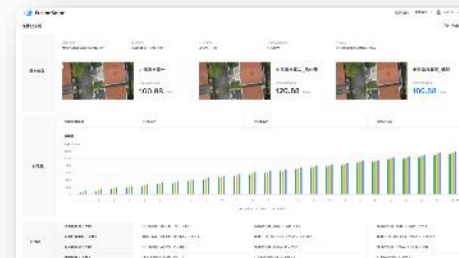
## No site visits needed

- **Satellite imaging** eliminates the need for site visits to complete project design



## Less time-consuming

- **Automatic module layout** accelerates system design.
- One-click **automatic electrical connection** for easy design



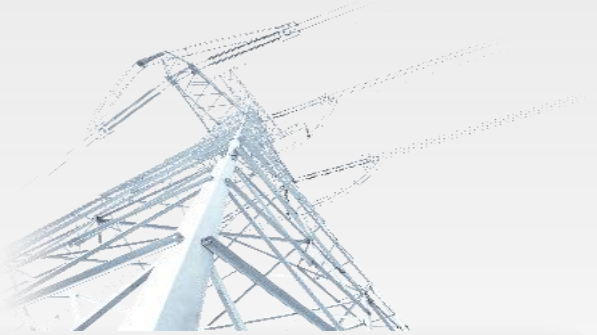
## Smart design

- Comprehensive analysis and **comparison of multiple solutions** to achieve optimal design

## Value 6: Adapting to Customer Requirements in Different Industries

### Friendly to various grids

#### Grid Adaptation



- Intelligent reactive power compensation to prevent energy yield loss
- Intelligent harmonic algorithm, THDi < 1%, grid-friendly

### Friendly to different business models

#### PV+ESS solution

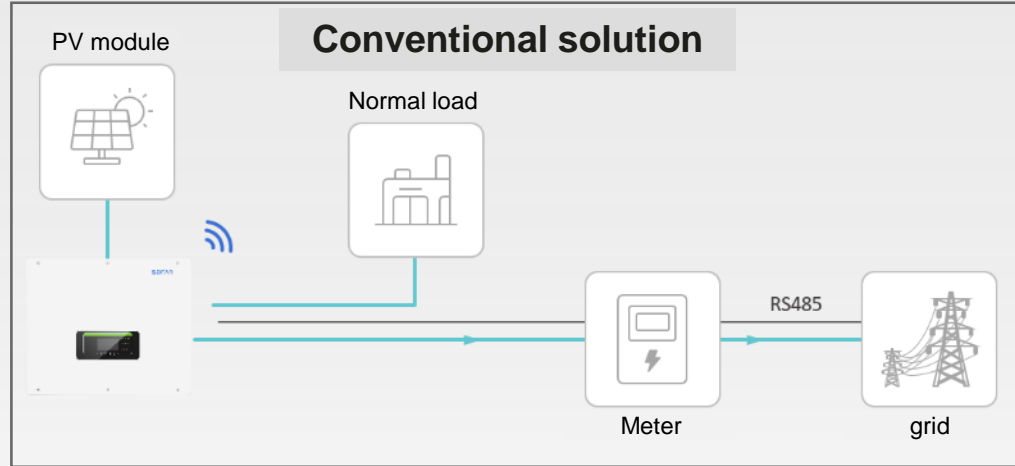


- PV+ESS collaboration to support more business models
- Electricity price settings for more accurate benefit calculation

# Intelligent reactive power compensation adjustment: closed-loop control, precise control of reactive power output, and reduced energy yield loss

Industry-Leading (Free)

Conventional solution: The inverter has a fixed power output, which cannot be accurately compensated for.



**Manual configuration**

The power factor output is fixed based on the load and must be adjusted manually.

**Delayed adjustment**

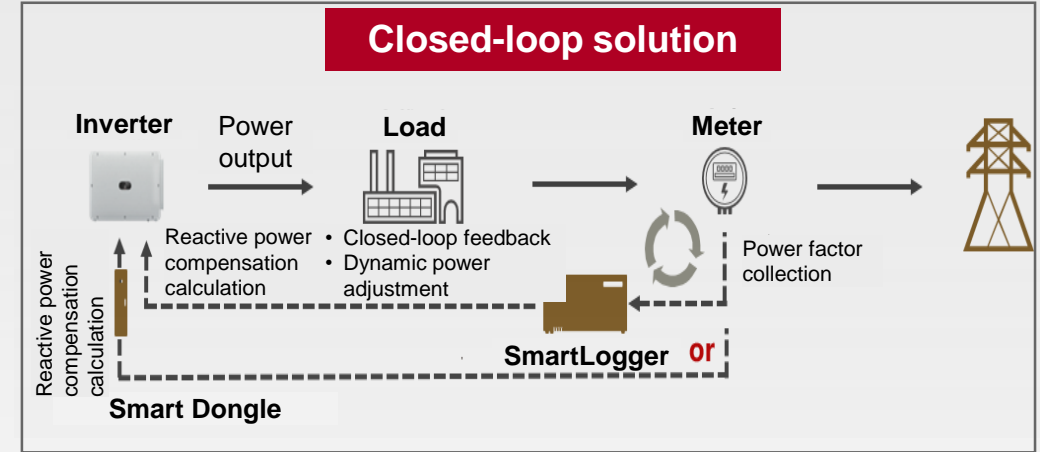
The power factor of the grid cannot be obtained in time, resulting in inefficient communication and high O&M costs.

**Low reliability**

Unable to support high-voltage or low-voltage ride-through, affecting power supply stability.

V/S

**Huawei solution: Intelligent reactive power compensation adjustment and dynamic closed-loop control**



**Intelligent**

Automatic closed-loop power factor with a control **precision of 0.01** without manual intervention

**Efficient**

Dynamic power adjustment, system reactive power **response time < 10s**, effectively reducing energy yield loss

**Safe**

Safe compensation at night avoids PID and prevents electric shocks.

**1.7 MW Rooftop Project of Zhejiang Sunoren**

	Before Huawei solution	After Huawei solution
Power factor	0.8	<b>0.97</b>
Penalty (CNY/Month)	1000–2000	<b>0</b>

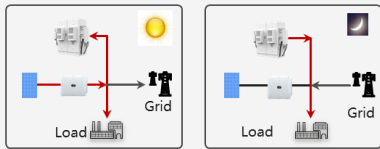


# PV+ESS, maximizing self-use and saving electricity costs, ensures uninterrupted production

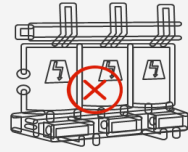
## PV+ESS solution improves self-use and saves electricity costs

- PV+ESS can achieve more business modes, such as maximum self-consumption, TOU, and grid reinforce, etc.

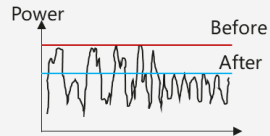
### Max. self-consumption



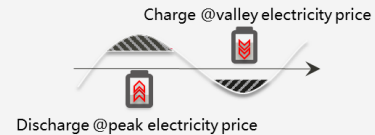
### Grid Reinforce



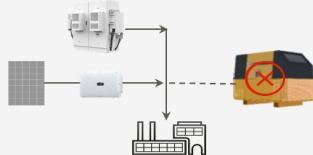
### Peak Shaving



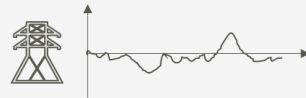
### TOU (Time of use)



### Micro-grid



### Grid ancillary services



## Japan's Tsuruda Electric Factory, Ensure the Stable Operation of Precision Equipment

### Customer pain points:

- Tsuruda Electric Factory has an average load of 50 kW during the day, and the electricity cost is high.
- Natural disasters such as typhoons and earthquakes often cause power outages and production interruptions, affecting factory operation and causing great economic losses.



### Customer benefits:

- Solution: 142 kW PV + 200 kW energy storage
- The PV+ESS is 100% self-consumption, and the power supply ratio is 94.8%. The electricity fee is reduced by 94.8%.
- Huawei's advantage: Intelligent harmonic suppression, THDi < 1%, ensures stable power supply for precision equipment and prevents equipment aging caused by harmonics.

Upgrade



AFCI

DC SWITCH 1

Smart String Level  
Disconnection

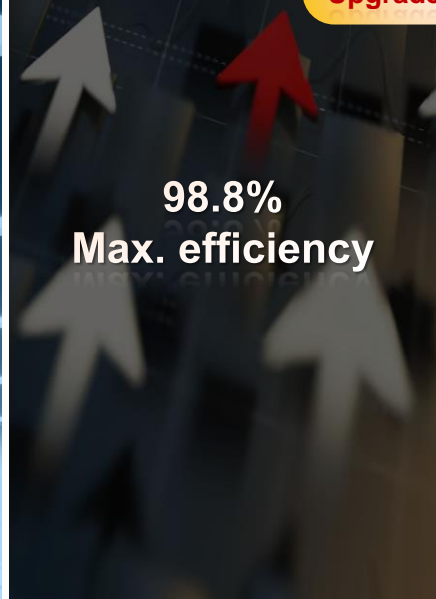


SUN2000-150K-MG0



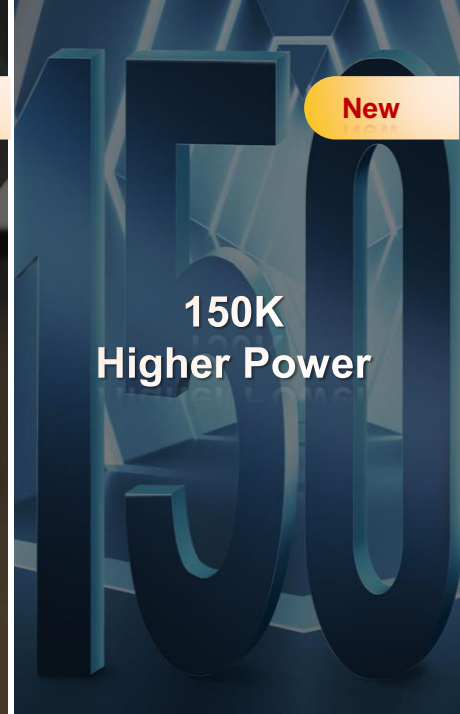
Upgrade

98.8%  
Max. efficiency



New

150K  
Higher Power



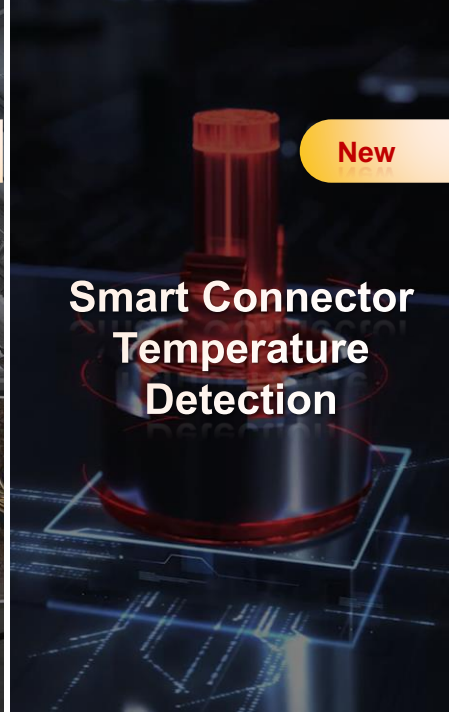
New

PV Ground-Fault  
Protection



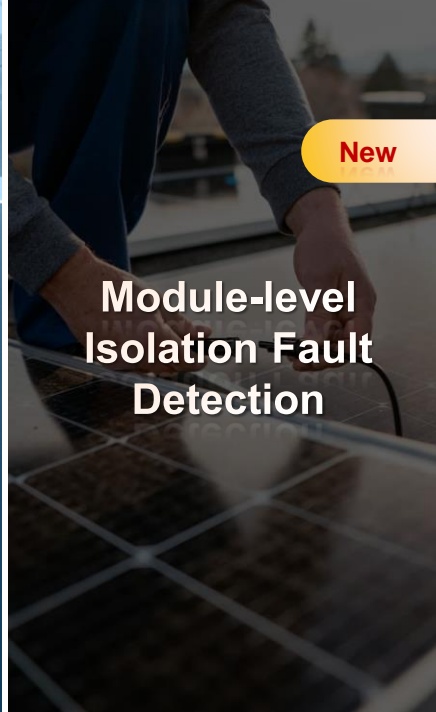
New

Smart Connector  
Temperature  
Detection

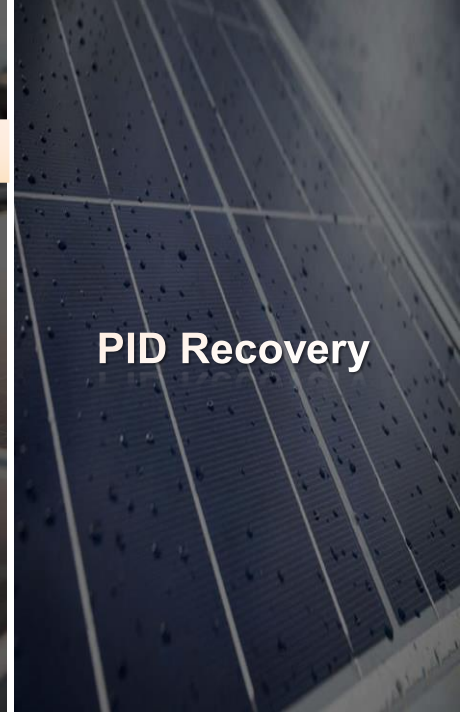


New

Module-level  
Isolation Fault  
Detection



PID Recovery  
Detection



# INTEGRATING ALL YOU NEED



6 core values for higher ROI

⬠ Higher Yield   ⬠ Active Safety   ⬠ Long-Term Reliability   ⬠ Simplified O&M   ⬠ Better BOS   ⬠ Grid-Friendly

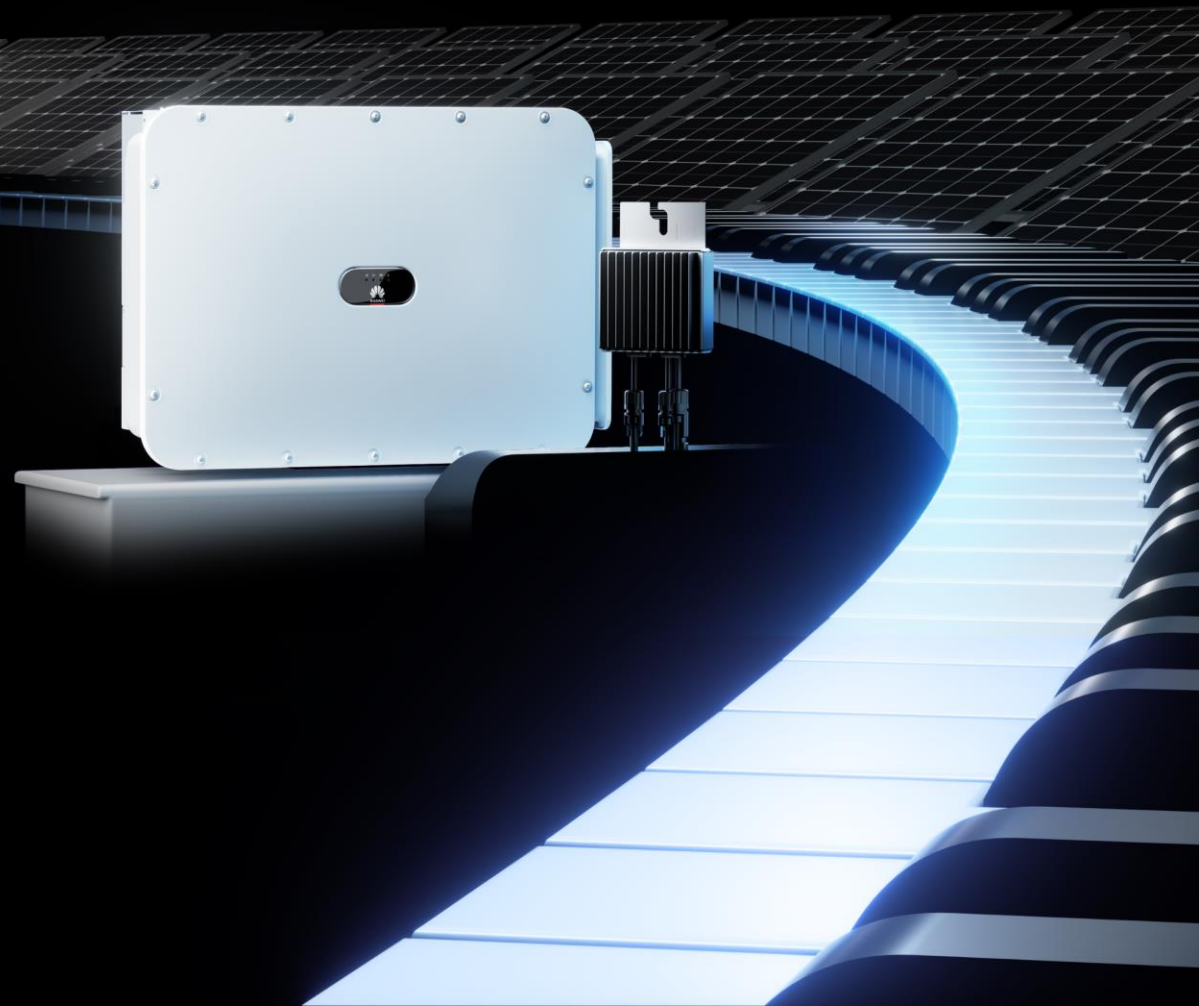




Building a Fully Connected, Intelligent World

## Huawei Fusionsolar C&I SUN5000 Series Solution

SafeLink | ProfiLink | SmartLink





# Huawei Fusionsolar C&I SUN5000 Series Solution

Module SafeLink

Cable SafeLink

**SafeLink**

Device SafeLink

Smartdesign

**SmartLink**

Module-level Management

Long-term Reliability

Construction

Release the Potential of Rooftop

Operation

Resolves Component Mismatch

Problems

Maintenance

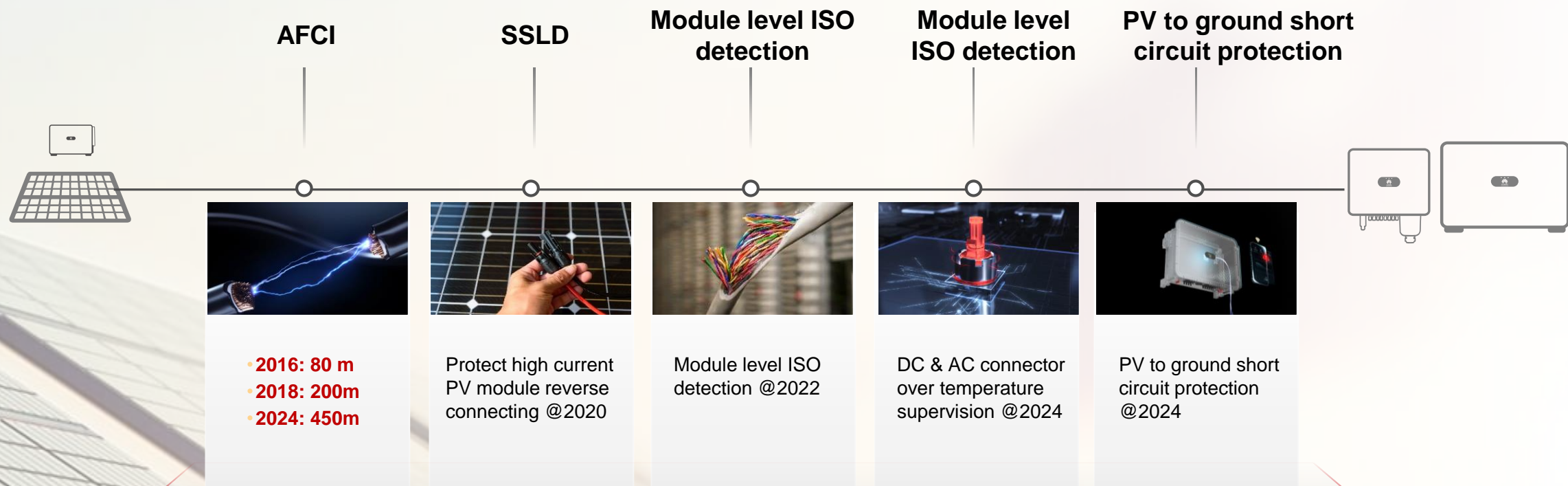
Module-level fault locating

**ProfiLink**



SUN5000-150K-MG0-ZH  
MERC-1100/1300W-P

# Never Stop Innovating on Safety Throughout Decade





# Industry-leading Rapid Shutdown, Adapts to High-safety Scenarios

## Traditional: Rooftop high voltage



- **Fire safety risks,**  
Firefighters are in danger of electric shock
- **O&M safety risks:** O&M personnel may easily get injured by high voltage

VS

## Huawei: Module-level rapid shutdown



- **30s rapid shutdown,**  
Ensuring personal safety
- **Rooftop 30V voltage,**  
No risk of electric shock

## Rapid Shutdown Becomes An Important Standard



EU: VDE-AR-E  
2100-712



US: NEC 2020



Thailand: EIT



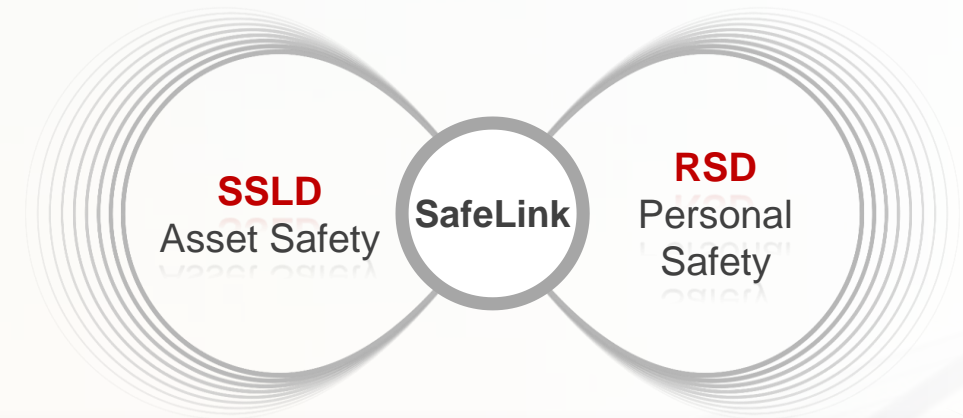
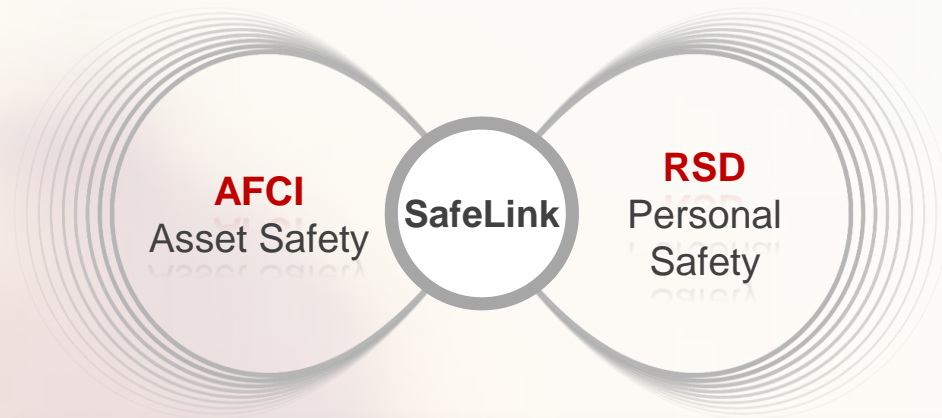
Brazil: Inmetro  
RSD



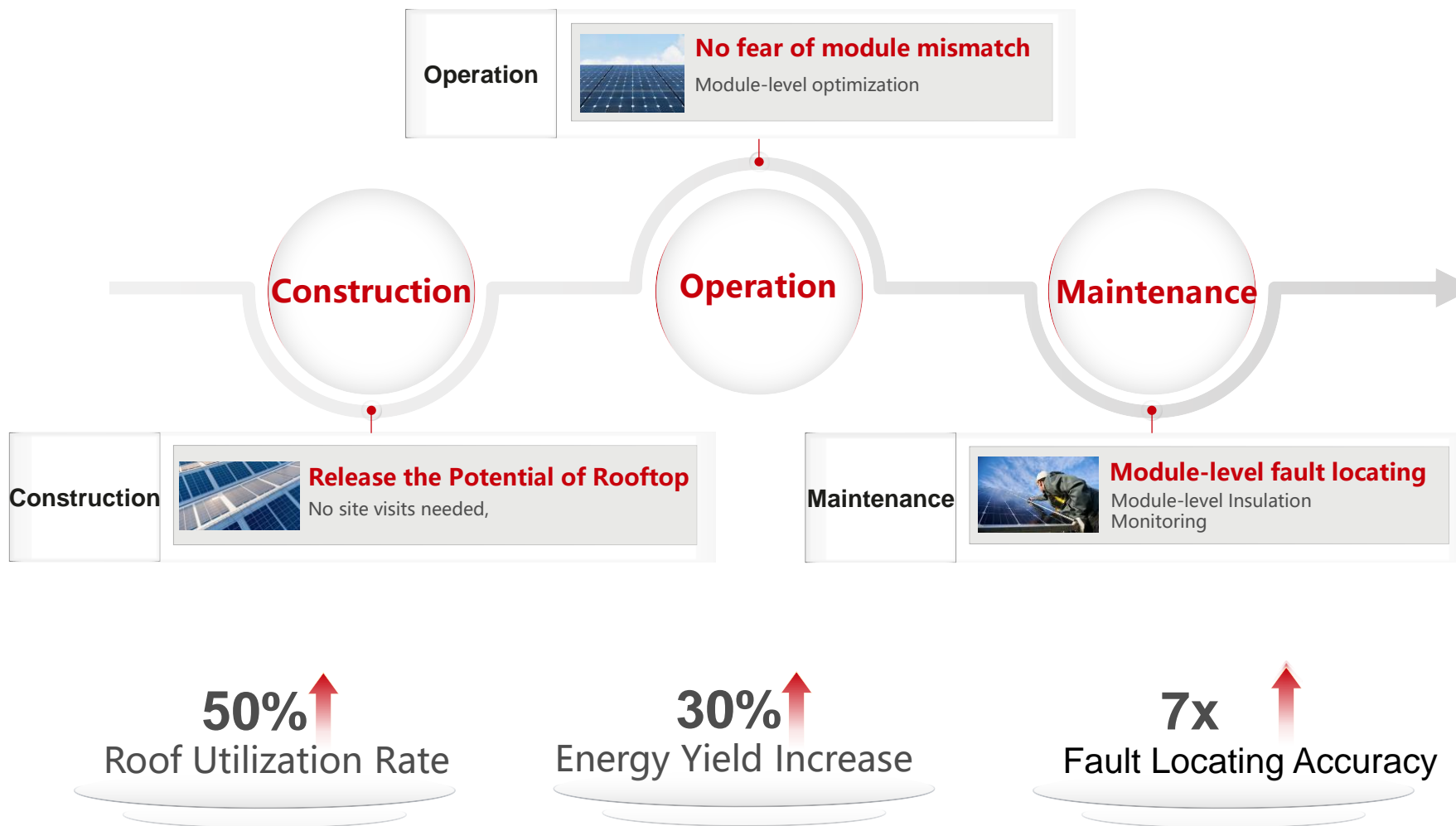
**HW: Meets the most advanced**  
safety standards, NEC 2017 & 2020



# Linkage between features ensure the safety of both asset and personal safety



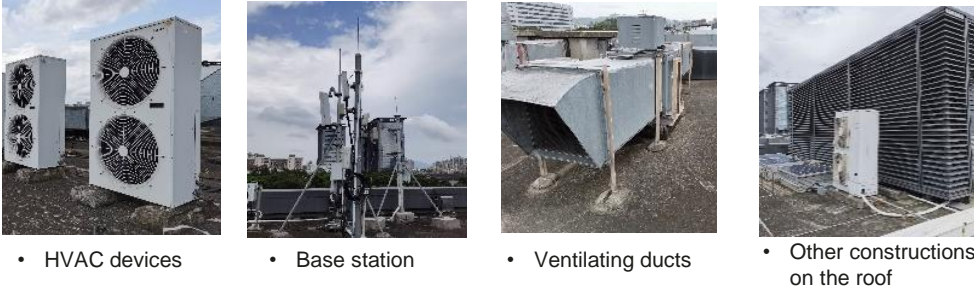
# Unleashing PV Modules' Power Generation Potential, Eliminating O&M Management Blind Spots, and Achieving Better Revenue and Expenditure





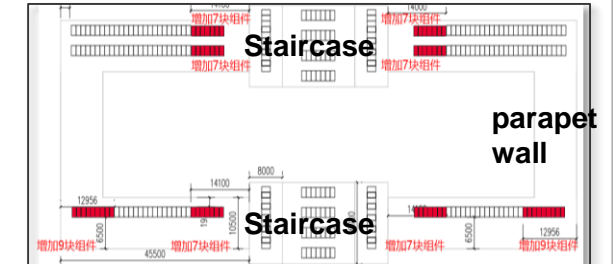
# Module-level Optimization, 50% Higher Space Utilization Rate & 30% More Energy Generation

## High-quality Roof Resources Are Limited



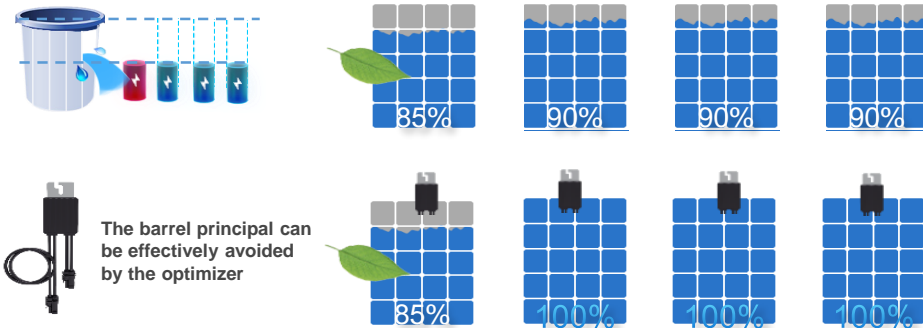
- Shadings on the rooftop make us hard to make full use of space

## Module-level Optimization, Improving Space Utilization by 30%



With Optimizer, the number of installed module increased by **26%** @China

## Independent Operation of PV Modules



- Prevents **PV module mismatch** caused by inconsistency of each module's performance.

## Avoid Energy Loss Caused By Mismatch Between PV Modules.

### Roof Site @Zhejiang

**Without shading**, lifecycle power generation was improved by **5.5%**.



### Roof Site @Shanghai Durr Factory

South slope: ↑ **4.62%** North slope: ↑ **5.03%**

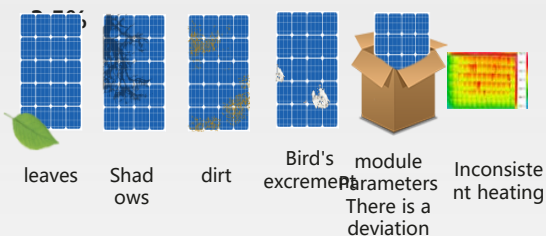


# Unique "Module-level" Asset Management, Real-time Detection of Inefficient Module, Reducing O&M Cost

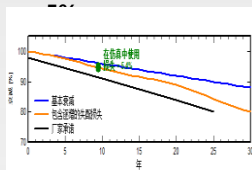
Targeting PV module mismatch,  
increasing energy yield by 5% to 30%.

**module manufacturing tolerances, environmental mismatches,  
and attenuation cause 5% - 30% module mismatches**

module manufacturing tolerance  
synthesis and environmental mismatch



Life Cycle PV Module Attenuation Mismatch

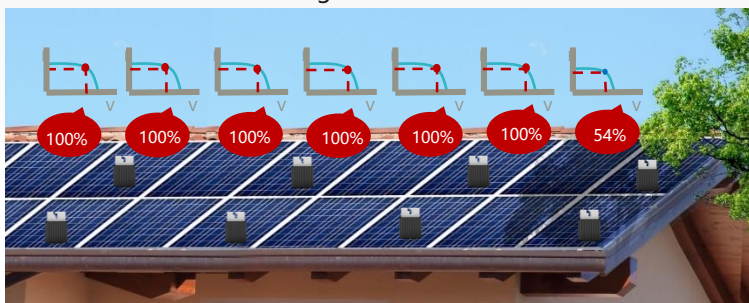


The actual mismatch loss in the lifecycle of the module is higher than the committed value.

Mismatch leads to the increase of power generation loss year by year.

**MPPT at the PV module level, which eliminates the short barrel effect caused by PV modules series mismatch and effectively increases energy yield**

- Track the maximum power point of each module independently
- PV modules with poor power generation performance will be isolated, and other PV modules in the PV string will not be affected.



Identifying inefficient module

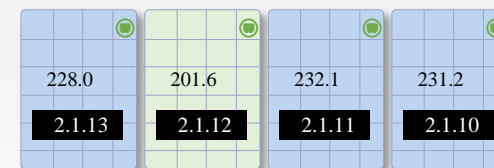
**Monitors the power generation of each PV module in real time, detects low-efficiency PV modules in a timely manner, rectifies the PV modules in a timely manner, and maintains the PV modules as required to ensure revenue.**



Blocking of foreign objects



module damage



**Traditional solution**

The energy yield decreases due to blocking of foreign objects, mismatched PV modules, and damaged PV modules. However, it is difficult to detect the energy yield by the energy yield data.

The power generation status of PV modules cannot be determined. Therefore, the PV modules need to be cleaned onsite periodically.

**SUN5000 Solution**

The SUN5000 Ultra Optical Solution can monitor the energy yield of each PV module in real time, detect abnormal energy yield and reduce the PV modules, and perform maintenance even if the PV modules are abnormally low, ensuring user benefits.

VS

# SmartLink Enables One System to Provide Lifecycle Intelligent Experience

**SmartDesign 2.0 –  
Your Digital Expert Assistant**

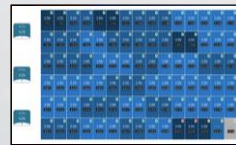


**Module-level Management –  
Minimal long-term O&M Cost**

**Upcoming**



Free of site survey  
Multi-solution comparison to achieve  
optimal design

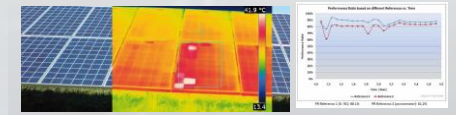


Faults can be accurately located  
without manual inspection

**Provide Module-level  
Accurate IV Detection Reports**



**More accurate PR prediction  
upon deeply module level  
status analysis**





# Long-term Reliability: 30% Less Component for Utmost Reliability & Guaranteed 24 Hours Reconnection If Any Failure

**Failure Rate  
< 300 ppm**

Unique architecture with  
**30% Less Components**



Utmost performance with rigorous testing  
**Under extreme weather conditions**



**Guaranteed  
24 Hours Response**



Faster Recovery:  
Authorized service provider  
for replacement **within 24 hours\***



Quicker Response :  
**7\*24** Hotline & Online support :  
Multi Language Covering **20+** Countries



Higher Reimbursement:  
Optimizer Replacement  
**300-700€/ time\*\***

# SafeLink

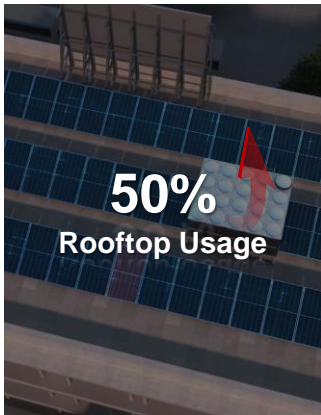
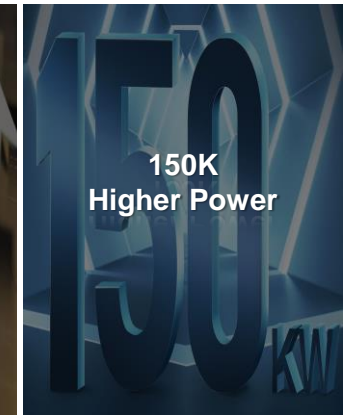
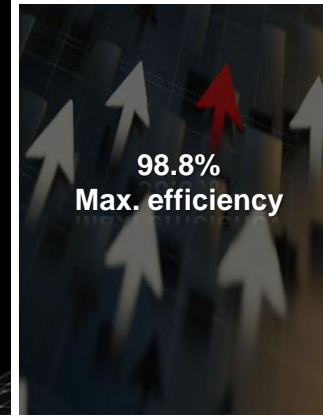
AFCI

Smart String  
Level  
Disconnection

Unique



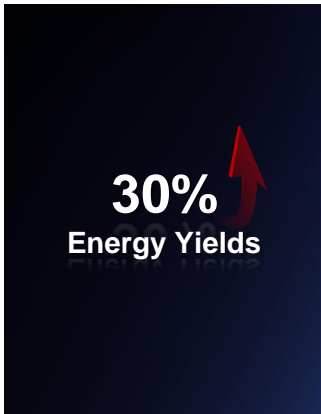
SUN5000-150K-MG0



DC-to-ground  
Protection

Smart  
Connector  
Temperature  
Detection

Unique



# Smart Link

Smartdesign



Module-level  
management

# Long-term Reliability



# Huawei Fusionsolar C&I SUN5000 Series Solution



SUN5000-150K-MG0  
MERC-1100W/1300W-P

# 150 kW



# FusionSolar Brings Ubiquitous Solar, Ubiquitous Safety and Ubiquitous Intelligence



# 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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