

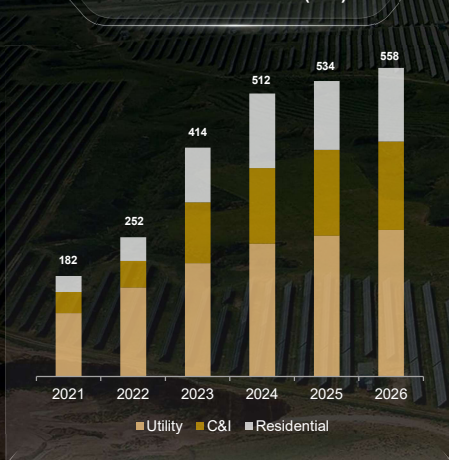
# Top 10 Trends in Smart PV

Felix Kamer

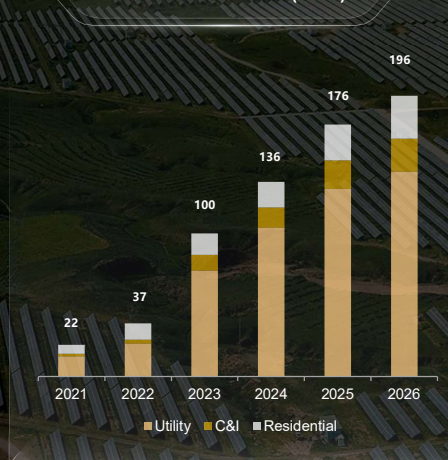
Director Digital Power  
Huawei Switzerland

## PV & ESS continues to develop at a Rapid Speed, Accelerating PV to become the Main Source of Energy

Global PV New  
Installations Forecast (GW)



Global ESS New  
Installations Forecast (GWh)



Proportion of electricity generated from  
renewable sources @ 2050

**90%**

PV has become the absolute  
mainstay of energy

Global PV installed  
@2030 **5200 GW**

Global PV installed  
@2050 **14000 GW**

\* Scenarios according to temperature rise control at 1.5°C

\* Data source BloombergNEF



# PV & ESS Industry is increasing & expanding with Opportunities and Challenges ahead



## Grid-connection Challenge

Improving the grid-friendliness of  
PV power generation  
Enhance the grid's ability to consume  
new energy



## Operation Challenge

Power station expansion to watershed  
plateau, desert, agriculture, etc.  
Massive distributed PV Plant access to  
cloud, increasing challenges



## Safety Challenge

Safeguarding the security and  
stability of the new power system  
Guaranteeing the security and  
stability of power system networks



# 2

Tens of millions of power  
plants management

# 3

Full-Lifecycle  
Intelligence

# 4

Grid Forming  
in All Scenarios

# 5

Four-Dimensional  
Safety

# 6

Cell to Grid  
BESS Safety

# 1

## PV & ESS is becoming the Stable Power

# 7

MLPE & CLPE

# 8

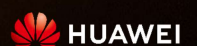
High Voltage and  
Reliability

# 9

High Energy Density

# 10

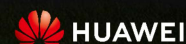
High Power Quality





## Trend 1: PV & ESS is becoming the Stable Power

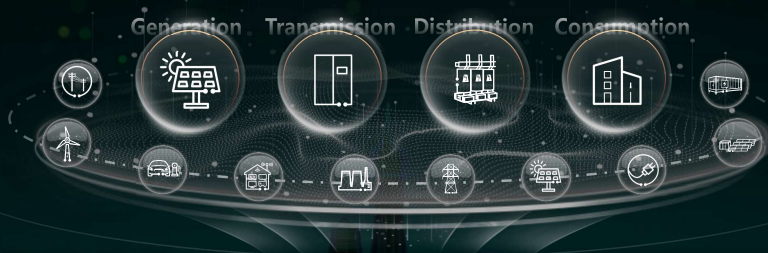
As prices of PV & ESS continues to decline and new technologies boosting, the PV & ESS system already became stable power, and will be the primary power in next 3 years



## Trend 2: Tens of Millions of Power Plants Management

The number of power plants increases exponentially, and the efficient and intelligent scheduling of power generation, transmission, distribution and consumption will become a key requirement

### Multi-NE friendly coordination and dynamic balancing



#### Massive management

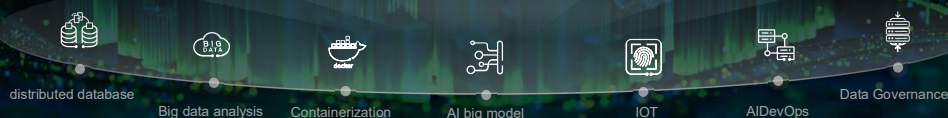
Smooth launch of new features,  
insensitive capacity expansion

#### Multi-energy coordination

Generation-grid-load-storage  
collaborative scheduling

#### Ecosystem openness

North- and southbound  
eco-friendly



## Trend 3: Full-lifecycle Intelligence

Power plant management shifts from "maintenance" to "operation"  
Intelligent technology will significantly improve the benefits of "planning, construction, maintenance, and operation"



## Trend 4: Grid Forming in All-scenarios

The Grid Forming technology has been applied in some commercial scenarios successfully, it will rapidly expanded to all scenarios in the future, which could enhance the grid and promote the large-scale renewable energy feed-in





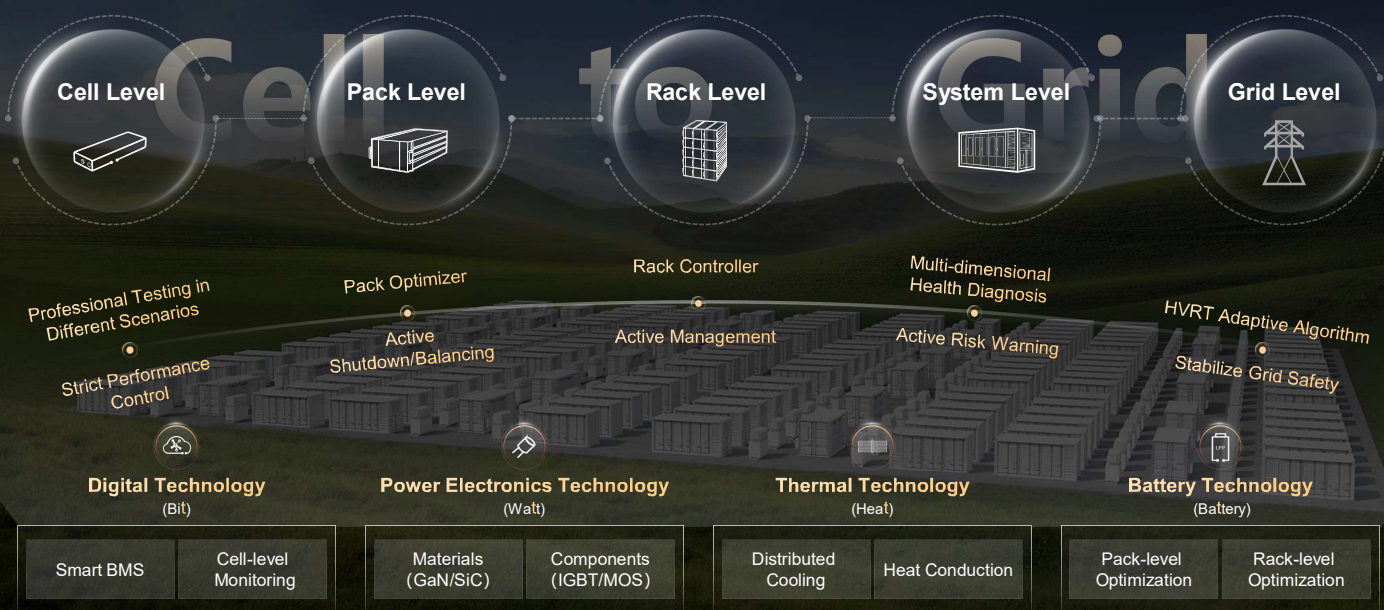
## Trend 5: Four-dimensional Safety

Safety demands have evolved from mere "equipment safety" to a four-dimensional "holistic safety" to ensure the new power system's long-term reliability



## Trend 6: Cell to Grid ESS Safety

The large-scale application of BESS and the upgrade of safety standards require energy storage system to realize the capability of safety from cell level to grid level





## Trend 7: MLPE & CLPE

The need for refined management has incentivized the large-scale commercialization of module-level power electronics (MLPE) and further influences the energy storage industry, leading to cell-level power electronics (CLPE). MLPE and CLPE have become new requirements for distributed PV plants

### Rapid growth of distributed photovoltaic

In 2028, the capacity of distributed photovoltaic and energy storage market will increase to  
**311 GW & 64 GWH**

In 2028, the penetration rate of MLPE in the distributed photovoltaic market will increase to  
**30%**

The “granularity” of the PV market continues to refine

### Safety is the cornerstone

- Countries successively introduced standards to ensure voltage safety on the DC side  
EU VDE2100    USA NEC2020    THA EIT
- Multiple industrial standards were released to monitor cell condition  
IEC 62619    ISO 13849    IEC 63056

### MLPE



Centralized



String



MLPE



### CLPE



Straight-through  
(Series/Parallel high voltage)



PLPE



CLPE



**Safer**

Module-level rapid shutdown  
DC safety protection



**Higher income**

Higher accuracy for higher yields



**More intelligent**

More refined module-level O&M



**Safer**

More refined charging and discharging  
Cell-level safety algorithm



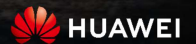
**Higher income**

Participation in power trading



**More intelligent**

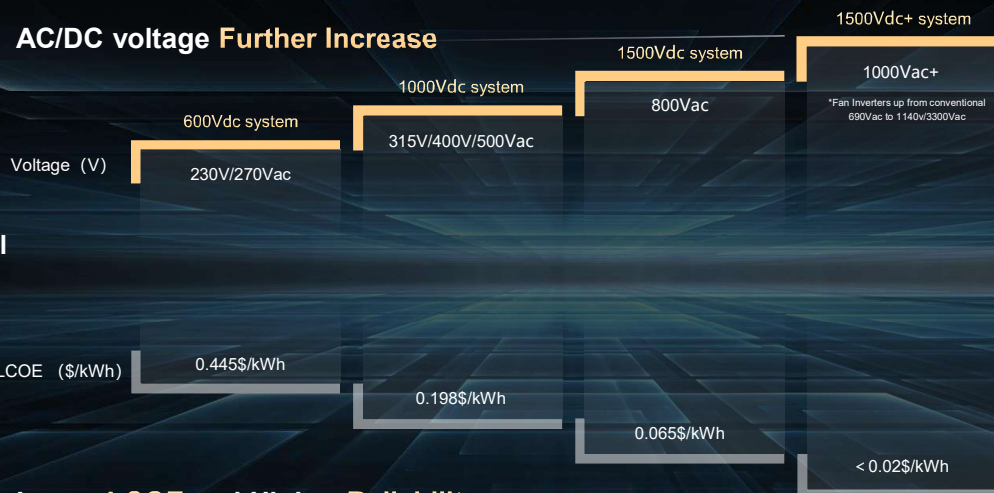
Independent charging and discharging  
of each battery pack  
Increased throughput



## Trend 8: High Voltage and Reliability

High voltage reduces LCOE of the PV&ESS system, high reliability improves high availability and achieves ultimate security

### AC/DC voltage Further Increase



Device-Level Reliability

System-Level Reliability

Dual-Stage HV Structure  
System-Level Safety Protection

Lower LCOE and Higher Reliability

\*LCOE data from IRENA





## Trend 9: High Energy Density

The energy density of inverters continues to improve through the application of third-generation semiconductors and digital technology



## Trend 10: High Power Quality

Promote the large-scale application of PV & ESS in the entire industry by continuously improving power quality

Rapid development of new power system

Rapid growth of high-end manufacturing



**High Power Quality**

Improving the quality of PV power consumption



**More stable**



**More reliable**

**Improve the quality standards of electric energy industry**



IEC-61727 IEC-55011

EN 50549 EN-55011

32004

FCC

**THDu**

The voltage regulation algorithm accelerates the voltage regulation speed and adapts to load fluctuations.

< 5% > < 3%

**THDi**

Intelligent harmonic suppression algorithm, adaptive compensation, and harmonic suppression

< 5% > < 1%

**EMC Design**

Enables millisecond response times to increase grid friendliness

Class A > Class B

**Active/reactive power response ability**

Enables millisecond response times to increase grid friendliness

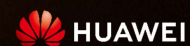
Second-level > Millisecond-level

HUAWEI





# 1 PV & ESS is Becoming the Stable Power



Thank you

