Huawei’s Vision: Safe and Reliable Grid-Forming Solutions for the Future

Leading the energy storage industry and achieving 100% application of renewable energy. Bring green electricity into thousands of industries, thousands of households

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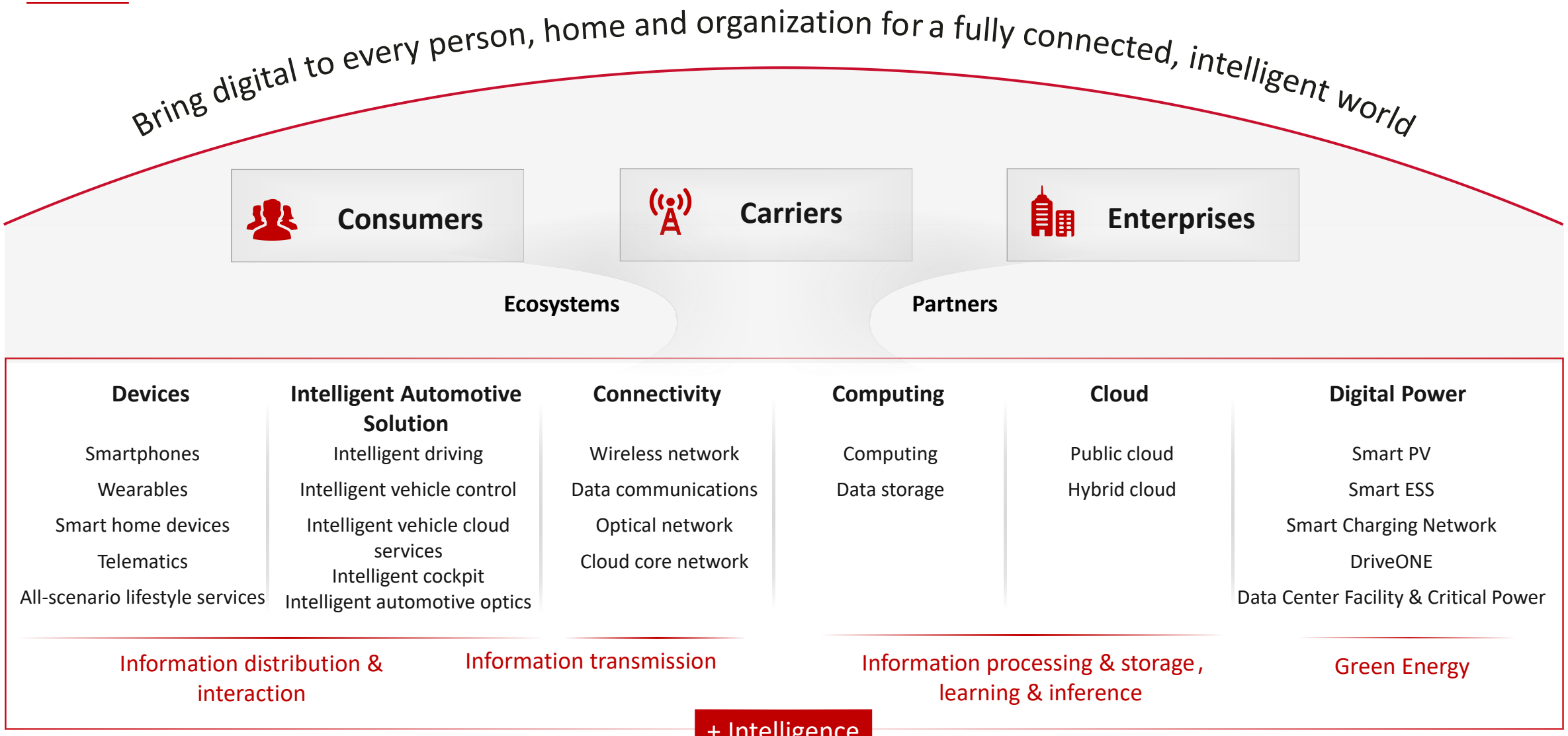
Budapest, 2025.11.06.

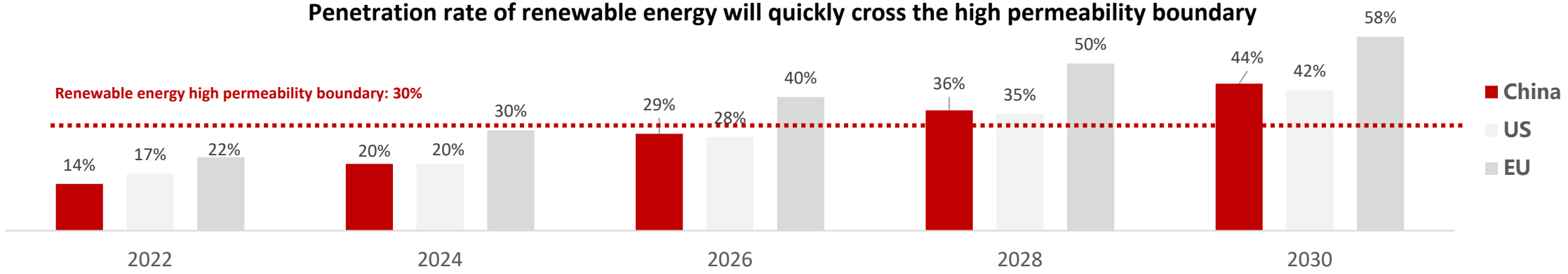
Focusing on ICT to provide products, solutions, and services to three customer groups alongside ecosystems and partners



Global low-carbon development promotes the rapid increase of renewable energy penetration rate, causing significant changes in power system characteristics

Trend

Penetration rate of renewable energy will quickly cross the high permeability boundary



Traditional power grid → **New power system**

Power supply structure	Power grid structure	Load characteristics	Operating characteristics	Technical basics
Fossil energy → **Renewable energy**	One-way flow balance → **Two-way flow graded balance**	Rigid consumption → **Flexible production and consumption**	Multivariate coordination of source with load → **Source network with load and storage**	Mechanical electromagnetic system → **Electromechanical + power electronics**

Weak support capability

- Weak frequency adjustment and support capabilities of new energy equipment
- Weak voltage control and support capabilities of new energy equipment

Increased risk of oscillation

- High-ratio power electronics equipment raises wideband oscillation issues
- Power grid scenarios are becoming more and more complex, and the grid-tied features of devices vary greatly.

Stochastic fluctuation enhancement

- Renewable energy output has randomness and volatility.
- Devices on the grid are becoming more difficult to stay available and respond as needed

Immunity reduced

- Weak transient overload capability of renewable energy
- Challenges to the Reliability of Power Electronic Equipment in Complex and Harsh Conditions

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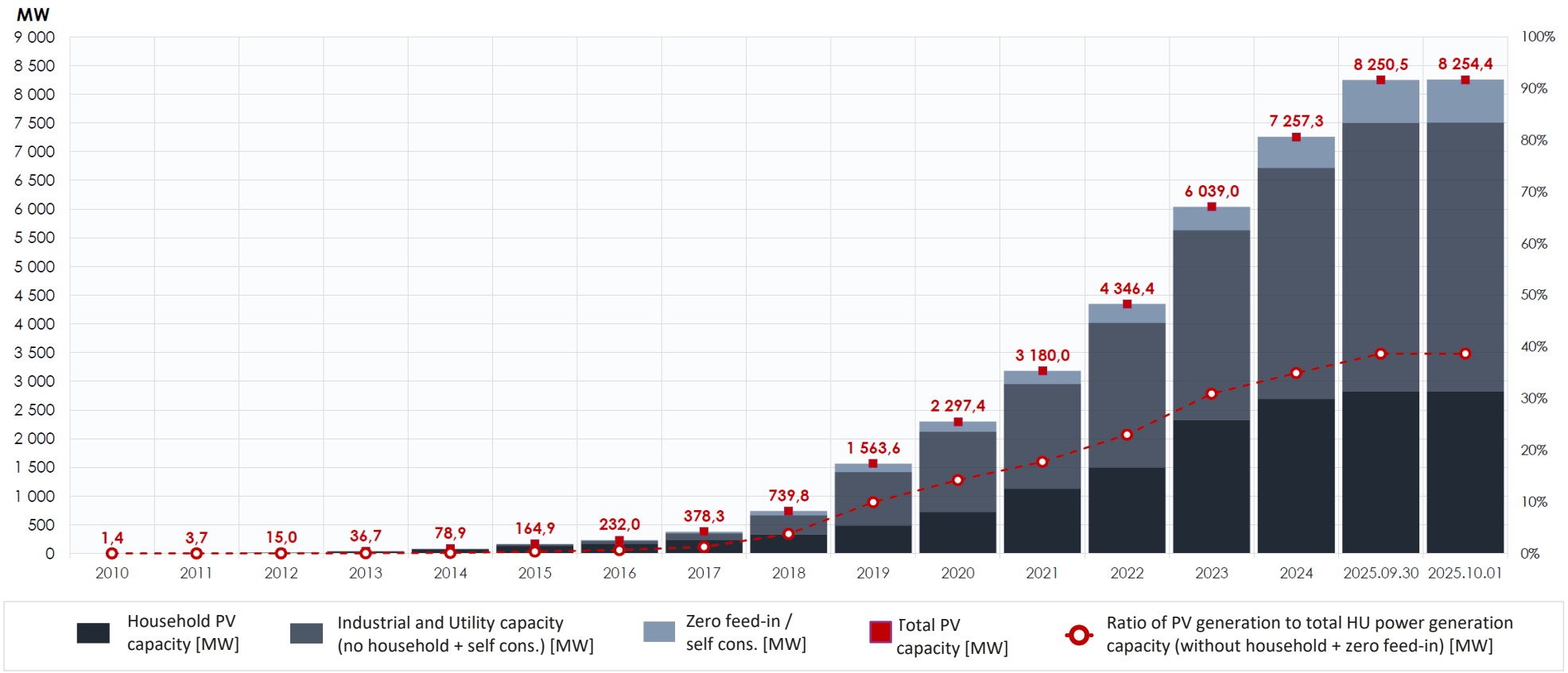
Track record of changes of solar generation in the Hungarian power grid

Trend

Change of total built-in capacity and ratio of PV generation in Hungarym 2010-2025 October[1]



Utility and Industry	Self-consumption / zero feed-in	Household	TOTAL PV
4 680,7 MW	746,2 MW	2 827,5 MW	8 254,4 MW
3 503 pcs	1 920 pcs	312 269 pcs	317 692 pcs

How does it compare to the **total Hungarian power generation**?

(2025.10.01.)

- **15.67 GW**
  Sum of energy mix
  (with houshold PV)
- **PV capacity ratio exceeds 50%** and PV generation reaching 30% in total electricity generation
- Bottleneck for the moment, pressure on **capacity auctions**
- **BESS capacity surged** from <100MWh in 2023 to closing on 1000MWh+ in 2026

[1]source: MAVIR.hu

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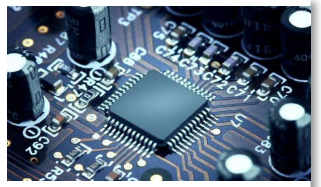
Grid Forming helps new energy to transform from current to voltage source, but it is extremely difficult to achieve plant level Grid Forming capability

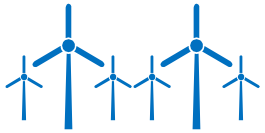
Challenge

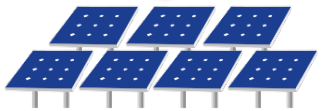
Renewable energy power generation system

Power CPU



Algorithm CPU





Power supply characteristics

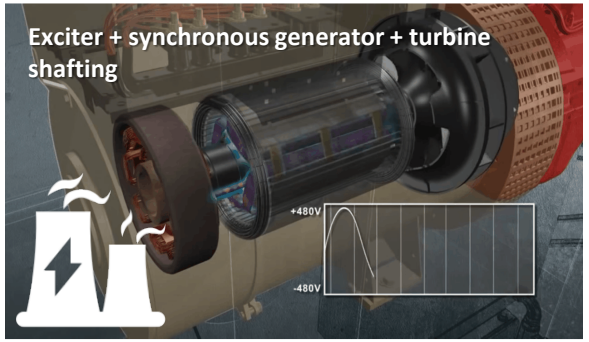
Current source

Frequency stability

No inertia

New energy + Grid Forming = Conventional power generation system

Conventional energy generation system



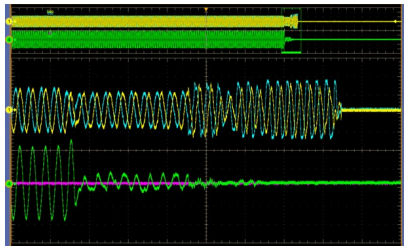
Power supply characteristics

Voltage source

Frequency stability

Strong inertia

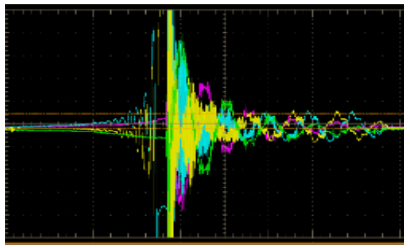
Equipment-level GF is difficult to cover all working conditions



Grid Loss Due to Current Limitation

- ✓ The synchronization capability of GF equipment is related to the grid conditions, and there is a risk of out-of-synchronization.
- ✓ When the grid is in severe transient state, the grid loses due to current limiting

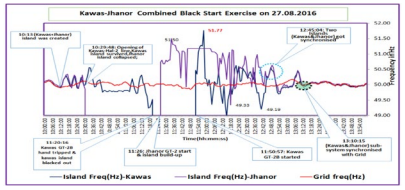
Difficulty in parallel connection of field and station voltage sources



The circulating current is N times than normal output current.

- ✓ The parallel electrical distance of multi-structure GF equipment in the station is short, and the parallel connection of voltage source equipment will cause the high frequency circulation problem.
- ✓ Unbalanced voltage amplitude, phase angle and output impedance will cause power uneven distribution and different characteristics of circulation current.

Difficulty in Synchronous Grid Forming and Coordination of Massive Networking Devices in Regional Power Grids



During the black start, synchronization fails for multiple times, causing grid loss

- ✓ Power electronic equipment is small in capacity and quantity, and it is difficult to coordinate with each other.
- ✓ In the large-scale networking of network construction devices, the dynamic process of voltage vectors of each node cannot be synchronized completely, which is prone to stability problems.

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Smart String Grid-Forming ESS Platform ,Safe, stable, efficient, and intelligent throughout the lifecycle from cells to grids

All-architecture safety

Energy storage safety is **not only cell safety:** full-architecture security of electromechanical / thermal / environment / system / grid

All-scenario grid forming (proactive grid support)

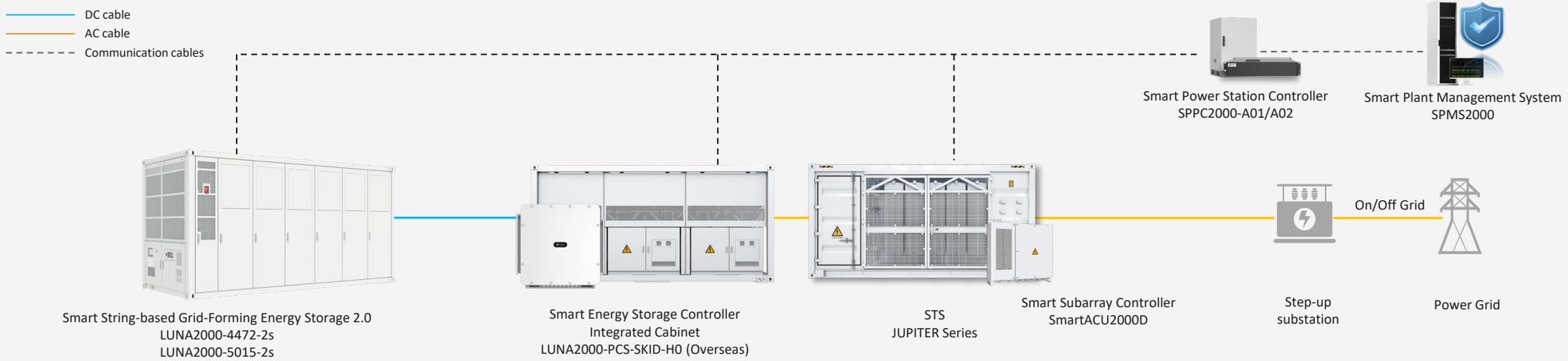
Voltage stability: SC support + dyn. reactive current
Frequency stability: virtual inertia
Phase angle stability: POD, LVRT-HVRT

Full-lifecycle cost-effectiveness

Full business model application
Better performance and configuration over the life cycle

Full-link digitalization

Energy storage security guard, real-time monitoring of security status, and Reduced O&M costs



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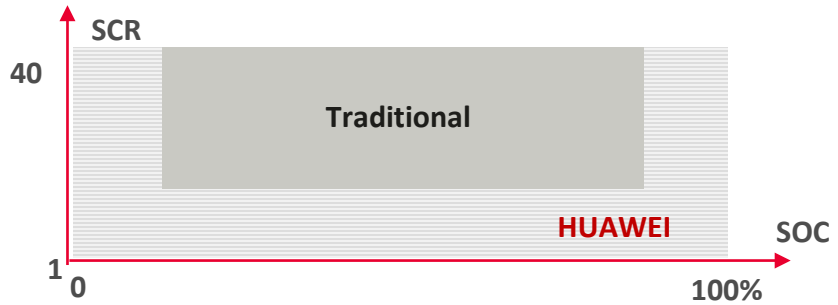
Special Chip and Algorithm: Support the full range of SCR/SOC grid forming and ensure the stability and reliability of the life cycle

	Traditional Solution	VS	Smart String Grid Forming ESS solution
Application	Insufficient support for low SCR No Full-range SOC Grid Forming Capacity Equipment-level partial Grid Forming Capacity		Full-range SCR (1-40) Full-range SOC (0%-100%)* Plant Level Grid Forming **PQ mode SOC 0~100%, SVG mode SOC 2-98%*

Algorithm

Slow response, low inertia

30ms response, ~1 time reactive current
No equivalent inertia
Insufficient wideband flapping suppression capability

Black start single array one by one

Whole microgrid recovery
Several hours ~ days
Load rate <30%

Specifications only claimed or simulated **, not verified**

Three Stability Enhancement

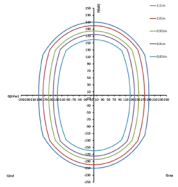
Voltage： **10ms** fast response to abnormal voltage
1.5~6 times reactive current for 10s
Frequency： **5ms** inertia start time, inertia time constant **0-20s**
Phase Angle： suppression of low , medium and high frequency oscillations **(0.1-100Hz)**

GW level whole grid black start

Whole microgrid recovery
Minute-level with 70% loads

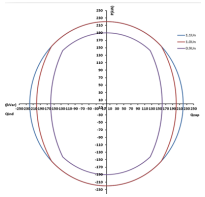
Completed **2300+** third-party certificated tests.

Chip

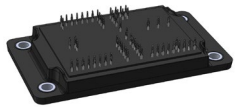


Elliptic curve
Limited reactive power output

General silicone gel potting
Difficult to adapt to high humidity and large temperature difference scenarios



High Overload Power Module
Circle curve (Four Quadrants)



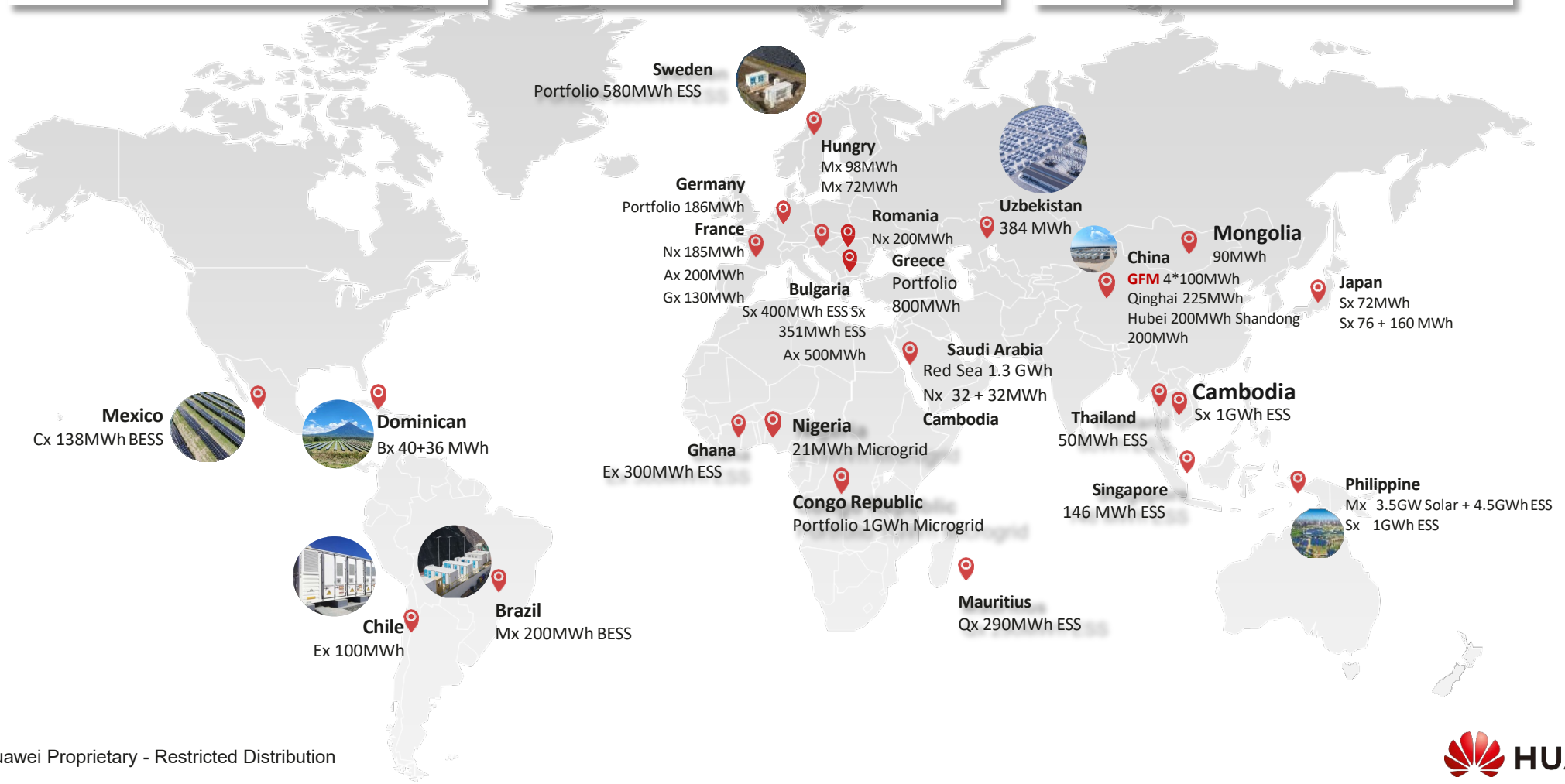
New plasticized structure
30% higher moisture resistance

34+ GWh FusionSolar Smart String Grid Forming ESS Solution Gained Worldwide Recognition

34+ GWh BESS
Global BESS accumulated

3.5GW Solar + 4.5GWh BESS
Largest On-grid Hybrid Plant

400MW Solar + 1.3GWh BESS
Largest Microgrid Plant



Thank you.

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每个组织，构建万物互联的智能世界。

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