

# Digital Power

December 2024 Issue 04

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# Shifting to New Power System via Grid-Forming ESS



**Jinlong Hou**

Director of the Board of Huawei  
President of Huawei Digital Power

In recent years, the PV and wind power industries have been developing at a tremendous rate, with even more potential for future growth. COP28 proposes to triple renewable installations from 2022 to 2030, to exceed 11,000 GW. With the rapid development of renewable energy, global power systems are faced with a high penetration rate of renewable energy. However, renewable energy requires flexible resources that help to regulate power systems. The randomness, fluctuation, and intermittence issues inherent in renewable technologies aggravate the power system balance and safety problems. This hinders the stable operation of power grids and becomes a roadblock for the global development of renewables. The grid-forming technology concept is a key to improving the active support capabilities of renewable energy. As such, many countries are doubling down on the development and application of grid-forming solutions in commercial projects by releasing technical standards and policies.

## Investing in research

Since 2011, Huawei has been investing heavily in research into the safety and stability of grid-connected renewable systems to promote the transition from grid-following and grid-supporting to grid-forming and drive the sustainable development of the industry. Huawei has applied its innovations in a wide range of scenarios and projects worldwide. In the Middle East, the world's first city microgrid powered by 100% renewable energy was built by using cutting-edge technologies including utility-scale grid forming. The project consists of a 400 MW PV plant and a 1.3 GWh energy storage system (ESS). Since being put into operation in September 2023, the project has provided more than 1 billion kWh of green electricity.

Till now, the project has been running safely and stably for more than one year. Key grid-forming performance indicators have been fully verified, including the synchronous grid-forming activities of 1,000 power conversion systems (PCSs), minute-level power recovery, resistance to the impact of 100% of the transformers

switching on/off, and zero-voltage fault ride-through in an off-grid scenario.

The grid-forming technology deployed in the Middle East is also being applied to microgrid scenarios such as mines and islands. For example, when this technology is used to build microgrids for mines, the solution drastically improves power supply reliability and reduces energy consumption costs by more than 50%. To date, Huawei has completed more than 10 microgrid projects for mines and islands in Africa and Latin America. In the future, the grid-forming microgrid technology will be applied in more places around the world to help bridge the power divide.

### Performance testing with customers and partners

In Qinghai and other provinces of China, Huawei has worked with power grid companies and power generation enterprises to promote and carry out the grid-forming ESS performance tests in five projects. These comprehensive and large-scale tests have successfully verified the ESS performance indicators in various working conditions and scenarios, including unit-level, plant-level, regional power grid simulation, and off-grid scenarios. More than 2,300 test items have been completed for the key indicators for grid-forming technologies.

In Hami, a prefecture-level city in western China, comprehensive and systematic grid-forming technology tests have been carried out on the CR Power wind power plant, which is located at the supply end of the DC ultra-high-voltage (UHV) line and is equipped with Huawei's 100 MWh grid-forming ESS. In Golmud, Qinghai, the China Green Development

Investment Group's (CGDG's) 100 MWh grid-forming ESS project for its multi-energy renewable power plant passed the 35 kV and 110 kV short-circuit tests on the first attempt. The test results show that not a single one of the 600 PCSs was disconnected from the power grid, and they generated three times the apparent current and 2.8 times the asymmetric current within 10 ms, supporting the power grid voltage.

In the Ngari Prefecture, the 24 MWh grid-forming ESS project managed by ZDI is located at a high altitude and in a weak power grid environment. The plant passed the 35 kV short-circuit test on the first attempt, with no PCSs disconnected from the grid. The PCSs rapidly generated three times the apparent current within 10 ms, levelling out the power supply with no fluctuations and no overvoltage.

Huawei's Smart String Grid-Forming ESS technology has been systematically tested in the following four aspects: multi-site self-synchronized amplitude and frequency regulation technology, wideband self-stabilizing and stabilizing control technology, new two-stage conversion architecture of the smart string ESS, and grid-forming ESS power modules. The tests verified that the technology can provide support for power systems in multiple scenarios with a high proportion of renewable energy.

In July 2024, Huawei's Smart String Grid-Forming ESS underwent a rigorous technical appraisal meeting organized by the Chinese Society for Electrical Engineering. The committee comprises experts from research institutions and companies, including members of the

Chinese Academy of Sciences and the Chinese Academy of Engineering, along with experts from State Grid Corporation of China (SGCC). The appraisal meeting aimed to evaluate the key technologies and applications of the Smart String Grid-Forming ESS designed for various scenarios with a high proportion of renewables. The committee unanimously agreed that the applied projects have achieved world-leading capabilities in terms of improving new power system stability and renewable energy integration.

### Next steps

Promoting the high-quality development of the grid-forming energy storage industry and enabling innovations to play a greater role in propelling the industry, requires three serious next steps.

- First, it is important to gradually expand the scale of the application of grid-forming ESS as the technology matures.
- Second, the industry needs to establish a high-quality system of standards for grid-forming ESS solutions.
- Finally, it is vital to form a market mechanism that is conducive to the high-quality development of grid-forming ESS technology.

Looking ahead, Huawei Digital Power will continue to integrate what it refers to as the "4T" technologies — bit, watt, heat, and battery — to provide high-quality, safe, and reliable equipment. We will work with customers and partners not only to promote the development of the grid-forming energy storage industry, but also to contribute to the construction and development of new power and energy systems. ▲

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## Global Policy Review



### International Energy Agency: Released the World Energy Outlook 2024

According to the International Energy Agency, clean energy is entering the energy system at an unprecedented rate. A new, increasingly electrified energy system is taking shape as global electricity demand continues to surge. Low-emission sources are set to generate more than half of the world's electricity by 2030, and the demand for coal, oil, and natural gas is expected to peak by 2030.

### International Energy Agency: Released the Renewables 2024

The International Energy Agency predicts

that the global renewable capacity will surpass countries' current ambitions by nearly 25% by 2030. Approximately 140 countries around the world have introduced policies on energy security and climate change. It is estimated that a total of 5500 GW of renewable capacity will be added worldwide by 2030. Solar power and wind power together will account for more than 95% of the renewable capacity addition. China is set to cement its position as the global leader in renewables by 2030.

### BP: Released the BP Energy Outlook 2024

According to BP, oil consumption is projected to decline significantly to 25–30

million barrels per day by 2050 under the Net Zero scenario. Natural gas demand is expected to grow steadily, increasing by approximately 20% by 2050, with its share in primary energy increasing to just over 25%. Underpinned by further gains in cost competitiveness and a sharp acceleration in the deployment of new capacity, wind power and solar power will witness an 8x increase by 2050 and a 14x increase under the Net Zero scenario.

### European Union: Released the Energy Union Report 2024

According to the report, renewables contributed to around 50% of electricity generation in the European Union (EU) in the first half of 2024. Wind energy surpassed natural gas to become the EU's second-largest source of electricity behind nuclear energy. From August 2022 to May 2024, the EU's demand for natural gas decreased by 138 billion cubic meters. From 1990 to 2022, the EU's greenhouse gas emissions fell by 32.5%. On August 19, 2024, the EU achieved the 90% gas storage target for the winter season.

### Europe: Released "The future of European competitiveness" Report

According to "The future of European competitiveness" report, Europe now faces an energy transition. It must lower energy prices, continue to decarbonize, improve competitiveness, and capitalize on the opportunities offered by clean technologies. The report proposes a joint plan for decarbonization and competitiveness to reduce energy costs and accelerate the decarbonization

process by leveraging coordinated policies.

### **Germany: Announced the Long-Term Strategy on Negative Emissions**

In September 2024, the Federal Ministry for Economic Affairs and Climate Action (BMWK) of Germany announced the Long-term Negative Emissions Strategy for Unavoidable Residual Emissions. The country has set a target for net-negative greenhouse gas emissions and a mid-term plan for negative emissions by 2060, contributing to the global climate goals of the Paris Agreement. Germany's long-term negative emissions strategy will establish annual negative emissions targets, evaluate various CO2 removal methods, and analyze economic incentives and feasibility to identify and implement optimal technologies and solutions. Germany is poised to become a global frontrunner in CO2 emission reduction policies with this strategy.

### **Japan: Released the Technology Strategy for Energy Efficiency and Transition to Non-Fossil Energy 2024**

This strategy aims to promote the research, development, and dissemination of technologies for energy efficiency and the transition to non-fossil energy. It is based on the 6th Strategic Energy Plan, the Green Growth Strategy Through Achieving Carbon Neutrality in 2050, and the basic policies of green transition, as well as the revision of the Energy Conservation Act. Additionally, the strategy seeks to identify and

prioritize critical energy conservation and decarbonization technologies. These include key technologies for energy saving, technologies for transitioning to non-fossil energy, including hydrogen, technologies for optimizing electricity demand, and technologies for advancing energy conservation and decarbonization in the industrial and transportation sectors.

### **China: The National Energy Administration Released the White Paper on China's Energy Transition**

The white paper provides a comprehensive description of China's achievements in promoting new green energy consumption models, building new energy systems, and deepening international cooperation on green energy. China has made significant breakthroughs in the development of clean energy. By the end of 2023, the installed capacity of wind and PV power had increased tenfold compared to the level 10 years prior; clean energy capacity accounted for 58.2% of the total installed capacity, and the clean energy yield increase accounted for more than half of China's total energy consumption increment. For every 3 kWh of electricity consumed by society, 1 kWh is sourced from clean energy.

### **China: The National Energy Administration Released the Notice on Issuing the Rules for the Issuance and Trading of Renewable Energy Green Electricity Certificates**

This document regulates the issuance,

trading, and management of green certificates for China's power generation projects based on renewables, such as wind, solar, conventional hydropower, biomass, geothermal, and marine energy. A green certificate is the only proof of the environmental attributes of electricity generated from renewables in China. It uniquely certifies the production and consumption of renewables-based electricity. The issuance and trading of green certificates are required to adhere to the principles of "unified issuance, open trading, market competition, information transparency, and whole-process traceability."

### **China: The National Development and Reform Commission and Other Departments Issued the Guiding Opinions on Vigorously Implementing the Renewable Energy Substitution Initiative**

According to the document, the new energy security strategy of "four revolutions and one cooperation" will be implemented, with efforts to ensure unified planning and secure substitution, properly coordinate the relationship between conventional and renewable energy sources, promote the integration of power generation, grid, load, and storage, and comprehensively improve the secure and reliable supply capability of renewables. Significant progress has been made in renewable energy substitution across key areas during 2021 and 2025. The national consumption of renewables will exceed 1.1 billion tons of standard coal equivalent by 2025.

## Clean Power Generation

### Grid-Forming Energy Storage: Essential for New Power Systems, With a Rapid Penetration Rate

China has set clear power system decarbonization targets to achieve carbon neutrality. Widespread installations of clean energy sources such as wind and solar are driving the construction of a new power system in China. The new power system will feature a high proportion of renewables and power electronics equipment, which is likely to pose risks to power grid stability. To address this issue, grid-forming energy storage systems (ESSs) with stable voltage sources will be used to provide stable voltage and frequency support to the power grid. Their penetration rate will increase rapidly thanks to national and local policy support and power system reconstruction. Additionally, the demand for oversizing and high-performance power conversion systems (PCSs) is expected to drive up both prices and sales.

### SolarPower Europe: Released the European Market Outlook for Battery Storage 2024–2028

The report urges the EU to implement a comprehensive energy storage strategy and set a target of achieving 200 GW of capacity by 2030. This will fully unlock the growth potential of solar PV in the EU. According to the analysis, the installed capacity of battery energy storage systems

(BESSs) in 2023 reached 17.2 GWh, an increase of 94% compared to 2022. Approximately 70% of the installed capacity is from residential ESSs, about 21% from large-scale or utility systems, and 9% from industrial and commercial sectors.

### France: Crucial Adjustments to the Carbon Footprint Policy for PV Modules

The French Energy Regulatory Commission released the Review Decision on Modifying the Review Criteria for Bidding Projects for three types of PV bidding projects in France:

building rooftop projects, utility-scale projects, and technology-neutral projects. According to the document: (1) The calculation method of the carbon footprint of PV modules in building rooftop projects is adjusted. For imported PV modules, the default values provided by the countries where PV modules were manufactured will be used in the life cycle assessment (LCA) for various production phases. The measured values provided by manufacturers and obtained from upstream suppliers will no longer be used. (2) The upper limit for the carbon footprint of PV modules





used in building rooftop projects is increased from 550 kg CO<sub>2</sub>/kWc to 740 kg CO<sub>2</sub>/kWc.

### **Germany: Accelerated Promotion of Renewables Like PV**

According to the Federal Statistical Office of Germany, 61.5% of Germany's electricity generated in the first half of 2024 came from wind, solar, hydropower, and biomass energy. Compared to the first half of 2023, the share of renewables in electricity generation grew by more than 9%, surpassing the energy yield in the first half of any of the previous years. The German government is driving the development of renewables, including promoting a statutory expansion path and accelerating the approval procedure through treaties. In the first half of 2024, one-third of Germany's electricity was generated by wind turbines. Meanwhile, thanks to new PV systems, the share of solar energy has also increased significantly, accounting for 13.9% of the total energy.

### **South Korea: 1.2 GW Solar Installations in the First Half of 2024**

According to data from the South Korean Energy Agency, the installed solar capacity in South Korea reached 1.2 GW in the first half of 2024. However, the country's solar

market has been on a downward trend since its peak in 2020, with planned deployments for 2024 ranging between 2.7 GW and 2.8 GW. This decline can be attributed to the government's focus on nuclear energy, which has led to regulatory restrictions and budget cuts for solar initiatives. These policies are expected to persist over the coming years, further impacting the growth of the solar industry in South Korea. Currently, the majority of solar installations in the country are utility-scale projects, primarily driven by the private sector. Given the high capital requirements and limited availability of financing options, most new developments tend to be mid-size or large-scale projects.

### **India: 172 GW Solar Panel Manufacturing Capacity by 2026**

The State of Solar PV Manufacturing in India 1H 2024 report estimates that India's total solar project pipelines will reach 132.7 GW between 2024 and 2026. Additionally, the Approved List of Models and Manufacturers (ALMM) order was reimposed in April 2024. By June 2024, the total manufacturing capacity of solar panels in India reached 77.2 GW, and the total manufacturing capacity of solar cells reached 7.6 GW. Over 57% of module manufacturing capacity is used to manufacture solar modules of M10 and G12 silicon wafer sizes.

Monocrystalline (mono) Passivated Emitter and Rear Cell (PERC) modules accounted for most of India's module production capacity, followed by Tunnel Oxide Passivated Contact (TOPCon), polycrystalline, and thin film modules. According to the report, India's module manufacturing capacity is projected to surpass 172 GW, and cell capacity is expected to exceed 80 GW by 2026.

### **China: Started the World's First UHV Flexible DC Project (±800 kV from Gansu Province to Zhejiang Province)**

The ±800 kV ultra-high voltage (UHV) DC power transmission project from Gansu Province to Zhejiang Province started in July 2024. The total investment of this project is about CNY35.3 billion, and the total length of the line is 2370 km. This project is the world's first UHV flexible DC project, which will significantly improve the capability of large power grids to integrate renewable energy sources such as wind power and PV. After the project is completed, over 36 billion kWh of electricity can be supplied to Zhejiang Province annually, using the resources of Gansu Province to meet energy demands in Zhejiang Province. Additionally, more than 21 billion kWh of electricity generated from renewables can be integrated into the power grid each year, reducing carbon dioxide emissions by 17 million tons and supporting the large-scale

development and utilization of clean energy.

### **China: Connected 160.88 million kW PV Installations to the Power Grid in the First Three Quarters of 2024**

On October 31 2024, China's National Energy Administration released the PV power generation and construction data for the first three quarters of 2024. In the first three quarters, the on-grid capacity increased by 160.88 million kW, including 75.66 million kW from utility-scale PV plants and 85.22 million kW from distributed PV plants. Residential PV plants accounted for 22.8 million kW. By the end of September 2024, the total on-grid capacity was 772.25 million kW, including 430.35 million kW from utility-scale PV plants and 341.91 million kW from distributed PV plants. Residential PV plants accounted for 138.52 million kW.

### **China: Solicited Opinions from 31 Organizations on Pollution Control of Waste PV Device Recycling and Disposal**

The Ministry of Ecology and Environment of the People's Republic of China published the "Technical specification for pollution control of waste photovoltaic power device recycling (draft for comments)" standard. This standard is applicable

to pollution control during the entire process of waste PV device disposal. It serves as a technical reference for site selection, engineering construction, operation management, environmental protection acceptance after project completion, sewage discharge license management, clean production review, etc., in the environmental impact assessment of construction projects related to the comprehensive utilization of waste PV devices. The standard applies to the recycling and disposal of solid wastes, such as waste parts and leftover bits and pieces generated during the production, installation, and maintenance of PV devices.

### **China: Issued the 2024 Guiding Opinions on Energy Work**

China's National Energy Administration issued the Guiding Opinions on Energy Work in 2024 to promote the development and construction of hydropower and nuclear power, continuously improve the green and low-carbon transformation policy system, scientifically optimize the renewable energy utilization target, and promote the high-quality development of wind and PV power. Additionally, it seeks to deepen the transformation of energy utilization, strengthen the transition to clean and low-carbon energy, and encourage the energy industry to save energy,

reduce pollution, and reduce carbon emissions. The document estimates that the total energy production in China will reach about 4.98 billion tons of standard coal equivalent, with wind and PV power accounting for more than 17% of the total electricity generated in China.

### **China: National Energy Administration Issued Measures for Administration of the Development and Construction of Distributed Photovoltaic Power Generation (Draft for Comments)**

This document specifies the requirements for distributed PV industry management, filing management, construction management, power grid connection, and operation management. Distributed PV projects are classified into four types: natural-person residential, non-natural-person residential, general commercial and industrial (C&I), and large-size C&I. The distributed PV grid connection modes include fully fed to the grid, self-consumption, and self-consumption + surplus feed-in. Additionally, the document also states that distributed PV power generation projects are required to participate in the electric power market in accordance with relevant national regulations.

# Mobility Electrification



## Global: EV Sales Surpassed 10 Million in 2024

CleanTechnica, a well-known automobile research institute, released the global electric vehicle (EV) sales figures in August 2024. According to the report, the number of registered EVs worldwide reached 1.5 million in August, a year-over-year increase of 19%, accounting for 22% of the global vehicle market. Battery electric vehicle (BEV) sales reached nearly 1 million registrations, with a year-over-year increase of 6%, accounting for 63%, the highest proportion in EV sales. In the first eight months of 2024, global EV sales reached 10.026 million,

accounting for 19% of global vehicle sales. BEVs accounted for 12% of all EVs sold. EV sales have been gradually increasing over the past two years. China remains the world's strongest market for EV sales.

## UK: EV Sales Hit a Record High

In September 2024, the UK's BEVs delivered a stellar market performance. The number of newly sold BEVs increased by 24% year over year, reaching 563,870, with a market share of 20.5%, which was a record high in the UK. According to data released by the Society of Motor Manufacturers & Traders (SMMT), Chinese automakers

sold a total of 23,581 vehicles in the UK market, a year-over-year increase of 12.7%. Their market share increased from 7.67% in September 2023 to 8.57% in September 2024, surpassing the sales of US, Japanese, and South Korean automakers. The influence of Chinese EV brands in the UK and even Europe is gradually increasing, and Chinese EV brands have become the main force driving the growth of the local EV market.

## Germany: VDA Lowered Annual EV Sales Forecast

The German Association of the Automotive Industry (VDA) has

lowered its forecast for annual EV sales in Germany. The EV sales in Germany fell 20% year-over-year in the first nine months of 2024. VDA estimated that the BEV and plug-in hybrid electric vehicle (PHEV) sales were expected to decline by 21% to 551,000, compared with previous forecasts of 17% to 578,000. The main reason for the decline was that BEV sales fell more than expected. The slowdown in sales in 2024 was more obvious due to the sudden cancellation of subsidies for car purchases by enterprises in Germany in 2023 and high sales in the same period last year. VDA expected the annual BEV sales to decline by 29%, higher than the previously estimated 25%.

**Europe: European Commission Imposed Countervailing Duties on BEV Imports from China over**

**a Period of Five Years**

On October 29, 2024, the European Commission announced countervailing duties on BEV imports from China over a period of five years, which took effect on October 30. Countervailing duties are imposed on Chinese automakers, with a rate between 17.0% and 35.3% (SAIC Motor) on top of the 10% normal tariff. According to the statement released by the European Commission, the above measures will expire at the end of the five-year period unless the validity period review is initiated during the period.

**Japan: Tax Breaks on Domestic EV Batteries and Semiconductors**

According to Nikkei, Japan planned tax breaks for domestically-made EV batteries and semiconductors from April 2024 to enhance economic security. The move aimed at encouraging companies to bring production home

and would also facilitate the country's energy transition. Japan's Ministry of Economy, Trade and Industry has listed batteries, including car batteries, as a key to national economic security. It has allocated JPY330 billion in the second supplementary budget to support the supply and development of domestic batteries.

**Europe: Investing 39 Billion Euros Every Year to Fully Deploy Green Transportation Technologies**

According to a report by the European Federation for Transport and Environment (T&E), Europe needs to shift its public investments from road and airport building to energy infrastructure, including power grids and charging stations, which are key to decarbonizing road transport. Europe needs to spend 39 billion euros in public money every year to maintain its competitiveness and ensure that green transport technology is promoted across Europe. Failing to do so will result in Europe failing to achieve its net zero goal and lead to a decline in the competitiveness of its leading industries like car making, battery production, and ship and plane building.

**Singapore: The Land Transport Authority Issued Amendments to Electric Vehicle Charger Regulations**

The Land Transport Authority of Singapore issued the Electric Vehicles





Charging (Electric Vehicle Charger) (Amendment) Regulations 2024 to update the technical reference standards of EV chargers and define the safety and performance standards. The main Regulation specifies "the technical reference of the EV chargers" and "the prescribed safety and performance standards to be homologated models of EV chargers."

### **China's National Energy Administration: Total Number of Chargers in China Reached 10.244 Million**

According to China's National Energy Administration, by the end of June 2024, the total number of chargers in China reached 10.244 million, a year-over-year increase of 54%, including 3.122 million public chargers and 7.122 million home chargers. The total rated power of public chargers exceeded 110 million kW, meeting the charging requirements of 24 million EVs. Moving forward, the National Energy Administration will continue to promote the construction of a high-quality charging infrastructure system to facilitate the green and low-carbon transformation of transportation and the construction of a modern infrastructure system.

### **China: Released National Standards for EV Charger Design**

In July 2024, China released two mandatory national standards for EV chargers: GB 44263-2024, "Safety

Requirements for Electric Vehicle Conductive Charging System" and GB 39752-2024, "Safety Requirements for Electric Vehicle Conductive Supply Equipment." These two standards will be implemented on August 1, 2025, indicating that the charger industry will usher in a stricter safety supervision era. The standards cover the safety, reliability, and compatibility of charging systems, aiming to improve the overall quality of chargers and ensure charging safety for users.

### **China: The MIIT Publicly Solicited Opinions on the Industry Specifications for the Comprehensive Utilization of Waste EV Batteries (2024)**

The Ministry of Industry and Information Technology (MIIT) planned to raise requirements on enterprise layout and project site selection, factory conditions, facilities and equipment, technical processes, source tracing capability, resource utilization, energy consumption, product quality, and environmental protection. Recycling enterprises are required to actively develop and apply recycling technologies, equipment, and processes for positive and negative electrode materials, separator films, and electrolyte, improve the recycling level of waste EV batteries, and ensure that major valuable metals are effectively extracted and recycled by means of smelting or material repair.

### **China: Released the Code of Practice for New Energy Vehicles Safety Operation Inspection**

The new code will be implemented on March 1, 2025. It specifies the inspection procedures, items, and requirements for the safety performance of EVs, which are applicable to BEVs and PHEVs (including REEVs), and it serves as a reference for the inspection of other types of EVs. According to the code, the battery charging safety test and electrical safety test of EVs will be mandatory during the annual inspection of EVs in 2025.

### **China: Gradual Implementation of "Vehicle-Road-Cloud Integration" Pilot Projects**

China's MIIT and other four departments jointly released the Notice on Piloting the Vehicle-Road-Cloud Integration Application of Intelligent Connected Vehicles (ICVs) to announce that the pilot application of "vehicle-road-cloud integration" will be carried out from 2024 to 2026. In July 2024, the list of pilot cities for vehicle-road-cloud integration of ICVs was released, which attracted significant attention from the market. All provinces and cities are actively responding to and promoting relevant policies. With the in-depth implementation of policies, continuous innovation, and breakthrough technologies, the pilot projects are being implemented seamlessly.

## ICT Infrastructure

### Microsoft: The First Wood-Based Data Center

Microsoft built its first wood-based data center using cross-laminated timber (CLT). This fire-resistant wood material enabled the company to reduce the use of steel and concrete and cut carbon emissions by 35%. Microsoft plans to achieve "zero carbon" by 2030 and offset all its carbon emissions by 2050. Microsoft is also working with green building materials companies such as Stegra in Sweden

to develop a hydrogen-based steel process, expecting to reduce carbon emissions by 95%.

### Sunrun: Providing Distributed Solar Power for Data Centers

Sunrun, a US residential solar power system provider, is in talks with data center developers to provide distributed solar power for data center facilities. Sunrun is working on a couple of different state-of-the-art models, which may involve using electric utilities to provide

bespoke solar systems for new data centers or leveraging existing Sunrun systems in nearby communities. Currently, an increasing number of energy companies are competing to provide new power sources for the new wave of AI-driven data center construction.

### Nuclear Energy Offers Green Solutions for Data Centers

According to the research report of SDIC Securities, the demand for electricity will increase rapidly



in the future, and the sustainable development of data centers will become a key issue. Nuclear energy can provide green solutions for data centers. In March 2024, Amazon Web Services (AWS) bought a data center campus, Cumulus Data Assets, from Talen Energy. The campus is directly powered by the adjacent Susquehanna Steam Electric Station, which generates clean power for the campus. Companies like Microsoft and Google are also actively studying the application prospects of new nuclear power technologies, such as small modular reactors (SMR) in the data center field.

### **Ireland: Data Centers Consumed More Electricity than Urban Households**

According to the Central Statistics Office (CSO), Ireland, in 2023, the percentage of total metered electricity consumption by data centers reached 21%, exceeding the electricity consumption of urban households for the first time, which accounted for 18%. According to the Agence France-Presse (AFP), tech giants such as Google and Amazon, attracted by the low tax rate for Irish enterprises, have set up more than 80 data centers in Ireland. Some companies also plan to expand or build new data centers in Ireland. The debate over the energy consumption of data center facilities

has become increasingly intense in Ireland. According to a report released by the IEA in January 2024, the energy consumption of data centers in Ireland will reach 30% of the national energy consumption by 2028.

### **China: Released the 2024 White Paper on Data Center Facility Management Requirements**

The Open Compute Technology Committee (OCTC) released the 2024 White Paper on Data Center Facility Management Requirements, aiming to guide the comprehensive management of data center facilities. The white paper describes the composition and key functions of the management platform, including asset management, configuration management, energy consumption management, topology management, statistics management, user management, and safety protection management. The white paper also summarizes the significance of the data center facility management solution to promote digital transformation. It points out the value of the solution in improving competitiveness, reducing operations costs, enhancing user experience, and achieving sustainable development.

### **China Academy of Information and Communications**

### **Technology (CAICT) and Other Organizations Jointly Released the Next-Generation AI Infrastructure White Paper**

The white paper provides the definition, characteristics, and value of the next-generation AI infrastructure, which integrates compute resources, data services, and cloud services based on the output of large models. It is designed to maximize the performance of large models and generative AI applications. The white paper also proposes the next-generation AI infrastructure evaluation system. It also mentions that the construction of next-generation AI infrastructure will lower the threshold for large model development and application and create greater social value in government and enterprise services, industry sectors, and scientific research innovation.

### **The Global Virtual Power Plant Market Will Be Worth USD6.2 Billion by 2028**

According to BCC Research, the global virtual power plant market was valued at USD2.1 billion in 2022 and is expected to reach USD6.2 billion by 2028 with a CAGR of 21.5% during the forecast period from 2023 to 2028. Virtual power plants are leading the way in building more reliable and sustainable energy networks.





# From Foundation to Flight: The Global Journey to Carbon Neutrality

The path toward carbon neutrality is taking shape.

In every era, humanity establishes a shared mission. Today, that mission is achieving carbon neutrality.

From the Paris Agreement to the 29th United Nations Climate Change Conference held in Azerbaijan, tremendous efforts are underway in various industries and sectors around the globe to protect our planet.

In 2020, China announced its ambition to reach peak carbon emissions by 2030 and become carbon neutral by 2060. Four years later, China has reached a new level in its carbon reduction efforts. In 2024, the National Development and Reform Commission, the State Administration for Market Regulation, and the Ministry of Ecology and Environment issued the

Action Plan for Further Strengthening the Construction of the Standard Measurement System for Achieving Carbon Dioxide Peaking and Carbon Neutrality (2024–2025), demonstrating China's determination to become carbon neutral.

How can we drive sustainable development? How should each





## From Foundation to Flight: The Global Journey to Carbon Neutrality

technology, coupled with cutting-edge innovations such as intelligence and digitalization, will fuel our efforts to achieve carbon neutrality.

Technological advancements are essential for promoting sustainable development. In particular, three technological areas will play a crucial role: fossil fuel, renewable energy, and carbon capture and storage technologies.

First, fossil fuel technologies will enable clean and efficient energy utilization.

Fossil fuels are a major source of carbon emissions. To combat these, it is necessary to transform fossil fuel technologies. Take China as an example. Technological innovations, such as energy-saving use of coal power and heating system upgrades, have significantly reduced the coal consumption in the energy mix.

Second, renewable energy technologies will extend the use of green energy.

Replacing conventional fossil fuels with renewable energy sources, such as wind, solar, and hydropower, is the key to achieving carbon neutrality. Renewable energy technologies will shift from collecting and converting energy to its large-scale use. In particular, building a new power system centered on renewable energy and developing clean energy as the main energy source are today's top priorities.

New power systems centered on renewable energy are facing numerous challenges, particularly when it comes to power grid integration. Technical transformation and upgrades throughout power generation, transmission, distribution, and consumption will make renewable energy more grid-friendly and support integration.

Grid-forming energy storage technology is key to facilitating this process. Grid forming is an essential technology for new power systems and is at the forefront of power system innovations in various countries. Huawei Digital Power has established expertise in connecting renewable energy to the grid and other grid-friendly technologies. The tech giant is powering the shift from following the grid to supporting and forming it instead, helping build a new power system for renewable energy. The priority of developing renewable energy technologies is shifting from individual energy collection and storage to large-scale grid integration and popularization of renewable energy. In this process, digital and power electronics technologies will play an increasingly important role in managing watts with bits.

Third, carbon capture and storage technologies will help control carbon emissions.

In addition to optimizing the energy mix and developing alternative energy sources, we can also play an active

individual and organization within our society and economy collaborate with each other to maximize green efficiency?

This article delves into three of the latest technology trends and development dynamics for carbon neutrality: technology, enterprise, and society.

More importantly, it calls for deep collaboration that strives to achieve carbon neutrality and build a greener planet.

### Technological Advancement

Technology plays a pivotal role in going carbon neutral while ensuring stable economic development and improving people's lives. Breakthroughs in energy

role in controlling carbon emissions. For example, carbon dioxide can be separated from industrial processes, energy utilization, and even directly from the atmosphere. It can be used or injected into a deep underground geological reservoir for storage. Carbon capture and storage technologies can permanently reduce carbon dioxide emissions. These technologies are developing rapidly, establishing the last line of defense for the Earth against carbon emissions.

A myriad of technologies can facilitate the clean and efficient use of fossil fuels, build new power grids with renewable energy, and promote carbon capture, thus creating an enriched system that brings us closer to carbon neutrality.

Ultimately, ongoing technological progress will be pivotal to achieving global carbon neutrality.

### Corporate Responsibility

Undoubtedly, enterprises are at the center of carbon emissions. It is the responsibility of each and every enterprise to cut emissions and go carbon-neutral. Carbon neutrality should be an integral part of corporate development goals, just like economic development, job creation, and social welfare.

There are at least two critical ways in which enterprises can undertake their carbon neutrality responsibilities.

Firstly, companies can include carbon neutrality goals and commitments as part of their strategies.

As various countries and regions are actively proposing carbon neutrality goals, enterprises can also set goals that align with their vision and mission. Then, they can determine their strategic plans and implement actions around these goals.

Huawei Digital Power is an active player in green corporate social responsibility. By setting its own carbon neutrality goals, Huawei Digital Power has built a low-carbon governance system for its entire value chain, promoting comprehensive zero-carbon actions covering the products, supply chain, and business operations.

At the product level, Huawei Digital Power blends low-carbon and environmentally friendly concepts into its product design and implements them throughout the product lifecycle. In 2022, Huawei was awarded the world's first Carbon Footprint Verification (CFV) for inverter products issued by the British Standards Institution (BSI), contributing to carbon neutrality in the PV industry.

At the supply chain level, Huawei Digital Power incorporates low-carbon concepts into its supply chain management strategy, valuing the environmental protection performance of its suppliers. As of August 2024,

Huawei Digital Power has encouraged its top 92 suppliers, which account for 90% of all procurement, to carry out an organizational-level carbon inventory, collect statistics on carbon emissions, develop emission reduction plans, and implement emission reduction projects. This drives the company's entire supply chain to achieve low-carbon targets.

At the business operations level, Huawei Digital Power adopts measures such as energy-saving technologies, energy management, and the use of clean energy during manufacturing and daily operations to reduce carbon emissions. Huawei Digital Power has built a near-zero-carbon campus for its Antuoshan building. It uses innovative technologies — such as building integrated photovoltaics (BIPV), refined energy storage system, fully liquid-cooled ultra-fast charging infrastructure, and an AI-based collaborative scheduling algorithm — to manage energy more efficiently and optimize energy usage. It is estimated that the campus can produce 1.5 million kWh of green electricity each year by making full use of the building exterior for PV installations, equivalent to reducing carbon dioxide emissions by about 871.5 tons.

According to the science-based carbon targets validated by the Science Based Targets initiative (SBTi), Huawei Digital Power will achieve net-zero emissions of greenhouse gases across the entire value chain by 2040. Proposing carbon





neutrality goals and making them a reality has become imperative for Huawei Digital Power and other global enterprises.

Secondly, enterprises should actively calculate their carbon footprint and reduce it accordingly.

A carbon footprint indicates the amount of carbon dioxide emissions directly or indirectly caused within a specific period of time. It covers carbon emissions throughout the business lifecycle, from production to transportation and operations. Actively calculating the carbon footprint allows us to quantify carbon emissions, helping enterprises determine appropriate reduction measures.

In addition to enterprises, academic institutions, organizations, and governments also have the responsibility to calculate their carbon footprint and transparently share their impact. All enterprises, organizations, and individuals should join forces to achieve carbon neutrality goals.

### **Social Collaboration**

To achieve carbon neutrality, we, as a society, must work together, drawing on technological advancements and

corporate efforts. Effective collaboration systems, market mechanisms, and public awareness campaigns are necessary to facilitate collaboration and drive sustainable development for carbon neutrality. Here are some ways we can work together toward this common goal.

First, we must establish a carbon emission trading mechanism.

Such a market mechanism will encourage enterprises to achieve their carbon emission targets. Countries and regions around the world have been establishing carbon emission trading mechanisms and carbon trading markets. China has seen positive results from this strategy. As of September 30, 2024, a total of 481 million tons of carbon credits have been traded under the carbon emissions allowance (CEA) in the Chinese market, amounting to CNY28.421 billion. The carbon emission trading mechanisms will keep improving to drive carbon neutrality.

Second, we need to promote climate finance.

Climate finance is a key topic in the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. It has become a key

factor in global economic development and carbon neutrality campaigns. Carbon neutrality responsibilities and capabilities should be major considerations in financial systems. Financial support should be provided to develop key technologies and efforts for carbon neutrality, and financial approaches should help enterprises achieve their emission reduction targets. In this way, social resources will be effectively leveraged to achieve carbon neutrality.

Third, it is critical to drive public awareness and education.

Carbon neutrality is vital to humanity. The whole society should act together. We should raise public awareness of climate change issues, strengthen the recognition of carbon neutrality, and ensure global participation in this campaign to drive sustainable development.

We are now on the long and arduous road toward sustainable development. A synergy of technological advancements, corporate efforts, and social collaboration is the only way to achieve global carbon neutrality objectives.

Becoming carbon neutral will establish a defense for our planet and lead us to a better, greener future. ▲

# Developing Green, PV-Based New Power Systems

The green and low-carbon transformation of the power sector is a multifaceted endeavor, encompassing various aspects such as power generation, transmission, distribution, and consumption. To effectively promote the high-quality and sustainable development of the power sector, it is imperative to streamline the entire industry chain and foster collaboration among multiple stakeholders.

According to the "World Energy Outlook 2024" report by the International Energy Agency (IEA), the global renewable energy capacity additions exceeded 560 GW in 2023. This represents a significant milestone in the transition towards clean energy. Furthermore, it is projected that by 2030, the global renewable capacity will surpass countries' current ambitions by approximately 25%. This highlights the growing recognition of the importance of clean energy and the accelerating pace of the global energy transformation. As a result of this transformation, power systems worldwide are undergoing unprecedented green upgrades across all aspects, including power

generation, transmission, distribution, and consumption. This comprehensive overhaul is driven by the increasing realization of the need to combat climate change and the imperative to meet the energy demands of both production and everyday life.

## Accelerating the development of clean energy

The power sector is transitioning from a reliance on coal to a diverse energy mix comprising an increasing proportion of clean energy sources. The total installed capacity of clean energy sources, including hydropower, wind power, solar power, hydrogen, and nuclear power, is on the rise. Data indicate that in 2023, the global total installed capacity reached 8856 GW,





and the energy yield reached 29,734 TWh. Wind and solar energy yield accounted for over 30% of the world's electricity mix for the first time. China was a major contributor, with 51% of the world's additions in solar energy yield.

Governments worldwide have implemented various policies to promote the growth of renewable energy sources. In 2022, the European Commission introduced the REPowerEU energy plan, which aimed to increase the target for renewable energy in the region from 40% to 45% by 2030 as part of the Fit for 55 package. Germany has also taken steps towards a greener future with its Renewable Energy Act (EEG 2023),

raising the target for renewable energy in the electricity mix from 65% to 80% by 2030. Similarly, Brazil's Federal Law No. 14,300 offers generous subsidies until 2045 for existing distributed photovoltaic (PV) plants and those constructed by the end of 2023.

For wind and solar power, China has introduced comprehensive regulations, including the Regulations on Grid Connection of Renewable Energy and the Interim Measures for Grid Connection of Distributed PV Power Generation. These regulations outline the procedures, standards, and technical requirements for integrating power plants into the grid, providing clear guidance and policy support for the integration of renewable energy

sources. According to the China Photovoltaic Industry Association, China's PV industry experienced robust growth in 2023, with a total production value exceeding CNY1.75 trillion and installed capacity additions reaching 216.88 GW, representing a 148.1% year-on-year increase. The industry's continuous expansion is underpinned by declining costs of key equipment, driven by technological advancements and economies of scale. Notably, the cost of PV parity has been achieved, signaling a significant milestone in the industry's development. As energy storage system (ESS) technologies evolve, the cost of PV cells is expected to decrease further. By 2028, it is projected that the levelized cost of electricity (LCOE) for PV + ESS systems

will fall below CNY0.3. At this point, both PV and ESS will have achieved grid parity, making them cost-competitive with conventional energy sources. Consequently, PV + wind + ESS is set to emerge as the predominant energy mix, driving the transition to a more sustainable and reliable power system.

According to the Global Wind Energy Council (GWEC), 2023 witnessed the installation of 120.7 GW of wind turbine capacity globally. A significant portion of this, 81.6 GW, was supplied by Chinese wind turbine

manufacturers, with six of the world's top 10 suppliers being Chinese firms. Over the past few years, the global installed capacity of offshore wind has consistently increased as more countries undertake or plan their first offshore wind farm projects and the cost of offshore wind power declines. Hydropower, characterized by its low cost, continuous, environment-friendly, and carbon-free power generation, is crucial to energy transformation.

According to the IEA, pumped storage hydropower accounts for over 90% of the world's stored energy. The

Asia Pacific region is experiencing the most rapid growth in this sector, with a notable expansion of pumped storage hydropower plants. The "World Hydropower Outlook 2023" reveals that the combined installed capacity of pumped storage in East Asia and the Pacific has reached 84 GW.

Hydrogen is emerging as a leading energy source due to its carbon-free nature and exceptional energy efficiency. The "Hydrogen Insight 2023" report, jointly published by the Hydrogen Council and McKinsey & Company, estimates that global





direct investment in hydrogen will surge to US\$320 billion by 2030. The "Research Report on International Hydrogen Technology and Industrial Development 2023," released by the Hydrogen Energy Industry Promotion Association under the China Association for the Promotion of Industrial Development, forecasts a tenfold increase in global hydrogen demand and a hydrogen industry chain output value surpassing US\$2.5 trillion by 2050. Currently, hydrogen finds widespread applications in transportation, industry, and construction, driving the transition

towards greener and low-carbon practices across various sectors. In October 2024, the Federal Network Agency of Germany approved the construction of a nationwide hydrogen core network, with an estimated investment of up to EUR18.9 billion. China's Medium- and Long-Term Plan for the Development of the Hydrogen Energy Industry (2021-2035) outlines strategic initiatives for local governments to foster innovation in the hydrogen energy sector.

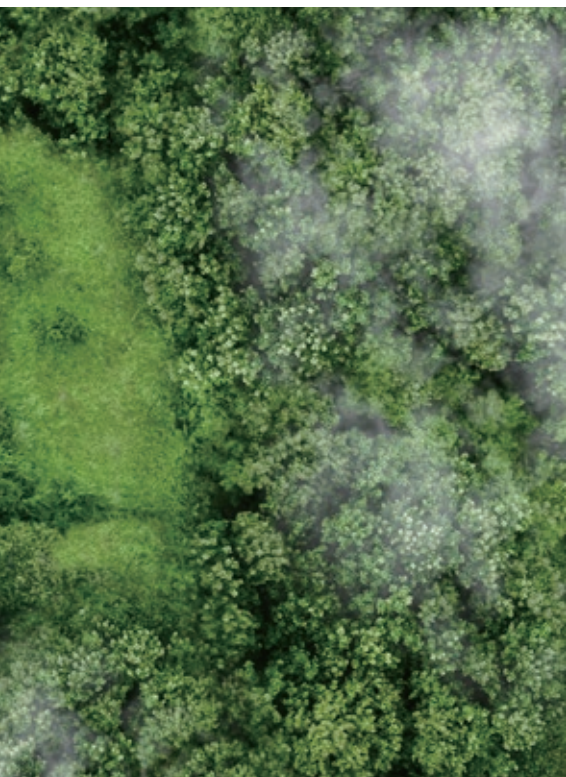
Despite the benefits of the renewable energy industry, there are also challenges, including the increased imbalance and unreliability of the power system as clean energy sources grow in proportion. Grid-forming ESSs have emerged as a crucial component of new power systems, emulating the characteristics of synchronous generators to enhance system support, stability, and emergency procedures. This technology can improve peak shaving and frequency regulation, enhance voltage stability, and ensure reliable grid connection, enabling efficient renewable energy utilization. Huawei Digital Power is committed to advancing the high-quality development of the grid-forming ESS industry, working to transform technologies from grid-following to grid-forming and facilitating the construction of new power systems. Through these efforts, countries are

successfully integrating renewable energy, stabilizing energy supply, and reducing carbon emissions.

### **Minimized loss through improved transmission efficiency**

Power transmission plays a vital role in ensuring energy security and optimizing the energy mix, serving as a critical link for achieving a greener and low-carbon transformation of power systems. The integration of dispersed renewable energy sources, including wind and solar, necessitates an efficient power transmission and transformation system that can effectively integrate these decentralized power resources and transmit them to the load centers. It is estimated that the market size of the power transmission and transformation industry will reach about CNY2.29 trillion in 2029.

To achieve green and low-carbon development in the power transmission link, several key actions need to be taken. First, it is crucial to expedite the construction of new power systems and the utilization of clean energy. Second, there is a need to improve the bearing capacity and self-recovery capability of power grids, along with the efficient utilization of renewable energy. Third, the construction of cross-province and cross-region power transmission channels should be promoted. This will facilitate the smooth flow of renewable



energy from resource-rich areas to high-demand load centers. Lastly, it is essential to expedite the development of ultra-high voltage (UHV) direct current (DC) projects.

It is widely acknowledged that adopting high-voltage transmission lines is an effective solution to reduce power loss caused by resistance during power transmission. For instance, high-voltage direct current (HVDC) transmission technology is characterized by high transmission efficiency, high stability, rapid response to load changes, flexible control, convenient scheduling, large capacity, and minimal loss. These features effectively shorten transmission lines and reduce long-distance transportation costs. As a result, HVDC transmission technology is an ideal choice for transmitting renewable energy. According to the State Grid Corporation of China (SGCC), the total investment in UHV projects is expected to reach CNY380 billion during 2021-2025, representing a 35.7% increase compared to 2016-2020. The Federal Network Agency of Germany states that Germany will build and expand a total of 6,000 kilometers of transmission system by the end of 2024, with an investment of EUR20 billion.

It is important to highlight that smart grids effectively enhance the operational efficiency, reliability, and stability of power grids, while also

reducing line loss. This contributes to the sustainable development of power grids. China has recognized the potential of smart grids and has implemented several policies to promote their growth. Notable examples include the Guiding Opinions on High-Quality Development of Distribution Networks under New Conditions and the Opinions on Accelerating the Digital and Intelligent Development of Energy. To further advance smart grid construction, innovative approaches such as virtual power plants (VPPs) and Shared ESS are being employed, along with cutting-edge technologies like cloud computing, big data analytics, IoT, mobile Internet, AI, and blockchain. These advancements significantly enhance the ability to adjust resources on the demand side. By the end of 2024, Europe plans to invest EUR600 billion in power grid construction, with a focus on UHV AC/DC projects and the digital and intelligent upgrade of power grids.

### **Power distribution is a key step toward diversifying energy consumption**

Power distribution networks play a crucial role in delivering electricity from the central power grid to individual homes. Unlike the main grid, these networks consist of numerous dispersed devices. However, if issues like excessive overload or low voltage are not promptly detected

and addressed, the reliability of the power supply can be compromised. To address this concern, in August 2024, the China National Development and Reform Commission, National Energy Administration, and National Data Bureau jointly issued the Action Plan for Accelerating the Construction of New Power Systems (2024-2027). The action plan emphasizes the need to enhance end-to-end management of power distribution networks, establish and revise distribution network standards, and develop an evaluation system for their progress. By improving the adequacy, reliability, and flexibility of power distribution networks, we can better integrate renewable energy sources and enhance the diversified utilization of energy.

Currently, the power distribution networks are underdeveloped, and local integration is insufficient, posing challenges to the industry. To address these issues, it is necessary to optimize the power grid structure, enhance regulation and integration, improve the management of power distribution devices to ensure device stability, and explore the application of new power devices to enhance the operation efficiency of power grids.

The connection of distributed energy is crucial. However, connecting massive amounts of distributed energy can increase the line load current of the power distribution network, making



voltage adjustment more difficult and significantly impacting the distribution network. To prevent this, it is essential to consider various factors during planning and management and to continuously strive to upgrade and optimally reconstruct the power distribution network. This will enhance the integration capability of distributed energy, reduce transmission loss, and improve energy utilization. Correctly selecting the location and capacity of a distributed power supply and correctly connecting cables onsite are crucial to maintaining the reliability and safety of the distribution network.

Thanks to policy support and technological advancements, small-scale wind and solar power systems are being widely used in communities. Distributed PV systems and wind turbines offer a clean and sustainable power supply, bringing about reduced electricity costs and improved energy supply stability.

### **Actions to promote green energy consumption**

An IEA report indicates that the annual investment in clean energy has reached nearly US\$2 trillion, which is almost double the total investment in oil and coal. This significant increase in funding demonstrates the growing momentum behind green electricity. During the 7th China International Import Expo held in 2024, there was a noteworthy development: for the first time, 10,000

green power certificates were purchased from power generation enterprises in Shanghai. These certificates were equivalent to 10 million kWh of green electricity, ensuring a sustainable and environmentally friendly energy supply throughout the entire duration of the Expo, from its preparation to its closing.

Despite the increasing availability of green energy, there is still a lack of awareness among many users regarding its benefits and usage. This hinders the widespread adoption and advancement of green electricity. To address this issue, it is crucial to expand the outreach of green electricity, enhance incentive mechanisms, and encourage green consumption. One effective approach is to promote the use of energy-efficient electrical appliances in areas such as green buildings and transportation, thereby reducing carbon emissions. Additionally, the transformation of the power sector towards green and low-carbon sources will provide clean energy for electric transportation, leading to a reduction in carbon emissions in the transportation sector. This, in turn, will drive the power sector towards a cleaner and more efficient energy mix. On the demand management side, we can improve system efficiency by guiding users to use electricity responsibly and reducing power demand during peak hours. Implementing time-of-use pricing can facilitate peak shaving, lower

overall electricity costs, and promote sustainable and low-carbon growth.

### **Sustainable development of new power systems brings more benefits**

The green and low-carbon transformation occurring in the power sector offers a multitude of advantages. This transformation facilitates optimization and upgrade of the energy mix and encourages the development and utilization of renewable energy. It can enhance people's living standards, fuel high-quality economic growth, and play a crucial role in alleviating climate change worldwide. Additionally, the low-carbon transformation in the power sector can stimulate technological innovation and industrial upgrades, eventually creating jobs for communities. Given these numerous benefits, the transformation is an irreversible trend.

Nevertheless, advancing the green and low-carbon transformation of the power sector is a complex and systemic undertaking involving multiple aspects such as power generation, transmission, distribution, and consumption. To truly achieve the high-quality and sustainable development of the power sector and build a greener world, it is essential to streamline the entire industry chain and implement reforms and collaborations in various areas. ▲



# Mobility Electrification: Embracing the Future

From private cars to public transportation, logistics vehicles and beyond, EVs are becoming more common in many areas. We're now on the fast track to the era of EVs.

According to Canalis, the global sales of electric vehicles (EVs) are projected to reach 17.5 million units in 2024, reflecting a significant year-on-year growth of 27.1%. This surge in sales is indicative of the increasing popularity and recognition of EVs. The electrification of mobility is an inevitable step, considering that the transportation sector is a major contributor to energy consumption and carbon emissions. Despite notable challenges such as price pressure, battery safety concerns, insufficient charging infrastructure, and range anxiety, the transportation sector still needs to accelerate the transition to EVs, and this can be achieved by

leveraging favorable policies and technological innovations and raising public awareness.

## Electrification is a Global Phenomenon

In response to global climate change, the international community has taken significant steps by reaching the Paris Agreement, with governments worldwide committing to reduce carbon emissions. Consequently, many countries have developed comprehensive plans to promote the growth of the EV industry. Notable examples include the EU's green transport strategy and South Korea's EV development plan for 2021–2025.

Furthermore, governments have implemented a range of supportive policies, regulations, and standards to incentivize and facilitate the rapid development of the EV industry.

China prioritizes the growth of the EV industry and has designated it as a strategic emerging sector. To facilitate the electrification of transportation, the country has introduced a range of policies. One notable initiative is the New Energy Vehicle Industry Development Plan (2021–2035), which sets a target for EVs to comprise approximately 25% of total vehicle sales by 2025. Additionally, the government has implemented

nationwide preferential policies, including subsidies for EV purchases and purchase tax exemptions.

It's worth mentioning that far-reaching laws like the Clean Air Act and other efforts to achieve carbon neutrality are driving the electrification of mobility. From private cars to public transportation, logistics vehicles and beyond, EVs are becoming more common in many areas. We're now on the fast track to the era of EVs.

### **Technological Innovation: The Driving Force**

Electric, intelligent, and green development in the transportation

sector has transformed the driving and traveling experience. Changing mindsets, technological progress, and business model innovations, particularly low-carbon and environmentally-friendly transport vehicles, are making urban transportation safer, more convenient, and more efficient.

#### **1. The Power of Batteries**

Batteries are core components of an EV. Battery performance and safety have a significant impact on the EV range, charging duration, power output, service life, and driving experience. Thanks to innovative battery technologies, EVs have seen a steady improvement in practicability,



safety, and market competitiveness.

For instance, solid-state batteries use solid-state electrolytes instead of liquid electrolytes, offering numerous advantages such as high safety, high energy density, and long service life. These batteries are widely regarded as the next-generation battery for the automobile industry chain and will inevitably face intense competition in the market. China prioritizes the research, development, and industrialization of solid-state batteries. In recent years, it has introduced a series of policies, including the Implementation Opinions on Strengthening the Integration and Interaction of New Energy Vehicles and Power Grids and the Guidelines

on Promoting the Development of the Energy Electronics Industry, to accelerate the development and application of solid-state battery technology. Against this backdrop, multiple battery manufacturers and automotive enterprises in China have announced their progress in solid-state batteries, including the mass production of semi-solid-state batteries. SERES and CATL have collaborated on ultra-fast charging technologies, battery safety, and integration of vehicles, electricity, and charging to advance innovations in battery technology. The AITO M9 fully uses CATL battery products. It is predicted that the global shipment of solid-state batteries will reach 614.1 GWh in 2030, and the market value in China will reach CNY20 billion.

Waste batteries contain hazardous substances such as lead and mercury. Improper disposal of these substances can cause significant environmental damage and have adverse effects on human health. Recycling traction lithium batteries is essential to protect the ecological environment, enhance resource utilization efficiency, and ensure the sustainable development of the EV industry. However, the research on and implementation of EV battery recycling are still in their early stages worldwide. In China, the Ministry of Industry and Information Technology and other departments have introduced relevant policies and regulations, including Interim Measures for the Recycling of Traction Batteries in New Energy Vehicles and Administrative Measures for





Echelon Utilization of Traction Batteries in New Energy Vehicles. These measures aim to regulate the comprehensive utilization of waste traction lithium batteries by proposing pilot projects for recycling traction lithium batteries used in EVs and exploring diversified recycling models. The ultimate goal is to establish an industry chain extension system that covers traction battery recycling, echelon utilization, and material regeneration. With an estimated millions of tons of traction batteries set to be retired worldwide by 2030, there is a significant market opportunity for traction battery recycling.

### 2. Breakthrough in Charging and Energy Management

Charging and energy management are crucial aspects of EVs. They enhance the driving range and battery life, optimize charging efficiency, balance grids and loads, reduce charging duration and costs, thus improving the overall driving experience and safety.

Technological advancements have brought ultra-fast charging technology into the spotlight. The mass production of third-generation semiconductor materials like silicon carbide and gallium nitride has significantly accelerated the development of high-voltage charging technology, making ultra-fast charging a reality. It is projected that by 2028, vehicles equipped for ultra-fast charging will

capture over 60% of the market share. A prime example is CATL's latest 4C superfast charging battery, which can be fully charged in just 15 minutes. Furthermore, the widespread adoption of 800 V high-voltage platforms will significantly enhance vehicle efficiency and reduce charging duration. Increased collaboration between cloud systems, charging stations, chargers, and vehicles, and more intelligent charging networks will considerably enhance user experience and improve grid synergy. According to the Action Plan for Accelerating the Construction of a New Power System (2024–2027) introduced by the National Development and Reform Commission and other departments, energy storage resources of EVs should be fully utilized to promote intelligent and coordinated charging. Coordinated charging of EVs reduces grid operation risks while improving grid benefits and reliability. Fast charging, intelligence, networking, and diversified value-added services will reshape user experience, drive technological innovation of EVs, and accelerate the energy transition.

As AI and big data technologies continue to evolve, EV energy management systems are becoming increasingly intelligent. By detecting the energy consumption, road conditions, and driving habits of vehicles in real time, intelligent energy management systems automatically adjust energy

allocation policies to optimize energy efficiency. Additionally, the systems interact with the power grid to implement bidirectional energy flow between vehicles and the power grid, providing energy storage and peak-shaving services. The Internet of Vehicles (IoV) technology intelligently optimizes charging policies, determining the optimal charging time and location based on power grid loads and electricity price fluctuations. This reduces charging costs and balances the supply and demand of the power grid.

### 3. Inclusive Intelligent Transportation Systems

Intelligent transportation systems effectively apply advanced technologies, such as information, computer, data communication, sensor, electronic control, automatic control, operations research, and AI technologies, to transportation, service control, and vehicle manufacturing. These systems ensure safety, improve efficiency, enhance the environment, and save energy. Intelligent transportation systems provide technical support and operation platforms for mobility electrification, and mobility electrification provides a foundation for the wider application of intelligent transportation systems. For instance, intelligent traffic signal control systems adjust the signal light duration based on real-time traffic to optimize the traffic flow, intelligent parking

management systems improve parking efficiency, and intelligent public transportation systems optimize bus routes and shifts to shorten the waiting time for commuters.

From the technical perspective, motors and electric control systems are fundamental hardware for intelligent EVs, as they allow EVs to efficiently integrate devices, such as sensors and controllers, to implement higher-level autonomous driving and intelligent functions. Autonomous driving technology further improves the stability and reliability of vehicles and ensures driving safety through environment sensing, intelligent voice assistance, and predictive maintenance. IoV technology facilitates intelligent communication between vehicles, enabling them to exchange traffic information and improving overall transport efficiency while reducing traffic congestion and accidents. Additionally, AI technologies optimize the energy efficiency and cruising range of EVs, making vehicles smarter, safer, and more environmentally friendly.

### Mobility Electrification Is Gaining Speed

Recent statistics indicate that the transportation sector is responsible for approximately 23% of global carbon emissions. To achieve global carbon neutrality, a crucial step is the electrification of mobility. The

increasing adoption of EVs worldwide has led to the rapid construction of high-quality charging infrastructure and the integration of intelligence into transportation. Consequently, the transportation sector is experiencing a golden era of development.

#### 1. EVs for Every Home and Business

In a survey conducted by McKinsey on European consumers in 2024, it was found that 38% of car buyers who have not yet purchased EVs expressed their intention to choose an EV as their next vehicle. IEA's Global EV Outlook 2024 projects that EV sales in China will reach approximately 10 million units in 2024, making up about 45% of total car sales in the country. Additionally, the report states that EVs will account for roughly one in four cars sold in Europe.

The rapid rise in the popularity of EVs is accompanied by several challenges that need to be quickly addressed. Key among these is the need for automakers to continuously enhance the performance, cruising range, charging speed, safety, and comfort of EVs. Additionally, the deployment of charging stations must keep pace with the growing number of EVs on the road to ensure convenient and reliable charging options. Furthermore, IoT services must be enhanced to enable greater interconnectivity between vehicles and homes, as well as among

transportation facilities.

Huawei Digital Power has been committed to advancing mobility electrification since 2014. It has continuously invested in the industry, driving development with technical breakthroughs. Its DriveONE e-mobility solution is designed to provide a safe, comfortable, and optimal driving experience, enabled by integrated and intelligent control of the power domain. Huawei DriveONE features the industry's first SiC high-voltage four-wheel-drive platform, which integrates front asynchronous and rear synchronous motors. A four-wheel-drive car built on the platform consumes the power equivalent to a two-wheel-drive car and can accelerate from 0 to 100 km/h in 3 seconds while extending the cruising range by more than 40 km. The DriveONE 10-in-1 high-voltage ePowertrain enables an A-segment car to drive 10 km with every kWh of energy charged, gaining industry-wide recognition. Huawei DriveONE's iTRACK function infuses intelligence into the powertrain, swiftly enabling cars to seamlessly counter slipping and bumping, enhancing safety while ensuring a comfortable driving experience.

#### 2. High-Quality Charging Infrastructure is Set to Become Ubiquitous

"An army marches on its stomach." Similarly, the widespread adoption of

EVs relies heavily on the availability of charging stations. As the demand for EV charging infrastructure continues to rise, it is imperative to focus on the rapid construction of intelligent and efficient charging stations that are scalable, interconnected, and environmentally friendly, aligning with the principles of sustainable development. According to the latest statistics, the global public charging network saw an addition of nearly 310,000 chargers in the second quarter of 2024. China leads the world in the installation of public chargers, while Europe is experiencing the fastest growth. Many Chinese cities are racing to deploy ultra-fast charging stations. For instance, Shenzhen is transforming into a city powered by ultra-fast charging, aiming to build a world-class ultra-fast charging infrastructure service network capable of supporting

diverse application scenarios by the end of 2024. Guangzhou has launched a city-wide strategy for ultra-fast charging to promote the research, development, and implementation of high-power fast charging technologies. Chongqing is also developing into a city that offers convenient ultra-fast charging by targeting to install 4000 ultra-fast chargers by the end of 2025. The integrated solution of PV + ESS + charger, which combines PV power generation, energy storage, power output, and battery status detecting functions, has emerged as a preferred choice for numerous industrial parks and public areas. Additionally, residential charging infrastructure has gained significant popularity, supported by financial assistance and preferential policies.

Huawei Digital Power is building

a user-friendly, grid-friendly, and efficient smart charging network for diverse charging scenarios, including cities, city clusters, logistics, and campuses. It promotes cutting-edge ultra-fast charging technologies to enable the smooth evolution of PV + ESS + charger, achieving superior experience, high quality, and optimal benefits. Compared with conventional solutions, Huawei's solution improves power utilization by about 30%. It doubles the turnover rate under the same power conditions, accelerating the development of charging infrastructure for high-quality charging anywhere, anytime. For instance, Hubei Communications Investment Group Co., Ltd. worked with Huawei Digital Power to transform the Hanshi Expressway into a comprehensive energy demonstration line in Hubei by leveraging Huawei's FusionCharge



solution, meeting the charging requirements with ease during peak periods.

### 3. Electric Public Transportation Contributes to Smart and Low-Carbon Cities

According to the Opinions on Accelerating the Comprehensive Green Transition of Economic and Social Development introduced by the State Council, China will intensify efforts to promote low-carbon transportation vehicles and transition urban public service vehicles to electric. By 2030, the carbon emission intensity per converted turnover of transport vehicles will decrease by about 9.5% compared with 2020.

According to the Notice on Initiating the First Batch of Pilot Areas for Comprehensive Electrification of Vehicles in Public Fields, pilot projects for vehicle electrification have been initiated in 15 cities, including Beijing, for business vehicles, urban buses, sanitation vehicles, taxis, postal express vehicles, urban logistics vehicles, and airport vehicles. It is estimated that more than 600,000 EVs will be launched, and over 700,000 chargers and 7800 battery swapping stations will be built. In recent years, electric buses and taxis are evidence of urban vitality. Shenzhen is the first city in China to fully electrify its bus fleet, reducing the annual carbon dioxide emissions from buses by 1.353

million tons. In Zhengzhou, the Level 3 intelligent and networked bus rapid transit (BRT) system for the East 3rd Ring Road is one of the first pilot projects of intelligent transportation in China. The system significantly improves the public transportation experience. In the Meishan Port Area of the Ningbo-Zhoushan Port, 62 unmanned electric container trucks have been deployed for loading and unloading. With just one hour of charging, the trucks have a driving range of over 120 km.

To promote the electrification of public transportation, a series of policies and measures have been introduced, including pilot projects to electrify public vehicles and the implementation of renewal subsidies for electric urban buses and traction batteries. Additionally, technological advancements accelerate iterative upgrades and infuse intelligence into vehicles. Vehicle-road-cloud integration solutions optimize traffic management, improve the safety and reliability of autonomous driving, and enhance the quality of public transportation services, effectively accelerating the electrification of urban public transportation systems.

### The Industry Offers Tremendous Opportunities

Electrification is speeding up the development of the global transportation sector. The number

of EVs in the market is growing significantly. Electrification and intelligent technologies are widely used in various fields. Intelligent vehicles that combine autonomous driving, AI, IoV, and electrification technologies substantially improve traffic safety and optimize the travel experience. Flying cars are also expected to gain popularity, driving the development of the low-altitude economy and leading industry innovations in the future.

Mobility electrification will become more widely recognized, shaping a broader market landscape. Governments worldwide will continue to increase their support for the EV industry and promote business development along the industry chain. In addition, technologies and infrastructure such as batteries, drive systems, and charging facilities will be continuously optimized. Thanks to continuous innovations, EVs will be adopted in more areas. Driven by policies, technological innovations, and market demands, the transformation of mobility electrification is gaining global momentum at a rapid pace. This transformation will effectively improve the urban ecosystem, alleviate traffic congestion, significantly reduce operation costs, enhance the green travel experience, and promote the high-quality development of the industry. The electrification of mobility will shape a greener and smarter future. ▲



# Fusionsolar

## Huawei FusionSolar C&I OASIS Solution



Active Safety, Integrate Innovation,  
Accelerating PV+ESS+Charger to Become Ubiquitous

# CGDG: A Project in Golmud Writes a New Chapter in Grid-Forming Energy Storage

Golmud City in Qinghai, China, has a dry, windy climate and vast desert areas. This provides natural advantages for developing renewable energy plants, which is why Golmud has emerged as a national hub for clean energy development. Amid this journey, the city is actively exploring ways to fully leverage grid-forming energy storage technologies.

As we continue to pursue carbon neutrality, renewable energy is taking on a bigger role in the global energy mix. New power systems often rely primarily on

clean energy, such as wind and solar power. As this evolution speeds up, we will inevitably see a larger proportion of clean energy being connected to the power grid.



As a crucial ecological barrier in Haixi Prefecture, Qinghai Province, Golmud City has abundant solar, wind, hydro, and geothermal energy resources. However, as this region produces and feeds more renewable energy to the power grid, grid stability becomes more vulnerable. This is a common issue in renewable energy development worldwide.

Grid-forming energy storage systems (ESSs) can actively support power grids and ensure safe and stable power system operations. As such, projects are increasingly using grid-forming ESSs to coordinate multiple types of power supplies, such as PV, wind, and solar thermal power. The 50 MW/100 MWh grid-forming ESS project for the multi-energy renewable power plant in Golmud, Qinghai, is a prime example. The project was developed by the China Green Development Investment Group (CGDG) and completed in January 2024.

### **A new frontier in the clean energy industry**

Located in the hinterland of the Qinghai-Tibetan Plateau, Golmud is endowed with abundant natural resources. The vast land, abundant

sunlight, and strong winds provide fertile ground for the development of the clean energy industry in this city.

For years, Golmud has actively introduced advanced technologies in energy storage and PV, wind, and solar thermal power. This has helped the city continuously improve the quality and scale of its clean energy development, approaching a new frontier in the clean energy industry.

In the first half of 2024, 88.2% of the electricity generated in Golmud came from clean energy sources, indicating a significant improvement in clean power supply capacity. However, this rapid growth also suggests a need for higher safety when integrating clean energy into Golmud's power grid.

The CGDG 50 MW/100 MWh grid-forming ESS project in Golmud is part of the answer, which uses Huawei Digital Power's Smart String Grid-Forming ESS as its core technology.

The project is located in the city's PV industrial park. The total installed capacity is 700,000 kW, including 200,000 kW of PV power, 400,000 kW of wind power, 50,000 kW of solar thermal power, and 50,000 kWh in ESSs.

Part of the challenge in Golmud is its weak power grid. To address this, Huawei's Smart String Grid-Forming ESS proactively supports the power grid and enables renewable power systems to work just as reliably as conventional generators. This is significantly increasing the integration of renewable energy into the power grid.

This project solves the challenges that often accompany renewables, such as low stability and inertia. It delivers a future-oriented solution for areas with a high installed capacity and proportion of renewables and lays a solid foundation for Golmud to further develop its clean energy industry.

### **Project progress alongside technical exchanges**

Building an ESS plant is already a challenging task. In regions like Golmud, with high altitude, dry climate, and intense ultraviolet radiation, constructing a 50 MW/100 MWh Smart String Grid-Forming ESS plant is even more difficult.

Despite challenges such as a tight project timeline, high altitude, strong winds, and low temperatures, CGDG



and Huawei Digital Power worked closely together and successfully completed various construction tasks on schedule.

The China Electric Power Research Institute, Northwest Branch of State Grid Corporation of China, State Grid Qinghai Electric Power Company, CGDG, and Huawei Digital Power jointly tested the grid-forming ESS grid connection performance. These tests verified the solution's performance, its compatibility with various types of power supplies, and the parallel

operation capabilities of multiple devices.

Testing included the world's first 35 kV and 110 kV short-circuit test. Even during the induced short-circuit fault, over 600 power conversion systems (PCSs) were running reliably and stably to provide fast reactive power support for the system.

CGDG and Huawei Digital Power have made impressive strides. They have successfully developed a zero-carbon power system and added stability to



the power grid with a high proportion of renewable energy. They have also explored the necessary technical specifications and policy mechanisms to develop a multi-energy complementary system that interconnects several energy sources. These insights are valuable for researching, reserving, and applying grid-forming energy storage technologies.

In addition, the two companies have researched how power transmission works in grids with a high proportion of renewable energy in multi-energy complementary scenarios. Drawing on this research, they came up with a plan for the Qinghai power grid to develop solar thermal plants that can support the ultra-high-voltage DC project in Haixi. Finally, they carried out a technical and economic feasibility demo that supports Qinghai's renewable energy development.

These actions showcase two key points of innovation. They have generated new green policies for the sustainable development of multi-energy complementary systems and a development model for solar thermal plants. They have also provided practical support for relevant national policies, aiming to form a long-term mechanism to advance energy transitions.

### Facilitating the construction of a new power system

On May 31, 2024, the CGDG 50 MW/100 MWh grid-forming ESS plant officially went live in Golmud, Qinghai. This plant is a best practice when it comes to increasing the proportion of renewable energy in Qinghai's power grid. It also effectively solves some of the challenges related to renewable energy integration into weak power grids.

On June 15, the 35 kV three-phase short-circuit test was completed. It verified the ESS's and the plant's frequency and voltage regulation capabilities in response to different voltage levels and asymmetric fault events.

Then, on June 30, the 110 kV single-phase short-circuit test was completed. It confirmed that even during a short-circuit fault, over 600 PCSs could run reliably and stably to provide fast reactive power support for the system.

These stringent tests illustrate that Huawei's Smart String Grid-Forming ESS is compatible with various types of power supplies, enables multiple devices to work in parallel, and supports large-scale integration and distribution of renewable energy.

Huawei Digital Power is committed to enhancing the safety and stability of renewable integration

by combining digital and power electronics technologies, leveraging technical experience, and collaborating with global power companies, grid enterprises, and electricity providers to continuously promote the development of grid connection technologies.

To ensure comprehensive safety from cell to grid, Huawei has built an ESS that offers ultimate safety through cell-level isolation, pack-level fire suppression, and rack-level 6-layer protection. Besides, the BMS implements multi-dimensional intelligent diagnosis across the entire link. All these features improve the active safety of the ESS.

Recognizing the importance of grid-forming energy storage, China's National Energy Administration has published a series of notices and action plans to encourage the large-scale application of grid-forming energy storage, accelerate the construction of new power systems, and enable the industry's sustainable development.

As a leader in the field of digital power, Huawei will continue to innovate in renewable energy grid connection and grid-friendly technologies. It will also deepen the integration of digital and power electronics technologies to drive the development of new power systems. ▲



# CR Power: Pioneering the Smart String Grid-Forming ESS

Grid-forming technology is key to tackling the challenges associated with renewable energy integration in weak power grids, which is why it has become the preferred choice within the industry. China Resources Power (CR Power) and Huawei Digital Power work together to promote innovation in the implementation of grid-forming technologies.

In traditional agriculture, people harvest in the autumn and store grains for the winter. Like winter grain storage, an energy storage system (ESS) stores electricity produced using renewable energy sources during peak production periods and discharges energy when the production capacity is low.

With the rapid growth of renewable energy, such as PV and wind power, ESSs have started to take on other functions beyond balancing supply and demand. They also play an important role in peak shaving, grid support, and power backup, which are made possible by using grid-forming technology. As a key technology for new power systems,

a grid-forming ESS can actively support power grids, highlighting the advantages of renewables. Just like grain storage uses natural resources to deliver a smooth supply of food, an ESS ensures a stable and sustainable energy supply.

For areas rich in renewable energy, a grid-forming ESS can enable efficient grid integration and large-scale renewable energy transmission, supporting economic and social development. However, grid-forming is still an emerging technology and needs to undergo rigorous and real-world testing. One standout example is the Santanghu grid-forming ESS demonstration project in Hami, China,

which was implemented by CR Power and Huawei Digital Power.

### **Innovative practices create industry value**

Some people see the grid-forming ESS as a huge power bank — an idea that seems easy to grasp but is actually inaccurate. Essentially, the grid-forming ESS is a voltage source. Voltage parameters can be set for the ESS to produce stable voltage and frequency. The grid-forming ESS can be connected to or disconnected from the power grid — a flexibility that allows it to provide strong support for the power grid.

The fact that the grid-forming ESS serves as a voltage source also allows it to address issues related to short-circuit capacity and the lack of inertia, making it a significant technology for new power systems.

Before the Hami demonstration project was launched, CR Power and Huawei Digital Power completed the 1 MW/2 MWh array-level grid-forming ESS grid-connection performance test at the PV plant in Gonghe, Qinghai. The China Electric Power Research Institute and Qinghai Electric Power Research Institute guided the testing in January 2023.

For the ESS and PV systems operating in grid-forming voltage source mode, performance testing evaluated their ability to provide active support for

frequency and voltage regulation during grid disturbances. These tests were conducted at the Gonghe PV plant and included a comparison with the conventional grid-following current source. In total, 180 test cases were completed, covering seven key aspects.

The industry has shown a keen interest in testing the grid-forming PV + ESS project in Qinghai. China's National Energy Administration has also highlighted the importance of the grid-forming ESS and suggested further empirical verification for engineering applications.

CR Power cooperated with Huawei on the testing in Qinghai, expanding the range of applications for its new technologies and obtaining first-hand data about grid-forming ESS tests. The company has also applied for two invention patents. The actions have laid a solid foundation for the Santanghu project.

There is industry consensus that grid-forming technology is a feasible way to tackle renewable energy integration in weak power grids. This has prompted multiple provinces and cities in China to release policies that encourage the implementation of technology.

### **Trending development in the PV industry**

In recent years, driven by the global push for carbon neutrality, the installed

capacity of renewable energy sources like solar and wind power has been steadily increasing worldwide. China leads the world in both installed renewable energy capacity and development speed. As a result, the demand for grid-forming ESS and other flexible adjustment resources within China's power systems and grids has become increasingly urgent.

The Santanghu project is in Hami, where the local power grid is weak because the short-circuit ratio (SCR) of the wind farm power generation unit is 1.96. This project is a typical use case for a grid-forming ESS, which can help increase the proportion of renewable energy. It has become one of CR Power's research demos for the grid-forming ESS.

Prior to the Santanghu project, CR Power verified the technology and had in-depth discussions with Huawei Digital Power. Additionally, the local National Development and Reform Commission, energy bureau, and grid dispatch center approved and supported the project. The local China Electric Power Research Institute also participated in the subsequent empirical tests and in preparing the grid-forming ESS acceptance standards.

After strict evaluation, the project owner decided to upgrade one-tenth of the Santanghu ESS plant's capacity, that is, 25 MW/100 MWh, to the grid-forming





ESS technology. The key advantage of this decision is the ability to reuse the existing civil engineering foundation, ensuring the project meets its grid-connection target by year-end, with a highly controllable construction timeline. The project successfully passed unit-level, site-level, and system-level tests, completing the world's first 100 MWh-level Smart String Grid-Forming ESS testing. This included evaluations under high- and low-voltage disturbances, phase angle jumps, low-frequency oscillations, damping performance, and seamless switching between grid-following and grid-forming modes (covering 10 categories, 55 subcategories, and 826 test applications). These tests verified the system's stable operation and support capabilities under both transient and steady-state conditions, marking a significant milestone for the first utility-scale grid-forming ESS. Another first was the Smart String Grid-Forming ESS black start, which showed a much

shorter start-up time than conventional solutions, taking just minutes instead of hours or even days.

As a 100 MWh-level Smart String Grid-Forming ESS, the system replicates all the key characteristics of synchronous generators. The Santanghu 25 MW/100 MWh grid-forming ESS in Hami has been successfully connected to the power grid, playing a key role in facilitating the large-scale integration of renewable energy plants into weak power grids.

The Santanghu project marks the industry's first utility-scale demonstration of grid-forming ESS, driving technological innovation while reducing wind power curtailment and enhancing power generation efficiency. By shifting the system from grid-following to grid-forming, it plays a vital role in developing new power systems where renewable energy serves as the

primary energy source.

The success of this project also indicates that CR Power and Huawei Digital Power have reached key milestones in using grid-forming ESS technology to enhance the grid-connection performance of renewable energy plants and accelerate the development of new power systems that rely on renewable energy. It also establishes a strong foundation for future research and testing. In addition, grid forming has been recognized as an essential component for building the next generation of power systems.

Looking ahead, CR Power and Huawei Digital Power will continue working on innovative solutions with world-leading grid-forming ESS technology. They will accelerate the development of clean, low-carbon, safe, and efficient new power systems and contribute to the renewable energy industry. ▲



# Sembcorp ESS: Activating the Green Engine of Jurong Island in Singapore

As the world intensifies efforts toward carbon emissions reduction and sustainable development, Singapore, known as the "Garden City," has unveiled the Singapore Green Plan 2030, setting clear development goals and specific measures. Today, the first batch of significant results has already been achieved.

As of now, over 140 countries and regions worldwide have joined the carbon neutrality movement. These include large economies such as China, Brazil, Germany, and the UK, as well as many smaller countries with relatively scarce natural resources.

Singapore is one of these countries. Due to the reasons mentioned above,

along with the government's forward-thinking policies, Singapore places greater emphasis on resource recycling compared to most countries, positioning itself as a leader in the green energy transition. Singapore not only leads by example but also employs effective measures such as legislation and strategic plans to regularly assess energy consumption facilities. In addition, the

country encourages businesses and households to adopt more efficient energy devices and technologies.

In December 2022, the 200 MW/285 MWh energy storage system (ESS) project on Jurong Island, constructed by Singapore's Sembcorp Industries, was officially launched. The project features a 115 MW/146 MWh Smart String ESS and technical support from Huawei Digital Power. Commissioned in six months, it is Southeast Asia's the largest ESS at the point of completion and is the fastest in the world of its size to be deployed.\*

*\*Based on independent assurance provider DNV's global database of 4,210 ESS projects totalling 32 GWh and publicly available information as of January 5, 2023 for a comparable size utility-scale ESS (same or higher rating and same design)*

### A Construction Miracle in Six Months

Sembcorp Industries (Sembcorp), a leading renewable energy company and a renowned provider of industrial and urban solutions, is committed to driving the energy transition and sustainable development.

The company is on track to achieve its target of 10 GW of gross installed renewables capacity by 2025 and aims to grow its installed renewables capacity to 25 GW by 2028.

The Sembcorp ESS project on Jurong

Island is a key part of this initiative.

In May 2022, the Energy Market Authority (EMA) of Singapore issued an expression of interest to build, own and operate an ESS in Singapore and subsequently appointed Sembcorp as the ESS developer and operator. The primary function of the Sembcorp ESS is to enhance power grid stability and resiliency. With a maximum storage capacity of 285 MWh, the ESS can meet the electricity needs of around 24,000 average four-room HDB households for one day, in a single discharge.

Its short response time to store and supply power in milliseconds is essential in mitigating solar intermittency caused by changing weather conditions in Singapore's tropical climate. Additionally, the Sembcorp ESS provides backup power to the grid. What is particularly remarkable is that, through close collaboration with partners such as Huawei Digital Power, the ESS achieved

a construction-to-activation miracle, with the entire process completed in just six months. Throughout the planning, construction, and activation stages, the project attracted wide attention inside and outside the industry, with active involvement from various government agencies of Singapore.

The construction process of the ESS was not without challenges and setbacks. For example, the impact of Typhoon Muifa affected the delivery of project materials and logistics, and record-breaking rainfall in Singapore, the highest in 40 years, disrupted the onsite construction pace. However, through the joint efforts of Sembcorp and its global partners, including Huawei, these issues were resolved, and Singapore's first large-scale utility-scale ESS was successfully completed on time.

### Leading Green Development Through Exemplary Practices

At the Banyan site of the project,





Sembcorp fully adopted Huawei's Smart String ESS platform. The platform's innovative distributed temperature control system maintains the temperature difference between batteries within a specific range to ensure optimal battery lifespan.

As a critical pillar of the energy transition, the energy storage sector has long faced challenges in areas such as safety, efficiency, lifespan, and O&M. Leveraging its strong expertise in PV, energy storage, and ICT technologies, Huawei Digital Power has integrated numerous key technologies to create the innovative Smart String ESS platform.

This platform features a fully modular system design: the battery system can isolate faulty battery packs independently without affecting the normal operations of other battery packs in the battery rack. The modular design not only offers high availability but also allows for flexible deployment and smooth capacity expansion, minimizing the impact of faults. It also includes automatic SOC calibration, eliminating the need for site visits, which significantly reduces O&M costs.

Specifically, each battery pack is equipped with an energy optimizer, each battery rack is managed by a controller, and distributed cooling is enhanced by intelligent technologies. With these features, Huawei Digital Power minimizes

problems of series mismatch between battery packs, parallel mismatch between battery racks, and battery temperature rise difference. With features like pack-level optimization and rack-level management, the ESS can improve its available energy by over 15% throughout its lifespan. In terms of safety, Huawei's Smart String ESS has also earned the rigorous certificate of conformity (CoC) for fire suppression of Singapore.

Huawei Digital Power also integrated advanced ICT technologies such as AI and cloud battery management system (BMS) into the solution to provide warnings for potential short circuits, transitioning from passive safety to proactive safety. Additionally, AI technology uses prediction models to forecast battery state of health (SOH). It employs intelligent battery lifespan, behavior, and environmental prediction models in conjunction with a smart temperature control strategy, optimizing the balance between battery degradation and temperature control energy consumption to ensure the optimal levelized cost of storage (LCOS) in real-time.

As a modular and smart next-generation ESS, the Sembcorp ESS can be easily configured to meet different needs and adjusted to support both on-grid and off-grid systems. Such an advantage can minimize system downtime and shorten response time during the replacement of

faulty batteries.

Over a year since the project was launched, the Sembcorp ESS at Banyan has met the required performance parameters for discharge capacity and round-trip efficiency, playing a significant role in supporting Singapore's transition to clean energy.

As a testament to the close collaboration between the two parties, in July 2023, Sembcorp and Huawei Digital Power signed a memorandum of understanding (MOU). The two companies will cooperate on innovation in PV and energy storage technologies, microgrids, and other applications, strengthening grid resilience and stability, while continuing to enhance practices such as integrated PV through grid-forming energy storage technologies.

Undoubtedly, the construction and operation of the Sembcorp ESS marks a landmark event in Singapore's green energy transition. Not only is it of great significance, but its value is also exceptional. As stated in the Singapore Green Plan 2030, the goal is "to create a green, liveable, and sustainable home for Singaporeans." The Sembcorp ESS serves as a model, setting an example for Singapore's energy transition and firmly leading the sustainable development of this beautiful garden city with the power of example. ▲





# China Three Gorges Corporation: Building a Blue "PV Great Wall" on the Desert

The Kubuqi Desert region and other regions with similar conditions are exploring more ways to develop a "PV economy." They strive to deeply integrate PV-based sand control and intelligent technologies to effectively combat desertification and improve the happiness index of residents by generating more social benefits.

For thousands of years, humans have been battling against desertification, with China leading the charge in these efforts.

As early as the Western Zhou Dynasty (1046–771 BC), residents in northern China were aware of desertification and grew plants, including *Tamarix chinensis*, *Tamarix ramosissima*, and saxaul, to prevent

desertification.

In the Han and Tang dynasties, the Silk Road brought about the extensive cultivation of plants in desert areas. Business travelers and residents along the Silk Road worked with the governments to develop water conservation facilities, minimizing the adverse effects of deserts on transportation and residential areas.



In modern times, the Kubuqi Desert in Inner Mongolia has become a benchmark for effective sand control. Through measures such as afforestation and ecological restoration, the management of the Kubuqi Desert has achieved remarkable results, with the United Nations commending it as a model for turning a desert into an oasis.

By the end of 2023, the ten-million-kW-level wind+PV project in the Kubuqi Desert — the first of its kind in China — was connected to the grid. PV was introduced, with a "PV Great Wall" that showcases a striking landscape of blue solar panels emerging alongside lush green forests.

### Continuously Adding Value

As an integral part of China's energy strategy, the construction of utility-scale wind and PV power plants in deserts and wastelands is accelerating.

The 1 million kW PV project developed by China Three Gorges Corporation and Inner Mongolia Energy Group in the north-central part of the Kubuqi Desert is a prime example.

The PV plant was successfully connected to the power grid on December 29, 2023, marking a milestone of the "renewable energy + desert management" model and setting a benchmark for sand control and economic development in other regions.

Located in the Inner Mongolian Plateau, the Kubuqi Desert has a temperate continental climate that provides abundant wind energy resources and more than 2800 sunshine hours each year. This makes the region an ideal location for developing wind and solar energy.

In this project, vegetation and crops are planted beneath and between

the rows of solar panels while power is generated on the solar panels. This three-tiered approach includes bordering forests, windbreak forests, and vegetation within the PV plant, promoting sand fixation and ecological restoration.

The entire plant implements the Huawei Smart PV Solution. Huawei's smart string inverters play a key role in the plant's operation. They ensure long-term stable operation and reliable output with a system availability of up to 99.999%.

Based on the characteristics of deserts and wastelands, Huawei's smart string inverters feature a fully sealed design that isolates completely the power compartment and wiring compartment. The inverters have an IP66 protection rating and are resistant to high temperature, high humidity, low temperature, and sandstorms.



Additionally, Huawei's smart string inverters use innovative Smart Connector-level Detection (SCLD) technology to ensure high reliability in design, production, and manufacturing. Once detecting abnormal terminal temperatures, the inverters start protection to prevent fault deterioration and spreading. To address challenges in windy and sandy environments, the IP68-rated smart fans inside the inverters support self-cleaning, greatly improving O&M efficiency.

The Huawei Smart PV Solution features innovative designs, which significantly enhance system reliability, ensure long-term value creation for customers, and maximize return on investment (ROI).

In addition to their excellent hardware performance, Huawei's smart string inverters have achieved significant breakthroughs in intelligent management. The inverters facilitate remote detection and management, enabling O&M personnel to determine the running status of PV systems, perform real-time optimizations through data analysis, and ensure that the systems operate optimally.

### "Blue PV Great Wall" on the Desert

In the first phase of this project, the installed capacity is 1 million kW,

covering an area of about 21.3 km<sup>2</sup>, equivalent to 3000 standard football fields. Inspecting the entire plant using traditional methods would take about 180 days. By contrast, the drone-based intelligent inspection system conducts detailed inspections of all equipment in the plant within one month, ensuring normal operations.

The total installed capacity of the project is reported to be 16 million kW. Upon completion, the project is expected to supply approximately 44 billion kWh of electricity to areas including Beijing, Tianjin, and Hebei annually. This will alleviate power shortages in these areas and become an important clean energy transmission pipeline.

This PV project demonstrates new approaches to desertification, including sand control beneath solar panels, opening up a new horizon for integrating ecosystem optimization with PV industry development.

In 2023, Ordos City made steady progress in constructing utility-scale wind and PV plants in deserts and wastelands. The government has planned a sand control zone on the northern edge of the Kubuqi Desert and south of the Yellow River. This zone spans approximately 400 km in length and has an average width of about 5 km, accommodating



installations of up to 100 million kW.

A large number of PV modules shield the ground from solar radiation, significantly reducing wind speed and evaporation. They effectively optimize the micro-ecology of plants and their surroundings, increasing biodiversity and vegetation coverage.

Power generation on solar panels, green plants growing in between, and livestock raising under the panels have become the "new normal" in the local region. The green plants typically include cash crops and herbs, such as wolfberries and licorice, which optimize the ecosystem while boosting local economic growth.

In this blue sea of PV panels, small



wild animals can be occasionally spotted. The desert ecosystem is undergoing subtle and pleasant changes.

The industry and governments in the Kubuqi Desert region and other regions with similar conditions are still exploring more ways to develop a "PV economy." They strive to deeply integrate PV-based sand control and intelligent technologies to effectively combat desertification and improve the happiness index of residents by generating more social benefits.

The views from the drone are stunning and show millions of PV modules spread across the undulating dunes, resembling a breathtaking expanse of a glistening blue sea.

Imperceptible to the naked eye, a significant amount of green electricity is being generated, reducing millions of tons of carbon dioxide emissions every year and providing a sustainable source of energy that facilitates green and low-carbon development in Inner Mongolia.

For many years, the northern regions of China have witnessed severe desertification. However, they are now embracing the potential of their abundant solar energy resources, enabling the generation of PV power. This has led to the integration of multiple industries. Spanning hundreds of kilometers, the "PV Great Wall" serves as a vital ecological safety shield in northern China, contributing to a greener future with its distinctively vibrant presence. ▲



# Unveiling the Magic Box in the Fairyland of Windmills

Adhering to the corporate philosophy of innovation and courage, Kronenburg Techniek successfully deployed the Europe's first project that integrates optimizers, inverters, ESSs, and chargers in the Kronenburg Techniek Offices Campus. This example will continue creating benefits for the company and the industry.



Speaking of the Netherlands, what is the first thing that comes to your mind?

Is it a huge windmill that stands steadily and works ceaselessly? Or is it the Orange Squad that marked the country's football history by perseverance and perfect teamwork? Alternatively, it could be an amazingly vast sea of colorful tulips.

Just as there are a thousand interpretations of Hamlet, different people have different impressions of the Netherlands. Nowadays, this "lowland country" has made continuous efforts to shape a green future.

You can find solar panels row upon row in the green fields and various energy storage systems (ESSs) neatly arranged in the central business districts of a

city. These modernizers tell us that the Netherlands is striving to pioneer in the process of global carbon neutrality.

## Wait or change?

Like many European countries, the Netherlands is struggling with overloaded power grids and regional power outages under the burdens of the soaring demands for charging stations and heat pumps and insufficient investment in new infrastructure.

For households and individual users, continuous power outages will lead to chaos and people feel desperate about the life without electricity. Imagine what would happen if a large modern campus encounters a power outage.

Kronenburg Techniek made it clear, "No way!" Founded in 1965 and located in Houten, the company has been



engaged in design, engineering, as well as production and maintenance of electrical and fire safety installations and related parts.

Adhering to the corporate philosophy of innovation and courage, Kronenburg Techniek successfully deployed the Europe's first project that integrates optimizers, inverters, ESSs, and chargers in the Kronenburg Techniek Offices Campus.

In addition, such a green project has made a name for the company and promoted its products and services, and will continue creating benefits for the company and the industry.

Ernst Kronenburg, CEO of Kronenburg Techniek, is very satisfied with the project achievement. Together with his father, he is also the campus owner. You may have noticed that his family name

is included in the company name, which is one of the characteristics of many family-owned enterprises in Europe.

According to Ernst, before this project, the Kronenburg campus had only the required grid capacity of 55 kW due to the limited power distribution capacity of the Dutch power grid. However, engineers estimated that the grid capacity should be more than 200 kW.

In this case, can the Kronenburg campus request the power grid for a larger capacity? "Yes, of course. But our request for the capacity was rejected," said Ernst, "According to the current schedule, we have to wait another seven years to get the desired capacity."

Seven years is an astonishing figure. Kronenburg Techniek made up their mind to gradually get rid of the

dependence on traditional power grids and take solid carbon-neutral actions to leverage clean energy and save electricity costs.

Therefore, they began to seek cooperation with mainstream clean energy solution suppliers in the market.

### **A box full of magic**

According to Ernst, capacity expansion and self-consumption of electricity are widely-accepted commercial energy storage modes in the Netherlands and the rest of Europe. The advantages include high flexibility, cost-effectiveness, and rapid replication for large-scale deployment.

Before the Kronenburg campus was constructed, Kronenburg Techniek had consulted many photovoltaics (PV) and energy storage companies, including



some leading companies in the industry, but backed off at last considering their weaknesses in different degrees.

"Huawei stood out." Ernst stated, "For this project, Huawei provides a dedicated solution that integrates optimizers, an 88 kW PV system, two ESSs with a total capacity of 400 kWh, and a 720 kW power unit for charging the company's electric vehicles at an ultra-fast speed."

Each ESS in this solution can provide backup power for a maximum of two hours. This is what Huawei FusionSolar LUNA2000 Smart String ESS is known as an industry benchmark. It adopts the industry's first modular+ architecture and houses independent energy optimizers, fully unleashing the potential power of each battery pack.

At first, Ernst and his colleagues had doubted Huawei's expertise in energy storage. Only after gaining deep understanding did they realize that Huawei had years of experience in this field, particularly with advanced technologies in energy storage safety.

The LUNA2000 Smart String ESS also provides three protection mechanisms: intelligent overcurrent protection, pack-level short-circuit protection, and rack-level short-circuit protection. These

mechanisms can effectively block external short circuits and overcurrent risks to ensure safety.

Explosion relief panel is a highlight design in the ESS, revealing Huawei's unique ingenuity. Once batteries experience thermal runaway, the panel automatically opens upward to release pressure and gas, preventing injury to maintenance personnel and firefighters. A few months before, an accident occurred in Germany, where firefighters were injured due to the lack of explosion relief panels.

For the power unit, Ernst commented, "It is like a box full of magic." It supports a maximum of 720 kW DC output power and uses the liquid cooling design to ensure that the power unit runs efficiently and quietly at full power. The power unit houses multiple DC/DC charging modules to dynamically allocate power based on actual needs, improving the module utilization by nearly 30% and enabling EV owners to enjoy a smooth charging experience.

### **A pretty good business**

"Unlike some other owners, we chose to install a PV system on the rooftop and equip each PV module with an optimizer." Ernst noted, "Generally, PV modules on flat roofs do not require



optimizers, but we want to gain a higher yield and more return on investment."

This is true. Even on flat roofs, the energy yield is affected by factors such as the sunlight angle, panel direction, and shading. Kronenburg Techniek expects the optimizers to safeguard the independent operation of each PV module to solve problems such as shading and multiple directions of roofs, and maximize the utilization of rooftop resources and the energy yield within the device lifecycle.

Huawei's solution supports integration with third-party energy management systems (EMSs). Ernst told us that Huawei provided end-to-end support from pre-sales to after-sales, and is dedicated to high product quality and smooth engineering implementation. The success of this project attracted

more attention and inquiries from campus owners.

He agreed that the PV+ESS application mode effectively settles the issue of insufficient power supply for the charging network in the campus. In addition, Kronenburg Techniek can maximize energy storage benefits through flexible energy scheduling and response.

"The integration of the PV system, ESSs, optimizers, and power unit safeguards the smooth operations of our campus without the need to reconstruct the mains, and our investment will be paid back in only 3.5 to 4 years. This is a pretty good business!" To Ernst's great relief, Kronenburg Techniek could save the electricity costs by 32,000 euros while reducing carbon emissions by 45 tons each year.

Currently, commercial and industrial energy storage has shown a strong momentum of growth in countries such as the Netherlands, Germany, and the UK. An increasing number of companies turn to the PV+ESS mode. The Energy Storage Coalition is urging the European Commission to deliver an Action Plan on Energy Storage, which provides regulatory clarity and encourages Member States to invest in and deploy ESSs.

With the distinct strengths and innovation capabilities in the PV and energy storage fields, Huawei Digital Power has become a preferred choice for many European enterprises. With a wealth of success cases, Huawei Digital Power will continuously drive global energy transition and green development through technological innovation to enable clean energy as a main energy source for every home and business. ▲





# From Consumer to Producer: Zero-Carbon Journey for a Green Town in Sweden

Gnesta has demonstrated how solar energy can transform residents from electricity consumers to green electricity producers. It also shows how a single zero-carbon household can help create a green and interconnected zero-carbon community, setting a benchmark for building low-carbon communities in Europe and beyond.

The film *The Girl with the Dragon Tattoo*, based on the novel with the same title by Stieg Larsson, was a blockbuster in 2009 and won the "Best Film Not in the English Language" award of that year given by the British Academy of Film and Television Arts (BAFTA).

Its shooting location — Gnesta, a small town in Sweden with only 6000 residents — also became famous. Many tourists and fans came here to see the fictional places of Hedestad and Hedeby

Island featured in the film.

Today, Gnesta is gaining recognition for another very important reason. It's drawing people's attention for its outstanding efforts to build a green community and promote sustainable development.

## **Gnesta's green transition**

Gnesta is home to only about 2000 households with 6000 residents. It aims for every household to have a PV system and generate its own green energy.

In 2023, a quarter of the households already installed PV systems, and the remaining 1500 will soon follow suit.

By installing PV systems, Gnesta is building a sustainable, green community. PV systems help residents generate their own electricity and save on utility costs. But beyond this, the residents see other benefits in various aspects of their lives. For example, a ceramic artist installed a PV system to pursue her dream of holding a zero-carbon ceramics art exhibition. A vegetarian wants to grow more vegetables with a PV system supplying power to his greenhouse. PV has become a major topic of conversation among neighbors, second only to weather.

There is a Swedish saying, "Ingen kan hjälpa alla, men alla kan hjälpa någon," which means that no one can help everyone, but everyone can help at least one person. This also relates to Gnesta's PV installations. Everyone can do their part to reduce the consumption of fossil fuels and choose a sustainable lifestyle. One person's efforts are limited, but the combination of everyone's efforts can make a great difference.

Sweden has consistently been a pioneer in addressing environmental pollution and mitigating climate change. Gnesta's PV installations — powered by Huawei FusionSolar solutions — are not only significant to Sweden but also a

milestone in PV development in Europe.

The European PV market is expected to grow at a compound annual growth rate of 12% in the next five years. Although policies and initiatives vary across the region, most agree that embracing PV will be essential to carbon neutrality.

As a top player in the global PV industry, Huawei Digital Power has deployed 33 service teams, 10 national technical support centers, and more than 200 onsite service engineering teams across Europe. They are ready to provide customers with better products and solutions, faster services, and a better user experience.

### Support from innovative technologies

Huawei Digital Power relies on the latest advances in technologies to deliver innovative solutions to customers. Gnesta's residents are no exception. Huawei launched a "battery-ready" architecture for PV inverters, which allows customers to add an energy storage system (ESS) whenever energy demand increases. This means that Gnesta's residents can flexibly upgrade their systems now or in the future.

At the same time, Europe is seeing the increasing popularity of electric vehicles (EVs), especially in Nordic countries. Residents in Gnesta can

charge their EVs with electricity produced by their own PV systems, achieving green travel.

In addition, the Huawei FusionSolar Residential Smart PV Solution has built-in high-standard active safety mechanisms, such as AI intelligent arc protection and automatic rapid shutdown of rooftop DC voltage. This solution is highly reliable thanks to rigorous design, production, and testing, and can withstand various extreme environments, ensuring long-term, stable operations.

Moreover, the Huawei FusionSolar Residential Smart PV Solution can be installed on various types of rooftops and respond to different energy consumption patterns. That's why each household that joins Gnesta's PV revolution is choosing Huawei's technology to power its green energy consumption.

Of course, the green energy transition is not without its challenges. These include inconsistent energy production, storage constraints, and the need for flexible long-term solutions. Due to factors such as weather and shading, PV users may struggle with inconsistent PV energy production and how to store excess PV energy.

To address these issues, Huawei Digital Power solutions feature multiple innovative technologies.



- Module-level optimization: The optimizers allow each PV module to run independently despite shading or multi-directional rooftops, increasing the average energy yield by 5% to 30% throughout the system's lifecycle.
- "Battery ready" inverter architecture: Inverters are equipped with battery ports and support PV+ESS on/off-grid scenarios. With an ESS, users can store excess PV energy for later use, reducing the consumption of electricity from the power grid.
- Intelligent energy management: Owners can view energy production and consumption in real time on the app. The Energy Management Assistant (EMMA) helps predict power generation and consumption, and optimize energy scheduling for generation, storage, and consumption.

### Toward sustainable development

Gnesta has become a benchmark for green energy applications in Sweden and Europe.

In terms of costs, Gnesta's residents are seeing significant savings thanks to their PV installations and a reduced reliance on the power grid. In addition, the Swedish government's incentives for green energy, such as subsidies and tax exemptions, have made the upfront investment easier.

Beyond reducing costs, Gnesta's residents can store excess electricity and sell it to the local power grid. This ensures energy independence and creates a reliable and self-sufficient energy model.

In the long term, the modular design of Huawei's solution will ensure flexibility

and scalability so that the upfront costs can provide returns for a longer time. Also, the materials used by Huawei FusionSolar Residential Smart PV Solution are highly durable and recyclable. These design choices make the solution more economical and feasible, promoting Gnesta's sustainable development.

Gnesta has demonstrated how solar energy can transform residents from electricity consumers to green electricity producers. It also shows how a single zero-carbon household can help create a green and interconnected zero-carbon community, setting a benchmark for building low-carbon communities in Europe and beyond.

As Gnesta's partner, Huawei Digital Power will continue to help more towns and cities achieve green development. ▲





# Ultra-fast Chargers Along the G318 Highway: Going Green at 4000 Meters Above Sea Level

In 2024, ultra-fast chargers have become available along the entire G318 Highway from Tianquan to Litang, Lhasa, and onward to Mount Qomolangma at an altitude of nearly 4000 meters. EV owners can now drive all the way to Mount Qomolangma — what a dream.

**T**he G318 Highway is an iconic route that every self-driving adventurer dreams of exploring.

with its customers and partners to deploy Huawei's highly reliable FusionCharge Solution along this highway.

However, it was once restricted to fuel-powered vehicles. The harsh environment, challenging road conditions, high safety risks, and limited charging infrastructure made it less appealing for electric vehicle (EV) owners.

After a year of hard work, the deployment has been completed. Since September 24, 2024, ultra-fast chargers have been available in Tianquan, Zheduo Mountain, Kazila Mountain, Litang, Linzhi, Lhasa, Shigatse, and Mount Qomolangma along the G318 Highway. The average altitude of these charging stations exceeds 3600 meters, a record high.

This has changed. Since October 2023, Huawei Digital Power has been working

Since project completion, this highway bears a new name — the road of green energy. EV owners can easily drive on this high-altitude highway, known as "China's most beautiful avenue," without any range anxiety.

### Confidence in heading for the dreamland

Despite the success, it has not been easy to deploy ultra-fast chargers along the G318 Highway.

Huawei FusionCharge Solution is developing new technologies through R&D and innovation, which were essential in tackling some of the challenges in high-altitude deployment.

As EV sales have surged over the years, charging infrastructure has struggled to keep pace. Many consumers are hesitant to buy EVs due to concerns about the lack of charging stations, the inconvenience of insufficient charge points, and slow charging speeds during long-distance trips. On top of that, encountering incompatible chargers adds to the frustration.

Huawei FusionCharge Solution improves the charging speed and efficiency for EV owners. The solution supports a wide voltage range — from 200 V to 1000 V, nearly 99% of users can charge their vehicles on the first try. As a result, the solution empowers EV owners to travel as they want, winning the market's trust.

Huawei Digital Power always pursues superior quality throughout product design, manufacturing, and inspection.

The liquid cooling module, a core component of Huawei's Ultra-fast Charging Solution, is die-casted and enclosed. This protects the module from sandstorms and condensation and allows it to dissipate heat throughout its service life of over ten years.

The module has been successfully deployed and put into commercial use in extremely cold areas (such as Hulunbuir at  $-42^{\circ}\text{C}$ ) and extremely hot areas (such as Turpan at  $70^{\circ}\text{C}$ ).

So far, Huawei has worked with its customers and partners to deploy fast and ultra-fast chargers in more than 200 cities across 31 Chinese provinces. Now, EV owners can enjoy the fast and high-quality services offered by Huawei's Ultra-fast Charging Solution, whether they are on a highway, in a commercial district, or in a town.

Of course, EV owners can now even travel all the way along the G318 Highway, arriving at the PV + ESS Liquid-Cooled Ultra-fast Charging Station at the foot of Mount Qomolangma. This station is equipped with Huawei FusionCharge Solution, which took some design ingenuity.

Notably, the solution isn't just fast; it is also green. It can reduce carbon dioxide emissions by about 135.05 tons each year. The solution ensures convenience

for EV owners and protects the environment.

### A new "home" for EV owners

In the past, some chargers were installed along the G318 Highway, but the harsh environment led to a severe shortage of charging stations and equipment. EVs often ran out of power, with the nearest charging station hundreds of kilometers away. EV owners frequently had to adjust their travel plans, waiting for slow chargers or relying on long extension cords to recharge.

Building charging stations along the G318 Highway was far more challenging than on flat plains, both technically and logistically. Teams had to traverse mountains over 4000 meters high and endure extreme weather conditions. Huawei drew on its extensive experience with large-scale commercial applications to tackle issues like unstable voltage and freezing temperatures in remote areas. The R&D team conducted numerous simulations, replicating conditions in various regions through advanced software and hardware testing to support partners in construction. After multiple site surveys and discussions, Huawei, along with its customers and partners, successfully completed the installation, power-on, commissioning, and operation of liquid-cooled ultra-fast charging stations in Tianquan, Litang, Sangdui, Lhasa, Shigatse, and



## Ultra-fast Chargers Along the G318 Highway: Going Green at 4000 Meters Above Sea Level



Mount Qomolangma — all within a remarkably short timeframe.

The site survey, site selection, project construction, and equipment commissioning were thoroughly evaluated and inspected. The well-designed product solutions and thoughtfully planned station layouts made it possible to successfully deploy charging stations along the G318 Highway, providing a welcoming "home" where EV owners can recharge their vehicles. This success story highlights the quality and reliability of Huawei FusionCharge Solution in high-altitude environments.

The trust that Huawei's partners showed throughout the process is another reason for its success. Up until October 2024, Chongqing SuperChargers, Huawei's partner, was still exploring to build and develop renewable energy charging infrastructure in plateau areas. The company's goal was to overcome difficulties such as high altitude, variable climates, and unstable electricity infrastructure. It launched two new liquid-cooled ultra-fast charging stations

in Jianziwan Mountain and Haizi Mountain. This shortened the distance between charging stations, providing comprehensive and reliable charging services for EV owners traveling along the route.

Now, EVs can take a leading role in traveling along the G318 Highway.

### Green travel with multiple benefits

Beyond its breathtaking scenery, the G318 Highway is an important source of opportunities for local economic growth.

The G318 Highway was previously used by many fuel cars. Now, more travelers are coming as EV owners can drive the route. Improving the charging facilities is boosting the tourism industry, bringing surging economic growth and new jobs to sectors such as accommodation, catering, and other services. Residents are also the biggest beneficiaries of the highway. For example, they can travel faster for business trading while resources, funds, and technologies can quickly make their way from Eastern to Western China.

In addition to economic benefits, the G318 Highway Ultra-fast Charging Project will reduce the use of gas cars, thereby slashing carbon emissions and air pollution. It is part of a larger push to promote green travel, electric transportation, and low-carbon lifestyles. This project aims to protect the fragile ecological environment and is slated to become a new model for local industrial economic development.

This is an important project for Huawei Digital Power and its customers and partners. It is driving the industry to build a comprehensive charging ecosystem across China. The industry-leading solution is one of the milestones in developing national renewable energy infrastructure.

This project is a best practice that follows Huawei's vision of "jointly charging the road ahead." It will encourage a multitude of EV owners to travel the distant highway. More importantly, it will serve as a pilot to inform government plans and policies around charging infrastructure and the promotion of EV-driven travel. ▲



# Chongqing, Building a City of Convenient Ultra-fast Charging

Chongqing is a city in a green transition. Building a city of convenient ultra-fast charging is an important measure for Chongqing to meet the increasing demand for EV charging and lay a solid foundation for green travel and low-carbon city construction.

In modern industry and commerce, one million kWh of electricity per year is not much. However, in the charging domain, the number is of great significance.

More than one year after Huawei launched its FusionCharge Solution, multiple stations in China achieved an annual energy charge of one million kWh. One of the benchmark stations is the SuperChargers fully liquid-cooled ultra-fast charging station in Baguocheng, Chongqing, which began operations in November 2023.

If each electric vehicle (EV) needs an

average of 30 to 40 kWh of energy per charge, then the station should have served over 30,000 vehicles in the year. However, the actual number of vehicles served is much higher.

Few drivers will wait to charge their vehicles until the battery state of charge (SOC) drops below 20%. In addition, of the many EVs on the road, hybrid electric vehicles (HEVs) far outnumber battery electric vehicles (BEVs). As such, the charging station must have charged well over 30,000 vehicles throughout the year.

What a great achievement! This means a lot, especially for Chongqing,

which has ambitious plans to build a convenient ultra-fast charging city.

### A City of Ultra-fast Charging Along the Jialing River

Chongqing is the latest city to announce the development of ultra-fast charging. On April 3, 2024, the General Office of Chongqing Municipal People's Government issued the Notice on the Action Plan of Convenient Ultra-fast Charging for New Energy Vehicles (2024–2025).

This is the first official document that clarifies Chongqing's ultra-fast charging construction goals. It sets out detailed requirements for the work to be carried out across Chongqing's various sub-districts that include urban, peri-urban, and rural areas.

According to the Notice, by the end of 2025, the city will build more than 2000 ultra-fast charging stations and more than 4000 ultra-fast chargers. By then, the city aims to establish a convenient ultra-fast charging ecosystem with a balanced layout, intelligence, and high efficiency, developing a complete mechanism with advanced technologies to promote collaborative development in Chongqing's EV industry.

The Technical Guide on the Construction of Ultra-fast Charging Infrastructure in Chongqing, released together with the Notice, launched the city's public ultra-fast charging brand, JetCharge. The

brand showcases Chongqing's ambition to develop ultra-fast charging.

The SuperChargers fully liquid-cooled ultra-fast charging station could be considered a prelude to the Notice. The station uses Huawei FusionCharge Solution, which provides up to 600 kW of charging power, bringing the ultimate charging experience to Chongqing's citizens.

SuperChargers ultra-fast charging stations also offer other services beyond charging, including self-service car washes, service stations, and business spaces. The stations are gradually expanding their presence across core business districts, logistics parks, transportation hubs, parks, scenic spots, and residential areas.

Flagship stations, such as the SuperChargers fully liquid-cooled ultra-fast charging station in Baguecheng, Chongqing, help alleviate range anxiety among vehicle owners and serve as a business model showcase to highlight the advantages of these stations.

### Promising Business Viability

Does the business model really work? Let's do some math.

By November 2024, Chongqing SuperChargers Digital Energy Technology CO., Ltd has built and launched more than 60 ultra-fast charging stations. The stations are powered by Huawei Digital

Power's leading products and solutions and outperform traditional charging stations by 60% in terms of average daily energy charged.

Let's imagine that there are 1000 stations. If the average daily energy charged by each charging connector is 200 kWh, the annual revenue will reach CNY700 million, without considering other lines of business beyond charging. In fact, for many gas stations, revenue from non-oil sales accounts for 40% or more of the total sales, a model that also applies to ultra-fast charging stations.

It is clear that ultra-fast charging stations are a good business opportunity and are crucial in supporting China's EV industry development.

The increasing availability of ultra-fast charging stations is a key factor in higher EV penetration. The business involves innovations in technologies, high-end manufacturing, consumption scenarios, business models, and eco-cultures. It is becoming an important part of the entire industry ecosystem.

Huawei FusionCharge Solution uses technologies such as ultra-fast charging + fast charging, double tier power pooling, and PV + ESS + charger integration. As such, the new ultra-fast charging stations are highly adaptable to different grid environments, which increases operators' confidence to invest, users' confidence to buy, and



manufacturers' confidence to produce high-quality EVs. All of these achieve a promising business model.

### A Green City Embraced by Mountains and Waters

"One of the greenest regions in China is Southwest China, and the greenest city in Southwest China is Chongqing." The word "green" refers not only to the color on the map but also to the fact that Chongqing is a city in a green transition.

Apart from environmental and ecological governance, Chongqing is also committed to its green and low-carbon benchmarks. Over the past few years, Chongqing has built 54 national green factories and four green campuses. The output value of local green campuses has increased to 73.1% of the total industrial output, ranking first among low-carbon pilot cities in the central and western regions of China.

Building a city of convenient ultra-fast

charging is also an important measure for Chongqing to meet China's carbon peaking and carbon neutrality goals. Supported by Huawei Digital Power's products and solutions, the charging stations meet the increasing demand for EV charging and lay a solid foundation for green travel and low-carbon city construction.

Ms. Wang is a regular visitor to the fully liquid-cooled ultra-fast charging station in Happiness Park, Jiulongpo District. She feels strongly about ultra-fast charging. "It's really convenient! I used to have range anxiety, and I would feel uneasy once the SOC dropped below 50%. But that's history now. My car can go 200 kilometers on a 5-minute charge," she said.

Huawei Digital Power is working with Chongqing SuperChargers to deploy fully liquid-cooled ultra-fast charging stations across Chongqing. We are building an ultra-fast charging network

with the ultimate experience and wide coverage for citizens and tourists, helping Chongqing to become a city of convenient ultra-fast charging.

Chongqing SuperChargers will continue promoting Huawei FusionCharge Solution to build high-quality charging infrastructure. Additionally, as an active member of the ultra-fast charging ecosystem, the company will accelerate its nationwide planning, contributing to the healthy and orderly development of the charging industry.

Ultra-fast chargers can make a significant difference in people's lives. To meet the needs of EV owners for comprehensive and high-quality charging networks, Huawei Digital Power will join forces with vehicle manufacturers, power grids, operators, and partners to build an open, cooperative, and win-win ecosystem that delivers the benefits of ultra-fast charging to more people ▲



# Huawei FusionCharge Solution Jointly Charging the Road Ahead



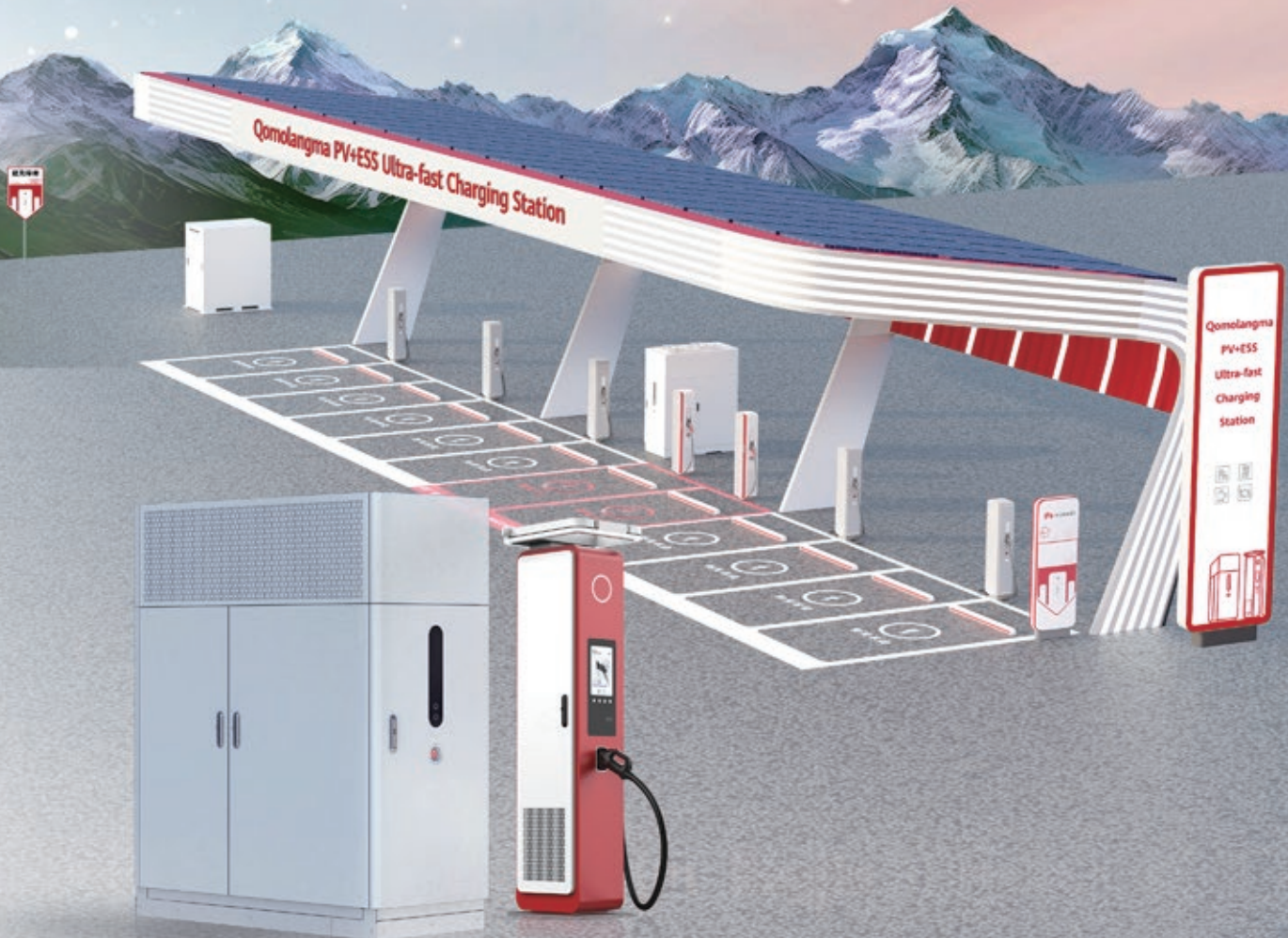
Excellent Experience



Superior Quality



Optimal ROI







# Huawei DriveONE and AVATR: Unlocking the Secret to Speed and Stability

In the fiercely competitive electric vehicle (EV) market, how can automakers win over consumers and sell over 10,000 units a month? In addition to AVATR's growing product portfolio and increasingly competitive features, another powerful and often overlooked force is at play: Huawei DriveONE.

2024 has been a milestone year for China's EV industry, automotive sector, and manufacturing as a whole.

China has become the first country in the world to reach an annual

production capacity of ten million EVs. The global market share of Chinese brands has reached new heights. Additionally, EV sales now account for more than half of monthly car sales, outpacing traditional fossil-fuel vehicles.





Amid this increasingly competitive landscape, several dynamic players are rapidly emerging. One such player is AVATR, a company founded in 2018 and headquartered in Chongqing. In October 2024, AVATR's sales reached a historic high — 10,056 units sold, double the previous year's and month's numbers.

### **An extraordinary smart mobility experience**

The name AVATR is derived from English

and symbolizes a transformation. It represents the collaboration of three industry giants: Changan Auto, Huawei, and CATL, in the fields of vehicle R&D and smart manufacturing, smart automotive solutions, and smart energy ecosystems. AVATR is dedicated to exploring human-centered mobility technologies of the future, aiming to achieve advancements in power, smart driving, and safety. Ultimately, the brand looks to create an unparalleled smart travel experience for its users.

What kind of sparks will the synergy of these three companies ignite? Anticipation is building. Let's look at one of the innovations delivered by Huawei Digital Power — a long-standing leader in energy technologies. The company has developed the DriveONE power domain full-stack solution that integrates digitalization, power electronics, and other technologies. So far, it has been implemented in models like the AVATR 11 and AVATR 12.

Since launching DriveONE in 2018, Huawei Digital Power has become a leader in power domain solutions for the EV industry. Its mission is to create new value in the smart and connected EV sector by offering safe and comfortable driving experiences.

Currently, over a dozen leading Chinese automakers use Huawei DriveONE

in more than fifty car models. The solution is supporting the EV industry's development and its consumers.

In March 2024, the AVATR 12 pure electric edition was relaunched with a refreshed design. It is equipped with the Huawei DriveONE power domain full-stack high-voltage system, offering a maximum power of 425 kW, peak torque of 687 N·m, and acceleration from 0 to 100 km/h in just 3.9 seconds. In the past, only million-dollar sports cars could achieve such performance. This edition also comes standard with an 800 V silicon carbide platform, offering an incredibly fast charging experience that makes travel more efficient and convenient.

Beyond striking performance, Huawei DriveONE prides itself on meticulous engineering. Three key technologies — millisecond-level super nerve reflex, intelligent sensing, and adaptive adjustment — allow Huawei's iTRACK intelligent software to precisely recognize complex road conditions. With 10,000 road condition perceptions and 1000 torque adjustments per second, the system ensures a smooth, slip-free, and stable ride, providing greater comfort and safety for everyone in the car.

Meanwhile, the automotive sector is rapidly transitioning towards a low-carbon, intelligent future. To

this end, Huawei Digital Power is integrating digital technologies and platforms that enable safer, more comfortable, and more agile control while accelerating the electrification of mobility.

The Huawei DriveONE power domain full-stack solution already powers EVs across numerous brands, helping them deliver more power, exceptional comfort, high safety, a long range, and flexible convenience. The result is a luxury driving experience that drivers and passengers love.

### Extraordinary power, exceptional experience

When buying an EV, most buyers are concerned with the appearance, interior, and cost. However, the EV's core — its electric drive and control systems — should not be overlooked. These represent the biggest difference between EVs and traditional vehicles.

In April 2024, Huawei Digital Power officially launched its electrification strategy, unveiling a series of new power domain solutions aimed at promoting the integration of green energy and mobility. By collaborating with customers and partners, Huawei Digital Power is accelerating EV adoption.

Huawei Digital Power introduced the

"10 km per kWh of energy charged" concept that addresses range anxiety. The company also launched the DriveONE 10-in-1 high-voltage ePowertrain, which significantly boosts vehicle efficiency. DriveONE pioneers a power platform architecture that integrates power, functionality, and domain control. This approach results in higher efficiency, smaller size, and a lightweight design weighing only 70 kg, making it easier for automakers to reduce air resistance.

In terms of performance, Huawei DriveONE has built the industry's first SiC high-voltage four-wheel drive platform with front asynchronous and rear synchronous motors. It features 22,000 rpm ultra-high speed, ultra-high power density, 10 kg less weight, and intelligent oil cooling 2.0. The system enables vehicles to accelerate from 0 to 100 km/h in just 3 seconds — just like sports cars. Plus, it increases the vehicle's range by approximately 40 km.

Huawei DriveONE is also more intelligent and safer. The solution intelligently recognizes road conditions and uses Huawei's iTRACK to adaptively adjust the torque when a vehicle encounters obstacles like speed bumps. This reduces the wheel speed fluctuation by 50% and shortens the time for residual vibrations by 40%. In adverse weather conditions,



iTRACK can detect even the slightest wheel slip on rainy or icy roads and adjust the motor output torque within milliseconds based on real-time road conditions. This helps maintain vehicle stability, reducing slipping or skidding on snow-covered roads and ensuring a smooth driving experience for both the driver and passengers. Huawei Digital Power is committed to achieving zero breakdowns in the power domain, a goal made possible through AI cloud systems that leverage data collaboration and device-cloud synergy.



As one of AVATR's key partners, Huawei Digital Power has been essential in helping the automaker rise to prominence in the highly competitive EV market. In December 2023, AVATR officially signed a strategic cooperation agreement on ultra-fast charging networks with Huawei Digital Power. This agreement announced plans for deep collaboration in building an ultra-fast charging ecosystem, platform interconnection, and charging services. The partnership will offer AVATR car owners the opportunity to experience Huawei's ultra-fast charging, which is

known for its fast, quiet, light, and safe performance combined with efficiency and convenience.

Huawei DriveONE delivers a safe and fast driving experience. Looking to the future, Huawei Digital Power is committed to its core values of being customer-centered, staying focused, and diligent in its efforts. The company will continue to support automakers in building high-quality vehicles, providing users around the world with superior electric mobility products, and encouraging more consumers to embrace EVs. ▲





# A "Super Brain" for the SERES Super Factory

With the data center as an intelligent foundation, SERES Super Factory ensures smooth, fast, and efficient production and operation at every step, making it a standout leader in China's automobile manufacturing industry.

On November 1, 2024, SERES released its October production and sales report. In October, it sold 36,011 new energy vehicles (NEVs), marking a 104.61% year-on-year increase. From January to October 2024, its total sales reached 352,724, a remarkable 310.99% increase compared to the same period last year.

Given the company's size, tripling growth is considered a "miracle" in the automotive industry. This "miracle" is possible thanks to the company's AITO series, produced at its SERES Super Factory in Chongqing.

The factory spans 1.838 square kilometers, roughly the size of 200 football fields. To build each AITO M9, 1600 intelligent devices and 3000 robots work together to complete dozens of

complex and precise procedures.

## Super Factory, Super Smart

Standing in the four workshops — stamping, welding, coating, and final assembly — you might feel like you've stepped into a futuristic world. Mechanical arms move overhead and transfer robots zip back and forth. As you walk out of the workshops, you'll see unstaffed, fully electric heavy-duty trucks, known as the Q-Truck, moving smoothly in an organized flow. Not only is it impressive, but it's also incredibly smart.

Thanks to AI, big data, and IoT technologies, the Super Factory can verify designs and simulate production processes before starting actual manufacturing, helping identify and address potential issues to optimize production. In addition, the factory

implements early warning, detecting, and traceability for key production steps. Quality data is automatically collected throughout the entire process, from steel plate to finished vehicle. Plus, the device status is detected in real time, and quality data is recorded and uploaded to prevent issues during production. This significantly boosts production efficiency and improves detection accuracy.

For example, it takes at least five minutes to manually inspect 162 screws on the chassis. AI inspection takes only five seconds, while improving the efficiency by 60 times and achieving 100% accuracy.

Behind SERES Super Factory's intelligent applications is its "super brain", the SERES data center. With the data center as an intelligent foundation, SERES Super Factory ensures smooth, fast, and efficient

production and operation at every step, making it a standout leader in China's automobile manufacturing industry.

### Data Center Deployment in Just Seven Days

The data center adopts Huawei's smart modular data center solution, FusionModule2000. The solution integrates the power supply, cooling, cabinet aisle, and cabling subsystems into a single module, realizing one data center per module. The solution also eliminates the need for raised floors, making it highly adaptable to different environments. As a result, it was deployed in just seven days, setting a new speed record for modular data center construction.

The FusionModule2000 uses contained aisles to isolate cold air from hot air and deploys in-row air conditioners to provide local cooling, effectively improving the heat exchange efficiency. In addition, refrigerant pumps maximize the use of free cooling sources, achieving an extremely low PUE and making the data center greener and more efficient.

Furthermore, the SERES data center implements simplified O&M. Traditional data center O&M depends on manual inspection, which makes it difficult and slow to locate faults. Huawei FusionModule2000 uses a 43-inch smart screen for E2E visualized power and cooling management, simplifying O&M. It also supports iManager-M that runs 24/7 remote O&M via a mobile app.

O&M personnel can view device status anytime and anywhere, improving O&M efficiency and ensuring stable "super brain" operations.

### Stable Power Supply, Safeguarding the Super Factory's Reliability

The "super brain" needs a stable power supply to ensure operations. The SERES data center uses Huawei's flagship smart power supply product, UPS5000-H.

Compared with similar products in the market, Huawei UPS5000-H is compact but powerful. It uses 100 kVA/3 U ultra-high-density power modules to achieve one MW per cabinet, reducing the installation footprint and time. With an efficiency of up to 97%, the power supply remains highly efficient even at low loads in hibernation mode. It can power nearly 100 servers at once, ensuring the "super brain" stays in optimal conditions and providing comprehensive support for the Super Factory's efficient operations.

Huawei UPS5000-H uses iPower to

improve system reliability and simplify O&M. In S-ECO mode, the system delivers an efficiency of 99.1%. It also supports 0 ms switching between all modes, achieving high efficiency and ensuring a stable power supply. Several sectors – such as government, transportation, finance, and precision manufacturing – have chosen this high-density and efficient next-generation modular UPS.

### From Traditional to Smart Manufacturing, SERES's Promising Future

Powered by the "super brain," the SERES super factory has already undergone a digital transformation in manufacturing, with its data center serving as the backbone. The trust of hundreds of thousands of NEV owners and millions of passengers reflects the outstanding performance of SERES and its AITO series, all supported by the Super Factory. Moving forward, Huawei will continue to enhance smart manufacturing at the Super Factory by unlocking even more potential from the "super brain," powering the digital era forward! ▲





# Building Green Networks in Malaysia's Remote Sarawak State

100% PV-powered sites along the banks of the Rajang River connect the rural network of Malaysia to the rest of the country. Huawei collaborates closely with Malaysia REDtone to deliver green connections for sites for a more interconnected world.



Countries and regions around the world are setting off a wave of digitalization and decarbonization. In Malaysia, digitalization means access to reliable basic networks, low-carbon operations of networks, and no digital gaps across the country.

Rajang River (Sungai Rajang in Malay) is the longest river in the tropical state of Sarawak. While the nature here is stunning, the area's remoteness means that the communication services in many villages along the banks of the Rajang River are unreliable. Without a stable electricity supply, generator sets are needed to power many of the local telecom sites. The generators are expensive and difficult to maintain, reducing access to networks and exacerbating the digital divide in Malaysia.

### Is It Possible to Bridge Malaysia's Digital Divide?

As early as 1996, Malaysia started a nationwide ICT project aiming to provide more areas with equal development opportunities. In 2020, the country launched the Jalanan Digital Negara (JENDELA) plan to promote the development of digital communications and enhance network coverage, bridging the digital divide in remote areas.

REDtone, a leading local broadband provider, is one of the participants in the JENDELA initiative. Initially, REDtone used generator sets to supply power to sites in remote areas like Sarawak. Although this was effective at first, as the number of sites requiring a stable connection increased, the solution became more of a burden.

Malaysia's tropical climate brings heavy rains throughout the year, leaving many roads in remote areas muddy and unpassable. Meanwhile, generator sets require regular maintenance with onsite visits at least twice a month. And if they fail, it takes a long time to restart them, further reducing power supply reliability. Additionally, while the noise from the generators is not a significant challenge, environmental pollution has become an important issue. Due to the increasing scope, lack of access, slow service restoration, and pollution, it was too expensive and labor-intensive for REDtone to ensure a good user experience while using generators.

As such, REDtone had a two-pronged goal — to reduce energy and O&M costs while providing more stable and greener network connection services for end users in remote areas.

### The Solution Did More Than Save Money and Improve Services

REDtone's challenges are not unique; many carriers are facing similar issues. As carbon neutrality takes center stage and energy prices rise, reducing carbon emissions and energy costs has become essential for carriers. Huawei Digital Power has launched a series of innovative solutions to build simplified, green, and cost-effective intelligent sites for various industry customers.

REDtone chose the Huawei iSolar PV+energy storage solution to reconstruct existing sites, enabling sustainable solar energy to support efficient and stable power system operations. The solution has benefitted REDtone in several ways.

The Huawei iSolar PV+energy storage solution uses the PV+energy storage algorithm to dynamically charge and discharge batteries based on how much energy is produced versus consumed. The surplus energy is stored in intelligent lithium batteries, preventing PV power waste and ensuring that green power serves as the main power supply for sites. Sites with sufficient irradiance can rely entirely on solar energy with zero carbon emissions.

At the same time, solar energy minimizes the need for refueling. As a result, REDtone is saving over 90% in energy OPEX, which is way above the company's expectations.

The new solution also prolongs the uptime of the site power supply system to 99.5%. This is a significant improvement in reliability compared to generator sets, preventing service interruptions even if there is a fault.

Finally, remote O&M replaces the two site visits per month. O&M personnel can use the NetEco to detect the status of site power supplies, PV modules, and batteries in real time, changing passive response to proactive O&M and redefining the operational experience.

### Bridging the Digital Divide with Green Energy

As we work toward carbon neutrality, PV power is becoming increasingly popular. In Renewables 2024, the International Energy Agency (IEA) predicts that PV power will be at the core of global renewable energy development over the next decade.

More industries are realizing that PV power can help enterprises cut energy costs and improve their competitiveness. As technologies advance, PV systems are becoming cheaper and more efficient. In the future, enterprises may not only consume but also generate energy.

For example, in the telecom industry, site facilities consume a lot of energy

for routine network operations. Carriers used to regard this as a cost burden. Now, sites have become important energy sources. More sites mean more energy sources and more value creation in the carbon neutrality era.

Huawei Digital Power strives to break through technical barriers and innovatively integrate communications, energy, and cooling devices. In addition to simplifying site evolution, Huawei Digital Power has introduced the PV+energy storage model, minimizing site energy consumption and carbon emissions and extending digitalization to more remote areas.

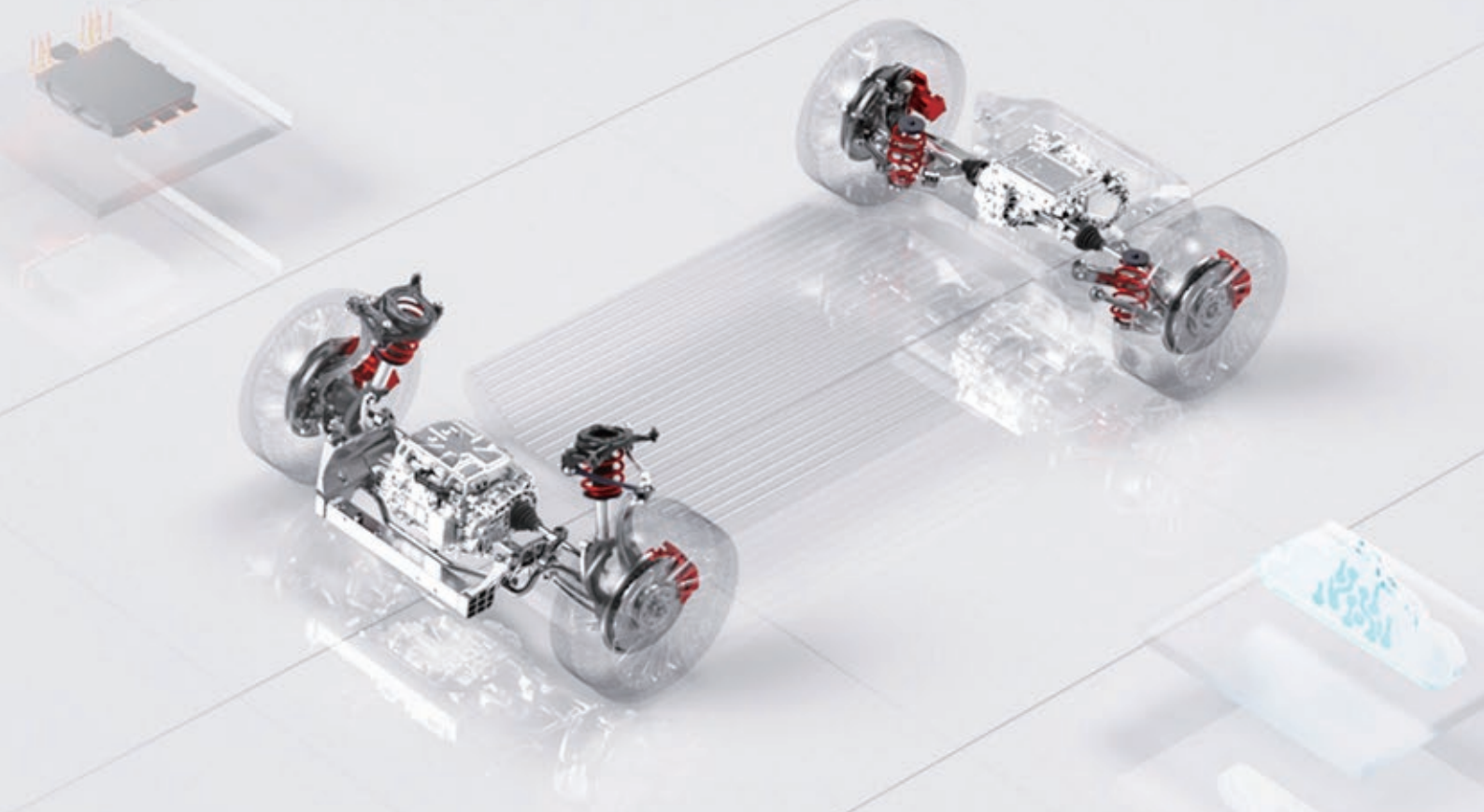
Various regions, especially in Southeast Asia and Africa, are implementing the Huawei iSolar PV+energy storage solution to integrate digital and power electronics technologies. Huawei's innovative solution and business model bring digital to every person, home, and organization for a fully connected, intelligent world.

Today, 100% PV-powered sites along the banks of the Rajang River connect the rural network of Malaysia to the rest of the country, supporting the JENDELA initiative. Huawei collaborates closely with Malaysia REDtone to deliver green connections for sites for a more interconnected world ▲



# Driving Excellence with Unmatched Power

Huawei **DriveONE**  
Pioneering NEV eMobility Solutions



Leading the digitalization of the intelligent electric mobility and  
accelerating the electrification of the automotive industry





# Krannich Solar: A Perfect Match of Global Market Coverage and Huawei's Technical Innovation

Krannich Solar and Huawei Digital Power continue to expand their relationship and explore new market segments, such as C&I energy storage. Krannich will grow in its role as a global wholesaler in several regions while Huawei Digital Power increases its presence in these markets.

**T**hirty branches on six continents across the globe, 135,000 square meters of warehouses supplying goods for more than 100 countries, a line of trucks stretching roughly the distance from Copenhagen to Amsterdam each year, and a deployed area of solar modules equivalent to 12,100 football pitches...

All these are Krannich Solar's achievements, a professional PV product wholesaler with three decades of experience.

Currently, Krannich's portfolio includes over 5,500 products, including solar modules, optimizers, inverters, mounting systems, storage solutions, E-Mobility, and accessories. In addition, Krannich has established partnerships with world-leading renewable energy manufacturers, including in-depth cooperation with Huawei Digital Power in Europe, Japan, and South Africa.

## From a Two-Man Operation to Global Market Coverage

Two Krannich brothers founded the

company in Germany in 1995, selling solar systems to its first customers. Today, the elder brother, Kurt Krannich, is still the company's CEO.

30 years ago, the PV market was in its infancy, and the market scale was much smaller. However, Kurt Krannich believed in using solar power to generate electricity. As a practical thinker and theoretical researcher, he was passionate and dedicated to the PV market, which has allowed the Krannich group to become a market leader today.

In 2004, Krannich opened its first branch outside Germany, entering the Spanish market. Since then, the company has expanded to employ 1,200 employees, serving a range of global PV customers covering private households, commercial enterprises, and even solar parks. By 2023, the renewable energy product wholesaler sold 4,100 MW PV modules, 7,000 MW inverters, and 1,600 WMh batteries.

Jan Brunner, CSO of Krannich Solar, explained that Kurt Krannich began purchasing goods for first installers back in 1995. That was the beginning of the company's wholesale model, making it an important part of the PV supply chain. Rather than working with end users, Krannich has always cooperated with professional PV installers who deliver products to end customers.

### Deep Cooperation with Huawei Digital Power

Krannich started the partnership with Huawei Digital Power in 2018, which focused on the commercial and industrial (C&I) market in Greece. Soon, this cooperation extended to the rest of Europe and globally. In 2023, the partnership expanded further to cover all Huawei Digital Power product portfolios.

Currently, Huawei Digital Power is one of Krannich's most important cooperation partners. At the same time, Krannich is one of the largest European wholesale partners of Huawei Digital Power.

Jan Brunner stated that Huawei Digital Power's advantages lie in its broad product portfolio, well-known brand, and customer-oriented solutions. "These three points are a perfect match for the Krannich strategy. It was, therefore, only a matter of time before Huawei was offered in the Krannich's portfolio.", he said.

The fact that Huawei's business covers the global market is another important factor that contributes to the cooperation between Krannich and Huawei. Krannich has a global structure and centers on long-term development. As such, Krannich is always looking for partners that can offer a presence in more than one market, fitting its global outlook.

Jan Brunner said: " When a huge Chinese group meets a European medium-sized company, it's not always easy to find the right way of working together. So, there was a phase where we had to get used to each other. But we succeeded in developing mutual understanding and a common vision. And we have learnt that we are a powerful team - even in difficult times."

### Shared Technical Training and Market Expansion

When developing new markets, Krannich Solar and Huawei have started visiting the first batch of customers together. Additionally, various online and offline activities have become important platforms for Krannich to help Huawei demonstrate and promote new products.

Every year, Krannich Solar participates in more than 20 trade shows worldwide. For example, Intersolar, held in Munich, Germany, is the world's most influential exhibition for the solar industry. Krannich has been present at the exhibition since 2005.

At Intersolar 2024, C&I energy storage was one of the major industry trends. Increasingly, manufacturers are entering the market or expanding their portfolios. As such, the gap between large-scale and residential energy storage products is bridging. In line with this trend, Krannich introduced Huawei's LUNA2000-H1 energy storage system,

*"Huawei Digital Power's advantages lie in its broad product portfolio, well-known brand, and customer-oriented solutions. These three points are a perfect match for the Krannich strategy. It was, therefore, only a matter of time before Huawei was offered in the Krannich portfolio."*



**Jan Brunner**  
Chief Sales Officer (CSO) of Krannich Solar

which attracted wide attention.

While Krannich Solar actively promotes Huawei products, Huawei is committed to providing better enablement support and training for Krannich.

Jan Brunner said, "We are very pleased that Huawei supports us with technical trainers and product experts. The joint marketing and training strategy helps us develop loyal customers and thus increase our footprint in the end customer market. In our view, hardly any other manufacturer invests so much in sales and technical support."

### **More Discovery Possibilities for Future Development**

Online sales represent one of Krannich's competitive edges. Currently, Krannich Solar sells its products mostly through its webshop. Its online services cover 18 branches and 2,500 products. This is backed by strong supply chain capabilities with regularly updated prices and availability, precise delivery dates, and always up-to-date product information.

Another Krannich advantage is its excellent service. Krannich Solar deeply understands and knows the PV market. Its expert team can provide customers with professional consulting services for PV systems of various scales and service support covering the entire project lifecycle.

Facing the quickly growing and changing PV market, Krannich Solar is exploring wider and deeper cooperation with Huawei to fully utilize Krannich's global customer coverage and Huawei's strong innovation capabilities.

Jan Brunner said that Krannich Solar and Huawei Digital Power are expanding their relationship and exploring new market segments, such as C&I energy storage.

"Krannich will grow in its role as a global wholesaler in several regions while Huawei increases its presence in these markets. The cooperation with Huawei Digital Power is still young, but we expect successful long-term growth for both companies." Jan Brunner added. ▲





# HDT Energy: Collaborating with Huawei to Illuminate Latin America's Future

HDT Energy is partnering with Huawei Digital Power to explore PV markets in Brazil and Latin America. HDT has in-depth knowledge of the local business models, cultures, and resources. Huawei Digital Power's leadership and innovation in the distributed PV field, especially its high product reliability, provide the boost HDT needs to explore the local market.

**H**DT Energy, a solar solution provider in Brazil, has close ties with China throughout its corporate history. It leverages Huawei Digital Power's low-carbon products and solutions to help Brazil and Latin America advance the renewable energy industry.

HDT Energy is more than just the exclusive representative of Huawei Digital Power in Brazil; it is also a significant player in Huawei's Latin American network. With its status as a certified value-added partner (VAP), distributor, and a three-star Huawei service partner, HDT Energy

is committed to providing local partners and customers with best-in-class photovoltaic (PV) solutions that combine performance, safety, and efficiency, covering a wide range of scenarios including utility-scale, commercial and industrial (C&I), and residential plants.

### Iron-Triangle Joint Operations

HDT Energy was established by Leonardo Cyrino (as CEO), Roni Griner (as CFO), and Bruno Monteiro (as CSO). Roni Griner, the founder of HDT Group, which is the parent company of HDT Energy, established HDT in 2005 as an international trading company to source retail products from China to South America.

In 2015, Leonardo Cyrino co-founded GD Solar, the first and largest distributed power generation company in Brazil. GD Solar made investments in building Brazil's first distributed PV plant in remote self-consumption mode, with the rated peak power exceeding 200 MWp. After selling GD Solar in 2018, Leonard started exploring new business opportunities. Thanks to his extensive knowledge and strong network connections with investors, developers, and manufacturers in the solar PV ecosystem, Leonardo developed a business model perfect for the PV market in Brazil and founded HDT Energy with Roni. Bruno

Monteiro previously served as the Digital Power Business Director for ABB, Brazil.

The skills of the three CXOs complement each other and play a crucial role in the success of HDT Energy. Leonardo understands the PV market, customer requirements, and business models. Bruno has extensive experience dealing with PV manufacturers like Huawei, and Roni has significant business relationships with Chinese manufacturers catering to the South American market.

HDT Energy was officially established in 2019 with the vision of "Energy of the future, today" and started collaborating with Huawei Digital Power to explore the PV market in Brazil and Latin America.

### Providing Comprehensive Services Beyond Products

With a mature business environment and favorable sunlight conditions, Brazil is particularly suitable for solar energy development and has been actively promoting renewables. It is now one of the world's largest solar power producers.

In 1997, Brazil's National Energy Policy Act outlined an overall framework for promoting renewables and encouraged the development of clean energy, including solar energy.

The introduction of the net metering system enables distributed PV power generators to transmit surplus power to a power grid to obtain a better ROI.

Brazil provides various financing options and tax benefits to encourage PV sector growth. These include reductions or exemptions on taxes, such as ICMS, PIS, and COFINS, for the sale of PV goods and services. Additionally, investors in distributed PV power systems and utility-scale PV plants can secure low-interest loans over periods exceeding 10 years.

To help customers benefit from these policies, while selling PV inverter products, HDT also provides additional services, including business evaluation, technical support, logistics services, tax management, investment, and financing.

According to Leonardo, HDT has a better understanding of the local situation in Brazil, including the business models and local cultures, and has strong relationships with local investors, distributors, and service providers. Therefore, HDT can help Huawei Digital Power achieve its business objectives in the local market while collaborating with local ecosystem partners in Brazil, including EPC companies, supply

*Within just five years of its establishment, HDT has emerged as a prominent player in the Digital Power sector in Brazil. We have earned a reputation among our network of investors, partners, collaborators, and influencers as a thriving hub of boundless opportunities. The strategic alliance between HDT and Huawei holds immense potential for exponential growth and creating new paradigms.*



**Leonardo Cyrino**  
HDT CEO

chain companies, and investment and financing institutions.

Huawei Digital Power's leadership and innovation in the distributed PV field, especially its high product reliability, provide the boost HDT needs to explore the local market.

Leonardo shared feedback from the largest inverter distributor in Brazil. The distributor collaborated with multiple vendors, but the quality of the inverters always led to issues that cost a lot of time and money. After collaborating with HDT and using Huawei products, the distributor had no after-sales issues for over a year. This achievement exceeded Leonardo's expectations.

### **Expanding from Utility-Scale to C&I and Residential Businesses**

At its inception, HDT was committed to developing large-scale distributed PV power generation projects. Thanks to the partnerships with GD Solar, the collaboration projects between HDT and GD Solar have become local

benchmarks for solutions and quality.

In the first three years of collaboration with Huawei (2019 to 2022), HDT built up a lead in the utility-scale plant market.

In 2023, Huawei decided to collaborate with HDT to explore the retail market in Brazil through run-rate channels, covering single-phase and small three-phase inverters in residential and C&I scenarios. The market at that time was flooded with low-cost and low-quality equipment, but showed significant development potential.

To support the development of new market segments, HDT actively collaborated with Huawei to develop local run-rate partners. Huawei's strong brand influence in the global market significantly contributes to the collaboration. For example, Bel Energy, a leading player in Brazil's PV equipment distribution market, has formed a strong partnership with Huawei, known for its innovative PV solutions. Connectoway, which



was previously Huawei's solution partner in the telecom industry, now collaborates with Huawei in the solar PV business. Previously, Bel Micro's primary business involved selling computer hardware and software. Collaboration with Huawei enabled Bel Micro to enter the energy field and provide solar PV products for customers.

After two years of collaboration with these distributors and service providers, Huawei's retail revenue in Brazil has increased fourfold, accompanied by a corresponding increase in market share.

HDT, which is a certified four-star service partner of Huawei Digital Power, provides scenario-specific and user experience-oriented products and services to its partners and customers. Additionally, it provides online and onsite training and certification for more than 400 employees per month. The Smart I-V Curve Diagnosis software helps customers remotely manage each inverter and improve energy yield efficiency through online analysis.

Currently, the collaboration between HDT and Huawei Digital Power has expanded from Brazil to Chile. In the Chilean market, the two parties will focus on developing PV plants with small distributed power generation units.

### **Creating Opportunities in the PV Market**

While helping Huawei Digital Power increase its market share, HDT has achieved rapid growth. After just five years of its establishment, HDT has emerged as a prominent company in Brazil's digital power sector.

Leonardo said that the exclusive distribution collaboration mode between HDT and Huawei Digital Power has become a model in the local market. Both parties are committed to creating opportunities in the PV market, exploiting market potential, and expanding growth within the ecosystem through partnerships.

He said that Huawei's expertise and channel support provide significant and unique long-term benefits to the entire industry, helping cope with fierce market competition and embrace fast-growing market opportunities.

Today, in Latin America, Huawei Digital Power provides cutting-edge products and actively creates a conducive environment for industry partners and organizations to develop new industry standards. This collaborative approach promotes a healthy and sustainable energy ecosystem across the region. ▲



# KVC Unites with Huawei to Forge a Green Future in Malaysia

The partnership between KVC and Huawei Digital Power began in 2016. KVC chose Huawei as its partner for Huawei's dedication to innovation, strong brand image, and advanced product technology. The top-tier products and innovative solutions offered by Huawei align with KVC's objectives.

In line with Malaysia's national policy to promote renewable energy, the country aims to achieve net-zero carbon emissions by 2050, with renewable energy needing to account for 70% of its energy mix.

The introduction of the net energy metering (NEM) scheme has catalyzed the adoption of solar photovoltaic (PV) systems nationwide. Against this backdrop, the synergy between KVC and Huawei has emerged.

Through strategic partnerships with global leaders, KVC has diversified from electrical supplies to digital energy solutions, expanding its B2B distribution, solutions, and services. This transformation has solidified KVC's position as a trailblazer in the energy transition.

### **A Strong Partnership Built on a Shared Vision**

KVC, founded in 1989 in Kuala Lumpur, Malaysia, began as a distributor of electrical products. In 2012, the company became part of Sonepar, expanding its global reach while harnessing its own local expertise and network. Today, KVC operates across Malaysia, with 16 branches and 8 distribution centers, serving over 7,000 customers across eight major industries: residential and commercial sectors, general manufacturing, ports and railways, power generation and renewable energy, data centers, water treatment, telecommunications, and oil and gas. Its portfolio boasts partnerships with industry-leading companies.

In 2023, KVC achieved revenue of MYR986 million (approximately CNY1.6 billion), with renewable energy accounting for MYR115 million of that total.

According to Eddie Wong Kok Leong,

Country Managing Director of KVC Industrial Supplies, the partnership with Huawei Digital Power began in 2016, concurrent with the introduction of Malaysia's Net Energy Metering (NEM) scheme. This scheme encouraged residential, commercial & industrial, and government sectors to adopt solar power and allowed users to sell surplus electricity to the grid at market rates. The scheme led to a surge in demand for PV products in Malaysia, making the collaboration with Huawei a natural fit.

Eddie explains that KVC chose Huawei as its partner for Huawei's dedication to innovation, strong brand image, and advanced product technology. The top-tier products and innovative solutions offered by Huawei align with KVC's objectives, and their collaboration aims to provide customers with efficient, reliable, and safe green energy solutions.

### **Deepening Collaboration to Enhance Customer Service Capabilities**

Despite their differing cultural backgrounds, KVC and Huawei quickly formed a strong partnership based on their shared vision for clean energy.

Over the past eight years, the two companies have signed multiple memorandums of understanding, further solidifying their collaboration.

Today, as a value-added partner (VAP) of Huawei Digital Power, KVC has expanded its partnership with Huawei to encompass a broader range of products, including energy storage systems (ESSs) and chargers. The partnership promotes these solutions through various channels, such as exhibitions, conferences, and seminars, reaching a wider audience in the industry.

Eddie highlighted Huawei's innovative intelligent energy management and intelligent detection technologies as key drivers of success in the local market. For instance, a large manufacturing facility adopted Huawei's intelligent management technology to implement a fully digitalized Smart PV solution, enabling it to optimize energy load balancing and minimize downtime caused by power grid interruptions.

To date, KVC has successfully deployed Huawei's Smart PV solutions for a wide range of industries. These solutions have not only reduced reliance on fossil fuel-based electricity but also significantly lowered energy costs and improved operations efficiency in sustainability efforts.

Through its collaboration with Huawei, KVC has gained extensive expertise in the PV sector, which has brought about revenue growth and a strengthened



position as a leader in renewable energy in Malaysia. Meanwhile, KVC has enhanced its capabilities to meet the diverse needs of its customers.

Recently, Eddie participated in Huawei's Global Partner CEO Forum, held at Huawei's Dongguan campus. At the event, Huawei provided valuable insights into its company management, business planning, human resources, and more, while showcasing its leading practices in technological innovation, talent development, product R&D, and manufacturing.

Eddie noted that this clearly demonstrated Huawei's long-term commitment to its partners and further solidified KVC's confidence in continuing to deepen its collaboration with Huawei.

### **Solutions Empowering Industry Customers in Their Energy Transition**

As a leading distributor, KVC offers a vast portfolio spanning nearly every area of electrical equipment, including switches, low-voltage electrical appliances, air conditioners, power supplies, cables, lamps, tools, and connectors, with over 25,000 stock-keeping units (SKUs). However, KVC's role extends beyond mere product sales. KVC provides tailored solutions designed to meet the unique needs

of its customers, with a goal to "help customers build, operate, optimize, and enhance their assets."

In 2019, KVC introduced its branded solution, XstructureD, which caters to various sectors, including infrastructure, renewable energy, lighting, safety, cables, and industrial automation. KVC's team of experts collaborates closely with customers to deliver customized solutions that elevate their overall experience.

A key component of XstructureD is Huawei's Smart PV solutions. Featuring an AI-enhanced tracking system, Huawei's PV inverters offer higher energy generation efficiency, improving the benefits from PV systems and shortening the payback period. KVC offers comprehensive onsite support services, including installation and commissioning of PV systems, as well as training to ensure seamless integration of Huawei's products, solutions, and services.

### **Striving Towards Higher Goals**

In August 2023, Malaysia unveiled the National Energy Transition Roadmap (NETR), aiming to optimize the country's energy mix. This initiative underscores Malaysia's commitment to energy efficiency, renewable energy, and the reduction of greenhouse gas emissions in the fight against climate change.

*Despite different cultural backgrounds, KVC and Huawei have quickly formed a strong partnership founded on a shared commitment to clean energy. Moving forward, KVC will maintain its customer-focused approach, further strengthening its partnership with Huawei to contribute to Malaysia's green future.*



**Eddie Wong Kok Leong**  
Country Managing Director of KVC Industrial Supplies

The implementation of NETR is expected to unlock significant opportunities for the growth of Malaysia's renewable energy sector, with projected investment opportunities worth up to MYR1 trillion by 2050.

During the inaugural Group-wide Sustainability Week of Sonepar in September 2024, KVC announced the launch of the branding identity, Net Carbon, which signifies the company's commitment to ramping up decarbonization efforts in industries such as manufacturing. Net Carbon aims to reduce the production carbon intensity to accelerate decarbonization across the manufacturing sector.

In late October 2024, KVC broke ground on its new central distribution center in Nilai, covering 6 acres of land. Scheduled to begin operations in 2026, the new facility will enable faster and more efficient distribution, significantly reducing delivery periods

and enhancing service levels for customers across the region.

By 2026, KVC intends to expand its product offerings to 48,000, doubling its current product offerings and strengthening its partnerships with leading international manufacturers.

Eddie emphasized that KVC plans to further expand its product offerings in line with sustainable development initiatives and extend the Net Carbon brand into smart industrial solutions. KVC aims to deepen its partnership with Huawei, introducing Huawei's energy storage solutions to play a critical role in Malaysia's sustainable energy future under the NETR roadmap.

As KVC continues on this journey, the company, alongside its strategic partner Huawei, remains committed to its customer-centric approaches and deepened cooperation for shared growth, contributing to the green future of Malaysia. ▲



# Digital China: Exploring New Business Models and Innovation Through Deep Partnership with Huawei

Huawei Digital Power manages R&D and production, while Digital China focuses on sales and service support. They integrate products and services to offer customers comprehensive digital power solutions. Apart from technological advantages, excellent product quality is at the core of Huawei Digital Power's value that wins customers' trust.

As an industry leader with an annual revenue of CNY120 billion, Digital China generates over CNY10 billion in business for Huawei each year, with nearly CNY2 billion of that directed to Huawei

Digital Power.

Achieving a scale of this magnitude is never a smooth journey but rather one that requires ten years of collective effort. Throughout this cooperation,



the two companies have continued to build new areas for collaboration and business models. As they have scaled up, they have also contributed to innovation and development in the green energy industry.

### Partnership through ups and downs

In 2010, Digital China started working with Huawei on the data communication product line. In 2013, the company became an important partner in Huawei Digital Power's UPS business. Then, in 2014, they began to cooperate in the PV business. Since then, their cooperation has been quickly growing, covering all of Huawei's lines of business.

According to Wang Weili, General Manager of the Digital Power BU, Digital China Cloud Business Group, Digital China has always been very optimistic about renewable energy. However, they lacked the appropriate opportunities to enter the market. Back when Huawei launched its inverters, Digital China was looking for cooperation pathways. That's why they soon signed a cooperation agreement on PV products.

Mr. Wang was also confident in Huawei's insights into the PV inverter market. "At first, Huawei was just a new player in the PV market with a

small market share. However, things changed after Huawei discovered the potential of distributed inverters. They then stopped selling central inverters and started promoting the emerging string inverters. This has proven to be a great success, as Huawei is now a market leader."

It did not take long for Digital China's Huawei Digital Power business to enter a growth phase. In 2018, Digital China collaborated in-depth with Huawei. However, with market and policy changes, as well as a decrease in PV projects, capital, and feed-in tariff, many companies, including Digital China, saw their business scale shrink.

"Huawei supported us even when we were facing difficulties like this. They helped us overcome one challenge after another and put our business back on track. Troubled times bear witness to our friendship," Mr. Wang said.

### Customer collaboration for technological innovation

After 2021, China's carbon peak and carbon neutrality goals have brought the PV industry back into the spotlight. The scope and scale of cooperation between Digital China and Huawei Digital Power have expanded again, reaching an annual revenue of nearly CNY2 billion.

In 2022 and 2023, Huawei Digital Power launched new energy storage system (ESS) products and the liquid-cooled ultra-fast charging solution. Digital China followed suit and has become an authorized partner (VAP or Diamond Sales Partner) for Huawei Digital Power's PV, energy storage, and charging businesses.

Mr. Wang believes that, apart from technological advantages, excellent product quality is at the core of Huawei Digital Power's value that wins customers' trust. PV projects are long-term, so products need to work properly for 10 or even 20 years.

In this partnership, Huawei Digital Power manages R&D and production, while Digital China focuses on sales and service support. They integrate products and services to offer customers comprehensive digital power solutions.

China General Nuclear Power Group (CGN) adopted Huawei's Smart String Grid-Forming ESS Solution provided by Digital China in its energy storage project (100 MW/200 MWh) in Gong'an, Hubei. The energy storage plant has set a benchmark in terms of improving regional power grid architectures and increasing the operational flexibility of power grids.

Project construction began on

*"The cooperation between Digital China and Huawei Digital Power goes far beyond revenue and brings even more value. It has changed our perception of traditional distribution channels and helped us build service capabilities for end customers."*

*Wang Weili  
General Manager of the Digital Power BU, Digital China Cloud  
Business Group*



September 25, 2022, and the procurement contract was signed in late October. However, the project needed to be fully grid-tied by the end of 2022. Given such a tight schedule, Huawei significantly supported Digital China, ensuring timely and high-quality delivery.

As CGN's first demonstration project in the energy storage field, the plant features higher discharge capacity, higher ROI, simpler O&M, and more reliable operations. It provided a testing platform for the Group to explore the business and operational models, as well as a technical roadmap for shared energy storage. The project has won multiple innovation awards.

### **Transition to the customer-facing business model**

For Digital China, the cooperation with Huawei Digital Power goes far beyond revenue and brings even more value.

Digital China has a strong understanding of digital

transformation and keen insight into customer needs. It began its business transition early and introduced the innovative "data cloud integration" strategy. The goal is to establish itself as a leading partner of digital transformation.

Along its transition, Digital China seizes opportunities in emerging technologies and focuses on getting closer to end users. As a rapidly emerging field, digital power is becoming a customer-facing business.

Mr. Wang said that Digital China's cooperation with Huawei was initially only for distribution. Digital China sold Huawei's products to downstream partners rather than end customers, while the digital power business was designed mainly for end customers, most of which were key accounts such as state-owned energy enterprises.

Once again, Huawei Digital Power played a key role in helping Digital China consolidate its capabilities

to directly serve customers. This included developing its capabilities in electrical engineering, systematic delivery, and project operations. These skills allow Digital China to deliver projects to key accounts and service providers.

"It has changed our perception of traditional distribution channels and helped us build service capabilities for end customers. To this day, the Digital Power BU of the Digital China Cloud Business Group is a pioneer in customer awareness among our departments," Mr. Wang said.

Now, as a four-star certified service provider of Huawei Digital Power, Digital China can provide customers with high-quality services such as project implementation and after-sales

support. In addition, the company can receive resources such as technical training, technical support, and marketing from Huawei to further improve its capabilities.

### A future of possibilities

As the renewable energy industry continues to develop rapidly, it also tends to become more branded. According to Mr. Wang, less than 5% of the hundreds of inverter manufacturers in China have been able to survive. The importance of working with market leaders with strong innovation capabilities is evident.

He believes the industry will continue to grow rapidly for at least another decade, especially in the emerging energy storage and charging businesses. This is driven by both

industry policies and trends.

In 2024, China's Report on the Work of the Government first mentioned "developing new energy storage." Now, new energy storage is an essential technology and infrastructure for new power systems. It can promote the green transformation of the energy mix, helping achieve carbon peak and carbon neutrality goals.

At the same time, the automotive industry is going electric and requires more charging capacity. Huawei's innovative liquid-cooled ultra-fast charging solution is celebrated by electric vehicle (EV) owners. As China expands its EV sales overseas, the demand for ultra-fast charging outside of China is expected to grow exponentially.

Going global has become one of Digital China's strategic priorities. The company has begun to deploy its Digital Power business overseas, which is expected to be an important growth engine in the future.

The rise of the renewable energy market is also fostering new business forms in the energy industry. Digital China is actively exploring new business models for operations and services and hopes to further cooperate with Huawei Digital Power to build a better future. ▲







Building a Fully Connected, Intelligent World

# Huawei FusionModule

## Builds a Medium/Small Computing Center Facility



Power the Digital Era Forward



## CNBM Technology: Building Capabilities and Exploring New Business with Huawei

CNBM Technology is a committed "intelligent digital service and ecosystem service provider." The company is exploring the C&I market and the integration of digital intelligence services, the two fast-growing business domains, and developing new strategies in integration services. CNBM Technology will continue to create its unique value and work with Huawei and other ecosystem partners to integrate multiple products, services, and brands. This will provide industry customers with full-stack solutions for a wide range of scenarios.

Smart PV frequently appears in reports about CNBM Technology, often mentioned in contexts such as "PV plant control systems based on industrial Internet architectures," "smart PV solutions," and "energy management systems in

low-carbon smart campuses."

This highlights the growing importance of the Digital Power business for CNBM Technology, particularly its solution-based services, which have become a core offering. This capability



is built on the company's extensive experience, resources, and strong partnerships.

Currently, CNBM Technology is expanding into the rapidly growing C&I market and integration services. At the same time, it is strengthening its digital energy capabilities through independent R&D and support from its partners, like Huawei.

### **Journeying together for over a decade**

Founded in 2005, CNBM Technology is a subsidiary of the China National Building Materials Group Corporation (CNBM) and registered a revenue of over CNY19.2 billion in 2023. CNBM Technology provides two primary service offerings: ecosystem services and intelligent digital services. The company has established strategic cooperation relationships with many leading ICT vendors in and outside China. At the same time, it is creating its own digital solutions and developing a unique pipeline to help customers during the integration of digital intelligence services.

CNBM Technology first started exploring a partnership with Huawei Digital Power back in 2012. Now, it is one of Huawei's major ecosystem partners and has held the top market share in China's government and enterprise business among distributors

for 15 consecutive years.

Xi Hai, General Manager of the Renewable Energy Department of CNBM Technology, has witnessed the evolution of this cooperation from first contact to fruitful achievements. He recalls that the partnership first started with a visit by Hou Jinlong, Director of the Board of Huawei and President of Huawei Digital Power, to CNBM Technology to discuss cooperation opportunities in an overseas project. Huawei's Smart PV product portfolio impressed Xi Hai due to their potential in the PV market. This was CNBM Technology's first step into the solar power industry.

In the middle of 2013, Huawei Digital Power officially started to recruit partners. CNBM Technology quickly responded and received cooperation authorization in August 2013.

According to Xi Hai, few vendors were interested because of the limited PV market scale. However, CNBM Technology had a positive outlook on the digital energy industry and decided to become one of Huawei Digital Power's first partners.

Xi Hai proudly displays the "Fellow Traveler" trophy Huawei granted him on his desk, which is showcasing the success of this cooperation.

### **Leading technologies win customer trust**

Talking about their cooperation over the last decade, Xi Hai described it as a relationship built on mutual understanding and support to overcome challenges.

Although both companies saw a promising future for renewable energy, they inevitably encountered setbacks due to factors such as market changes. However, neither backed down, even in difficult times, and their perseverance paid off. In 2023, CNBM Technology's revenue from doing business with Huawei Digital Power exceeded CNY2 billion, a ten-fold increase in ten years.

Huawei Digital Power offers superior products and technologies, which has made it quickly become a market leader. In particular, it offers some of the market's best PV inverters, which has further consolidated its position in the market and allowed it to leverage its ICT expertise with power electronics technologies to support PV intelligence.

Xi Hai vividly recalls one specific meeting held by the State Power Investment Corporation Limited (SPIC) in Golmud, Qinghai. The meeting discussed the test results proving that Huawei's inverters had a much higher energy yield and a lower fault rate than other mainstream inverter brands



"CNBM Technology is one of the first partners to join Huawei Digital Power. By the end of 2023, CNBM Technology had delivered Huawei's Smart PV Solution to nearly 70 GW PV plants. Looking back on our cooperation over the past decade, we have built a sound and profound relationship. Looking ahead, we will explore new cooperation opportunities and leverage our unique advantages to create value for partners and customers and promote the development of renewable energy."



**Xi Hai**  
**General Manager of Renewable Energy Department, CNBM Technology Corporation**

under the same test environment. Up until now, Huawei's inverters have been running stably for more than ten years. Such an amazing performance is all down to Huawei's principle: Huawei will do everything it can to outperform others in a specific market domain.

### **The C&I market is expected to boom**

Currently, CNBM Technology is cooperating with multiple Huawei Digital Power product lines, including FusionSolar, energy storage systems (ESSs), Smart Charging Network, and Data Center Facility. The company has also obtained a series of Huawei certifications, such as distributor, diamond partner, value-added partner, and 4-star service provider.

Unlike other information services provided by CNBM Technology, the digital energy service directly targets end customers. It focuses on China's renewable energy market, which is

primarily comprised of five large and six small power generation groups. The aim is to help energy enterprises build utility-scale plants by expanding cooperation opportunities.

While the digital power market is very targeted, the C&I market involves a wider range of customers. For example, in Western China, C&I mainly involves utility-scale plants that have been operating for years. Meanwhile, regions in Eastern China have a larger space for a distributed PV market in factories, schools, and industrial parks.

According to Xi Hai, CNBM Technology boasts 20 years of expertise in enterprise-level ICT value-added distribution, nearly 10,000 channel partners, about 100 branches and offices in China, and more than 1000 value-added distribution business teams working in various regions and industries. CNBM Technology plans to streamline internal resources to

expand the C&I distributed PV market. As Huawei's authorized VAP, CNBM Technology looks forward to working with channel partners and helping them grow, says Xi Hai.

Huawei strongly supports CNBM Technology. The two companies have worked together extensively to enable channel partners and help them achieve business success.

### **Building new integration service capabilities**

CNBM Technology has begun transforming its renewable energy business and has been looking for new development directions since early 2024.

According to Xi Hai, CNBM Technology felt the urgency to establish its presence in the integration service market amid technological changes and new development plans.

This move is strategic both for the renewable energy department and the company as a whole. By building an integration service team and forging its core capabilities of "professional IT services + multi-vendor joint solutions," CNBM Technology is committed to integrating multiple products, services, and brands, as well as providing scenario-specific solutions

and services for industry customers.

CNBM Technology has rolled out many solutions in the digital energy domain. These include its flagship energy management solution deployed in low-carbon smart campuses. This green solution integrates PV, ESS, power consumption, and charger management to form a comprehensive energy management and control platform. By doing so, campuses can improve energy utilization and quickly regain the investment they make in renewable energy while cutting carbon emissions.

The smart manufacturing expertise that CNBM Technology has accumulated over the years is vital to the transition toward integration services. Designed for the industrial Internet architecture, the self-developed Smart PV plant control system includes three key components: the equipment-side collection and control system, the plant-level management system, and the centralized control system.

Through solutions like these, CNBM Technology embraces new development opportunities in the renewable energy sector. At the same time, the company is pursuing overarching goals. It aims to create value for partners and customers, thus promoting renewable energy development, says Xi Hai. ▲



# Grid-Forming ESS Technology: Key to New Power Systems

The grid-forming energy storage system (ESS) has become one of the key technologies for new power systems because it can proactively support the stability of grid voltage, frequency, and power angle.

**A**s the world pursues greener practices, the share of clean energy in the global energy mix is rising rapidly, adding more renewable capacity.

Globally, more than 560 GW of green energy capacity has been added in 2023, according to the "World Energy Outlook 2024" by the International Energy Agency (IEA). Over the past decade, the share of fossil fuels in the global energy mix has gradually decreased. In fact, despite a 15%

increase in global energy demand, 40% of the supply comes from clean energy.

In China, by the end of 2023, clean energy accounted for 58.2% of the country's total installed capacity, according to the "China's Energy Transition" white paper released in August 2024. And more than half of China's energy consumption growth comes from clean energy sources.

However, such a high proportion





of renewable energy may put the stability of power systems at risk, creating a shared challenge for the global renewable energy industry. The grid-forming ESS has become one of the key technologies for new power systems because it can proactively support the stability of grid voltage, frequency, and power angle.

### **The grid-forming ESS is crucial for new power systems**

With more clean energy production and installed capacity, new power systems will require more power electronic equipment and rely more heavily on renewable energy sources. This shift presents challenges for grid integration, connectivity, and stable operations.

Conventional power grids use

synchronous generators to regulate power and voltage, ensuring stable operations. As the penetration rate of renewable energy grows, grid-connected devices that use the grid-following control technology are unable to actively support voltage and frequency when the power grid experiences faults.

In the new power system, grid-forming ESS technology can replicate the characteristics of synchronous generators, enabling it to actively implement grid forming, respond independently, and provide instant inertia and voltage support to maintain grid stability. This technology is crucial for integrating a high proportion of renewable energy, allowing renewables to transition from being a supplementary power source to a primary energy source.

In recent years, China has released policies that encourage renewable energy projects to deploy grid-forming ESSs, improving the overall stability and adaptability of power grids. In October 2024, China's National Development and Reform Commission, National Energy Administration, and National Data Administration issued the "Action Plan for Accelerating the Construction of New Power Systems (2024–2027)" to promote the application of the grid-forming technology.

The northwest of China has also issued policies to encourage or make it mandatory for renewable energy projects to deploy grid-forming ESSs. As a result, the industry bidding progress was accelerated significantly in the second half of 2023. And, by June 2024, the bidding for 2.28

GW/7.58 GWh grid-forming ESS projects in China has been completed.

**Technological innovation solves industry bottlenecks in grid-forming ESSs**

Grid-forming ESSs are trending but face several technical challenges. They lack sufficient capabilities in voltage and frequency support, wideband oscillation damping, and weak anti-interference; they also have low inertia.

Thanks to years of experience in digital and power electronics technologies, Huawei has developed many innovations and best practices in algorithms, devices, and components to address these challenges with

its Smart String Grid-Forming ESS Platform.

- Algorithms: Huawei's multi-site self-synchronized amplitude and frequency regulation technology can adjust the amplitude and frequency of multiple sites in a power system to ensure consistency among the voltage and frequency parameters of the sites. This proactively supports and ensures the stability and reliability of the power grid. At the same time, the wideband impedance reshaping algorithm enables grid-forming ESS devices to have positive damping characteristics within the wideband range, ensuring stable operation of the ESS devices. This innovative wideband stabilizing

control technology ensures that the grid-forming ESS can output damping power to proactively suppress grid oscillation and help stabilize the grid. This technology is not restricted by the grid scale or strength, thus applicable to power grids with multiple types of power supplies.

- Devices: Huawei has pioneered a two-stage power conversion architecture for the Smart String ESS, decoupling voltage from active power and ensuring grid stability and ESS safety. This approach improves the availability, capacity expansion, and upgrade capability of the ESS.
- Components: The components including high-reliability power modules ensure long-term, stable, and reliable device operation in complex and harsh environments. In addition, Huawei has also built a safe and reliable capability system for designing and manufacturing foundational core components.

**Large-scale roll-out accelerates the grid-forming ESS industry**

A new technology must undergo rigorous testing before it can be commercially used on a large scale. Huawei Digital Power has worked with customers and partners to perform comprehensive functional and performance testing on grid-forming ESSs at the device, single-site, and multi-site levels. This



includes 35 kV and 110 kV short-circuit tests that took place between 2022 and 2024 in Hami, Qinghai, and the Ngari Prefecture. Successfully completing these tests indicates that Huawei's Smart String Grid-Forming ESS is ready for large-scale implementation in real-life engineering applications.

- The CR Power 25 MW/100 MWh grid-forming ESS project in Hami passed the world's first performance tests at a 100 MWh smart string grid-forming ESS plant. The project also completed the world's first black start test for an on-grid smart string grid-forming ESS plant, shortening the start time to minutes.
- The CGDG 50 MW/100 MWh ESS project for the multi-energy renewable power plant in Golmud, Qinghai, completed the world's first performance tests at a 100 MWh multi-energy grid-forming ESS plant. The tests verified the complementary features of PV, wind, solar thermal, and conventional ESS.
- The Ngari Prefecture is situated at an altitude of 4500 m, and winter temperatures can drop below  $-20^{\circ}\text{C}$ . The region has an extremely weak power grid. The ZDI 6 MW/24 MWh ESS project in Ngari Prefecture passed the world's first performance tests at a grid-forming ESS plant located at a high altitude and facing low

temperatures and weak power grid conditions.

The success of these tests demonstrates that Huawei's Smart String Grid-Forming ESS significantly improves renewable energy grid integration and can be used in a range of scenarios, including strong and weak power grids and off-grid conditions. When on the grid, Huawei's solution achieves capabilities similar to those of synchronous generators (including synchronous condensers) in supporting the stability of voltage, frequency, and power angle. In off-grid scenarios, the solution has been commercialized and can operate reliably for a 100% PV+ESS microgrid at the GWh level.

In July 2024, Huawei's Smart String Grid-Forming ESS underwent a rigorous technology evaluation meeting that assessed the solution's key technologies and applications and their usability in various scenarios that utilize a high proportion of renewables. The committee comprised experts from research institutions and companies, including the Chinese Academy of Sciences, the Chinese Academy of Engineering, and the State Grid Corporation of China (SGCC).

The experts unanimously agreed that the preceding projects have achieved world-leading capabilities in terms of improving new power system stability

and renewable energy integration. The committee also agreed that these projects have developed and adopted the Smart String Grid-Forming ESS through research in multi-site self-synchronized amplitude and frequency regulation technology, wideband self-stabilizing and stabilizing control technology, smart string two-stage conversion architecture, and power modules.

Outside China, Huawei's Smart String Grid-Forming ESS has been deployed in the Middle East for building the world's first city powered by 100% clean energy. This solution helps maintain the power grid's stability and implement continuous off-grid fault ride-through. It also supports the GWh-level black start of the entire microgrid, enabling power recovery in minutes.

With the increasing adoption of renewable energy and the use of power electronic devices, problems such as randomness, high fluctuations, low inertia, intermittency, and weak support will become more and more prominent in power systems. As such, grid-forming ESSs will become essential for new power systems. Huawei's Smart String Grid-Forming ESS Platform will continue promoting the evolution from grid following and support to grid forming, enabling clean energy to become the main energy source. ▲





# Fast and Safe: Why Huawei FusionCharge Solution Is Popular Among Consumers

Huawei's FusionCharge Solution features intelligent algorithms, precise current control, insulation design, protection mechanisms, and safety control policies. As a result, it ensures the safety of people, EVs, and chargers, bringing an ultra-fast and safe charging experience to EV owners.

**T**he surging demand for electric vehicles (EVs) has increased the need for fast and safe charging. Meanwhile, the fast and ultra-fast charging infrastructure is becoming more popular. Major regions in China, such as Shenzhen, Guangzhou, Chongqing, Fuzhou, Beijing, and Hainan, have invested heavily in

building ultra-fast charging stations.

How can we choose high-quality and convenient chargers to make EV charging faster and better? Huawei Digital Power, a charging network solution provider, launched a liquid-cooled ultra-fast charging technology that features a cutting-edge safety

protection design, achieving fast and ultra-fast charging coupled with ultimate safety.

### **With the rise of fast and ultra-fast charging, a fast charging speed is critical to reducing the range anxiety.**

The entire EV industry is rapidly evolving toward fast and ultra-fast charging. In the past, automakers increased the traction battery capacity to extend the EV range. However, things are not as simple as they look like. This method would impose hundreds of kilograms of mass to EVs, posing significant challenges to the EV architecture, body, and chassis. The huge amount of extra money cost also bothers R&D personnel during the project initiation.

On the flip side, the industry has commercialized the use of third-generation semiconductor technology, namely silicon carbide (SiC), for traction batteries. Leading battery manufacturers have launched fast and ultra-fast charging batteries with a C-rate of 4C, 5C, or higher, able to charge an EV in ten minutes or less. As fast and ultra-fast charging EVs have been put into mature commercial use, EV manufacturers have accelerated to launch 800 V high-voltage EV models without the concern about the size of traction batteries of EVs. In this way, EV owners

are free from range anxiety and spend less money in purchasing EVs.

To meet the charging demands of EVs and accelerate the construction of a unified charging network, charging network solution providers, represented by Huawei, are dedicated to developing high-quality charging infrastructure. The maximum power of Huawei's power unit is 720 kW. Huawei's ultra-fast charging dispenser supports a maximum current of 500 A, a maximum voltage of 1000 V, and a maximum output power of 600 kW. Take the XPENG G9 and Li MEGA models that support high-voltage fast charging as examples. These EVs can run 200 km upon 5-minute charge, significantly satisfying EV owners. In addition, Huawei's fast charging dispenser supports a maximum power of 250 kW, which can easily meet the charging requirements of most EVs in the market. Huawei's FusionCharge Solution delivers an excellent experience, making it an exceptional choice for EV owners.

The solution also provides an optimal user experience during charging and adopts intelligent algorithms to push the latest features in the charging protocol to users. During a charging session, chargers are highly compatible on the premise that the safety requirements of the GB standards are met, therefore

achieving the first-attempt success rate up to 99%. Moreover, an EV-charger compatibility test database is established for different EV models, continuously fed to big data deep learning. This solution is applicable to diverse EV models in the market, even including trucks and high-voltage cars. In addition, the charging noise is lower than 55 dB, creating a tranquil environment for EV owners to take a rest while charging their EVs and for residents who live near the charging station.

### **Huawei's FusionCharge Solution ensures the safety of people, EVs, and chargers.**

With the rapid rise of EVs, safety accidents occasionally occurred, which threatened the safety of drivers and passengers as well as assets. To achieve fast and ultra-fast charging, one must increase the charging power by adding charging voltage and current. This leads to a sharp change in the battery temperature and voltage, potentially resulting in the thermal runaway of batteries. Besides technical challenges, regular charging facilities don't have the proper layout to ensure safety, devices often short-circuit, and aged or damaged insulation components in electrical circuits or short circuits in chargers may cause a fire.

To address these concerns, China has



gradually strengthened supervision and imposed higher standards on EV charging safety. According to the "Code of practice for new energy vehicles safety operation inspection" released in August 2024, the traction battery safety charging inspection (only for models equipped with DC fast charging) and electrical safety inspection will become mandatory during annual vehicle examinations in 2025.

Till now, Huawei Digital Power has worked with customers and partners to build more than 50,000 fast or ultra-fast chargers nationwide, covering more than 200 cities in 31 provinces across China. In addition to

superior experiences for customers, the key to the success also lies in the super long service life of more than 10 years and comprehensive safety protection provided by Huawei's FusionCharge Solution. The solution features intelligent algorithms, precise current control, insulation design, protection mechanisms, and safety control policies. As a result, it ensures the safety of people, EVs, and chargers, bringing an ultra-fast and safe charging experience to EV owners.

Thanks to the strict requirements on the quality standards, Huawei's FusionCharge Solution enhances the safety level of the chargers



## Fast and Safe: Why Huawei FusionCharge Solution Is Popular Among Consumers

at the initial stage of design and production. A single component adopts the enhanced insulation design and can withstand a voltage of 4000 V DC. The maximum safety distance of the core parts is 10 mm, doubling that of the traditional solution. In addition, the liquid cooling module, a core component of the solution, is die-casted using a 3000-ton hydraulic press, and is not directly in contact with the external environment. This prevents sandstorm and condensation erosion, and ensures efficient heat dissipation and long-term stable operation. To prevent incidents of extremely low probability, Huawei's FusionCharge Solution equips its innovative ceramic DC contactors with capabilities that far outperform traditional solutions in terms of large current tolerance, high-temperature resistance, mechanical service life, and insulation. The contactors can easily cut off high currents and extinguish high-voltage arcs if an exception occurs. Huawei's ceramic DC contactors have a service life of 500,000 cycles — five-fold that of the industry average. They also feature four or five times better high-temperature resistance compared with regular contactors in the industry. Additionally, they have stronger explosion-proof and arc-extinguishing capabilities, significantly reducing the risks of

electric leakage, electric shocks, and explosions.

The shell of the charging cable that may come in contact with the human body is made from high-strength, high-elasticity materials with a high comparative tracking index (CTI), which meets China's testing standards. The insulation coefficient is further improved through physical protection. Huawei's FusionCharge Solution can also quickly respond to exceptions and reduce safety risks. For example, if the residual current becomes greater than the threshold of 30 mA, the residual current device (RCD) will cut off the current within milliseconds to prevent electric leakage and shocks. A co-processor is deployed in addition to the main one. Using a plant-level transmission protocol, a dedicated fast channel responds quickly to safety issues during emergencies, protecting EV owners.

Throughout a charging session, Huawei's FusionCharge Solution leverages intelligent algorithms to accurately control the current and quickly and constantly track changes in the energy demand of EV batteries, ensuring the right charging current, a longer battery lifespan, and high safety. When the charging session starts, the battery is at a low battery state of charge (SOC) and is hungry for energy. The

liquid-cooled ultra-fast charging solution can quickly and accurately boost the battery while preventing overcharging. Midway through, the energy demand tends to be stable. The solution can control the ripple of the charging current to about 0.5%. Toward the end of the charging session, the battery is about to be fully charged, requiring real-time and accurate current control. The solution can adjust the charging current within milliseconds.

To reduce range anxiety and provide a better charging experience for EV owners, Huawei's FusionCharge Solution greatly improves charging efficiency and convenience, making the iterative EV charging more assuring. The comprehensive safety protection design sets Huawei's FusionCharge Solution apart from the competition in terms of both charging speed and safety. In the future, Huawei Digital Power will continue to support the construction of fast and ultra-fast charging facilities, building smart charging networks that satisfy user and power grid demands. Huawei Digital Power will continue to deliver efficient services across various charging scenarios, including intra-city, inter-city, fleet, and campus charging stations. Its mission is to help more EV owners travel safely with constant power and jointly charge the road ahead. ▲



# Huawei's iTRACK, Making Your Ride Smoother

Huawei's iTRACK can keep cars stable in different driving scenarios, such as snow, ice, rainy days, and bumpy roads, guarantee optimal tire grip performance, and ensure safe driving. What's the secret behind this remarkable capability?

**W**hat will cars look like in the future? They will be smarter and safer.

This is not just wishful thinking — cars are truly advancing rapidly. Take the AVATR 12, for example. It comes with an Advanced Driving System that offers a smooth driving experience, even on the highway. The system behaves like a skilled driver, automatically adapting the speed to match the traffic conditions. AVATR 12 also provides powerful voice control and a 360-degree panoramic display, allowing drivers to view the vehicle status and surrounding environment in real time

through a simple and intuitive UI. When the car is approaching an obstacle, the system automatically plays a prompt tone. The car's intelligent and user-friendly design makes driving easier, safer, and more comfortable.

AVATR 12 is a testament to the intelligent and user-friendly development of Chinese automobiles. According to J.D. Power's 2024 China Tech Experience Index (TXI) Study, the industry's TXI Innovation Index score increased from 528 in 2023 to 550, indicating that China's automotive industry has reached record highs in terms of intelligence. In the future, as



technology continues to advance and consumer demands rise, intelligence and user-friendliness will be essential for the vehicle and service experience. Smart cars will not just serve as methods of transportation; they will be like partners that provide people with intelligent, automated, and user-friendly experiences.

### Reshaping the Driving Experience

Many people have wonderful imaginations about smart driving. But beyond fancy features, safety and comfort are still central for most drivers.

In an episode of Huawei Digital Power's Carbon Talk — "iTRACK, Making Your Ride Smoother" — we

take a real drive test. When AVATR 12 passes a speed bump without Huawei's DriveONE iTRACK, people in the car feel noticeable jolts, and water spills from a glass placed inside the cockpit. However, when the car is equipped with Huawei's DriveONE iTRACK, although the water in the glass ripples, it does not spill, and the ride is a lot less bumpy.

iTRACK is an innovative technology by Huawei's DriveONE. It intelligently and proactively operates the ePowertrain through ultra-fine sensing and real-time self-management. Huawei's iTRACK redefines the ePowertrain, achieving cross-generational competitiveness and independent intelligence. AVATR 11 and AVATR 12 are equipped with Huawei's iTRACK, which makes the vehicle drive system more sensitive to road conditions. Whether encountering speed bumps, pits, or challenging weather like snow and freezing rain, the system can promptly adjust the driving status to ensure stable, comfortable, and safe driving.

### Highly Sensitive to Road Conditions, Ensuring Driving Safety

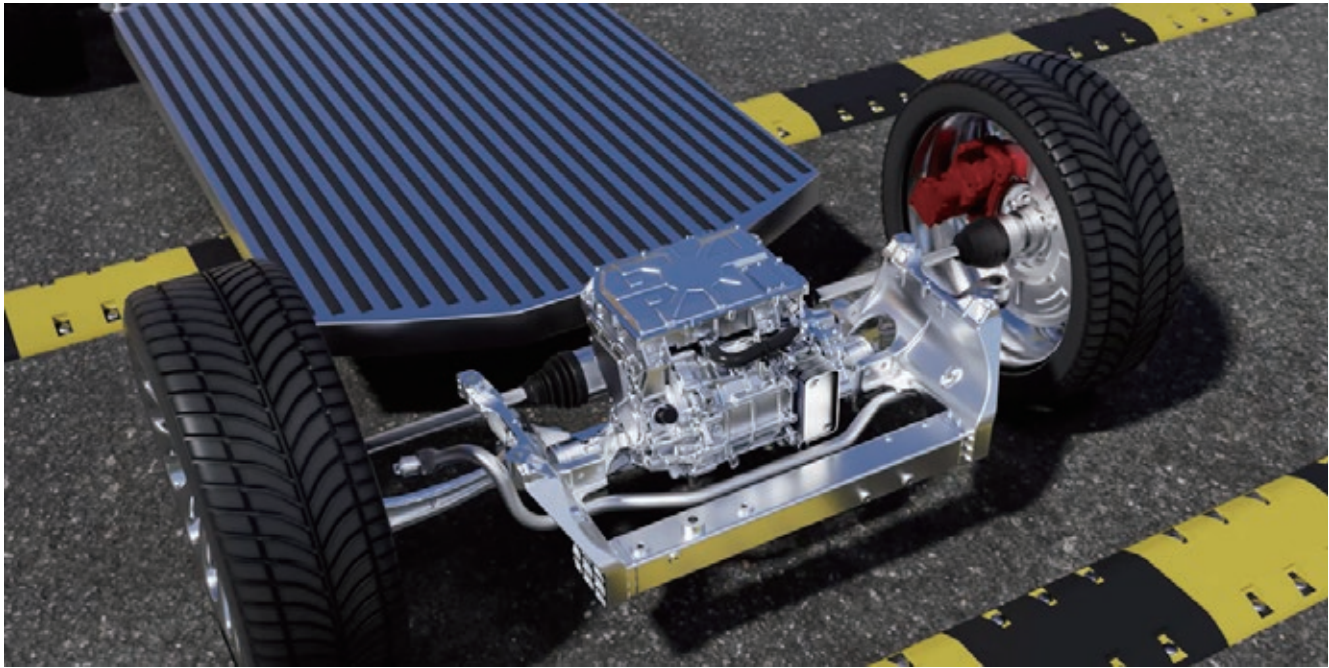
Over millions of years of evolution, humans have developed a highly advanced nervous system that helps us quickly adapt to diverse environments. The brain coordinates with the peripheral nervous system and commands the body's movements.

This allows for rapid neural reflexes within milliseconds, enabling the body to respond promptly and accurately to changes in the environment.

A car is a tool, but, in a way, it serves as an extension of the human body. A real smart car should have visual and tactile senses like a human being, being able to perceive changes in the external environment. In addition, it should have a brain and a nervous system to make timely judgments and act based on the perceived information.

Huawei's iTRACK acts like the car's nervous system. It can "see," "hear," or even "touch" subtle changes in the external environment, make correct judgments very quickly, and optimize its actions. Using innovative, intelligent sensing technology and an adaptive algorithm for intelligent torque adjustment, Huawei's iTRACK improves driving performance in multiple scenarios, quickly responding to environmental changes. For example, the all-scenario sensing technology can sense road conditions 10,000 times per second based on signals transmitted by high-precision sensors. It identifies what's going on and determines issues like road adhesion, transmitting the information to the controller. Thanks to these powerful capabilities, Huawei's iTRACK can keep cars stable in different driving scenarios, such as snow, ice, rainy days, and bumpy roads, guarantee optimal tire grip performance, and





ensure safe driving.

Winter in snowy regions challenges many drivers' skills, patience, and attention. Icy roads have low adhesion, which can cause vehicles to skid or drift unexpectedly and put the drivers and passengers at risk. Conventional control solutions feature a wheel speed sensor, which is not very precise and takes a long time to realize that the car is skidding. Once it does, the torque reduction command has to go through the ESP, VCU, MCU, and motor, reducing control and slowing down the response. Then it will be too late to correct a car that has already skidded and deviated. In contrast, Huawei's iTRACK can detect road conditions

10,000 times per second, adjust the torque 1000 times per second, and take actions within milliseconds, effectively preventing skidding and ensuring safety.

Another accident-prone scenario is driving into an underground parking lot on rainy days. The narrow passages become wet and slippery due to the roads' epoxy coating, so vehicles may skid or hit a wall. Huawei's iTRACK is specifically designed to address the challenges of driving on slippery roads. Whether it is four-wheel, two-wheel, or single-wheel skids, iTRACK can accurately identify and promptly suppress skidding.

### Smooth Rides, Maximum Comfort

Along with essential safety features like anti-skid performance, comfort and stability are equally crucial. Experts suggest that in the era of smart vehicles, the powertrain and chassis systems — responsible for power output and ensuring safety — will play an even more significant role. Huawei's iTRACK not only redefines the ePowertrain's capacity in vehicle control but also expands the control of the chassis to enhance comfort. By leveraging intelligence, shortening control loops, and enabling proactive management, iTRACK allows for seamless control from sensing to execution, enhancing the overall driving experience.

Huawei's iTRACK features smart chassis technology that significantly improves driving comfort. In common scenarios like speed bumps, it effectively smooths out the ride, making it safer and more comfortable. For example, when the vehicle passes over a speed bump, iTRACK reduces the usual fluctuations in wheel speed, bringing a smoother ride.

Why does the vehicle experience jolts and shaking, to begin with? When passing a speed bump, the tires hit the speed bump, momentarily leave the ground, hit the ground again, and start the next hop. All the movements reduce comfort. Huawei's iTRACK quickly and accurately detects road conditions and wheel status, and promptly and precisely adjusts the torque using an adaptive adjustment algorithm. This effectively reduces jolts when the car goes over a speed bump. On top of that, Huawei's iTRACK uses millisecond-level closed-loop control, which makes it 100 times faster than traditional systems. Such a control allows the wheels to adjust quickly, reducing impact and minimizing lingering vibrations. Tests show that Huawei's iTRACK can reduce the wheel speed fluctuation by 50% and shorten residual vibrations by 40%.

### **Huawei's iTRACK, Making Travel Smarter**

Fueled by the rapid advancements in

vehicle intelligence and connectivity, the intelligent connected vehicle (ICV) industry has become one of the fastest-growing sectors in China. According to McKinsey, the global ICV market is expected to reach \$1.5 trillion by 2030. With the help of AI, deep learning, and big data analytics, vehicles are now able to navigate complex road and traffic conditions in real time, make autonomous decisions, and deliver significant improvements in safety, comfort, and convenience.

Huawei's iTRACK couples intelligent driving and intelligent cockpit systems to provide users with a smarter and more efficient driving experience. It uses the intelligent, comprehensive architecture of the ePowertrain as the foundation to implement millisecond-level super nerve reflexes. Its unique technologies — intelligent sensing and the adaptive algorithm for intelligent torque adjustment — enable vehicles to easily adapt to complex road conditions.

When you are driving an AVATR 12 and enjoying the thrilling 0–100 km/h acceleration in just 3.9 seconds, you may not even notice Huawei's iTRACK. But this is the amazing part — it instantly suppresses skidding and bumps, providing safety and comfort for everyone in the vehicle.

Huawei's iTRACK, ride smoother. ▲



# What Makes a Power Supply System Power-Saving and Efficient in the Intelligent Computing Era?

Traditional power supply solutions for data centers are struggling to keep up with the demands of intelligent computing. Issues like low efficiency, large footprints, and long delivery time are posing significant challenges. Is there a better way forward? Huawei's FusionPower9000 might be the right answer.

With the rapid rise of AI, the intelligent computing industry is experiencing explosive growth. According to the "Intelligent Computing Industry Development Research Report (2024)" by the China Telecom Research Institute, over 250 intelligent computing centers have

been built or are under construction in China as of June 2024. The Action Plan for High-Quality Development of Computing Infrastructure predicts that by 2025, intelligent computing power in China will account for 35% of the total, becoming a key driver of the digital economy.



## What Makes a Power Supply System Power-Saving and Efficient in the Intelligent Computing Era?

As computing power continues to surge, power supply solutions — the backbone of data centers — are facing increasing challenges. Traditional power supply systems are plagued by low efficiency, large footprints, long delivery time, and high O&M costs, making it difficult to support the rapid growth of intelligent computing.

### Disadvantages of traditional power supply solutions

Amid the transition from general-purpose to intelligent computing, data centers are embracing high density, low carbon, and intelligence. However, the disadvantages of traditional power supply solutions are hampering this evolution.

- **Solutions take up a lot of space, resulting in a low space usage effectiveness (SUE).**

As server computing power continues to increase, IT devices in data centers demand higher power density, leading to a growing footprint for power supply equipment. For example, in a 16-kW server rack setup, using a traditional power distribution solution would result in a 1:1 ratio between the power distribution room and the IT equipment room. This would undoubtedly reduce the available space for the equipment room.

- **Inefficiency wastes energy.**

Green and low-carbon development is the future of data centers. The

Special Action Plan for Green and Low-Carbon Data Center Development issued by multiple Chinese government departments in July 2024 stipulates that the average power usage effectiveness (PUE) of data centers in China must be below 1.5 by the end of 2025. The biggest drivers for reducing PUE are efficiency and the loss of power supply solutions.

In a traditional power supply solution, the upper limit of the full-link power supply efficiency is about 95.5%. This increases both the PUE and energy costs. Let's take as an example of a 12-MW data center in Beijing containing 1500 8-kW racks and using a 2N architecture. If the load is 50%, the coefficient of performance (COP) of air conditioners is 3.0, and the electricity fee is CNY0.75/kWh. This results in losses amounting to CNY1.86 million per year in terms of electricity cost across the power supply and distribution link.

- **Delivery is slow and capacity is difficult to expand.**

The rapid growth in computing power creates challenges for data center services that traditional power supply solutions struggle to address. These solutions often rely on an assembly approach that involves multiple device brands and complicated onsite installations. Delivery typically takes 28 weeks or more, and their tight integration with equipment room



buildings makes capacity expansion difficult and inefficient.

- **Onsite assembly leads to unpredictable engineering quality.** A regular power solution consists of many devices that are not consistent with each other and cannot be easily integrated. In addition, it is difficult to control the engineering quality due to cross-construction and complex management. This undermines the reliability and security of the entire solution.

- **Low O&M efficiency, difficult**

**troubleshooting, and delayed risk identification persist.**

Traditional power supply solutions usually rely on manual O&M, which drags down efficiency. Links are invisible and cannot be detected in real time. This prevents quick fault locating. Moreover, due to the lack of proactive O&M functions, it is not possible to identify risks in advance and mitigate them.

**The FusionPower9000 is the right answer in the context of intelligent computing.**

The above challenges signal an urgent

## What Makes a Power Supply System Power-Saving and Efficient in the Intelligent Computing Era?



need for a future-proof power supply solution. Huawei's FusionPower9000 — which features a low-carbon design, flexibility, safety, and intelligence — redefines the power supply solution and lays a solid foundation for intelligent computing.

Focusing on low carbon and high efficiency, the FusionPower9000 enhances full-link efficiency and optimizes the footprint design. It achieves a full-link efficiency of up to 98.3% in S-ECO mode and an online dual-conversion efficiency of 96.1%. For a 12 MW data center, this

translates to a savings of CNY15.67 million in electricity costs over ten years. Additionally, with a power density of 56.2 kW/m<sup>2</sup>, it requires 30% less space than traditional solutions.

The FusionPower9000 is very flexible to deploy. For example, when deployed outdoors, it decouples the power supply from the data center building. Each power system is housed in a single container, with a plug-and-play design that simplifies capacity expansion. The standardized approach reduces the time-to-market (TTM) from 28 weeks to 18 weeks, improving efficiency and shortening the overall delivery time by 35%.

As for safety and reliability, FusionPower9000 provides comprehensive assurance through technological innovation. Over 90% of FusionPower9000 components are prefabricated, and the system is pre-integrated and pre-commissioned before factory delivery, which significantly reduces quality risks during onsite installation and commissioning. The solution adopts a distributed architecture and remote deployment, which physically isolate the power supply system from the equipment room and mitigate potential safety risks. With a 25-year service life, intensity-9 earthquake resistance, scale-12 wind resistance, and IP55

protection, the product can operate reliably under various extreme conditions.

The FusionPower9000 also features intelligent O&M. It can detect the status of key nodes in real time using a full-link visualized management system. The solution predicts the state of health (SOH) of circuit breakers and automatically sets their parameters using AI technologies. What's more, it can proactively prevent potential risks, significantly improving O&M efficiency and reducing the need for manual interventions.

Huawei's FusionPower9000 has been widely deployed across Asia Pacific and Europe. For example, it powers the world's largest prefabricated modular data center in the Asia Pacific where it took just 12 months to deploy the first phase of the project (60 MW, 3168 racks, and 21 kW/rack).

An all-new solution fit for the era of intelligent computing, Huawei's FusionPower9000 resolves past challenges while delivering a forward-looking design. Huawei Digital Power will continue to work with its customers and partners to help data center facilities evolve toward low carbon, flexibility, safety, and intelligence, powering the digital era forward. ▲





# Virtual Power Plants: Driving Green Innovation in Telecom Transformation

The transformation enables pure backup power resources to serve as energy storage facilities, thereby maximizing asset utilization and unlocking the full potential of each site. The ability to achieve this represents the fundamental value proposition of VPPs.

**B**ase stations are evolving into "power plants!"

With the widespread adoption of 5G technology, the number of telecom sites is increasing, leading to higher energy consumption. According to the Research Report on Global

5G Standard Essential Patent and Standard Proposals (2024) released by the China Academy of Information and Communications Technology (CAICT) Center for Intellectual Property Rights and Innovation Development, by June 2023, 320 telecom operators in 119 countries and regions had

launched 5G networks. The number of 5G base stations has reached 5.94 million, and the number of 5G users is over 1.87 billion. To deal with the high energy consumption, telecom operators are upgrading their power systems and batteries and using intelligent management methods to create virtual power plants (VPPs) from widely distributed base stations. The VPPs reduce telecom operators' electricity costs and carbon emissions. Meanwhile, they can sell stored green energy to power grids during peak hours to relieve power supply pressure and increase revenue.

### Development Opportunities for VPPs

The concept of a VPP originated in Europe during the 1990s, with the aim of addressing the instability and uncontrollability of power generation from renewable energy sources. According to predictions by Spherical Insights & Consulting, the global VPP market is expected to grow to \$13.7 billion by 2032.

Currently, countries around the world are making progress in implementing VPPs. Since 2010, North American electric power companies have been studying the application of VPPs and have established multiple VPP demonstration projects. These projects virtually aggregate scattered solar, wind, and energy storage devices, realizing intelligent energy

management and optimization.

In Europe, where power generation resources are scattered, VPPs are primarily used for power supply. By aggregating distributed power generation resources, VPPs enable the stable integration of renewable energy into the power grid, coordinating power generation. Germany's Renewable Energy Sources Act requires that each renewable energy power generation project with a capacity of more than 100 kW participates in the electricity market. In Germany, VPPs are now fully commercialized, playing a crucial role in the country's transition to a more sustainable energy system.

Since June 2024, China has implemented the Measures for the Supervision of the Electricity Market, which clearly designates VPPs as the primary entities for electricity transactions. The Action Plan for Accelerating the Construction of New Power Systems (2024-2027), jointly issued by the National Development and Reform Commission, the National Energy Administration, and the National Data Administration, aims to establish and enhance the technical standards system for VPPs. Additionally, the action plan seeks to improve market access, safe operation standards, and transaction rules.

Undoubtedly, the development of VPPs will effectively drive the adoption

of new power systems, facilitate the transformation of energy supply structures, expedite the transformation of the energy industry, and contribute to the timely achievement of carbon neutrality objectives.

The rapid advancements in digitalization and intelligence are laying a robust technical foundation for the emergence of VPPs. These technologies enable VPPs to seamlessly integrate and optimize communications and software, enabling them to coordinate and optimize the distribution of energy resources effectively. Consequently, VPPs participate flexibly in electricity market adjustments and grid operations, enhancing the overall efficiency and reliability of the power system. Economic and societal development have led to an ever-increasing demand for electricity. In recent years, the emergence of green energy and new energy storage technologies has improved the traditional, centralized power generation model and enabled advanced resource control and adjustment mechanisms. This has helped to resolve the conflicts between power supply and demand, making the power grid more resilient and efficient. Therefore, VPPs, with their flexible, cost-effective, and environmentally friendly characteristics, have emerged as a new favorite in the market.



VPPs play a crucial role in overcoming space limitations and bridging the gap between energy producers and consumers. By facilitating a transition from the conventional one-way flow of energy to an interactive and collaborative feed-in and two-way flow, VPPs offer significant opportunities and pose unique challenges. Exploring the social values that VPPs bring to telecom operators is an important area for further investigation.

### **VPPs Are Integral to Telecom Operators' Energy Transformation**

With the rapid advancement of

5G technology and the changing telecom landscape, operators are now facing unprecedented pressure and challenges across multiple fronts. An urgent issue that operators must address is the transformation of their energy sources. In the 5G era, the energy consumption of networks has increased exponentially. As 5G-Advanced becomes commercially available, the energy consumption of operators' sites is expected to escalate further, presenting operators with challenges in terms of building green sites, enhancing site energy efficiency, maximizing site value, and increasing revenue.



Considering the looming energy crisis and the need for sustainable environmental development, operators are faced with rising electricity prices, significant operational expenditures (OPEX), and an unreliable power supply. Consequently, many operators have recognized the strategic importance of developing their green energy systems. From the perspective of achieving carbon neutrality, operators must prioritize energy conservation and carbon reduction through service innovation and optimization. These efforts serve as an essential requirement for operators to achieve sustainable development and also represent a social responsibility that operators must embrace.

VPPs play a crucial role in enabling operators to transition from being energy consumers to becoming prosumers. The energy transformation of operators encompasses two key aspects: Power for ICT and ICT for Power. Power for ICT refers to operators shifting their focus from solely providing power supply for communications equipment to enhancing site energy efficiency and reducing capital expenditure (CAPEX) and OPEX. This can be achieved through initiatives like constructing energy-efficient sites and equipment rooms. On the other hand, ICT for Power highlights that operators not only consume energy but also generate and regulate green electricity.

The primary objective is to produce greener, safer, and more efficient electricity, while also leveraging site resources to facilitate additional services like VPPs and residential power supply.

VPPs are revolutionizing conventional power production and supply processes, driving the shift towards more sustainable energy consumption. By actively participating in VPPs, operators can implement bidirectional energy interaction and consume energy on demand, leading to enhanced energy utilization and reduced consumption costs. Additionally, VPPs are transforming both technology and business models. Energy storage, once solely used for backup power, is now being harnessed by operators as active participants in the electricity market. This allows them to benefit from subsidies obtained through market participation, paving the way for the integration of onsite energy generation and electricity services. Consequently, the transition from backup power to a combination of backup power and energy storage will unlock the full potential of onsite energy resources.

With access to a wide range of resources, VPPs can be a part of diverse markets, including electric energy, ancillary electricity, and capacity markets. As business models continue to evolve, operators can

leverage their energy storage resources to participate in a broader range of services, ultimately increasing their revenue streams and transitioning from cost-saving measures to profit-generating opportunities. For instance, operators can aggregate their energy storage resources to support ancillary electricity services, such as power grid frequency regulation and peak shaving, which can lead to obtaining subsidies for electricity services. This transformation enables pure backup power resources to serve as energy storage facilities, thereby maximizing asset utilization and unlocking the full potential of each site. The ability to achieve this represents the fundamental value proposition of VPPs.

### **Build a Solid Foundation for VPPs**

To achieve energy transformation, integrate site energy storage and electricity services, and participate in electricity market scheduling, it is essential to build a simplified, intelligent, and integrated site energy storage system.

It is imperative that electricity market services should not interfere with site power backup, necessitating the decoupling of batteries from existing services. Given that existing power systems come from multiple vendors and have different specifications, the compatibility between power

systems and batteries must be considered when deploying a VPP, which adds to the complexity. By decoupling batteries from power systems during VPP deployment, the efficiency of deployment can be significantly improved, allowing existing power systems to participate in VPPs and maximize the utilization of site resources. Therefore, simplicity plays a crucial role in the successful deployment of VPPs.

The effective management of a large number of site energy storage resources necessitates the implementation of a robust, quick, and efficient scheduling capability. To meet the demands of electricity service capacity, a resource pool comprising thousands of sites is essential for comprehensive scheduling. Furthermore, the ability to respond within seconds and intelligently regulate frequency is crucial for rapid scheduling, especially when dealing with service bursts. Additionally, precise scheduling is imperative to ensure high accuracy in electricity service provisioning, with some countries and regions requiring precision levels of over 95%.

Ancillary electricity services encompass a diverse range of offerings, including frequency regulation markets in Europe and peak shaving and frequency regulation markets in China. To reduce deployment costs, operators

should implement an integrated system that supports multiple services and facilitates long-term evolution.

Huawei is dedicated to collaborating with partners to explore energy management and optimization solutions. Huawei has proven expertise in constructing simplified, intelligent, and integrated site energy storage systems. Its groundbreaking VPP solution for telecom sites is powered by a unique intelligent algorithm and high-performance hardware. The solution integrates digital and power electronics technologies to enhance power grid stability and safety significantly. Additionally, the solution offers self-networking capabilities, operates independently of existing equipment, and simplifies deployment without disrupting the current architecture, ensuring streamlined installation and rapid delivery. The energy management platform provides big data analysis and intelligent site selection capabilities, working seamlessly with the VPP intelligent gateway and high-performance intelligent lithium batteries to achieve cloud-network synergy and intelligent scheduling. The solution implements multi-service integration, encompassing peak staggering, peak shaving, and frequency regulation services within a single system. Widely implemented across various regions, particularly in Europe, Huawei's VPP solution empowers operators

to participate in electricity markets and optimize energy storage assets successfully.

As a leading technical enabler, Huawei is committed to driving innovation in site energy storage systems. Huawei's concept of "site power backup + peak staggering + VPP" enables operators to seamlessly evolve their asset investments, embrace clean, low-carbon, safe, efficient, flexible, and intelligently integrated energy applications, and accelerate their transformation from energy consumers to prosumers.

### **Balance Power Grids, Save Energy, Reduce Carbon Emissions, and Accelerate Transformation**

According to Fortune Business Insights, the global VPP market reached a value of US\$1.42 billion in 2023, and it is projected to grow at a compound annual growth rate (CAGR) of 37.7% from 2024 to 2032. As the global energy structure continues to transform and electricity markets undergo reforms, VPPs are expected to play a crucial role in aggregating energy and participating in electricity market scheduling. The energy infrastructure is shifting from a cost-centered to a value-centered approach, with energy operations like peak staggering and VPPs maximizing the value of site/base station energy infrastructure. ▲

# Huawei Smart Power

## All-Scenario Telecom Power Solutions



One Power  
Platform



All Modular  
Design



Fully  
Intelligent





# Smart String Grid-Forming ESS

An Epochal Shift to Carbon Neutrality

