


Digital Power

January 2024 Issue 03



Developing New Infrastructure for the Digital Energy Era Across Three Core Dimensions

Qinghai Golmud:
a Decade of Solar
Innovation and Pioneering

The Red Sea Project:
a City Powered by 100% Clean Energy

G318 Highway:
Embracing Ultra-Fast Charging

SKE: Shaping a Clean
Energy Future for
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Developing New Infrastructure for the Digital Energy Era Across Three Core Dimensions



Jinlong Hou

Director of the Board of Huawei
President of Huawei Digital Power

Carbon neutrality represents an inspiring journey toward a revolutionary economic and social transformation, with a stable energy infrastructure as its backbone. The global energy industry is no longer driven by resource dependence but by technology. Low-carbon, electrification, digitalization, and intelligence are the four key paths for energy evolution and transformation. The energy industry has entered a new era of digitalization, deeply integrated with the digital world.

In this new era, we are taking advantage of opportunities by integrating bit, watt, heat, and battery (4T) technologies to build energy infrastructure for new power systems, electric transportation, and digital transformation. Our commitment to this goal is reflected through our focus on three core dimensions.

- **New power system energy infrastructure: accelerating the transition from traditional energy to new energy**

This type of infrastructure has three major application scenarios, namely clean energy bases, urban energy systems with coordinated power generation, grids, loads, and storage, as well as home energy management systems.

In the context of clean energy base scenarios, the high proportion of renewable energy and power electronics applications, large land footprints, and remote locations pose significant challenges to grid connection and operations and maintenance (O&M). To overcome these challenges, Huawei Digital Power has developed and implemented grid forming technology, which is applied to photovoltaic (PV)

Developing New Infrastructure for the Digital Energy Era Across Three Core Dimensions

and energy storage systems (ESSs). The PV+ESS solution proactively enhances the power grid and provides the functions of traditional synchronous generators, enabling the transformation from grid following to grid forming and making solar PV energy the mainstream energy source. In terms of O&M, Huawei Digital Power leverages the latest information and communications technologies, such as the Internet of Things (IoT), big data, and artificial intelligence (AI), to implement smart diagnosis of plant faults. This approach enables intelligent and unattended clean energy bases.

In urban scenarios, there is a growing demand for low-carbon and intelligent energy systems that integrate generation, grids, loads, storage, and consumption through innovative products and solutions. These include distributed energy systems, virtual power plants (VPPs), smart charging networks, vehicle-to-everything (V2X), integrated smart energy, and smart microgrids. By working together, these technologies make the city safe, resilient, efficient, low-carbon, and intelligent.

For home energy consumption, a green, low-carbon, user-friendly, intelligent home energy management system can be installed, which includes optimizers, PV, ESS, charger, load, and management system. This one-stop solution will transform homes from energy consumers to prosumers in new power systems, reducing carbon emissions and improving energy efficiency.

• New electric vehicle (NEV) energy infrastructure: leading the electrification and intelligent upgrade of transportation

Huawei Digital Power is a leading provider of e-Mobility and FusionCharge solutions in the mobility electrification industry. Our high-quality collaborative development approach enables us to launch the hyper-converged e-Mobility all-scenario solution and fully liquid-cooled ultra-fast charging solution. These solutions help electric vehicles surpass fuel vehicles and provide a refueling-like charging experience, accelerating the process of mobility electrification.

We work closely with our customers and partners to develop supercharging solutions across China, including gas stations, highway rest areas, and urban public areas with high traffic of electric vehicles. Our goal is to build a unified highway network and city network, integrating PV, ESSs, and chargers to enable NEVs to use renewable electricity. We will ensure that our high-quality charging networks are compatible with vehicle models of various voltage levels, and offer various business models that bring better return on investment to charger operators and achieve a positive business cycle of sustainable development.

Currently, we are working with provinces and cities such as Sichuan, Shenzhen, Taiyuan, Zhengzhou, Guilin, and others to accelerate the construction of high-quality charging infrastructure, continuously improving public charging services and enhancing the electric mobility experience for users.

• New digital industry energy infrastructure: building a solid foundation for the digital economy

As the world undergoes rapid digital

transformation and the demand for connectivity and computing power increases, the number of data centers and telecom sites is set to double. However, this growth will also lead to a surge in electricity consumption and carbon emissions, posing significant challenges.

Huawei Digital Power recognizes the need to bring more bits with fewer watts and fewer carbon emissions. To address these challenges, the company is building a new digital industry energy infrastructure for data center facilities and site power facilities. This infrastructure is designed to continuously reduce energy consumption and carbon emissions for generating each bit while being supported by digital and intelligent technologies.

Energy infrastructure is vital for ensuring a reliable power supply and can be seamlessly integrated into the intelligent urban energy system. The infrastructure can regulate energy production and power systems, instead of being a mere consumer of energy.

During this critical period of industrial transformation, infrastructure plays a central role in accelerating transformation, promoting innovation, and stimulating the economy. Huawei Digital Power leverages the advantages of integrating 4T technologies, establishes a solid path for the new energy infrastructure across three core dimensions, and moves toward a new era of digital energy. With a vision of "brilliant stars and endless roads," we are committed to driving sustainable and efficient energy solutions for the future. ▲

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Global Policy Review



Commission released the Act to embed a list of critical raw materials and a list of strategic raw materials in EU law. The Act also sets clear benchmarks for domestic capacities along the strategic raw material supply chain and aims to diversify EU supply by 2030: (1) at least 10% of the EU's annual consumption for extraction; (2) at least 40% of the EU's annual consumption for processing; (3) at least 15% of the EU's annual consumption for recycling; (4) not more than 65% of the Union's annual consumption of each strategic raw material at any relevant stage of processing from a single third country.

European Union: New Regulation Concerning Batteries and Waste Batteries Comes into Force

On August 17, 2023, the Regulation came into force. Since 2027, traction batteries to be sold in Europe must hold a "battery passport" with records of the battery manufacturer, materials, carbon footprint, and supply chain. As China's battery capacity accounts for 77% of the world's battery capacity, with Europe as the major target market for China's lithium batteries, the release of the Regulation will hinder China's exports to Europe. Chinese battery companies will face great challenges in Europe, including carbon-related trade barriers, industry chain localization,

International Energy Agency: Released the Renewable Energy Market Update — Outlook for 2023 and 2024

the International Energy Agency dives right into the development of the global renewable energy markets. It predicts that the world's newly installed renewable energy capacity will soar to 107 GW in 2023, the largest increase ever, equivalent to the total installed energy capacity of Germany and

Spain. In addition, the decline in PV module prices, increased adoption of distributed PV systems, and favorable policies for large-scale PV deployment will continue to contribute to the rapid growth of all major PV markets, including markets in China, the European Union (EU), and India.

European Union: Launched the Critical Raw Materials Act

In March 2023, the European



and carbon peaking.

European Union: Kicked Off Higher Renewable Energy Targets

The Parliament and member states have reached a provisional deal on the new Renewable Energy Directive to increase the proportion of renewable energy in the EU's overall energy consumption from 32% to 42.5% by 2030, with an additional 2.5% indicative top-up that would allow reaching 45%. Specifically, Germany set a target for renewables to meet 80% of electricity demands in the country by 2030. Italy also raised its target for renewables to 64% by 2030. In addition, Portugal announced a minimum quota of energy use from renewable sources of at least 49% in the gross final consumption and 85% in electricity generation by 2030.

Nine European Countries: Signed the Ostend Declaration

At the second North Sea Summit in April 2023, Belgium, Denmark, Germany, Netherlands, France, the UK, Ireland, Norway, and Luxembourg signed the Ostend Declaration, pledging to increase their offshore wind capacity to 300 GW by 2050, which will cost 800 billion euros. The Declaration aims to unleash the energy and industrial potential of the North Sea and make it "the biggest green

energy base in Europe" by 2050.

European Commission: Proposed the Net-Zero Industry Act (NZIA)

The NZIA will accelerate the EU's transition to clean energy as part of the Green Deal Industrial Plan. The Act sets a benchmark for the manufacturing capacity for strategic net-zero technologies to meet at least 40% of the EU's annual deployment needs by 2030. The technologies include photovoltaic, wind, battery/energy storage, heat pump, electrolyzer/fuel cell, sustainable biogas/bio-methane, and carbon capture and storage (CCUS) technologies. Furthermore, the European Commission proposes establishing a European Hydrogen Bank, a financing instrument internally run by Commission services. Following the initiative, the EU launched the first auction under the European Hydrogen Bank to support renewable hydrogen production in Europe, with an initial 800 million euros of emissions trading revenues channeled through the Innovation Fund.

Germany: Launched the New National Hydrogen Strategy

According to the revamped Strategy approved in July 2023, the hydrogen demand in Germany is expected to reach 130 TWh by 2030, 50% to 70% of which relies on imports. Therefore, the German government is developing

strategies for import management. Regarding domestic production, the policymakers agreed on the National Hydrogen Strategy with a 5 GW electrolysis target for the production of green hydrogen by 2030. The updated strategy has doubled the target to at least 10 GW by 2030. In addition, the German government plans to have a national core hydrogen network with a length of around 1800 km ready by 2032, mainly based on existing gas pipelines.

China: Released the Notice on Further Strengthening the Update and Application of Energy Saving Standards

In March 2023, China's National Development and Reform Commission, as well as the State Administration for Market Regulation, released the Notice on Further Strengthening the Update and Application of Energy Saving Standards, aiming to accelerate the update of energy saving standards in key fields such as the industry, energy, urban and rural construction, transportation, public institutions, agriculture, and rural revitalization. In addition, the notice sets targets to steadily improve the energy consumption limit requirements of key energy consumption sectors, continuously enhance the energy efficiency of key energy consumption products, and expand the coverage of energy-saving standards.

Clean Power Generation

Europe: Released the PV Manufacturing in Europe — Understanding the Value Chain for a Successful Industrial Policy

In May 2023, the European Technology and Innovation Platform for Photovoltaics (ETIP PV) released a report which points out the major challenges to rebuilding the EU's PV industry, including low production capacity of polysilicon, ingot and wafer, insufficient industrial manufacturing capabilities, and investment to build a strong local supply chain, shortage of skills related to manufacturing and operation, as well as the operational barriers from raw material production to module assembly during the PV manufacturing process. The report pays special attention to capacity availability throughout the PV value chain.

United Kingdom: Public Support Rate of PV Projects Reaches 61.5%

In August 2023, Solar Energy UK released a report on British people's attitude towards PV project development. The research shows that most residents who live near PV plants support PV technology. Of the population living near existing, proposed, or under-construction PV plants, 42% strongly support the development of PV plants. In addition, the research also finds the growing popularity of PV plants over the years. For example, in the development phase of a PV plant, the percentage

of support from people living near the plant decreases to 17%. However, once the plant is operable, the support rate increases to 61.5%.

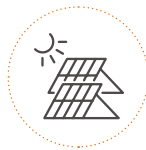
Germany: Installed PV + Wind Capacity Exceeds 8 GW in the First Half of 2023

The first half of 2023 witnessed the installation of 6.5 GW PV systems and 1.75 GW wind energy generation facilities in Germany, and the total installed capacity hit a record high of over 8 GW. Specifically, 465,000 PV systems were installed and put into operation, marking a significant milestone compared with the increase of 165,000 PV systems in the first half of 2022. In addition, in August 2023, the Federal Ministry for Economic

Affairs and Climate Action of Germany approved a series of measures to simplify the deployment of PV systems to achieve the national goal of installing 215 GW PV systems by 2030.

Brazil: Installed PV Capacity Exceeds 30 GW

According to the data from Brazil's National Electric Power and Energy Agency, as of July 2023, Brazil's total installed PV capacity reached 30 GW, with 8624 MW coming from centralized plants and 20,580 MW from small and micro plants (less than 5 MW per plant). In the first half of 2023, the newly installed PV capacity reached 6.6 GW. If this growth rate is maintained throughout the year, it is estimated that the newly installed PV capacity in the



country will reach 14 GW by the end of 2023.

South Korea: PV Energy Is One of the Main Energy Sources of Electricity Generation

According to data from the Yonhap News Agency, the total PV energy yield in South Korea reached 21,778 MW between 12:00 and 13:00 on April 9, 2023, accounting for 39.2% of the national total electricity consumption in this period. Since the start of 2023, there have been 14 days when PV energy was supplied to over 30% of the country's total electricity consumption between 12:00 and 13:00. PV energy is becoming the main energy source of electricity generation in the country. According to the latest plan of the South Korean government, renewable energy generation will account for 21.6% of all electricity generation in 2030. The government also intends to vigorously promote the installation of solar panels on the roofs of commercial facilities.

India: Installed Rooftop PV Capacity Reaches 2.1 GW

The Ministry of New and Renewable Energy of India announced the achievement of a milestone of 2.1 GW PV capacity installed in phase II of the national rooftop solar program. The program was launched in March 2019, with the approved total outlay of Rs. 118.14 billion to support the installation of residential PV systems and provide incentives for power distribution

companies whose installed capacity is higher than the basic installed capacity of the operating areas. As of July 31, 2023, out of the allocated 3.37 GW of installed capacity, 2.207 GW of rooftop PV systems have been successfully installed in the residential sector.

China: Power Grid Consolidation and Improvement Projects to Be Implemented in Rural Areas

In July 2023, China's National Development and Reform Commission, the National Energy Administration, and the National Rural Revitalization Administration jointly released the Guidelines for Implementing the Power Grid Consolidation and Improvement Projects in Rural Areas. The guidelines aim to fully enhance the power grids in rural areas, comprehensively consolidate rural power assurance, and promote the construction of a new rural energy system. In addition, the guidelines propose building a safe, reliable, intelligent, and open power grid in rural areas with enhanced power supply assurance, comprehensive power services equal to urban power services, and capabilities to support distributed renewable energy development, utilization, and local consumption by 2035.

China's National Energy Administration: Released the Notice on Wind Power and PV Power Development and Construction in 2023

Released on January 2, 2023, the notice stipulates that all regions shall coordinate the work from the early stage of PV projects to grid-connected operations by following the principle of revenue-based expenditure and stable development to ensure the steady and orderly construction of PV plants. The notice requires establishing strict grid connection standards and extensive efforts in controlling PV pollution and reducing carbon emissions.

China: The Power Equipment Industry Grows Steadily

According to the Work Plan for Stable Growth of the Electric Power Equipment Industry (2023–2024) released by the Ministry of Industry and Information Technology, the annual revenue growth rate of main businesses in the power equipment industry is expected to exceed 9% and that of the industrial added value to be around 9% from 2023 to 2024. The plan encourages equipment manufacturing enterprises to improve supply quality and ensure the construction of large-scale wind + PV energy bases. Thanks to the booming PV industry, 61 listed companies in the PV industry chain have achieved a total net profit of CNY69.661 billion in the first half of 2023, and nearly 80% of these companies achieved a year-on-year increase in the net income attributable to shareholders of their parent companies.

Mobility Electrification



Europe: Sales of Fuel Vehicles to Be Banned from 2035

On February 14, 2023, the European Parliament endorsed the deal on zero CO2 emissions for new passenger cars and vans in 2035. Europe will ban the sales of new fuel cars and vans from 2035. The deal is backed by industry giants such as Mercedes-Benz and Volkswagen. Mercedes-Benz claims to be ready for all-electric sales by 2030. In addition to Europe, China, Mexico, Japan, Canada, and other countries have also embarked on making timetables for banning fuel vehicle sales.

Japan: Tax Breaks on Domestic EV Batteries and Semiconductors to Be Kicked Off

Japan will start tax breaks on domestic EV batteries and semiconductors from April 2024. The move follows the industrial policies the European Union implemented to enhance

economic security. Under the proposed amendments to the tax law for fiscal year 2024, Japan's Ministry of Economy, Trade and Industry recommends tax breaks for companies involved in manufacturing strategic key products in Japan. The tax breaks will be based on the production output of batteries and chips. Specific details, including applicable projects, will be finalized by the end of 2023. In addition to tax breaks, Japan will take measures to ensure the supply chain of strategic materials.

France: Powering the Development of the EV Industry

In the first half of 2023, France accelerated the installation of EV auxiliary facilities. The number of public chargers nationwide exceeded 100,000 in May. The French government said the EU approved a subsidy of 1.5 billion euros to build a new battery factory in Dunkirk, North France,

which is expected to start producing EV batteries in 2026. France regards the EV industry as one of the strategic industries that promote green transformation and reindustrialization and has launched several initiatives to promote the development of the EV industry. Now, North France is working to build Europe's "battery valley."

United Kingdom: BT Is Thinking Outside the Phone Booths for EV Charging

EasyGo, Northern Ireland's first private and EV-dedicated charging company, has announced plans to transform former phone booths into DC fast chargers in urban and rural areas. BT has shown interest in the plan and intends to follow EasyGo's plan to take Northern Ireland as a pilot. The specific plan would be handed over to Etc., a part of the BT Group. Etc. will pilot related technologies shortly and determine the

commercial implementation scheme. Currently, 60,000 phone booths in Northern Ireland are available for transformation. Etc. also intends to promote the scheme to other parts of the UK.

Japan: EV Chargers to Be Doubled in 2030

As reported by Japanese media, to popularize EVs, the Japanese government decided to increase the number of chargers to 300,000 by 2030, double the original plan of 150,000. These chargers will be located in public places such as highway rest areas, roadside stations, and other commercial facilities. Of the 300,000 chargers to be installed, 270,000 are standard chargers deployed in commercial facilities and residential buildings, while the other 30,000 are fast chargers for places like highways. In addition to increasing the number of chargers, Japan plans to improve the output power of chargers to improve the charging speed.

China: Expanding the NEV Market

According to the forecast data of the China Association of Automobile Manufacturers (CAAM), the sales volume of new energy vehicles (NEVs) in China will reach 14.5 million in 2023, a year-on-year increase of more than 60%. Specifically, BEVs will account for over 80%, and plug-in hybrids will grow significantly. With the continuous innovation of battery

technologies and cost reduction, NEVs have a much longer range. In addition, the fast charging technology and charging facilities have been continuously improved to provide more convenient charging services for consumers.

China: Large-Scale Rollout of Charging Infrastructure

After over a decade of progress, China now boasts the world's most extensive charging infrastructure, featuring a diverse range of facilities that surpasses any other in both quantity and variety. This network spans a broad service spectrum, making it the largest of its kind globally. By the end of July 2023, the number of charging facilities in China had reached 6.928 million, a year-on-year increase of 74.1%. From January to July, 2023, the energy charged to NEVs in China was 44.14 billion kWh, up by 99.6% year on year. The amount for these seven months in 2023 surpassed the total amount of the whole year of 2022.

China: Released Several Measures for Promoting Automobile Consumption

In July 2023, China's National Development and Reform Commission and other ministries and commissions issued a notice, requiring the strengthening of the construction of NEV auxiliary facilities and continuously promoting the formulation of standards related to battery-swapping facilities to enhance compatibility

and universality. The notice also emphasizes accelerating the promotion and application of the battery-swapping mode, actively carrying out pilot projects of the battery-swapping mode for vehicles in the public sector, supporting the construction of the battery-swapping facilities for urban public transportation stations, and encouraging cities and highways to build battery-swapping stations if applicable.

China: Updated the Guidelines for the Establishment of National Standards Systems for the Connected Vehicle Industry (Intelligent and Connected Vehicles)

In July 2023, the 2023 version of the guidelines for intelligent and connected vehicles was officially released. As the second part of the Guidelines for the Establishment of National Standards Systems for the Connected Vehicle Industry, it lays a solid foundation for the high-quality development of the intelligent and connected vehicle industry. The new version fully considers the in-depth integration of intelligent and connected vehicle technologies and cross-domain collaboration. It forms a "three horizontal and two vertical" technical logic architecture. By 2030, an intelligent and connected vehicle standards system will be developed to support the collaborative development of vehicle intelligence and network enablement.

ICT Infrastructure

Globe: Liquid Cooling Technology Is an Inevitable Trend for Hyperscale Data Centers

International Data Corporation (IDC) predicts that about 20% of edge computing data centers will adopt liquid cooling technology in the future, excluding traditional large-scale data centers. According to Research and Markets, the global liquid-cooled data center market value will reach US\$4.55 billion by 2023, with a compound annual growth rate (CAGR) of 27.7%. The research data of CCID Consulting indicates that by 2025, China's liquid-cooled data center market value will exceed CNY120 billion, with a growth rate of over 30% and a penetration rate of about 20%.

France: Promoting the Implementation of the 2023–2025 Digital Infrastructure Strategy

France's Ministry of Economics and

Finance and Industrial and Digital Sovereignty and the Strategic Industry Committees have jointly signed a contract for implementing the 2023–2025 digital infrastructure strategy. The contract highlights the following strategic focuses: France will implement reindustrialized 5G and future network construction, build an experimental network platform for 5G/6G use cases, and promote 5G development in industries such as automobile, health, and safety; create a vibrant and innovative ecosystem to build a common vision for the future development of digital infrastructure; promote the digital transformation of the industry; and improve the international influence of the digital infrastructure department.

Japan: Scaling up Data Centers in Tokyo

As reported by NIKKEI, the statistics

from real estate service provider Cushman & Wakefield show that the energy capacity of data centers in Tokyo and its suburbs (Greater Tokyo Area) is expected to catch up with that of data centers in Beijing in three to five years. The growth of data centers in the Greater Tokyo Area is mainly driven by the increasing network traffic in Japan. If more Japanese enterprises take on digital transformation and support remote office work, the demand for data centers will surge accordingly. Data communication channeled through Japan will be driven by vigorous investment in constructing Pacific submarine cables.

Singapore: Increasing the Proportion of Renewables in Data Centers

Singapore signed the Paris Agreement about climate change on September 19, 2023. In the Agreement, Singapore



commits to reducing carbon dioxide emissions by 36% from 2005 levels. Such a milestone commitment is worthy of attention for Singapore's data center and cloud service providers. The electricity consumed by domestic data centers accounts for 6.9% of the total energy consumption, and renewables used in data centers only account for a small proportion. However, industry experts predict that the proportion will increase as more data centers are constructed and put into operation.

China: Issued the Government Procurement Standards for Green Data Centers (Provisional)

China's Ministry of Finance, Ministry of Ecology and Environment, and Ministry of Industry and Information Technology formulated the standards, which have been in effect since June 1, 2023. The procurement personnel shall follow the standards and principles of energy saving, environment protection, and resource recycling when purchasing data center equipment and operations & maintenance (O&M) services.

Beijing, China: Issued the Regulations on Further Strengthening the Energy Saving Review of Data Center Projects

In July 2023, the Beijing Municipal Commission of Development & Reform issued regulations to guide the high-quality and standard

development of data centers for citywide carbon neutrality. According to the regulations, new, reconstructed, and expanded data centers should contribute to the development and service implementation of the city as the national center in politics, culture, international exchange, and scientific and technological innovation. The regulations also encourage construction parties to build distributed renewable energy facilities to improve the utilization of new and renewable energy. For new and expanded data centers, the PUE of projects with an annual energy consumption of less than 10,000 tons of standard coal should not exceed 1.3.

China: Released the Data Center Infrastructure Integration Guide

In August 2023, the Guide was officially released. The preparation of the guide was led by the Open Data Center Committee (ODCC), and the guide was jointly compiled by multiple parties, including the China Academy of Information and Communications Technology (CAICT) and Huawei. Based on the Technical Requirements for Intelligent Data Center Construction Capability Maturity Assessment as well as the Technical Requirements for AI-based Data Center Energy Saving, the guide outlines the data center graphs that integrate fields of the Internet, finance, and government affairs based on the

trends of prefabricated integration, high-density deployment, intelligent delivery, and low-carbon operation of data centers. The guide aims to facilitate infrastructure construction in key fields and high-quality implementation of integrated data intelligence application scenarios.

China: Three Major Telecom Operators Drive the Green Transformation of ICT Infrastructure

China Mobile uses green development modes and strives to achieve energy saving and emission reduction by building green base stations, data centers, supply chains, and ecosystems. China Telecom adheres to the concept of green development, takes multiple measures to reduce carbon emissions, builds a new type of safe and green information infrastructure based on cloud-network synergy, and continuously unleashes the potential to benefit the entire industry. China Unicom plans green actions by focusing on low-carbon operations of mobile base stations, green and low-carbon data centers and communication equipment rooms, network simplification and optimization, and smart energy management platforms. These actions shift the key point of carbon reduction from reducing absolute energy consumption to improving energy efficiency and optimizing energy mixes.

Decarbonization, Electrification, Digitalization, and Intelligence: Four Key Pathways Toward Energy Transformation



Charles Yang
President of Global Marketing,
Sales and Services,
Huawei Digital Power

Carbon neutrality is promoting an unprecedented transformation in energy, the lifeblood of our civilization. There are four key pathways – decarbonization, electrification, digitalization, and intelligence that will allow us to achieve such an energy transformation.

Irresistible momentum for the digital energy industry

Despite challenges in achieving carbon neutrality, the energy mix has become cleaner, with renewable energy replacing traditional energy and playing an increasingly dominant role, accounting for 91% of the total

power generation in 2050. PV will become a main energy source as its annual installed capacity rapidly increases, and energy storage will also be indispensable.

In terms of energy consumption, electricity will account for a major proportion of the energy output for end users. The share of electricity in energy consumption will increase to 51% by 2050, with electric vehicles (EVs) playing a significant role in the growth of electricity consumption. According to the International Renewable Energy Agency (IRENA), the number of EVs on the road is expected to increase to 2.18



billion by 2050.

The numerous technological breakthroughs in various fields such as 5G, AI, cloud and blockchain can already be seen in our daily lives, whereby digital technologies are no longer an auxiliary means to improve efficiency, but the foundation and platform for promoting innovation and development for higher productivity in various industries.

In terms of intelligence, AI generated content (AIGC), represented by ChatGPT, has led to a significant increase in intelligent computing

power. In the future, computing power is expected to increase exponentially and AI will be deeply integrated into the real economy, changing our working styles and driving new rounds of technological and industrial revolutions. We firmly believe that, driven by digitalization and intelligence, new energy systems will emerge continuously, and renewable energy business models will achieve business viability.

Following the trends of decarbonization, electrification, digitalization, and intelligence, the digital and energy worlds will be

deeply integrated. It is fair to say that the energy industry has ushered in a new era of digital energy. Energy infrastructure construction will embrace great changes and the convergence of digital and AI technologies, digital and power electronics technologies, and generation-grid-load-storage will improve the energy efficiency and resource allocation of the entire world.

Integrating digital and power electronics technologies, developing clean power, and enabling energy digitalization

Huawei Digital Power will integrate

digital and power electronics technologies, develop clean power, and enable energy digitalization to drive energy revolution for a better, greener future. Huawei Digital Power focuses on clean power generation, energy digitalization, mobility electrification, green ICT power infrastructure, and integrated smart energy. It integrates bit, watt, heat, and battery (4T) technologies, works with partners to provide all-scenario low-carbon products and solutions for global

customers, and contributes to the achievement of the carbon neutrality goal.

- **Grid-forming energy storage system (ESS), building the world's first 100% renewables-powered city**

Huawei's grid-forming technology is implemented through the grid-forming algorithm and smart string architecture to support stable grid connection with a high penetration of renewable energy. This technology has been verified in

the world's first GWh-level grid forming PV+ESS project, the 1.3 GWh microgrid of The Red Sea Project (TRSP), helping build the world's first city powered by 100% PV.

- **Intelligent operations and maintenance (O&M) with AI, ensuring high quality and availability**

In Gonghe County, Qinghai Province, China, Huawei helped China Power Investment Corporation build the world's largest PV plant with a capacity



Decarbonization, Electrification, Digitalization, and Intelligence: Four Key Pathways Toward Energy Transformation

of 2.2 GW, capable of producing more than 4 billion kWh of green electricity each year. The Smart I-V Curve Diagnosis for this plant shortens the inspection time from 5 months to about 10-15 minutes. The cause identification accuracy, identification rate, and recurrence rate all exceed 90%, significantly reducing O&M costs and ensuring efficient running of the PV plant.

- **Redefining the driving and charging**

- **experience, accelerating global mobility electrification**

Mobility electrification depends on the collaborative development of vehicles and charging facilities. Huawei Digital Power positions itself as a solution provider of powertrains and charging networks. Through collaborative development in both on-board and off-board businesses, it has launched hyper-converged power systems and ultra-fast charging solutions. Huawei's products and solutions help achieve a refueling-like charging experience and accelerate the process of mobility electrification.

- **Enabling telecom network infrastructure as an energy producer**

With the rapid growth of global connections, telecom networks have become a major energy consumer, consuming more than 300 billion kWh of electricity each year. Considering that global operators currently have more than 10 million telecom base stations, such a vast infrastructure can double up an energy producer to reduce carbon emissions. In terms of energy control and scheduling, as the penetration of renewable energy increases, the power grid stability is challenged, which not only increases the peak-valley price difference, but also brings opportunities in virtual power plants (VPPs). In China, successful practices have been achieved in peak-valley price difference arbitrage

and VPPs.

- **Adhering to the corporate position of a tech product company and building an industry ecosystem with partners**

Positioning itself as a tech product company, Huawei Digital Power has developed the world's most advanced technologies and the most reliable technology ecosystem over the past 30 years. In the energy field, it integrates digital and power electronics technologies to create unique value for the industry.

Huawei Digital Power will continue to innovate technologies and products and work with industry and ecosystem partners to build an industry ecosystem for a new era where all things and energy are connected. For example, we cooperate with customers to launch innovative products that solve the industry pain points; work with business and service partners to provide high-quality solutions; deepen cooperation with local industry partners to promote local industry upgrade and development; and collaborate with industry organizations to jointly promote industry policies and industry standards for high-quality development.

The digital energy industry is full of opportunities. Through joint efforts, we can build a better, greener future. ▲





Building New Power System Energy Infrastructure with PV as a Main Energy Source, Accelerating Energy Transition and Carbon Neutrality



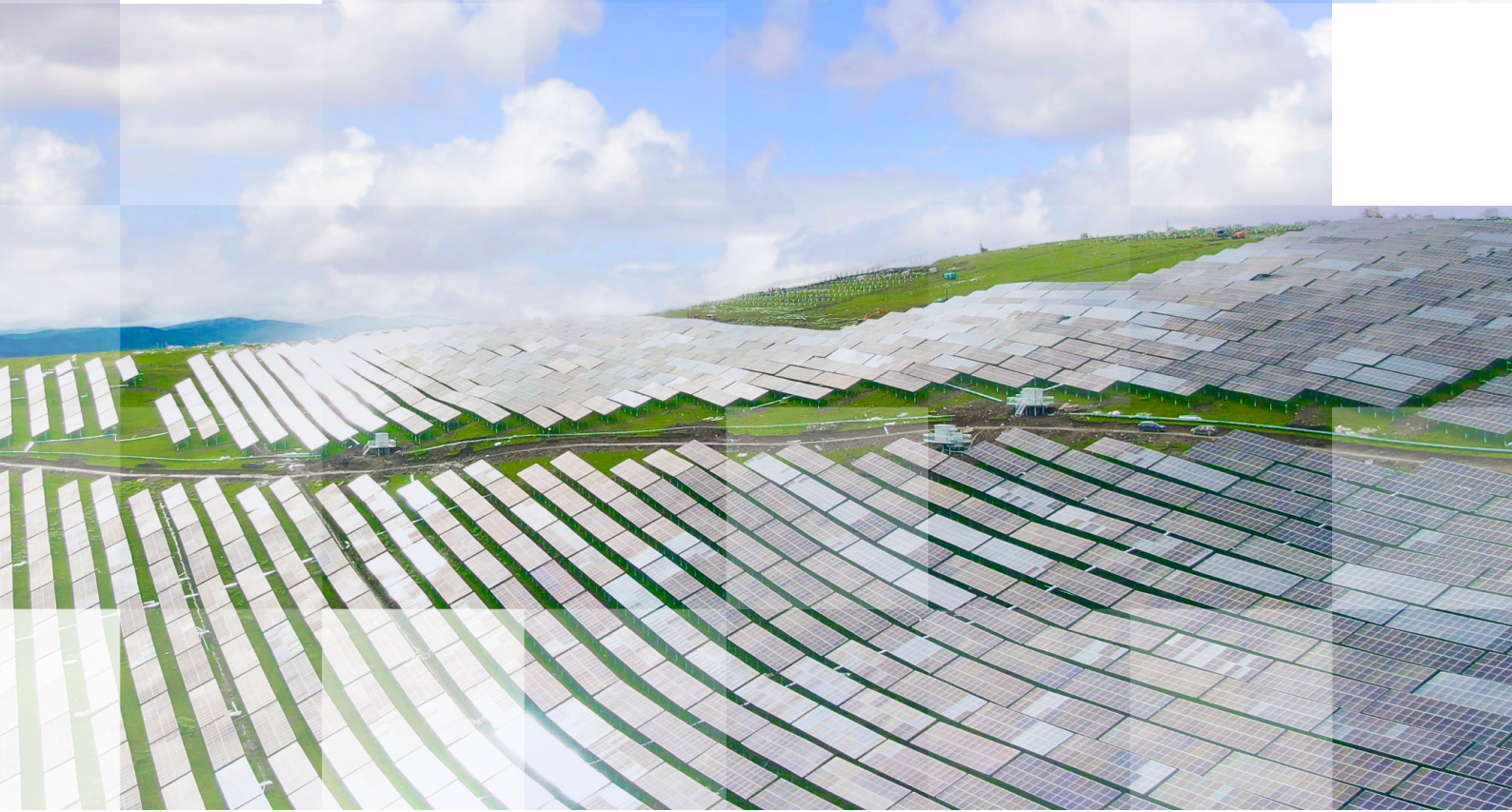
Guoguang Chen

President of Smart PV & ESS Business,
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The first-ever global stocktake on climate change was concluded at the 28th meeting of the Conference of the Parties (COP28) to the UNFCCC, that ended on December 13, 2023. Based on the current rate of emissions reduction, it appears challenging to limit the rise in global temperatures to 1.5°C or even 2°C. The Intergovernmental Panel on Climate Change (IPCC) has indicated a need to reduce greenhouse gas emissions by 43% by 2030 and achieve zero emissions by the middle of this century in order to meet the goals of the Paris Agreement. At the conference, 130 countries signed a pledge to triple the world's installed renewable energy

generation capacity and to collectively double the global average annual rate of energy efficiency improvements by 2030. In November 2023, the United States and China jointly issued the Sunnylands Statement on Enhancing Cooperation to Address the Climate Crisis, which aims to triple global renewable energy capacity by 2030.

The world is rapidly transitioning to renewable energy, and the shift from traditional to renewable energy is unstoppable. Building new power system energy infrastructure that prioritizes renewables and electricity is becoming inevitable. Globally, solar power is seen as the most promising



and fastest-growing renewable energy source, making it a key player in the ongoing energy transition. According to authoritative sources, solar power is expected to not only surpass hydropower, gas power, and coal power in terms of installed capacity in 2023, 2025, and 2026, respectively, but will also become the world's largest energy source. It is projected that from 2023 to 2030, the annual installed capacity of solar power will exceed 500 GW, making it a main energy source in the process of building new power system energy infrastructure.

Three critical challenges confronting the growth of PV as

a main energy source

The first is grid connection challenges. The increasing penetration of renewable energy results in the decline of power grid strength. The transient stability problem becomes prominent, posing a severe challenge to the power grid stability.

The increase in the penetration of renewable energy leads to a high proportion of renewable energy and power electronic devices in the power system. However, grid-following PV cannot support the power grid, and power electronic devices differ from synchronous generators, posing significant challenges to the safe and

stable operation of existing power systems. It is worth noting that the use of distributed PV systems in urban and residential scenarios is steadily increasing. The scattered nodes of distributed energy systems make it challenging to implement unified and standardized management, which presents difficulties for operations and maintenance (O&M). Therefore, improving the grid friendliness of PV power generation and enhancing the power grid's ability to integrate renewable energy are critical for industry development.

The second is operation challenges. Utility-scale scenarios have diversified



to include plateaus, deserts, wastelands, and offshore. Meanwhile, distributed PV plants are small and widely distributed, posing great challenges to O&M and safety.

For instance, on the plateaus of

Yunnan and Sichuan, the high altitude and large expanse make plant O&M challenging. In the offshore PV plant in Shandong, China, the high salinity environment and severe typhoons in summer present significant safety and reliability challenges.

In cities, distributed PV plants are typically small, spread out, and commonly installed on rooftops. Moreover, their independence from each other makes it difficult for unified O&M. In addition, PV plants demand standardized management, scientific



data analysis, and intelligent remote monitoring throughout the planning, design, construction, and O&M phases.

The third is safety challenges. The PV industry's accelerating shift toward the PV+ESS stage has introduced new

safety challenges. As PV installation on rooftops and ESSs in campuses become widespread, ensuring the end-to-end safety and stability of new power systems has become a critical issue that demands collaborative efforts from all industry players. Besides, the shift of grid control functions from the control center to distribution, load control, and third-party platforms has significantly increased the potential attack surface of the power grid. The power system has become a main target of cyber attacks, making the network security situation more complex and severe. Therefore, it is crucial to enhance the network security protection capabilities of key elements in the power system.

Building new power system energy infrastructure with PV as a main energy source in the future

The new power system energy infrastructure is essential for accelerating the energy transition. It takes grid forming as the basic technology, PV+ESS parity as the basic goal, four-dimensional safety as the design principle, and digitalization and intelligence as the key technologies.

- **Grid forming as the basic technology: Shifting PV from supplemental to a dominant source**

Grid forming technology shifts the original energy control of renewables

from current source control to voltage source control. It provides strong inertia support, instantaneous voltage regulation, and fault ride-through, improving active and reactive power control and response capabilities and proactively mitigating frequency and voltage fluctuations. This is an important technology for grid connection. Besides, the transition from grid following to grid forming is priming PV to become a main energy source.

The traditional PV+ESS system uses the current source algorithm and PQ mode for grid following. When the voltage or frequency of the power grid changes abruptly, the traditional system can only follow these changes and is unable to provide stable support for the grid. However, Huawei uses the voltage source algorithm to establish an internal electric potential for the power converter. When a sudden change occurs on the power grid, the internal electric potential can maintain the stability of parameters such as the voltage and frequency for the power converter. In addition, the system can automatically and quickly respond to grid changes based on the tested parameter differences, ensuring power grid stability for an SCR ranging from 1.1 to 20 or higher.

- **PV+ESS parity as the basic goal: Making PV ubiquitous and affordable**

Technological advancements are driving the transition from PV parity to PV+ESS parity. Upgrades and iterations in technology are necessary for PV generation, transmission, and distribution. For example, the power density of PV modules, inverters, ESSs, and arrays needs to be continuously improved to reduce system costs. PV modules are evolving from P-type PERC to N-type TOPCon. It is estimated that TOPCon will replace PERC to become the mainstream PV module technology in 2024. Third-generation semiconductor materials such as high-density silicon carbide and gallium nitride will be widely used thanks to breakthroughs in perovskite technology. With a series of intelligent and digital methods, module-level power electronic devices can precisely manage each string of PV modules, which will improve the energy yield and O&M efficiency of power plants, and reduce the levelized cost of electricity (LCOE) of PV to CNY0.1/W. The price of battery cells will drop to CNY0.25/Wh, and the levelized cost of storage (LCOS) of ESSs will drop to CNY0.4/kWh. Integrating and applying these technologies is the key to continuously reducing the LCOE and LCOS of PV and ESS and further driving industry evolution.

- **Four-dimensional safety as the design principle: Enabling long-term, safe, and stable system operations**

We have transitioned from merely equipment safety to four-dimensional safety to ensure long-term, stable, and reliable operations of the new power system.

Firstly, we have built a secure supply system for the core equipment of power plants. We implement preventive diagnosis and refined management to ensure the safety of each device node in the power system, which guarantees long-term, stable, and efficient operations.

Secondly, we have built a secure and trustworthy network architecture and provided product-level and carrier-grade network security certification to ensure reliable, available, secure, and resilient networks.

Thirdly, grid connection technologies have evolved from adapting, supporting, to enhancing the grid. The digitally smart power grid can implement dispatch prediction and control as well as emergency recovery, leveraging multiple energy sources while ensuring safety throughout the interactions between generation, grids, loads, and storage.

- **Digitalization and intelligence as the key technologies: Facilitating autonomous driving and full-lifecycle digital operations**

The new power system energy

infrastructure in the future consists of hundreds of millions of energy systems distributed in large-scale power plants, campuses, buildings, homes, and electric vehicles. Autonomous driving for the entire power system is possible only when digital technologies are leveraged to achieve intelligence.

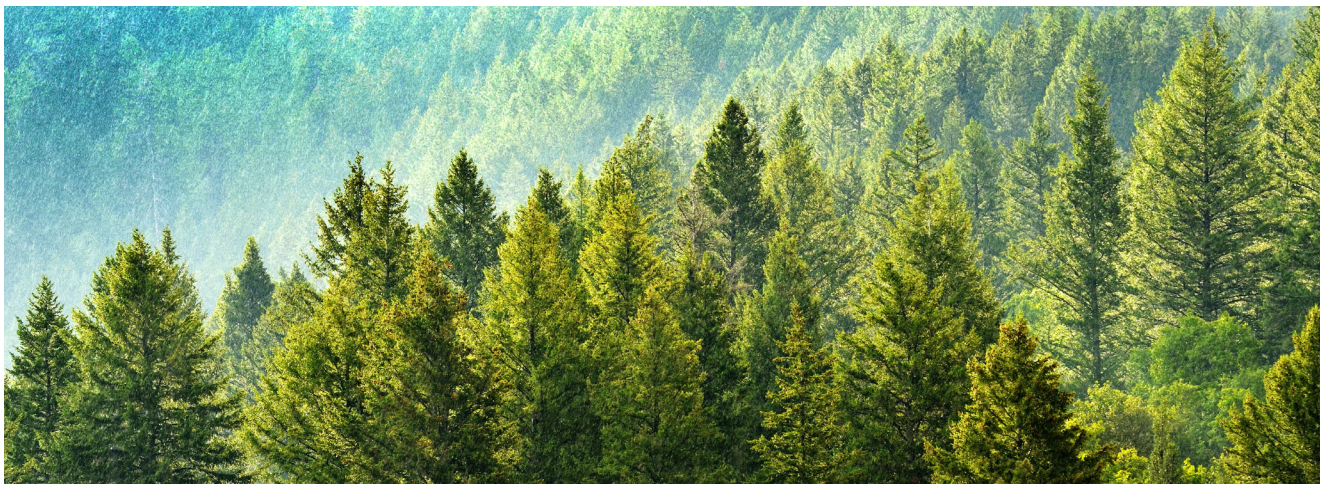
As PV plants become a main source of energy, managing their lifecycle becomes crucial in enhancing asset value. Generally, large PV+ESS plants occupy vast areas, face harsh environments (high altitude and cold weather), and suffer from inconsistent construction quality. Based on ICT technical advantages, Huawei has developed digital solutions that cover the entire plant lifecycle from planning, construction, maintenance, optimization, and operations. The solutions help customers build and operate plants more effectively.

- During plant construction, construction quality evaluation, progress control, and safety management are supported.

- During plant O&M, fault diagnosis and intelligent troubleshooting are implemented across all links for the entire plant.

- During plant operations, performance ratio and grid support capabilities are improved.

Building New Power System Energy Infrastructure with PV as a Main Energy Source, Accelerating Energy Transition and Carbon Neutrality



Enabled by the cloud with tens of millions of data records and AI technologies, residential PV+ESS+charger+load energy systems are intelligently and collaboratively managed, and comprehensive energy management capabilities for C&I PV+ESS+charger are implemented. Ecosystem openness and data sharing continuously support regional energy sharing and free energy integration.

Meanwhile, we believe that the high-quality development of the PV industry requires the establishment of relevant standards and regulatory systems covering safety, construction, interface, control, and management standards for power grids, power sources, loads, and energy storage, so as to improve the synergy of the entire power system.

As a cornerstone of sustainable

industry development, safety is of the utmost importance. It is imperative that safety standards are established such as DC arc detection and rapid shutdown, to ensure the safety of equipment, systems, personnel, and property.

In the future, Huawei FusionSolar will adhere to three strategies to accelerate the construction of the new power system energy infrastructure:

I.Focus on the convergence of 4T (Watt/Bit/Heat/Battery) technologies, increase research and development investment, continuously innovate to lead in technology, and accelerate the development of the solar industry.

II.Collaborate with partners to establish high-quality industry standards and promote healthy development of the industry.

III.Join hands with global ecosystem partners to create, share, and win together, driving sustainability and high-quality development in the industry.

The carbon neutrality goals bring unceasing momentum for decarbonization and intelligence. We will leverage our competitive edge in advancing digital technologies and power electronics technologies. We will work with customers and partners to build an open and win-win ecosystem and build new power system energy infrastructure with PV as a main energy source. The carbon peaking and neutrality targets will be achieved ahead of schedule through the accelerated construction of the new power system energy infrastructure. The robust development of this infrastructure will bring benefits to every home and business. ▲

Collaborative Development of Ultra-Fast Charging and Fast Charging: Comprehensive Acceleration of High-Quality Charging Infrastructure



Bob He

President of Data Center Facility & Critical Power Product Line, Huawei Digital Power

With new rounds of technological revolution and industry transformation, the global new energy vehicle (NEV) industry is developing at full speed. The demand in NEVs is not only injecting strong impetus into countries' economic growth, but is also helping to address climate change challenges and improve the global ecological environment.

After years of fast development in the global electric vehicle (EV) market, S&P Global Mobility recently predicted that the market will continue to grow in 2024. Global sales of electric passenger vehicles will reach 13.3 million,

accounting for about 16.2% of global passenger vehicle sales.

When it comes to China, the China Association of Automobile Manufacturers believes that China's total automobile sales will reach 31 million in 2024 (3% YoY growth). Out of that total, sales of passenger vehicles will make up 26.8 million (3.1% YoY growth), and sales of NEVs will reach about 11.5 million (20% YoY growth).

At present, NEV customers are becoming more and more pragmatic. How to dispel the doubts of major potential major consumer groups and solve the main problems of customers

Collaborative Development of Ultra-Fast Charging and Fast Charging: Comprehensive Acceleration of High-Quality Charging Infrastructure



in using EVs becomes the key for the automobile industry to move toward the era of full electrification.

Although NEVs have outperformed gasoline vehicles in terms of driving and application experience, NEVs still have a lot of disadvantages to overcome, such as long charging time and lack of access to charging infrastructure during major holidays. As a result, many NEV customers become frustrated, and this prevents many customers from choosing NEVs over gasoline vehicles.

Therefore, transformation is much needed.

New era of high-voltage fast charging

The staggering growth of the NEV industry is related to both industry trends and strong government support and customer interest. Correspondingly, the development of NEV charging infrastructure has also gained support from the top-down design. At present, NEV subsidies have been extended from vehicles to chargers as part of the new infrastructure construction.

By the end of 2022, the number of chargers nationwide in China was 5.21 million, and the EV-to-charger ratio reached 2.5:1. It seems that the EV-to-charger ratio is quite acceptable.

However, the truth is, most charging options available are low-power options, while the number of facilities that offer high-power fast charging is insufficient.

Take Shanghai for example. The city is well known as the most important production and sales area of NEVs in China. As of February 2023, the city boasted 147,600 public chargers and 164,900 charging connectors. However, only 10,875 of these connectors are fast charging DC connectors with a power output greater than 120 kW, representing only 6.59% of the total.

This problem will only be more

prominent in cities than other places.

Meanwhile, when more and more people choose private vehicles for traveling long distances, fast charging infrastructure along highways are insufficient, which affects people's travel experience. "Waiting for 4 hours to charge for 1 hour" is a nightmare for customers, which reduces people's interests in NEVs to a large extent.

To address the above issues, it has become the industry consensus to vigorously develop fast charging infrastructure for the public. The public has become accustomed to fueling up and going within five minutes. Therefore, it is expected that NEVs can also achieve quick charging within five minutes.

With the continuous iteration and evolution of charging technologies and the in-depth application of SiC power components with high voltage resistance, low loss, and high power density, the 950 V voltage platform is gradually prioritized by EV enterprises. A 950 V/500 A high-voltage fast charger can provide 480 kW charging power, making charging as fast as conventional refueling.

The continuous evolution of the charging infrastructure is not only an effective means to solve the urgent problems of customers, but also a

necessary condition for the vehicle electrification to reach a higher level. For the fast-growing NEV industry, efficient, safe, and reliable charging infrastructure is essential. Higher charging power and a sounder charging network are urgently required to break range anxiety.

To address the demand for "fast charging within 5 minutes", a brand-new innovative charging cradle, the 1000 V high-voltage architecture, emerges. High-voltage fast charging starts to ramp up.

Facilitating industry development with innovative solutions

Currently, the 1000 V charging platform has been included in the latest version of the high-power fast charging interface standard for passenger vehicles, ushering in a brand-new 1000 V fast charging era. It is obvious that the future development of high-voltage fast charging has been recognized and is expected to enter the fast lane.

High-voltage fast charging is a game-changer that promises to revolutionize the charging experience and enhance the healthy development of the entire industry chain. On one hand, the charging advantage brought by the high-voltage architecture will become the core selling point of the product, thereby improving the overall

competitiveness of EV enterprises.

On the other hand, high-voltage fast charging can increase the return on investment (ROI) of the chargers. By serving more customers in a shorter period of time, chargers reduce fixed costs associated with capacity expansion. This enhances the service capability and significantly reduces the footprint of the chargers.

In recent years, the sales of high charging power models in China have continued to rise. According to the released plans of 800 V plus high-voltage fast charging models in major EV makers, it is estimated that by the end of 2026, the market penetration of high-voltage fast-charging models will exceed 13 million.

With high-voltage charging infrastructure lagging behind, coverage becomes a major issue where collaborative efforts are urgently required from EV enterprises, ICT vendors, and charger operators. In addition to quantity, the quality, reliability, and stability of the charging infrastructure must also be considered.

According to data from the China Electricity Council, among the existing DC chargers in operation, 500 V chargers account for 36%, 750 V chargers account for 60%, and 1000 V chargers account for less than 4%. Based on the current ratio of EVs to

Collaborative Development of Ultra-Fast Charging and Fast Charging: Comprehensive Acceleration of High-Quality Charging Infrastructure

chargers, it is estimated that additional 980,000 1000 V DC chargers will be needed between 2023 and 2026 in order to accommodate the projected 13 million high-voltage fast charging vehicles.

As the main direction of charging infrastructure evolution, the prospects of ultra-fast charging and fast charging cannot be underestimated. At the same time, the manufacturers of EVs and the chargers are also required to work together closely.

To meet the requirements of EV enterprises for ultra-high voltage technologies and solutions, Huawei Digital Power has developed an innovative high-voltage platform solution to help continuously

improve the competitiveness of EVs. In 2023, Huawei released a 900 V efficient high-voltage drive platform, achieving 5-minute charging for a 200 km cruising range. In the future, the charging time may be further shortened.

In consideration of device overheating caused by high-voltage fast charging, Huawei introduces the fully liquid-cooled ultra-fast charging technology: Based on traditional air cooling technology, Huawei Digital Power introduces the liquid cooling module to remove the heat generated inside the devices through liquid circulation.

Ideally, the technology supports ultra-fast charging, with higher equipment reliability and longer service life.

In addition, this technology is compatible with all EV models and can automatically adjust the output power and current based on the requirements of different EV models, achieving a one-time charging success rate of up to 99%.

Accelerate the implementation of " high-quality charging anywhere"

Huawei Digital Power has long been committed to the convergence of digital technologies and power electronics technologies. It advocates the PV+ESS+Charger integration solution and application model to accelerate transportation electrification and facilitate the innovation and development of transportation and energy convergence.



The global concept of green and low-carbon development and the "carbon neutrality" goal of major countries provide a broad market space for PV+ESS+Charger integration. In line with low-carbon energy transformation, PV+ESS+Charger integration will witness rapid development in the foreseeable future.

At a country level, China has released policies such as Smart PV Industry Innovation and Development Action Plan (2021-2025), Notice on Organizing and Carrying Out the Pilot Work of Pioneering Zones for Comprehensive Electrification of Public Sector Vehicles, and Accelerating the Construction of Charging Infrastructure to Better Support New Energy Vehicles Going to the Countryside and Rural Revitalization. These policies are to support the integrated application of PV power generation, energy storage, DC power distribution, and flexible power consumption technologies, and to promote the application of PV+ESS+Charger integration projects in various fields.

Under the conditions, the construction of the PV+ESS+Charger industry is improved and accelerated, and the application scenarios of PV+ESS+Charger integration are continuously implemented. In the field of NEVs, PV+ESS+Charger is recognized as one of the ideal solutions to solve

the imbalance between EVs and chargers, and is also an innovative attempt in the construction of NEV charging stations.

In PV+ESS+Charger integration, electric energy is stored in ESSs during off-peak hours, and is discharged to support ultra-fast charging loads at peak hours. This is to provide green electric energy for NEVs, achieve peak shaving, reduce the energy cost, and improve the system operating efficiency.

With the innovative PV+ESS+Charger solutions and the DigiPower Management Platform, Huawei Digital Power supports energy dispatch management, PV+ESS integration, and high-power ultra-fast charging, enabling fast charging services similar to refueling services and continuously creating value for the industry.

In the future, with the continuous upgrading of EV models, a faster, more convenient, and safer charging experience can be provided from the following dimensions.

- First, collaborate with EV enterprises to interwork EVs and ultra-fast charging protocols. This will solve the charging compatibility problem of different EV models, and achieve high-power fully liquid-cooled ultra-fast charging, realizing charge-and-go.

- Second, leverage multiple ecological partners and EV-network synergies to streamline multiple platforms. This will realize digital diversion, so that EV customers can enjoy more convenient charging services.

- Third, use the controller, motor, and battery systems with the collaborative all-round design. Charging can be shut down in milliseconds upon exceptions, and alarms are generated when batteries are faulty, to ensure personal and vehicle safety during charging.

In 2024, with the fully liquid-cooled ultra-fast charging solution, Huawei Digital Power will work with customers and partners to deploy more than 100,000 Huawei fully liquid-cooled ultra-fast chargers in more than 340 cities and major highways in China, realizing "high-quality charging anywhere" and comprehensively breaking the range anxiety of NEV customers. We firmly believe that the nationwide application and deployment of fully liquid-cooled ultra-fast charging technology will continuously accelerate the construction of high-voltage and high-quality charging infrastructure in the EV industry, providing a strong guarantee and longer range for EVs. By promoting the strategic development of NEVs, we will help achieve the "carbon neutrality" goal and truly realize social, livelihood, and economic benefits. ▲



Building Smart and Efficient Power Domain Solutions for New Energy Vehicles to Boost Industry Development



Chao Wang

President of the eMobility Product Line,
Huawei Digital Power

Against the backdrop of the global carbon neutrality initiative, electric vehicle (EV) development has become a common aspiration of automobile industry players. China's new energy vehicle (NEV) market —the largest in the world — is embracing more opportunities. As of 2023 Q3, NEV penetration in China reached 32.1%, nearly 6 percentage points higher than in 2022.

With NEVs continuously penetrating people's life and progressing toward intelligence, consumers are paying

closer attention to charging, range, and cost — three major concerns for the development of the NEV industry. The range anxiety and charging anxiety in the past few years have driven an increase in the battery capacity of NEVs, resulting in heavier vehicles. Instead of seeing a linear growth in the range consistent with the increasing battery capacity, NEVs are facing a deteriorating revenue. As such, low manufacturing costs and short development periods have become the core competitiveness among automakers.

Facing the preceding concerns, the NEV industry has developed technical roadmaps for multi-path charging and refined energy consumption. In order to improve the charging experience and make it similar to refueling a car, high-voltage fast charging solutions are becoming a mainstream choice for mid-range and high-end NEVs. Up to 41 high-voltage NEV models were launched in 2023, compared with just 7 models in 2021, about a six-fold increase in just two years. In terms of energy consumption, the industry is paying more attention to energy efficiency. An additional 1% in the electric drive efficiency achieves a 1.5% longer range. As the largest energy consumption subsystem in an NEV, the power domain is facing higher scrutiny from automakers on improving the overall efficiency.

Building a high-voltage power domain improves the charging experience by extending the range without additional batteries. Under the same range requirements, new technologies are emerging to achieve optimized battery configurations, lighter vehicles, and lower vehicle costs, accelerating the positive development of the industry. The advancement of efficient and high-density powertrain technologies will not only pave the way for more NEVs to adopt the high-voltage power domain solutions, but will also drive the third-generation semiconductor industry

toward maturity, facilitating the wider application of SiC modules from high-end NEV models to economical models.

With the in-depth application of high-voltage and efficient technologies and future-oriented evolution, the power domain is seeing three major trends: full electrification, EV intelligence, and AI cloudification.

Full electrification

The maturity of power domain technologies is improving the overall driving experience, with a continuous decrease in the power domain latency paving the way for autonomous driving technologies. Driven by both advances in technologies and favorable market conditions, the current power domain and electric drive systems will be converged into one system that consists of electric drive, braking, steering and suspension.

Among the drive, braking, steering, suspension, and control systems, the electric drive system achieves higher kinetic energy recovery, lower NEV energy consumption, and longer range; the electric braking system brings a safer and more comfortable driving experience, lower NEV energy consumption, and longer range thanks to less brake drag from the electric caliper. With the application of electric steering and electric suspension in high-end NEV models, more agile

control and smoother driving will bring a revolutionary driving experience to users. In the future, the application will expand from high-end NEV models to mid-range and lower-end NEV models on a large scale.

EV intelligence

Following the full electrification trend, EV intelligence begins by building an intelligent "brain" in the power domain. Effective measures have been taken to implement integrated control over and intelligent collaboration between the drive, braking, steering, and suspension systems in the power domain, expand the safety coverage of the power domain, create a more comfortable driving experience, achieve agile control, and improve NEV quality to the next level. For example, through the integrated control of both the drive and braking systems, the braking distance is reduced from 37 meters to 30 meters, the high-speed obstacle avoidance distance is reduced from 35 meters to 25 meters, and energy efficiency is improved.

On the basis of integrated control over the power domain, power and thermal components also tend to share a collaborative control with it. For example, in low temperature environments, the traditional cabin and battery heating use independent temperature control solutions such as the PTC and climate control. However, the heat dissipated from

the drive system and electric control system is not effectively used, and therefore the heat management path needs to be optimized. These heat sources that adopt differentiated collaboration strategies based on different working conditions require further research and development to maximize energy use efficiency, which has great potential. Currently, the industry has seen divided technical routes, including power convergence, "power + heat" convergence, and "power + heat + control" convergence. In further innovative technical research, the power domain will advance toward the ultimate convergence of power, functions, chips, and domain controllers, achieving high performance with a simple architecture. On the one hand, the real-time response of the power system is greatly improved. On the other hand, the energy efficiency of the entire EV is maximized. Through AI-based optimization management of the energy flow of the entire EV, the range in winter is significantly extended. In addition, ultimate convergence will shorten the loop path, reduce the number of ports and components, unify chip types, and shorten the development interval, continuously improving the competitiveness, reliability, and supply assurance capability of EVs.

AI cloudification

The intelligent power domain forms



the foundation of AI cloudification and is on track to evolve from an electric power domain to EV intelligence and to AI cloudification with the support of ICT technologies. In addition, the power domain features data synchronization and device-cloud synergy, achieving zero breakdown in the power domain of the entire EV.

By streamlining the lifecycle of design data, incoming material data, production data, test data, running data, and maintenance data, a comprehensive data profile is established for the power domain of each NEV. Then, through the collaboration between the NEV running status and cloud-based AI, the power domain status is visualized, risks can be warned, and faults can be diagnosed and traced to prevent recurrence. The AI cloudification of the power domain is an important part of the in-depth development of the NEV

cloud system from data collection to intelligent applications. Currently, the AI-based big data analysis model of Huawei DriveONE-Cloud has been implemented in power electronics R&D, design, and manufacturing processes, greatly improving the first pass yield (FPY) of electric drive system products. Huawei will further deepen the application scope of AI cloudification and create more value for the full-lifecycle application of NEVs.

In the next three to five years, the NEV industry will continue to grow rapidly, which will bring far-reaching benefits to the future intelligent EV industry. Huawei DriveONE will work with partners in the industry chain to accelerate full electrification, EV intelligence, and AI cloudification of the power domain, helping automakers improve the value of NEVs and accelerate the full electrification of the automobile industry. ▲

Intelligent and Green: a Leap Forward in the New Digital Industry Energy Infrastructure



Bob He

President of Data Center Facility & Critical Power Product Line, Huawei Digital Power

As the saying goes, "a journey of a thousand miles begins with a single step." Global concerted efforts are well underway for the journey toward digitization and decarbonization, and to propel the high-quality development of the digital economy and society, a sound energy infrastructure for the digital industry must be constructed and developed in an innovative fashion.

The new digital industry energy infrastructure will contribute to carbon peaking goals

Stable and reliable energy acts as the main cog for driving forward the national economy, improving people's livelihood, and long-term social stability. Driven by digital and power electronics technologies, the energy infrastructure

for the digital industry will lay a solid foundation for digital transformation across various industries. It will promote the convergence of digital and real economies while functioning as a powerhouse for carbon neutrality.

China has ramped up its investments in new infrastructure in recent years, which is helping expand domestic demand, driving technological innovation and industry development, and feeding new needs with high-quality supply. Building reliable, efficient, and green energy infrastructure for the digital industry is a top priority for industry innovation, and enterprise development. With the launch of the East-to-West Computing Resource Transfer program in China, more innovative technologies and business models are required to

support the centralized and intensive development of data centers in different regions. The program also poses strict requirements on the power usage effectiveness (PUE) of data centers in the eight national computing hubs. The PUE of data centers in western China must be lower than 1.2, and that in eastern China must be lower than 1.25. All of the above has set a new direction for the construction of digital industry energy infrastructure.

To accelerate carbon neutrality, the digital energy industry awaits urgent transformation. Decarbonization, electrification, digitization, and intelligence are key pathways for such a transformation. And energy is pivotal to both social and economic development, and the energy industry

should embrace digital technologies to promote infrastructure advancement and industrial chain modernization in the new era. To accelerate the digital and intelligent development of the energy industry, in addition to contributing to carbon peaking and neutrality, new infrastructure that integrates conventional energy with digital and intelligent technologies must be thoroughly developed. According to industry practices, delivering more bits while consuming fewer watts and reducing energy consumption and carbon emissions per bit has become a consensus for product and solution innovation in developing the new digital industry energy infrastructure. Such an insight has exerted an in-depth influence and is penetrating numerous fields, such as data center facility, site

power facility, and critical power supply.

Today's world is in the midst of great changes that have not been seen in a century. Major players in various sectors, including infrastructure and energy, are exploring feasible pathways toward sustainability. More digital and intelligent energy infrastructure should be constructed, and such infrastructure should empower data center development and enterprise digital transformation, ultimately boosting the high-quality development of the digital economy. For example, energy infrastructure armed with digital and intelligent technologies will not only play a key role in power supply, but will also be integrated into smart cities where power generation, grid, loads, and energy storage are

well collaborated. The infrastructure will not only be applied to energy consumers, but also regulators of energy production and power systems. In this way, the digital industry energy infrastructure will gain momentum in a broader context.

Data center facility: exploring the shortest path to carbon neutrality with computing and intelligence

Computing is the future. As one of the most important contributors to productivity, computing creates huge value for various industries and is therefore regarded as the fuel of the digital world. The future will also be intelligent. A new wave of AI represented by foundation models is making the impossible possible. Intelligent applications are unleashing the demand for computing, creating greater computing power and extending the boundary of intelligent applications.

An upsurge of computing and intelligence leads to surging electricity demands. Currently, there are more than 20 million data center racks and 10 million telecom sites around the world. These numbers will double in the future, posing both a challenge and an opportunity for the data center facility market. According to the Action Plan for High-Quality Development

of Computing Infrastructure, energy computing application centers should be built at a faster pace to support intelligent energy production scheduling systems with synergy between power generation, grids, and loads, multi-energy complementation, and intelligent control of energy consumption demands. Leading enterprises are encouraged to construct green, smart, and customized data centers that leverage existing energy resources and match actual application requirements to deliver computing power that integrates energy, service, and data flows.

Undoubtedly, green, simple, smart, and reliable digital infrastructure is necessary for enterprises to carry out digital and intelligent transformation, which is also true for data center facilities and critical power supply.

1. The simple design enables fast and cost-effective construction of data centers.

Thanks to technological advances, diverse applications such as cloud computing, big data, and AI have emerged. As the world has been witnessing the evolution from conventional data centers to cloud data centers and then to intelligent computing centers, the data center architecture has become increasingly complex. The consequent challenges

include high density, soaring energy consumption, difficulties in capacity expansion, troublesome operations and maintenance (O&M) management, and low reliability. Therefore, simplified data center infrastructure construction that includes streamlined deployment, O&M, and full-lifecycle management must be taken as a top priority.

It is estimated that the compound annual growth rate (CAGR) of global computing power will exceed 50% in the next five years. Different from traditional applications, intelligent applications usually have a surging demand for computing power in a short period of time. For example, ChatGPT hit 100 million monthly active users only two months after its launch. To strong demand, data centers should be deployed faster to accelerate service rollout. As intelligent computing develops rapidly, the power density per rack becomes higher and the power consumption of devices such as servers and chips keeps increasing. It is challenging to reduce power consumption while meeting the requirements for rapid service growth.

Modern data centers are defined by large scale, fast IT service rollout, and difficulties in predicting service requirements. Newly built and reconstructed data centers must address challenges facing



traditional data centers, such as long construction period, high capital expenditure (CAPEX), and cumbersome O&M. Prefabricated and simplified architectures at system and data center levels, as well as the modular design of components and prefabrication of products, can be used to facilitate equipment installation, maintenance, and capacity expansion. In terms of data center energy supply, prefabricated modules can be adopted to deploy highly integrated power supply and cooling systems. Such an integrated and prefabricated architecture will simplify O&M management and reduce costs.

In terms of data center cooling, modular and distributed cooling solutions are widely recognized by customers and are becoming the preferred substitutes for centralized

cooling solutions. A distributed cooling system sets cooling sources for each data hall and adopts redundancy configuration as required, greatly improving the reliability of the data center. In addition, the distributed cooling system can be easily prefabricated, reducing onsite engineering workload and simplifying O&M.

In practice, Huawei's FusionDC ecosystem solution uses prefabrication and modularization technologies to turn engineering works into products and products into modules. The solution can shorten the construction period of a data center with 1000 racks from over 18 months to 6–9 months, accelerating service rollout.

1.O&M must be automatic and intelligent.

It is an inevitable trend to empower data center O&M with intelligent technologies. As the number and scale of data centers keep growing, not only does the management complexity increase considerably, but O&M professionals are becoming more difficult to recruit. To cope with the challenges, it is necessary to improve the level of digitalization, intelligence, and automation in data center infrastructure. In response to the call for carbon neutrality, digital and intelligent technologies can be used to empower data center O&M management by shifting the focus from energy consumption to carbon emissions. Intelligent approaches can maximize O&M efficiency, optimize energy efficiency, and facilitate full-lifecycle carbon management.

Huawei's iCooling energy efficiency



optimization technology can help data centers achieve a designed PUE in actual operation thanks to intelligent cooling. For example, the technology can reduce the PUE by 8%–15% for a data center that uses a water-cooled chilled water system.

2. Reliability is the top priority for data center evolution.

Only reliable data centers can provide support for steady business operations. Facing numerous security threats or attacks, data centers must build comprehensive defense lines covering architecture security, proactive security, and cyber security.

From the perspective of data center solutions, predictive maintenance must be implemented at the system, component, and device levels, and hardware reliability and system resilience must be enhanced. As cyber security threats multiply, data center facilities will put more emphasis on software security, privacy, and availability, and hierarchical defense can ensure security and reliability for data centers. In short, hardware reliability, software security, system resilience, security, privacy, and availability are prerequisites for the continuity and reliability of data center services.

As for data center solutions, Huawei DCIM, with iPower, provides functions such as component life prediction and temperature prediction for the data center power supply and distribution system. From passive maintenance to proactive warning, Huawei DCIM ensures system safety and reliability. In addition, Huawei DCIM utilizes multiple techniques, such as transmission encryption and storage hardening, and carrier-class security design standards to provide all-around data security assurance.

As for energy security, as the proportion of new energy access

increases gradually, it poses huge challenges to the stability of the power grid and power consumption as the power generation of new energy is highly volatile and unpredictable. Deploying energy storage is the best way to avoid these disadvantages. Looking into the future, when deploying energy storages in data centers, we should give priority to mitigating the unreliability of green energy, and optimize the energy storage connection mode to achieve load peak shaving. This can lower the peak PUE and operational expenditure (OPEX) of data centers and reduce the use of diesel fuel. It seems almost inevitable that energy storage will be integrated with the short-term backup power system of data centers, providing extra assurance for data center reliability.

3.Going green is the only way forward and the responsibility lies firmly on our shoulders.

For an enterprise to sustain and thrive, environmental, social, and corporate governance (ESG) is not only social responsibilities and business standards, but also standards of operation and management that must be put in place. At the data center level, improving the utilization of energy and resources and reducing the impact on the environment are the best ways to practice ESG.

Driven by the goal of "carbon neutrality", the data center industry will undergo profound changes, and low-carbon data centers will become mainstream. Clean energy will be widely used, energy-saving technologies will be promoted, and low-carbon technologies such as the recycling of excess heat in the recovery stage will gain momentum in data centers. We can maximize energy utilization and minimize environmental impact only through efficient energy utilization, high-density deployment for saving space, and full-link carbon emission reduction.

For instance, China's East-to-West Computing Resource Transfer program aims to explore new ways in energy conservation with strong emphasis placed on intensive operations, large-scale development, and environmental protection. Moving forward, clean energy such as solar and wind will gradually replace fossil fuels and be widely used in data centers. PUE is still a major indicator to measure energy efficiency in data centers. According to the Uptime Institute, the PUE of most new data centers can reach 1.3 to 1.25. With stricter policy requirements and rapid technology evolution, more and more advanced energy-saving technologies will be widely applied in data centers, further reducing PUE.

It is worth noticing that heat recovery, a new energy-saving solution, has been successfully implemented in several large-scale data center campuses. Excess equipment heat in data centers is transported to other facilities through hot aisles, thus improving waste heat utilization and saving energy costs. At present, data centers at home and abroad are encouraged to make full use of the waste heat from cabinets. This is also an important way for data centers to move towards low carbonization.

In Huawei's innovative practices, its indirect evaporative cooling EHU, with hardware such as the AeroTurbo fan and IceCube macromolecular heat exchanger core, can maximize the use of natural cooling sources, reduce the number of times that heat is exchanged, and shorten the cooling link, saving water and electricity by up to 60%.

Site Power Facility: building a green and low-carbon network

As we see that the overall scale of the industry will be further expanded, the development quality will be significantly improved, and a new digital infrastructure will be built that is high-speed and ubiquitous, integrated and interconnected, intelligent and green, and secure and reliable. Currently, operators are implementing high-

quality development as well as green transformation, and are upgrading through the digital and intelligent management of carbon assets.

As intelligence and digitalization further penetrates more members of society, more operator networks need to evolve, especially as the level of intelligence continues its steady rise. Problems such as soaring energy consumption and high carbon emissions are beyond the capability of traditional site deployment methods. As for core Site Power Facility, operators should build a full-scenario and full-lifecycle low-carbon target network covering green site construction, green power supply, and green operation. This is in an effort to achieve sustainable network development with a minimal environmental impact.

1. Green network construction: Site construction can be simplified and energy efficiency can be improved.

In the past, communication sites were built indoors or in cabinets, resulting in low efficiency and high costs. Furthermore, operators tend to have multiple types of live networks that include the 2G to 5G range, and with the exponential development of 5G sites, construction costs have skyrocketed. Against this backdrop, operators need to find ways to reduce construction costs. Simplified and green

sites can break through this bottleneck while reducing carbon emissions. Specifically, traditional room sites are replaced with cabinet sites with reduced construction workloads and a shorter TTM; cabinets are replaced with poles with zero footprint and quick deployment. The modular and integrated design, such as one cabinet for one site and one blade for one site, makes site devices more applicable and operatable. Besides, it greatly reduces site deployment complexity, and improves maintainability. By combining all of the above, the efficiency of cabinet sites is increased to 90% and that of pole sites to 97%, compared with 60% for traditional sites.

This is also true for the construction of green equipment rooms. In Huawei's iSuperSite solution, one cabinet is deployed, eliminating the need to build an equipment room. This raises the energy efficiency from 60% to 90%. When expanding the capacity of an existing equipment room, we can reach an energy efficiency of up to 75% as only one cabinet is needed.

As the advocate and practitioner of simplified sites, Huawei has developed a solution that can meet the power demands of communication devices of all frequencies at a site with a 12 kW blade power supply; in its iSuperSite solution, one cabinet can provide the

same power supply capacity as an equipment room, simplifying network construction and cutting carbon emissions.

2. Green power supply: Green power is becoming a main power source, and the benefits can be seen immediately.

With the world going carbon neutral and gravitating toward cleaner forms of energy, various green power sources are deployed for power supply at communication sites. Solar is gaining popularity in more sites, and wind power and hydrogen are now alternatives to utility power in some remote areas. Driven by technological advancement and business model transformation, cost-effective and low-carbon power supply is now a preferred choice in site construction.

Huawei promotes green electricity at sites based on scenarios and power supply options. In Huawei's hybrid power supply solution, multiple energy sources are intelligently scheduled, and solar, utility power, gensets, and energy storage are provided for areas that have no utility power or where conditions are unstable, so as to reduce or eliminate dependence on gensets. This can cut the levelized cost of electricity (LCOE) and carbon emissions, and improve power supply stability. For areas with high utility power prices, Huawei's solution can

maximize the consumption of green energy and reduce electricity fees and carbon emissions.

3. Green operation: Intelligent management cuts cost and carbon emissions, and VPP unleashes the value of site energy storage.

Following the green trend, operators are now aiming at intelligent operation and simplified O&M, with a shift from basic O&M management of power and environment monitoring systems to intelligent management of site energy efficiency and carbon emissions. In the future, intelligence will be added to sites from three aspects. First, intelligent O&M management. The whole site can be managed and controlled by adopting technologies of digital data collection, sensing, and communication. Second, intelligent management of energy efficiency. Emphasis is placed on the efficiency of the entire network with technologies of big data analytics, multi-energy management, and energy control. Third, intelligent management of carbon emissions. Carbon emissions of the whole site can be visible, manageable, and optimized by employing technologies of artificial intelligence and low-carbon capability analysis and prediction, which ensures the flexible scheduling of carbon emissions and free flow of energy.

Huawei is one step ahead in making

sites more intelligent. For instance, Huawei's CloudLi smart lithium battery realizes intelligent energy storage, a leap from simple backup power, which facilitates intelligent intra-site collaboration, saves end-to-end investment in energy storage, and fully unleashes the value of energy storage. In addition, with Huawei's NetEco (a network management system), site energy efficiency and carbon emissions can be made visible, manageable, and optimized, thus improving O&M efficiency and site reliability while reducing O&M costs.

With a larger share of renewable energy in power generation and electrification of power consumption, more complicated loads will emerge, broadening the gap between electricity prices in the power market. Given the above, the virtual power plant (VPP) will be a powerful supplement to the global power market with a closed-looped business model.

Operators/Tower vendors tend to run numerous sites, and communication sites are deployed in places where electricity demands are generated, a large number of distributed energy storage devices (such as lithium batteries) are used, and these sites are heavily loaded. Having these advantages, operators/tower vendors can participate in the VPP market by

increasing the energy storage capacity to existing sites as well as deploying and upgrading secure service platforms. In this way, they can benefit from grid-network collaboration, turn themselves into energy producers and sellers rather than energy consumers, and mobilize the energy infrastructure on the live network. This means the VPP can provide new ways for operators/tower vendors to contribute to the green development of electricity.

Driven by digitalization, intelligence, and decarbonization, there are numerous similarities between the construction and application of energy infrastructure in the digital industry, including data center facilities and site power facilities. They share many similarities whereby digital technologies are used to simplify energy infrastructure architecture, improve efficiency, cut carbon emissions, and facilitate automatic and intelligent O&M management. In addition, power backup and energy storage are integrated and VPPs are applied, ensuring the reliability and stability of systems and echoing the call of green development. The combination of innovative concepts, technologies, and business models will advance the evolution and upgrading of the digital industry energy infrastructure, which will in turn support the green and sustainable development of enterprises. ▲



Qinghai Golmud: a Decade of Solar Innovation and Pioneering

The Qinghai-Xizang Plateau is the source of the Yangtze River and the Yellow River. Located in the hinterland of the plateau, Golmud City has witnessed the rise of Huawei Digital Power's PV business. In Golmud, we achieved innovative breakthroughs and worked diligently in a down-to-earth and united manner to create value for customers and partners. From snow plateaus to deserts, from cities to the countryside, we distribute green energy to thousands of households. At Huawei Digital Power, we make solar dreams a reality.



Jinlong Hou

Director of the Board of Huawei
President of Huawei Digital Power

Golmud means "a place with many rivers" in Mongolian. Located in the hinterland of the Qinghai-Xizang Plateau in Qinghai Province, China, it lies nearly 3000 m above sea level and has a rugged terrain. In the 1950s, Golmud witnessed the construction of the Qinghai-Xizang Highway. It was also the starting point of the second phase of Qinghai-Xizang Railway. Now, Golmud serves as a hub that connects to Lhasa, the Kunlun Mountains,

grasslands, and deserts.

Decades later, Golmud has not only witnessed the rise of the PV industry, but has played an important role in the high-quality development of Huawei Digital Power for more than 10 years. Huawei's first ever string inverter and Smart PV solution were deployed in Golmud. Together with our customers, Huawei has created a new green energy milestone, spearheading industry development.

Golmud is not only a geographical name, a project code, but also embodies the spirit of energy industry practitioners. Such spirit has two meanings. One is to understand customers' real needs in daily operations and solve problems. The other is to be open to and capable of innovations that are valuable to customers. The spirit of Golmud drives us to work together, pursue excellence, and continuously create value for both customers and partners.

Understand customers' real needs in daily operations and help them solve problems

In 2012, I headed up a team that went to visit Golmud. On the vast and boundless deserts under the Kunlun Mountains, we were deeply impressed by the scene in front of us. Rows of PV panels stood under the sun and stretched endlessly for several kilometers. When we met our customers, the most frequently asked questions are: What is the difference between Huawei's products and other products in the market? What value can Huawei's products bring?

During our visit, we found that the mainstream central inverter at that time had various problems, mainly due to the windy and sandy environment in northwest China. Firstly, a large amount of dust

accumulated on the equipment every day, resulting in a cleaning workload that was excessively high. Secondly, the equipment was damaged frequently, requiring onsite repairs by experts, which took at least one to two weeks. Thirdly, if a PV panel was faulty, hundreds of thousands of PV panels needed to be checked one by one to locate the fault. Fourthly, as inverters were large, they needed to be installed in dedicated buildings with air conditioners, requiring protective measures against sandstorms and water as well as engineering work such as building cable troughs and burying cables under the ground. These problems reduced power generation efficiency and affected the levelized cost of electricity (LCOE).

Therefore, we were presented with these challenges: Can Huawei's equipment be sand-proof and waterproof, withstand extreme temperatures, and support outdoor installation without air conditioners? Can Huawei's equipment be easy to operate, compact in size, and controlled intelligently?

From products to business models, we are open to and capable of innovations that are valuable to customers

To address the preceding pain points, we put forward a bold idea:

replacing the traditional central inverters with string inverters which feature the IP65 protection rating, support a wide operating temperature range from -40°C to $+55^{\circ}\text{C}$, and are both waterproof and sand-proof. Such inverters are resilient to extreme heat and cold, sand, and dust, help increase the energy yield, feature a long service life, and reduce construction and maintenance costs. However, we were not only facing technical challenges, but were also under great pressure with strategic trade-offs. After in-depth discussions and multiple verifications, we chose the more difficult technical path of string inverters. At this time, the customer gave us a chance to prove ourselves — an 8 MW pilot project.

Through this pilot project, we finally verified that the smart string solution increased power generation efficiency, reduced equipment and operations and maintenance (O&M) workloads, and enhanced user experience. In terms of reliability, the multi-MPPT function and highly precise MPPT management eliminate interference caused by shading and voltage mismatch to different PV strings, significantly improving the energy yield. At the same time, the overall intelligence level of the system is greatly improved, effectively reducing the LCOE



throughout the lifecycle of the PV plant. It is worth noting that the inverters are protected to IP65 in the string design for the very first time. In terms of heat dissipation, thermally conductive materials, thermal simulation, and a fan-free design are used to ensure optimal cooling performance while the device runs stably. In terms of O&M, the Smart I-V Curve Diagnosis is able to scan a 100 MW PV plant in only 10 minutes and generate detailed reports. Digital technologies help accurately locate faults, significantly improving O&M efficiency and making system maintenance faster and more accurate.

To innovate the business model, we think outside the box and focus on creating value for customers, adhering

to the principle of higher revenue with equal investment for customers' power plants. We shift from providing inverters to a full set of Smart PV solutions. We offer an edge in LCOE throughout the plant lifecycle rather than price competition. Our quotation is changed from quantity-based and carrier-based to power-based, which is more commonly used in industry. We firmly believe in impressing customers with value and winning customers with professionalism and perseverance.

Nowadays, string inverters have become the mainstream in the industry, and the innovation in Golmud leads the development of the PV industry. The once barren desert has become a prosperous land, where power is generated on the panels as

sheep graze unperturbed below. The harmonious symbiosis of technology and nature lights up thousands of households on the plateau.

From humble beginnings in Golmud and a decade of hard work, Huawei Digital Power continues to grow with its customers, achieving numerous breakthroughs for shared success. The support and trust that our customers have placed in us serve as a progressive driving force, illuminating our path of continuous innovation and progress against all odds. In the future, we will adhere to the spirit of Golmud, integrate digital and power electronics technologies, develop clean power, and enable energy digitalization to drive energy revolution for a better, greener future. ▲



Building a Fully Connected, Intelligent World

Fusionsolar

Making the Most of Every Ray

FusionSolar Grid-forming Solution



Commercial & Industrial Smart PV Solution

Residential Smart PV Solution



The Red Sea Project: a City Powered by 100% Clean Energy

The Red Sea Project (TRSP) is attracting worldwide attention. With construction expected to be complete by 2030, it will be powered by 100% clean energy, marking a milestone in the transformation of global energy mix.

The Red Sea, located between Asia and Africa, is the youngest ocean on Earth. Not only is it a natural world wonder, but also one of the world's most important oil transportation routes. Now, a new oasis is about to appear.

TRSP, covering an area of about 28,000 square kilometers, is located on the Red Sea coast in Saudi Arabia, where a pioneering project in green and low-carbon transformation is taking place. This project is also an important part of Saudi Vision 2030.

After completion, it is expected that about 1 million tourists will visit the 100% clean energy powered city each

year. The power source of TRSP comes from a 400 MW PV + 1.3 GWh energy storage project, the world's largest microgrid energy storage project so far.

Following the global carbon neutrality trend, Saudi Arabia hopes to explore new energy paths with this project, and reduce its high dependence on the oil industry by promoting a diverse economic development strategy.

A new miracle standing by the Red Sea

As the world's first GWh-level stand-alone microgrid project with 100% renewable energy, TRSP is powered by the PV and energy storage system

(ESS), with just a few gensets for backup. Therefore, the system must meet high requirements on stand-alone and stable operations.

In addition, the project is subject to adverse weather conditions in the Red Sea region. The highest temperature in summer exceeds 50°C, and the environment also has high humidity and a high concentration of salt in the air due to the project's proximity to the sea (only 100 m away from the sea at its closest part). As a result, the transportation, construction, and operations and maintenance (O&M) of the project are highly challenging, and the available capacity and service life of the ESS may be deteriorated.

Building a GWh-level renewable microgrid from scratch in the desert near the sea involves a complete process of power generation, storage, and consumption and multidisciplinary technologies. There are no related standards or key technologies to refer to as the project is the first of its kind in the world.

In October 2021, Huawei Digital Power and SEPCOIII Electric Power Construction Co., Ltd. signed a contract for the energy storage project in TRSP, Saudi Arabia, helping ACWA Power build a clean energy city.

In this project, Huawei provided the

microgrid solution with the Smart String PV Controller and Smart String ESS as the core equipment. Based on its technological strength, Huawei deeply integrates digital and power electronics technologies to overcome various technical difficulties. For example, through technologies such as digital twin and simulation, Huawei's team, which is made up of PhD experts, built the entire grid simulation model of TRSP in less than one month and completed all-round verification under multiple conditions. In the Huawei lab in Shanghai, the world's largest 8.8 MW microgrid test platform was built to simulate various working conditions in the actual operation of large microgrids, ensuring solution reliability.

A miracle is appearing here.

A new city rising in the desert

Electricity is indispensable in our work and life. If a power outage occurs, electrical appliances such as elevators, lights, and phones cannot be used, and various institutions and buildings including hospitals, shopping malls, and schools, may stop running.

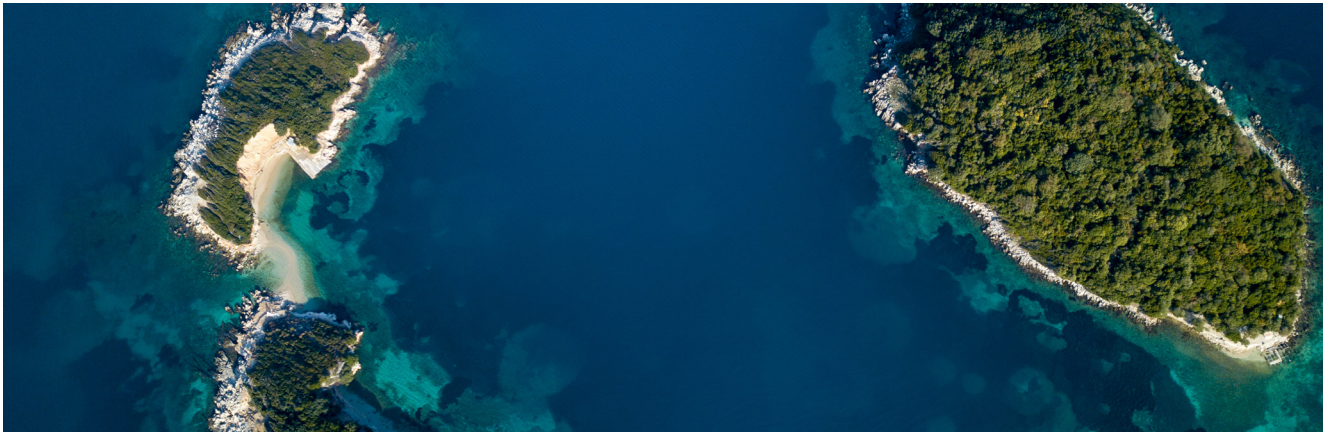
However, even if there is no fault, the power system will be shut down and repaired periodically every year. This inevitably requires the system to be restarted. During the restart, the power supply is disconnected and you have to wait for the power grid recovery.

Due to the sheer scale of the microgrid ESS in TRSP, the traditional black start solution is unrefined and inefficient, taking two or three days for a complete black start.

As a future-oriented city that explores new economic development, TRSP cannot accept the traditional method.

One of the highlights of Huawei's smart microgrid solution is the industry-leading grid forming energy storage technology. It supports the parallel operation of more than 1000 Smart Power Control Systems (PCSs) in off-grid mode and synchronous black start of multiple arrays. The microgrid features stable operation and off-grid continuous fault ride through, as well as GWh-level black start of the entire microgrid, restoring power within minutes and effectively avoiding loss caused by power outages.

Traditional PV+ESS solutions use grid following technology, which provides a current source and does not support stand-alone and stable operations. Huawei's grid forming energy storage technology features a voltage source, stand-alone design, rotational inertia, and reliable frequency regulation and peak shaving capabilities to maintain power grid stability. This technology redefines voltage stability, frequency stability, and power angle stability, supporting a stable grid connection under a high proportion of renewable energy.



All green, cleaner world

Energy is one of the fundamental elements for both human survival and development. Energy has been an indispensable part of human society since the discovery of fire.

To tackle climate change, the world has reached a consensus on working toward carbon neutrality. As a key component of the carbon neutrality goal, energy transformation must continue.

Previous projects using 100% clean energy are usually applied to residential communities or companies, and these showcases are not as convincing.

As a city which will potentially receive a million tourists every year, TRSP sets a benchmark for energy transformation and this will significantly impact the future of clean energy development.

We can envision what a future city should

look like: The city will have a stable and green power supply by converting natural resources such as solar energy into electric energy, driving the normal operation of the economy and society.

TRSP uses Huawei's Smart String ESS, where each battery pack and each battery rack can be fully charged and discharged, because they are equipped with an optimizer and a rack controller, respectively. Therefore, a battery pack with poor performance will not affect the entire system and this solution increases the system available capacity by more than 15% compared with traditional solutions.

The Smart String ESS supports mixed use of old and new batteries, and the ESS augmentation does not require additional PCSs or transformer stations, significantly reducing costs.

In the meantime, the distributed cooling

design ensures that each battery rack has its own air conditioner. The air conditioners are equipped with a dust-proof and sand-dissipation device, highly suitable for extreme sandstorm environments in the Middle East.

Despite its complex technical principles, the engineering workload for onsite construction is actually quite simple. Huawei's Smart String ESS features flexible adaption in different business models and eliminates the need for onsite battery installation and internal cable connection. This reduces the construction time by three months and reduces the construction cost.

As a leading global provider of digital power products and solutions, Huawei Digital Power draws on its experience and strength in digital and power electronics technologies to not only make the world cleaner but offer more green solutions for a sustainable future. ▲

Huawei Fully Liquid-Cooled Ultra-Fast Charging

Charge Up While You Coffee Up



Enhanced
charging



Superior
quality



Flexible
architecture





Largest Energy Storage Plant in Henan Province: Green Power for Local Economic Development

Neihuang County in Henan Province, China, is situated in what was the original path of the Yellow River. The county's name means "inside the Yellow River", and it's famous for strong northerly winds in the winter months and strong southerly winds in the summer months. The wind power industry in Neihuang County has blossomed over the past few years, together with the deployment of energy storage, powering the county's economic development.

The growing world population, rapid industrialization, and expanding urbanization have led to an increasing demand for energy, which is inextricably linked with a variety of environmental issues and excessive emissions of greenhouse gases.

Today, global warming and the

consequent adverse weather have become a real threat — extreme rainfall and flooding are no longer just contained within the confines of sci-fi disaster movies.

More and more countries are committed to achieving carbon neutrality by using fewer fossil fuels and cutting greenhouse

Largest Energy Storage Plant in Henan Province: Green Power for Local Economic Development



gas emissions. During this energy transition period, the renewable energy industry, especially energy storage, will be playing a pivotal role.

Three benefits of energy storage technologies

Over the past several decades, great progress has also been made in the energy storage industry, which is indispensable in energy supply and has a positive impact on the environment and sustainable development.

An energy storage system (ESS) can store and release electricity converted from renewables, such as solar and wind energy, to provide a continuous, stable, and clean power supply. This solves the problems of fluctuations that typically plague the renewable energy industry, reducing dependence on fossil fuels.

Energy storage is tantamount to energy

security.

As the demand for energy is rising, overreliance on traditional energy supply chains may have unpredictable serious consequences and can even trigger an energy crisis.

Energy storage can balance both energy supply and demand, reduce the demand for traditional supply chains, and relieve the pressure caused by the difference between peak and off-peak energy consumption. It can also ensure the stability and reliability of the energy system in case of emergencies, such as natural disasters and power grid faults.

More importantly, the development of energy storage provides a driving force for economic growth.

All types of energy systems involve high investment and operating costs and are subject to unpredictable prices and unstable supply, which may lead to a series of economic problems.

Energy storage helps reduce energy costs and boost energy efficiency, while stimulating the development of related industries and creating jobs. It provides a more sustainable and reliable power source for economic growth.

Therefore, fostering the growth of the energy storage industry holds immense importance in protecting the

environment, ensuring energy security, and driving economic development. In China, some provinces, municipalities, and autonomous regions have taken action.

Integrated development of wind power and energy storage

Henan Province has always been at the forefront of the energy storage industry in China. In June 2023, Henan Province issued the Implementation Opinions on Accelerating the Development of New Energy Storage (Opinions for short), which clearly stated that the scale of new energy storage should reach 6 million kW by 2025.

The newly released Opinions has raised the bar significantly compared with the previous 2.2 million kW goal. The government hopes to accelerate the development of the energy storage industry through energy storage projects and ultimately drive economic growth.

On October 24, 2023, the 100 MW/200 MWh energy storage plant developed by CR Power in Neihuang County went online. This project is part of the 300 MW wind+storage integrated demonstration project for rural revitalization and the largest energy storage plant project in Henan Province. It is jointly built by CR Power (Neihuang), XJ Electric Energy Storage, and Huawei Digital Power.

Neihuang County is located in the North Henan Plain, and is situated in a warm temperate zone with a semi-humid continental monsoon climate, providing excellent conditions for wind power generation. As the county continues to increase its wind power installations, energy storage becomes essential for a stable and reliable power supply.

The second phase of the Neihuang wind power project has integrated wind power and energy storage to smooth the intermittent wind power generation and improve the flexibility of grid operations, setting a benchmark for other similar projects and contributing to the achievement of China's carbon peaking and neutrality goals.

This is also Huawei's first 100 MW energy storage project in China.

Drawing on its technical experience and strengths in communications, cloud computing, and artificial intelligence, Huawei Digital Power is a leading global provider of digital power products and solutions, promoting the deep integration of "bit" and "watt". It provides a stable, reliable, and efficient Smart String ESS for the second phase of the Neihuang wind power project.

All-round support with innovative technologies

To address the challenges in the energy storage industry in terms of safety,

efficiency, service life, and operations and maintenance (O&M), Huawei integrates key technologies in PV, energy storage, and digital information technologies to build the Smart String ESS solution.

Through innovative architecture and intelligent features, this solution resolves the inconsistency and uncertainty of batteries using power electronics technologies and continuously reduces the levelized cost of storage (LCOS) throughout the lifecycle. It offers higher revenue, better investment, simplified O&M, and enhanced safety and reliability.

In terms of system management, Huawei creatively uses four key technologies: cell-level monitoring, pack-level optimization, rack-level management, and distributed cooling to implement refined management of the ESS.

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. These features minimize problems of series mismatch between battery packs, parallel mismatch between battery racks, and battery temperature rise difference.

To implement pack-level optimization, each battery pack has a built-in

optimizer. The optimizer is connected to the cells in parallel, and the optimizers in a battery rack are connected in series.

If a single battery pack discharges to 5% state of charge (SOC), the optimizer automatically starts to ensure that this battery pack does not affect the discharge of other battery packs. In this way, each battery pack can discharge to the maximum extent, increasing the discharge throughput by 6% within the lifecycle.

Each battery rack is connected to a Smart Rack Controller for independent adjustment and management to control the operating voltage of each battery rack and make the discharge and charge current between battery racks consistent, avoiding bias current.

In addition, the Smart Rack Controllers set the output voltage to 1200 V to maximize the potential of each battery rack. The distributed cooling design ensures independent heat dissipation of each battery rack, increasing the charge and discharge throughput by more than 7% within the lifecycle, maximizing the return on investment.

Looking ahead, Huawei Digital Power will continue increasing investment in digital and power electronics technologies, and working with partners and customers from various industries to build a better, greener future. ▲



Green Miracle: Mahidol University's Rooftop Power Plant

Solar panels are deployed in every possible place you can imagine: crop fields, deserts, mountains, and even on the rooftops of Mahidol University in Thailand. Through leveraging Huawei FusionSolar solutions, Mahidol University is recognized as the largest single-site commercial and industrial (C&I) PV+energy storage system (ESS) site in the Asia-Pacific region.

In the 2004 film *The Day After Tomorrow*, catastrophic climatic events that triggered a new ice age are vividly depicted. The stupendous special effects of the film brought home the heightened risk of climate change, with real-like tornadoes, tsunamis, rainstorms, and earthquakes.

In the last two decades, countries around the world have come up with policies and taken initiatives to address the challenges of climate change. In particular, the implementation of the Paris Agreement signed in 2016 has given people confidence in international cooperation on carbon reduction.

As the second-largest economy in Southeast Asia, Thailand has a

population of nearly 70 million and a land mass of more than 513,000 square kilometers. The nation consumes a high volume of fossil fuels such as oil, natural gas, and coal, which generate a large amount of greenhouse gases and cause serious environmental pollution.

To address these issues, the Thai government is seeking to promote energy transition and low-carbon development, and has set itself the goal of achieving carbon neutrality by 2050. To this end, Thailand has been vigorously promoting clean energy, particularly PV energy, and encouraging businesses and residents to install PV systems on their rooftops.

In southern Thailand, there is a century-

old university, Mahidol University, which is considered one of the most prestigious universities in Thailand. Mahidol University is not only a leading educator, but also a pioneer in exploring carbon neutrality in Thailand.

The roofs of the campus buildings are covered with rows of solar panels, shining in the sun and converting sunlight into electricity.

As for the solution provider, Huawei FusionSolar was awarded the project after strict scrutiny and competitive testing. Huawei FusionSolar is an innovator and leader in technology development and has accumulated years of expertise and experience, and Huawei FusionSolar is synonymous with high quality and high safety.

The Thai government has strict requirements on rooftop PV. To ensure the quality and safety of the PV systems, the Engineering Institute of Thailand (EIT), an authoritative organization in Thailand, has released the Thai Electrical Code: Solar Rooftop Power Supply Installations 2022.

The code requires that the DC side must be equipped with an inverter that has enhanced intelligent arc protection (AFCI), in addition to rapid shutdown devices being installed.

Huawei FusionSolar products and solutions fully meet the above criteria. These products are made and designed

to the highest standard in terms of quality and safety.

Huawei FusionSolar's AFCI function has obtained the L4 certification, which is the industry's highest-level certification, and can accurately detect arc faults and implement rapid shutdown (RSD) within 0.5 second, which is much shorter than the mandatory standard of 2.5 seconds.

We can see that the Thai government attaches great importance to PV rooftop safety and is determined to standardize the industry. As a result, Thailand has become one of the first countries in the world to make PV rooftop safety a mandatory standard.

Using Huawei FusionSolar C&I solution, Mahidol University has built the largest single-site C&I PV+ESS plant in the Asia-Pacific region. The PV capacity is 15 MW, the ESS capacity is 600 kWh, and PV modules are fully configured with optimizers.

As a world-leading Smart PV+ESS solution provider, Huawei FusionSolar has extensive experience and technical strengths. Through cooperation with Mahidol University, Huawei FusionSolar hopes to set a benchmark and exemplar for the large-scale application of the PV+ESS integrated solution in Thailand and other Asia-Pacific countries.

The PV+ESS system in Mahidol University can cut electricity fees by US\$2.3 million and carbon emissions by 11,000 tons each year, which is equivalent to planting

15,000 trees. It is not only a source of clean energy, but also a net contributor to the environment.

This solution is fully configured with optimizers, maximizing rooftop areas of the 41 buildings for PV installation and increasing energy yield by 10%. Electricity can be stored in the ESSs to provide backup power.

Even when the inverter is shut down during an emergency, the PV modules on the rooftops are still generating current under sunlight. The fully configured optimizers can implement module-level RSD to reduce the voltage to a safe level for operations and maintenance (O&M) personnel and firefighters.

In addition, the 4-layer ESS safety design ensures system safety so that the university can use clean energy safely.

The Smart PV+ESS system not only provides green energy for the university to cut carbon emissions and electricity costs, but also provides a platform for students to closely study green power operations so that they can spread green and low-carbon ideas beyond schools.

Driven by technological innovation, Huawei FusionSolar will continue to work with partners around the globe to provide reliable green energy solutions for homes and businesses across application scenarios, and making greater contributions to the environment and sustainable development. ▲



G318 Highway: Embracing Ultra-Fast Charging

It is both urgent and meaningful to construct high-quality charging stations along the G318 highway, meeting charging requirements for NEV owners.

Known as the most beautiful yet riskiest road in China, the G318 highway is a magnificent route that every thrill-seeking adventurer wants to try.

This route takes drivers through breathtaking landscapes that include majestic gorges, rugged peaks, massive pastures, turbulent rivers, as well as lush forests and spectacular glaciers.

During China's National Day holiday in 2023, ultra-fast charging stations became available on the G318 highway,

which facilitate the charging of new-energy electric vehicles (NEVs).

Ultra-fast charging in the snow plateau

The 890 km route stretching from Litang County to Yading in Sichuan province is the most popular stretch for self-driving adventurers. It is deemed both urgent and meaningful to construct high-quality charging stations along the highway, meeting the charging requirements for NEV owners.

Huawei Digital Power, one of the leaders



in global new energy, actively responded to the planning and layout for building high-quality charging infrastructures along the route from Litang County to Yading, as outlined by the Sichuan Province. In collaboration with customers and partners, Huawei Digital Power has embarked on creating the "G318 Ultra-Fast Charging Green Corridor," which includes the construction of fully liquid-cooled ultra-fast charging stations at rest areas and gas stations along the

route. This is an almost impossible mission to build ultra-fast charging stations in the high-altitude areas with extreme environments.

Huawei Digital Power, together with customers and partners, overcame various challenges by building a series of ultra-fast charging stations in multiple locations along the route. The charging stations officially went live at the beginning of October, 2023, relieving

range anxiety for NEVs and contributing to low-carbon and green development.

These liquid-cooled charging stations can offer NEV owners a "grab a coffee, hit the road fully charged" experience.

Overcoming challenges for long trips with NEVs

"I'm just out for several minutes. When I'm back, my car has been charged for a range of 200 kilometers. The charging

speed is really unbelievable!" Mr. You, an NEV owner from Mianyang city, Sichuan province, enthusiastically shared his ultra-fast charging experience.

In the past, due to the inconvenience of slow charging, Mr. You dared not to turn on the climate control in his NEV in order to preserve power. A long contact list of towing companies was a must for each NEV owner in case of dead batteries.

Huawei's fully liquid-cooled ultra-fast chargers in the rest areas have gone viral thanks to photos and videos uploaded by NEV owners who experienced ultra-fast charging in these areas.

Huawei's fully liquid-cooled ultra-fast charging dispenser supports mainstream NEV models and has a maximum output power of 600 kW and a maximum current of 600 A, boosting NEV owners' confidence in driving NEVs on the G318 highway.

By leveraging full liquid-cooling technology, the dispenser is able to deliver highly reliable, high temperature and humidity resisting, dust-proof, and anti-corrosive features, adapting to complex working conditions in the plateau areas.

The charging dispenser achieves a one-off charging success rate of 99%. The power capability of the ultra-fast

chargers is able to support the long-term battery evolution of NEVs in the future. Even trucks can be fully charged in minutes on the G318 highway. As a result, NEV owners can enjoy a relaxing experience on the magnificent highway, free from battery anxiety.

Promoting the overall development of renewable energy

The coolant in the liquid-cooled charging module circulates and exchanges heat with the external air, without any air duct on the front and rear, enhancing charger safety while decreasing the charging temperature much faster, and making less noise.

The chargers not only bring an ultimate experience for NEV owners, but also benefit renewable charging stations by expanding business models.

According to the staff of the renewable charging station in the Yakang highway rest area, a single Huawei's fully liquid-cooled ultra-fast charger is able to provide charging services for more than 500 times on average during a holiday, compared with 174 times of an old one.

The three-fold charging efficiency enables ultra-fast charging stations to serve more NEV owners by self-operating or authorized services, increasing the revenue by three times and enabling investors to recover the construction cost rapidly and realize

profits.

Compared with traditional air-cooled ultra-fast chargers, Huawei's fully liquid-cooled ultra-fast chargers use more advanced technologies, are much more efficient, and most importantly, are more cost-effective after considering comprehensive factors, such as the purchase, maintenance, operation, and maintenance costs.

The high availability and high reliability of fully liquid-cooled ultra-fast chargers promote NEV industry and charging infrastructure development in China, setting up a promising business mode of ultra-fast charging stations.

Statistics show that more than 70% of NEV owners are more willing to choose charging stations equipped with 120 kW or higher-power chargers. Charging stations with Huawei's fully liquid-cooled ultra-fast charging technologies will inevitably become the top player, gathering more valuable customers.

In the future, Huawei Digital Power will continue to work with customers and partners to accelerate the construction of fully liquid-cooled ultra-fast charging stations along the G318 highway, building a smart charging network with high quality for sustainable development, and enabling efficient charging in all possible locations. ▲

Smart Trips in Shenzhen "Ultra-Fast Charging City"

Shenzhen is developing into an "Ultra-Fast Charging City" to promote low-carbon green development and the achievement of the dual-carbon goals. As a leader in the global new energy industry, Shenzhen keeps accelerating its pace and strives to build itself into a real "new energy city."



Chinese people legally enjoy 115 days off a year, long enough to take a road trip through cities and countryside nationwide. However, the trip is not always satisfying because new-energy electric vehicle (NEV) drivers encounter challenging situations: insufficient charging lots, long queuing, excessive charging time, etc. Is there any means to inject power into the vehicles in seconds to support long driving ranges? Gasoline?

Ultra-fast charging is the preferred solution.

Shenzhen to develop into an "Ultra-Fast Charging City"

NEVs are ushering in explosive growth and China has embarked on a new journey in this industry. As of August 2023, NEVs account for up to 36% of new car sales in China, while the

percentages in Europe and the United States are 22% and 8%, respectively. NEVs bring brand-new intelligent driving experiences, from acceleration to in-vehicle infotainment, which typically outperform traditional fuel-powered vehicles.

In particular, the charging of batteries on an NEV costs only cents in terms of electricity fees per kilometer. Such low costs lure fuel-powered vehicle owners but they still resist due to the hassle of NEV charging. Customers who are used to driving gasoline vehicles are unwilling to suffer from significant regional disparities in the deployment of chargers, slow charging, and especially the huge shortages of fast and ultra-fast chargers.

According to McKinsey, convenient charging has replaced purchasing costs and range anxiety to become the top



concern for NEV consumers. Statistics from the China Association of Automobile Manufacturers (CAAM) also show that more than 40% of NEV consumers complain about long charging time.

To address these challenges, ultra-fast charging becomes the future of mobility. Automobile manufacturers, charging operators, and even some cities start to invest in ultra-fast charging. In the International Digital Energy Expo (IDEE) 2023 (held on June 29), the city of Shenzhen, Huawei Digital Power, and ecosystem partners announced to build Shenzhen into an ultra-fast charging hub with an integrated network for charge, energy storage, and discharge.

Shenzhen takes the lead in constructing charging facilities for NEVs. The ratio of charging lots to the number of NEVs in Shenzhen is far higher than that in

many other first- and second-tier cities. According to the Special Plan for NEV Charging Facilities in Shenzhen, the city is mapping out the future of NEVs. Shenzhen seeks to establish itself as an "Ultra-Fast Charging City" by building 300 ultra-fast charging stations by 2024, with a 1:1 ratio of ultra-fast charging stations to gas stations. The charging stations will cover various locations, including airports, high-speed railway hubs, municipal parks, large-scale shopping malls, and expressway service areas, establishing a leading ultra-fast charging network that matches supply and demand now and in the near future.

Brightest star of the city's image

At present, many cities, including Shenzhen and Guangzhou, and other new cities in China are competing to become an "Ultra-Fast Charging City". Shenzhen has its unique advantages

and ample reasons. As the saying goes, a thing cannot exist without its basis. Investing in ultra-fast charging is meaningful for a city with a large number of NEVs. By the end of August 2023, the number of NEVs in Shenzhen had almost reached 900,000, ranking among the top in the world.

Shenzhen has 24,000 new energy and digital energy enterprises, which far surpasses other cities. Shenzhen is also a global leader in photovoltaics (PV) and lithium-ion energy storage technologies.

As a tech product company headquartered in Shenzhen, Huawei Digital Power is committed to bridging the energy divide and enabling more people to use stable and clean energy by providing energy solutions that are applicable to various industry application scenarios.

In the mobility electrification industry, Huawei Digital Power positions itself as a solution provider of powertrains and charging networks. Through collaborative development in both on-board and off-board businesses, it has launched hyper-converged power systems and ultra-fast charging solutions. Huawei's products and solutions help achieve a refueling-like charging experience and accelerate the process of mobility electrification.

Currently, the Futian District Government in Shenzhen is working with Huawei Digital Power to build fully liquid-cooled ultra-fast charging showcases in Futian District Convention and Exhibition Center, Huanggang Park, and Lianhuashan Park, bringing the ultimate charging experience. This is exciting news for NEV owners in Shenzhen.

Accelerating new energy development

The emergence of ultra-fast charging stations not only solves the charging anxiety of NEV owners, but also lays a solid foundation for the sustainable and healthy development of NEVs. Moreover, this helps unleash a vast market potential and new business models. As NEVs can be charged adequately with "the time it takes to drink a cup of coffee," more consumers will choose NEVs.

In addition, more and more enterprises will take part in building ultra-fast charging stations to seek more revenue. For example, shopping malls that offer

efficient and safe charging facilities can attract a large number of customers. The shopping malls deploy ultra-fast charging stations independently or together with construction parties for better reputation and increased share benefits.

Compared with traditional solutions, Huawei's fully liquid-cooled ultra-fast charging solution achieves efficient and safe charging, which is an optimal choice for constructors and operators of ultra-fast charging stations. The solution integrates digital and power electronics technologies, boosting the productivity of charging facilities and achieving business success.

Other large cities will learn from Shenzhen to invest in and accelerate citywide ultra-fast charging construction.

Currently, Huawei, together with customers and partners, has deployed fully liquid-cooled ultra-fast charging showcases in cities such as Beijing, Shanghai, and Shenzhen, bringing an ultimate charging experience to NEV owners and helping operators and cities create more value.

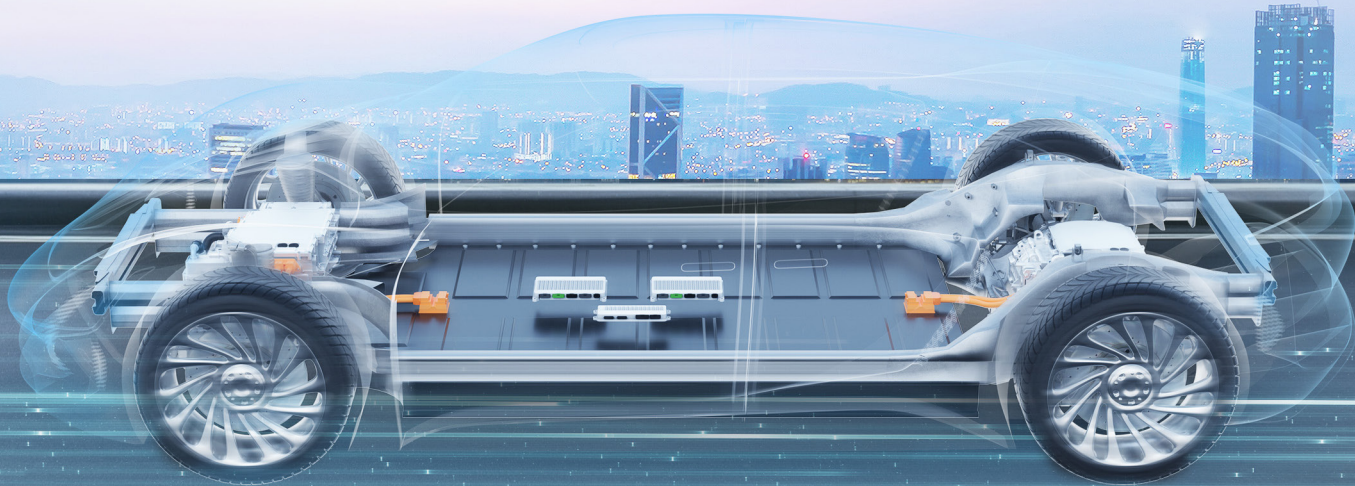
In the future, Huawei will continue to build ultra-fast charging networks in heavy-traffic scenarios of NEVs, such as urban public areas and expressway service areas. The networks for cities, expressways, and campuses will boost charging and NEV development in the automobile industry. ▲



Building a Fully Connected, Intelligent World

DriveONE NEV eMobility Solutions

Continuous Innovation for extraordinary experience





Underground Power Assurance Line of a "Smart Nation"

Huawei's SmartLi UPS solution not only ensures secure and reliable services for the Thomson–East Coast Line (TEL) of Singapore's Land Transport Authority (LTA), but also reduces the occupied area by 50% compared with traditional UPS solutions, perfectly meeting customer requirements.

For those who are new to Singapore, the beautiful scenery here must leave the greatest impression on the mind. There is, however, one big puzzle: Why doesn't Singapore struggle with traffic jams despite having such a high population density?

In fact, the traffic jams in different countries are a result of many different factors, and the ultimate solution is to build a highly developed public transport system, which is also a

fundamental way to relieve traffic jams.

Singapore, renowned as the "Garden City," boasts a sound urban structure and transportation network. The Singaporean government has been continuously improving traffic flow from different aspects, establishing an efficient and convenient urban transportation network.

Specifically, the rail network covering the entire nation has played an irreplaceable role. The Singaporean



government plans to double the length of its rail network by 2030, bringing 80% of households on the island within a 10-minute walk of a rail station.

Immense value of Huawei's solution

In 2014, LTA started constructing the TEL, one of the most important rail lines in Singapore. The TEL is completely underground with 32 stations, serving 500,000 to 1 million commuters every day.

There is no doubt that building and operating rail systems in a high-temperature and high-humidity coastal environment is a challenging task. Take the power supply system as an example. Components are prone to faults, which may not only paralyze the urban transportation system, but also jeopardize passengers' safety.

In addition, the cost of excavating underground spaces for the metro is high. Therefore, how to reduce the occupied area of the power supply system and create more space for deploying other infrastructure on the fully undergrounded TEL is one of the core concerns of LTA.

After conducting a thorough investigation and comparison from various perspectives, LTA chose to adopt Huawei's SmartLi UPS solution, which can provide reliable power supply for key metro service operating systems (such as communication, signaling, automatic fare collection system, comprehensive management system, and emergency lighting).

For LTA, Huawei's SmartLi UPS solution not only ensures secure and reliable services for the TEL, but also reduces the occupied area by 50% compared with traditional UPS solutions, perfectly meeting customer requirements.

On August 28, 2021, the 12 km tunnel of TEL Stage 2, which adopts Huawei's power supply system, was put into service. On October 11, 2022, TEL Stage 3 was officially opened for passenger service, offering reliable transportation services.

It is reported that TEL Stage 4 is scheduled to be completed in 2024. The engineering team is conducting strict tests on various systems,

including power supply, to ensure seamless integration with existing lines.

Huawei's SmartLi UPS solution is playing a significant role in the TEL.

Achievements of modern technology

For metro equipment, the power supply system is the prerequisite for the normal operation of extra-low voltage subsystems and must be both secure and reliable. In addition, the power supply system is associated with various core metro applications, such as communication, signal, monitoring, fare collection, and information display. Therefore, no lapse is allowed.

In the power supply system of the entire rail network, UPSs make up the core equipment. Due to the harsh operating environment, scattered equipment, and difficult maintenance and management, metro line operators attach great importance to the reliability, availability, operations and maintenance (O&M), and cost of the UPS solution.

Huawei's SmartLi UPS solution is an overall power supply solution that integrates power electronics and digital intelligence technologies and works with Huawei modular UPSs to meet higher power supply requirements.

Based on the design concepts of simplicity, intelligence, efficiency,

and reliability, Huawei's solution implements a fully digital power supply and distribution system on the basis of modularization and intelligence for energy consumption reduction, fast deployment, flexible capacity expansion, and simplified O&M.

Instead of using the traditional single-point distributed power supply, the TEL adopts Huawei's SmartLi UPS centralized power supply. In this way, spare parts are adopted in a unified manner, greatly reducing O&M difficulties and spare part warehouse maintenance costs.

To achieve a system efficiency of up to 97%, Huawei's SmartLi UPS adopts modular alternating hibernation technology for higher efficiency at low loads, greatly reducing power consumption. The solution contributes to green, sustainable, and low-carbon operations for the Singaporean metro network and instills new impetus into the nation's Green Plan.

The solution is also equipped with cutting-edge technology, iPower. It can perform predictive maintenance, implement full-link visualized management, quickly and accurately locate fault points, detect the running status of components in real time, and provide early warning to reduce fault risks such as fire, greatly

enhancing the reliability of power supply.

Assisting Singapore in achieving "Smart Nation" status

For engineers who are used to visiting sites to carry out maintenance, Huawei's SmartLi UPS solution provides valuable assistance compared to traditional methods. Maintenance engineers can receive warnings and view the system status in real time while just sitting in front of the workbench. They can also locate faults and provide preventive measures in a timely manner to ensure the safety of the power supply and distribution system.

For the TEL, Huawei's SmartLi UPS solution has a lifecycle of up to 15 years, which means that every penny of metro investors is used to the maximum extent. In addition, the modular design ensures that the owners can flexibly expand and upgrade the system at any time.

In addition, Huawei's SmartLi UPS solution uses the most secure, stable, and fire-proof lithium iron phosphate (LFP) cell material and adopts the exclusive active current sharing technology. With the three-level BMS system, Huawei SmartLi UPS solution ensures the reliability of lithium batteries at different levels, eliminating safety concerns for the

TEL and providing the best travel experience for hundreds of thousands to millions of passengers.

In the product solution design, Huawei Digital Power attaches great importance to the users' requirements. On the basis of ensuring the main electrical performance, Huawei Digital Power enhances the reliability design for erected components, including capacitors, to enhance the reliability design and nip minor issues in the bud. All of these efforts make Huawei's SmartLi UPS solution more resistant to high temperature and humidity and have a longer service life.

As a leading player in the global digital power industry, Huawei Digital Power has unique insights into the customers' requirements in the metro industry and provides comprehensive and high-level professional service capabilities. Therefore, a series of innovative products and solutions are provided to meet the application requirements of key metro services.

As a further step, Huawei Digital Power will continue to adopt innovative technologies based on its cooperation agreement with the TEL, improving the metro network and facilitating the economic development and people's livelihood of Singapore. ▲



Going Digital for Inclusive Development in Thailand

High capital expenditure (CAPEX), operational expenditure (OPEX), and energy consumption cost are three major challenges to modern data center operators. To address these challenges, Planet Communications Asia PLC (PlanetComm for short) chose to cooperate with Huawei Digital Power, marking an important step toward green data center development in Thailand and the global industry.

Over the past three years, more and more people have been developing itchy feet, craving different environments and new experiences. Bangkok, one of the most visited cities in Southeast Asia, has received over 12 million tourists from January to June in 2023 whereas the number was roughly 15 million each year before.

In addition to a diversity of attractions such as temples and museums, the city

is also flourishing in colorful modern digital lifestyles, attracting people from all over the world.

Thailand is going digital at an accelerated pace. The people who are rushing there are triggering an explosive growth of data. As critical infrastructure that carries data and computing power, data centers unlock infinite possibilities for the development of the local digital economy.

Building a robust digital foundation for the industrial economy

With an increasing emphasis on digital infrastructure development in recent years, the Thai government proposed Thailand 4.0, which aims to promote the development of the digital economy and connect all industries by applying more innovative and advanced technologies.

As the digital economy proliferates worldwide, PlanetComm is looking to leverage its technical advantages and accelerate the development of data centers in Thailand.

Founded in 1994, PlanetComm is a leading broadband operator in Thailand. It was registered with Thailand's Market for Alternative Investment (MAI) in 2014 to provide services for telecom network infrastructure, cyber security, data centers, and Internet of things (IoT) platforms.

According to Prapat Rathlertkarn, CEO of PlanetComm, PlanetComm is committed to achieving a zero-carbon society through advanced technologies and providing optimal green ICT infrastructure for partners and customers.

This ambition is in line with Huawei Digital Power's vision for the future. As a leading global green energy

technology provider, Huawei Digital Power is committed to providing customers with world-leading green energy solutions that promote the construction and development of global green data centers, consolidating the digital foundation for the industrial economy.

Prefabricated modular data centers have become a major development trend of the industry. A plug-and-play solution for such data centers has facilities pre-designed, assembled, integrated, and tested in factories. It facilitates management, reduces investments, and accelerates deployment.

In cooperation with PlanetComm, Huawei Digital Power provides its FusionDC1000A prefabricated modular data center solution for the customer. This solution ensures higher operational efficiency, lower carbon emissions, shorter delivery time, longer service life, and more efficient operations and maintenance (O&M) than conventional data centers.

The partnership has attracted great attention from Thailand and even the global industry, expecting to set a good example for green data center development.

Taking up the challenges in data center construction

As data and computing power have

become the new fuels for production, data centers become increasingly significant. Speed is everything. The same is true for data centers. Quick and accurate response to service requirements is a key metric of modern data centers.

Operators need to overcome three major challenges in conventional data centers: high CAPEX, OPEX, and energy consumption cost.

Prefabricated modular data center solutions can be their right choice. All required facilities are integrated inside a prefabricated modular data center, which is ready for use once they are assembled like building blocks onsite.

Huawei Digital Power is now a leader of concepts, technologies, products, and solutions in this field. Huawei's FusionDC prefabricated modular data center solutions help customers build green, simple, smart, and reliable data centers.

Among them, Huawei FusionDC1000A complies with the industry's highest Tier III Ready design. It integrates smart cooling and power supply to achieve low carbon emissions, reduce the power usage effectiveness (PUE) by up to 15%, and save electricity fees by 567,648 THB each year.

Moreover, Huawei FusionDC1000A offers unique advantages in fast



deployment, CAPEX reduction, elastic capacity expansion, and intelligent O&M. It can effectively cope with the challenges brought by the rapid growth of cloud, AI, and 5G services to data center construction, helping create core values for PlanetComm.

According to Prapat Rathlertkarn, PlanetComm's adoption of Huawei's FusionDC1000A prefabricated modular data center solution marks an important step toward green data center development in Thailand and the global industry.

Leveraging advanced solution features to tap more benefits

Huawei's FusionDC1000A prefabricated modular data center solution delivers a number of benefits to PlanetComm:

- Space-saving: integrated design. Huawei's intelligent uninterruptible

power system (UPS) improves the power supply stability of the data center. The all-in-one design halves the installation space of power supply equipment. The modular design facilitates future capacity expansion.

- Time-saving: prefabrication. With all facilities fully prefabricated in the factory, a data center built using Huawei's FusionDC1000A solution integrates power supply and distribution, cooling, fire extinguishing, security, and monitoring subsystems and enables one-stop delivery, halving the time to market (TTM) when compared with conventional data centers.

- Worry-free: intelligent O&M. Effective and efficient O&M is critical to a data center. Power, bypass, and control modules adopt the redundancy design and support hot swap, allowing an

engineer to complete maintenance within 5 minutes. The product delivers an efficiency up to 96% when it works in online mode.

In addition, Huawei FusionDC1000A supports remote O&M through a mobile app, on which engineers can view the running status of the data center anytime and anywhere. The intelligent system analyzes data in real time and pushes warnings promptly so that engineers can quickly rectify any faults. On average, the fault response time is shortened from 8 hours to 2 hours, helping PlanetComm engineers minimize service impact and maximizing data security.

The above cooperation has led to great success. Prapat Rathlertkarn is convinced that the FusionDC1000A ensures higher efficiency, lower carbon emissions, faster delivery, longer service life, and improved O&M efficiency than conventional data centers.

While exploring the booming data center market in Thailand, PlanetComm will expand its cooperation scope with Huawei Digital Power in data center business and other areas to provide world-class services for local customers through prefabricated modular data centers. Moving ahead, they will work together to meet industry demands and drive carbon-neutral development. ▲



Uninhabited Island: Building a Green Telecom Site Against All Odds

Through integration and intelligent scheduling of multiple energy sources, Huawei reduces the levelized cost of electricity (LCOE), increases the green energy share, and leads the low-carbon transformation for telecom site power supply. From deserts, islands, snowfields, to mountains, Huawei completed numerous impossible missions, creating green miracles one after another.

"I just video-called my family on the boat and shared my trip with my friends on social media. My daughter used to say that the signal was not very good here. Now it has changed." A tourist who got off the boat at Mount Putuo said with excitement.

As a popular tourist route, the voyage from Zhujiajian Island to Mount Putuo used to be plagued by network connection problems for a prolonged

period of time due to the long distance between base stations and weak signal coverage.

To meet the communication demands of both tourists and local residents, China Mobile Zhoushan built a new telecom base station on Zhuzishan Island between Zhujiajian Island and Mount Putuo, which solved the coverage problems.

The seemingly simple idea actually



Uninhabited Island: Building a Green Telecom Site Against All Odds

entails unimaginable engineering challenges, because Zhuzishan Island is uninhabited with no docks or easy ways to get on the island from the reef.

Difficulties in site construction on an uninhabited island

You may have seen uninhabited islands in adventure movies such as *Cast Away* and *Lord of the Flies*. However, the reality is far from what is depicted in the movies.

Differing from the base stations that are constructed in areas with good infrastructure, one of the biggest challenges for building base stations on uninhabited islands is electricity availability. After all, the stable operations of base stations rely on stable power sources.

For base stations on the mainland, electricity is typically one of the lower priorities, as the mains supply is easily available. However, as mentioned earlier, Zhuzishan Island is uninhabited

with no electrical resources.

Constructing an electrical bridge between the mainland and Zhuzishan Island would involve an extremely long build period and incur high engineering costs, not to mention the complex submarine geological environment that further deters the feasibility of the mains solution.

So, what about traditional diesel generators?

Diesel generators produce a large amount of carbon dioxide and other harmful substances, which inevitably destroys the island's ecological environment. In addition, subsequent maintenance and refueling would incur high costs and transportation risk.

Therefore, the diesel generator solution is not feasible.

Moreover, as a common and highly destructive type of atmospheric corrosion, the higher concentration of salt in the air around coastal islands results in accelerated corrosion on electrical equipment as salt penetrates the protective oxide layer. This problem is particularly apparent on Zhuzishan Island, which can affect the dynamics of power supply.

Did the project team hit a dead end? On the contrary, having taken all of

the above factors into consideration, the project team has a clear picture, that is, building an intelligent, corrosion-resistant, and highly reliable off-grid power generation system.

Green miracles

According to the calculation of electricity demand and PV power generation capability, China Mobile Zhoushan, the China Mobile Design Institute, and Huawei Site Power Facility worked together and launched the innovative PV deployment solution. The solution provides stable power supply for the base station on the Zhuzishan Island.

The above design comes from Huawei's iSolar 2.0 solution, which uses a high-voltage series connection architecture and four-in-one compact PVPU for easy PV deployment, reducing the installation workload by 15% and simplifying the construction significantly.

The weather on the island is a constant battle. If PV modules are fixed at a certain angle, the PV system cannot work at its maximum efficiency for most of the time, affecting the normal operation of the base station.

To solve this problem, the iPV optimizer in Huawei's iSolar 2.0 PV deployment solution can individually optimize each PV module to ensure

maximum efficiency and reduce shading loss, increasing the energy yield by 20%. At the same time, the PV+ESS algorithm can increase the PV power utilization rate to 100%.

In addition, the green site on Zhuzishan Island adopts the outdoor corrosion-resistant integrated design. The MIMO power system supports integration and intelligent scheduling of multiple energy sources including solar, mains, and genset, achieving seamless switching between solar and genset power supply.

On sunny days, PV power is supplied to the system and surplus power is stored in intelligent lithium batteries. At night or in bad weather, the energy storage system (ESS) can supply power to the base station. On cloudy and rainy days or even in extreme weather, the ESS can provide continuous and green power supply to the base station for about 20 days.

Through integration and intelligent scheduling of multiple energy sources, Huawei reduces the levelized cost of electricity (LCOE), increases the green energy share, and leads the low-carbon transformation for telecom site power supply. From deserts, islands, snowfields, to mountains, Huawei completed numerous impossible missions, creating green miracles one after another.

Visioning a greener world

With Huawei's iSolar solution, more than 90% of the electricity consumed by the site on Zhuzishan Island comes from solar energy. If this solution is applied to 1000 telecom sites, 7140 tons of annual carbon emissions can be reduced, which is equivalent to planting 390,000 trees.

As regards to user experience, the proof of the pudding is in the eating. With this new base station, feedback has shown that with the additional coverage, millions of tourists can enjoy staying connected with the outside world while en route to Mount Putuo.

Huawei has performed numerous practices with telecom operators worldwide in exploring green site power supply. The innovative PV deployment solution completely replaces traditional solutions where multiple devices need to be combined, solving problems such as low power generation efficiency, high operations and maintenance (O&M) expenditure, and safety risks.

This solution not only supplies power to base stations, but also utilizes green PV power to achieve low-carbon or even zero-carbon sites, significantly reducing the electricity costs of base stations.

In addition to power generation,

Huawei's iSolar solution also includes battery units for energy storage. With the large-capacity cyclic intelligent lithium batteries, base stations can achieve energy self-sufficiency and flexibility.

Through integration and intelligent scheduling of solar, mains, genset, and energy storage, Huawei helps telecom sites minimize the use of genset and slash energy OPEX and carbon emissions. In addition, lithium batteries with high cycle life help further reduce electricity costs and accelerate genset-free modernization on the live network.

In terms of site O&M, Huawei's management system supports intelligent site O&M and achieves visible, manageable, and optimizable site energy efficiency and carbon emissions. This helps telecom operators improve efficiency and cut emissions, accelerating the achievement of carbon peaking and carbon neutrality goals.

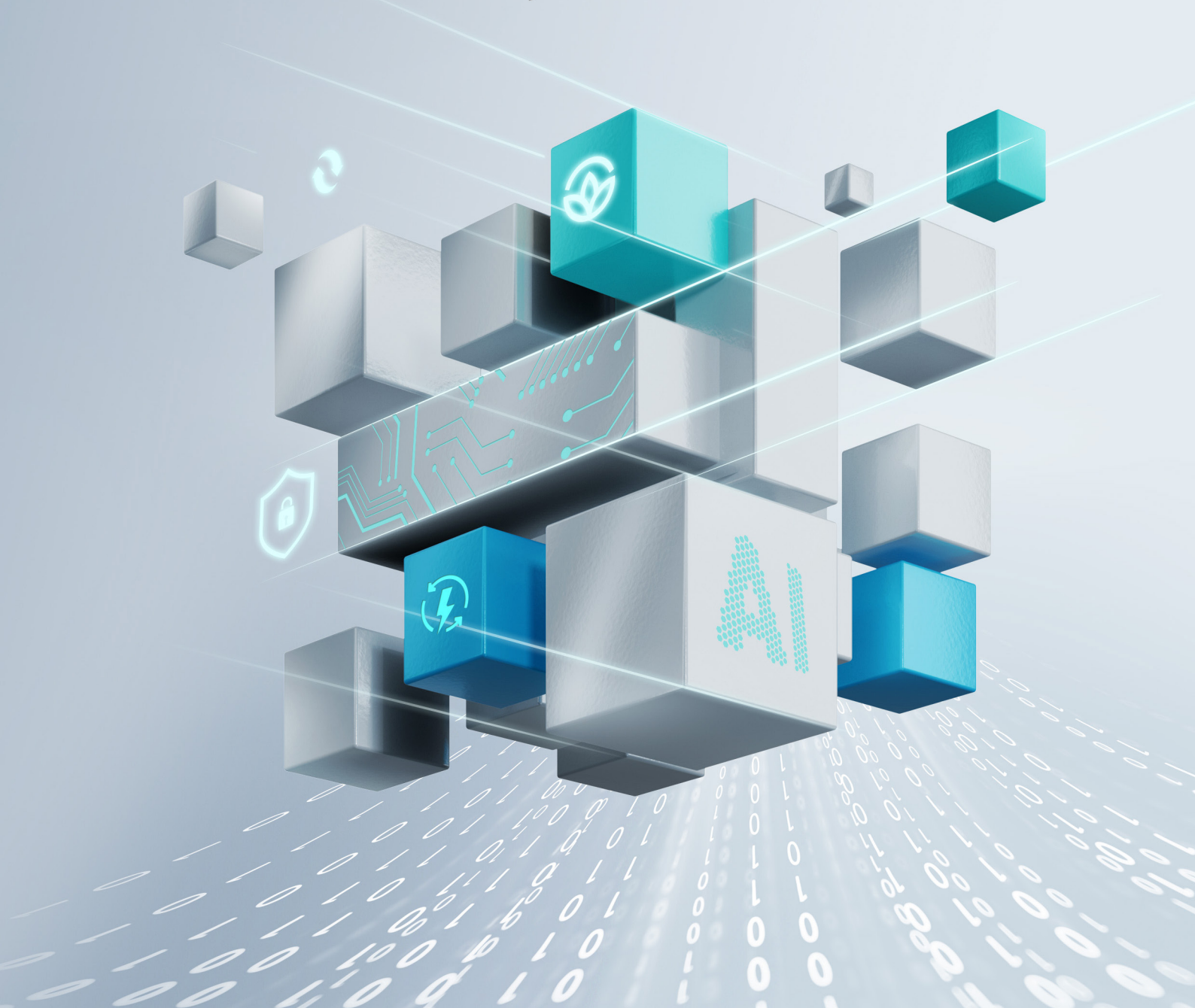
With its strength in digital and power electronics technologies, Huawei is continuously developing its Digital Power businesses, including Smart PV, Site Power Facility, and Data Center Facility, to promote the innovative convergence of watt, thermal, and energy storage technologies for a greener world. ▲



Building a Fully Connected, Intelligent World

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PolyTech: Open to New Technology for Success

PolyTech has been partnering with Huawei since 2014. With the global community rallying behind carbon neutrality, PolyTech is confident that demand for solar, electric vehicles (EVs), and battery products – today's main suite of decarbonization technologies – will continue to boom.

Thailand has seen strong, stable growth in its solar market in recent years, positioning itself as one of Southeast Asia's most secure demand centers for renewable technology. PolyTech Thailand, a

diverse company with an expansive and growing green energy division, has more than doubled its solar inverter sales every year since 2016. Today, the company is the dominant player in Thailand's solar inverter market.

The President of PolyTech Thailand, Narratchai Leeraphant, says solar's strong uptake in the country means the market is ready for next-generation technologies, such as batteries, EV chargers, solar optimizers, and "full stack" product bundles.

Recent changes to Thai safety standards and regulations for solar system rapid shutdown will make optimizers a growing trend in the country, Leeraphant says. "So, we can upsell through the upgrade of inverters to inverters plus optimizers, for which our solution is the most advanced in the market," he adds.

Partnering with Huawei to bring the energy storage market to maturity

Solar is so well established in Thailand that it is already proving difficult to install more rooftop systems in some areas. As such, technology to store and use the surplus green energy is increasingly required.

PolyTech has been partnering with Huawei since 2014, starting as the brand's inverter distributor in Thailand and today offering Huawei's range of battery energy storage systems and data-center products. "PolyTech and Huawei have dealt

with price, customer expectation, and what current battery technology can offer." Leeraphant adds, in reference to battery systems.

He says the next step is to educate the market about safety standards and the value of advanced battery technologies, in order to bring the energy storage market to maturity.

While Asia's rooftop market still tends to be dominated by commercial and industrial installations, demand among the residential sector is booming. The primary barrier for the residential segment is the fact that most people are not actually at home during the daytime to use the solar power their panels would generate. Huawei's LUNA2000 residential energy storage system (ESS), which PolyTech introduced into the Thai market in 2022, will close this gap, enabling households to shift their solar energy from immediate consumption to storage for later use.

There is also growing demand for integrated renewable technology product bundles. This full stack strategy is becoming increasingly popular among solar manufacturers and retailers worldwide and is particularly valuable in Southeast Asia, where electricity networks remain a challenge. These integrated

product suites are easier to install and more user-friendly – especially important for a region where renewable technology uptake postdates that of Europe, the US, and Australia.

Full stack bundles are valuable for engineering, procurement, and construction (EPC) firms. The market price for installing rooftop solar is very competitive due to a high number of players. Adding EV chargers to the solar solution brings more value, compared to other competitors.

Embracing changes to kick off emerging businesses in advance

Added value is often on Leeraphant's mind – alongside heading up PolyTech he owns a multinational restaurant franchise business and the Thai International School. While on the surface these endeavors would appear to have little in common with the solar industry, Leeraphant sees plenty of crossover. The restaurant business has provided lessons in how to manage the energy sector's sub-tiers of dealers, Leeraphant says, while the school has offered both a platform to teach a generation of students about renewable technology and an opportunity to showcase products to parents who make up a

We see our growth will still sharply increase in these next years, if we cooperate with the right partners. The key factor for success is that you must be open to new technology and new alliances all the time.

*Narratchai Leeraphant,
President of PolyTech Thailand*



cohort of top managers and business owners.

For Leeraphant, the key to good business is staying open to new technology, even if it disrupts companies. While PolyTech has long been involved in the energy sector, its roots are in oil and gas. Despite that, the company entered into new green markets back in 2011 and, two years later, installed Thailand's first public EV charger, long before EVs and charging products were mainstream. "Polytech had been studying the EV business since 2011, long before other companies," says Leeraphant.

Since 2020, demand for EVs and related charging equipment has surged, Leeraphant says, putting PolyTech in a strong position to leverage its knowledge in the sector. Leeraphant sees huge growth potential for public direct current (DC) chargers, of which PolyTech has already installed around 450

in Thailand. In 2021, the company delivered 120 MW of DC charging capacity and almost quadrupled that volume last year, when it reached 450 MW. The demand for commercial and industrial (C&I) and residential chargers is also spiking in Thailand.

With nations across the globe committing to carbon neutrality, and Asia expected to experience a big upswing in electricity demand, Leeraphant is confident that demand for solar, EVs, and battery products – today's main suite of decarbonization technologies – will continue to boom.

"We see our growth will still sharply increase in these next years, if we cooperate with the right partners," he says, "The key factor for success is you must be open to new technology and new alliances all the time. Maybe it is not the right time yet, but when the time comes, you have to be ready and be the first who sets the market direction, otherwise you can only be a market follower." ▲



SKE: Shaping a Clean Energy Future for Europe with Huawei

Over the past decade, Huawei has grown to become a global leader in PV and energy storage technologies. Through its collaboration with Huawei, SKE has also become a leader in the European PV market, forming a symbiotic and powerful partnership.

Over the course of a decade, SKE has expanded its business from Austria to 16 countries and regions in Europe. Through close collaboration with Huawei, SKE has grown into a leader in the European PV market, providing advanced product solutions while focusing on industry talent development.

From Austria to Greece, from Bulgaria to Croatia, from Ireland to Cyprus, SKE and Huawei's FusionSolar roadshow truck, is traversing Europe, traveling along the vast roads of Southern Europe, Eastern Europe, and Central Europe, embarking

on a series of exhibition tours.

As a value-added partner (VAP) and service partner for Huawei FusionSolar, SKE delivers comprehensive capabilities, including products, technology, solutions, and talent, to distributors and customers across Europe. In this process, SKE has also achieved mutual growth with Huawei FusionSolar, becoming a leader in the European digital energy market.

Providing localized support for partners and customers across half of Europe

SKE, founded in 2008, is headquartered in Austria. In its early days, SKE was an

electrical engineering company involved in the development of PV projects with only a small number of employees.

The turning point for SKE came in 2013. In that year, Huawei officially launched its inverter product after three years of research and development, entering the PV business sector and gaining widespread acceptance among European customers.

Europe has been one of the most proactive forces in addressing the challenges of climate change, moving toward carbon neutrality and carbon peaking. Through the European Green

SKE's mission is to "lead the change," aiming to lead the historic transition from fossil fuels to clean energy. The close collaboration with Huawei is undoubtedly the best path to achieving this mission.

*Dr. Thomas Frank
Managing Director SKE*



Deal and European Climate Law, the European Union has formulated a clear strategy for the development of renewable energy, making full use of clean energy sources, primarily PV, to replace fossil fuels.

Recognizing this clear market trend and Huawei's technical advantages in the PV field, SKE partnered with Huawei in 2013, taking responsibility for the sales, service, and support of Huawei FusionSolar in Austria, becoming one of Huawei's first partners in Europe.

As customer demand grew rapidly and the market position of Huawei FusionSolar continued to rise, SKE's collaboration with Huawei gradually expanded. Today, SKE's business has expanded to 16 European countries and regions, covering Albania, Bosnia and Herzegovian, Bulgaria, Greece, Ireland, Kosovo, Croatia, North Macedonia, Moldova, Montenegro, Austria, Romania, Serbia, Slovenia, United Kingdom and Cyprus, providing sales, logistics, training, certification, and technical support for all Huawei FusionSolar products to local distributors and customers.

These countries and regions span the European continent, stretching thousands of kilometers east and west, with different languages and cultures. Therefore, SKE uses the local languages to provide support for local partners, helping them address technical issues related to Huawei FusionSolar product solutions, and offering planning, commissioning, analysis, and after-sales service to customers.

Cooperating with Huawei to turn insights into commercial success in the three major segment markets

Dr. Thomas Frank, Managing Director SKE, shows that after 10 years of development, the company has penetrated every facet of the three major smart PV markets: utility, commercial and industrial (C&I), and residential, providing them with targeted Huawei FusionSolar solutions.

In the utility sector, SKE offers Huawei FusionSolar solutions for PV power plants and large-scale projects, ensuring they can operate more efficiently and intelligently. The high efficiency of

Huawei inverters ensures a high return on investment, reliability, and ease of maintenance for PV power plants.

In the C&I sector, the Huawei FusionSolar solutions provided by SKE ensure that PV systems on commercial building rooftops are simpler and more reliable, utilizing optimizers to increase electricity generation and yield higher returns.

In the residential sector, SKE provides Huawei FusionSolar solutions to builders and homeowners, helping households improve PV electricity generation efficiency and save on electricity expenses.

From SKE's point of view, Huawei FusionSolar solutions are widely popular among European users because Huawei seamlessly combines PV technology with digital technology, accelerating the digitization of the PV industry, making energy production and consumption more intelligent.

At the same time, the perfect combination of inverters, optimizers, and energy storage systems has enhanced Huawei's market competitiveness, helping SKE earn the trust of local distributors and customers.

At Intersolar Europe 2023 in Munich, Germany, Huawei Digital Power collaborated with SKE and other partners to showcase the latest achievements and industry insights in the field of PV and energy storage. As one of Huawei's VAPs, SKE is poised to advance

toward becoming a five-star certified service partner (CSP) by taking the lead in launching pilot projects for the Technology and Application Center (TAC) and spare parts, aiming to improve service experience and efficiency for customers. This stride forward signifies not only the profound synergy between SKE and Huawei but also a passionate commitment to industry innovation.

Cultivating talent to promote the healthy development of the PV industry

It's worth noting that while SKE provides solutions to its customers, it is also committed to fostering local professional talent to promote the healthy development of the PV industry. To achieve this, SKE has established the SKE Academy to facilitate the transfer of knowledge "from experts for experts."

Dr. Thomas Frank, Managing Director SKE, stated that due to the staggering growth of the PV industry, there is a rapidly increasing demand for skilled professionals. Many people entering this industry lack the relevant technical skills, and the PV sector places high demands on service quality and the competence of its workforce. This has created a significant need for talent development.

The SKE Academy offers training courses, exams, and certifications for electricians, installers, PV vendors, system planners, and other related roles. Since its inception, the SKE Academy has produced thousands of qualified students.

While providing the PV industry with skilled professionals, this initiative has also elevated SKE's market leadership, providing a unique competitive advantage and teaching local distributors and customers how to most effectively utilize Huawei FusionSolar.

As a VAP and service partner of Huawei, SKE, along with local distributors in Europe, conducts roadshows and seminars to promote Huawei FusionSolar. The SKE and Huawei FusionSolar roadshow truck mentioned at the beginning of this article has received high praise from customers.

Over the past decade, Huawei has grown to become a global leader in PV and energy storage technologies. Through its collaboration with Huawei, SKE has also become a leader in the European PV market, forming a symbiotic and powerful partnership.

To meet the demands of its rapidly expanding business, SKE is building Europe's largest logistics center for energy storage solutions and PV products near Linz, Austria. By mid-2025, this 30,000-square-meter warehousing and office space will come into operation, and the SKE Academy will also be located there.

SKE's mission is to "lead the change," aiming to lead the historic transition from fossil fuels to clean energy. The close collaboration with Huawei is undoubtedly the best path to achieving this mission. ▲



Rixin: Comprehensive Cooperation with Huawei to Embrace the BIPV+ Era

Huawei Digital Power and Rixin are working together to integrate their intelligent BIPV businesses, offering customers safe, sustainable, efficient, intelligent, and accessible clean energy through joint efforts in products and marketing.

Wuhan Rixin Technology Co., Ltd. (Rixin) is an integrated energy solution provider that specializes in solar PV, particularly in the area of building-integrated photovoltaics (BIPV). Supported by Huawei Digital Power,

Rixin offers customers safe and reliable PV products, solutions, and services.

Driven by the "carbon neutrality" goal, the PV industry has become a strategic emerging industry backed

by the Chinese government, and the BIPV market is experiencing a golden age of rapid growth. In recent years, the PV market has undergone lightning speed changes, which poses significant challenges for industry players and is necessitating strategic adjustments.

To cope with the above changes and challenges, Rixin has bolstered its comprehensive strategic cooperation with Huawei Digital Power in recent years and launched BIPV+ affordable smart energy solutions, striving to become a BIPV solution leader in the industry.

From utility-scale plants to BIPV+

Founded more than two decades ago, Rixin is one of the earliest PV product providers in China. In 2022, its revenue climbed to CNY660 million and the number of employees exceeded 400.

Xu Jinming, founder and chairman of Rixin, was a university lecturer before he established the company in 2001, when he came to the realization that the PV industry is destined for a bright future. In its early days, Rixin was mainly engaged in the manufacturing, sales, and export of PV modules and solar lighting systems. It provided lighting

equipment for farmers and herders in areas without electricity in Western China, with many projects funded by the World Bank.

In 2007, starting from the Beijing Olympics project, Rixin embarked on PV projects across China. In this period, Rixin undertook more than 90% of state-supported PV demonstration projects in Hubei Province. In 2013, Rixin actively participated in the construction of utility-scale PV plants, and improved its capabilities in BIPV solutions and projects.

After 2018, to adapt to market trends, Rixin launched BIPV+ affordable smart energy solutions, building core competitiveness in fields such as smart BIPV standard products and services, wind+PV+energy storage, and clean energy services. In addition, Rixin has cooperated with Huawei Digital Power to jointly develop residential and commercial and industrial (C&I) PV.

According to the founder, Rixin made this transition due to two main reasons. Firstly, subsidies for PV plants have declined. Secondly, constructing and operating large-scale plants requires a huge amount of capital, which puts the company at

a disadvantage when competing with large state-owned enterprises. BIPV+ demands high technical capabilities and can better demonstrate the strength of Rixin. By incorporating Huawei's digital and intelligent technologies, Rixin can secure a leading position in this fast-growing market.

Distributed BIPV makes renewable energy more affordable

On Rixin's website, "Affordable Clean Energy for You" is placed in the most prominent position as the company's slogan.

The founder explained that emphasizing "affordable" is necessary because it meets market demand. Only by being affordable can PV power win market recognition. Additionally, Rixin has made technological advancements through cooperation with Huawei Digital Power, which has improved its capabilities and reduced the cost of PV construction.

The above progress is driven by the distributed PV products, technologies, and solutions offered by Huawei Digital Power.

The cooperation between Rixin and Huawei Digital Power dates back to

BIPV+ demands high technical capabilities and can better demonstrate the strength of Rixin. By incorporating Huawei's digital and intelligent technologies, Rixin can secure a leading position in this fast-growing market.

*Xu Jinming
founder and chairman of Rixin*



2012. Back then, Huawei had just entered the PV industry, and the market was dominated by central inverters. However, Xu believed that distributed PV for buildings is the future trend, which coincides with Huawei Digital Power's concept. Therefore, he became interested in the smart string inverter promoted by Huawei Digital Power because of its advantages such as flexibility and reliability.

Huawei's distributed PV technology maximizes the areas eligible for PV installation, allowing PV modules to be installed in previously unsuitable areas. In addition, Huawei optimizers can intelligently manage each PV module, improving system safety and performance ratio.

Currently, distributed PV accounts for 60% of all new PV installation. In 2022, the annual new installation of distributed PV exceeded 50 million kW for the first time, representing a year-on-year increase of 75%. The market is now divided into three

major scenarios: utility-scale, C&I, and residential.

Rixin, in collaboration with Huawei Digital Power, helped CNPC build its first "green electricity" gas station in Hubei.

Gas stations naturally place high requirements on safety. In CNPC's "Smart Gas Station" green power project on Panlong Avenue in Wuhan, Rixin Xihe smart modules are equipped with Huawei Smart PV Optimizers, which can quickly reduce the voltage to zero on the rooftop in case of emergencies. The optimizer has the AFCI function to enable rapid shutdown in 0.5s to reduce any fire risks.

Module-level monitoring is implemented. By connecting to the Smart PV management system and the mobile app, the customer can monitor the status of each PV module in real time. When a fault occurs, the system can accurately locate the fault for prompt rectification. Furthermore,

the optimizer minimizes the impact of shading and installation orientation on rooftop PV modules, increasing the eligible installation area by about 40% and the energy yield by more than 12%.

Learn from Huawei's experience to accelerate business success

Comprehensive cooperation with Huawei Digital Power has boosted Rixin's confidence in fully embracing the transformation towards BIPV+. Xu stated that Huawei Digital Power and Rixin are working together to integrate their intelligent BIPV businesses, offering customers safe, sustainable, efficient, intelligent, and accessible clean energy through joint efforts in products and marketing.

Xu gave an example of how Rixin was able to enter the high-end residential PV market with the help of Huawei Digital Power. By combining Rixin's 20+ years of experience in PV for buildings and Huawei's Smart PV technology, the two parties successfully built a photovoltaic zero-carbon park in Wuhan's Liangzi Lake Tourist Zone. PV systems and buildings in the park were synchronously designed and constructed in an integrated manner, making full use of the roofs, scenic corridors, pavilions, garage canopies,

and road lighting. Additionally, a platform was established to manage construction and energy. The park perfectly combines the aesthetics of buildings and the strength of solar PV, achieving energy efficiency, precise control, and high safety. Not long ago, Rixin Photovoltaic Zero-Carbon Park passed the certification of the National Center of Quality Inspection and Testing for Building Energy Conservation, becoming the first photovoltaic zero-carbon park in China to obtain the "ZERO CARBON CAMPUS" certificate.

After the completion of such an iconic project, how will the company replicate this success?

Xu noted that Huawei excels in experience replication. Rixin is learning from Huawei and adopts Huawei's CC3 model. With the support of Huawei Digital Power, Rixin is speeding up the replication of application scenarios and achieving business success.

Huawei Digital Power has offered robust support to Rixin throughout the process, from executives to R&D and business teams. In-depth communication has not only strengthened mutual trust between the two parties, but spilled over to the customer side by increasing

trust as a result of Huawei Digital Power's prompt service response to Rixin.

Xu still remembers the first solar PV plant that Rixin and Huawei collaborated on. Shortly after its completion, it was hit by a once-in-a-century flood, which damaged many of the inverters. Replacing inverters in the disaster-hit area was difficult. However, the after-sales team of Huawei Digital Power arrived at the site the very next day and completed the repair on the third day, earning high praise from the state-owned enterprise customer.

After more than two decades of development, Rixin continues to focus on independent R&D and production to serve customers. The company has also focused its efforts on the field of BIPV, combining digital and intelligent technologies with solar PV to provide customers with next-generation clean energy that is safe, reliable, and affordable.

In the process of transformation, Rixin is now selective when targeting customers. Rather than actively seeking out new customers, the company is carefully choosing ones that align with its strategies and can help it achieve high-quality development. ▲



KepuTech: Three Strategic Leaps, Growing Through Challenges

KepuTech's "customer-centricity" service concept and "dedicated employees" corporate culture directly mirrors those of Huawei's business philosophy. This makes their cooperation magnetic and powerful.

When Li Jishan, the current deputy general manager of KepuTech, joined the firm in 2009, it was just a UPS agent with only 20 employees. At that time, KepuTech received all of its main business from the UPS agency, but it did not settle for the status quo.

"Mr. Liu Jianxin, our company's founder, is very confident about the future of our company. In addition, our team members like to step out of their comfort zones and strive for excellence." Li Jishan said.

James C. Collins once said in his book

Built to Last: "Enterprises must reject complacency and relentlessly pursue progress if they want to become great." KepuTech has the courage to step out the comfort zone in each development stage, meet new challenges in each new business venture, and continuously reach higher achievements.

Over the past 20 years, KepuTech has become an excellent service provider in the digital infrastructure service field, with professional qualifications such as general contracting for electromechanical engineering construction (grade III), professional contracting for electronic and intelligent engineering (grade I), and professional qualifications for intelligent building system design (grade II). In addition, KepuTech has won the title of "National Top 30 Data Center Engineering Enterprises" for two consecutive years. Meanwhile, KepuTech serves as a run-rate gold partner, gold distributor, and five-star certified service provider (CSP) for Huawei Digital Power. With its powerful product R&D capabilities, KepuTech has become an independent software vendor (ISV) solution partner of Huawei. KepuTech serves regions beyond Shandong Province, covering Hebei and Henan. It aims to become an excellent enterprise with businesses all over the country.

First leap: Transforming to a service business by stepping out of the comfort zone

Before 2000, China had to import most of its UPS core technologies. After 2000, China's UPS extra low voltage (ELV) market continued to grow and Chinese brands began to gradually master the core technologies of UPSs. The golden period of development had come for the UPS industry in China.

KepuTech was founded in the changing period of industry and market. Like many other startup companies, KepuTech took just over a decade to gain a firm foothold, ensure sustainable business growth, and expand the enterprise scale to some extent. At that time, KepuTech fell into a dilemma: keep running the original business or diversify.

"Before 2013, our company kept expanding the business, but we mainly focused on equipment sales. Soon, we encountered bottlenecks due to inadequate comprehensive capabilities. A product-centered company cannot generate high value in the long run. To create more value, we must be able to develop our own solutions." Li Jishan said.

Therefore, KepuTech decided to transform from a product seller to an engineering vendor and extend its business to fully over data center infrastructure.

This transformation was a shift in

mindset and laid a foundation for the transformation of KepuTech in the future. After three years of development, KepuTech successfully transformed into a comprehensive service provider with mature professional engineering qualifications, as well as construction and service experience in multiple large-scale projects.

In 2016, KepuTech started exploring the market outside Jinan city and set up a branch office in Qingdao. Li Jishan was the owner of business in Qingdao at that time.

Li Jishan said: "After continuous efforts in these last years, our company started to think how to use the power of brands and manufacturers to develop new markets. This is also our target in the Qingdao market."

At the same time, Huawei was vigorously developing the Data Center Facility product line, a market with infinite potential. All sorts of opportunities were contributing to a preliminary cooperation deal between Huawei and KepuTech in Qingdao.

Second leap: Achieving bigger dreams with the help of Huawei

With the digital and intelligent transformation of various industries, KepuTech gradually evolved from

Through cooperation with Huawei, we have not only gained business growth, but also learned a lot. In the future, KepuTech will expand the market in China and strive to become a national digital infrastructure service provider.

*Li Jishan
Deputy General Manager of Shandong KepuTech Co., Ltd.*



electrical equipment sales to the data center business, which would witness a rapid development in the future, and penetrated digital infrastructure services through data center construction. KepuTech and Huawei were working together to provide advanced product solutions and cutting-edge technical solutions for users in various industries.

"We believe that our cooperation with Huawei was inevitable. At that time, Huawei Digital Power grew rapidly but lacked excellent partners. It is a shame that we could not cooperate earlier. After more than half a year's communication, we officially signed a run-rate gold partner contract with Huawei in Qingdao on April 8, 2017."

At that time, cloud computing rose in popularity and digital transformation was surging. Data centers kept growing in both scale and quantity, with multiple phases involved, such as sales, integration, configuration, delivery, as well as operations and maintenance (O&M). This presented huge growth

opportunities to KepuTech.

In the first year of cooperation, breakthroughs were made in services. One year later, Li Jishan found that business capabilities in Jiaodong were insufficient to support Huawei's business growth. Therefore, KepuTech signed a further cooperation plan with Huawei.

The cooperation between the two parties led to remarkable achievements. In 2018, KepuTech became the national run-rate partner champion of Huawei Digital Power. In 2020, KepuTech's sales volume in a single product line of Huawei Digital Power exceeded CNY100 million.

"Along with the close cooperation with Huawei over the past few years, our workforce has grown from 50 in early days to 190. In addition to Digital Power, we have also cooperated with Huawei in government, enterprise, and e-commerce businesses, and established branches in Hebei and Henan with the help of Huawei." Li

Jishan said.

There are two main reasons that have contributed to such achievements.

First, KepuTech has expectations for business transformation. It takes the development trend of the market under control, is willing to learn new things and technologies, and has the courage to invest resources and the strength for cooperation with Huawei. Such effort and trust must be rewarded.

Second, KepuTech shares many similarities with Huawei in enterprise spirit. KepuTech takes Huawei as the benchmark in terms of team building, employee cultivation, and even corporate culture building. KepuTech's "customer-centricity" service concept and "dedicated employees" corporate culture directly mirrors those of Huawei's business philosophy. This makes their cooperation magnetic and powerful.

Leaping into the future, aiming at becoming a national enterprise

Since 2017, KepuTech has cooperated with Huawei in the Digital Power field. On the basis of continuous market exploration and local channel partner development, KepuTech has achieved seamless interconnection in product run-rate, solution, channel expansion, and project delivery. Their

cooperation also has expanded from Digital Power Data Center Facility and Site Power Facility to all product lines of Huawei's enterprise business. It is worth mentioning that KepuTech Information Industry Group Co., Ltd. was established, opening up a new chapter of development.

Li Jishan also said: "Currently, the sales revenue of our cooperation with Huawei has exceeded CNY100 million for several consecutive years, and the proportion of our business has increased year by year. We have not only gained business growth, but also learned a lot from Huawei."

To sum up, from KepuTech's cooperation deal with Huawei, we have learned four aspects:

First, strong brand driving force. Huawei has an extensive brand awareness, which means quick brand story spreading and minimal cognitive barriers to customers.

Second, a complete set of product lines. Huawei provides not only Digital Power products, but also network, cloud, and optical products. When facing customers' requirements for overall solutions, KepuTech does not need to interconnect with other suppliers.

Third, advanced core technologies

and product quality. "We used to sell products of many other brands. No matter what the technology iteration or product quality is, we can sort products just by comparison. Huawei's technologies have reached the industry-leading level." Li Jishan said.

Fourth, strong cooperation with partners. For example, KepuTech cooperated with Huawei in bidding for some specific projects to jointly expand the market and obtain orders, forming a joint combat force.

More importantly, through directly cooperating with Huawei, KepuTech has redefined the business development direction and steadily improved its run-rate, solution capabilities, and engineering capabilities.

After two decades of operations in the Data Center Facility field, KepuTech has accumulated numerous solution services and industry market exploration capabilities. In addition, KepuTech provides customers with intelligent construction engineering services, information system integration solution services, and intelligent building engineering services. In the strategic planning for the next three to five years, KepuTech is determined to develop the nationwide market and strive to become a national digital infrastructure service provider. ▲



Shanghai Guangsai: From Data Center to Site Power Facility, the New Mission of No. 001

Ten years ago, Shanghai Guangsai (SG) became a partner of Huawei Digital Power as the No. 001 authorized agent. Ten years later, its revenue has increased by over one hundred times. While SG makes continuous progress in the data center market and its service capabilities, it is now setting its eyes on the field of site power facility.

Ten years ago, Zhang Nailin (Zhang) was in a discussion with Huawei about product planning and cooperation details. Back then, Huawei was gearing up for a product launch to develop the digital

energy market.

The recognition from industry customers defined the future of Huawei and more seriously, the fate of SG. For a brighter future, Zhang then decided

to fully align SG's business model with Huawei's.

Surmounting development bottlenecks: faith in Huawei from the very outset

Founded in 2009, SG started as the agent of two international UPS brands with several scattered projects.

Zhang, founder of SG, had been engaged in the power supply business for years and was the regional general manager of a well-known brand before venturing out himself. Nonetheless, up until 2013, SG still grew at an unfavorable pace.

The turnaround came in 2014 with Huawei entering the digital energy market as a new UPS player. According to Zhang's recollection, numerous peers were not optimistic about Huawei and adopted a wait-and-see attitude. Typically, a new brand takes several years to gain any sort of traction in the market, as the power supply equipment supports the core system of an enterprise, which exerts strict demands on its reliability.

However, Zhang had faith in Huawei from the very outset and that high level of confidence stemmed from his knowledge about Huawei. First, he was clear about Huawei's strength as many of his former colleagues had joined Huawei. Second, Huawei's persistent

pursuit for high quality products met the requirements of industry customers. Third, SG had large room for growth in the initial stage and Huawei could provide comprehensive support.

Therefore, SG, without any hesitation, joined Huawei's partner team as the No. 001 Gold Partner of Huawei Digital Power Product Line in China.

Behind the 100-fold growth: product technical capabilities

Today, Huawei is the only brand that SG has been agenting. SG has staked all its fortune on this partnership and the reality proves it to be the "winner". During the 10 years from 2014 to 2023, SG's revenue increased by one hundred times from over one million yuan to over one hundred million yuan.

Technical strength and product performance are the basis for partners and industry customers to trust a vendor. Zhang also suggested that agents should take technical and product capabilities as the primary consideration when selecting a partner.

Huawei has been embracing the latest technologies and following a technical path distinctive to others. In the 2010s, traditional tower and transformer-based UPSs dominated the market, while Huawei featured more advanced and high-end modular and transformer-less products. The accurate judgment

on the development trend has enabled Huawei to reap the benefits of market expansion, even as a latecomer.

SG has also contributed to this achievement. Zhang said that early in 2013, Huawei conducted multiple surveys to gain opinions of its partners and customers.

Such efforts were also highly appreciated by the customers. A large supermarket chain, which has its own outlets in major cities, previously used tower UPSs of a competitor, and after learning about the advantages of Huawei's modular products in terms of size and module expansion, it comprehensively replaced the tower UPSs with Huawei's 120 series products.

This customer alone brings SG millions of yuan in revenue every year. From small projects and peripheral systems, SG gradually applied Huawei Digital Power products to key accounts and core systems.

Service capability improvement: building closer customer relationships

Developing high-value businesses is the focus of ICT market agents in recent years, including SG.

Apart from its distribution business, SG places emphasis on the service business, for which Huawei has also

SG insists on exclusive cooperation with Huawei. Finding an ideal partner is quite a tough job as it involves finding good products, good services, and common growth, which can all be manifested by cooperating with Huawei.

Zhang Nailin
General Manager of Shanghai Guangsai



provided full support. Early in 2015, SG had become a service provider of Huawei Network Energy. The service business has now become one of its three main business segments, parallel with the distribution of data center products and site power products.

The service business, in addition to profit improvement, also brings closer customer relationships, according to Zhang. During the provision of maintenance services for customers, SG gains a deeper understanding of its customers' needs, while customers in turn have more faith in SG and select SG as the first choice.

On the improvement of service capabilities, Zhang pointed out that the first is to delve into and make full use of training courses at different levels provided by Huawei to quickly improve hands-on skills; the second is to seek support from Huawei when necessary. When SG encounters difficulties that cannot be solved individually, Huawei's R&D team makes a quick response; the

third is to evaluate competitors' products, and manage and maintain all customers' products to alleviate customers' concerns.

Mutual support: starting a journey of the next 10 years

As the No. 001 agent of Huawei Digital Power, SG has gone through a 10-year journey with Huawei. Its distribution business scale has been among the top of Huawei's partners and ranked No. 1 for many years.

Zhang said that although other vendors have been coming to him over the past 10 years, SG insists on exclusive cooperation with Huawei. He said that finding an ideal partner is quite a tough job as it involves finding good products, good services, and common growth, which can all be manifested by cooperating with Huawei. Therefore, he hopes that both sides can proceed on the path that they have walked along together.

During the journey, Huawei has also provided strong support for SG in

business expansion.

For example, when two brands were shortlisted in a bidding of a bank customer, SG invited the customer's executives to visit Huawei's HQ and won most of the share with Huawei's support. A service customer was very interested in Huawei's intelligent lithium battery products when attending HUAWEI CONNECT. Currently, the customer is in contact with the procurement department.

In some special periods, such support appears to be precious and deepens mutual trust between the two sides.

During the response to COVID in 2022, SG encountered great difficulties in maintaining normal operations, project delivery, and support for its employees. After learning about the situation, Huawei immediately mobilized its resources and manpower to help SG solve the order delivery problem and sent sufficient living materials to those in need. After brainstorming, SG successfully completed the equipment installation and commissioning for makeshift hospitals through remote video guidance.

Embracing the new mission: focusing on the site power facility market

In the era underpinned by China's goals in carbon peaking and carbon

neutrality, the digital energy market, especially impacted by the emergence of renewables such as PV, is witnessing significant changes. With changes come opportunities. Rising fields, including site power facility, bring new momentum for growth.

Expanding apace, site power facility nowadays is not confined to the telecom industry but infiltrates into petrochemical, transportation, logistics, water conservancy, and other sectors. Huawei has been engaged in the site power facility market for many years, and naturally SG has been authorized with the exclusive distributorship in multiple provinces of China.

SG, seizing the opportunity, is investing heavily to expand the site power facility market while making continuous progress on the market of data center power supply. Zhang revealed that SG is expected to win more distribution contracts in more provinces next year, and as it's an exclusive process, their rights and interests are more guaranteed, which generates stronger motivation.

Meanwhile, Huawei's regional distribution system is still to be perfected. Zhang is now in active communication and coordination with Huawei to ensure a smooth cooperation in the long run, thus together building a strong energy foundation for the digital transformation of industries. ▲

Enabling Green Energy: Harnessing Grid-Forming Technology for Mainstream PV Integration

Our grid-forming technology transforms PV power generation from grid following to grid forming by changing the control mode, improving active and reactive control and response, and smoothing out frequency and voltage fluctuations.



In January 2023, the Qinghai Plateau remained covered in snow. At the PV plant of China Resources in Gonghe County, the shining safety helmets and fluttering red banners stood out prominently against the white snow, exuding a sense of joy and celebration. This day marked a significant milestone in the development of PV+ESS systems. With the guidance of China Electric Power Research Institute and Qinghai Electric Power Research Institute and the collaborative efforts of China Resources and Huawei, the world's first grid-forming PV+ESS system successfully passed the acceptance inspection. This achievement has laid a strong foundation, both in theory and practice, for constructing a new power system with a high proportion of renewable energy and accelerating the evolution of PV power as a main energy source.

Enabling energy transformation with grid-forming technology

The world is transitioning towards clean energy and electrification to achieve carbon neutrality. Every industry in every country is moving in this direction. According to the International Renewable Energy Agency (IRENA), global installed PV capacity is expected to reach 5200 GW by 2030 and 14,000 GW by 2050, making it the primary energy source.

Driven by the energy and digital

revolution, technological innovation in the energy sector is at its peak. Emerging energy technologies such as renewable energy, energy storage, and smart energy are advancing at an unprecedented pace, promoting the green and low-carbon transformation of the global energy industry.

China's National Energy Administration and Ministry of Science and Technology issued the 14th Five-Year Plan for Energy Technology Innovation, which aims to increase the proportion of renewable energy, build a new power system, and promote the digitalization and intelligence of the energy industry. The plan emphasizes the need to accelerate strategic and forward-looking core power grid technologies to construct advanced, efficient, and intelligent power grids that support grid connection of large-scale renewable energy and distributed power supply, and bidirectional interaction between power generation, grids, and loads.

As the proportion of renewable energy increases, breakthroughs in stable grid connection and renewable energy consumption become critical in building a new power system.

To advance PV power generation from grid following to grid forming, the industry has explored theories, technologies, and application practices, concluding that changing the control mode, improving active and reactive

control and response, and smoothing out frequency and voltage fluctuations are key. This is where Huawei's grid-forming technology comes in.

China's scientific research institutions and enterprises have made significant progress and innovative advancements during this transformation. As early as 2021, State Grid Qinghai Electric Power Company, China Electric Power Research Institute, Tsinghua University, Zhejiang University, and Huawei spent four months researching the safe and stable operation of power systems with high proportions of renewable energy supported by large-scale ESSs. They proposed power allocation and control policies for grid-forming ESSs, providing a new means of unlocking the potential of renewable energy and DC power transmission. In 2022, ACWA POWER, SEPCOIII, and Huawei collaborated to build the Red Sea project in Saudi Arabia, the world's largest PV + ESS microgrid project, which provides clean and stable power for one million people. This project serves as an example of the future of sustainable urban living through 100% clean PV and ESS energy.

Addressing the challenge of renewable power feed-in and consumption

The increasing integration of renewable energy across various industries is accelerating the shift from traditional



power systems, which rely mainly on synchronous generators, to new power systems with a significant proportion of renewable energy and power electronic devices. However, such industry transformations and technological disruptions do not occur overnight. They start small by breaking away from conventional technologies or patterns and gradually evolve and mature.

Regarding the current application scenario, a high concentration of intermittent renewable energy on the grid can seriously impact its stability. This can result in various problems, such as wide-band oscillation, transient overvoltage, power quality degradation, and stability issues in isolated PV + ESS power supply. In the event of a fault, conventional renewable energy systems cannot proactively support voltage and frequency in the same way as a synchronous generator, which poses a potential risk to the safe and stable operation of the power system.

The transmission of high-proportion renewable energy through UHV DC exacerbates transient overvoltage at the transmitting end. Compared to

the instantaneous voltage regulation function of synchronous generators, conventional PV + ESS systems exhibit slow reactive power response and weak voltage regulation during the fault ride-through process, further intensifying overvoltage at the grid connection point and limiting the feed-in and consumption of renewable energy.

When high-proportion renewable energy is transmitted over a long distance through the AC power grid, it depletes the voltage stability margin. A typical PV + ESS system only controls power but not phase during operation, and is therefore unable to actively adjust voltage. Consequently, when the AC line is faulty, active and reactive power cannot be controlled. To maintain voltage stability, the system needs to curtail the output power of the PV plant to ensure that it does not exceed the static stability limit.

The low-inertia system at the transmit end of high-proportion renewable energy makes it more difficult to stabilize frequency. For instance, in a scenario with a strong DC and weak AC system, if the DC system experiences a

fault, a significant amount of PV power is transferred to the AC transmission line. The weak inertia support at the transmit end increases the rotor angle difference between the transmit and receive ends, which may result in unstable power angles in worst-case scenarios. When a conventional PV + ESS system transmits power through AC transmission lines over long distances, low-frequency oscillations occur due to insufficient system damping.

Moreover, the islanded operation of renewables cannot provide a reliable and stable power supply due to low inertia and short-circuit capacity. Maintaining stable frequency and voltage poses a significant challenge. The PV + ESS renewable system also uses power electronic converters as the power generation unit, which introduces complex AC-DC coupling problems to the system. For example, when inductive motors or transformer loads are connected to the power grid or when the power grid is short-circuited, a large number of harmonics are generated, which interferes with DC voltage control and may cause large-scale grid disconnection accidents.

To tackle these challenges, Huawei has innovatively converged digital technologies with power electronic technologies, PV with ESS, and energy flow with information flow based on its long-term research and implementation in the PV and energy storage fields,

particularly in grid connection technologies. This convergence enhances grid connection stability and consumption of renewables and has created a grid-forming solution widely recognized in the industry.

The cutting-edge technologies of Huawei's grid-forming solution for stable grid connection

At the 16th International Photovoltaic Power Generation and Smart Energy Conference & Exhibition (SNEC PV Power Expo) held in Shanghai on May 24, 2023, Huawei's platform was bustling with activity. The company's next-generation all-scenario Smart PV + ESS solution, which includes the grid-forming solution, attracted a large crowd, and showcased the promising future of clean energy bases.

Conventional grid-following PV + ESS solutions are limited in their ability to withstand overcurrent, resulting in a reactive current that is only 1.04 times the rated current during fault ride-through. In contrast, Huawei's grid-forming solution supports multiple parallel PCSs and provides reactive current up to 3 times the rated current. Furthermore, while conventional solutions have a response time of 30 ms, Huawei's grid-forming solution can respond in just 10 ms.

To establish PV as the most reliable primary energy source, there are several obstacles that

must be overcome. Technological advancements must continuously reduce the levelized cost of energy (LCOE) for PV + ESS systems to make them commercially viable in more areas and scenarios. The operations and maintenance (O&M) efficiency of plants, which are often numerous, dispersed, and safety-intensive, must be improved. Grid connection stability and the consumption of renewables must also be improved, as grid disconnections and outages have been observed in regions such as Australia and the UK. Additionally, end-to-end system safety must be ensured as the power of PV and ESS devices continues to increase.

Huawei's grid-forming solution offers a significant advantage in stable grid connection, supporting up to 50% of renewable energy on power grids. Through the redefinition of voltage, frequency, and power angle stability, Huawei's grid-forming solution achieves stable operation even in weak grid conditions and suppresses wide-band oscillation.

Huawei's solution comprises innovative technologies such as voltage stability reconstruction, frequency stability reconstruction, wide-band oscillation suppression, fault ride-through on 100% power electronic systems, batch black start, and active harmonic suppression, all of which facilitate the transition to clean energy.

Conventional synchronous generators exhibit subtransient characteristics, meaning that the internal potential remains constant during a fault while a significant amount of reactive power is generated or absorbed transiently. Additionally, synchronous generators display transient characteristics, whereby the excitation system enters a strong excitation state in response to a severe voltage dip caused by a fault, providing emergency reactive voltage to the system. However, the growing presence of renewable energy sources presents considerable challenges to voltage stability. As a result, the voltage support capacity of PV + ESS systems must be redefined.

When a specific voltage and phase are input, the grid-forming solution transitions from conventional current control to voltage control. Like synchronous generators, the grid-forming solution adjusts the internal potential to regulate the terminal voltage and reactive power. The reactive power regulation process of the grid-forming solution differs entirely from the control policy for conventional current sources. Voltage detection and phase sequence decomposition are not necessary. Quick reactive power response during fault ride-through is achievable by controlling and adjusting the internal electric potential. In January 2023, field test results in Qinghai, China, demonstrated that Huawei's grid-forming technology can respond

to reactive current within 10 ms during power grid voltage dips, facilitating quick recovery of terminal voltage.

However, power electronics equipment lacks overcurrent resistance capability. As a result, conventional PV + ESS systems can only provide reactive current approximately equal to the rated current during fault ride-through. Huawei's grid-forming solution employs voltage synchronization technology, enabling multiple string PCSs to operate in parallel without inducing circulating current. Additionally, due to the small granularity of string PCSs, the reactive current can be 1 to N times the rated current. The field test results in Qinghai, China, indicate that Huawei's grid-forming solution provides a short-circuit capacity three times the rated capacity during power grid voltage dips, boosting the transient current support capability.

Smart PV + ESS transforms passive grid following to proactive grid forming

The Smart PV + ESS solution has completely revolutionized PV power generation. According to the International Energy Agency (IEA), renewables typified by PV will become the largest source of global electricity generation by early 2025, surpassing coal. As the world undergoes an energy transformation, with the rapid growth of renewables, opening of the electric power market, and large-scale grid

connection of renewables, the market for grid-forming solutions is poised for a golden period of development.

The successful implementation of utility-scale, C&I, and residential plants has proven that grid-forming solutions can improve the operational stability of renewable plants, ensuring efficient, stable, and safe power supply, facilitating the application of renewables, and achieving sustainable development.

Huawei is committed to building a more stable, safer, and smarter digital renewable energy infrastructure for new power systems. Huawei's grid-forming solution has overcome the challenges posed by high proportions of renewables, high proportions of power electronic devices, and GW-level plants. By combining energy storage and management technologies, the solution not only achieves efficient utilization of PV energy but also maximizes the balance between power generation and consumption as well as energy utilization, promoting the transformation of PV energy from grid following to grid forming.

With the accumulation of profound technical knowledge and a strong business presence in the PV and energy storage fields, Huawei deeply integrates digitalization, intelligence, and power electronics technologies, forging innovative solutions for intelligent power systems. ▲



Smart String ESS, the Optimal Solution for ESS Safety

Integrating digitalization and intelligence will improve the efficiency, stability, and safety of ESSs. This integration will address challenges related to system safety, efficiency, battery life, and O&M.

As the world shifts towards renewable energy, particularly photovoltaics (PV), energy storage systems (ESSs) become indispensable for PV and other renewable energy sources. While cost-effectiveness is a significant consideration for PV+ESS, safety is paramount. ESSs can enhance the energy self-sufficiency rate, lower the electricity expenditure of businesses, and ensure the stability of power supply only if their safety is guaranteed.

Safety is the priority

Undoubtedly, safety is the cornerstone of sustainable industrial development. The occurrence of ESS safety accidents worldwide has raised significant concerns. Many countries have laws

and regulations that specify PV and ESS safety requirements. For instance, all rooftop PV systems in Europe and Australia must include DC arc detection and rapid shutdown functions. In China, new standards will be formulated to regulate ESSs used for new power systems, ESS connection to the power grid, ESS safety, and emergency handling, according to the Guide to Building a Carbon Peaking and Neutrality Standard System jointly released by the Standardization Administration, the National Development and Reform Commission, and the Ministry of Industry and Information Technology.

Despite years of development, energy storage products still face such problems



as inadequate safety measures, low efficiency, short lifespan, and challenging O&M. The surrounding environment and personal safety are significantly compromised in an ESS safety accident. For example, commercial and industrial (C&I) ESSs are installed in complex settings such as factories, hospitals, shopping malls, and campuses, with a higher concentration of people and assets than in scenarios involving traditional utility-scale ESSs, which makes firefighting more challenging and safety concerns more pressing.

Technology, cost-effectiveness, and safety have always been topics of interest in the developing energy storage market. The evolution of energy storage follows a clear path, focusing on improving performance, enhancing durability, and increasing energy density, power density, and environmental friendliness. However, it is anticipated that cost and safety will become the primary focus areas in the future of the energy storage market.

As per a survey conducted by TÜV Rheinland, most enterprises consider "safety" the primary concern regarding

ESSs. Any vulnerability in the system can potentially result in safety issues at a system level. For instance, the failure path of C&I ESSs involves the introduction of risk sources, the occurrence and spread of thermal runaway, and, in extreme cases, ESS fire and explosion. Each phase presents unique safety technical challenges.

The inherent safety of an ESS is closely linked to the performance of its cells. For instance, lithium batteries are susceptible to instability due to various exothermic side reactions that may arise during routine charge and discharge cycles. To enhance the safety of ESS right from the outset, it is imperative to elevate the standards for battery materials, battery selection, and production techniques.

The safety of ESSs can be effectively managed during the early warning phase and the fault and thermal runaway warning phase. During the latter phase, the internal reaction of the ESS can lead to irreversible thermal runaway of the cell or pack. However, during the early warning phase, advanced technologies such as real-

time monitoring of cell data, intelligent prediction of cell risks, and hierarchical fault warning can provide advance warnings of thermal runaway. This not only saves time for O&M personnel but also prevents thermal runaway risks.

To minimize the impact of thermal runaway, it is crucial to implement rapid isolation measures to prevent its spread. Therefore, incorporating a multi-level isolation design into an ESS is essential. This design should enable rapid shutdown or isolation of faulty components when parameters such as current, voltage, and temperature are abnormal.

Furthermore, in the event of an ESS explosion, the door and air conditioner on top may be blown out, and the shell may disintegrate, posing significant safety risks to O&M personnel and firefighters in the vicinity. Unfortunately, statistics show that between 2018 and 2023, there were 55 ESS safety accidents worldwide (including six explosion accidents) that resulted in casualties.

Continuous technological innovation is essential to tackle crucial safety challenges, guarantee end-to-end ESS safety, and safeguard the safety of equipment, assets, and personnel.

Smart String ESS lays a foundation for safety

Ensuring ESS safety is a multifaceted and intricate matter that requires

comprehensive efforts at every stage, ranging from materials and systems to research, development, and practical application. As we consistently enhance safety standards and supply chain management systems, we must also leverage the convergence of digital and energy technologies (bits+watts) to advance ESS safety by improving products and technologies.

Huawei has been continuously innovating to ensure ESS safety. According to the Top 10 Trends of Smart PV released by Huawei Digital Power, the main trends are "Upgraded Safety" and "Security and Trustworthiness." Enterprises must systematically consider all scenarios and processes and fully integrate power electronics, electrochemistry, thermal management, and digital technologies to upgrade system safety. In energy storage scenarios, multiple technologies, such as power electronics and cloud technology, are required to refine the management of energy storage products from battery cells to the system. The traditional protection mode based on passive response and physical isolation has been replaced with active automatic protection, fault prediction, and warning. This implements multi-dimensional safety design from hardware to software and from the structure to the algorithm level. To cope with safety challenges, enterprises need to establish a complete set of secure and trusted management mechanisms, including the reliability,

availability, security, and resilience of systems and devices in terms of organization and management.

Advancements in energy storage technologies have opened up new opportunities for achieving extremely high safety levels. Within the solar PV industry, string PV inverters have surpassed central inverters due to their ability to provide precise management over multiple MPPT circuits, reducing the impact of mismatch between PV strings and improving the system's energy output. This highlights the advantages of string solutions regarding failure rate, system safety, and O&M efficiency, making them the preferred option in the industry. The Smart String ESS solution has emerged based on the success of the string inverter solution proposed by Huawei.

Huawei's Smart String ESS solution integrates digital technologies with PV and ESS technologies. This innovative solution is built on a distributed ESS architecture. It incorporates cutting-edge technologies that enable battery pack-level optimization, rack-level management, digital and intelligent management, and a fully modular design. The ESS solution enables higher discharge capacity, superior ROI, simplified O&M, and consistent reliability throughout the lifecycle.

The Smart String ESS solution offers three key advantages over traditional

centralized ESS solutions: string-based, intelligent, and modular.

First, energy optimizers enable the refinement of energy management at the battery pack level, minimizing the impact of pack series mismatch and increasing the available capacity of the entire ESS. Second, rack controllers balance the capacity of battery racks during charge and discharge, reducing the parallel mismatch between battery racks and implementing rack-level energy management. Finally, a distributed smart cooling architecture is utilized: Each battery rack is equipped with an independent string-level air conditioner that dissipates heat independently and evenly. This helps reduce temperature differences between battery racks and improve temperature balance in the ESS.

Advanced ICT technologies, including cloud, AI, and BMS, are used to precisely pinpoint derivative internal short circuits, calculate internal short circuit resistance, detect sudden internal short circuits in real time, and promptly alert against battery fires. Furthermore, intelligent technologies can be leveraged to develop predictive models that estimate SoX parameters and predict battery health. Multi-model intelligent cooling policies, such as battery lifespan, battery behavior, and environmental prediction, are implemented to achieve an optimal balance between battery degradation and energy consumption for cooling,

ensuring real-time optimization of LCOS.

The ESS features a modular design that enables the isolation of faulty battery packs while ensuring the normal operation of other battery packs within the battery rack. Additionally, onsite manual adjustment of the SOC during battery pack or module replacement is not required. The Smart Power Control Systems (PCSs) also adopt a modular design, allowing for continued operation in case of a single PCS failure. Even if multiple PCSs experience faults, the system still functions normally.

Addressing safety challenges

Integrating digitalization and intelligence will improve the efficiency, stability, and safety of ESSs. This integration will address challenges related to system safety, efficiency, battery life, and O&M. Numerous cases have demonstrated that the Smart String ESS provides greater efficiency, cost-effectiveness, safety, and reliability than traditional centralized ESSs. Currently, it can be regarded as the optimal solution for ensuring ESS safety.

Huawei offers active safety solutions for devices, assets, and personnel to cover the entire failure path of the ESS. Huawei's comprehensive Smart String ESS architecture integrates electrochemistry, thermal management, power electronics, digital technologies, and safety design. Through pack-

level optimization and rack-level management, Huawei's solutions resolve the inconsistency and uncertainty of lithium batteries by utilizing power electronics technologies. With four-level active safety protection and two-level passive isolation, refined management enables higher available capacity and meets higher safety standards.

Huawei's Smart String ESS solution has made significant progress in industrial applications, receiving recognition from customers in Southeast Asia's largest energy storage project in Singapore, as well as the world's first 100% renewable and largest microgrid energy storage project, the 1.3 GWh Red Sea Project in Saudi Arabia. In the Singapore energy storage project, Huawei's Smart String ESS solution meets the local CoC fire protection requirements, EN ISO 1182, and EN ISO 1716, and successfully passed the flame retardant and fire wall tests of materials.

According to energy consulting firm Wood Mackenzie, the global capacity of newly installed ESSs is predicted to increase eight times, surpassing 300 GWh by 2032. However, for the energy storage market to progress significantly, safety standards and management mechanisms must continue to improve, warning and handling capabilities for safety issues must be enhanced, device safety must be ensured, and challenges related to O&M must be addressed. ▲



What Makes Ultra-Fast Charging Possible?

Huawei's fully liquid-cooled, ultra-fast charging technology generates high power and speeds up charging by increasing both current and voltage. The integration of liquid cooling technology is essential in maintaining reasonable current and voltage levels, enhancing product reliability, minimizing charging noise, and prolonging the lifespan of the equipment.

As the largest market for new energy vehicles (NEVs), China had 16.2 million NEVs by the end of June 2023, a 4.9% market share. However, the charging infrastructure issue can hinder the NEV market's expansion. In response to this challenge, Huawei unveiled its fully liquid-cooled ultra-fast charging technology in April 2023, which enables a maximum charging power of 600 kW and supports ultra-fast charging. This innovative solution has the potential to overcome the charging barrier and facilitate the growth of the NEV market. As for the technology itself, it

is a cutting-edge charging system that utilizes liquid-cooling technology to achieve ultra-fast charging speeds. It's worth noting that the actual charging power may vary slightly due to factors such as vehicle models, software versions, power consumption, operating conditions, and environmental factors.

A revolutionary leap toward refueling-speed charging

Currently, the biggest concern for potential NEV users is inconvenient charging, which also presents a structural challenge to the rapid growth of the NEV market. Users face negative



charging experiences due to insufficient charging stations, unevenly distributed facilities, and slow charging speeds. The Survey Report on Consumption and Use of Public Charging Piles of New Electric Vehicles, released by the China Consumers Association in March 2023, identifies insufficient charging stations, poor accessibility, and lack of chargers as the main pain points for NEV charging. During the May Day holiday in 2023, people queued for an average of 2.7 hours, with some queuing up to 4 hours at the busiest charging stations in China to charge their NEVs. For operators, existing charging facilities have a short lifespan, unbalanced usage efficiency, and cannot evolve, leading to higher costs and reduced profits. In response to these challenges, Huawei Digital Power aims to facilitate the growth of the NEV industry and accelerate mobility electrification by integrating digital and power

electronics technologies and providing a refueling-speed charging experience. Huawei's innovative technology provides a charging experience unseen in the past. Consumers can now charge their NEVs at a maximum power of 600 kW, allowing them to fully charge their vehicles while taking a coffee break.

From an operator's perspective, fully liquid-cooled ultra-fast charging technology outperforms traditional solutions under the same working conditions. This is because it can double the turnover rate and reduce OPEX by 46% for charging stations. If we evaluate the ROI of highway and urban public charging stations using charging leveled cost of energy (C-LCOE), Huawei's innovative charging solution has a 60% lower C-LCOE than traditional solutions.

You may wonder what fully liquid-

cooled ultra-fast charging technology is all about.

What is the key to its rapid charging capability?

This solution uses liquid cooling technology in the charging power cabinet and dispensers. With integrated PV and energy storage, Huawei has established a fully liquid-cooled ultra-fast charging architecture that enables synergy between vehicles and chargers and power grids and networks. Huawei's fully liquid-cooled ultra-fast charging technology can generate high power and speed up charging by increasing current and voltage. Compared to traditional chargers, chargers based on Huawei's technology can bear a current and voltage upper limit of 600 A and 1000 V, significantly improving from the 250 A and 750 V of traditional chargers. During this process, liquid cooling technology determines current and voltage safety, product availability, charging noise, and equipment lifespan.

Traditional charging solutions face challenges in increasing charging power by boosting current and voltage. These solutions are also limited in their cooling capabilities, particularly with naturally-cooled technologies. As a result, as the current increases, more heat is generated during charging, which can shorten the lifespan of NEV batteries and even cause fires due to short circuits. Additionally, higher

current levels mean heavier charging cables, with some fast charging cables weighing several kilograms and negatively impacting user experience.

In contrast, Huawei's solution offers quick cooling of charging devices and is equipped with lightweight charging cables, making it a convenient option for female drivers. Furthermore, traditional charging solutions often negatively impact insulation, heat dissipation, and battery safety when voltage increases. Huawei's solution uses DC protection components that can withstand high temperatures and high voltage, sealed with ceramics that offer double the insulation capability of epoxy resin. Thermal insulation materials are also applied to dissipate heat in a more organized way, enhancing protection against thermal diffusion and ensuring device safety when charged at high voltages.

Moreover, Huawei's liquid cooling technology reduces charging noise and extends the lifespan of charging power cabinets and dispensers by 10 to 20 years. Despite these benefits, concerns remain regarding whether fast charging speeds may damage NEV batteries. In response to these concerns, Huawei's fully liquid-cooled ultra-fast charging technology can adapt to the charging curves of batteries from different NEV models without causing overload, ensuring the battery lifespan is not negatively impacted.

When will NEV drivers be able to enjoy an excellent charging experience?

Huawei Digital Power believes that charging networks are vital to NEV energy infrastructure. As a provider of power systems and charging networks, Huawei Digital Power envisions ubiquitous charging facilities by integrating PV + ESS + Charger. This proven technology has already been put into commercial use since 2023.

To achieve this vision, Huawei Digital Power has focused on two aspects. First, it conducted interconnection tests with vehicle manufacturers to ensure that chargers using its technology can adapt to different brands (GB/T interface). Second, Huawei Digital Power collaborated with customers and partners to develop ultra-fast charging solutions across China in hundreds of thousands of gas stations, highway rest areas, and urban public areas with a high density of electric vehicles. It aims to establish a unified highway and city network.

In the future, Huawei's innovative solutions will support access to AC/DC energy storage for intelligent peak shaving, eliminating the need to reconstruct the mains supply, and generating additional revenues for operators. Along with facilitating the high-quality development of charging networks, Huawei Digital Power aims to create business value for the mobility

electrification industry by offering various business models, ensuring its sustained growth.

Many cities in China are now accelerating the development of charging networks. Guangzhou, located in southern China, plans to construct a city-wide charging and battery-swapping capacity of 4 million kilowatts and 1000 ultra-fast charging stations by 2024. Shenzhen, a special economic zone in Guangdong province, has set an ambitious goal to become an "ultra-fast charging city" and has announced plans to construct over 2000 ultra-fast charging stations by 2035. Other Chinese cities, including Chengdu, Mianyang, Yibin, Taiyuan, Zhengzhou, and Guilin, are also actively pursuing the development of ultra-fast charging networks.

The National Development and Reform Commission of China and nine other government departments have provided policy assurance that China will have a charging infrastructure system of 6.543 million chargers to meet the charging demand of 20 million EVs by 2025. As opportunities arise for the entire industry, Huawei Digital Power is confident that its fully liquid-cooled ultra-fast charging technology will enhance the charging experience for NEV drivers, expedite mobility electrification, and promote carbon neutrality in transportation. ▲



What Is the Evolution Direction of Next-Generation Data Centers? Huawei's GSSR Data Centers May Provide an Answer

The advent of digitalization and intelligence has ushered in a new era of prosperity for data centers. When we consider the full-lifecycle management perspective, where do data centers stand in the future? Huawei Digital Power's GSSR (green, simple, smart, and reliable) concept offers a potential solution to this inquiry.

Data centers have significantly influenced our lives since their inception in the late 1950s, with their impact becoming increasingly apparent in the first two decades of this century. As a pillar of the digital economy, data centers have played a crucial role in driving global economic growth. According to the China Academy of Information and Communications Technology's Global Digital Economy White Paper, the digital economy of 47 major countries accounted for up to 45% of their GDP in 2021. With data becoming the fifth factor of

production after land, labor, capital, and technology, and computing power being a new type of productivity, data centers have emerged as a crucial foundation of the digital world.

Despite being around for decades, data centers are experiencing new industry changes due to the rapid development of new technologies such as generative AI, cloud computing, and big data. This has led to a surge in demand for computing power from all industries, presenting a new golden age for global data centers.

What Is the Evolution Direction of Next-Generation Data Centers? Huawei's GSSR Data Centers May Provide an Answer

However, such a boom in data centers has led to a significant increase in energy consumption.

According to the International Data Corporation (IDC), data centers are expected to account for 4% of global power consumption by 2030, up from the current 3%. However, the Uptime Institute Global Data Center Survey 2023 reveals that the average power usage effectiveness (PUE) of global data centers has remained at around 1.58, indicating significant room for improvement. PUE is calculated as the total energy consumption of data center equipment divided by IT equipment energy consumption, with a perfect score being 1.0.

In recent years, there has been an increased demand for simplified deployment, intelligent operations and maintenance (O&M), and data center safety. Rather than merely housing computing, network, and storage devices, data centers must evolve into new infrastructure for the digital industry. Digitalization and intelligence have ushered in a new era for data centers. When considering the future of data centers from the perspective of full-lifecycle management, where are they headed?

Beginning: We are on the cusp of a new era of industrial transformation.

While data centers are a product of computers, modern data centers or Internet data centers (IDCs) emerged in the 1990s. They gained significant traction during the era of the Internet and cloud

computing. The energy management of global data centers over the past three decades can be categorized into the following phases:

Phase 1: Data centers grew at scale, with a focus on availability and reliability.

During the early stages of data center development, the industry experienced rapid growth, with a focus on expanding the scale and number of racks. Although energy consumption and efficiency were managed extensively, the industry faced challenges such as low rack deployment rates, high energy consumption, and complex O&M costs, which remain bottlenecks today. According to the Ministry of Industry and Information Technology (MIIT), the average PUE for ultra-large data centers in China was 1.46 by the end of 2019, while large data centers had an average PUE of 1.55 (with the lowest being 1.15), showing a slight change from the previous two years. The national average PUE for data centers currently under construction in China is approximately 1.41, while the designed average PUEs for ultra-large and large data centers are 1.36 and 1.39, respectively.

Phase 2: Green data centers are imperative for meeting carbon peaking and neutrality targets.

To date, numerous countries have pledged to advance the eco-friendly development of data centers. European data center operators and industry associations have declared their aim

for carbon neutrality in data centers by the year 2030. In China, the MIIT has mandated a reduction in PUE for ultra-large and large data centers to below 1.3 by 2025, as part of the Green and Low-Carbon Development Action Plan for the Information and Communication Industry (2022–2025). In its East-to-West Computing Resource Transfer program, China sets a stricter standard: the PUE in Western China should be lower than 1.2, and that in Eastern China lower than 1.25.

Phase 3: Data centers gradually evolve into "all-rounders."

As the industrial Internet and various industries shift towards digitalization, there is an increased demand for data centers to meet higher standards. These standards include intelligent and simplified O&M, modular deployment, elastic capacity expansion, comprehensive reliability, availability, and low carbon emissions. In response to the challenges of the digital-intelligent era, Huawei Digital Power has introduced the innovative concept of GSSR (green, simple, smart, and reliable), which provides a roadmap for developing next-generation data centers.

Future: Why are GSSR data centers expected to dominate?

So, what sets GSSR data centers apart in leading the way in future industrial development? Huawei Digital Power recognizes data center facilities as a new digital infrastructure essential to transforming the data center industry. On

the one hand, adhering to "more bits, fewer watts, and less CO₂" allows each watt to support more connections and computing power. On the other hand, utilizing a modular, intelligent, and secure top-level design can significantly reduce CAPEX and OPEX while improving O&M efficiency throughout the entire energy management lifecycle of data centers.

With cutting-edge technologies at our disposal, GSSR data centers deliver more bits while consuming fewer watts, thanks to three key features: high efficiency and energy savings, high density and space optimization, and full-link carbon reduction.

In traditional cooling solutions, frequent heat exchange results in poor cooling performance. Huawei's indirect evaporative cooling EHU400 solution uses natural cooling sources to the fullest extent and employs AI-based optimization to exchange heat only once, maximizing cooling efficiency for its GSSR data centers. This has resulted in a reduced PUE of 1.15 for the Huawei Cloud Ulanqab Data Center.

To ensure an efficient and reliable power supply, Huawei launched the FusionPower6000 3.0 solution, increasing the entire link's efficiency from 94.5% to 97.8%. The FusionPower6000 3.0 can seamlessly switch back to battery mode when working in S-ECO mode. In 2023, Huawei released the international edition of the FusionPower6000 3.0 solution

for large data centers. It replaces cables with prefabricated bridge-like busbars for plug-and-play, saving over 30% of the installation footprint and shortening delivery time from two months to two weeks. The entire link is visible, manageable, and controllable through intelligent O&M, and the service life of key components is predicted through over 150 temperature measurement points on the entire link, ensuring intelligent and proactive safety.

Huawei Digital Power offers its cutting-edge Fan Wall Chilled Water Solution for cooling efficiency. This technology can support a water inlet temperature of up to 20°C, resulting in a 15% reduction in power consumption of chillers. In the case of the China Unicom IDC building project, where large-capacity electromechanical equipment could not be reconstructed, Huawei's advanced fan wall air conditioners were implemented. Because these air conditioners use water with an inlet temperature of 18°C instead of the typical 12°C, the overall energy consumption was reduced by over 20%.

Simplified deployment and maintenance have enabled the construction and operation of data centers to become more cost-effective and efficient. Nowadays, modular power systems are the preferred choice for data center solutions because they significantly improve construction efficiency. With prefabricated and modular construction technologies, GSSR data

centers can reduce onsite engineering workload and shorten time to market (TTM) by more than 50%.

For instance, by utilizing Huawei's ecosystem solution of FusionDC, the construction period of a 1000-rack data center can be shortened from over 18 months to 6–9 months. GSSR data centers are equipped with intelligent O&M and AI-based energy efficiency optimization, which ensure efficient O&M while improving energy efficiency. The cooling system of a data center consumes approximately 30% to 45% of its power. Therefore, reducing the electricity the cooling system consumes is crucial for energy conservation and emission reduction.

Huawei's iCooling solution utilizes AI-based technologies to optimize the energy efficiency of cooling systems, resulting in precise and on-demand cooling. This intelligent solution has been deployed at Huawei Cloud Langfang Data Center, which houses over 4000 racks, and has reduced its PUE from 1.42 to 1.26, saving more than 30 million kWh of electricity annually. In the first phase of deployment at Jinqiao Data Center of Shanghai Stock Exchange, the iCooling solution managed 2000 racks and reduced the annual PUE by 13%. It is projected that upon implementation across all 18,600 racks, the solution will save over 20 million kWh of electricity annually.

GSSR data centers ensure architecture

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security, active safety, and cyber security. In the past, due to the lack of effective monitoring technologies, many critical components in the data center facility system were replaced only after faults occurred. These components include busway capacitors and fans of the UPS, which frequently fail. GSSR data centers now implement an active safety mechanism that collects data on capacitor temperature, load rate, and ripple characteristics, predicts component lifespans using AI algorithms, and generates warnings before faults occur. This represents a shift from reactive to active and predictive maintenance, significantly reducing the failure rate and enhancing the reliability of data centers.

Co-creation: Expediting GSSR data center deployments

Currently, the GSSR concept is being embraced by an increasing number of partners and enterprise customers in the industry.

This innovative idea is the product of years of innovation by Huawei Digital Power in the domain of new energy infrastructure for the digital industry. In addition to integrating advanced digital and power electronics technologies, GSSR data centers also reflect the vision of Huawei Digital Power for the data center industry. Huawei Digital Power continuously works with industry leaders, technical experts, and industry customers to release a White Paper on the Top 10 Data Center



Facility Trends every year, which is of great significance for the development of the data center facility industry, and in particular, for large and ultra-large data centers under construction.

With regard to sustainable development, Huawei Digital Power believes that data centers should be measured by more comprehensive indicators rather than just relying on PUE. These indicators include renewable energy utilization, water usage effectiveness (WUE), carbon usage effectiveness (CUE), space usage effectiveness (SUE), grid usage effectiveness (GUE), material recovery rate, and lifetime contaminant emissions.

Through in-depth collaboration with ecosystem partners and industry customers, Huawei Digital Power has been gradually implementing cutting-edge technologies, innovative products, and solutions by adhering to the GSSR concept.

In 2023, Centrin Data and Huawei Digital Power collaborated to produce a green

and reliable power supply and distribution solution designed to save time, power, and space and prevent potential problems. They applied the "Centrin Data - Intelligent Power Pod" model to the data center in Ulanqab, which integrated the power source, grid, load, and storage, aiming to establish a demo base for data centers.

BodaData deployed Huawei's FusionPower6000 3.0 solution in the intelligent computing center in Qianhai, Shenzhen, to create a power supply and distribution system with full-chain convergence, prefabrication, and AI management. These efforts were made to make the data center simple, green, smart, and reliable.

Driven by information technology and the call of carbon neutrality, the global data center industry is moving towards GSSR. GSSR is a leading management concept and a flagbearer of low-carbon and intelligent data centers. It is expected to transform data centers from major energy consumers to a new digital industry infrastructure. ▲



Telecom Operators in VPPs: Transition from Energy Consumers to Prosumers

A virtual power plant (VPP) harnesses the full potential of underutilized power resources and maximizes their value through digital technologies. It intelligently manages and controls the basic resources of a new power system by sharing fragmented but massive power resources on a larger scale and optimizing resource configuration.

Telecom operators want to maintain their high-quality development by predominantly using clean energy to power communications. This will enable them to achieve carbon neutrality at a faster pace. As the energy mix gradually transforms, telecom sites and data centers will no longer be major energy consumers in the future. Instead, they are likely to become energy production infrastructure. Telecom operators' active participation in VPP regulation will be crucial for their transition from energy consumers to prosumers.

Preferred option: Use VPPs for flexible power grid regulation

Flexible regulation is crucial for maintaining power balance and ensuring a power grid's secure and stable operation. Traditionally, power grid regulation relied on physical power plants like hydropower and coal-fired plants. However, VPPs offer a more comprehensive approach to power generation, grid management, load balancing, and storage optimization. VPPs allow coordinated control of diverse resources in an integrated manner, even though they lack the

physical form of traditional power plants. VPPs can function as power suppliers and provide ancillary services like power regulation. Key VPP technologies include coordination and control, intelligent metering, and information and communications technology (ICT). Essentially, VPPs leverage digital technologies to intelligently manage and control the basic resources of a new power system by sharing fragmented but massive power resources on a larger scale and optimizing resource configuration.

According to estimates from the State Grid Corporation of China (SGCC), an investment of 400 billion CNY is required to meet just 5% of the peak load if coal-fired power plants are used for peak shaving. However, if VPPs are used for the same purpose, the investment would significantly drop to 50–60 billion CNY, representing a clear economic advantage over coal-fired power plants at 1/8th the cost. As cities grow, resources such as land and water remain limited. When considering the environment and the economy, traditional power plants will not be able to meet future requirements of power grid regulation. VPPs, with their more flexible regulation capabilities, will become the preferred option.

Shenzhen showcase: All 5G base stations are included in VPPs

China's first VPP management center has been established in Shenzhen. As of

June 2023, the management center has connected with 66 VPP operators and is currently managing 30 of them. The total power capacity exceeds 1.5 million kW, with an estimated maximum of 300,000+ kW adjustable load capacity in real time. This makes the center China's strongest VPP platform to date, featuring the highest data collection density, supporting the widest variety of load types, owning the largest quantity of directly managed resources, and covering the broadest range of usage scenarios. By 2025, Shenzhen plans to complete the construction of VPPs with a 1-million-kW adjustable capacity in order to develop new power systems and sustain its green industry development.

Shenzhen has connected a variety of generation-grid-load-storage resources to VPPs, including 170,000 charging piles, 5100 sets of 5G base stations, 6000 electric bicycle power charging and swapping cabinets, 1200 PV stations, 15 energy storage demonstration stations, 13 vehicle-to-grid (V2G) stations, and several large data centers. The 5G base stations alone are expected to provide a fast and flexible regulation capacity of over 200,000 kW for power systems.

Value proposition: Once a cost-saving measure, base stations are now profitable investments

What benefits can telecom operators derive from investing their communications base stations in VPPs?

First, global telecom operators possess abundant land resources and backup power and energy storage resources for their telecom sites, making them ideal candidates to construct an energy infrastructure that can be self-sufficient or feed power into grids. Second, the development of useful applications, such as staggering electricity usage and VPP regulation, has enabled communications base stations to transition their value proposition from cost-saving to profit-making. VPPs are gaining momentum worldwide and receiving increasing policy support. In Europe, energy storage facilities in 26 countries can now be integrated with VPPs. China released its 14th Five-Year Plan for a Modern Energy System in March 2022, which aims to encourage the inclusion of flexible resources such as energy storage facilities, VPPs, and user-interruptible loads in electricity ancillary services. The Management Regulations on Electricity Ancillary Services issued by China's National Energy Administration also recognizes VPPs as an integral part of electricity ancillary services. Lastly, green power supply and energy storage will significantly reduce telecom network carbon emissions, accelerate the transformation of telecom operators toward a new energy mix, and facilitate the communications industry's evolution toward its carbon neutrality and net zero goals at an earlier timeline.

Technical requirements: Key indicators for base stations to function in VPPs

However, integrating traditional site power into VPPs faces challenges due to frequency regulation and other requirements. VPPs have flexible regulation features that demand differentiated technical indicators such as admission capacity, response time, and regulation precision in various service scenarios. This makes it challenging for traditional site power to integrate with VPPs, hindering the achievement of an effective business cycle.

For instance, many traditional site power devices use lead-acid and aging batteries, which do not match the requirements of VPPs. Furthermore, the computing and power regulation capacities of the power and environment systems, namely, the communications power supply system and the equipment room environment monitoring system, are occupied, leading to another major conflict with the management requirements of VPPs. Additionally, traditional site power provides low speed and precision of regulation, resulting in a lack of prompt and accurate response to regulation requests from VPPs.

For telecom operators to fully integrate their base stations into VPPs, their primary objective should be to explore innovative technical solutions that enable the installed energy infrastructure to meet the complex requirements of VPPs.

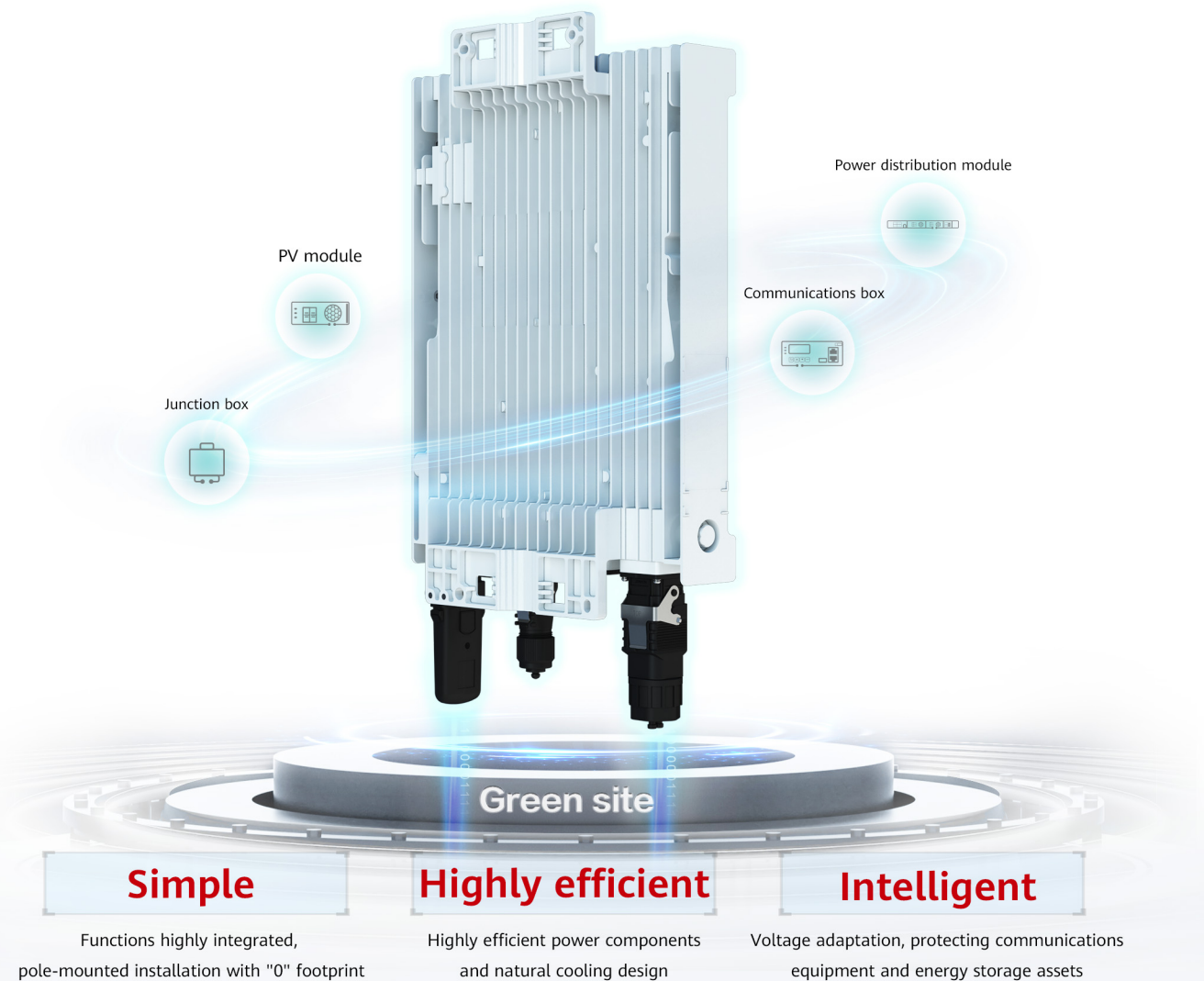
Huawei Digital Power believes that a high-performance telecom power VPP solution with large scheduling capacity, high regulation accuracy, and quick response is required to achieve effective telecom energy storage integration. To achieve better hardware adjustment precision and higher response speed, the solution will require robust hardware (VPP smart gateway and VPP intelligent lithium battery). More importantly, it should include a high-performance software platform to achieve intelligent collaboration and optimal end-to-end performance, meet the service level agreement (SLA) requirements of versatile VPP services, and maximize revenue and benefits. Furthermore, the solution should be adaptable to various scenarios and allow devices to be smoothly integrated into the live network.

Role transition: From energy consumers to prosumers

Huawei Digital Power is dedicated to using its technological advantages in digitalization and power electronics to construct new energy infrastructure for digital industries. One of our key objectives is to enable telecom operators to actively participate in VPPs. Historically, telecom operators were solely consumers of energy. However, with the rapid advancement of clean energy, distributed energy, and VPPs, telecom operators will play a more significant role as energy prosumers. ▲

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