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Technology Brings Us Closer to Carbon Neutrality

Energy Transformation: From Prometheus' Fire to Advanced Technologies

> Yalong River: Powering China with Clean Solar and Hydro Energy

Solar Panels Revitalize the Flora and Life in the Kubuqi Desert

The Largest Green Data Center Cluster in Central China Is Well on Its Way

Building Green, Energy-efficient Telecom Sites with Turkcell



Technology Brings Us Closer to Carbon Neutrality



Charles Yang President of Global Marketing and Sales Services Dept, Huawei Digital Power As our society has progressed, technology and energy are now the drivers of modern civilization. Technology started with the steam engine, evolving to electricity, and then information. Now, we are in the age of intelligence. Meanwhile, agriculture transitioned to industry, which is now also shifting toward intelligence. Alongside the evolution of our civilization, energy has been transformed, beginning with firewood, then relying on fossil fuels, and now, we turn to renewable energy sources.

Carbon neutrality has become a shared vision of the world. More than 130 countries and regions have announced their timetables to go carbon neutral.

China has announced its carbon peak and neutrality strategy and is playing a key role in the global carbon neutrality process. For this, there are three key drivers — carbon neutrality is supported by policy, enabled by technology, and promoted by capital.

In the near future, we expect that the global energy industry will no longer depend on natural resources, but will be technology-driven. Digital and electronic power technologies will enable the transformation of the energy industry.

Huawei Digital Power integrates digital and power electronics technologies, develops clean power, and enables energy digitalization to drive an energy revolution for a better, greener future. On the road to carbon neutrality, we are working on the following areas to save energy and reduce carbon emissions.

Low-carbon power generation

According to the International Energy Agency (IEA), the electric power sector accounts for about 40% of global carbon emissions and generates the largest share of carbon emissions than any other industry. To reduce carbon emissions in power generation, we need technologies that will develop renewable energy. In this way, we can build a safer, more economical, stable, and clean power generation network.

For example, we can use technologies such as AI and Smart DC System (SDS) to improve PV energy yields and O&M efficiency, making power generation more economical. We can also use smart PV + storage generators to form grids and increase the proportion of renewables in energy consumption by 30%. Plus, we can use arc-fault circuit interrupters (AFCIs) to implement intelligent arc protection.

All these technologies will promote the use of green power in more homes and businesses.

Electrification

The transportation sector accounts for 23% of global carbon emissions. In China, about 80% of these comes from

road traffic. Promoting the use of new energy vehicles (NEVs) will be essential to achieving carbon neutrality. As NEVs and green travel gain increasing popularity, we are moving closer to the goal. Charging, cruising range, and safety remain the three major concerns that put consumers off from going electric. To accelerate mobility electrification, we are committed to redefining the driving experience and safety of electric vehicles and maximizing the cruising range for each kilowatt hour of electricity.

Efficient power consumption

As the digital economy develops rapidly, computing has become a new productive force. Data centers are at the core of the digital economy, but they consume increasingly more energy.

As 5G networks are rolled out, telecom sites will support stronger connectivity but consume three times more energy than 4G sites. As such, we must draw on ICTs to improve the energy efficiency of ICT infrastructure including data centers and telecom sites.

GeSI, an international sustainability organization, predicts that ICTs will help the world reduce carbon dioxide emissions by 20% by 2030. With established expertise in the ICT field, Huawei is committed to building green and low-carbon data centers, communications networks, and efficient mission-critical power supply solutions to build a green foundation for an intelligent world.

Energy integration

Energy integration is another crucial area of focus — impacting our buildings and campuses. The construction industry accounts for 10% of global carbon emissions, a fact that is often overlooked.

We are eager to work with customers to build low-carbon homes, campuses, villages, and cities, integrating the circular economy into the entire product lifecycle to minimize carbon emissions. To build a near-zerocarbon society, we need to promote green power in all energy-consuming areas including homes and campuses, improve power generation efficiency, reduce power consumption costs, and recycle materials.

Green and low-carbon transformation is imperative. Energy transformation will be the next step in our civilization. It will exert profound influence on the way we live, signaling unprecedented changes for consumers, enterprises, industries, and countries. We must all be part of this transformation.

Looking ahead, Huawei Digital Power will continue to work with upstream and downstream partners in the industry to power homes and businesses through technological innovation. Together, we hope to enable sustainable development for a better, greener future.

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Global policies





The World Energy Outlook 2022 anticipates rapid growth in renewables.

The world, especially Europe, is facing a severe energy crisis. In its World Energy Outlook 2022, the International Energy Agency (IEA) expects global energy demand to continue growing by about 0.8% every year until 2030. Almost all of the new demand will be met by renewable energy sources. Also, the report predicts that carbon emissions will peak by mid 2020s. By 2030, renewable energy will have quadrupled its installed capacity compared to 2021. Plus, it will account for over 60% of the total energy yield in 2030, reaching 88% by 2050.

The EU will continue to control electricity prices and force lower electricity consumption.

Facing an important energy crisis, the EU has a three-pronged approach: cap the electricity prices set by low-cost power plants, tax the excess profits of fossil fuel companies, and impose mandatory reductions on electricity consumption. For example, renewable energy and nuclear power generation companies can't earn more than 180 euros per MWh. The EU is also levying a temporary tax of at least 33% on excess profits of oil, gas, coal and refining enterprises, which will be imposed based on "taxable profits for fiscal year 2022". At the same time, the region is looking to reduce total electricity consumption by 10%, with a mandatory goal of 5% during specific peak hours.

France is quickly developing renewable energy, aiming to achieve carbon neutrality by 2050.

France reiterated its energy transformation plan in June 2022. It will continue to develop renewable energy to achieve carbon neutrality by 2050. By then, France plans to have ten times more installed capacity in solar power reaching over 100 GW, set up 50 offshore wind farms to reach a capacity of 40 GW, and double the onshore wind power capacity. In addition, France envisions that renewable energy will account for 32% of its final energy consumption by 2030.

The US will invest US\$369 billion in climate policy over the next 10 years.

The US has reached a preliminary consensus on the Inflation Reduction Act of 2022, which allocates US\$36.9 billion in funding for climate policies over the coming decade. The funds will be mainly used to support domestic energy production and manufacturing, including tax credits for PV panels, wind turbine generators and electric vehicles. The plan will also help mitigate the impact of pollution on low-income communities, and reduce carbon emissions by about 40% by 2030.

New energy accounts for 1/4 of the electricity demand in the UK.

The British Energy Security Strategy released in April 2022 expects the UK to achieve an installed capacity of 70 GW in solar energy by 2035 and 50 GW in offshore wind power by 2030. The latter includes a 5 GW deep-sea floating offshore wind programme. On top of that, the nuclear power generation capacity will climb to 24 GW by 2050, meeting a quarter of all energy demand in the UK.

Japan prioritizes renewable energy development; and 2030 will mark a decarbonization milestone.

According to the 2022 White Paper on Environmental Circular Society Biodiversity, 2030 will be a critical year for Japan's decarbonization with greenhouse gas emissions reaching only 46% of what they had been in 2013. By 2030, renewables will make up more of the energy mix: solar energy will represent 14–16% of the energy mix (compared to 7% now), wind 5% (1.7% now), and hydrogen 11% (9% now). If these targets are met, the proportion of renewable energy will grow from about 23% today to 37% by 2030. New sources like hydrogen and ammonia will account for about 1% of the power structure.

India has allocated 2.44 trillion rupees (US\$29.28 billion) to upgrade clean energy grids.

India announced a plan worth 2.44 trillion rupees (US\$29.28 billion) on December 8, 2022 to build power transmission lines connecting renewable energy for power generation. The country hopes to double its clean energy capacity by 2030. The Ministry of Power of India said that the project will connect solar power plants in Rajasthan and Gujarat and wind farms in Tamil Nadu to the national gird.

COP27: Set up the "Loss and Damage Fund".

The 27th session of the Conference of the Parties of the UNFCCC (COP 27) concluded with a historic decision to establish a "Loss and Damage Fund" for poor countries hit by climate disasters. Although subsequent details are to be discussed, it is a key step in addressing climate change.

Clean power generation

The U.S. PV + storage market is booming.

The US Inflation Reduction Act of 2022 has expanded clean energy tax credits for solar power, and increased tax breaks for wind and solar projects in low-income communities. In order to cut energy consumption costs, the Biden administration will give special support to U.S. communities in terms of solar power, including financing, reducing solar power consumption costs, increasing the solar workforce, and establishing solar incentives.

The total installed PV capacity in the EU will reach 320 GW by 2025.

The European Parliament passed the Renewable Energy Directive (REDII), which authorizes the investment of 210 billion euros in energy systems by 2027. The total installed PV capacity in the EU will hit 320 GW by 2025, doubling that of 2021. It will further grow to 600 GW by 2030. Renewable energy will take up at least 49% of the total energy consumption in the construction industry by 2030. Estimates show that installing an additional 15 GW of rooftop solar PV panels can save 2.5 billion cubic meters of natural gas each year.

Two policies in Brazil boost the PV market.

The Brazilian Electricity Regulatory

Agency (ANEEL) announced two new PV policies to stimulate the PV market in Brazil, the largest economy in South America. These policies are likely to drive the growth of the entire PV market in South America. The first policy is to slash taxes on power generation for large PV plants by 80%, thereby stimulating the utility PV market. The second policy is to establish a system for measuring the net power of small residential and commercial PV systems to promote the development of small PV power projects.

The Ministry of Industry and Information Technology (MIIT) launches a carbon footprint certification for the PV industry.

The Guidelines on Promoting the Development of the Energy Electronics Industry (Draft for Soliciting Opinions) by MIIT highlight China's efforts to establish evaluation standards and certification for the PV carbon footprint. It is likely that the PV carbon footprint certification will extend to other industries, changing ecosystems of these industries.

China has nearly doubled its PV installed capacity compared with last year.

The National Energy Administration reports that China registered a total newly installed PV capacity of 58.24 GW from January to October 2022, a year-on-year increase of 99%, exceeding the annual newly installed PV capacity of 2021. China has also seen a significant increase in PV exports (silicon wafers, cells, and PV modules), supplying the energy transformation in Europe as well as the rapid expansion of emerging markets such as Brazil and India. According to the General Administration of Customs of China, China's PV product exports hit a record high of about US\$44.03 billion from January to October 2022, up by 90.3% year-on-year.

The National Development and Reform Commission (NDRC) and National Energy Administration ask providers to connect residential PV to the grid.

The NDRC and National Energy Administration issued the Guiding Opinions on Implementing the Rural Power Grid Consolidation and Improvement Project (Draft for Soliciting Opinions), which point out the importance of providing gridconnected power generation for distributed renewable energy. The Opinions urge power grid and power supply companies to simplify gridconnected procedures, optimize service processes, and promote online service applications. This is in an effort to ensure that rural distributed renewable energy can "be connected to the grid as much as possible", maintaining a reasonable level of consumption.

ICT infrastructure

China's national standard for Maximum Allowable Values of Energy Efficiency and Energy Efficiency Grades for Data Centers took effect on November 1, 2022.

The standard (GB 40879-2021) was approved and published by the State Administration for Market Regulation and the Standardization Administration. It took effect nationwide on November 1, 2022. The standard applies to newlybuilt and reconstructed data centers. It is used to measure energy consumption as well as calculate and assess energy efficiency for data center buildings or modules that are equipped with independent power distribution, cooling systems, and electric air conditioners. This standard sets three grades for data center energy efficiency. Grade 1 indicates the highest energy efficiency. The lowest allowable value is grade 3, which means that data centers must have a PUE below or equal to 1.50.

Omdia predicts that liquid cooling will become the standard in data centers.

The scale of the liquid cooling market may exceed US\$3 billion by 2026, with a compound annual growth rate of 50.4% from 2021 to 2026, as forecasted by Omdia in the Data Center Thermal Management Market Analysis – 2022. Driven by energy consumption reduction and sustainable development goals, the combination of air cooling and liquid cooling systems is likely to become commonplace in data centers in the near future.

Shanghai quickly rebuilds and upgrades small and old data centers.

The Shanghai Communications Administration published the Action Plan for New Data Centers (2022-2024), which emphasizes the need to promote the development of green and low-carbon computing power in Shanghai. To this end, Shanghai will accelerate the application of green and energy-saving technologies, and step up efforts to reconstruct and upgrade small and old data centers. This will help the data center industry







in Shanghai shift towards intensive and sustainable development.

Data centers consume a lot of energy, so it's imperative for them to become green and reduce carbon emissions.

According to the China Academy of Information and Communications Technology (CAICT), the annual power consumption of data centers in the information and communications industry in China grew by 28% from 2017 to 2020. Data centers in China consumed 216.6 billion kWh of power in 2021, accounting for 2.6% of the country's power consumption — 1.8 times more than Beijing's consumption in the same year. Data centers also produced 135 million tons of carbon emissions, accounting for about 1.14% of the national total. By 2030, China's data centers will be consuming over 380 billion kWh of electricity per year and their carbon emissions would exceed 200 million tons if renewable energy is not adopted.

The total energy consumption rating per unit of telecom services will be cut by 15% by 2025.

MIIT and NDRC released the Action Plan for Green and Low Carbon

Development in the Information and Communications Industry (2022-2025) on August 22, 2022. The plan sets out the objectives and measures to encourage green development in the ICT industry, make breakthroughs in energy saving and emission reduction, and increase the overall resource utilization efficiency of the industry. Specifically, the plan aims to reduce the comprehensive power consumption per capita of information traffic by 20%, and the overall power consumption per unit telecom services by 15%, both compared with those at the end of 2020. The plan will also promote 30 typical ICT use cases to comprehensively reduce carbon emissions. The ultimate goal is to decrease the PUE of newly-built large and ultra-large data centers to below 1.3, improve the energy efficiency of 5G base stations by over 20%, and cut the PUE of reconstructed core equipment rooms to below 1.5 by 2025.

5G base stations in China consume 20% less energy.

Already today, 5G base stations in China consume 20% less energy than when they were first put into commercial use in 2019. The average designed power utilization ratio of large-scale data centers planned in China has been reduced to 1.3. Moving forward, MIIT will revise the standards related to energy saving and efficiency improvement in digital infrastructure, promoting green data centers and 5G base stations.

Electric transportation

About 20% of cars will be new energy vehicles (NEVs) by 2025.

The Comprehensive Work Plan for Energy Conservation and Emission Reduction for the "14th Five-Year Plan" Period by the State Council stresses the need to increase the proportion of NEV sales, reaching 20% of all cars sold by 2025. In addition, the plan aims to increase the proportion of NEVs used for urban public transportation, leasing, logistics, and sanitation; implement the China VI and IV Emission Standards. phasing out vehicles that only met the China III Emission Standard or lower. There will also be a push to develop intelligent transportation and use big data to optimize how transportation is organized.

Subsidies for NEVs ended in 2022.

Since the NEV pilot in 2009, related subsidy policies have been changing as the industry grows. These policies were extended from pilot cities to the whole country and covered all NEVs rather than just public vehicles. However, NEV subsidies were terminated in 2022, as required by the latest subsidy policy.

Charging piles are booming as part of the NEV industry.

Data from the Wireless Power Consortium indicates that the number of public charging piles in China increased by 489,000 million in the first three quarters of 2022, a year-onyear increase of 106.1%. There were also 1.382 million more charging piles, a year-on-year increase of 353.1%. The vehicle-to-pile ratio dropped for the first time after remaining stable for nearly five years from 2017 to 2021, hitting 2.6 by the end of Q3 2022. The charging pile sector has outperformed NEVs.

Recharging facilities for electric vehicles need to provide higher service assurance.

The Implementation Opinions on Further Improving the Service Assurance Capability of Electric Vehicle Charging Facilities by the NDRC set out to improve the service assurance of charging facilities for electric vehicles by the end of 2025. The document requires the industry to meet the charging needs of 20 million NEVs through a balanced, intelligent, and efficient charging system. At the same time, innovation and related standards are needed for charging and battery swap technologies. There will be efforts to develop and promote high power charging standards, strengthen crossindustry collaboration, advance industrial upgrades, and encourage the R&D of new technologies such as wireless and automatic charging.

The EU has reached an agreement on the New Batteries Act.

The European Council and the European Parliament have reached a temporary agreement on the New Batteries Act aimed at making all batteries in the EU market more sustainable and safer. After the act comes into effect, sustainability requirements for carbon footprint, recovery components, performance, and durability will be gradually introduced starting in 2024. By mid-2025, a more comprehensive producer responsibility extension system will be in place and higher recovery targets will be introduced over time.



Energy Transformation: From Prometheus' Fire to Advanced Technologies

Fire gives light and heat to humans. After overcoming their fear of fire, humans gradually learned to use fire, and human civilization opened a new chapter. Looking back at the history, we can see how every energy revolution can help make a great leap forward in social productivity.

mong the representative characters in the masterpieces *Works and Days* and *Theogony* written by ancient Greek poet Hesiod, we have a hero called Prometheus to thank for the gift of fire — a gift he stole from the ancient Greek gods and gave to humans. Here, fire represents the connection to civilization, the advancement of art, science, and technology, and ultimately, free will. Maybe unintentionally, but still Prometheus gave us progress.

According to history, humans learned to make fire as early as during the Paleolithic Age. It wasn't until the 18th century that coal replaced firewood as the main source of energy, marking the start of industrial revolutions. Now, as we shift away from our reliance on coal and fossil fuels, let's remember the importance of progress in energy transformation, and set ourselves to adopt clean energy for the good of civilizations yet to come.

Industrial Revolutions and Energy Transformation

Fire wasn't enough to power the hunger for industrial production that came to rise in the late 18th century. So, coal began to feed new machinery and transport methods. The first industrial revolution was born in the UK and by 1850, around 92% of the nation's energy consumption relied on coal.

Then, in the early 20th century, came the second industrial revolution. This one was powered by internal combustion engines and alternating current. By the 1950s, the world came to rely on oil as its primary source of energy.

The third industrial revolution was close behind, this time driven by the advancement in information technologies. Energy transformed once again, and in the 1980s and 1990s, we began seeing more natural gas and shale oil in the energy mix. Our energy systems have come to rely on batteries and power grids. The new and seemingly endless abundance of energy continued to power economic globalization and the Internet.

These latest changes coincided with the first developments in renewable energy — hydro, wind, and solar power as well as biogas. As these sources become more prominent, we are seeing the beginnings of the fourth industrial revolution. If we look back at history, this should come as no surprise. After all, each round of industrial revolutions goes hand in hand with the discovery

and large-scale adoption of new sources of energy.

Technologies Driving the Energy Revolution

Next-generation ICTs are changing our lives — this is not an overgeneralization, but a hard fact. Innovations like AI, cloud computing, and IoT are powering real-life applications such as autonomous driving, intelligent manufacturing, smart cities, and AI + life sciences. The fourth industrial revolution will largely rely on AI technologies for profound social and economic changes.

The energy sector will be no exception. Digital and AI technologies offer a wide range of tools that can change the way we generate, consume, and store energy. For instance, AI recognition can make energy inspections more efficient and the work environment for related personnel more comfortable. An energy cloud has the potential to significantly enhance the management efficiency and precision of energy systems. Meanwhile, power electronics technologies are bound to slash PV power generation costs and improve efficiency.

However, these innovations didn't just come to be. They are part of the global mission to curb global warming and protect our planet's environment — a process that urgently requires energy transformation. So far, more than 130 countries and regions have set carbon neutrality goals to reduce carbon emissions. To achieve these goals, clean energy will play an absolutely important role, and so will the technologies that enable its generation.

Progress Against All Odds, Just Like Prometheus Taught Us

Ongoing evolution requires action. Maybe Prometheus gave us the gift of fire, but we cannot wait for a gift of clean energy. Instead, we must create it. How do we do that?

Energy transformation will require us to reconstruct the energy mix. We will need to draw on digital and AI technologies to promote renewable and clean energy in practice. The only way to achieve carbon neutrality is to replace non-renewable energy with clean energy in everything we do. In doing so, we must develop an all-new power system that relies primarily on the renewables like solar and wind power. To truly replace conventional fossil energy systems, this new energy must come at a low cost, provide large capacity, and be highly adaptable.

Digital and power electronics technologies will play a key role in unleashing the full potential of renewable energy, upgrading to new power systems. They will facilitate the digital and intelligent transformation of traditional energy systems. As the industry shifts from reliance on resources to dependence on technologies, the winner in energy transformation will no longer be the one who owns energy, but the one who owns technology.

Some forward-thinking companies are already ahead of the game. For example, Sunseap, a PV solution provider, has built a 5 MW offshore PV power plant with a footprint of five hectares. The plant is expected to produce 6 million kilowatt-hours of electricity per year. As one of the world's largest offshore power plants, it can supply energy to 1,250 households and reduce carbon dioxide emissions by about 4,258 tons.





Another example is the 300 MW Junma Solar Power Station in the Kubugi Desert, Inner Mongolia. Developed by SPIC Nei Mongol Energy, the power station is a hybrid model that harnesses solar energy while shading sandy areas with PV panels to control desertification and rehabilitate the local flora. By the end of November in 2022, Junma has generated a total of 2.543 billion kilowatt-hours of green power, which is equivalent to reducing around 2.03 million tons of carbon dioxide emissions. Meanwhile it has helped to restore the ecosystem of desert spanning about 10.7 square kilometers.

To realize the goals of carbon neutrality, we must all be part of the journey toward clean energy transformation. This will involve PV power plants, power grids, drive systems and power supply systems of new energy vehicles, data centers with optimal PUE, green communication networks, and a countless number of other sectors.

Huawei Digital Power is up for the challenge. We are ready to embrace changes and be committed to integrating digital and power electronics technologies for clean energy transformation and energy digitalization. Huawei Digital Power calls on our global partners and customers to embark on the journey toward clean power generation, green ICT power infrastructure, and electric transportation. ▲

Green and Low-Carbon Power Generation for Sustainable Development

According to the ancient books of the pre-Qin period, a tribe leader called "Sui Ren Shi" invented a way to make fire by drilling hard and sharp wood on another piece of hard wood, thus ending the days of ancient human beings eating raw meat with hairs and blood. Today, the energy industry continues to play the role of a basic industry, which is of great value in ensuring high-quality economic development, social security and stability, and people's livelihood.

he use of energy dates back to the ancient times when people learnt to make fire —a milestone in human civilization. Today, energy takes many more complex forms and uses, but continues to play a fundamental role in our society, powering economic development, social security and stability, and people's livelihoods.

The global energy industry is undergoing significant changes and facing a large imbalance between supply and demand. In the digital era, technologies will continue to drive increased energy efficiency. Meanwhile, the pursuit of carbon neutrality promotes the use of renewable energy sources as well as clean and energysaving technologies. As nations seek energy transformation, we will continue to see green, low-carbon, and sustainable development in the future.

Clean energy transformation

Although the energy crisis in many countries will stimulate the demand for

fossil fuels in the short term, clean and renewable energy is undoubtedly the key to addressing the energy challenges faced by our society in the long run. According to the World Energy Outlook 2022 released by the International Energy Agency (IEA), the proportion of fossil fuels in the global energy mix will decrease from 80% to 75% by 2030 and fall further to about 60% by 2050. However, global energy demand will continue to grow every year from now to 2030; these increments will largely be provided for through renewable energy.



As such, we will see rapid development in the global clean energy industry. The IEA estimates that the global renewable energy yield will have grown by 20% in 2022 alone. Thanks to the use of clean energy, the growth in global carbon dioxide emissions is expected to fall from 4% in 2021 to 1% in 2022.

China's energy production and consumption follow similar trends. According to the data released by the National Bureau of Statistics, thermal power and hydropower accounted for over 90% of China's total power generation capacity in 2011. But in 2020, the installed solar and wind power capacities were already 11.51% and 12.84% respectively, signaling a significant change in China's energy mix. Although thermal power still accounts for more than 50% of the energy mix, green power generation represented by solar and wind power has a promising outlook.

China is not the only nation to accelerate energy transformation to

reshape their energy landscape. For example, the French government looks to increase the proportion of renewable energy generation to 40% by 2030. Similarly, Japan aims at increasing the proportion of renewable energy generation to 36% or even 38% by 2030, as cited in its New Basic Energy Plan. In general, the global energy industry is striving to fulfill the following core tasks:

• Replace fossil fuels with clean energy to achieve decarbonization.



• Accelerate the in-depth integration of digital and power electronics technologies, apply energy-saving technologies, and optimize the industry structure to achieve efficient energy usage.

- Actively explore new technologies, such as the Internet of energy and smart energy, to achieve intelligence throughout the energy lifecycle.
- Establish a global carbon emission control and market-oriented transaction mechanism to achieve global energy integration.

According to the Renewable Capacity Statistics 2022 released by the International Renewable Energy Agency (IRENA), by the end of 2021, the total installed renewable energy capacity had reached 3064 GW — the highest increase compared to all other energy sources. Hydropower accounts for the largest share of renewable energy generation. Solar and wind energy yields have increased by 19% and 13% respectively. The total solar energy capacity has exceeded the wind energy capacity. Wind power, hydropower, and PV are becoming integral to thousands of industries and households.

Smart green PV

PV is a dominant player in renewable energy. IRENA estimates that renewable energy will account for 86% of global power generation by 2050; of this, PV will account for more than 25%, becoming a major energy source. The global installed PV capacity will increase from 890 GW in 2021 to 14 TW in 2050. The penetration rate of PV and wind power in places like China and Europe is expected to exceed 80%.

For all this to happen, PV will need to become more stable and intelligent. There are several trends marking



the PV industry as green and clean renewable energy takes the center of the global energy stage.

Trend #1: Integration of PV and energy storage

Integrating PV and energy storage will help build new power systems that mainly use renewable energy. Energy derived from PV and wind power is often fluctuating and intermittent, which has historically made it unreliable and even unsafe for power grids. To offset these risks, energy storage is indispensable and will become mandatory for grid connections. This will require further integration between renewable energy generation and storage.

More and more power grid and plant operators are using smart PV solutions that integrate PV and energy storage systems (ESSs) to help PV plants generate high-quality power. As PV systems become more intelligent, we'll see exponential growth in the use of solar energy as a major power source.

Especially, Smart PV + ESS Generators are key to connecting renewable energy with power grids. The Smart PV + ESS Generator fully integrates digital and power electronics technologies to simulate the electromechanical transient characteristics of synchronous gensets. It delivers the grid-connected operation features of synchronous gensets, such as inertia, damping, primary frequency regulation, and reactive voltage regulation. The Smart PV + ESS Generator helps PV and wind power simulate the technical specifications of synchronous gensets in traditional thermal power plants and hydropower plants during grid connection. It also complies with the peak shaving and power grid scheduling requirements to support power grid frequency and voltage fluctuations, thus ensuring safe and stable power grid operations.

Trend #2: Energy storage for resilience

Energy storage will play a key role in building flexible and resilient power systems for the future. From a macro perspective, highly controllable energy storage with little waste is the key to adjusting energy usage fluctuation and achieving highly intensive energy usage. Energy storage will become key for a wide range of energy fields and will also be a feature in many different technologies.

ESSs will become ubiquitous throughout power generation, transmission, distribution, and consumption of new power systems. They will function as a reservoir, regulator, and stabilizer, and will evolve from a standby to an active system to ensure the safe and stable operation of power grids.

For example, in the process of gridconnected clean energy generation. the most important role of ESSs is supporting peak shaving and frequency regulation. A high proportion of clean energy significantly impacts the peak shaving of power systems. A largescale ESS can address this challenge by using its inherent advantages. With a complete and highly controllable energy storage technology, we can store the surplus electricity generated by the clean energy genset during offpeak hours. Then, we can discharge the electricity during peak hours to implement peak shaving. In this way, the pressure on the power grid caused by the fluctuation and uncertainty of clean energy generation can be effectively avoided. Ultimately, precise power control will allow us to save energy and reduce emissions.

Trend #3: PV powering households

In the future, distributed PV will power thousands of households. Unlike utilityscale PV plants, distributed PV systems can be installed in regular and flexible spaces, such as rooftops of factory buildings, slopes beside highways, and rooftops and open-air balconies of farmhouses. So, distributed PV can be used by more people in a wider range of contexts. The biggest advantage of distributed PV is that PV power can be consumed locally and the surplus electricity can be sold to power grids. As a result, residential rooftop PVs are becoming increasingly popular.

Today, many industry giants are actively rolling out new PV solutions. Among them, Huawei is also contributing to the PV industry. Drawing on over 30 years of experience in digital technologies, Huawei integrates digital with PV, energy storage, cloud, and AI technologies. So far, we have launched Smart PV + ESS Solutions for five scenarios, covering power generation, transmission, distribution, and consumption. This includes our solutions, such as Smart PV + ESS Generator, Smart String ESS, Commercial and Industry (C&I) Smart PV, Residential Smart PV, and Smart Microgrid. The solutions accelerate the reduction of levelized cost of electricity (LCOE) in the PV plant lifecycle and improve the power grid support performance. We hope that these advancements can help PV become a major energy source for our green future.

Increasingly popular wind power

Wind power is also increasingly more important. Today, wind power represents a clean, low-carbon, and price-competitive energy source in many countries. The technologies behind wind power are mature and it's relatively cheap to generate, so we've seen it rolled out on a large scale all over the world.

For example, according to the Global Electricity Review 2022, the proportion of wind power in Australia, Türkiye, Brazil, and the United States doubled from 5% in 2015 to 10% in 2021. As a result, wind power plays an increasingly important role in the energy structure.

To power this, the scale of wind turbines is increasing. Wind power generation technologies are gradually becoming more sophisticated, focusing on compactness and flexibility. Today, wind power provides a large capacity and is now moving offshore to generate energy. In the meanwhile, wind turbines are growing in both scale and capacity — the world's largest wind turbine blades can reach over 200 meters in length. Largescale wind turbines can significantly reduce the project investment cost and LCOE, making wind power ever more valuable for grid parity. The technology behind wind power generation is also evolving, with wind turbines generating megawatts of electricity.

In China, these trends are particularly prominent. According to CWEA data, the average power of newly installed wind turbines in China in 2021 was 3.51 MW. The average capacity of a single newly installed onshore wind turbine has increased from 1.5 MW to 3.1 MW, and that of a single newly installed offshore wind turbine went up from 2.7 MW to 5.6 MW.

Hydropower development

Hydropower is clean, stable, and cheap. Not a new energy source, hydropower is a preferred source of clean energy in many countries. For example, it represents a crucial part of the energy mix in North and Central America. According to the 2022 Hydropower



Status Report, the installed hydropower capacity of Europe increased by 3 GW in 2020, reaching 13% of the total energy yield of the EU.

According to the International Hydropower Association, the hydropower industry set a new record in 2020, producing 4370 TWh of clean electricity — equivalent to the annual electricity consumption of the United States. In 2020, 35 countries witnessed an increase in their installed hydropower capacity, reaching 21 GW. Among them, China saw the largest increase in installed capacity, which has exceeded 370 GW, making it the largest in the world. As a result, hydropower is at the forefront of carbon emission reduction. The energy source plays an important role in power generation and energy storage, but also contributes significantly to avoiding greenhouse gas emissions and slowing global warming. According to ASKCI, China's hydropower generation in a year is equivalent to replacing 450 million tons of coal, reducing carbon dioxide emissions by 1.18 billion tons.

Hydropower has significant benefits when it comes to energy saving and environmental protection, and will be crucial in helping us reach the carbon peak and carbon neutrality goals. IEA's Net Zero by 2050 lays out the possible path for the global energy industry to successfully decarbonize by 2050. In the net zero emission (NZE) scenario, PV and wind power will be the major sources of power generation, but the steady growth of hydropower will act as "ballast stones" to ensure stability. According to NZE, the world will need to build more hydraulic facilities to address climate change.

Forecasts show renewable energy will account for 86% of all generated energy by 2050. PV, wind power, and hydropower will help decarbonize power generation, helping us build a greener society. ▲

Green Mobility: the Fast Track to Electrification

If fire is the origin of human civilization, then electricity is the cornerstone of human civilization. At present, "electricity decarbonization" has become a trend, promoting the electrification of energy utilization. Increasing the proportion of electricity in final energy consumption, therefore, has become an important path to decarbonization.

> impacts the amount of carbon emissions we produce. As awareness about environmental protection grows, more people are choosing greener mobility, such as public transportation, energy-saving vehicles, cycling, or even walking.

Electrification is one of the crucial ways in which we can lower emissions. The good news is that electric vehicles (EVs) are becoming increasingly popular. A survey by Canalys estimates that over 6.5 million EVs were sold around the world in 2021, with sales more than doubling year on year. Statistics from the China Association of Automobile Manufacturers show that from January to November 2022, the production and sales of new energy vehicles (NEVs) in China reached 6.253 million and 6.067 million respectively, doubling those in the previous year and taking up a market share of 25%.

In China, e-mobility is an important point on the government's green development agenda, so there are many favorable policies to support NEV market penetration. Even so, NEV sales have evolved from being entirely driven by policy to relying on both



he International Energy Agency (IEA) estimates that the global

Electrification

How we choose to travel directly

Green Mobility: the Fast Track to Electrification



policies and a rise in market demand. Better user experience, lower cost, and availability of charging infrastructure are making NEVs, and in particular, passengers EVs, more popular among consumers.

Despite all this progress, there is still a long way to go if we want to switch entirely to NEVs. Various stakeholders in the industry must come together with a common goal of carbon neutrality. We need to electrify various types of vehicles, upgrade the automobile power system, and build a vehicle-road synergy system. According to the Ministry of Transport, by 2025, China aims to raise the proportion of NEVs in urban public transportation, taxis, and urban logistics to 72%, 35%, and 20%, respectively. In this process, the Ministry of Industry and Information Technology (MIIT) will continue to promote the stable development of the NEV industry.

Digital Technologies Will Be Crucial for Green Mobility

The automobile industry is going through a wave of changes. New trends such as electrification, intelligence, connectivity, and shared transportation signal unprecedented opportunities for this century-old sector. In less than a decade, EVs are likely to hold half the market share alongside fuel vehicles.

But for now, fuel vehicles are still the main method of transportation. Nonetheless, we can use digital technologies to reduce the fuel consumption of vehicles thereby reducing carbon emissions. For example, digital and intelligent technologies can be used to collect data and analyze the behavior of drivers in mines, vehicle fuel consumption, and their working conditions. Using this data, we can optimize vehicle speed, throttle, and braking to reduce fuel consumption.

State Grid Electric Vehicle Service predicts that by 2050, 58% of passenger vehicles in China will be powered by renewable energy, more than halving carbon dioxide emissions in the transportation sector. Digital and power electronics technologies will play an important role in this process. They can improve the driving experience, mileage, and safety performance of NEVs, promoting electrification.

For example, big data and AI technologies can intelligently manage buses, helping bus operators reduce costs and improve efficiency. Shenzhen Bus Group is a pioneer in the deployment of electric buses. It has adopted a smart charging algorithm to shave the charging peak. The algorithm has cut electricity fees by 5% to 10% each year. Using intelligent transportation networks enabled by vehicle-road synergy is another way to lower carbon emissions in the transportation sector. For example, the roadside smart system can command and dispatch vehicles, improve travel efficiency, and

igital Power



reduce carbon emissions. One of the most common vehicle-road synergy applications is the AI recognition function for traffic lights. Such traffic lights intelligently adjust the traffic flow to reduce vehicle congestion and carbon emissions.

Get Ready for 1000 V High Voltage Fast Charging

Today, it takes just 30 minutes to charge a vehicle battery — compared to 6 or even 8 hours in the past. However, consumers want an even faster charging experience, similar to the one they get when refueling conventional vehicles. To minimize charging time, EV makers are looking for new charging models: high-voltage fast charging and high-current fast charging. High-voltage fast charging can solve range anxiety and reduce the battery capacity and cost, which ultimately lowers the cost of the vehicle. Considering these advantages, many companies have launched fast charging solutions and car models. For example, Porsche launched an 800 V fast charging EV model and Huawei has released the DriveONE 800 V highvoltage platform, which delivers a 200 km driving range after just 10 minutes of charging.

The auxiliary technologies of 1000 V high-voltage charging, such as widebandgap semiconductors and fast charge batteries, are becoming more mature. As such, we expect that a 5-minute charge will be able to provide a 200 km driving range in the near future. High-voltage charging platforms will improve charging efficiency and speed, reduce energy consumption, and improve driving performance.

For 1000 V charging to become mainstream, we need to see a drop in the cost of several devices, such as fast charge batteries. Also, supply will need to be assured as will kilovolt public charging facilities. These changes will require collaboration among charging component manufacturers, charger operators, and automobile manufacturers.

Device-cloud Synergy Ensures Safer Driving

EV safety remains the biggest concern among consumers. Defects in intelligent technologies, function design, and batteries can jeopardize vehicle safety. Of course, we have already seen significant improvement in EV safety in recent years. Sun Fengchun, Academician of the Chinese Academy of Engineering, notes that the probability of an NEV catching a fire was 0.49‱ in 2019, dropping to 0.26‱ in 2020.

Digital technologies such as AI, cloud computing, and the Internet of

Things (IoT) play a key role in these advancements. Solutions like Huawei's DriveONE-Cloud are changing the way we manage EV batteries. This EV management system can learn and analyze EV battery data such as temperature, voltage, and internal resistance, generate a model, and then predict battery faults and send warnings. This helps prevent unexpected battery system faults and resulting traffic accidents.

In the future, we will see even stronger synergy between EVs and the cloud. Besides battery safety, management of all power domain components will be migrated to the cloud to generate digital twins. Automakers and users will be able to optimize the electric powertrain, charging system, electronic components as well as design, production, and running of EVs using AI and digital twins. Then, we can monitor and increase the reliability and safety of the car throughout its lifecycle.

What's Next?

Electrification will soon become the standard in most future transportation. Mobility in future cities will be completely electrified. Urban transportation will become a diverse, multi-layer, 3D system. Various types of charging facilities and public fast charging networks will be ubiquitous. New charging technologies will be used to meet different charging requirements. Ultimately, technologies such as 5G, big data, and AI will enable greener, safer, and more convenient mobility. ▲



How Can the ICT Industry Become More Energy Efficient?

The rapid development of economy and society has made very clear and strict requirements on the efficiency of electricity-use. With the rise of the digital economy, the energy consumption of ICT infrastructure has increased significantly. Therefore, the green evolution of data centers and telecom sites has become a core issue of common concern.

he digital economy is booming. Some of the main sectors behind this growth — electric power, manufacturing, transportation, construction, and ICT — are energyhungry. As the world bands together to pursue carbon neutrality, making these industries more energy-efficient is crucial.

For example, ICT infrastructure such as data centers and telecom sites —consumes about 4% of all global energy. Computing is an important driver of the digital economy, placing data centers at its core, which consume increasingly more energy. Similarly, as 5G networks are rolled out, telecom sites are delivering stronger connectivity while consuming three times more energy than 4G sites.

Despite its relatively large power consumption today, the ICT industry is poised to drive emission reduction in various industries. According to GSMA, by 2030, the ICT industry will account for only 1.97% of global carbon emissions. GeSI, an international sustainability organization, predicts that ICTs will help the world reduce carbon dioxide emissions by 20% in 2030. To achieve carbon neutrality, the ICT industry must focus on green technologies while facilitating the digital transformation of various industries.

Innovating to Build Green Data Centers

As a range of industries impose higher requirements on data centers, we need



to ensure that data centers will soon become more sustainable, simpler, autonomous, and reliable.

1. Using green energy sources to ensure sustainability

A sustainable development model focuses on a green and lowcarbon circular economy. To achieve sustainability, data centers need to shift to using green energy sources such as PV, wind power, and hydropower. This will allow data centers to reduce their carbon emissions by 1% to 2%.

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Instead of relying on Power Usage Effectiveness (PUE) alone, we can establish a multi-dimensional evaluation system that combines Carbon Usage Effectiveness (CUE), PUE, Water Usage Effectiveness (WUE), and Grid Usage Effectiveness (GUE). In this way, we can build sustainable data centers and control carbon emissions throughout their lifecycle.

For example, the Dongyuemiao data center is part of the largest zerocarbon data center cluster in Central China being built by the Three Gorges Group. The first phase of the project has deployed 4400 racks, which will reduce decade-long carbon emissions by 2.5 million tons.

2. Reshaping the data center architecture, power supply, and cooling

Conventional data center systems are complex and take a long time to build. To address these challenges, we can use a modular and high-density design to simplify the data center architecture.

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• Simplified architecture: To build a conventional data center, civil engineering takes place before power and cooling systems are deployed. However, this work can be performed in parallel if equipment rooms and devices adopt a modular design. A prefabricated data center solution shortens the construction period and improves the delivery quality.

For example, the Chengdu Intelligent Computing Center — the largest AI computing center in Southwest China — worked with Huawei to integrate prefabricated modules, steel structures, and civil engineering. The solution also uses advanced energy-saving products and technologies such as FusionPower6000, SmartLi, and AI. The prefabricated modules just need to be stacked onsite to deploy the data center, taking less than half the time. In 10 years, the Computing Center expects to save around 40 million kWh of electricity.

• Simplified power supply: To reduce the complexity of power supply links, we can increase the power density of devices, use lithium batteries, and integrate the utility power rectifier and inverter, PV inverter, and energy storage

system (ESS).

• Simplified cooling: As technologies evolve to provide higher power density per rack and stronger cooling capabilities, we can adopt simplified links and air-liquid cooling integration to maximize the efficiency of heat exchange. For example, Huawei's indirect evaporative cooling system shortens the cooling link while improving the cooling efficiency.

3. Using AI to enable autonomous driving

Many applications need upgraded computing performance, including virtual reality, realtime synchronization, and global synchronous connectivity. To support the exponential growth of computing performance, a building with 1000 racks will be transformed to a campus with 10,000 racks. This means that data centers will need to manage a great number of objects, which will be impossible to do manually. Intelligent technologies will enable autonomous driving, which will lead to automatic O&M, energy efficiency optimization, and operations.

• Automatic O&M: Larger and more

intensive cloud data centers require automatic O&M, which can be facilitated using AI. Intelligent sensing and sound and image recognition enable real-time and predictive O&M, reducing manual O&M time and costs while allowing data centers to run automatically.

• Automatic energy efficiency optimization: Data center operators can use AI technologies to optimize energy efficiency. They can establish a machine learning model between energy consumption and adjustable parameters such as IT load, climate conditions, and device status. The model will infer and determine the configuration logic that ensures the optimal energy efficiency. At the same time, intelligent cooling delivers the optimal energy efficiency and reduces the energy consumption of data centers.

• Automatic operations: Data center operators can use AI-based resource optimization technologies to manage data center assets throughout their lifecycles. They can establish a management model and an analysis platform focused on device management, and use AI to simulate



device status and predict services to automatically check data center asset status. Using an AI autonomous driving platform, data center operators can also flexibly schedule various energy sources to meet the demand for green power supply, PV deployment, and peak shaving with an ESS. This minimizes manual calculations and operations while maximizing the value of resources.

4. Protecting everything in data centers

Reliability is critical to data centers. Operators can reinforce their data centers by deploying proactive security

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and secure architecture.

• Proactive security is built upon data center visibility and sensing. It enables predictive maintenance from components to systems using big data and AI. In the past, people would handle faults based on trouble tickets. Now, fault response is automatic. Using real-time fault awareness, panoramic visibility, and AI-assisted fault locating, faults can be quickly detected and services can be recovered in moments.

• A secure architecture protects every component and the entire data center. Digital technologies will be further integrated with power electronics technologies to ensure security at all levels, including components, devices, and systems. We will see constant evolution in infrastructure resilience. At the component layer, the modular design enables hot swap of key components to accelerate fault recovery. At the device layer, the redundancy design enables seamless switchover to the normal module within 0 ms of a single point fault, ensuring uninterrupted device operations. At the system layer, the system availability reaches up to 99.999% thanks to an end-to-end visibility and management platform.

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Building Simplified and Low-Carbon Telecom Sites

According to the China Academy of Information and Communications Technology, there are now 2.22 million 5G base stations in China, accounting for more than 60% of the world's total. Meanwhile, the telecom industry strives toward carbon reduction. To do so, it needs to simplify telecom sites — from rooms to cabinets or from cabinets to poles. This leads to simpler network deployment and reduces both site energy consumption and carbon emissions.

The Chinese government has issued the Action Plan for Green and Low

Carbon Development in the ICT Industry (2022–2025). The plan aims to establish a management mechanism for the green and lowcarbon development of the ICT industry by 2025. It also expects key breakthroughs to be made in energy conservation and emission reduction. Finally, the industry on the whole will improve its resource utilization to facilitate green transformation in economy and society.

According to the International Telecommunication Union (ITU), ICTs can help reduce the global carbon emissions of other sectors by 15% to 40%. Meanwhile, global communications organizations and carriers are implementing energy conservation and carbon reduction measures in the telecom industry, starting by reshaping their telecom sites.

1. Building simplified sites with cabinet or pole solutions

Conventional base stations are mostly deployed indoors. Air conditioners are used to cool devices, resulting in low site energy efficiency (SEE) and high energy consumption. To solve the problem, sites can be simplified by replacing rooms with cabinets (one cabinet per site) or replacing cabinets with poles (one blade per site).

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Simplification is the key to coping with an ever-increasing number of sites and reducing their carbon emissions. Huawei's cabinet solution uses high-density power supplies and lithium batteries. Compared with the conventional solutions, it delivers double the energy density, power supply, and battery capacity per cabinet.

Huawei, together with China Mobile Beijing and China Mobile Design Institute, launched a third-generation 12 kW blade power solution through joint innovation. The customers used the solution to simplify their sites by deploying a PV power system, thus removing equipment rooms and air conditioners. The sites now take up 60% less footprint (excluding the PV power system), the SEE has improved by 20%, and each site prevents 6 tons of carbon emissions per year

2. Replacing lead-acid batteries with lithium batteries

Currently under research, 6G will enable the smart connection of everything, further unlocking the potential of innovation. 6G will provide universal and high-performance wireless connections and raise key

performance indicators to a record level. It will deliver ten times higher connection density than 5G. It will also enable centimeter-level positioning and millimeter-level imaging to meet the network requirements for immersive XR experiences. However, 6G telecom sites will once again impose higher requirements on efficiency, energy savings, and carbon reduction.

Now, we are seeing the legacy leadacid batteries being quickly phased out at telecom sites. They are replaced by lithium batteries with a much longer lifecycle and float charging life. An energy storage system consisting of lithium batteries features higher energy density, lower weight, and smaller footprint, making it more suitable for telecom sites. According to Green Globe International Inc. (GGII), the global market demand for lithium batteries in base stations will reach 60 GWh by 2025.

Digital technologies are also reshaping the power supply of telecom sites. Green energy supply is an important way to reduce carbon emissions. As such, we expect to see more sites using clean energy such as PV, wind power, and hydrogen.

Conventional PV power solutions for sites have several problems, such as limited available site area. impact of shading on energy yields, and complex routine O&M. New PV deployment solutions address these challenges by using intelligent algorithms to automatically schedule power generation, storage, distribution, and consumption and storing surplus solar power in an ESS to maximize clean energy utilization. Power generation modules and power supplies at sites can also be managed digitally. For example, a local operator in Greece, by deploying a PV power solution at its island sites, reduces the utility power usage by 51.2% and saves 14,500 kWh of electricity each year.

To answer the call of energy conservation and emission reduction, data centers and telecom sites are going green and becoming more simplified and intelligent. Efficient power consumption will pave the way to the green and low-carbon development of the ICT industry, helping build a better and greener future.

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Yalong River: Powering China with Clean Solar and Hydro Energy

The energy transformation calls for the construction of "clean, low-carbon, safe and efficient" energy system. To maximize energy output, apart from the adoption of the latest technologies and ideas, careful consideration should be given to the high-quality development of local economy. Let's read the story of a hydro-wind-solar renewable energy base along the Yalong River.



ost of China's rivers meander all the way from the mountains in the west to the ocean in the east. While nourishing life along their course, these rivers also offer inexhaustible power resources.

The Yalong River originates at the southern foot of Bayan Har Mountains. It flows along 1571 km, with a natural altitude difference of 3830 m and an annual runoff of 60.8 billion m³. The river's main flow ranks the third among China's 13 hydropower bases owing to its exploitable hydropower capacity of 30 million kW and annual technically exploitable generation of 150 billion kWh.

Yalong River Hydropower Development Company (Yalong River Company) prioritizes clean energy and energy security. To this end, the company is planning to build a clean and renewable energy base along the Yalong River to draw on its abundant hydro, wind, and solar resources.

This modern system of clean, safe, and efficient energy aligns with China's goals of carbon peak and carbon neutrality. Once completed, it will be one of the nine largest clean energy bases in China.

Integrating hydro, wind, and solar power

On April 12, 2022, Yalong River Company and Huawei signed a strategic cooperation agreement. Together, the energy and tech giants are looking to build a world-class energy base integrating hydro, wind, and solar power. For this vision, they will need to find innovative solutions for multisource energy collaboration, digital and intelligent power plants, and power plant safety.

One of the first projects under the agreement is the Kela PV Plant in China's Sichuan Province. Kicked off in July 2022, Kela is the first phase of the Lianghekou Hydro-Solar Plant project, which will be the largest of its kind in the world and located at the highest altitude (4000–4600 m).

The Kela PV Plant will feature Huawei's Smart PV solution and will integrate PV technologies with ICTs such as AI and cloud. The plant will make use of smart technologies, including a tracker algorithm, string-level disconnect, and grid connection algorithm. This will enable its systems to achieve a high performance ratio, intelligent O&M, safe and reliable operations, and grid support.

The installed capacity of the Kela PV Plant reaches 1 million kW and is to yield an average of 2 billion kWh of energy per year. The plant is expected to connect to the grid at full capacity in 2023.

When completed, the renewable energy base along the Yalong River is supposed to generate 220 billion kWh electricity each year, which is equivalent to reducing annual coal consumption by about 70 million tons and reducing carbon emissions by about 180 million tons.

The Kela PV Plant will have a 220 kV step-up substation, which is connected to a 500 kV pooling substation through a double-circuit 220 kV transmission line, and then to the Lianghekou Hydro Power Plant through a 500 kV transmission line.

The Lianghekou Hydro Power Plant is expected to reach an installed capacity of 3 million kW, a total reservoir capacity up to 10.8 billion m³, and a regulation capacity of 6.56 billion m³. This will enable it to store energy annually to compensate for the fluctuation and instability of PV power generation and buffer the seasonal variation of water availability.

Promoting high-quality development of Ganzi

However, energy generation is not the only benefit of the Kela PV Plant.

The plant is about to contribute CNY600 million (\$86 million) in taxes during its construction and CNY150 million (\$22 million) annually after it goes live. The tax money will benefit the local residents.

Locally, the PV project will be integrated with animal husbandry and is expected to improve the infrastructure, employment, tourism, and transportation. • PV + local husbandry: The PV module supports will be raised at least 1.8 m above the ground, leaving adequate space for grazing.

• PV + infrastructure upgrade: The project will be a great opportunity to overhaul the local infrastructure, such as roads, water supply, sewage treatment, and waste disposal facilities. It will also usher in afforestation and landscaping in the local villages.

• PV + employment: During its construction, the project will create more than 3000 jobs, significantly increasing the local employment rate. After going live, the plant will hire people for PV module cleaning and maintenance, security, and cleaning services.

The project will also boost local tourism and transportation to spur the rural economy.

Ganzi Tibetan Autonomous Prefecture, where the Kela PV Plant resides, is building a hydro-wind-solar renewable energy base, a husbandry base, and an internationally attractive cultural tourism industry. Undoubtedly, the Kela PV Plant will play a significant part in this endeavor.

Striving for the intelligent convergence of PV plant services

A journey of a thousand miles begins with a single step. Although the vision is lofty, the mission is hefty. The project is located in a frigid highaltitude area. Construction has to take place in short bursts when the weather permits and the geological conditions are complex. With a lot of the project areas being forests and grasslands, it's crucial to consider fire prevention and control.

What's more, the plant is expected to go live in 2023, leaving less than one year for construction. However, due to the low oxygen levels at higher altitudes, neither people nor machines can work to their highest capacity.

In addition, the project is huge, covering an area of 16 square kilometers, equivalent to 80 China National Stadiums. Once finished, it will house more than 2 million PV modules, 5000 inverters, and 300 transformer stations.

Despite all the above-mentioned challenges, Yalong River Company has a robust and well-defined management system to address any problem that arises. The company is prepared to assure quality, safety, and environmental protection, while keeping on schedule.

Yalong River Company is encouraging everyone involved in the project to have their aspiration and innovation catalyzed. Equipped with Huawei's digital and intelligent technologies, we hope to see Kela PV Plant become a demo project for low carbon, safety, and efficiency. So far, the project has been progressing well according to the plan.

The period from early November to late December was the last prime construction period of this year. The 527,000 PV support foundations must be buried into the soil before it was completely frozen. In late November, the lowest temperature on the construction site dropped to 15°C below zero, and the diurnal temperature variation reached 30°C. The frozen soil and ice further hampered the efficiency of people and machines. To fulfill the task, more machines were used, and more than 2000 workers worked in three shifts.

In the middle and late November, the road to the project site was blocked by snow and ice. Consequently, the transportation and installation of PV modules became even more difficult than ever. To overcome the challenge, the workers carefully carried PV modules from trucks to the project site with their hands and shoulders.

This is only one of many unforgettable stories during the construction. As of the writing of this article, everyone is still racing with time.

Yalong River Company has played an exemplary role in the intelligent convergence of PV plant services and will continue its mission of powering China with clean energy. ▲



Solar Panels Revitalize the Flora and Life in the Kubuqi Desert

The Kubuqi Desert was once the source of sandstorms sweeping over the North China, but with the development of clean energy, it is now full of vitality. The establishment of the Junma Solar Power Station helps revitalize the desert so that we can see the beautiful scene of "the sunset and the birds flying together" as described in an old poem. The Junma Solar Power Station, just like a galloping horse, has become the front runner in the nationwide photovoltaic industry.

ubuqi, in Mongolian, means "the bow string".

In the north of the Ordos Plateau, Inner Mongolia lies China's seventh largest desert. Stretching over 400 km from east to west and 50 km from north to south, the Kubuqi desert is only 715 km away from Beijing, and was often the source of sandstorms in China's capital.

Today, local shrubs and bushes can be seen in the Dalad Banner region of the deep interior of the Kubuqi Desert. With a keen eye, you may even catch a glimpse of hare or a fox. What has happened?

On the Kubuqi's horizon appears a galloping horse made up of over 196,000 PV modules. It is the Junma Solar Power Station. Junma means "fine horse" in Chinese. The Junma Solar Power Station not only powers the region with sustainable energy, it is also part of a larger revitalization program fighting desertification.

PV beyond energy — controlling sandstorms and revitalizing the land

"When I was little, the sky was yellow,

Power Story

the sand hurting my face," recalls Zhao Jinlong, a local villager who works in O&M at the Junma Solar Power Station. " Now, after work, I see the sun fall behind the horizon — it is beautiful," he adds.

Thirty years ago, Kubuqi was ravaged by wind and sand, lacking basic infrastructure like water, electricity, and roads. Farmers and shepherds lived in extreme poverty, relying on the few plants that took root in the harsh desert. Since then, the Chinese Government worked alongside local residents and several private companies to revitalize the area and reverse desertification through a sand control model. The project has become globally recognized, receiving favorable feedback from the United Nations (UN).

In September 2017, the sixth Kubuqi International Desert Forum and the 13th Conference of the Parties to the UN Convention to Combat Desertification were held in Ordos. At the conference, the UN released the Report on Ecological Wealth Creation in China's Kubuqi Desert, which acknowledged the greening of the 6253 square kilometers of Kubuqi. According to the report, the model has created an ecological wealth of CNY500 billion and 102,000 people are lifted out of poverty.

Following China's favorable policies for PV construction issued in 2017, the Dalad Banner region decided to



build the Dalad PV power base with an installed capacity of 2 million kW. The CNY15 billion project was kicked off in May 2018, led by SPIC Nei Mongol Energy. The first phase of the project was completed in record time — it took just 133 days to build a 300,000 kW PV plant. During the peak of construction, there were some 5500 people working on site.

From the onset, SPIC Nei Mongol Energy adopted a hybrid model to generate electricity using PV while shading the sandy areas with PV panels to control the sand and rehabilitate the local flora. As a result, herbs and shrubbery can be grown between the rows of PV panels.

Desert control is not an easy project and some of the first attempts failed. At the beginning, SPIC Nei Mongol Energy planted jujube trees brought over from Ningxia. However, their survival rate was less than 10%. Then, the company changed its strategy and planted desert false indigo around the Shuijinghu PV Power Station instead. These plants grew surprisingly well, and after harvest were fed to cattle and sheep from the nearby farms during the winter. The next spring, the plants were flourishing again.

The project manager told us: "At the time, we saw nothing but sand along the Xingba Highway. There were no trees, houses, electricity — nothing. But now, we have many birds and small animals, and we can even hear magpie twittering on the PV panels."

Li Shuaikun, who is responsible for production safety management, recalls the power plant construction: "We started to level the site in April 2018. The project timeline was tight. We were setting up piles and preparing grids on the ground. At the time, there was no vegetation at all. Now, Mongolian milk vetch, jujube trees, forage for cattle and sheep, even local shrubs are growing tall. Last year we planted watermelons on the side of the Shuijinghu PV Power Station, but the birds ate them."

PV panels help reduce ground wind speeds by up to 50%. Sand fixation grids and growing plants have also helped to control the sandstorms. Normally it takes a decade to achieve such a sand fixation effect. But here it took only four years.
In addition to environmental benefits, the PV plant also creates jobs for local villagers, such as planting cash crops and O&M. They have begun animal husbandry, since there are now plants to feed the animals. Plus, the desert attracts tourists, so locals have set up hotels, supermarkets, restaurants, guesthouses, and local specialty shops. Some even use online platforms for e-commerce.

Kubuqi is prospering, so more and more people like Zhao Jinlong are returning to their hometown to work and raise their family.

Smart PV — assuring stable operations with intelligent technologies

The Junma Solar Power Station uses Huawei's FusionSolar solution, including smart string inverters, MBUS, Smart I-V Curve Diagnosis, and Smart PV Management System. "We have cooperated a lot with Huawei over the years, and their equipment offers better quality than other similar string inverters. The best thing is their heat dissipation performance, which is better than many other vendors. It is easy to damage devices with fans in an area like this, because sand can penetrate them. Huawei inverters don't have fans, so they are less likely to get damaged," explains a project manager from the Junma Solar Power Station.

inverters that are running stably at the Junma Solar Power Station. The inverters use multiple MPPT circuits to address string mismatch. The conversion efficiency at full load is up to 99%, achieving higher energy yields. The inverters are also rated IP66, the highest protection level in China. The device has no fuse, fan, or vulnerable parts, thus ensuring high reliability in harsh environments like heat and sandstorms in a desert.

Huawei inverters feature Smart I-V Curve Diagnosis 4.0, which has revolutionized O&M. The process is similar to a medical CT scan, displaying all plant health problems on a large dashboard at the O&M center with just one click. The system can accurately locate PV string faults, automatically generate diagnosis reports, and provide energy yield loss evaluation and rectification suggestions. All this helps improve O&M efficiency and energy yields.

"Currently, the system can identify about 14 types of PV string faults, covering more than 80% of major faults. It takes about 20 minutes to scan the entire 300,000 kW power station. In addition, drone inspection and wearable devices are used. Despite the size of the project, we only need about 30 O&M staff, because so many processes are automated," said the plant owner.

Award-winning performance

Since its completion at the end of 2018,

the Junma Solar Power Station has won many awards. It won the China Energy Project Innovation Award in 2018, set a Guinness World Record with the largest solar panel image in the shape of a horse in 2019, and won the National Quality Engineering Award in December 2021.

By the end of November 2022, the Junma Solar Power Station had generated a total of 2.543 billion kWh of green electricity, which is equivalent to saving 840,000 tons of coal and reducing 2.03 million tons of carbon dioxide emissions. It also helped green about 10.7 square kilometers of desert areas.

In June 2021, the 1 million kWh Dalad Banner PV base was completed, and is expected to generate 2 billion kWh of green electricity each year and reforest another 40 square kilometers of desert.

As the project implementation continues, the Dalad Banner envisions a future with integrated clean energy, organic agriculture and forestry, and tourism. The plan is to complete four bases: a modern clean energy demonstration base with an annual energy yield of 4 billion kWh, organic agriculture and forestry base of 133.3 square kilometers, desert research and education base with an annual reception of 150,000 tourists, and three-industry integration demonstration base with an annual output value of CNY2 billion. ▲

There are currently 3300 smart string



Poland's Zklaster Power Plant Balances Environmental Protection with Renewable Energy Generation

Growing wild garlic under the PV modules while generating electricity? Smart PV solutions, by supporting agrivoltaics, have brought innovative ideas to the local economy. This kind of humanistic concern will bring to a new level the development and utilization of clean energy in Poland.

Poland, an EU member country, is one of the largest coal producers in Europe, with coal accounting for nearly 70% of its energy mix. In recent years, due to the implementation of the EU's "Green New Deal", Poland has been under increasing pressure for energy transition.

To deal with the pressure, Poland is actively promoting energy conservation in public services by opting for more energy-efficient heating and hot water systems, clean energy buses and trams, and innovation in energy technologies.

Of course, as in other countries and regions, generating green energy will be crucial to meeting the goal of carbon neutrality. As such, Poland's Ministry of Energy proposed the development of energy clusters to promote renewable, carbon-free energy generation.

On September 19, 2019, a town near Bogatynia unveiled a new project that would be of utmost significance for the country and its people in the coming decades. The Zklaster Power Plant, a PV project with 49 MW of installed capacity, is one of the critical nodes in the larger Zgorzelec Renewable Energy Development and Energy Efficiency Cluster.

Challenges and Opportunities in PV

In recent years, Poland has witnessed a rapid increase in demand for electricity. The supply side is turning to PV power generation to deliver clean, efficient, and carbon-free energy. The cost of generating PV energy has been on a steady decline.

Even so, there are still many challenges in promoting and building PV power plants.

Ms. Agnieszka Spirydowicz, CEO of Zklaster, said that the project has faced both social and economic challenges. They need to inform the public of the value of PV while finding a secure and resilient way to generate renewable energy.

The Zklaster Power Plant is surrounded by forests, which are home to diverse wildlife. As such, environmental protection has been a crucial concern since the planning phase of the power plant, with the efforts aiming to preserve the surrounding ecosystem and local biodiversity.

Such efforts undoubtedly lead to higher

costs, but they embody the very reason to build clean energy infrastructure in the first place — to protect our planet.

"Our power plant complies with various EU and global laws and regulations. It is quick to develop, cost-effective, and efficient. It can serve many power suppliers in Poland and play an increasingly important role in the local economy," said Ms. Spirydowicz.

The residents are also happy to live close to the power plant. There is more and more investment and interest in green energy, creating new local opportunities.

Using Huawei's Cutting-edge Tech at the Site

The Zklaster Power Plant houses 150,000 PV modules, delivering a capacity of 49 MW. Ms. Spirydowicz said the plant's performance and stability in operation during its first year and a half have exceeded expectations.

"When irradiance is normal, even a few hours of downtime is a huge loss for us," explained Ms. Spirydowicz. "Also, the seasonal fluctuation of renewable energy has a severe impact on the power grid. So, selecting the right inverters is very important."

Zklaster uses Huawei inverters to assure services. As a world-leading ICT enterprise, Huawei has integrated digital and power electronics technologies. Using smart controllers, the tech giant has developed Smart PV solutions with lower Levelized Cost of Energy (LCOE). These solutions maximize the value of inverters and contribute to innovation in the global inverter market.

Huawei's Smart PV solutions support agrivoltaics — using a land area for both zero-carbon PV power generation and agriculture or farming. At Zklaster, garlic is planted under the PV modules, creating another set of economic opportunities.

"Last year, we planted 10,000 wild garlic plants at the power plant in the hopes of promoting the practice as a local specialty. In the next couple of years, we will plant wild garlic beneath all the PV modules. We believe that this practice will become a benchmark in agrivoltaics," said Ms. Spirydowicz with confidence.

Balancing a Healthy Environment with Renewables

Poland's Institute for Renewable Energy reports that solar energy has become the biggest driving force on the Polish renewable energy market. As such, the Polish government has rolled out policies to encourage companies to join the market — provided that there is no or very little impact on the environment.

"We are paying close attention to environmental issues, as well as clean energy and biodiversity in local communities, including energy conservation, emission reduction, and maximizing renewable energy output. All this is possible when building and operating PV plants," explained Ms. Spirydowicz.

Since the construction of the Zklaster PV Plant, the number of animals and plants in the area has increased significantly. This proves that it is possible to effectively protect the local ecosystem and environment while promoting the economic development — both being important goals for clean energy projects.

Energy storage is a very important part for the renewable energy industry. Currently, the Zklaster Power Plant is using multiple technologies to develop a 200 MW large-scale energy storage project.

"In the future, we will continue to use more products and solutions from Huawei to provide PV plants with the most sustainable and reliable power generation technologies, facilitate the local industrial and economic development, and create more possibilities for people's life and work," added Ms. Spirydowicz.

Currently, energy prices are rising all over the world. The Zklaster PV Plant will continue to work with Huawei on leading and reliable solutions to provide green energy for enterprises and individuals in a cost-efficient way.



Kunming: Building the Green Dream on the Rooftops

It is important to foster good habits, and it is more important to keep them. That's why the push of external forces is inevitably needed. When people's lives begin to change in a green and low-carbon way, the local governments should play a leading role with their words and deeds.

hina first officially included the goals of carbon peak by 2030 and carbon neutrality by 2060 in its 2021 government work report. Last year's report specified the tasks that will help achieve these goals. As a result, local governments across China have been advocating upgrading industrial infrastructure, developing industryspecific carbon peak solutions, and exploring emission reduction strategies in public services.

As to how local governments are promoting the shift toward greener

lifestyles, the Administration Center of Kunming can serve as an excellent example. One of the municipality's flagship projects is the installation of PV modules on rooftops that were previously disused, rooftops of the municipal administration center in Chenggong District.

Kunming — The Ideal Site for PV Plants

PV power generation uses specialized devices to convert light energy into electric energy by forming potential differences between the different parts of a semiconductor after light is irradiated. Simply put, it takes sunlight and from it, produces electricity.

PV plants are easier and faster to build than traditional power plants, and PV power can be generated as long as there is sunshine. Kunming, the capital of China's southwestern Yunnan Province, enjoys 1,300 peak sun hours per year, making it the province's best location for PV power generation. Plus, known as the Spring City, the average annual temperature here is just 15°C. Luckily, this minimizes the output power attenuation of PV modules which is caused by high temperatures.

when it comes to green development, Kunming is one of the leading cities in China. By 2022, the total installed capacity of distributed rooftop PV modules in Kunming has already exceeded 130,000 kW.

The PV project on the rooftop of the Kunming Administration Center has inspired market-oriented rooftop PV deployment, showing many industries a replicable path toward sustainable, green, and low-carbon development.

With a total capacity of 1450 kW, this project is distributed across the rooftops of 12 office buildings, covering an area of 6630 m^2 and being capable of generating 1.865 million kWh of power each year.



Since the grid connection in late June 2022, the total energy yield has exceeded 600,000 kWh. On work days, the offices consume 95% of all the energy produced by the project, realizing self-sufficiency in power supply the center.

Assuming that the project has a service life of 25 years, it will have produced over 46.6 million kWh of energy through its entire lifecycle. Once fully operational, the project will save 612 tons of standard coal, reduce carbon dioxide emissions by 1859 tons, and cut down on emissions of carbon dust, sulfur dioxide, and nitrogen oxide by 590 tons each year.

Project Achievements — a National Best Practice

In October 2022, with the assistance of the Kunming Government, Huawei Digital Power and China Resources Power held a nation-wide conference to share the achievements of the distributed PV project in Kunming. The project mainly focuses on generating energy for self-consumption with a small amount of surplus power feeding into the grid. This business model is preferable to a full feed-in model.

Personnel of the administration center can use their mobile phones to check the PV power generation status, such as output power, energy yield, and O&M statistics of PV modules on the rooftop of each building in real time.

This project has showcased the benefits of rooftop PV for greener public services by optimizing the energy mix and reducing carbon emissions. The practice can be replicated in other industries with tremendous benefits.

Using a smart PV system, the administration center has reduced its electricity costs and can even make profits by supplying electricity to the larger grid (although this is not currently an objective of the project). Moreover, such projects turn unproductive rooftop areas into productive PV systems that generate financial, ecological, and social benefits. To date, distributed PV projects have already been deployed in industrial parks, factories, public buildings, transportation facilities, and residential areas.

In China, this project also aligns with strategic national objectives. For example, the *Regulations on the Development and Construction of PV Power Stations (Second Draft for Soliciting Opinions)* released by China's National Energy Administration in September 2022 clearly encourages the use of advanced technologies such as smart grids to converge power systems with PV power projects.

Huawei's Tech Powering Kunming's PV Project

Huawei, by actively investing in clean power generation R&D, has already solved several challenges in the PV industry through technology integration and innovation. So far, Huawei's lowcarbon Smart PV solution has been successfully implemented in China's Yunnan, Guangdong, Henan, and Fujian provinces.

Huawei's latest inverters and optimizers are enabling each PV module to work independently in the Kunming Administration Center. Optimizers can raise the current of shaded PV modules, preventing impact on other modules in the string. This minimizes instability factors such as hot spots, ensures the reliability and safety of PV power generation, and improves energy yields.

The project also uses Huawei's C&I Smart PV Solution 2.0, which is specially designed for commercial and industrial (C&I) scenarios. At the core of the upgraded solution is a smart PV controller, which works with three key components — a smart module controller, smart string ESS, and green power cloud — to achieve safety, reliability, productivity, and easy O&M.

Huawei has been actively promoting the digital and intelligent transformation of the PV industry by helping the customers build high-quality large-scale PV projects. In the future, Huawei Digital Power will continue to work with the customers and partners to promote the clean energy revolution, build a greener and better future, and play an important part in achieving the dual-carbon goals. ▲



The Largest Green Data Center Cluster in Central China Is Well on Its Way

Be it the "New Infrastructure "Strategy or the East-to-West Computing Resource Transfer Project, data centers are an indispensable part of the digital economy. By virtue of early construction and deployment, some established data centers have come to the fore. In this context, how can the "newcomers" catch up and even surpass?

> n March 29, 2022, China Three Gorges Corporation (CTG) completed the first phase of the Dongyuemiao Data Center Project in Yichang, Hubei Province. Built in partnership with Huawei, Dongyuemiao is one of the most important data centers in China, which will store important local data on its secure, reliable, and most importantly green infrastructure.

Powering Data Storage with Clean Energy from the Three Gorges Dam

Before shifting its focus to data center construction, CTG worked primarily on building hydropower stations. The company had already built several important stations across China, while also rapidly deploying renewable energy systems that rely on wind and solar



power. In the past decade, CTG has built itself into a world-leading clean energy enterprise.

The Dongyuemiao Data Center Project is part of the company's pivot to explore new and emerging opportunities on the digital infrastructure market. The first phase of this project is located on the right bank of the Three Gorges Dam one of the largest dams in the world. As a civilian facility with the highest level of security, the project is managed under the *Regulation on the Security of the Three Gorges Water Control Hub* issued



by the State Council.

Dongyuemiao is in a unique geographic position, where the hydropower generated by the Three Gorges Dam can provide it with a cheap and clean energy source as well as low-temperature water resources. The vision of the project is to build a zero-carbon data center.

By the end of 2025, CTG plans to complete the second and third phases of the project as well as the Ziyang Data Center. If the declaration is approved, CTG will invest over US\$1.44 billion to build the largest green data center cluster in Central China.

In addition, CTG plans to invest another US\$717.36 million to deploying highperformance, AI-based computing platforms and complete two digital industrial parks in Wuhan and Yichang. All this will serve as the core infrastructure for the digital and green development of Hubei Province.

The Technologies Behind Dongyuemiao

As part of the East-to-West Computing

Resource Transfer Project, China is moving large parts of its digital infrastructure to the country's western regions. In the process, it is focusing on making the infrastructure greener. These factors have created momentum for the development of the digital economy. Together, CTG and Huawei are seizing these opportunities.

As a valued technical partner, Huawei Digital Power is the provider of L0 and L1 full-stack solutions for this project, including solution and architecture design, main equipment supply and integration, as well as project management and delivery.

The original project timeline was one year, requiring Huawei's team to install 4400 racks and a 35 kV substation in an area of 40,000 m². However, due to some external factors, the project was delayed, leaving the team with less time for completion.

Thanks to Huawei's FusionPower6000 and SmartLi solutions, the project was still delivered on time. FusionPower6000 shortens regular delivery time from two months to two weeks and SmartLi saves 40% of footprint. Plus, the solutions are plug-and-play, so Huawei was able to replace the modular UPSs without affecting normal services. This guaranteed efficient power supply during project deployment and has since improved the power quality.

To ensure excellent power backup, Huawei deployed a mix of old and new lithium batteries enhancing battery security. With AI and iPower, engineers can proactively perform O&M because the system predicts potential faults and sends reports and warnings about the device health status.

Huaiwei's iCooling@AI solution features intelligent technologies and supports an inlet water temperature ranging from 15°C to 20°C. Using digital technologies, the system collects a lot of environmental and energy consumption data. Then, it uses the data to decide on the optimal strategy, choosing from hundreds of thousands of HVACV optimization combinations in one minute. This helps constantly decrease the data center PUE and improves the cooling efficiency by 15%.

Setting a Best Practice for Future Zero-Carbon Data Centers

Since the completion of the first phase of the project on March 29, 2022, the project has drawn a lot of industry attention. CTG, Huawei, and industry experts prepared the Construction Standards for a Zero Carbon Data Center based on the lessons learnt and best practices from this project.

As a result, the Ministry of Industry and information Technology included the Dongyuemiao Data Center Project on the List of Typical Examples of New Types of Data Centers 2021. Also, the China institute of Communications awarded the project the Zero-Carbon Data Center Award of the IDC Industry 2021.

Conclusion

The vision for digital Three Gorges goes far beyond the Dongyuemiao. In the coming phases, CTG will continue to invest in the development of green and digital infrastructure in the region, creating some of the largest and most efficient technological foundations for China's digital economy. ▲



Building Green, Energy-efficient Telecom Sites with Turkcell

An ancient Chinese poet once imagined that "the ends of the earth are like neighbors ". Thanks to the continuous upgrading of telecommunication technology, this imagination has finally become a reality. However, the increasingly higher power cost of telecom sites is making this reality more and more unaffordable. If the telecom sites cannot go green and energy-saving, the digital life we are now enjoying is very likely to suffer from "downtime".

ith extreme weather events and climate change becoming more severe, the world has agreed that carbon neutrality is crucial for our planet. As part of this global consensus, in October 2021, Türkiye announced its 2053 net zero target and released a series of related policies.

Türkiye witnessed surges in energy consumption alongside soaring electricity prices between 2018 and 2021. In 2021, commercial electricity prices were as high as TRY 2.13 per kWh, compared to the previous rate of TRY 0.95. Industries and individuals alike have felt the pressure of mounting electricity bills.

In the meanwhile, Turkcell — the country's largest telecom carrier has set a carbon neutrality target for 2050. By 2030, the telecom giant plans to rely entirely on renewable energy. In April 2022, Turkcell began working with Huawei to equip its sites with PV systems and energy storage devices. The company hopes to reduce site energy consumption and go green without compromising its service quality.

Project background and challenges

Originally, a typical Turkcell equipment room had three racks and consumed 24.9 MWh of electricity per year. Site Energy Efficiency (SEE) was only about 70%.

SEE is an international energy efficiency indicator for telecom networks. It was designed by Huawei and certified by the International Telecommunication Union (ITU). SEE distinguishes between the energy consumed by telecom equipment and the entire site, reflecting telecom network energy efficiency with more precision. Then, companies can compare SEE for different subnets and sites, and pinpoint inefficient devices.

Another important project challenge was the batteries used by Turkcell sites. Batteries guarantee site reliability during power outages and Turkcell used leadacid batteries. However, due to fast capacity attenuation, their service life is only three to five years.

Huawei's reconstruction solution

Huawei's digital technologies are applied at every step of the way, from power generation, and conversion to storage, distribution, and consumption. By integrating digital and power electronics technologies, Huawei enables real-time data collection, which in turn facilitates SEE optimization and remote parameter setting. The reconstruction project for Turkcell sites focuses on the power system, PV deployment, and battery optimization.

• Power system: Cabinets replace the legacy power supply systems in the equipment rooms, eliminating the need for air conditioners. Besides, Huawei's power supply systems use power supply units (PSUs) with a conversion efficiency of 98%. Together, these changes improve SEE from 70% to 96%.

• PV deployment: Huawei has deployed the iSolar 2.0 solution, so that each site can deliver a higher PV energy yield. The solution also increases PV power utilization using an energy storage system. In addition, its simplified structure minimizes the civil workload, cutting carbon emissions during reconstruction.

• Lithium batteries: To optimize reliability and energy scheduling, the project also makes use of new lithium batteries and a smart battery management system.

Huawei integrates digital and power electronics technologies to help carriers build and operate green, low-carbon, and evolving networks. For this project, Huawei deployed its iSolar 2.0 solution, which assures synergy between PV and energy storage, safe shutdown, and minimum energy loss in case of shading. Now, the system generates 12,000 kWh of PV power each year, covering 70% of the site's energy consumption. This reduces carbon emissions by 7 tons per site each year. iSolar 2.0 has a more flexible structure than other similar solutions, which allows it to generate more energy. In standard PV power solutions, a PV string is often composed of three PV modules. In Huawei's iSolar 2.0 solution, one or two modules can form a string.

Another important innovation used in this project is Huawei's cloud-based intelligent lithium battery management. First, the project deployed intelligent lithium batteries. Then, it uses Albased peak staggering so batteries can discharge during off-peak hours, reducing site electricity fees. The system also features a self-optimization function, which schedules different energy sources such as grid power, PV power, and energy storage, maximizing PV power utilization. By collaborating with power supplies and loads, Huawei's batteries evolve from backup power to a smart energy storage system.

Project impact

After the reconstruction, power supplies and batteries are housed in an outdoor cabinet, so in-room cooling is no longer required. Highly efficient PSUs and natural cooling further cut site energy consumption by 25%.

The three PV strings provide 7.2 kWp of installed capacity with an average energy yield of 41.1 kWh per day, reducing grid power consumption by 70% and significantly lowering the sites Emission Factor (EF).

Huawei has also reduced PV module power loss caused by shading. To do so, it has integrated an optimizer with each PV module, enabling module-level Maximum Power Point Tracking (MPPT). If a PV module is shaded, the output of other PV modules remains unchanged, reducing power losses by 20%. In the cabinet, Huawei's modular eMIMO power subrack supports multiple input and output modes, meeting the needs of different loads.

To achieve its 2050 carbon neutrality target, Turkcell plans to strengthen its cooperation with Huawei. At Mobile World Congress 2022, Turkcell and Huawei signed a strategic cooperation agreement on sustainable development. "To gain international competitiveness, we must take measures on climate change," said Bulent Aksu, Chairman of Turkcell's Board of Directors. ▲





Chengdu: A Green Hub for Intelligent Computing

At present, intelligent computing is an important engine for the digital economic development. More and more cities have deployed relevant infrastructure to increase their computing power, accelerating the upgrade and transformation of various industries.

t the end of 2022, China released an assessment report on the development of AI computing around the country. The report indicates that AI computing has continued to grow rapidly in China, and intelligent computing has surpassed general-purpose computing in terms of scale. In the next five years, the compound annual growth rate of intelligent computing in China is expected to reach 52.3%.

Beijing, Hangzhou, and Shenzhen

remain the top 3 cities in terms of possessing computing power. Surprisingly, Chengdu, which ranked the ninth last year, has leaped to the sixth place. Such a leap is owing to the Chengdu Intelligent Computing Center.

Laying the Groundwork for an Intelligent World

The digital economy has become one of the main drivers of global economic development, which makes computing the new fuel. As a result, there is a rapid rise in the demand for computing



power, especially AI.

Undoubtedly, AI is quickly becoming integral to many use cases across industries. If intelligent computing power cannot keep up with this trend, various applications will not be implemented as planned, and the industrial development will be slowing down.

Chengdu has been ramping up investment in new economy and development, looking to integrate the digital and real economies. It aims to build a leading innovative industry development system to drive the digital economy.

At present, Chengdu Hi-Tech Zone is working with Huawei on the Chengdu Intelligent Computing Center, which represents a world-leading nextgeneration AI computing platform. The center will be the primary AI big data hub in West China, an important foundation of the intelligent world. The data center is equipped with platforms for smart urban management, world-leading (E class) Al computing, and scientific research innovation for global intelligent data storage and machine vision.

The Chengdu Intelligent Computing Center is critical to the construction of national integrated big data centers in China. It will deliver intelligent computing power for Chengdu and set a benchmark for the development of intelligent industries in Chengdu, Chongqing, and all West China.

Local industries expect that the Center will attract more upstream and downstream enterprises to set up base in Chengdu. This will be a stepping stone to building a new local IT ecosystem for stakeholders in cloud computing, AI, and storage.

What Powers the Intelligent Computing Center?

Chengdu: A Green Hub for Intelligent Computing

The Chengdu Intelligent Computing Center adopted Huawei's prefabricated modular data center solution, which integrates advanced energy-saving products and technologies such as FusionPower6000, SmartLi, and iCooling. The solution minimizes engineering workloads by deploying modular products and smart modules to accelerate service rollout.

The facility consists of 65 prefabricated modules that were quickly hoisted, stacked, and commissioned on site. Prefabricated modules, steel structures, and civil work are integrated in the construction model — an important innovative approach used in this project. Additionally, the modular design prevents dust during construction and reduces construction waste by 80%.

With Huawei's green and low-carbon solutions, the Chengdu Intelligent Computing Center has also enabled fullcycle low-carbon management, aligning with China's goal of carbon peak and neutrality.

Currently, the Power Usage Effectiveness (PUE) of advanced data centers in China is about 1.5. The Chengdu Intelligent Computing Center maintains an even lower PUE. In the coming decade, the center plans to further cut down on its electricity consumption by at least 40 million kWh.

Building a Digital and Intelligent Foundation

The first phase of the Chengdu Intelligent Computing Center started operations on May 10, 2022. As a model project of the Chengdu-Chongqing hub for national integrated big data centers, the Chengdu Intelligent Computing Center is the largest AI computing center in Southwest China.

The center is equipped with platforms for AI computing, smart urban management, and scientific research



innovation.

The AI computing platform uses an AI cluster based on Ascend AI software and hardware. It provides an AI computing performance of up to 300P, which is equivalent to the computing power of 150,000 high-performance PCs. The robust computing power has helped Chengdu make a leap to the sixth spot in China's computing power ranking 2022.

The center lays an intelligent and digital foundation for local urban construction, people's well-being, and industrial development. Here, rows of server racks are running reliably. Each rack bears a red logo of the Tiangong platform and carries the Ascend AI full-stack hardware and software.

Since starting operations, the Chengdu Intelligent Computing Center has been running at full load. More than 90% of the computing power has already been used to support a variety of applications, indicating the soaring demand for digitalization and intelligence. Once phase 2 of the project is completed, the campus will provide a total AI computing performance of 1000P or higher.

In the future, AI computing power will be scheduled and used on demand in a cost-effective way, just like water and electricity are today. The Chengdu Intelligent Computing Center plans to be one of the major facilities providing this service. ▲

Building a Fully Connected, Intelligent World



FusionSolar for Higher Yields

Optimal Investment | Higher Yields | Smart O&M

Safety & Reliability | Grid Forming

Hengtongyuan: Long-term Commitment to PV and Energy Storage Markets, Trust in Huawei

"Insist on long-term commitment and be a friend of time". Holding to such a conviction, Hengtongyuan has been long committed to environmental protection, engaged first in water treatment, then in PV power generation, and most recently in energy storage. In its 20 years of ups and downs, the company has overcome various difficulties and obstacles to stay true to its original aspiration. Through efforts and sincere cooperation with Huawei Digital Power, Hengtongyuan has embarked on a journey to a new frontier. ounded in 2002, Shenzhen Hengtongyuan Environmental Protection Technology has been engaged in water treatment for environmental protection, PV power generation, and most recently energy storage. Working closely with Huawei Digital Power, Hengtongyuan is our Value-Added Partner (VAP) in charge of sales distribution in six provinces in South China. It is also diamond-level reseller, authorized inverter repair center in China, and advanced Certified Service Partner (CSP) for inverters.

The Start of Our Journey

Hengtongyuan and Huawei began working together in 2014, with a PV project that required Engineering, Procurement, Construction (EPC) services. Wan Rongqun, General Manager of Hengtongyuan, recommended Huawei's advanced string inverters to the project and won the bid.

When Huawei Digital Power began establishing partnerships with distributors in 2015, Hengtongyuan was at the top of the list.

At the time, Hou Jinlong, President of Huawei Digital Power, shared Huawei's insights on the renewable energy market at a conference. He also explained the requirements for companies that wished to cooperate with Huawei on future projects. To work on large projects together, Hengtongyuan had to set up eight new offices and build a team of about 20 staff members. This resolve made it the perfect partner for Huawei's customercentric projects. Soon, it became one of two Huawei authorized inverter repair centers in China.

Bracing Against the Tides of Change

On May 31, 2018, China cancelled PV subsidies, which threw the Chinese PV market into turmoil. With suddenly diminished paybacks, many companies were poised to go under.

Hengtongyuan faced severe losses in their PV business for the next two years, primarily relying on its water treatment projects for revenue. However, it did not abandon the PV market entirely. In 2020, this persistence paid off. The Chinese government set new targets for carbon peak and carbon neutrality, which drove the PV market to a rapid recovery. In 2020, Hengtongyuan was finally seeing returns on their investment.

To date, Hengtongyuan has closed a wealth of deals for Huawei inverters in South China, totaling a capacity of more than 4 GW. In 2022 alone, its turnover was around CNY500 million (US\$70 million). This has made Hengtongyuan an important service provider on the smart PV market, and smart PV is

quickly replacing water treatment as the company's pillar business domain.

Building Trust in Huawei Products

Wan Rongqun put his trust in the renewable energy market and Huawei's outstanding products and technologies.

Huawei was the first company to focus on distributed inverters, launching string inverters without fuses or fans. These products deliver safety, efficiency, and fast ROI, being very popular on the PV market.

For example, Hengtongyuan provided Huawei inverters for the Guilin 300 MW PV power plant project of Guangxi Yuchai Machinery Group. The solution improved power generation efficiency by 3% to 5% and significantly reduced the failure rate. The project led to significant profit gains and became a best practice in the province.

Huawei has also designed optimizers that reduce matching failures caused by dust, shading, module attenuation, and heat spots. The optimizers maximize the energy yield of each module and increase the entire system's energy yield by up to 30%.

The project with Sinopec gas stations in Fujian is a great example of the success of Huawei's optimizers. During the project, Hengtongyuan provided Insist on long-term commitment and be a friend of time. Together, Hengtongyuan and Huawei are working towards a green future while making strides on the growing renewable energy and energy storage markets.

Wan Rongqun General Manager of Shenzhen Hengtongyuan Environmental Protection Technology



Sinopec with a Huawei solution portfolio that included both inverters and optimizers. The result was a more efficient and safer PV power generation system.

Wan Rongqun explained that it's easy to improve customer loyalty when selling high-quality products, like those offered by Huawei.

Plus, Hengtongyuan has had the opportunity to improve its own capabilities through these projects. Now, the company offers customers onestop services throughout the lifecycle of Huawei PV inverters, optimizers, and energy storage systems, including sales, technical services, delivery, warranty extension, maintenance, PV power plant construction, and O&M.

Becoming a Competent Partner

Huawei's competent partners stand out from the crowd through outstanding sales and ongoing growth and learning.

Hengtongyuan came in with extensive engineering experience, which had already set it apart. But with Huawei's enablement training, joint marketing, and customer visits, Hengtongyuan further improved its solutions and market presence. Plus, the company has adopted Huawei's standardized management strategies, which have proven successful.

Currently, Hengtongyuan is seeing an increase in its project-based revenue from renewable energy solutions. In 2021, Hengtongyuan registered a renewable energy subsidiary which is qualified for power installation and fire suppression, and can offer low carbon/ zero carbon campus construction services.

Most recently in 2022, Hengtongyuan set its sights on the energy storage market. Wan Rongqun believes that it will be the new frontier for expansion, just like the renewable energy market a decade ago.

Together, Hengtongyuan and Huawei are working towards a green future while making strides on the growing renewable energy and energy storage markets. ▲



Pinnet Technologies: Striding Toward a Greener Future

Drawing on Huawei's energy storage solution, Pinnet Technologies provides digital power services for enterprises, building a digital and intelligent energy product overview to reduce energy costs and improve energy safety. As a more promising digital power market is unfolding itself, by going steadily, Pinnet Technologies is striding toward a brighter future.

angzhou Pinnet Technologies (Pinnet Technologies) is a high-tech enterprise in the energy field with a strong focus on R&D. The company's vision is to enable the digital transformation of Chinese enterprises. Pinnet Technologies provides customers with new energy management systems and enterprise energy digitalization solutions. It is also

one of the Value-Added Partners (VAP) for Huawei Smart PV inverters. Its accumulated supply capacity exceeds 8 GW, and its annual sales revenue is approaching CNY1 billion (US\$143 million).

Working Closely with Huawei

Founded in 2010, Pinnet Technologies has provided software development



services for Huawei Smart PV since 2012. The company possesses outstanding capabilities in professional communications technologies and software development.

When Huawei launched its Smart PV solution, Pinnet Technologies quickly became one of Huawei's distribution partners and sales agents. Today, Pinnet Technologies is a VAP for Huawei PV inverters in East China, Northeast China, and North China.

In 2017, Pinnet Technologies launched Pinnenger, a proprietary management system that enables higher efficiency in new energy generation and supports intelligent power plant solutions. This management system can intelligently manage devices, such as PV inverters, PV trackers, cleaning robots, and inspection drones, achieving efficient power generation and ensuring the safe and stable operations of power plants.

In 2020, Pinnet Technologies started to deploy commercial and industrial (C&I) energy storage services. Drawing on Huawei's energy storage solution, Pinnet Technologies provides digital power services for enterprises, building a digital and intelligent energy product overview to reduce energy costs and improve energy safety.

Over the years, the company has become a one-stop shop, where customers can access integrated software and hardware solutions and services. This satisfies both energy suppliers and users. Pinnet Technologies works in fields such as PV, wind power, energy storage, microgrid, and smart energy efficiency. Its client portfolio includes the State Grid Corporation of China, China Southern Power Grid, State Power Investment Corporation, China General Nuclear Power Corporation, and Jinko.

Looking back on the cooperation with Huawei over the past 12 years, Zheng Jiaxiang, Sales Director of Pinnet Technologies, said that the partnership has grown closer. The two companies now often work in sync, procuring win-win results as ecosystem partners. The partnership between Pinnet Technologies and Huawei has grown closer. The two companies now often work in sync, procuring win-win results as ecosystem partners.

> Zheng Jiaxiang Sales Director of Hangzhou Pinnet Technologies



In this partnership, Huawei provides standard and universal products and solutions. Then, Pinnet Technologies customizes these products and solutions using its industry-specific knowledge and relationship with customers. For example, Pinnet's management system software works in synergy with Huawei's inverter hardware, capitalizing on the strengths of both tech giants.

Playing to Each Other's Strengths to Grow

Mr. Zheng considers Huawei a "partner-friendly" company. He took as an example Huawei's current PV product cooperation policy. Using provincial VAPs avoids partner conflicts and malicious competition, maximizing partners' interests. This in turn encourages partners to spare no efforts.

In addition to friendly policies, Huawei holds a leading position in terms of product quality and brand influence. This has been a key reason for Pinnet Technologies to choose Huawei as a long-term partner. Of course, it has meant high stakes for Pinnet Technologies — after all, the company must also deliver outstanding capabilities, sales performance, and service quality.

In 2019, Pinnet Technologies purchased products worth CNY160 million (US\$23 million), but sold only CNY10 million (US\$1.43 million) in the first three months. This put a lot of financial pressure on the company. In response, Pinnet Technologies brought on 40 new employees in just a month and sent them out across China to close deals. The strategy proved successful.

Pinnet Technologies has built an "iron triangle" consisting of account managers, solution managers, and service managers, who together form a strong city-level operation team. Most of the solution managers come from R&D departments. They are very familiar with Huawei's products, technologies, solutions, and business models and can quickly get started. The iron triangle has shown strong capabilities and achieved a sharp increase in sales performance. The experience Pinnet Technologies has accumulated in R&D over the past decade has become its core competitive advantage in the energy digitalization market. Now, the company is quickly taking over important emerging markets.

For example, Pinnet Technologies drew on its city-level capacity to succeed in the 2020 PV centralized procurement project deployed by State Grid Zhejiang Electric Power. Through solution guidance and value implementation, Pinnet Technologies maximized the bid share from 60% to 75%. During the project, the company was ready with products well in advance, ensuring quick delivery.

A Path to Future Success

Building on Pinnet's existing experience, Huawei provides additional support to help the company grow. Zheng Jiaxiang believes that the biggest benefit of working with Huawei is not sales profits, but cultivating talents and management abilities. So far, Pinnet Technologies has seen growth in R&D, sales, and services.

In terms of R&D, Pinnet has adopted Huawei's advanced PPG development process and IPD management approach to systematize R&D management and ensure that their developed software is mature and reliable.

As for sales, Pinnet Technologies has

worked with Huawei to implement the three-step sales strategy executive visit, HQ visit, and strategic cooperation. This has helped them better understand customer use cases and requirements.

When it comes to services, Huawei has encouraged Pinnet Technologies to improve its service quality and has enabled the company to explore new markets and customers.

For Huawei, partner growth is crucial and well worthy of recognition. After the success of Pinnet Technologies in the inverter business in East China, Huawei handed over to the company several other regions — Northeast China, Inner Mongolia, and Hebei.

At the same time, Huawei continues to provide enablement for Pinnet Technologies. It offers the company management training courses for internal growth and joint services for customer-facing expansion.

In the future, we hope to continue expanding our partnership in products and solutions. As the goals of carbon peak and neutrality inch closer to realization, Pinnet Technologies and Huawei are committed to energy digitalization with the view of improving energy asset efficiency and discovering new energy business models for a greener future. ▲



JSM: Delivering Full-Stack Green Solutions and Services

It took ten years for Jun-sen-ming to achieve its first big leap. Since partnering with Huawei in 2019, the company has experienced explosive growth and doubled in size. In the new decade, Jun-sen-ming has full confidence in the sincerity and strength of its cooperation with Huawei to overcome challenges for a greener future. As the saying goes, "If you want to go fast, walk alone; and if you want to go far, walk together."

Starting in 2008, Jun-sen-ming (JSM) has been an important player on the UPS distribution market. Looking to grow and expand its market presence, the company began working with Huawei in 2019. The cooperation led to the company's explosive growth, which doubled its headcount in just three years.

Joining the UPS industry

Xu Changcheng, General Manager of JSM, wasn't always going to work in the IT industry. He started working in the sector by accident, but witnessing unprecedented industry growth, he decided to specialize and bet on the future of technology.

He specialized in uninterruptable power supply (UPS) technologies. "I realized that as the IT industry gained momentum, it would need more power security. So, I figured the future of the UPS industry should be very promising," said Xu.

A UPS is a device that supplies emergency power when the regular input or mains energy source fails, ensuring that services that need a power supply are never interrupted.

In 2008, Xu and his partners took a

risk when they took over JSM. The company already had a solid share in UPS distribution. Xu recalls: "JSM's performance was alright, but it didn't add much value beyond distribution. Some sort of transformation was necessary for long-term success."

Resources and scale are crucial to the distribution business. With a stronger supporting base, large distributors can cover more customers, while smaller companies tend to find themselves at a disadvantage.

"We decided that JSM needed to focus on end users and specialize in technologies and solutions," explains Xu. At the time, JSM only had seven or eight employees and was generating little profit. To succeed, the company needed to transform its technologies and services, learn and understand customer requirements, and accumulate more project experience.

JSM had a long way to go.

A decade of growth and learning

With its rough start in 2008, JSM persevered and grew into an important service provider in the fields of UPS and Digital Power. This set the company up to continue its successful journey and in 2019, JSM partnered with Huawei.

"Huawei has industry-leading technologies and complete product lines in the Digital Power domain. We wanted to expand our business in this sector, and to do so, we wanted to work with Huawei's excellent products and solutions," explains Xu.

The partnership has proven to be successful. Since Q4 2019, JSM has been growing at an unprecedented speed. From 2019 to 2022, JSM registered a 50% compound growth rate. By the end of 2022, its estimated sales volume was expected to exceed US\$64.75 million. The company has also doubled in size and is now home to over 100 employees.

"Most of the new staff have joined the pre-sale solution department, which provides customized solutions for our clients as well as the engineering management center that takes care of after-sales services. Currently, half of JSM's employees are working in these two departments," says Xu.

This transformation has marked the shift from focusing on sales to becoming a company centered on technology and services. "We position ourselves as an overall solution provider for Digital Power products. We are selling fewer UPSs and focusing more on solutions. Right now, more sales revenue comes from Huawei FusionPower6000, lithium batteries, smart modules, and DICM than UPS products," continues Xu.

New possibilities with Huawei

Partnering with Huawei has allowed JSM to expand their market presence. Huawei

JSM hopes to delve into new industries together with Huawei Digital Power. And our goal is to provide what our customers need and respond to their biggest challenges.

> Xu Changcheng General Manager of Jun-sen-ming Electronic Technology



offers a wide range of powerful solutions that respond to complex customer needs. By working together, JSM and Huawei can take on large-scale projects and generate a variety of best practices.

"In 2020, JSM and Huawei won the bid for an IDC project with the Huawei FusionPower6000 solution. The contract amount was over US\$14.4 million. In 2021, we took on a project in East China with Huawei UPS + lithium battery solution. And in 2022, we added a key national project that uses the Huawei FusionPower6000 solution — another contract worth US\$14.4 million," highlights Xu.

Now, JSM offers a wider variety of Digital Power products as Huawei's distributor, including lithium batteries, FusionPower6000 solution, and DICM software platform. On top of that, JSM has enhanced its solution capabilities by developing its own auxiliary products.

In addition, JSM and Huawei plan to strategically approach new industries together. Huawei Digital Power has a set of modular products that are suitable for many different use cases and industries. Once deployed in its entirety, the full-stack solution features a smaller footprint, more stability, intelligence, and energy conservation, which leads to faster installation and simpler O&M. Coupled with these technical advantages, JSM's experience in consulting, solution planning, deployment, and O&M is crucial for delivering quality and stability to customers.

Overcoming challenges for a greener future

JSM is based in Shanghai, which experienced serious impacts due to COVID-19 prevention measures.

During a crucial stage of a project in Hefei, the JSM team couldn't leave Shanghai due to COVID-19. Instead, they had to work with Huawei's local team in Hefei over video conferencing to push the project forward. The joint efforts worked very well. The client was happy with the final outcome and the innovative FusionPower6000 solution.

In another story, the JSM team

encountered difficulties when key milestones were to be implemented for a \$14 million IDC project. Huawei sent its staff to work onsite when JSM's team was facing various challenges. Once again, the joint efforts sealed the success of the project.

To Xu, both stories confirmed the sincerity and strength of the cooperation with Huawei. As such, JSM hopes to delve into new industries together with Huawei Digital Power, including smart manufacturing, IDC, finance, government and enterprise, hospital, school, chemicals, and new energy vehicles.

"Our goal is to provide what our customers need and respond to their biggest challenges. We envision JSM as a Digital Power solution provider that can benefit society," said Xu.

JSM is well positioned to make new progress in the coming decade. As the saying goes, 'If you want to go fast, walk alone; and if you want to go far, walk together.' JSM will continue collaborating with Huawei for future success.



Hohmori: A Flourishing Startup in Digital Power

How can a startup company become the top player in the field of digital power? Ma Chao, founder and CEO of Hohmori, a flourishing startup, shares a story of how the company has been growing with Huawei Digital Power.

he digital power industry is growing at an unprecedented speed. Founded in 2014, Beijing Hohmori Info-Technology (Hohmori) is embracing the opportunities in this growing industry. The company focuses on using innovative technologies like AI to reduce the Power Usage Effectiveness (PUE) of IT infrastructure. It is also helping other companies innovate using digital power technologies.

Hohmori is one of the core partners

of Huawei Digital Power. In just a few years, the company has expanded from just ten employees to a headcount of nearly 100. Its annual output value has also grown nearly ten-fold, from an initial CNY20–30 million (US\$2.8–4.2 million) to nearly CNY400 million (US\$56 million). Hohmori has also won wide industry recognition for its best practices and currently holds a strong position among ICT peers.

How did the startup quickly rise to the top of its field in the digital power industry? Ma Chao, founder and CEO of the company, shares Hohmori's story.

Taking the right opportunity when it comes

"Looking back, 2017 was a critical turning point. We made a key decision — we bid on digital power," says Ma Chao. He started the business with several experienced ICT partners, focusing first on Internet Data Center (IDC) services. However, the competition in this market was fierce, making it difficult for smaller companies to compete against established ICT integrators.

In 2017, Ma Chao noticed acutely that Huawei was gearing up to enter the digital power market, launching the industry's first modular UPS5000-E series products. Huawei was also onboarding new partners for the industry. Hohmori jumped at the opportunity.

"I believe that Huawei can take a strong foothold in any industry it sets sights on. We thought, if we can grow alongside Huawei, that will give us a fighting chance," explains Ma Chao.

While Hohmori didn't have much experience in digital power, as a startup, it had to pivot quickly. Startups don't have the luxury to wait until they are fully ready, instead they must jump right in and learn on the fly. And that's exactly what Hohmori did.

Creating and adding value while learning

Hohmori started out as a reseller of Huawei Digital Power products. Then, it developed its pre-sales and aftersales service capabilities, driving up its own value-add in the process.

Of course, Hohmori didn't start from zero. With a wealth of experience in the IDC industry, it quickly applied its existing knowledge to get certified as Huawei's gold partner in 2016. It also acquired Huawei's 3-star service certification in 2016 and the 5-star certification in 2022.

The company's vision is "to facilitate digitalization in three business domains." So, Hohmori has three business modules — equipment

rooms, plants, and computer rooms. These modules cover digital power, industrial software development, and 3D desktop cloud. Today, Hohmori's core customers include top players in the IDC and other industries.

Landing its first big client

Soon after shifting to digital power, Hohmori landed its first big order. In 2017, Microsoft Azure was looking for a strong supplier to upgrade dozens of UPSs for a data center in East China. Previously, Microsoft Azure used a supplier outside China. The performance was stable but the maintenance was too expensive. Moreover, the supplier couldn't perform inspections without power-off. This was an opportunity for the nextgeneration modular UPSs.

"Facing our first large project was stressful. But the team at Huawei Digital Power gave us a lot of support and encouragement. Together, we invited our customer to visit Huawei for product testing. Finally, we won the bid," recalls Ma Chao.

The project was a huge undertaking and set Hohmori on track to success: "At the time, this was one of the largest projects using Huawei Digital Power's modular UPSs. It was the very first paragon to encourage the large-scale application of hotswappable modular UPSs in the following years." Our customers are all leading enterprises in the industry. They expect a lot from data center construction. We need to grow alongside Huawei Digital Power and draw on each other's strengths to come out on top.

> Ma Chao Founder and CEO of Beijing Hohmori Info-Technology



Unleashing innovation to keep growing

Hohmori was finally ready to take on big projects, but real success requires innovative approaches to complex problems.

In 2019, Global Data Solutions (GDS) was working on a large data center in Langfang for Huawei Cloud. Hohmori was chosen as the core digital power supplier for the project.

The data center is the core node for Huawei Cloud in North China. The project was large and complex, covering an area of about 54,000 square meters. At the same time, energy efficiency and a low carbon footprint were crucial for the data center. Existing solutions weren't sufficient, so Hohmori had to come up with innovative ways to fulfill these requirements.

Huawei Cloud wanted the data center to have a PUE below 1.3. Considering its geographical location, using standard AHU indirect evaporative cooling would not reach this value. Meanwhile, liquid cooling was too expensive and above the project's budget.

Huawei Digital Power and Hohmori came up with an alternative option — a hybrid solution that uses AHUbased indirect evaporative cooling technology and CDU-based liquid cooling. Combining the excellent cooling efficiency of Huawei Digital Power products with Hohmori's leading engineering experience allowed the data center to reach a PUE of nearly 1.26 in 2020. This alone can save nearly 10 million kWh of electricity each year.

The Langfang project was challenging but rewarding. "This project adopted almost all Huawei Digital Power products, including AHUs, precision air conditioners, UPSs, lithium batteries, and iCooling solutions. It was like a general exam. It helped us improve our supply chain, capital reserve, and credit reserve, making us more competitive," explains Ma Chao.

Building a strong partnership

The data center project marked a new

phase in the partnership between Huawei Digital Power and Hohmori. They became strategic partners, creating new value together. At the same time, Hohmori's team kept expanding its capabilities.

"In the first phase of the project, Huawei took the lead while we helped. Huawei's delivery team provided us with hands-on training at the site. Then, in the second phase, we were responsible for delivery. This helped us learn and grow," says Ma Chao.

Ma Chao was impressed by the mentorship provided by Huawei Digital Power as part of its partner program. He explains: "Most partners cooperate with original vendors and it's a oneway partnership. The original vendor basically hires you for your existing knowledge, but rarely cares about your company's growth. We felt that Huawei really prioritized partner growth, creating a lot of value for partners."

Creating value together with partners

"Right now, it is difficult for small isolated companies in the ICT infrastructure industry to survive. The cost of starting business is increasing. To succeed, startups must stand on the shoulders of giants. Huawei is always helping us succeed," says Ma Chao.

He also adds: "In the entire digital power industry, Huawei is one of the

companies to offer full-stack solutions and a range of technologies. It can test and verify the various technologies it offers at its own data center, offering full-proof solutions to its customers."

Beyond sharing project success, Huawei Digital Power offers its partners a variety of certifications and training opportunities. All these are incorporated into a system to help partners succeed. Hohmori has followed this system step by step and has come out on top. Now, it is one of the largest providers of UPSs in the industry. Among other ecosystem partners, it leads in terms of the number of senior engineers certified through Huawei Digital Power programs.

"Our customers are all leading enterprises in the industry. They expect a lot from data center construction. If we don't work hard enough, we won't succeed. We need to grow alongside Huawei Digital Power and draw on each other's strengths to come out on top," concludes Ma Chao.

As the digital economy grows, many industries will increase their demand for computing power, which will require more energy-efficient ICT infrastructure. Ma Chao has full confidence in the company's future. "We very much agree with Huawei's Digital Power concept of 'bits drive watts'. Digital Power is a good track with wet snow and a really long hill. In the future, Hohmori will continue to grow with Huawei Digital Power."



TechEroPower: Cooperation Is a Two-Way Journey

While enterprises set more and higher requirements for digital transformation services, the corresponding division of labor and cooperation are becoming more and more meticulous. In some sense, cooperation is a two-way journey that requires long-term growth of both parties. What has happened between TechEroPower and Huawei Digital Power may very well illustrate this point.

s data centers grow in scale and importance, new requirements emerge for both technologies and facilities. In the past, the construction of equipment rooms was mainly concerned about location. Now, it's important to consider everything from capacity design and civil engineering to the types of air conditioners and UPSs we deploy.

TechEroPower Information Technology (TechEroPower) has been working in the field of equipment room infrastructure since its founding in 1999. It is ISO9001 certified in quality management systems. TechEroPower has owned over 10 patents for equipment room products and holds several utility model patents. The company has accomplished the delivery, operations, and maintenance of hundreds of projects.

Huawei and TechEroPower cooperate closely in Digital Power. TechEroPower is a five-star service provider and gold partner of Huawei Digital Power. In addition, TechEroPower established an authorized training and certification center in 2017.

Cooperation is a two-way journey that requires long-term growth of both parties. What has happened between TechEroPower and Huawei Digital Power may very well illustrate this point.

Sharing Common Values Enables Long-Term Cooperation

In 2000, the two companies began working together.

In 2001, the cooperation was suspended due to Huawei's strategic adjustment. Even so, Huawei's core values —customercentricity, dedicated employees as its foundation, and commitment to dedication — resonated with TechEroPower, which at the time was a start-up.

In 2014, Huawei launched several network energy products such as UPSs. TechEroPower, under the guidance of Li Qun, the company's Founder, was one of the first partners to become a gold distributor in Hunan Province, China. Li Gao, Sales Director at TechEroPower, said, "Even though the market and products have changed over the years, Huawei's customer-centricity has not. Their partner policy of openness, collaboration, and shared success also remains unchanged."

In 2015, TechEroPower established a five-star lab for network energy. With its technical strength and professional delivery capabilities, TechEroPower became the first five-star service provider, a run-rate reseller of Huawei Digital Power and a gold industry partner.

In 2017, TechEroPower established a training and certification center

authorized by Huawei Digital Power to train talents in the Digital Power field. Since then, TechEroPower and Huawei have been working together to serve customers, cultivate talents, and expand the energy market.

"Before working with Huawei, we didn't really have a strong corporate culture or project management regulations. We have gradually established our own project management processes and standards, which have increased customer satisfaction and trust, building a good reputation for TechEroPower." said Li Gao.

Serving Customers Together

Serving customers entails more than selling products; we must understand customers' requirements, customize solutions, and solve their problems. This is the meaning of customercentricity. To achieve this, we need collaboration between vendors, partners, and customers. Through cooperation with Huawei, TechEroPower provides customers with innovative Digital Power products and grows in the process.

In 2014, when rebuilding the equipment room for an electric power enterprise, TechEroPower recommended Huawei's modular data center solution. The solution was perfect for the customer's strategic objectives, but the customer was in need of a better understanding of the modular data center concept to accept the proposal.

To help TechEroPower, Huawei

We believe that Huawei will continue to promote its platform + ecosystem strategy, building an even more open, cooperative, and win-win ecosystem for a successful future.

Li Gao Sales Director at TechEroPower Information Technology

dispatched a team of 20 engineers focused on consulting, design, deployment, implementation, and O&M. The team demonstrated the project value to the customer and won the bid. "During this process, TechEroPower and Huawei worked together to understand the customer's challenges, provided suitable solutions, and helped the customer understand our value." said Li Gao. The project has been a success.

The modular data center takes up little space, is quick to deploy, and features simple O&M. It has helped the customer save energy. "After project deployment, I took five potential customers to visit the project site. All of them chose the modular data center solution." said Li Gao.

Through the many projects with Huawei, TechEroPower has grown its market presence and built its team capabilities. It has increased the per customer transaction value from hundreds of thousands CNY to tens of millions CNY. Moreover, the company's business has extended from UPSs to Huawei's full range of Digital Power products and a wider range of ICT products.

TechEroPower continues to invest in market expansion. It now offers solutions for a range of industries, including government, education, healthcare, and finance. It is also cultivating projects in cities, districts, and counties.

Exploring New Opportunities for Digital Power

The digital economy is growing quickly, increasing demand for Digital Power and talents. During its quick expansion, TechEroPower faced talent shortages.

Li Gao understands that there is an urgent need to cultivate, recruit, and retain talents that understand both IT and renewable energy.

To address this challenge, TechEroPower has been working with Huawei to build a talent development system. By combining its profound experience in the Digital Power field with Huawei's professional talent development and certification system, TechEroPower aims to prepare more professionals for the company and the entire industry.

In 2017, TechEroPower officially established a training and certification center authorized by Huawei Digital Power. The center collaborates with Shenzhen Polytechnic and has so far trained nearly 3000 professionals. It has also become an important source of revenue for TechEroPower.

Huawei focuses on a platform + ecosystem strategy. In response to this strategy, TechEroPower has cultivated its corporate culture, project management, and technical services, while expanding its portfolio of products and services.

Li Gao sees a lot of opportunities as the world pursues zero carbon emissions. He said, "We believe that Huawei will continue increasing investment in Digital Power R&D and develop more innovative products that meet our customers' needs. We also hope that Huawei will continue to promote its platform + ecosystem strategy, building an even more open, cooperative, and win-win ecosystem for a successful future."



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Smart DC Building the Green Future

Sustainable | Simplified Autonomous Driving | Reliable



Chow Energy PCL: Working with Huawei for a Better, Greener Future

As the world turns its attention to carbon neutrality, solar energy and new energy projects are becoming a growing trend. Chow Energy PCL, a Thai energy company, has made remarkable achievements in solar energy projects. As the perfect partner for Chow Energy PCL, Huawei has escorted the projects with its inverters of high efficiency, stability and durability. In the future, Chow Energy PCL will continue to join hands with Huawei on a wide range of projects in Thailand and around the world.

stablished in December 2014 and headquartered in Thailand, Chow Energy Public Company Limited (PCL) invests in, generates, and sells electricity from various kinds of energy. It owns, manages, and develops renewable energy projects. The company offers power plant engineering, procurement, construction, operation, maintenance, and monitoring services all around the world. Solar and renewable energy projects have become increasingly popular as the world shifts its attention toward carbon neutrality. Chow Energy PCL develops solar projects in Thailand and abroad, delivering over 100 MW capacity across projects like large-scale ground mounts and both residential and commercial rooftop PV systems.

Across the Asia-Pacific region, Chow

Energy PCL manages an energy pipeline in excess of one Gigawatt. Its expertise in solar energy extends to solar storage, agricultural sharing, and even floating solar projects with fisheries. Today, the company is slated for ongoing growth in both scale and success.

However, working with new energy is a challenge. Huawei is the perfect partner for Chow Energy PCL because
Huawei inverters offer I-V curve diagnosis functions that allow our supervision teams to monitor the installation on each rooftop, assuring efficiency, security, and optimization.

> Cristobal Chin CEO of Chow Energy Public Company Limited



Adding PV Plants to 7-Eleven Stores

One of the flagship projects deployed by Chow Energy PCL and Huawei involves building PV systems for 7-Eleven convenience store chain in Thailand.

Looking to reduce their electricity consumption, 7-Eleven selected Chow Energy PCL to set up more than 1200 solar rooftop systems. To start, Chow Energy PCL had to assure policy compliance and send field teams to evaluate the 7-Eleven sites. The designs consider the stores' energy consumption and available installation area to come up with the optimal set up for highest energy generation capacity.

Once installed, the 1200 solar rooftops

will represent over 22 MW of installed capacity nationwide. Chow Energy PCL's surveys estimate that these rooftop systems will supply around 20%–25% of the stores' energy.

Technologies Behind the Project

Thailand is a vast country and the 7-Eleven branches are located in areas with different weather and environmental conditions, impacting how solar energy is generated. As such, a robust technological foundation is crucial to assure stable power supply at each shop.

Each rooftop system should deliver the optimal performance at all times. To do this, they need to be monitored. Manually managing systems would require excessive resources, so a remote real-time monitoring system is also a must.

The project uses Huawei's FusionSolar management system, that centrally displays the status of each rooftop system. FusionSolar evaluates the performance of the inverters but also checks the conditions of the PV modules. With this information, Chow Energy PCL can quickly analyze system performance and dispatch teams to sites that encounter any issues. This process assures high performance and reliability.

Cristobal Chin, the CEO of Chow Energy PCL, explained that Huawei inverters deliver some major advantages for this project. They come with builtin monitoring and I-V curve diagnosis functions, which enable efficient operation and maintenance. The inverters send back data to Chow Energy PCL HQ, where supervision teams can monitor the installation on each rooftop, assuring efficiency, security, and optimization.

Solar Energy: Looking Ahead

As we strive toward carbon neutrality, these types of projects will become more and more common. We hope to see more companies turning to green technologies and clean energy generation. Chow Energy PCL and Huawei will continue developing innovative projects in renewable energy, cutting carbon emissions for a better, greener future.

Energy Storage Signals Great Potential, but Can We Make It Safer?

Among all kinds of renewable energy, PV and wind power are set to be the dominant players in the future. However, conventional ESS solutions face such problems as poor safety, low efficiency, short service life, and difficult O&M, thus decreasing the utilization efficiency of renewable energy. By virtue of its decades of experience in power electronics, energy storage, and digital technologies, Huawei has launched the Smart String ESS solution to fully guarantee the safety of energy storage.



s the world moves toward carbon neutrality, we are seeing explosive growth in the energy storage market.

Many authoritative investment and research institutes predict that the market in China alone will hit over a trillion CNY. For example, Everbright Securities estimates that the size of China's energy storage market will reach CNY0.45 trillion (USD65 billion) by 2025 and grow to about CNY1.3 trillion (USD186 billion) by 2030.

Energy storage is now increasingly deployed for renewable energy projects and plays a key role in new electric power systems. An Energy Storage System (ESS) is not just a simple combination of batteries. Rather, a leading ESS is a comprehensive system that integrates electrochemical, power electronics, digital, and heat technologies.

However, conventional ESS solutions face many challenges in terms of safety, efficiency, and O&M. Sometimes, safety accidents, like fires or explosions, may even put people's lives at risk, causing serious social and economic losses.

Can technology and innovation help us solve these problems? Here are some of today's best practices in modern ESS safety and optimization.

Challenges in the large-scale use of renewable energy sources

PV and wind power are set to be the dominant players on the renewable energy market. The International Renewable Energy Agency (IRENA) predicts that by 2050, the world will produce 55,000 TWh of electricity per year, of which 86% will come from renewable energy sources. The total installed capacity of renewable energy will reach 20,000 GW, 72.8% of which will originate with PV (8510 GW) and wind power (6044 GW).

For PV and wind power to become our principal energy sources, advanced energy storage technologies are indispensable.

These renewable energy sources are intermittent, unstable, and uncontrollable. This means that when connected on a large scale, they can deteriorate the stability of power grids if not properly stabilized and compensated for. In the past, power grids would curtail how much they relied on PV and wind power.

Now, energy storage offers an excellent solution to alleviate these problems. In terms of power transmission and distribution, energy storage can help with frequency regulation, voltage support, peak shaving, reactive power support with backup capacity, and transmission congestion relief. This



significantly reduces the fluctuation of PV and wind power, stabilizes renewable power generation, reduces energy waste, and assures efficient energy management. In the future, we expect that PV + storage will be the main option for PV plants.

Of course, conventional ESS solutions face their own problems, which include poor safety, low efficiency, short service life, and difficult O&M, deteriorating the utilization efficiency of renewable energy.

Lithium batteries are the core components of a Battery Energy Storage System (BESS), which is poised to become the main energy storage technology in the future. That said, internal and external excitation sources may quickly increase the temperature of battery cells, leading to severe thermal runaway. This can release flammable and explosive gases, causing fires or even explosions.

Generally, there are several issues that may lead to safety accidents in lithium BESSs:

1.The structure of ternary lithium battery cell material is unstable. At high temperatures, they generate oxygen, which can cause fires and explosions.

2.When a defect occurs between cells, signals cannot be quickly transmitted to the management system.

3.Key components (such as circuit boards and contactors) are faulty, causing sparks and arcs.

Conventional ESSs can only generate alarms after a fire has started, but can't offer warnings, posing safety risks.



Interdisciplinary innovation enables ESS advancements

Safer energy storage is not an issue for a single domain, but requires multidisciplinary collaboration and innovation.

As the energy industry embraces digitalization, it's begun to use "bits" (information flows) to drive "watts" (energy flows). That is, the industry is using new digital and intelligent technologies to promote the energy revolution. This means that we need to integrate digital and information technologies with PV and energy storage to build leading ESSs.

There are only a few companies in the digital energy sector that can combine all these disciplines and lead an ESS revolution. Huawei is one of them. Huawei has decades of experience in power electronics, energy storage, and digital technologies. Most recently, it launched its top-of-the-line Smart String ESS solution.

The solution adopts a distributed architecture and modular design. It uses innovative technologies and digital intelligent management to optimize energy at the battery pack level and control energy at the rack level. This results in more discharge energy, optimal investment, simple O&M, as well as safety and reliability throughout the lifecycle of the ESS.

Unlike conventional centralized solutions, Huawei's Smart String ESS adopts string and modular designs and intelligent technologies to address the industry's bottlenecks.

1.String design

The conventional centralized ESS is an all-in-one container. This requires extensive management, resulting in safety risks and high O&M costs. In contrast, the string design helps refine management. For example, it uses energy optimizers to manage battery packs, minimizing the impact of mismatch between packs connected in series. Huawei also uses a distributed smart cooling architecture. Each battery rack is cooled by an independent string-level air conditioner. In this way, each battery rack dissipates heat independently and evenly, reducing the temperature rise difference between battery packs on different racks.

2.Intelligent technologies

Huawei applies technologies such as AI and cloud BMS to internal short circuit detection. This helps it accurately locate and warn of battery fire risks before they occur. AI can also build prediction models to predict battery health, reducing the initial battery configuration. The intelligent cooling policy can find the optimal balance point between battery attenuation and cooling energy consumption in real time, ensuring the optimal levelized cost of storage (LCOS).

3.Modular design

Conventional ESS solutions have a large fault impact scope and low system availability. The modular design of Huawei's Smart String ESS ensures the high availability of core components, reaching 99.9%. For example, the battery system is modular. If a fault occurs, the faulty battery pack is isolated and does not impact the other battery packs. The key component — Smart Power Control System (PCS) — is also modular. When one PCS is faulty, other PCSs can continue to work normally. Even when multiple PCSs are faulty, the system can still run properly.

In conventional solutions, experts need to calibrate batteries onsite, resulting in high O&M costs. The modular design enables plug-and-play replacement of battery packs, negating the need for onsite maintenance visits. This saves 90% in O&M costs.

"3+1" Active Protection for Energy Storage Safety

The key value of Huawei's Smart String ESS lies in safety.

Drawing on its technological innovation, Huawei has developed a set of leading energy storage safety protection concepts. To ensure the safety of the entire ESS, we need to look beyond the safety features of battery cells, integrating electrochemical, power electronics, digital, and heat technologies. Together, these can deliver refined monitoring and management of each battery cell, pack, rack, and ESS, providing active protection.

As such, Huawei's Smart String ESS uses "3+1" safety, that is, three-level safety design plus intelligent warnings.

1. Structural safety

The solution design isolates the battery, rack controller, and control unit cabins to ensure stable, ongoing monitoring and fire protection. The protection rating of the entire system reaches IP55, the anticorrosion level of the container is C5. The system can withstand earthquakes up to an intensity of 9 on the Richter scale. Such high protection standards ensure high reliability.

2. Electrical safety

Four-level active shutdown and two-level physical isolation provide comprehensive overcurrent protection — when detecting overcurrent, the system triggers the BMS to limit the current of battery packs and racks using software. If the fault is escalated, the battery pack optimizer and rack manager shut down the system's hardware devices (four-level). Finally, the circuit breaker and fuse help prevent the fault from spreading (two-level).

3. Fire safety

Huawei's Smart String ESS is equipped with multiple temperature, humidity, and smoke sensors. These sense warning factors in the environment. For example, if the sensors detect flammable gas, the ESS automatically exhausts the gas to prevent fires and explosions. After the exhaust system is shut down, an extinguishant is immediately released to put out the fire.

4. Cloud BMS intelligent warnings

The Smart String ESS draws on Huawei's extensive experience in cloud and AI, using an innovative patented cloud short-circuit algorithm, which is based on big data modeling and training. The algorithm intelligently detects internal short-circuits, enabling early detection, early warning, and multi-level linkage protection.

Safety is always our top priority and is critical as we aim toward carbon neutrality and the green energy revolution. Huawei will continue its interdisciplinary innovation in digital and intelligent technologies to build more efficient, reliable, and safer ESSs. ▲



S-ECO Mode: The Next Step in Energy-Efficient UPSs and Greener Data Centers

In data centers, efforts are being made to improve the energy efficiency of UPSs. Over the past decades, we have seen leaps in UPS efficiency. Due to issues like topology, components, and techniques, however, further breakthroughs in energy efficiency may be limited. It is hoped that the S-ECO mode can help us on our way toward the goal of carbon neutrality.

s we move toward the goal of carbon neutrality, we need to take a long hard look at the power consumption of our digital systems. With the development of the digital economy, data centers have become the biggest energy consumers, thus in urgent need of more efficient systems to reduce their Power Usage

Effectiveness (PUE).

Among other things, Uninterruptable Power Systems (UPSs) account for a large proportion of the energy consumption of data centers, which makes them an important area of focus when it comes to energy efficiency objectives.

How Can Data Center UPSs Keep Optimizing Energy Efficiency?

Even the smallest changes in UPS efficiency can save a lot of energy and costs. Let's consider a 10 MVA data center as an example. When the UPS load rate is 40%, a 1% increase in efficiency will reduce the PUE by about 0.01. It doesn't sound like a lot, but in fact, this means that the data center can save about 500,000 kilowatt-hours of electricity each year. As a result, increasing UPS energy efficiency reduces costs and promotes emission reduction.

Over the past decades, we have seen leaps in UPS efficiency. Originally UPSs used transformers that ate up a lot of energy. After abandoning transformers, they opted for a rack-mounted and then modular design. Today's UPSs are entirely modular and can reach 97% efficiency when they work online. Further breakthroughs in energy efficiency have been limited, due to issues like topology, components, and



techniques.

It is true that UPSs can also work in the Economic Control Operation (ECO) mode, which delivers an efficiency of up to 99%. However, data centers rarely opt for this mode because it comes with several disadvantages. In the ECO mode, it takes the UPS up to 10 ms to transfer from bypass to inverter mode, which causes load power interruptions. In addition, the UPS cannot compensate for load harmonics, which leads to lower reliability.

To address these challenges, we have introduced the Super ECO (S-ECO) mode. Essentially, the S-ECO mode adds intelligence to UPS operations, helping data centers save energy while ensuring high reliability.

How Does S-ECO Mode Save Energy and Ensure Reliability?

The S-ECO mode uses innovative technologies to optimize the power supply architecture and logic of UPS operations. It addresses the previously unsolved issues related to low system efficiency in online double-conversion mode. It also resolves the problems seen in the ECO mode concerning output interruption, large harmonics, and input surge voltage interference.

The S-ECO mode offers several important benefits. It assures that the UPS can switch between modes in 0 ms. It also delivers high efficiency in the full load range. Plus, it offers high-voltage surge suppression and active harmonic compensation. Let's look at these advantages in more detail.

No interruptions when switching modes

The S-ECO mode prevents interruptions during switching, which occur in the ECO mode. It assures that transfers between modes take 0 ms, ensuring reliable power supply. When the UPS works in the S-ECO mode, it automatically detects the power quality of the bypass input. When the bypass input is normal, the bypass supplies power. But if it's abnormal, the UPS transfers to inverter mode in 0 ms, which meets the dynamic response level of class 1 defined in IEC 62040-3. Once the bypass recovers, UPS automatically transfers back to bypass mode.

Breaking the limit of energy efficiency

The S-ECO mode also goes beyond the efficiency limit we have seen in the previous iterations of UPSs. It makes UPSs more efficient when they are online and reduces the PUE in the full load range. When the bypass supplies power, the UPS consumes very little energy. At its peak, the system efficiency is above 99.1% and still reaches over 98.5% when the load rate is above 20%.

Huawei uses its proprietary zero-current hot backup technology alongside intelligent hibernation to achieve high efficiency in the full load range. The core principle is that the inverter in each power module is connected to a thyristor in series. The thyristors connect the forward voltage and cut off the reverse voltage. When the bypass voltage is normal, the thyristors of all power modules are cut off, using zero current and consuming no power. When the bypass voltage is abnormal, the thyristors implement the high and low voltage clamping function.

No more input surge voltage interference

The S-ECO mode prevents input surge voltage interference and suppresses high-voltage surges. Huawei S-ECO mode uses hardware-based high and low voltage clamping technology. When the bypass input experiences a transient voltage sag or high voltage surge, power modules use inverters — some implement low-voltage clamping by supplying 210 V, while others implement high-voltage clamping by supplying 230 V. This is possible thanks to the modular architecture of S-ECO and the clamping amplitude is ±10 V. Hardwarebased clamping ensures that transfers take less than 0 ms, so there is no need to wait for software detection or signal transmission delay, thus improving system reliability.

Active harmonic compensation

Finally, active harmonic compensation in the S-ECO mode ensures the same input Power Factor (PF) as in double conversion mode. In the S-ECO mode, the system automatically detects the actual harmonics. If they exceed the preset value, the inverter automatically starts to compensate for the harmonic component in the load, ensuring that the system input harmonics are small and the PF is high. For example, if we have a 100% non-resistive load, the input PF is only 0.7–0.8 in conventional ECO mode, but reaches 0.99 after compensation. Plus, you don't need to deploy an APF or SVG compensation device as you would in the ECO mode.

Ultimately, the S-ECO mode solves several problems we see in the ECO mode and delivers additional benefits. It delivers the efficiency of ECO mode as well as the reliability of online mode, making this technology a crucial milestone in the pursuit of energy efficiency in UPS technologies.

How Does the S-ECO Mode Perform in Practice?

Huawei has already verified the S-ECO mode and deployed it in several projects. We've tested input and output adaptability, efficiency, and other factors using our flagship UPS5000-H. The tests have confirmed that the S-ECO mode is highly reliable. TÜV Rheinland and China Telecommunication Technologies Labs have also performed strict tests on the product, confirming the result.

The typical load rate of a data center is 20%–80%. The tests have shown that the UPS5000-H can achieve an efficiency of over 98.5% when it carries 20%–100% loads and up to 99.1% at its peak efficiency. Compared with other energy-saving modes in the industry, the S-ECO mode is highly efficient within the full load range. When the bypass input is abnormal, the UPS switches to online dual-conversion mode and delivers an efficiency of up to 97%, which can still exceed 95.5% if the load is higher than 10%. The bottom line is that the UPS5000-H saves a lot of energy. It is suitable for mediumand large-capacity data centers and mission-critical power supply in various industries.

The S-ECO mode meets regulatory requirements, helps fulfill commitments

to green and low-carbon development, and delivers other benefits. At half-load, it delivers 2% higher efficiency than online double-conversion, a number that goes up to 3% at full-load. If we take the former as an example and the electricity fee is CNY0.8/kWh (US\$0.12/ kWh), the S-ECO mode could help a 10 MW data center save CNY7.784 million (US\$1.16 million) in 10 years.

Huawei has already deployed S-ECO technology at the Huawei Cloud Ulanqab Data Center and other colocation facilities. The result is 3%–4% higher system efficiency and high reliability. We hope that the S-ECO mode can continue to help us on our way toward carbon neutrality. ▲



Huawei UPS5000-H



Simpler Networks Cut Site Carbon Emissions

The proposal of the "double carbon" goal puts forward specific targets and guidelines for all walks of life to achieve green and sustainable development. As a basic component of the 5G era, 5G site power solutions reflects the general trend of green development in the ICT sector. To achieve energy saving and emission reduction, we need to be good at simplifying. Huawei is leading the "minimalist style" in the low-carbon network construction.

s the world pursues zero carbon policies, major carbon emitters like the ICT sector find themselves under a great deal of pressure. By 2035, the ICT sector is forecast to consume 5% of the total energy yield; and telecom sites will account for more than 60% of the sector's carbon emissions. As such, it is urgent for the sector to adopt renewables, improve energy efficiency, and actively pursue carbon neutrality.

5G is a gateway to a wealth of new services, but these produce an increasing amount of data that requires more and more wireless base stations for processing. A single 5G site consumes 2 to 6 times more energy than a 4G site. On top of this, 5G sites offer low coverage, requiring auxiliary facilities that generate more heat, further increasing power consumption.

The conventional way to expand site

capacity is to deploy new shelters or cabinets. However, the site energy efficiency (SEE) of shelters and cabinets is only 55% to 75% and 80% to 85%, respectively. Shelters take up a lot of space and require in-room cooling, which eats up even more energy. Plus, building shelters, rebuilding mains power, upgrading cooling systems, and hoisting devices using cranes produces a lot of greenhouse gases.

Four Ways to Increase Energy Efficiency at Telecom Sites

Huawei has designed a series of solutions and includes them in its low-carbon target network for site power. These solutions use a range of technologies — power electronics, ICTs, and AI — to address challenges at existing site power facilities, like complex construction, low energy efficiency,



poor manageability, and inefficient energy scheduling. The target network optimizes energy efficiency and slashes carbon emissions in four key ways:

1.Simplifying site construction

2.Improving operational efficiency at sites

3.Increasing the consumption of green electricity

4.Deploying intelligent site management

Simplifying Site Construction

Huawei offers upgraded site power solutions to help carriers build simplified, low-carbon telecom equipment rooms or reconstruct existing ones. This helps minimize carbon emissions across site construction, power supply, and O&M. In this way, 5G can be overlaid without adding energy OPEX.

Huawei has used innovative technologies to enable several advantages in our low-carbon site power target network solutions.

1.Simplified architecture: Sites fit in cabinets instead of rooms or poles instead of cabinets. Also, our sites use modular components for simplified deployment.

2.Simplified application: Sensing and AI technologies enable proactive site management and fault prevention, helping optimize SEE and reducing carbon emissions.

3.Low carbon: We curb carbon emissions across the lifecycle of 5G sites from power generation, conversion, storage, distribution, and consumption using green power, high-efficiency modules, lithium batteries, and intelligent power distribution.

Reshaping Telecom Sites

To make telecom sites greener, we need to reshape their construction and architecture. Low-carbon networks feature a simplified architecture with fewer redundant links between the network and basic power supply architectures. For example, the C-RAN architecture of the 5G network can be used together with an integrated power supply system. Site deployment must also be simplified. This involves migrating indoor sites to outdoor cabinets or even pole-mounted sites, reducing site footprint, material consumption, and cooling energy consumption.

A number of sites have deployed Huawei's low-carbon target network solutions, which have proven effective in reducing both carbon emissions and network construction and operation costs. Huawei solutions have clear advantages during site construction. Let's take a look at how Huawei solutions reduce the carbon footprint of 5G sites in practice.

Disadvantages of existing site expansion solutions

Telecom sites consume twice as much power once 5G is deployed. At the same time, they face insufficient mains power supply, battery capacity, cooling, and AAU voltage. Expanding site capacity would normally require building new equipment rooms or shelters and adding cabinets. This is expensive, especially in terms of energy OPEX. Plus, it's impossible to precisely manage load power consumption, making it hard to identify inefficient devices.

Advantages of the Huawei simplified cabinet solution

Huawei's simplified cabinet solution can accommodate 2G/3G/4G/5G devices and supports shared site deployment in just one cabinet, which is equivalent to multiple conventional cabinets. Simplified deployment and intelligent power consumption reduce end-toend costs. Huawei has also launched a unique high-power blade power solution that uses natural cooling. You can install it in just one hour and the solution features zero footprint, zero rent, zero maintenance, and low energy losses. Overall, the solution's TCO is 30% lower than cabinet solutions.

Success story

The iSuperSite demo site jointly built by Huawei, China Mobile Zhejiang, and the China Mobile Design Institute in Hangzhou passed the acceptance test in September 2022. It was listed as an energy-saving demo site since the carrier proposed its carbon neutrality plan. Before the reconstruction, the site was composed of six cabinets with six cooling systems. Each system was powered by an independent power supply. The equipment took up a lot of space, had a low SEE, and consumed a lot of power.

Huawei's iSuperSite solution replaced the separate power, equipment, radio frequency unit, and lead-acid battery cabinets with just one cabinet. This reduced the site's footprint from 5 square meters to 1, improving the SEE from 89% to 96%. Plus, Huawei's iPV generates 20% more power, reducing carbon emissions by 8 tons per site each year.

Solution highlights: Huawei's iSuperSite solution helps carriers upgrade and reconstruct existing sites, readying them for 5G while saving power, space, and costs.

Besides outdoor application, Huawei's cabinet solution also supports capacity expansion in central office (CO) sites.

Disadvantages of existing CO power solutions

The cooling capability is insufficient and hot spots exist, which cannot meet the heat dissipation requirements of new devices. Conventional in-room air conditioners are troubled by low cooling efficiency and high energy consumption. The SEE of conventional COs is usually



below 50%. The efficiency of legacy power systems and batteries is also low. Energy consumption is invisible, preventing optimization. Plus, there is limited equipment room space and few power supply and backup capabilities. Finally, reconstruction is time-consuming and costly.

Advantages of the Huawei CO power solution

Huawei's CO power solution combines the eMIMO power system, CloudLi, and modular cooling system in one cabinet that outperforms multiple conventional cabinets. The solution simplifies green 5G and fixed network deployment. The air conditioner in the cabinet precisely cools the devices, preventing hot spots and eliminating the need to increase cooling capacity. Enclosed cooling significantly improves the cooling efficiency. Plus, there is no need to build a new equipment room during capacity expansion.

Accelerating Green Transformation in Other Industries with ICTs

Huawei's low-carbon target network solutions for site power have been deployed in more than 100 countries and regions around the world, helping customers build green and low-carbon networks. By September 2022, the solutions had saved over 9.26 billion kWh of electricity, reducing carbon emissions by nearly 4.4 million tons, which is equivalent to planting about 6 million trees.

Huawei plans to introduce more green design concepts and advanced technologies to further reduce site energy consumption and enable green ICT development.



High-Voltage Fast Charging, the Next Trend

A revolution triggered by high-voltage fast charging technology may change the future of the new energy vehicle market. Just like mountaineers climbing Mount Everest need to conquer new heights one after another, after realizing the leap from 400V to 800V high-voltage fast charging, Huawei is pioneering the 1000V charging, with its upcoming second-generation high-voltage power domain solution.

rivers are almost ready to switch to electric vehicles (EVs), but range anxiety often prevents the shift to greener mobility. In response, EV makers are looking at super-fast, highvoltage charging, which promises 200 km mileage after only a 5-minute charge. If successful, the fast charging technology will be a game-changer for the EV market.

How fast is fast charging?

According to the Global EV Outlook 2022 released by the International Energy

Agency (IEA), electric car sales continue to break records due to policy support, consumer demand, and the availability of new EV models. The report predicts that by 2025, global EV sales will grow to 20.6 million, 23% of the total market share. In China, the penetration rate of EV models is expected to reach 100% by 2035.

Fast charging is essential for EVs, but today, it is still one of the bottlenecks preventing consumers from switching over from fuel-powered cars. Even if EV sales are on the rise, much more needs to be done in charging infrastructure, cruising range, and car safety.

There are different ways to charge an EV, including slow, fast, wireless, or mobile charging as well as battery swapping. The most common options are slow or fast charging. The latter has obvious advantages. Apart from a faster charging experience, it also allows automakers to reduce the vehicle size by integrating the electric powertrain and power system. What's more, the infrastructure of fast charging is easier to standardize. As such, it is likely that fast charging will become the standard for most EVs.

By connecting to an external charger with a high current, the vehicle battery can be quickly charged to about 80% and fully charged in about one hour. However, an hour is still too long compared to fuel vehicles. So, EV companies are looking for super-fast or high-voltage charging solutions.

In 2019, Porsche became the first company to use high-voltage fast charging technology, launching and mass producing Taycan — its 800 V charging model. Since then, other major new energy vehicle manufacturers have begun to invest in super-fast charging, producing new vehicle models.

Is 800 V high-voltage enough?

An EV is powered by its motor control unit (MCU) and battery, and its input and output voltage are usually between 200 V and 500 V. To speed up charging, we need to increase charging power or the charging voltage or current. High-voltage charging was adopted first because the infrastructure for high-current charging is not yet available on a large scale.

Company X is a high-current DC fast charging solution provider. The maximum output current of its V3 charger is close to 520 A, and the maximum charging power is 250 kW. However, high-current charging is not ideal, because the only time the company's products reach their maximum charging power is when the state of charge (SOC) is 10% to 30%. When the SOC is 30% to 90%, the maximum output current is only 330 A with a power of 150 kW for its V2 model. In addition, high-current charging does not support 4C charging and generates too much heat, which requires an additional cooling system.

Since Taycan's launch, many carmakers have begun to invest in the R&D of this new charging technology. An 800 V architecture has several advantages besides fast charging.

It produces less heat. The permanent magnet synchronous motor generates a lot of heat. When its temperature exceeds 180°C, demagnetization occurs. But with higher voltage, the current decreases, and when the resistance remains unchanged, the heat is also reduced. It features smaller cables. Higher voltage requires cables with a smaller diameter. It delivers better power components. Using 800 V charging, the MCU must adopt the SiC component. Thereby, the heat loss can be slashed by 60%.

To sum up, a high-voltage power system can solve such problems as excessive charging current, high charging facility costs, difficult battery heat dissipation, and low safety. As a result, we are seeing a high pace of development in highvoltage technologies.

High-Voltage Charging Is Ready for Mass Production

Using wide-bandgap semiconductors such as SiC has enabled the deployment of high-voltage powertrains. The breakdown electric field strength of SiC is nearly 10 times that of the Si-based semiconductors, which permits devices to operate at much higher voltages. SiC components that can withstand a 1200 V voltage have already gone into mass production, enabling the evolution of EV power systems.

Other auxiliary technologies include highvoltage conductive bearing anti-corrosion and high-voltage insulation. Plus, mass producing high-voltage OBC, BMS, and powertrain is not an issue from the perspective of car architecture. In fact, high-voltage fast charging technologies are now ready for commercial use.

Currently, mainstream EV models support 400 V to 500 V charging voltage, with a

charging current below 250 A. Charging takes about 1 hour, which is still too long. A few leading models have adopted 800 V high-voltage charging with a charging current of 250 A. As a result, it takes only 15 minutes to charge the vehicle during 30%–80% SOC.

If we keep raising the charging voltage from 800 V to 1000 V, the charging current will increase from 250 A to 600 A and the charging rate will rise from 2C to 6C. In this way, charging between 30% to 80% SOC will be done in just five minutes.

Huawei is among the pioneering companies to study 1000 V charging. In 2021, we launched DriveONE — a firstgeneration high-voltage power domain solution. The full series of products supports 800 V high-voltage. It is also the first mass-produced high-voltage power domain solution in China.

Compared with 400 V solutions, DriveONE speeds up charging from 50 minutes to less than 30 minutes using the same charging current. The latest vehicle model equipped with Huawei's power domain boasts a 200 km cruising range after just 10 minutes of charging (with an 800 V high-voltage power domain and 200 kW charger).

More than 10 mainstream carmakers have used Huawei DriveONE on both mid-range and high-end vehicle models. DriveONE's high-speed intelligent oil cooling enables the vehicle to accelerate from 0 to 100 km/h in just 4.8 seconds. The solution also features an AI optimization algorithm and bearing anti-corrosion technology, delivering a quiet driving experience throughout the vehicle's lifecycle. Asynchronous front motors and synchronous rear motors are coupled with efficient system design, extending the range of vehicles to over 600 km.

To sum up, DriveONE delivers ultra-fast charging, a quiet driving experience, and extended battery life. Huawei is currently working on the second-generation 1000 V ultra-high-voltage power domain solution.

Collaboration Will Be Key for Successful Evolution

We are seeing that high-voltage fast charging can resolve problems such as slow charging, high battery costs, and range anxiety. This will help increase the penetration rate of EVs. Huawei DriveONE will continue to invest in developing high-voltage power domain solutions, helping carmakers build valueadded competitiveness.

The industry's upstream and downstream stakeholders need to collaborate if we are to deploy high-voltage fast charging on a large scale. As such, related standards are urgently needed, which will promote the mass production of high-voltage fast charging vehicle models. In this process, Huawei will work with partners and build an ecosystem to bolster sustainable industry growth.

As the world continues to pursue carbon neutrality, e-mobility and new energy vehicles are gaining momentum. To support this trend, technology and innovation will be needed to power the evolution of charging solutions.





Building a Fully Connected, Intelligent World

Huawei Blade Power

Simplified architecture

2-12kW Poles replacing cabinets One site one blade

Low-carbon operation

97% SEE Solar access

Intelligent features

Intelligent peak staggering Peak shaving Consumption metering Energy slicing Voltage boosting





Huawei DriveONE eMobility Solution









Building a Better, Greener Future