White Paper on Top 10 Site Power Trends

HUAWEI

Huawei Digital Power Technologies Co., Ltd.

Address:Huawei Digital Power Antuoshan Headquarters, Futian District, Shenzhen 518043

Website:https://digitalpower.huawei.com

Email:support@huawei.com

Tel:4008302118

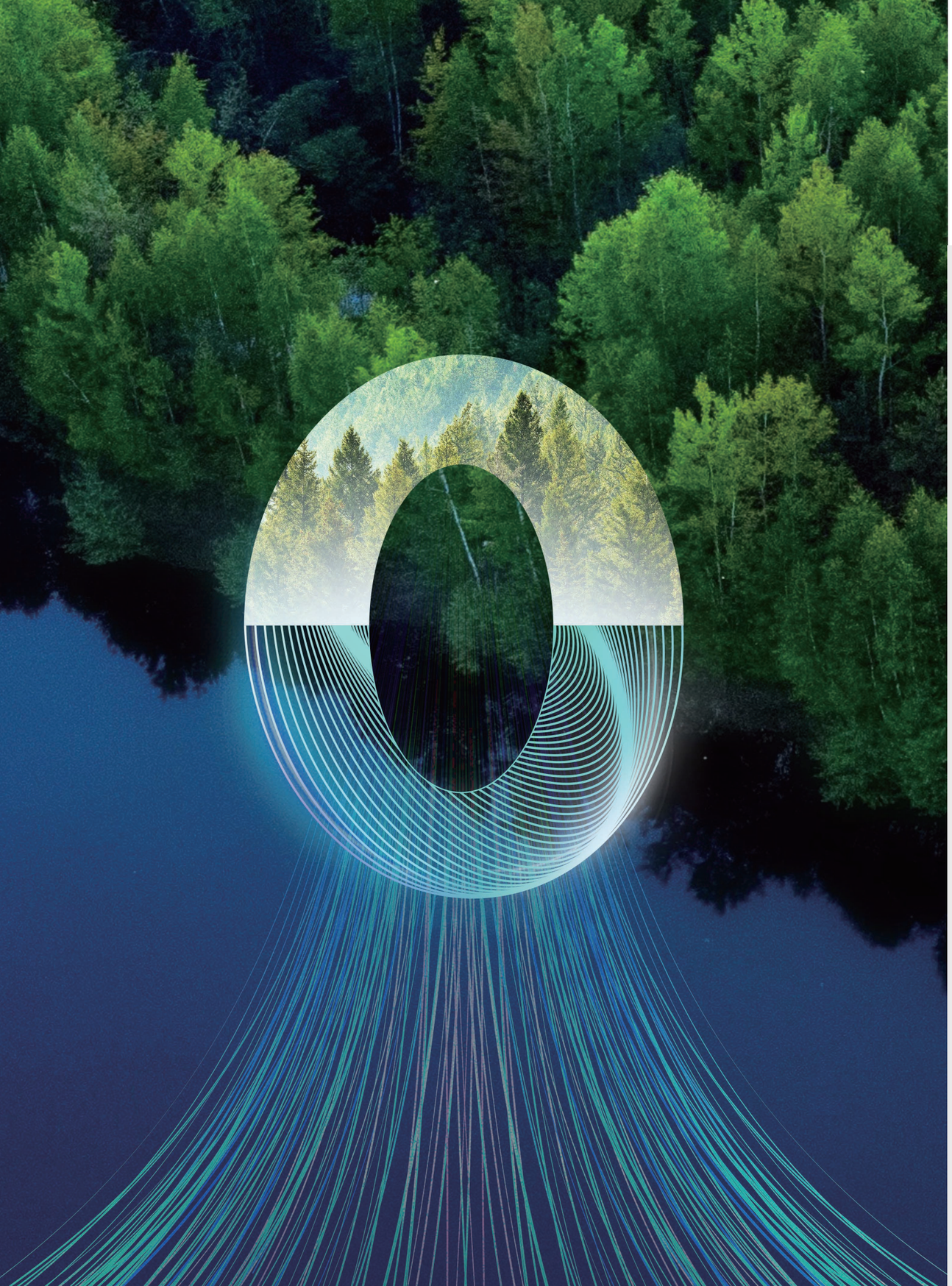
HUAWEI

Eternal pursuit of harmony between man and nature

As extreme weather events and climate change become more severe, the world has agreed that carbon neutrality is crucial for our planet. Lower carbon emission and digitalization are two major trends against this background. Lower carbon emission: Energy transition is on fast-forward and electrification has become a normal for end users. Meanwhile, digital technologies are ushering in a digital era. Convergence of IT and CT, 5G, AI, and big data are fully applied in various sectors, especially in the energy sector. ICT has become the technological foundation for digitalization in different industries.

ICT helps other sectors reduce carbon emissions, which plays a crucial role in realizing net zero carbon emissions. However, the massive number of ICT infrastructure itself is a major energy consumer and carbon emitter. It is estimated that ICT energy consumption will still account for more than 5% of the total by 2035, though energy-saving measures are taken. Communication base stations are responsible for more than 60% of the consumption in the sector. To lower carbon emission, the ICT sector need to simplify site construction, adopt green power supply, raise site energy efficiency, and perform intelligent management. To this end, a green, low-carbon, and smart energy network should be built.

This White Paper is formulated to inform you of the new technologies and future trends in terms of carbon reduction in telecom base stations.



CONTENTS

Trend 1
Energy digitalization

01

Energy digitalization conforms to the trend of energy transition

Energy technologies and digital technologies are rapidly integrated to realize energy transition and electrification. In terms of power generation, various clean energy sources such as photovoltaic and hydrogen are replacing fossil energy. Intelligent power grids are replacing traditional ones to realize digital power transmission.

On the consumer side: low-carbon networks are replacing energy-intensive networks.

In the transportation field: electric vehicles are replacing fuel vehicles to achieve electrification.

Generation: clean energy Consumption: electrification


Fossil energy


Fossil fuel vehicle


High ICT power consumption


Clean energy


Electric vehicle


Low-carbon network

The energy industry is undergoing a dramatic end-to-end digital transformation.

ICT is the technological foundation
Green ICT and ICT for Green are evolving trends

ICT is the technological cornerstone of the information society and the technological foundation for clean power generation and consumption electrification. Green ICT and ICT for Green are the main methods to become carbon neutral. Green ICT means the ICT sector must adopt low-carbon routes. ICT for Green means to help various industries lower carbon emissions using ICT.

Green ICT: It is estimated that by 2035, the global base station power consumption will account for 3% of the total, and the carbon emission of 5G base stations will increase by staggering 321%. Building low-carbon networks and realizing green ICT is a must.

ICT for Green: The development of digitalization brings diversified new services, causing site quantity surge. The convergence of ICT and industry services will accelerate. Communications sites will evolve towards shared sites.

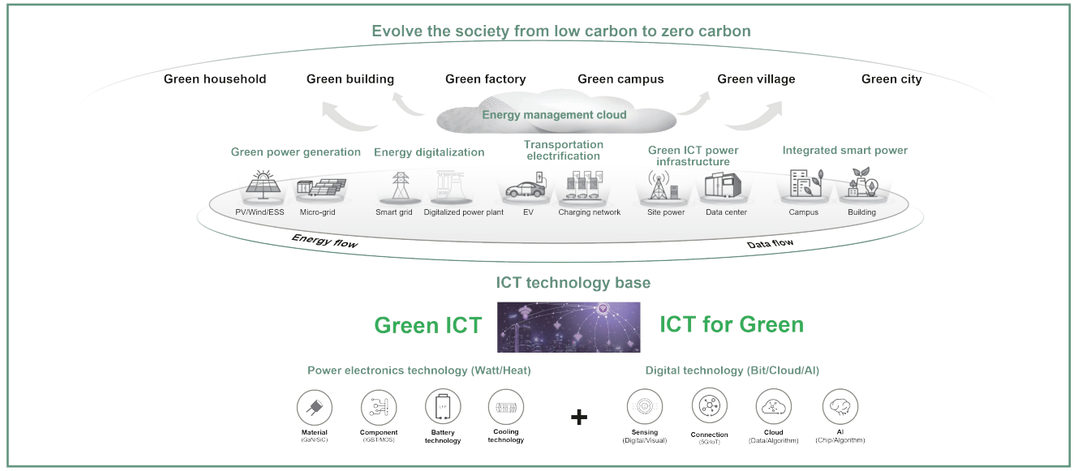


Figure: Building a low-carbon society based on the integration of energy and digital technologies and ICT technologies

Convergence of digital and energy technologies

The integration of digital technologies such as 5G, AI, and big data with energy technologies enables the integration of watt flow and bit flow, and helps bits manage watts. It is the cornerstone of building a low-carbon society and realizing energy digitalization.

Trend 2

Low-carbon network

Carbon reduction policies+energy crisis drive energy conservation in the telecom industry

Different countries have released various policies to help achieve carbon neutrality. For example, Europe's Green Deal and China's 3060 targets. At the same time, carriers are also actively exploring carbon reduction measures. In 2021 and before, carriers often passively respond to government policies. Since 2022, energy security issues and global electricity price rise lead to a sharp increase in OPEX. Carriers choose to take more active actions on energy saving and carbon reduction.

In addition, before 2022, there are no standards and indicators to measure whether a network is green and low-carbon. In October 2022, ITU-T released the first site carbon emission standard NCIe (network carbon emission intensity). Site carbon emission has a quantifiable measurement standard, which will also promote carbon reduction development.

Carriers plan to build networks with low carbon emission through lifecycle

The traditional network construction mode is complex.

For example, the equipment cost accounts for only 30% of the site construction expense, and 70% of the cost is hidden.

In terms of power supply, the mains and DG are used, which has low energy efficiency and high carbon emission.

As for O&M, manual O&M is costly, and the site status cannot be viewed and managed.

Therefore, carriers begin to lower carbon emissions in construction, power supply, and operation, and build low carbon networks throughout the lifecycle to meet the increasingly severe carbon emission requirements.

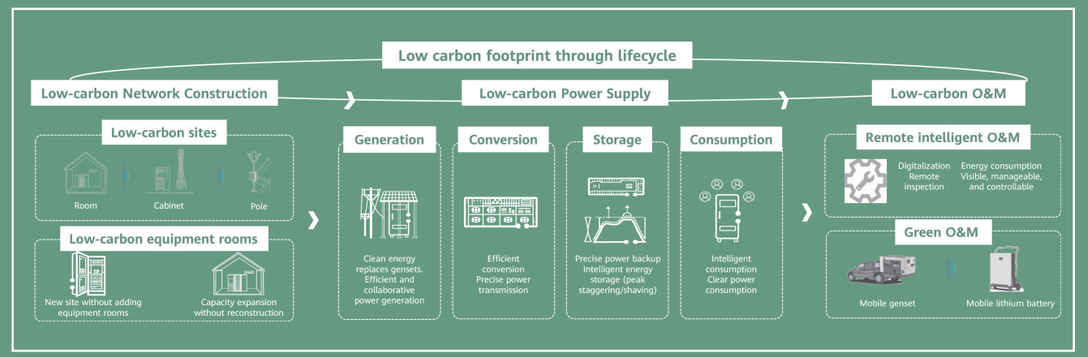


Figure: Building a low-carbon network throughout the lifecycle

Low-carbon construction: Simplified site construction reduces construction complexity and overall CAPEX. Clean energy is used to achieve green power supply. In addition, energy efficiency improvement is considered in all links from generation, conversion, storage, and consumption.

Low-carbon operation: Adopt a management system features visualized and optimizable energy efficiency and carbon emission to build intelligent sites.

Huawei's Low-Carbon Site Power Target Network enables green and low-carbon sites

Huawei continuously explores low-carbon network construction. Based on years of expertise, Huawei proposed a low-carbon target network for site power in 2022, promoting low-carbon development of sites. Huawei's low-carbon target network advocate all-scenario and lifecycle low carbon emission. All-scenario indicates the link from access equipment rooms to aggregation equipment rooms, and then to core equipment rooms. Lifecycle specifies the period from site construction, power supply, to operation.

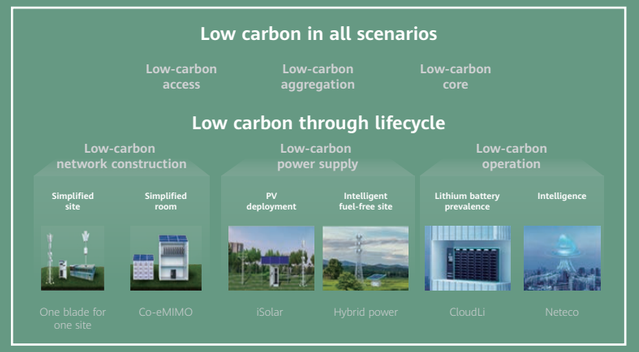


Figure: Huawei's Low-Carbon Power Target Network

Trend 3

Green power utilization

03

As carbon neutrality becomes a consensus, site power supply is rapidly shifting to green power.

Diversified power sources curb carbon emissions and protect energy security

In 2021 and before, 99% of the sites rely on mains and diesel generators. Though some explorations are made in green power, the utilization of green power accounts for only about 1%. In addition, PPA mode leads to high power costs.

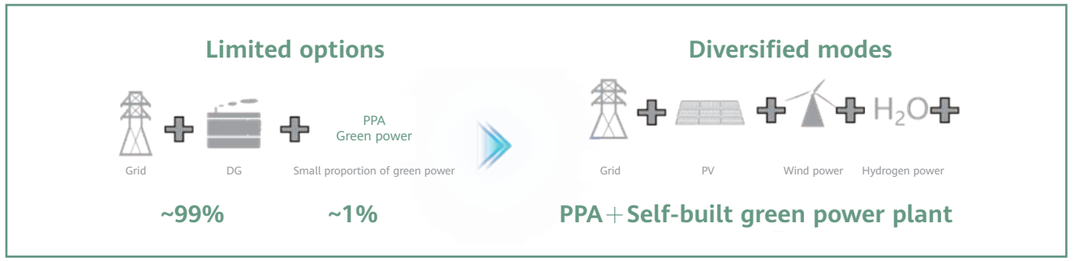


Figure: Diversified site power supply modes

In 2022, as the cost of clean energy is further reduced, the power supply of sites is diversified. More and more PV power is applied to sites. In some remote areas where it is difficult to introduce mains power, wind energy, PV, and hydrogen energy are applied.

In terms of green power purchase mode, carriers are gradually shifting from PPA to self-built green power plants in some regions, which brings about a 65% cost reduction.

As technologies advance and business models change, clean energy, such as PV, wind, and hydrogen, will become the mainstream in site power supply. Helping site power supply go green will be an important trend in site construction in the future.

Maximize green power consumption from different aspects at carriers' sites

Huawei maximizes green power consumption in terms of application scenarios and power supply modes.

In terms of scenarios

Huawei focused on fuel-free sites in scenarios without mains supply before 2021, and used PV and energy storage to ensure that sites are fuel-free and carbon emissions are reduced. For example, in Greece, Huawei helped the customer deploy a PV system to remove diesel generators, saving 51.2% of electricity. Since 2022, as the cost of green power decreases, Huawei focuses on green power supply in scenarios with stable mains supply, replace existing power supply with clean energy, and promote carbon reduction at sites. In areas where the mains supply is unstable, we are also working to enable sites to run without mains supply for 24 hours and increase power supply availability.

In terms of power supply

Huawei paid more attention to the use of solar energy and other clean energy such as wind and hydrogen. In Germany, Huawei worked with customers to explore the use of wind and hydrogen energy to diversify power sources.

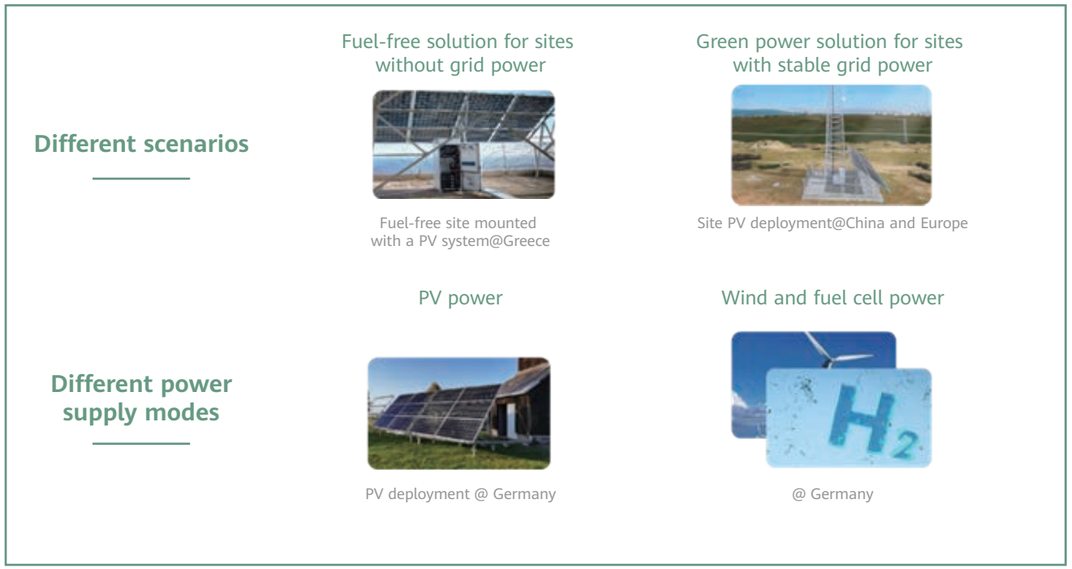


Figure: Huawei maximizes green power consumption from different aspects

Trend 4

Site simplification

04

OPEX pressure and carbon peak and carbon neutrality policies drive carriers to simplify sites, reducing costs and energy consumption.

In the past, indoor sites or cabinet sites are used, resulting in low SEE (60% for equipment rooms, 80% for cabinets, and 97% for pole sites) and high cost. As networks are overlaid, 2G, 3G, 4G, and 5G networks share the same site. In the 5G era, site quantity surge leads to a sharp increase in construction costs. However, the increase of carriers' networks has not brought revenue growth, and the operating pressure has further increased.

In 2022, the existing construction mode is not applicable due to the OPEX pressure and carbon peak and carbon neutrality policies. Carriers need to find ways to reduce construction costs. Simplified sites can reduce costs and carbon emissions and lower costs, which is an important trend in future site construction.

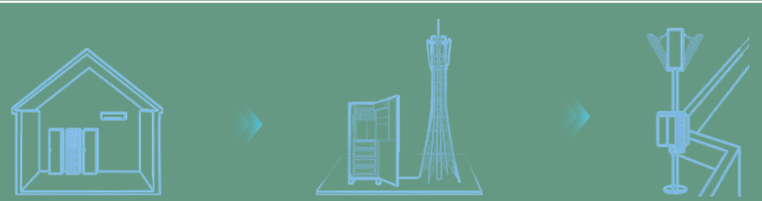


Figure: Evolving to simplified structure

Rooms to cabinets: Cabinets are used to replace traditional rooms. The construction workload is greatly reduced. The area occupied by cabinets is reduced from more than 10 square meters to 1–2 square meters, reducing the CAPEX and OPEX of site construction and shortening the TTM.

Cabinets to poles: The traditional cabinets are replaced by poles, realizing zero footprint and simplifying site deployment. In addition, the modular and integrated design enhances device universality and operability, and greatly reduces site deployment complexity.

Simplified solutions help carriers reduce network construction costs

Huawei provides all-scenario solutions from simplified sites to simplified equipment rooms, helping carriers reduce network construction costs.

Figure: Huawei's simplified equipment room and simplified site solutions

In terms of simplified sites, Huawei proposes one cabinet for one site to replace multiple cabinets with just one cabinet and put forward one blade for one site to mount sites on poles. In 2022, Huawei launched a 12 kW blade power supply system to satisfy the needs of all frequency bands. As for equipment rooms, Huawei provided the outdoor iSuperSite solution to provide the same power supply capacity as the equipment room with just one cabinet. In Mexico, the construction period was shortened from 6 months to 10 days, and the investment was reduced from US$100,000 to US$20,000. This helped customers simplify network construction and reduce carbon emissions.

Trend 5
High efficiency

05

Improve SEE and minimize OPEX from different aspects

Due to the OPEX pressure and carbon peak and carbon neutrality policies, carriers need to further improve site energy efficiency.

In the past, efficiency improvement focused more on components. In 2022, Huawei placed more efforts on efficiency optimization of the whole site.

Site structure: In the past, cabinets are used to replace equipment rooms. In 2022, the number of edge deployments increases, and blade power supply capabilities are aligned with cabinets. In addition, pole sites all adopt natural cooling, eliminating the needs of air conditioners. The site energy efficiency can be greatly improved from 80% to 97%.

Power supply efficiency: In the past, only conversion efficiency of PSUs was improved. In 2022, with the deployment of intelligent power supply and the gradual commercial use of wide-bandgap semiconductors, site power supply evolves towards efficient power generation, conversion, storage, and distribution.

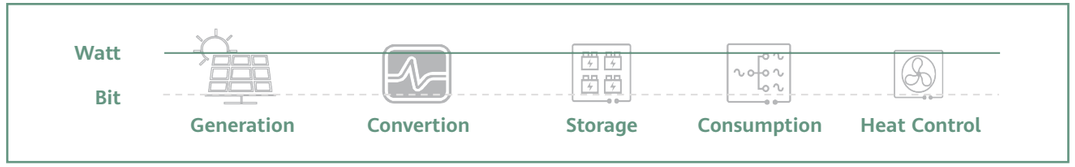
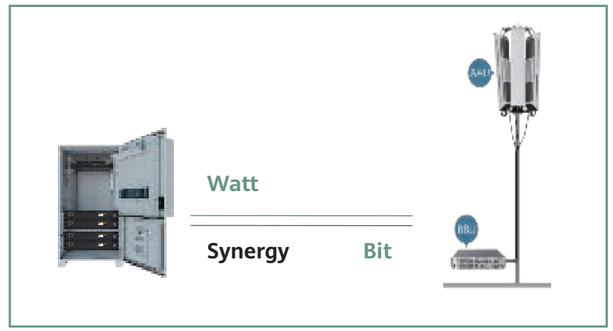


Figure: All-link high efficiency

Collaboration: Previously, network devices and power supply devices were managed independently, and power supply and network linkage were not implemented. In 2022, with the convergence of information technologies and energy technologies, bits manage watts and collaboration between energy devices and wireless devices is realized. This has become an important trend of site power facility.



Collaboration between energy devices and wireless devices

Huawei works with carriers to raise SEE

Huawei works with carriers to improve site energy efficiency by changing site structure, innovating power supply, and implementing collaboration. Simplified equipment room, cabinet, and blade power solutions are widely deployed to enable simplified site construction. Researches about wide-bandgap semiconductors are conducted and new components such as GaN are used in site power products. Besides, we worked with the wireless product line to implement linkage between the information flow of network devices and the energy flow of power supply devices.

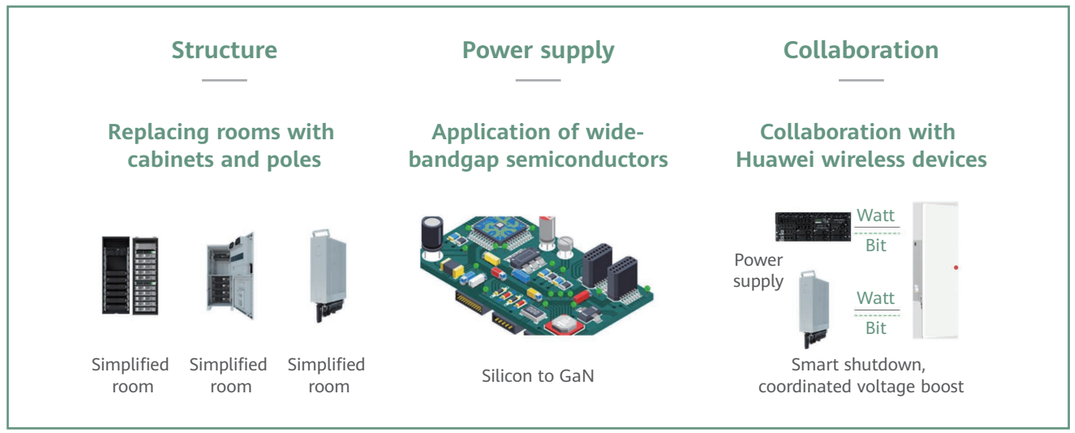


Figure: Huawei explores site energy efficiency improvement in various aspects

Trend 6

Smart site

From basic O&M to in-depth management

Driven by digitalization and carbon neutrality, site intelligence quickly shifts from basic dynamic and environment O&M to site energy efficiency and carbon emission management.

Before 2021, site O&M is only basic power and environment monitoring. Site status is not displayed and a large number of manual site visits is required. Site intelligence focuses on reducing O&M difficulties.

Figure: From intelligent O&M to intelligent energy efficiency and carbon emission management

In 2022, site energy efficiency and carbon emission become key indicators for measuring site capabilities.

Figure: Three-layer structure of smart sites

Intelligent O&M management: Digital data collection technologies, sensor technologies, and communication technologies are used to visualize site information and ensure that site indicators are manageable and controllable.

Intelligent energy efficiency management: Big data analysis technologies, multi-energy technology management, and energy control technologies are used to manage and optimize network energy efficiency to maximize site energy efficiency and achieve zero waste of watts.

Intelligent carbon emission management: AI technologies are used to perform carbon emission analysis and prediction. In this way, carbon emission of the whole site is visible, manageable and optimizable.

To summarize, site intelligence will become the main driver of the low-carbon networks.

Huawei explores site intelligence and upgrades site management frombasic power and environment monitoring to intelligence of the whole sites

Huawei's site intelligence solution performs end-to-end intelligence from bottom-layer digital devices, lithium batteries, power supplies, to the network management system.

Huawei uses advanced sensing, communications, and AI technologies to implement interaction between energy and information flows and has robust energy management capabilities. For example, the software-defined capability allows users to configure and define power supply on demand. The energy slicing capability enables on-demand energy storage. Customers can intelligently manage backup power based on load importance, achieving zero waste of energy storage.

Huawei's smart site provides customers with site energy efficiency improvement and carbon emission reduction.

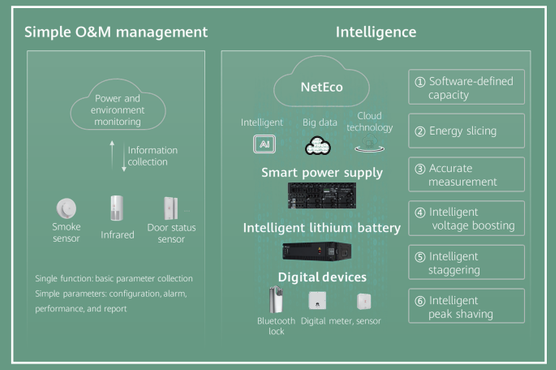


Figure: Huawei explores intelligence and upgrades from simple O&M to fully intelligent digital sites

Trend 7

Telecom site to shared site

07

Telecom sites power other sectors and unleash potential values

While ICT is going green, it is also helping other industries to save energy and reduce carbon emissions. In this process, telecom sites will become shared sites for the public.

Before 2021, telecom sites mainly serve carriers' communication devices, with a single scenario and a single customer. The investment in communication sites is large, and services are single. As a result, a large number of site resources are wasted. In 2022, with the convergence of ICT and the emergence of new services such as VPP, the demand for site convergence is rising. Telecom sites are transforming to shared sites, and carriers are becoming integrated power service providers.

Figure: From telecom carriers to integrated power service providers

New requirements such as site sharing and energy management will emerge. Telecom sites can provide site sharing services. Users of sites will expand from telecom sector to other sectors, such as oil and gas. In terms of business models, multiple modes such as VPP, electricity access with the network, and offset rent with electricity have emerged. Telecom sites can power not only base stations, but also supply public users.

Transforming from telecom sites to shared sites will maximize the site values.

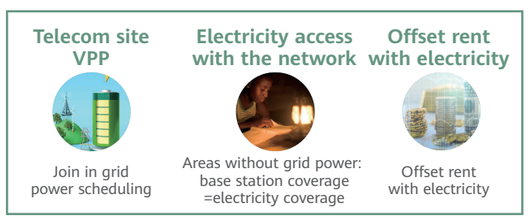


Figure: Various application scenarios of telecom sites

Continuously explore telecom sites services for other sectors with partners

Huawei works with partners to continuously explore telecom sites services for other sectors. In Shenzhen, China, Huawei and partners jointly explore VPP services for communication sites, aiming to connect energy storage systems of 5G and the power grid.

In the Middle East Huawei and partners jointly explore the power-for-rent service.

In Africa Huawei explores the power access with network service. In areas without access to mains power, base stations can serve as a power plant.

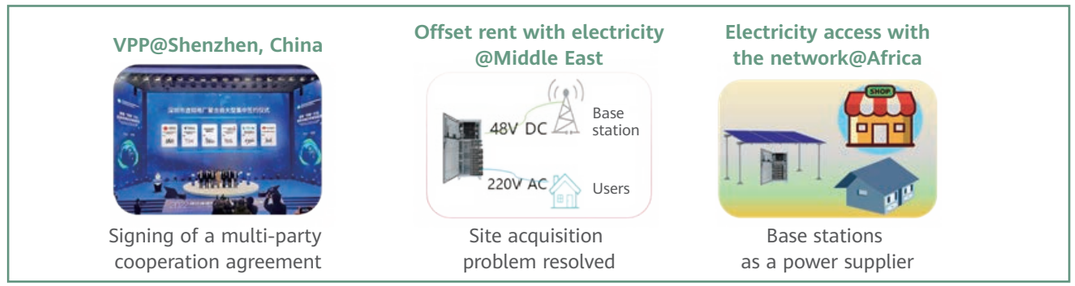


Figure: Huawei continuously explores telecom sites services for other sectors with partners

Various service scenarios are inseparable from Huawei's core technologies. For example, the eMIMO architecture can better meet power needs of multiple scenarios and services. The real-time networking technology implements low-latency networking to implement refined energy storage scheduling. The AC/DC conversion technology implements comprehensive management of AC/DC and adapts to different service requirements.

Huawei will continue to work with partners to explore more services for telecom sites.

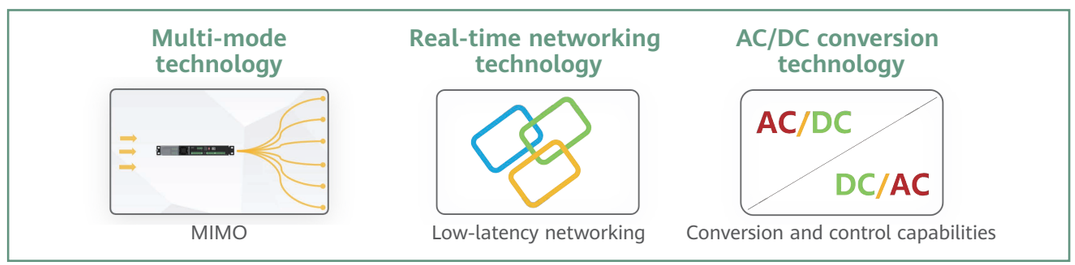


Figure: Huawei's core technologies help explore more services of communication sites

Trend 8
Multi-mode architecture

Multi-mode architecture: key to realize site versatility

Shared sites are targeted at multiple industries, scenarios, and devices, which pose high technical requirements on devices at the sites. Multi-mode architecture is the key technology to turn communication sites to shared sites.

Before 2021, energy access is mainly mains and diesel generators. The power supply mode is simple, and multiple sets of power supplies need to be deployed. For example, if both AC and DC loads are available at a site, both AC and DC power supplies are required. Therefore, the legacy sites often have complex structure and are difficult to maintain.

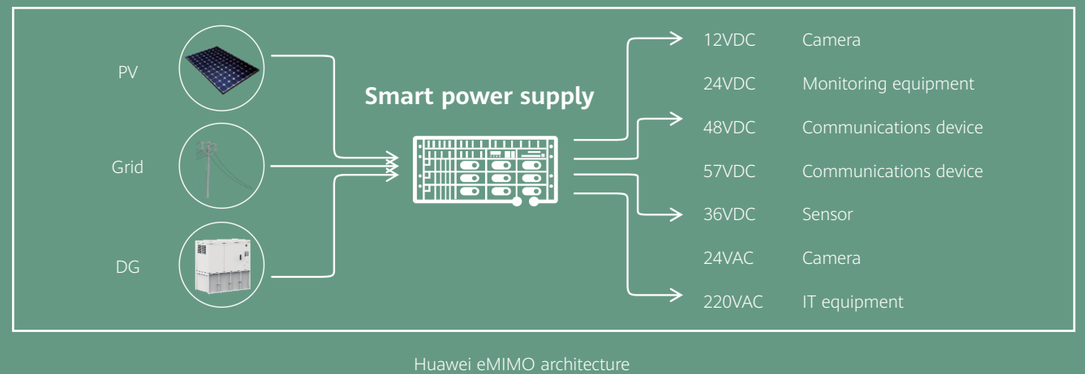
Figure: MIMO architecture

In 2022, multiple energy sources, such as mains, diesel generators, wind energy, and solar energy, have been accessed at shared sites. In terms of power supply, multi-mode output is supported, and all-in-one power supply gradually becomes the mainstream. Power supply convergence has become a trend when turning communication sites to shared sites.

Multi-mode architecture satisfies power needs of different services, and multi-mode collaboration enables free energy flow. Multi-mode technology is an important technical trend of communication sites turning to shared sites.

Huawei's innovative eMIMO architecture has been applied on a large scale globally

Huawei has released an innovative eMIMO architecture. A set of intelligent power supply supports the access of PV, mains, and DG and 12 V DC, 24 V DC, 48 V DC, 57 V DC, 36 V DC, 24 V AC, 220 V AC output, meeting the requirements of cameras, IT, and CT devices of different standards.



Huawei eMIMO architecture

By far, Huawei's eMIMO architecture is widely deployed in different scenarios around the world, such as the ICT convergence sites, the integrated power supply for oil and gas valve chambers in the Middle East, and free-flow tolling on highways.

Trend 9

Power backup+energy storage

Convergence of telecom energy network and power grids unleashes potential values of energy storage in base stations

The integration of telecom energy network and power grids allows energy storage to shave peak. Power back-up+energy storage is a key trend in building shared sites.

In 2021 and before, energy storage of communication sites serves only as backup power for mains. The energy storage investment in communication sites is huge, the sunk asset causes a huge waste of resources. Carriers have not developed a good way to unleash site capabilities.

In 2022, with the implementation of VPP, more and more carriers are turning to the collaboration between sites and power grids, and use energy storage in power grid scheduling. For carriers, this mode can activate sunk assets and increase revenue. For the power grid, an additional power supply guarantee is provided, which improves the stability of the power grid. The integration of communications networks and power grids is in the initial stage. It involves various parties and processes, such as the energy storage system of communications, the control and operation system of aggregators, the VPP management system of the power grid, and the grid-connection scheduling.

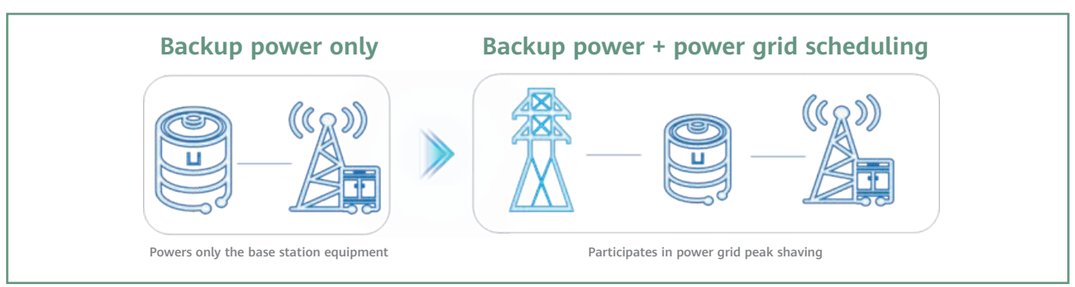


Figure: Energy storage to backup+storage

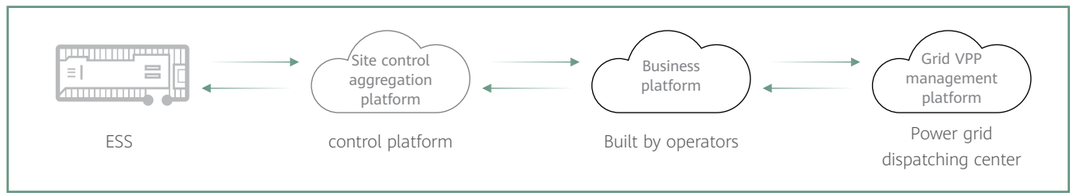


Figure: Multi-party exploration is still required for VPP linkage scheduling

Huawei works with partners to dig potential values of VPP sites

Huawei cooperates with partners to implement time-of-use tariff and VPP to unlock potential site values.

In Zhejiang, Huawei worked with a carrier to realize peak staggering using energy storage. In this way, the energy storage is charged at off-peak periods and discharged during peak hours, fully leveraging the electricity price differences. Compared with sites without this function, sites using Huawei's staggering technology can save 17.1% or even 43.5% power.

Huawei is also actively exploring VPP services for communication sites. In December 2022, the 2022 Carbon Peak and Carbon Neutrality Forum was held in Shenzhen. At the event, Huawei signed a six-party cooperation agreement with Shenzhen Virtual Power Plant Management Center, China Tower, China Telecom, China Mobile, and China Unicom to jointly explore and promote the connection of all 5G base station energy storage in Shenzhen to the power grid VPP.

Trend 10
Security and reliability

Security and reliability are increasingly valued.

For site power facility, security and reliability lie in network security and hardware safety.

With the advancement of digitalization and informatization, cyber attack risks increase. For example, in 2020, Brazil's power grid was attacked by ransomware, causing a loss of US$13 million. In 2019, in Venezuela, five rounds of cyber attacks on the power grid led to nationwide blackouts.

At the same time, with the deployment of various new energy facilities, energy hardware also poses safety risks. In 2022, a fire broke out in a PV power plant in South Korea, which was caused by thermal runaway inside the energy storage system. In 2021, a PV+ESS charging station in Beijing exploded, also due to a short-circuit in the plant's battery system.

With the trend of energy digitalization, governments and industries attach great importance to security and reliability. Different standards and regulations are issued to prevent security and safety problems. The IEC proposed the IET 62443 for network security of industrial automation and control system. ITU develops specifications for equipment room safety. In 2022, the China Association of Communications Enterprises proposed the Safety Technical specifications for LiFePO4 Battery System for Telecommunications, which is China's first lithium battery safety standard for communications.

Huawei Site Power Facility's efforts made on hardware safety and cyber security

Huawei Site Power Facility has established a comprehensive hardware safety and cyber security system to guarantee a secure site energy target network for customers. It has passed various international information technology security certifications, such as IEC 6243 and CC EAL, and has passed China lithium battery safety tests.

Hardware safety

- Passed professional lithium battery safety tests.
- Obtained IEC/CE certifications.

Cyber security

- IEC 62443-4-1 ML3/IEC 62443-4-2SL2
- CC EAL 3+ information technology security assessment (passed, to be issued)

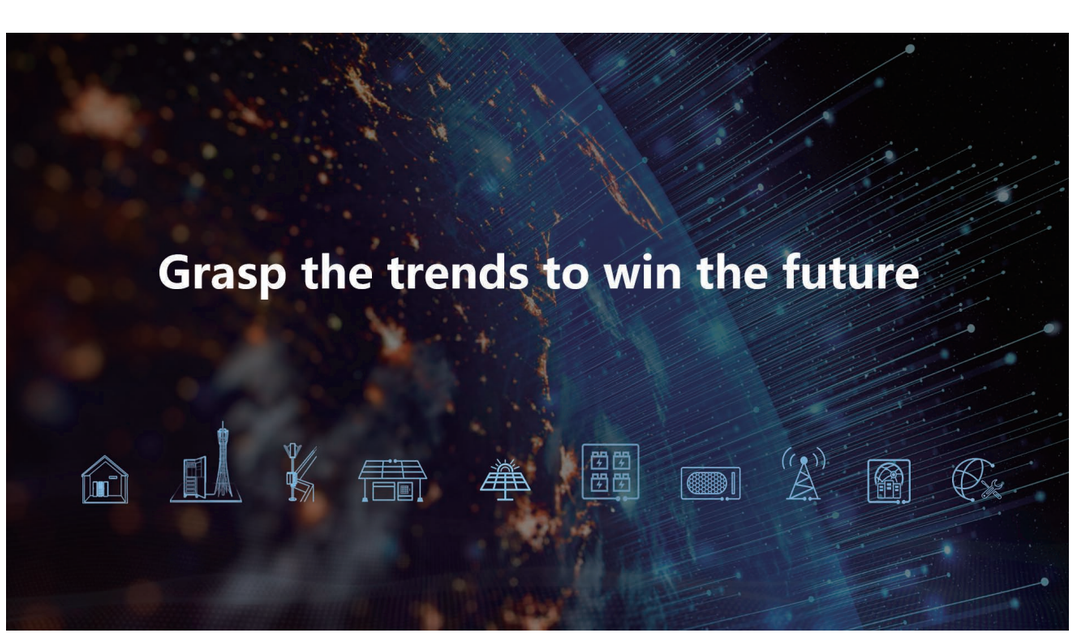
Figure: Huawei has passed multiple certifications

The end

Climate has become a serious and urgent problem for all mankind. Green and low-carbon adaptation has become the mainstream of development. Energy technology and digital technology will continue to be intertwined and integrated.

As a technology foundation, ICT plays an important role in achieving carbon neutrality. How to achieve Green ICT and ICT for Green will be a long-term exploration that deserves attention. This requires the joint efforts of governments, carriers, industry organizations, and equipment vendors. During this process, many problems need to be solved. But if we work together, we can make our networks lower carbon, greener, and smarter.

Huawei looks forward to working with industry colleagues to continuously explore and promote carbon neutrality in networks and build a better home for mankind.



Acronym/Abbreviation

No.	Acronym/Abbreviation	Full Name
1	CAPEX	Capital Expenditure
2	OPEX	Operating Expense
3	TCO	Total Cost of Ownership
4	TTM	Time to Market
5	ROI	Return On Investment
6	SEE	Site Energy Efficiency
7	NCIe	Network Carbon Intensity energy
8	GaN	Gallium nitride
9	VPP	Virtual Power Plant
10	EF	Emission Factor
11	SOH	State of Healte
12	SOC	State of Charge
13	IGBT	Insulated Gate Bipolar Transistor
14	PLC	Power Line Communication
15	MIMO	Multiple Input Multiple Output