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White Paper on the Top 10 Trends of Site Power 2024

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Simple,Green,Intelligent

Amid the global drive towards carbon neutrality, green technology innovations are dynamically transforming the site power sector. This wave of innovations is not only making operators and tower companies more sustainable but also fostering new applications and services.

The integration of digital technology with power electronics technology is at the forefront of building green and low-carbon networks. This enables operators and tower companies to build "Simple, Smart, and Green" site power facilities, empowering the global green transition. These innovations are enabling traditional energy consumers transition into prosumers, laying a solid foundation for low carbon ICT infrastructure.

What new changes and opportunities will the site power industry face in 2024? Huawei released the White Paper on Top 10 Site Power Trends, inviting you to explore the industry trends and future of the industry.

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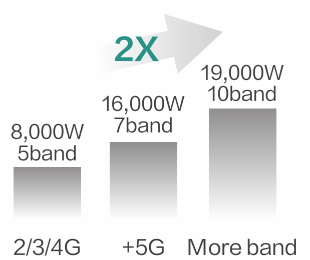
01 Trend 1
From Energy Consumers to Prosumers

Currently, in the context of carbon neutrality, operators are driven to evolve from energy consumers to prosumers under multi-dimensional pressure, such as the surging network power consumption and energy crisis. This transition is an important site power trend.

Operators' transition: response to multiple pressure sources and challenges

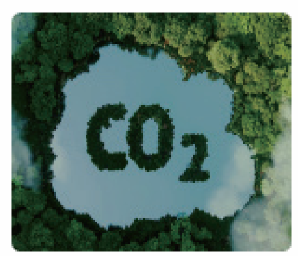
With the in-depth development of 5G technologies and changes in the environment, operators are facing multi-dimensional pressure and challenges. These factors drive operators' energy transition.

Surging network power consumption



Energy crisis

Carbon peak and neutrality



Surging network power consumption: The power consumption of 2G, 3G, or 4G networks is low. The power consumption of a 4G site is about 1 kW. In the 5G era, network power consumption increases exponentially. Generally, the power consumption of a 5G site is 3 to 4 kW, which is three to four times that of a 4G site. In addition, with the commercialization of 5G-A technology, operators' site power consumption will further increase. Therefore, building green sites, improving site energy efficiency (SEE), boosting site value, and increasing revenue are important development directions for operators.

Energy crisis: The deepening global energy crisis in 2023 significantly affected operators. On the one hand, operators' electricity fees are rising with huge operational expenditure (OPEX). On the other hand, operators are increasingly worried about whether they can obtain sustainable and stable power supply. Against this background, more and more operators are seeking to build their own green power systems.

Carbon neutrality: In the context of carbon neutrality, major regions and economies continuously paid attention to carbon neutrality policies in 2023. For example, China and the United States jointly released the Sunnylands statement. At COP28 in 2023, multiple countries and regions signed to continuously promote carbon neutrality. How to further save energy and reduce carbon emissions is also an important challenge for the development of operators.

Paris Agreement	EU	China	U.S.	Japan	India
• Limiting global warming to well below 2° C	• Launched the European Green Deal, carbon neutrality by 2050	• Peak emissions before 2030; carbon neutrality by 2060	• Rejoined the Paris Agreement, carbon neutrality by 2050	• Released the Green Growth Strategy • Carbon neutrality by 2050	• Reduce emissions intensity of GDP by 45% by 2030 • Carbon neutrality by 2070

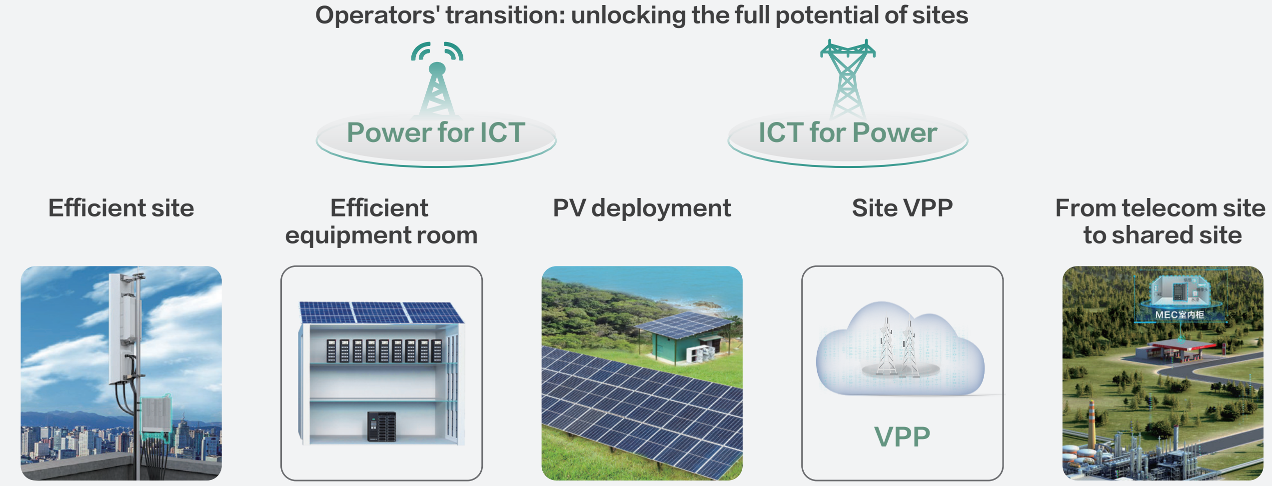
Operators' transition: evolving from energy consumers to prosumers

The operators' transition involves two aspects: Power for ICT and ICT for Power.

Power for ICT: Traditional power systems of operators are to supply power to communications devices. The key point is power consumption. In this process, operators play the role of energy consumers, that is, Power for ICT. Operators adopt methods, such as constructing efficient sites and equipment rooms, to improve SEE and reduce capital expenditure (CAPEX) and OPEX.

ICT for Power: Currently, operators are actively developing green power and exploring how to boost site value. For example, they use sites to participate in virtual power plant (VPP) scheduling and leverage telecom sites to provide power for social purposes. In this case, operators are not only power consumers, but also producers who produce green power and schedule power. That is ICT for Power. Operators focus on how to deploy better, safer, and more energy efficient green power, and how to use sites in other services to maximize site value.

Operators' transition: unlocking the full potential of sites



02 Trend 2 Green Power

Affected by business models, energy crisis, and safety risks, operators in various countries and regions are accelerating PV deployment at sites. Meanwhile, green power is becoming safer, more self-sufficient, and more profitable. Operators' regular deployment of green power will be an important trend.

From business returns to self-sufficient energy supply and safe operations

By 2023, operators deployed green power only in a small number of sites or remote sites without mains supply. According to surveys, the scale of green power deployment was about 1% to 2%. Operators tended to deploy green power in places where the costs of mains supply were high, such as Qinghai and Tibet, to reduce power supply costs and achieve significant commercial returns.

Figure: Green electricity construction for telecom sites of carriers

In 2024, green power deployment will become regular. In pursuit of commercial returns, operators are paying more and more attention to the safety and standards of green power. With the deepening energy crisis, the energy is more expensive and rarer, which poses new challenges to operators. For example, some operators in Europe face challenges of energy shortage. In this case, operators can deploy a large amount of green power to solve these problems, but the deployment and operations of green power also bring more safety risks. Therefore, operators focus more on the stability and safety of green power. International organizations for standardization also actively introduce new green power standards, such as the IEC 63027 PV detection standard, which lays a solid foundation for green power deployment.

Figure: Focusing on self-sufficient energy supply and safe operations

Self-sufficient, safe, and profitable green power system

To build a self-sufficient, safe, and reliable green power system, operators need to pay attention to the following points: lower investment, greater benefits, and higher safety.

Firstly the low-voltage serial connection of PV modules is gradually replaced with high-voltage serial connection. In the past, PV modules were deployed in low-voltage serial connection mode. In this mode, the voltage was about 80 V. When multiple PV modules were deployed in series and then in parallel, multiple cables were required, resulting in high investment. With the development of residential and industrial and C&I PV technologies, the high-voltage serial connection will be gradually used at telecom sites. In the high-voltage mode, more PV modules can be connected in series. In the scenario where PV modules of the same power are deployed, much fewer cables are required and engineering costs are reduced, helping operators deploy green power at lower costs. We believe that moving from low-voltage mode to high-voltage mode will become an important trend for green power deployment.

Secondly operators begin to deploy PV optimizers for PV modules. This improves overall benefits. In a traditional manner, operators deploy a large number of PV modules, and the PV modules are shaded by the tower in different time periods. The shading loss of one PV module reduces the energy yield of all PV module, resulting in the reduction of benefits. Nowadays, PV optimizers are deployed on PV modules to control each PV module. Only the shaded PV module is affected and the voltage of all PV modules in series is not affected, which ensures maximum power generation benefits. Therefore, the deployment of PV optimizers will become an important development trend.

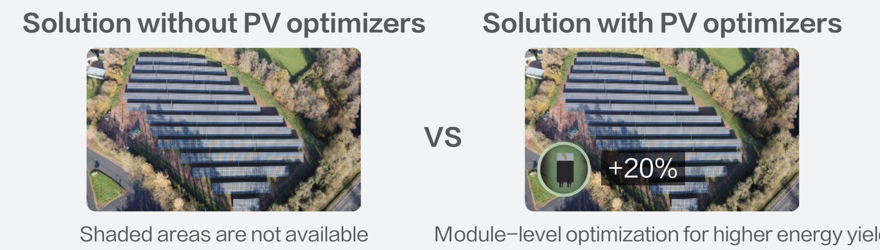


Figure: Comparison between the PV solution without optimizers and the solution with optimizers

Thirdly the safety of massive deployed PV modules is crucial. PV deployment may have problems such as arc safety. If arcing is not eliminated in time, personal safety may be affected. Therefore, operators are also focusing on safety detection technologies, such as arc detection and AFCI, to ensure the safety of green power. Safety will become an important trend.

03 Trend 3 Power Backup and Energy Storage

With the development of technologies and business models, operators can obtain subsidies by using telecom sites to participate in the power market. Site batteries and power services will be integrated. We believe that it is an important trend for operators as energy producers to expand from power backup to energy storage to unlock site potential and maximize site value.

Site services: from site power backup to batteries for participation in power market scheduling

As we know, operators deploy a large number of batteries at sites to ensure backup power for sites in case of power failures. Operators have made heavy investments in this area. However, in some areas with good mains power, the number of power failures is limited. Therefore, the batteries are idle for most of the time and used only for minutes in a year, and they require aperiodic maintenance, resulting in huge waste. The batteries are severely underutilized.

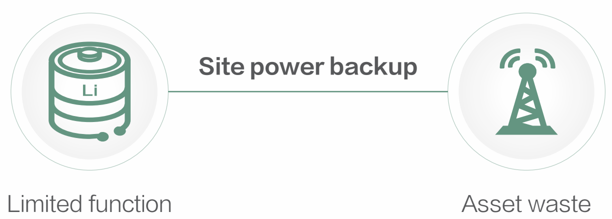


Figure: Batteries only for site power backup services

With the development of business models, operators can use their batteries to participate in more services and gain more profits in the future, shifting from merely saving money to making money. For example, operators can aggregate their batteries to participate in auxiliary services in the power market, such as power grid frequency regulation and peak shaving, to obtain power service subsi–dies. In this way, pure backup power resources become an energy storage facility, increasing value with previously wasted assets. We believe that this is also an important trend.

Figure: Batteries for power market scheduling

Integrating site batteries and power services for enhanced auxiliary services

Operators need to build a simple, intelligent, and integrated site energy storage system to use batter–ies for power market scheduling.

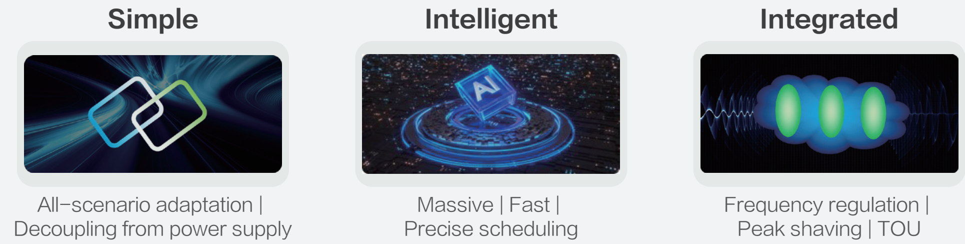


Figure: Integration of site batteries and power services requires a simple, intelligent, and integrated energy storage system.

Simple

Only with simple deployment, operators can participate in the construction of power market when both communication and power services are running. Communication services are important for the national economy and residents. Devices must run stably. Site batteries must be decoupled from live network services because the participation in power market services must not affect site power backup services. In addition, power supply devices on operators' live networks usually have multiple specifications from multiple vendors. If the VPP is deployed, operators must adapt power supply devices to batteries, which will prolong and complicate the deployment. Therefore, if operators decouple batteries from power supply devices, they can greatly improve the VPP deployment efficiency, achieve all–scenario deployment of 100% power supply devices on the live network, and maximize site resource utilization. Simplicity is the key to VPP deployment at sites.

Intelligent

Power auxiliary services feature large scheduling capacity, high burstiness, and high adjustment precision. To use massive site batteries to participate in power auxiliary services, operators must have intelligent capabilities for massive, fast and precise scheduling. Firstly, power services require large battery capacity and the power consumption and battery capacity of a single telecom site cannot meet such requirements. Operators must use thousands of sites to participate in power services so that they can pool resources to meet the requirements. Secondly, the high burstiness of different power services requires quick response. For example, the frequency regulation requires response in seconds. Therefore, the system must have the intelligent and fast scheduling capability. Thirdly, power services require high precision. For example, if a service requires operators to respond to 1 MW/h, operators shall precisely respond to this indicator. Some frequency regulation markets in China also require more than 95% scheduling precision. Therefore, the system must have precise scheduling capability.

Integrated

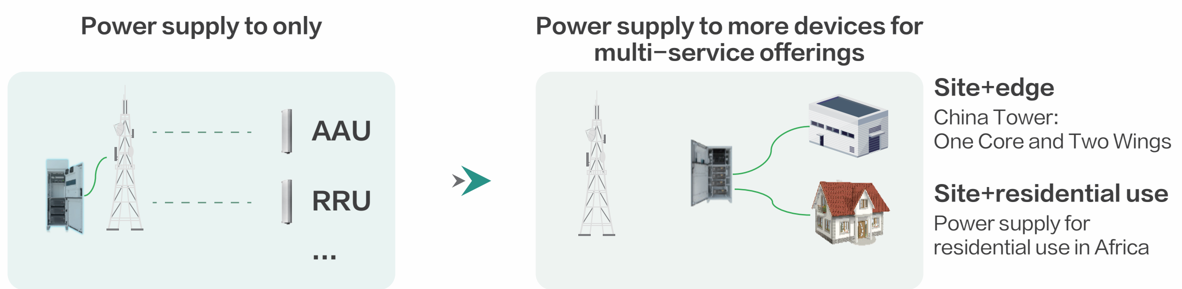
power auxiliary services are diversified, such as various frequency regulation markets in Europe, and peak shaving and frequency regulation markets in China. To reduce deployment costs, oper–ators shall develop a system to support multiple services and long–term evolution when deploying site batteries to participate in the power market.

04 Trend 4
Telecom Site to Social Site

In addition to the power supply to traditional communications devices, operators also want to leverage site resources for multi-service offerings, such as communications and edge computing, and communications and residential power supply. As an energy producer, site power is enabling the development of multiple services. The evolution from telecom sites to social sites will become an important trend.

From power supply to communications devices to power supply to more equipment for multi-service offerings.

By 2023, telecom site facilities only supplied power to communications devices, such as AAUs and BBUs. The main power supply system was –48 V, and the site function was limited. With the convergence of ICT, site capabilities continue to be improved. Operators are actively exploring the use of site power for more services. For example, China Tower proposed the famous "One Core and Two Wings" strategy that uses site power in more scenarios, such as energy operations and power supply to smart-connected devices, rather than only supplies power to tradition communications devices. In Africa, a tier-1 operator supplies the surplus power from telecom sites to commercial and residential facilities.

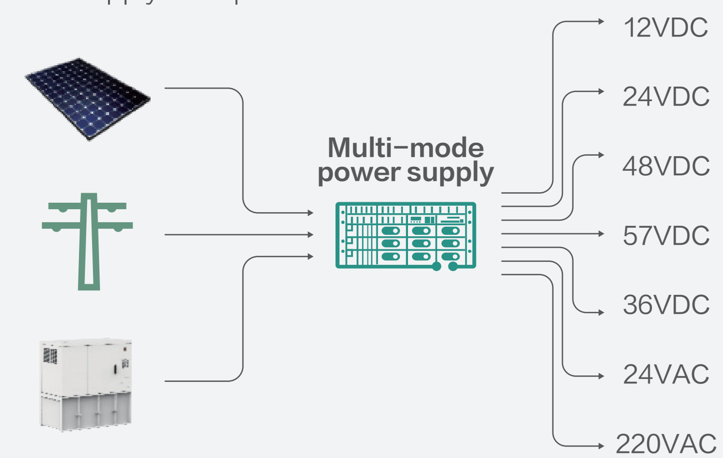


Technologies for leveraging site resources and diversifying revenue streams

With the development of operators' multiple services, operators also need to develop the power technologies to adapt to multi-service development, including the multi-mode power supply and intelligent collaboration.

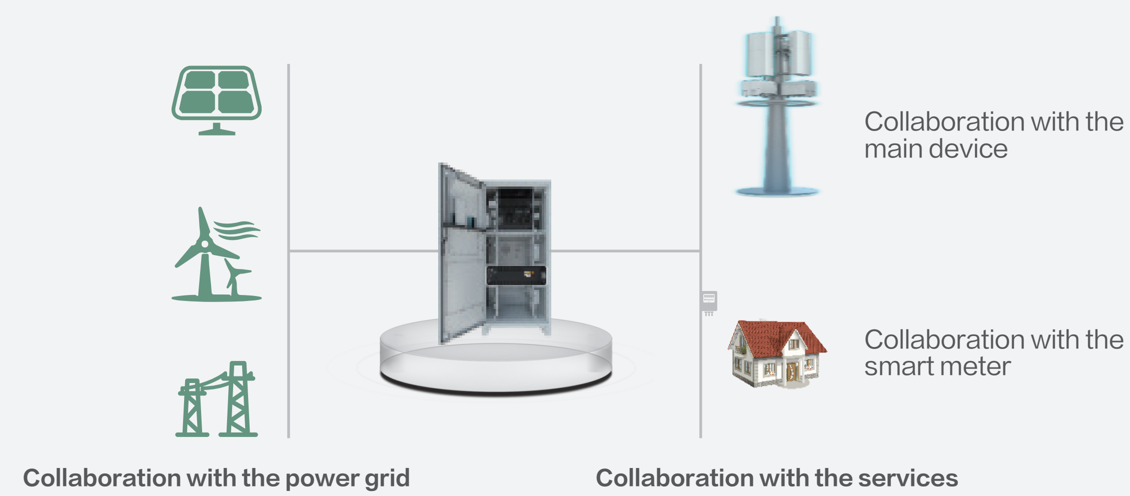
Multi-mode power supply

In addition to supplying –48 V power to traditional communications devices, the multi-service development requires the power supply to support multiple inputs and outputs. The simple AC-DC power supply shall be developed to multi-mode power supply. On the access side, mains supply, PV modules, and gensets must be supported. On the output side, more systems such as 12 V, 24 V, and 220 V systems must be supported to meet the access requirements of multiple devices. For example, 220 V AC power supply is required for IT devices, 24 V AC or 12 V DC power supply are required for cameras, and 220 V AC power supply is required for residential use.



Intelligent collaboration

The working condition and mode of traditional communication devices are limited. Multi-service development requires intelligent collaboration between power supply devices and multiple devices. For example, VPP services require collaboration with the power grid. Residential services require collaboration between power supply devices and smart meters. Green power services require collaboration between power supply devices and PV modules. How to improve collaboration between these new services and new devices is an important problem to be solved for diversified development.



05 Trend 5 Low-Carbon Site

In the process of continuous reduction of carbon emissions, low-carbon development of sites is a continuous trend, and leads to more new directions. With the development of green power technology and the promotion of various organizations, as energy consumers, operators gradually develop approaches for reduction of carbon emissions from limited and extensive to systematic and standardized approaches.

Operators' reduction of carbon emissions: Transition from limited and extensive to systematic and standardized approaches

By 2023, operators only improved the efficiency of individual devices and reduced electricity fees by removing air conditioners. Carbon emissions were reduced at the hardware-level. This construction model only focuses on the construction of each point and does not consider E2E systematization.

Nowadays, operators' approaches for reduction of carbon emissions will be more systematic and standardized. In terms of standards, the Network Carbon Intensity Energy (NCIe) indicator released by the ITU is an important indicator to evaluate the carbon emissions of operators' telecom sites and determines whether the optimization of carbon emissions is required. In addition to removal of air conditioners and gensets, operators can deploy green power and use solar energy, wind energy, and hydrogen energy to save energy and reduce carbon emissions. From traditional power and environment O&M to management of energy efficiency and carbon emissions, operators can monitor and manage carbon emissions on their networks.

Operators' multi-dimensional construction of low-carbon sites

Operators' construction of operators' low-carbon sites includes full-scenario PV deployment, hybrid power and genset removal, and management of carbon emissions and energy efficiency.

01 For PV deployment

the proportion of green power deployed by operators before was low. With the continuous decline in PV levelized cost of electricity (LCOE) and development of business models, operators deploy PV modules on a large scale. The deployment scope of PV modules is expanded from communication sites to communication equipment rooms and data centers, and from certain scenarios to all scenarios.

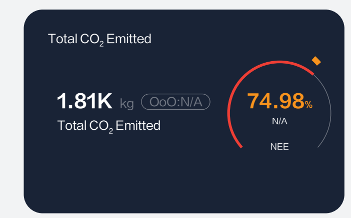
All-scenario PV deployment

Site | Equipment room | Data center

Hybrid power and genset removal

Solar hybrid|Grid hybrid |Diesel hybrid

Management of energy efficiency and carbon emissions



Dashboard for site carbon emissions; energy efficiency optimization

02 For genset removal

Operators in some regions, such as the Middle East and Africa, still have a large number of gensets at their sites. With the help of PV modules and batteries, they use solar hybrid, grid hybrid, and diesel hybrid solutions to continuously remove genset, reduce fuel costs, and promote carbon neutrality.

03 For management of carbon emissions and energy efficiency

previous site O&M focused on basic parameter management, and there was no reference standard for the reduction of site carbon emissions. Now, operators can use more intelligent approaches to reduce carbon emissions and manage energy efficiency.

06 Trend 6 Simple Site

As operators build their networks, the network scales are increasing, but the revenue does not increase. As energy consumers, operators turn to simple sites. A simple site features simple design, premium quality, affordable costs, and optimal user experience.

	~2023	2024~~
Design	Room → Cabinet	Cabinet → Pole
Quality	Less maintenance	Free of maintenance
Costs	Low costs of components	Lowest end-to-end TCO
Experience	No site power failure	High energy efficiency and low carbon emissions

Simple design

By 2023, operators mainly replaced equipment rooms at sites with cabinets. Massive use of outdoor cabinets reduced site CAPEX and OPEX. With the wide application of outdoor blade power technologies and the large-scale construction of Centralized RAN (CRAN) and Distributed RAN (DRAN), operators replace cabinets at sites with poles. From rooms to cabinets and then to poles, operators continuously pursue simple design for network energy deployment.

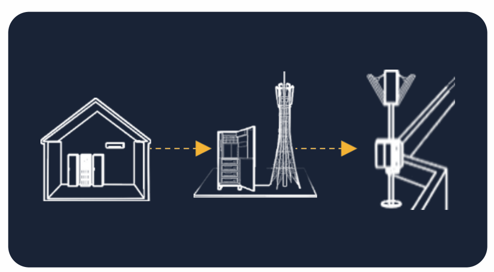


Figure: Room → Cabinet → Pole

Premium quality

By 2023, operators focused on how to reduce maintenance of power supply devices at sites. After 2024, operators will focus more on maintenance-free devices. For example, with the full outdoor and intelligent construction, outdoor blade power supply devices or blade batteries are usually maintenance-free for 5 to 10 years, and the maintenance costs can be zero within their life cycles.

Figure: Blade power supply

Affordable costs

By 2023, operators focused more on low costs of a single device, such as the procurement costs, but ignore the huge implicit costs such as engineering and O&M costs. It is estimated that the device costs account for only 30% of the costs of energy network construction, while the huge engineering costs, electricity fees, and manual site visit costs account for 70%. Therefore, the full-lifecycle costs and lowest end-to-end TCO are top priorities for operators' construction of sites.

Figure: Lowest costs full-lifecycle costs from construction to O&M

Optimal user experience

By 2023, operators only ensured stable power supply to sites, which was a simple and extensive approach. In the context of carbon neutrality, operators pay more attention to site carbon emissions and energy efficiency management.

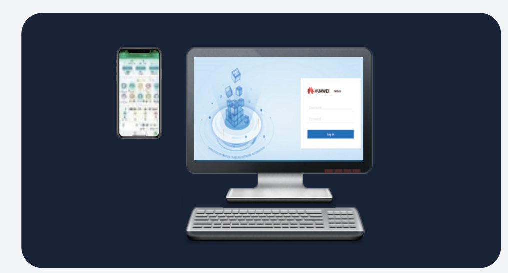


Figure: Visible carbon emissions,

07 Trend 7 Smart Site

With the convergence of power electronics and digital technologies, the visualized O&M of basic power and environment information is evolving into comprehensive intelligence for devices at telecom sites. "Functional sites" are evolving into "smart sites." Operators are trying to achieve full–link intelligence in power generation, conversion, storage, distribution, consumption, and management.

From simplicity and visualization to full–link intelligence

By 2023, site intelligence focused on simple and visualized site information, such as basic site parameters and site alarms. The intelligence level was low and the intelligent capability was limited, which could not meet the requirements for energy saving and reduction of carbon emissions at sites. In 2024, the degree of intelligence will further deepen. During site power construction, operators will focus on full–link intelligence. From power generation to management, comprehensive intelligence in power generation, conversion, storage, distribution, and management will be an important trend of operators' site power construction.

Full–link intelligence of generation, conversion, storage, distribution, consumption, and management for energy saving, carbon reduction, and more benefits.

Intelligent generation

Replace common PV modules with iPV modules. iPV modules reduce shading loss to increase the energy yield and rapidly eliminate electric arcs to remove safety risks.

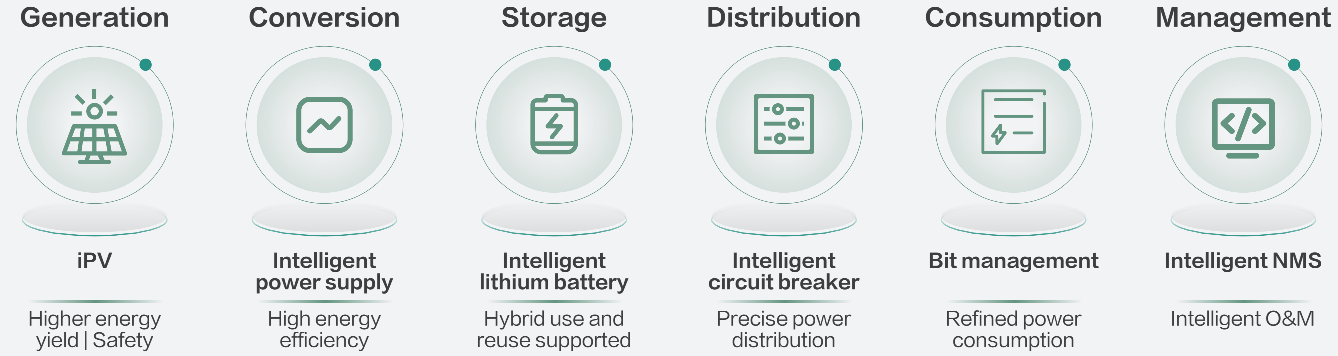


Figure: Full–link intelligence

Intelligent conversion

The efficiency of traditional power conversion is low, resulting in serious energy waste. Intelligent technologies are widely used for power supply devices to effectively improve power efficiency, save energy and reduce carbon emissions. For example, the intelligent parallel technology effectively improves the power output capability and reduces costs.

Intelligent storage

Traditional lead–acid batteries are dumb devices and difficult to manage. They cannot participate in multiple site services, resulting in resource waste. Intelligent technologies are used for lithium batteries to increase site value. For example, intelligent hybrid use effectively utilizes batteries on the live network, maximizes the use of existing devices, and reduces battery investment.

Intelligent distribution

Traditional power distribution is extensive, has few power disconnection levels, and is difficult to manage. In intelligent distribution, the intelligent circuit breaker technology and software–defined capabilities, such as precise metering and precise disconnection are used for precise management of site power distribution.

Intelligent consumption

Traditional loads function as power consumption and does not collaborate with power supply devices. In intelligent consumption, the intelligent collaboration function is used to connect devices. For example, the traffic flow of the main device is used to collaborate with the power supply device, and to use bits to manage watts for refined power consumption.

Intelligent management

Management is the brain of site power collaboration and scheduling. The wide application of intelligent methods also promotes manual O&M to intelligent O&M, saving energy and reducing carbon emissions.

08 Trend 8 Generation–Grid–Load–Storage Synergy

Operators' transition from consumers to prosumers also requires the support of fundamental key technologies. In terms of synergy, we believe that the generation–grid–load–storage synergy is an important trend.

Isolated nodes with limited collaboration capabilities

By 2023, each of the site power devices and loads, and the power grid is isolated. For example, when a site supplies power to communications devices, the power grid does not collaborate with power supply devices, and power supply devices do not collaborate with loads. There are only unidirectional power flows between them, and there is no information exchange for collaboration and scheduling. Devices cannot be effectively managed and optimized without collaboration. In this case, sites have low energy efficiency, high costs, and high carbon emissions.

Isolated nodes with limited collaboration capabilities

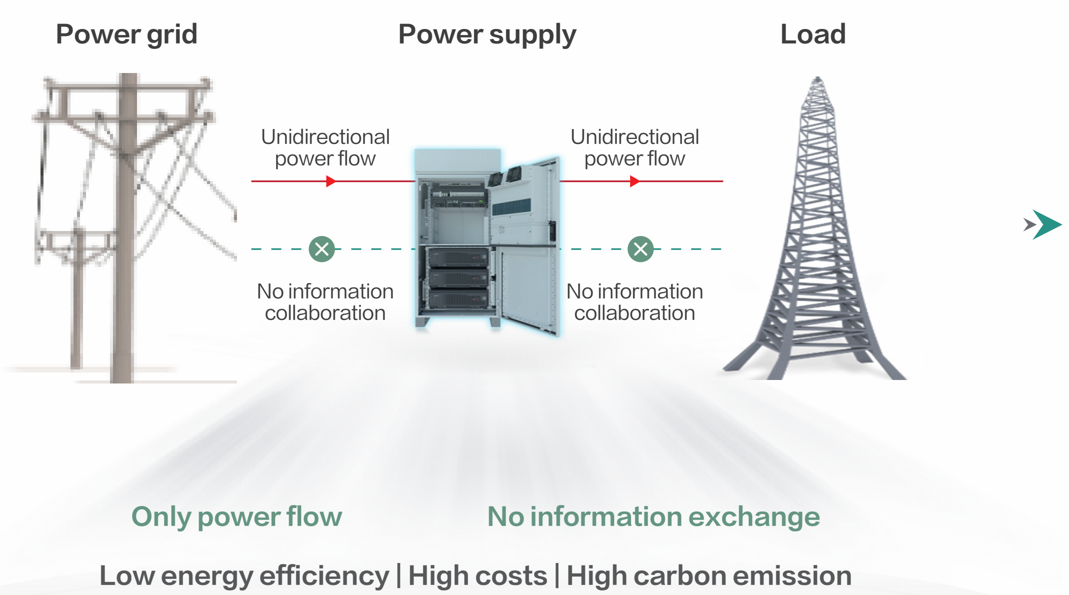


Figure: All devices as isolated nodes

E2E generation–grid–load–storage synergy

We believe that in 2024, with the trend of technology convergence, site power will break the barriers of information exchange and develop E2E generation–grid–load–storage synergy. For example, operators collaborate batteries with the power grid to achieve PV+energy storage synergy and 100% solar energy utilization. They use site batteries to participate in VPP auxiliary power services for obtaining power subsidies and maximizing site value. They collaborate batteries with the loads to achieve refined power backup and reduce site batteries investment. They collaborate the power grid with power supply devices to achieve intelligent peak shaving, reducing mains supply reconstruction and investment.

Intelligent features require the support of fundamental technologies, such as components, algorithms, and cooling in power electronics technologies, and sensing and connectivity in digital technologies. By using these technologies, power flows and information flows interact with each other between the power generation, power grid, loads, and batteries, improving energy efficiency, decreasing costs, and reducing carbon emissions.

E2E generation–grid–load–storage synergy

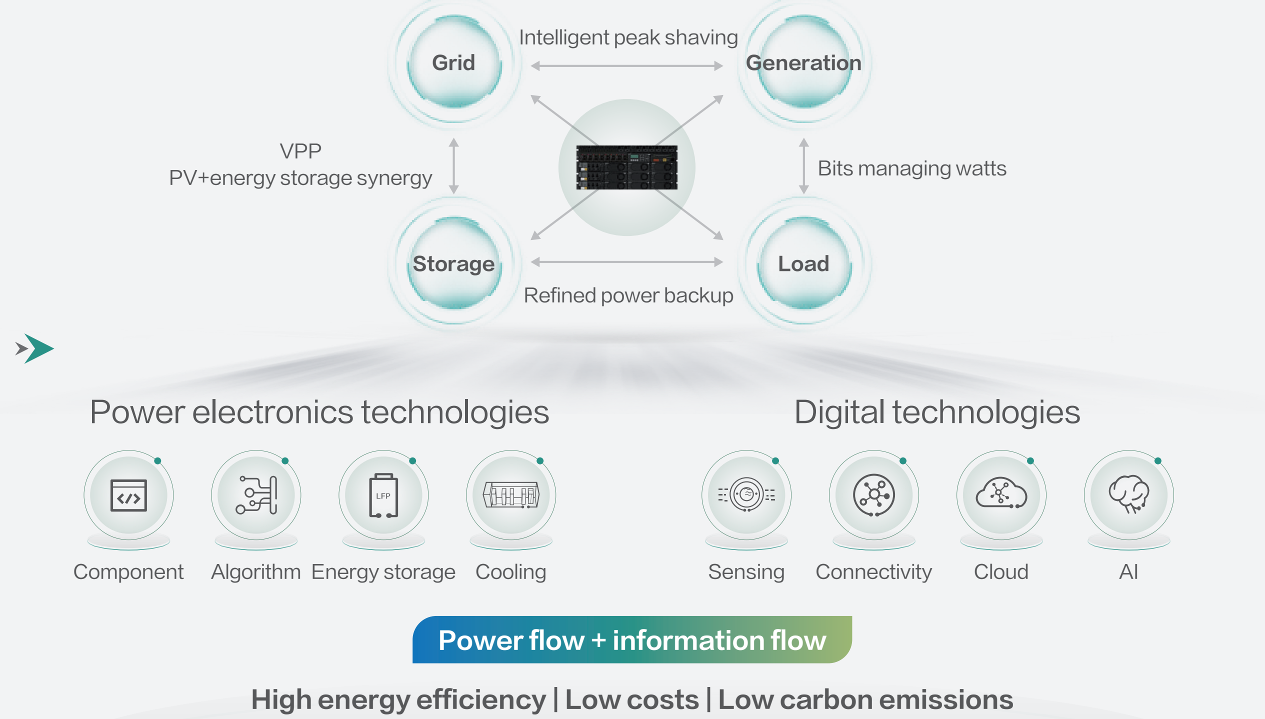
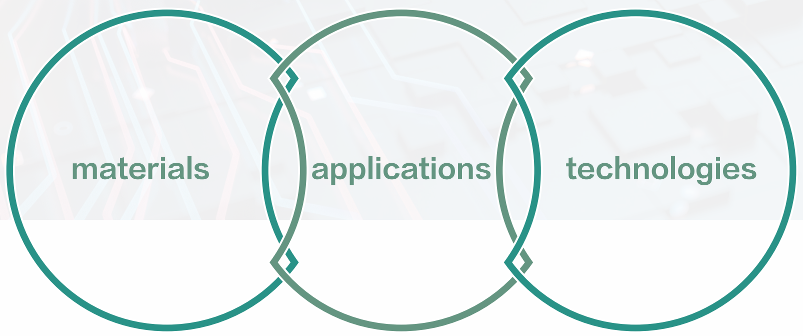


Figure: E2E generation–grid–load–storage synergy

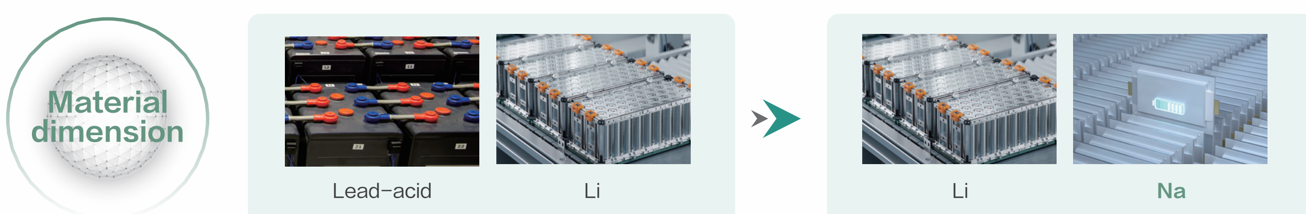
09 Trend 9
Diversified Battery Technologies

Another key technology is the battery technology. We believe that multiple factors, such as materials, applications, and technologies, will promote the diversification of site battery technologies and help operators continuously save energy and reduce carbon emissions.



Material dimension

New materials drive the development of new batteries. By 2023, operators mainly used lead–acid batteries and lithium batteries. Lead–acid batteries still have a huge inventory, but multiple high–quality features of lithium batteries have been widely recognized. The lithium batteries have more advantages and are more widely used at new sites and existing sites than lead–acid batteries. In 2024, we believe that sodium batteries will be more widely used by operators because raw materials for the sodium batteries are easier to obtain and cheaper. The transition from lead–acid batteries+lithium batteries to lithium batteries+sodium batteries adds options for site energy storage.

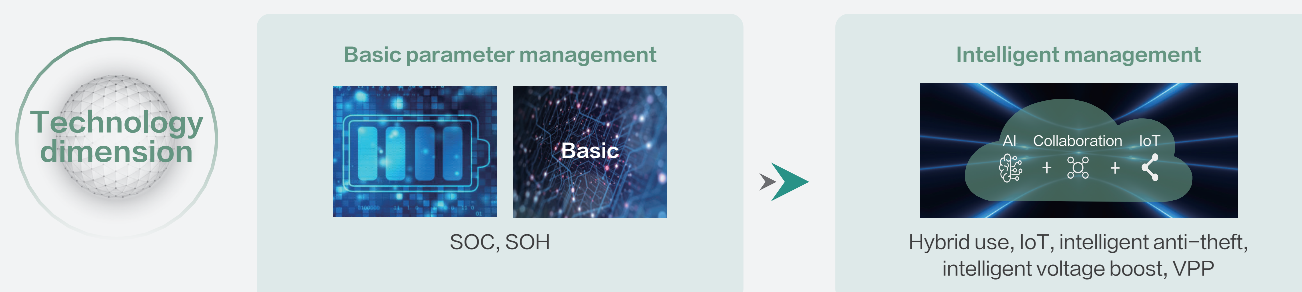


Application dimension

Lithium batteries have safety risks and are not applicable in low–temperature scenarios. Sodium batteries are safer, better in low–temperature scenarios, and have a higher charging rate. Lithium ions are chemically active in charged state, and the reaction of internal material releases a large amount of heat at a high temperature, making lithium batteries flammable. The operating temperature of the lithium batteries is generally from –20° C to +60° C. The discharge efficiency is only about 30% at –20° C. In contrast, sodium batteries are less active and safer. Sodium ions work at the temperature of –40° C to +80° C, and can release 90% of their capacity at –20° C. They can still be charged and discharged normally at +80° C.

Technical dimension

By 2023, the management of batteries mainly focuses on basic parameter management, such as state of health (SOH) and state of charge (SOC). The parameters are used to monitor battery status. This mode is limited. In 2024, with the development of services such as VPP, more intelligent technologies are required, such as intelligent hybrid use, intelligent anti–theft, and VPP.



10 Trend 10
Security and Trustworthiness

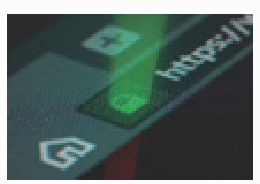
Building secure, trustworthy capabilities and achieve responsibility fulfillment from single–site security to energy cyber security

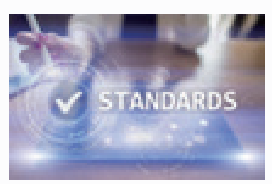
By 2023, operators require only no site power failure. With digitalization and informatization, the site power transition from a single site and a single device to an energy network improves energy efficien–cy, but poses more security risks.

In the future, we believe that operators will focus on energy cyber security instead of single–site power supply, including device, network, authentication, and process and result security.

Device security

Generally, component security, usage security, and maintenance safety are required. That is, the hardware components are secure and reliable, the system is secure during opera–tions, and the maintenance process is safe. Device security basically ensures stable power supply to sites.

Cyber security

Cyber security can be classified in to architecture security, data security, and defense against attacks.

Firstly, the overall architecture of the system must be secure and robust. For example, network layers and protocols used must be secure.

Secondly, network data must be confidential, such as secure encryption algorithms and secure data interaction algorithms.

Thirdly, defense against attacks, such as the defense against different types of attacks and vulnerability fixing, is required.

Cyber security ensures site confidentiality, robustness, and resilience.

Authentication security

During the construction of energy networks, more and more regions and countries attach importance to qualification and certification, and issue various laws and regulations to cope with increasing cyber security risks. To gain access to the local market, operators and device vendors must obtain corresponding qualification certificates. For example, the EU issued CE RED, which regulates the cyber security of radio devices. In May 2023, the EU issued the NIS2 Directive, which is a cyber security directive covering the entire EU. Obtaining qualification certificates is important for tracing data.

Trustworthy processes and results

In addition to certificates, governments or operators will also review whether device ven–dors have incorporated security and trustworthiness into their development processes to ensure the energy cyber security from the design source. For example, operators must use secure and trustworthy integrated product development (IPD) processes and secure certificates. Some countries and regions have released laws and regulations about data security. Therefore, trustworthy processes for vulnerability fixing and privacy protection are also critical.

Device, network, authentication, process, and result security are used to ensure secure energy net–works of operators, stable power supply to sites, confidentiality, traceability, and defense against attacks, and to achieve secure and trustworthy responsibility fulfillment.

Equipment security	Cyber security	Security authentication	Trustworthy processes and results
Component security	Architecture security	EU: CE RED | NIS2 | CRA	IPD process
Usage security	Data security	USA: UL	Security certificate
Maintenance security	Defense against attacks	China: authentication of key network equipment	Vulnerability management and privacy protection

End

Green development is the mainstream of the era, site construction continues to move towards green and low–carbon.

Huawei looks forward to working with industry colleagues to continuously explore and promote site power development, promote carbon neutrality in networks, and build a better home for humankind.

Building a Green Future with Huawei's Sustainable Site Power Solutions

One cabinet per site
700,000

One blade per site
2.6 million

Grid + solar power
700 MW

900 million kWh
green power generated

33.89 billion kWh
electricity conserved

16.2 million tons
carbon emissions reduced

21.99 million trees
equivalent environmental benefit achieved

*As of 31 December, 2023

Acronyms and Abbreviations

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