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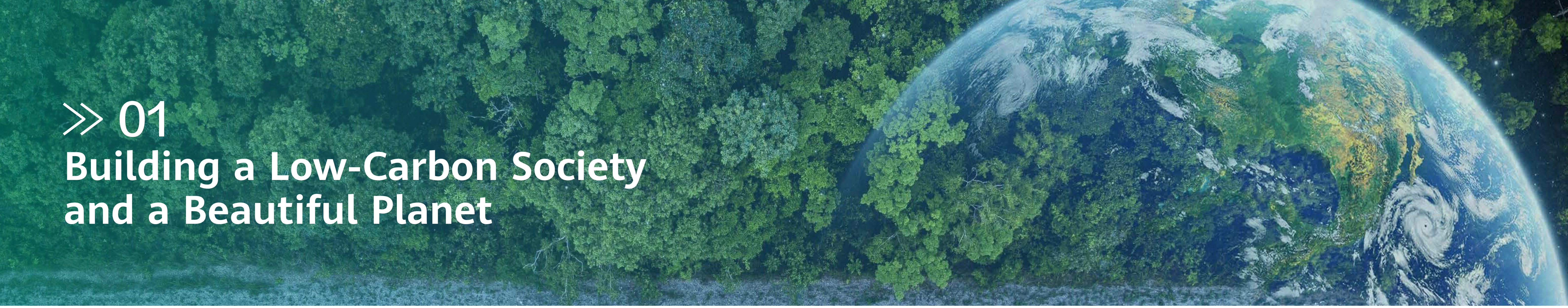
White Paper on Activating Telco Site Storage to Participate in Power Market

Utilizing VPP Technology to Create Blue Ocean


VPP

CONTENTS



01 Building a Low-Carbon Society and a Beautiful Planet

1.1 Promoting Carbon Neutrality and Building New Power Systems

To cope with climate warming and protect the environment, countries around the world have formulated carbon neutral goals and plans. For example, the European Union has proposed to achieve carbon neutrality by 2050, and the Chinese government has proposed a "2030/2060" plan for carbon neutrality. Carbon neutrality has been an initiative and goal agreed by all countries.

Regions and countries continue to launch new policies. In March 2023, the European Union introduced the Net-Zero Industry Act (NZIA), which used a variety of clean energy as strategic net-zero technologies to enhance the competitiveness of clean technologies. In November 2023, at COP28 in Dubai, more than 100 countries around the world signed a declaration to triple renewable energy capacity and double energy efficiency.

Paris Agreement	EU	China	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	• Released the Green Growth Strategy • Carbon neutrality by 2050	• Reduce emissions intensity of GDP by 45% by 2030 • Carbon neutrality by 2070

Chart: timetable for countries' carbon neutrality plans

Under the influence of carbon neutrality, countries have made great efforts to build new power systems. On the power generation side, clean energy such as solar, wind, and hydrogen energy is used to replace traditional fossil energy. On the power consumption side, electric vehicles are replacing fuel vehicles and energy-efficient ICT infrastructure is built for electrification. On the power transmission side, digital and intelligent means are used to realize digital power plants and intelligent transmission.

The new power systems feature large-scale deployment of green power, intelligent power consumption, and convergence of power electronics, digital and AI technologies. The systems are the main way to achieve carbon neutrality.

Figure: Wide application of renewable energy

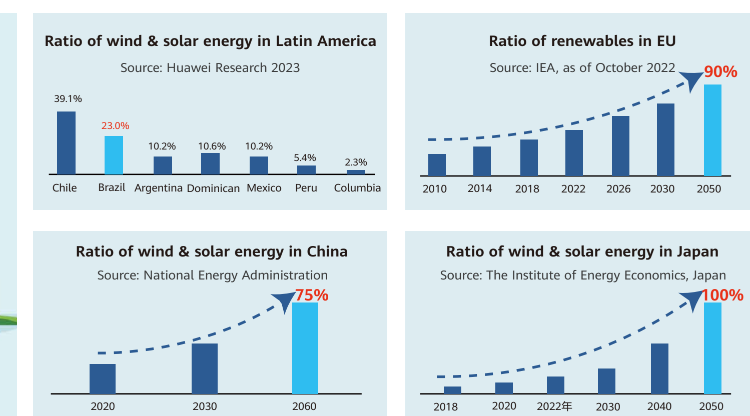


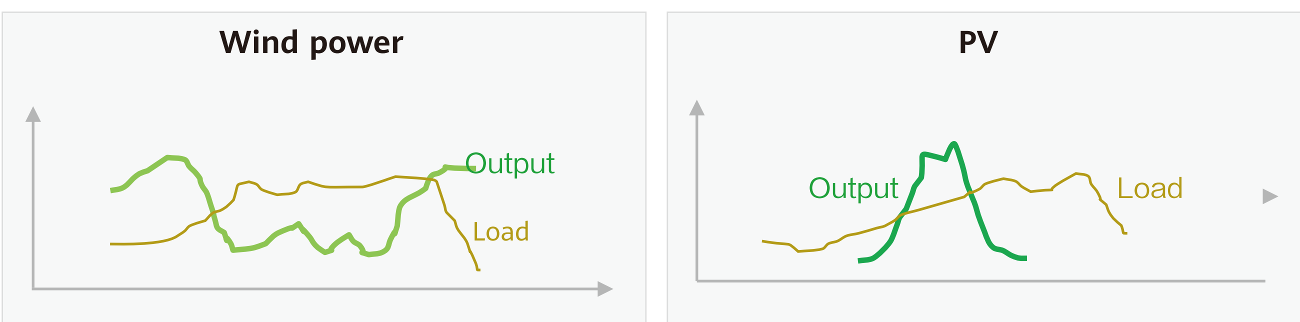
Figure: Continuous increase in proportion of renewable energy globally

1.2 Challenges of New Power System Deployment

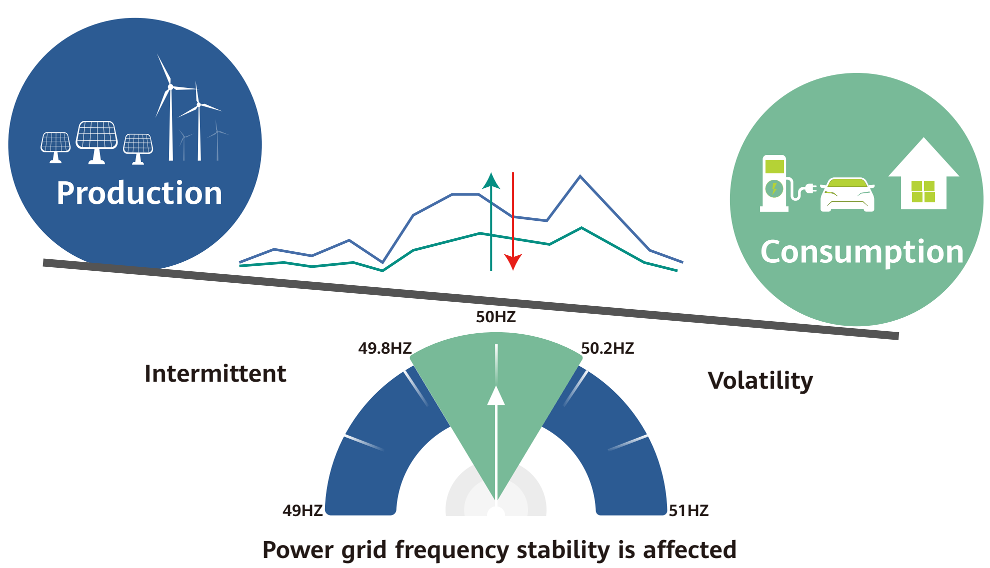
Renewable energy poses multiple challenges to the safe and stable operation of power systems, such as imbalance between the supply and demand and unstable grid frequency.

On the power generation side, there are massive renewable energy sources, and it is difficult to manage their access to power grids. In addition, renewable energy is inherently intermittent. For example, PV modules generate power during the day, but not at night. Wind power systems generate less power during the day but more power at night. The increasing deployment scale poses great challenges to energy balance and exacerbates the stability risk of grids.

On the load side, the promotion of electrification increases the instantaneous power of electricity, which brings huge pressure to grids. For example, the wide application of electric energy in the industrial field, electric vehicles in the transportation field, and distributed energy storage devices will break the traditional stable power consumption mode. Such trend increases the sudden use of electricity and poses threats to the stability of power systems.



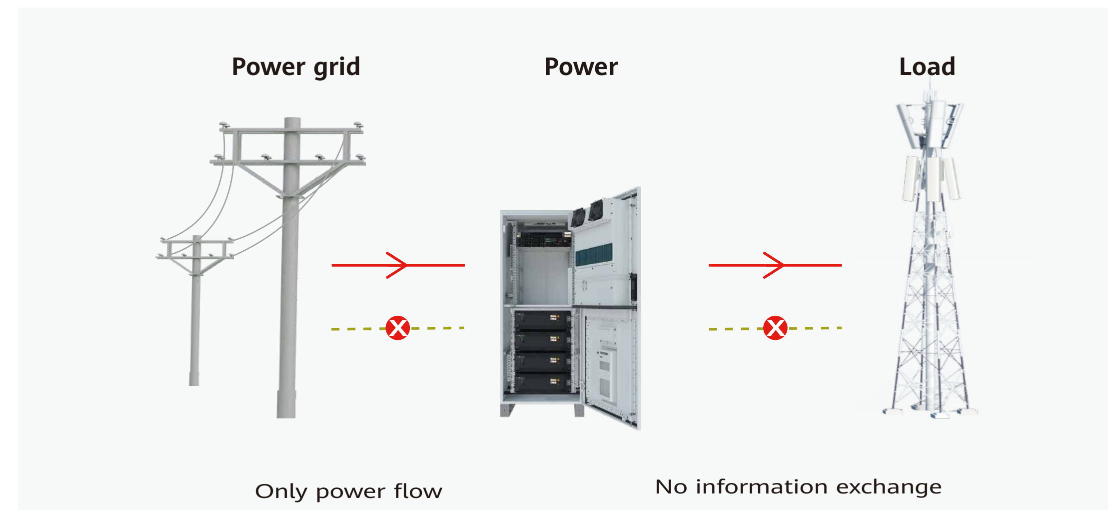
Unstable output of renewable energy



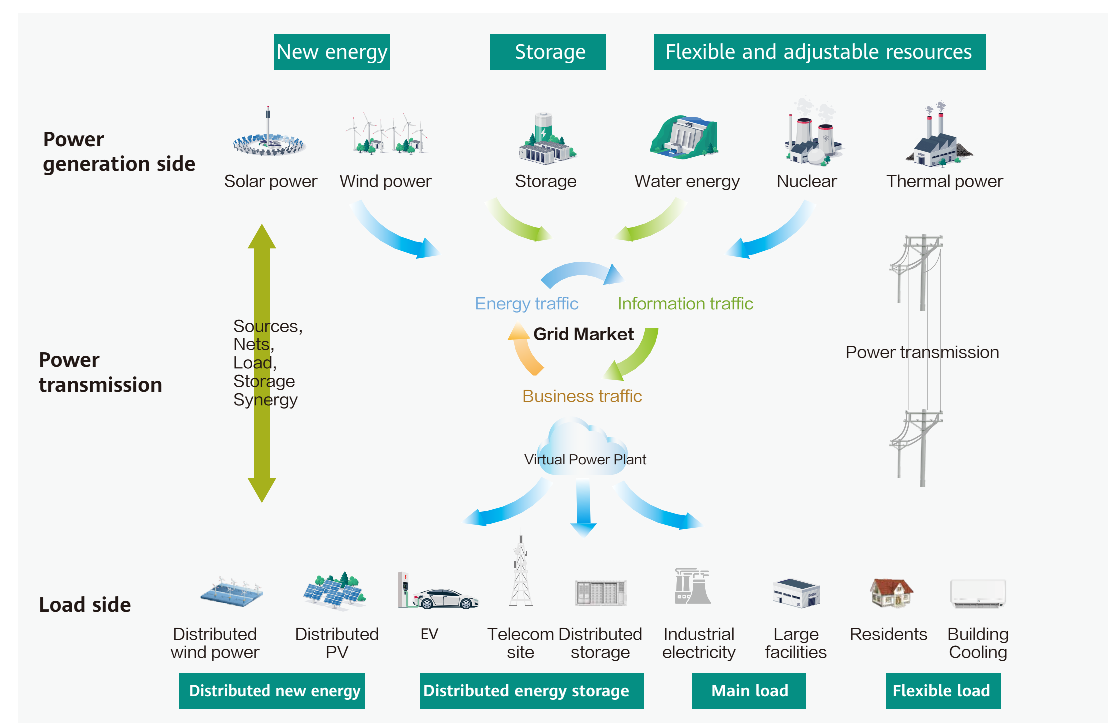
Unstable grid frequency and imbalance between the supply and demand

1.3 Power Systems as the Key to Development

In the context of renewable power generation, how to effectively solve the stability and balance problems brought by clean energy access? In the traditional energy system, power plants interact with users in the form of unidirectional power transmission and consumption. Energy balance and synergy are ignored, resulting in low energy efficiency, high power costs and high carbon emissions. With more renewable energy access in the future, how to build automatically balanced power systems based on energy synergy, link the power generation side and the load side, and realize refined bidirectional power supply will be the key direction of renewable energy development in the future.



Power system with bidirectional energy flow (example)



Balanced power system with energy synergy

02 Virtual Power Plant (VPP) and Power Market

2.1 Definition of VPP

VPP is a management system for energy synergy. It integrates resources such as PV on the power generation side and adjustable resources such as distributed energy storage devices on the load side. These resources are used as adjustable and tradable units for grid scheduling and transactions in power markets.

The VPP links and coordinates energy producers and consumers, changes energy flow from unidirectional mode to bidirectional mode, and feeds energy to grids without spatial constraints.

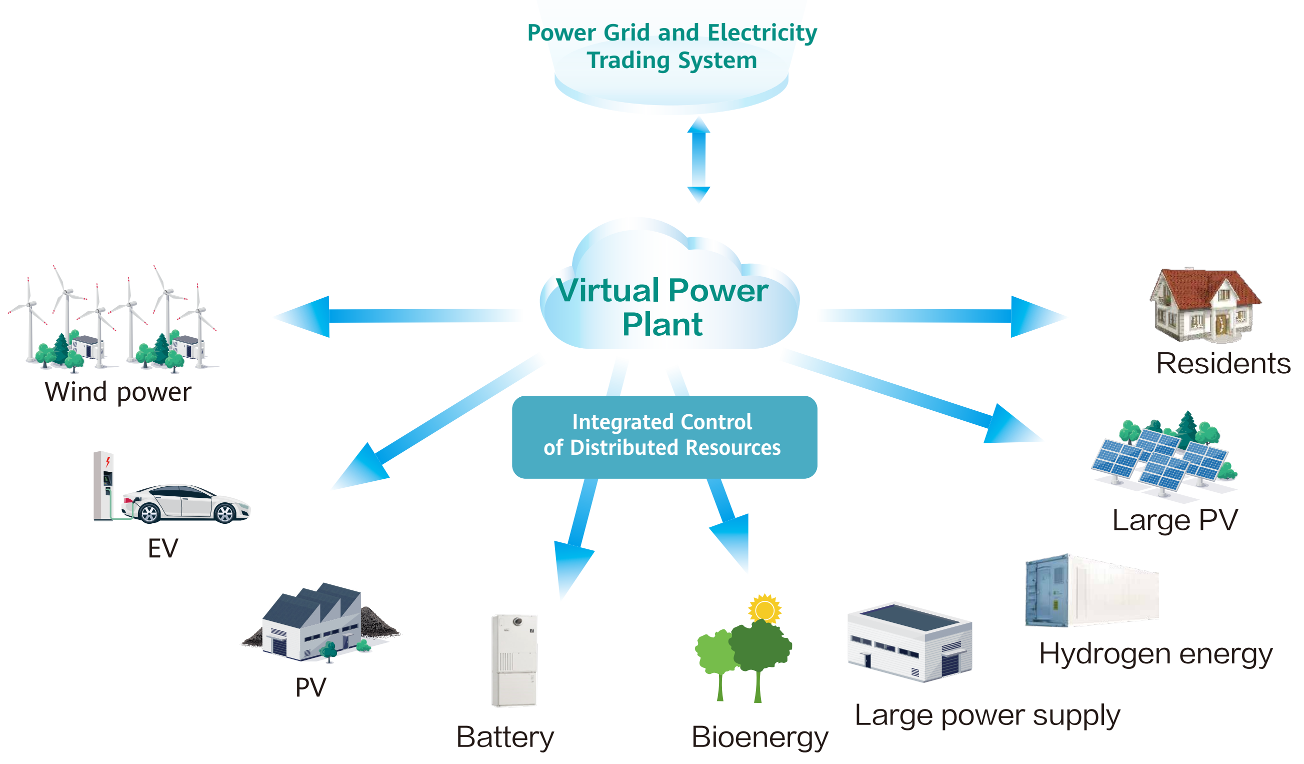


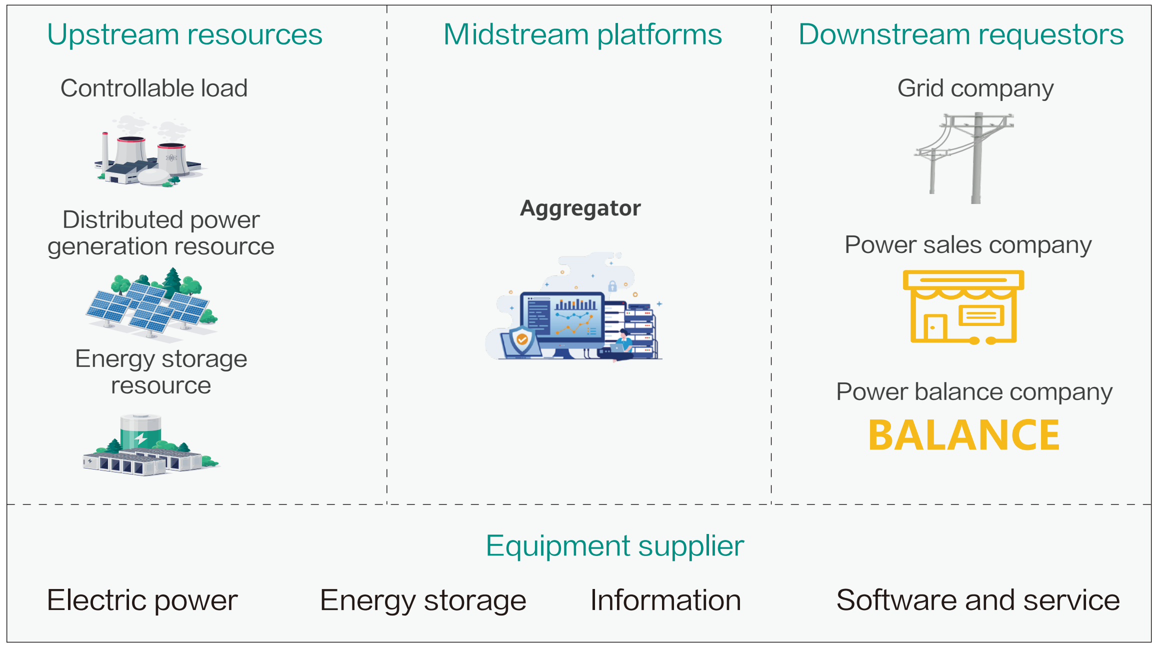
Figure: Virtual Power Plant

VPP resource classification:

Upstream resources include adjustable loads, distributed power generation resources, and energy storage resources. Adjustable loads are loads in telecom equipment rooms, data center facilities, charging stations, and industrial scenarios. Distributed power generation resources refer to small-scale power generation devices deployed around users, such as rooftop PV modules, wind power systems, and hydrogen power systems. Energy storage resources are energy storage devices such as backup batteries in equipment rooms and sites.

Midstream resources include aggregators. They use technologies such as the Internet and big data to aggregate, optimize, and schedule resources to participate in power markets. They provide a control capability for synergy.

Downstream resources include requestors such as grid companies and power sales companies. They propose electricity demands and purchase power services in power markets depending on the region.



VPP industry chain

VPP value:

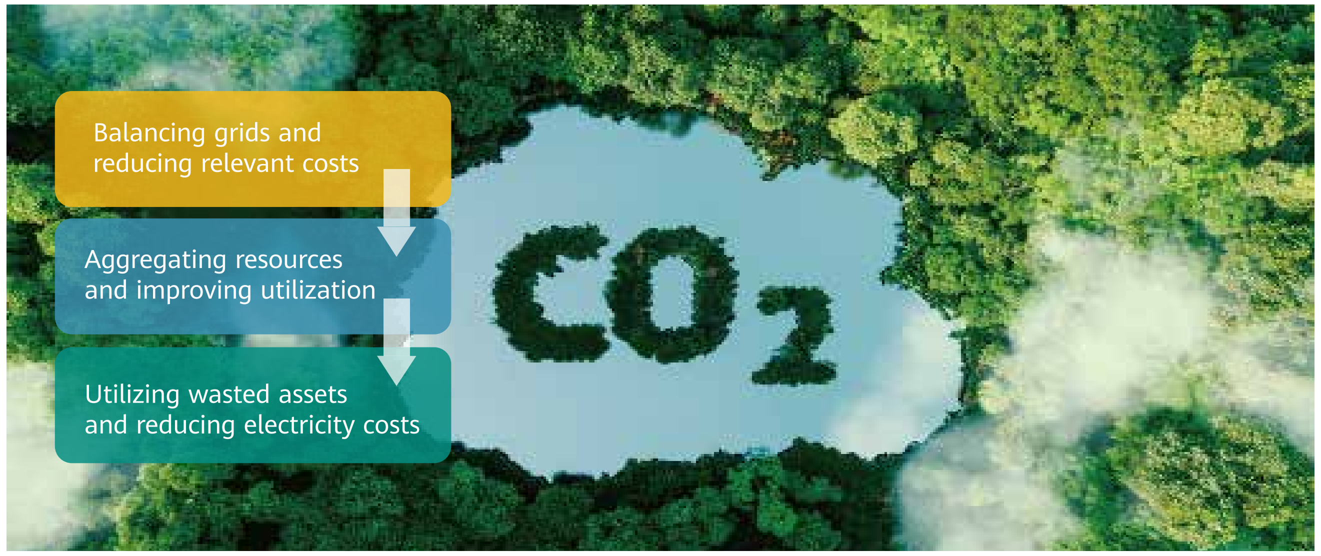
From the load side to the aggregator side, and finally to the grid side, a VPP can bring value to enterprises from end to end and help build a low-carbon society.

● On the grid side, the VPP can balance the power supply and demand, mitigate grid fluctuations, alleviate grid congestion, and reduce grid O&M costs.

● On the aggregator side, the VPP can aggregate multiple resources and incorporate them into power scheduling and power markets to leverage idle resources and improve energy utilization.

● On the load side, the VPP can intelligently manage traditional electrical devices and utilize wasted assets to participate in power markets and balance grids for higher benefits and lower electricity costs.

● The VPP can save energy and reduce carbon emissions by effectively reducing O&M costs and unlocking resource potentials. According to statistics, the regulation capacity of 100 MW batteries equals that of seventeen 100 MW thermal power plants, reducing carbon emissions by million tons.



VPP value for multiple parties

Technical difficulties of VPP:

As an energy aggregation, scheduling, and transaction system, the VPP involves power grids, power transactions, aggregation, and load resources. These aspects are facing challenges in terms of power electronics, information and communication, and digital technologies.

(1) Dynamic aggregation of distributed resources

The VPP aggregates multiple resources, including clean energy and traditional energy, distributed loads at sites, data centers, and charging stations, and distributed energy storage resources such as energy storage devices at sites and independent energy storage devices. Resource access is diversified. Therefore, how to manage resource access in an orderly manner, such as information coupling, label classification, and reasonable and effective business classification, is a technical difficulty to be solved.

(2) Quick cloud-edge-device collaboration

The VPP usually consists of three layers.

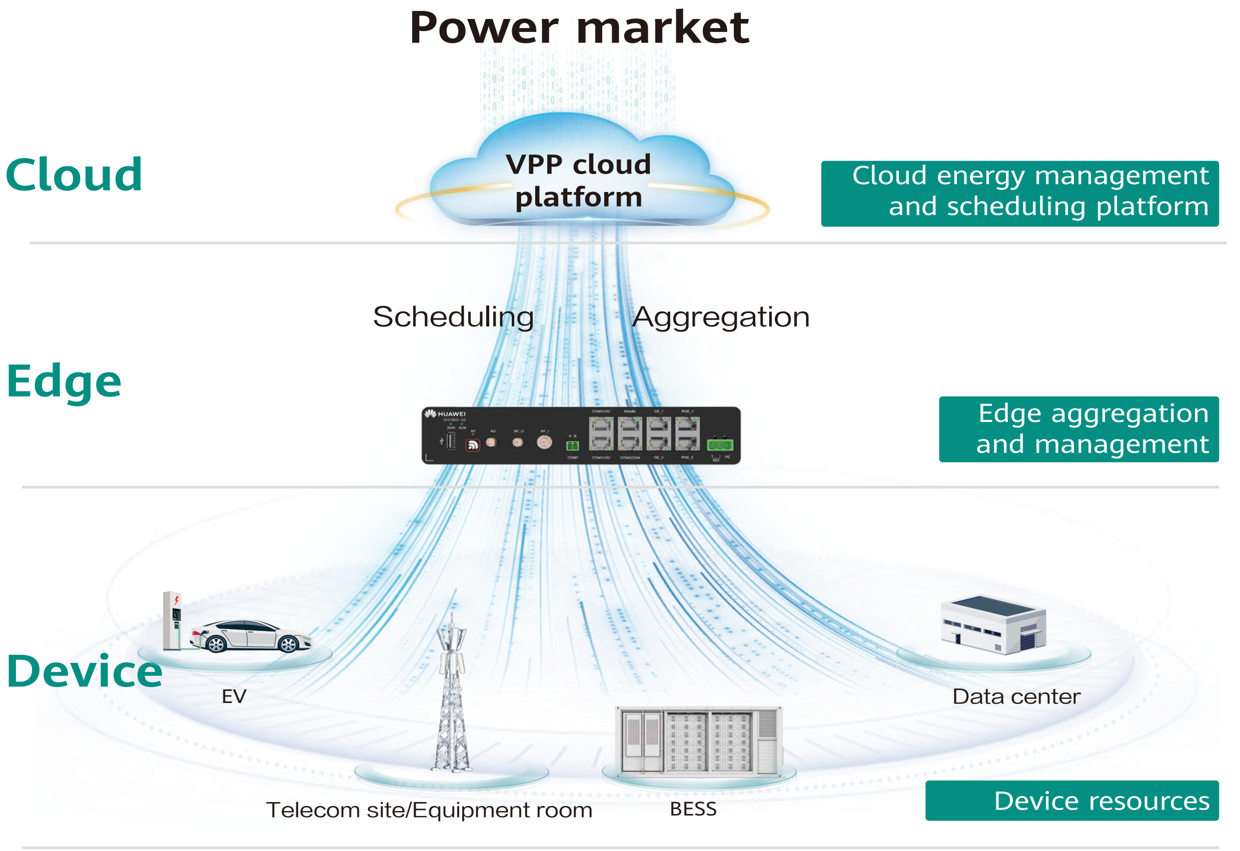
Cloud center: Generally, scheduling software, management software, and power market systems are deployed on the cloud. The cloud center consists of a large number of high-performance servers. However, the servers are usually far away from loads and power plants, which cannot meet the latency requirements of real-time tasks.

Edge node: Generally, edge nodes are deployed on the load side. They transmit and compute data, and directly manage load resources. How to aggregate and optimize load resources and how to transmit load data to meet the requirements of power markets are difficulties for edge computing nodes.

Load: Devices are the end of power output and the final resources in power scheduling. Battery response, charge, and discharge speed and device power prediction are the primary problems for the VPP.

(3) Aggregation optimization and selection

There are massive interactions between information flow and energy flow in power markets. For example, in the frequency regulation market, the VPP may receive multiple scheduling requests within a day. In addition, the VPP is required to balance different resources to aggregate proper loads for bidding, quotation, and optimizing operations. How to make optimal decisions to achieve these goals will be a key difficulty for the VPP.

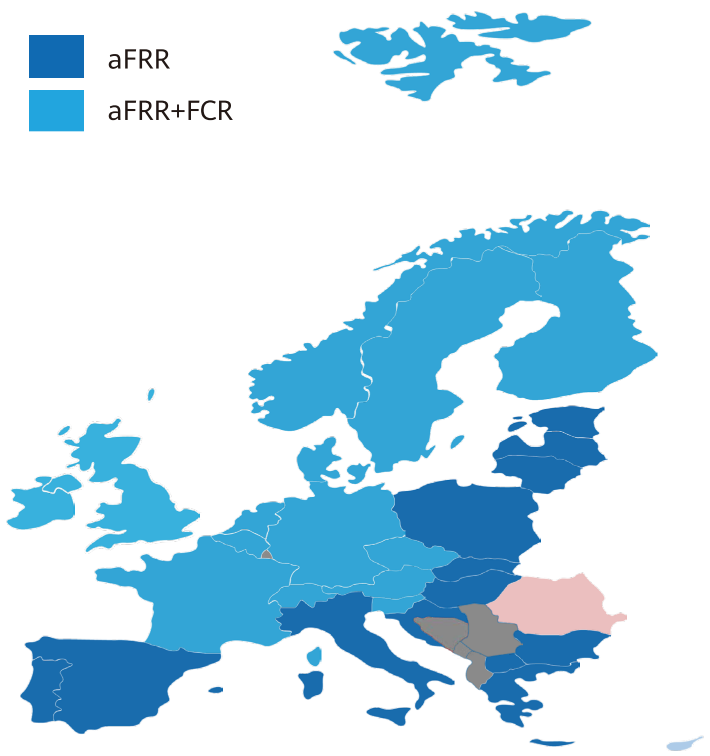


Distributed cloud-edge-device aggregation system

2.2 VPP Facilitating Multiple Power Market Services

Transactions in power markets are relatively mature and developing rapidly. For example, there are multiple market modes in the United Kingdom, such as the futures market, spot market, capacity market, and ancillary frequency regulation market. In Germany, the ancillary frequency regulation market has Frequency Containment Reserve (FCR), automatic Frequency Restoration Reserve (aFRR), and manual Frequency Restoration Reserve (mFRR).

The European markets have vast potential and services in the markets can be sold with high prices, which bring high returns. Currently, European countries are actively building a market system covering whole Europe. For example, in a country, the average price of frequency regulation is about 20 euros/MW/hour, and the average price of frequency regulation through aFFR is about 30 euros/MW/hour. If telecom site batteries are used for these frequency regulation and scheduling services, the return on investment (ROI) is short and the benefits are considerable.



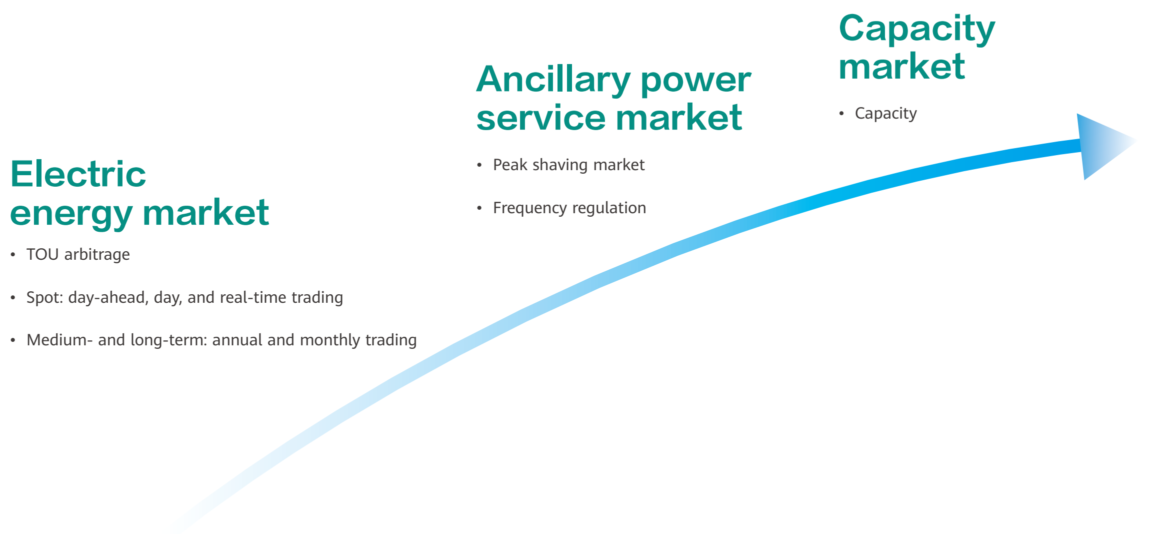
Some services in power markets of European countries

The VPP aggregates resources to facilitate services in the electric energy market, power ancillary market, and capacity market.

Electric energy market: Electric energy (unit: kWh) is the subject for trading. The electric energy market is divided into the spot market (such as day-ahead, intraday, and real-time trading) and medium- and long-term market (such as monthly and annual trading) depending on the time. The electric energy market can leverage the difference in peak and valley electricity prices to sell and buy electricity to reduce electricity costs. Electricity at the right price can be purchased as futures.

Ancillary power service market: This is a market in which services are provided by third parties, such as telecom site batteries, data centers, and aggregators, and generate benefits. Main services include frequency regulation (such as primary and secondary frequency regulation), peak shaving, reserve, and black start.

Capacity market: This is a market for trading reserved resources. Participators in the market buy or sell capacity through market competition to obtain sufficient capacity for stable power supply.



03 Telecom Operators' Transition: Evolving from Energy Consumers to Prosumers

In the process to curtail carbon emissions, ICT infrastructure, as the digital foundation of various industries, is playing an increasingly important role. As owners of ICT infrastructure, operators need to save energy and reduce carbon emissions. At the same time, they can use their own energy infrastructure and ICT technologies to construct a low-carbon society. In the past, operators were energy consumers, that is, supplying power to communication devices (Power for ICT). Driven by the new trend, operators can also use their resources to build a VPP, linking site power consumption and power grids, and evolving from energy consumers to prosumers. That is ICT for Power.

3.1 Operators Promoting Carbon Neutrality

Reducing operators' own carbon emissions

Operators have massive telecom sites with huge power consumption, high carbon emissions and little revenue increase. It is estimated that power consumption of operators will account for 3% of the total power consumption in China by 2030, and carbon emissions will reach 60 million tons. Against the background of carbon neutrality, operators are saving energy and reducing carbon emissions. They reduce construction costs and energy consumption by replacing equipment rooms at sites with cabinets and replacing cabinets with poles, reduce electricity costs and carbon emissions by deploying green power, and improve site energy efficiency (SEE) and visualize energy efficiency management by replacing lead-acid batteries with lithium batteries and deploying energy management systems.

Leveraging site energy storage resources to construct a low-carbon society

In addition to reduce carbon emissions of their sites, operators leverage their ICT resources and technologies to help various industries reduce carbon emissions. With rapid deployment of renewable energy on the load side and development of VPP business model, small and medium loads gradually participate in power market scheduling.

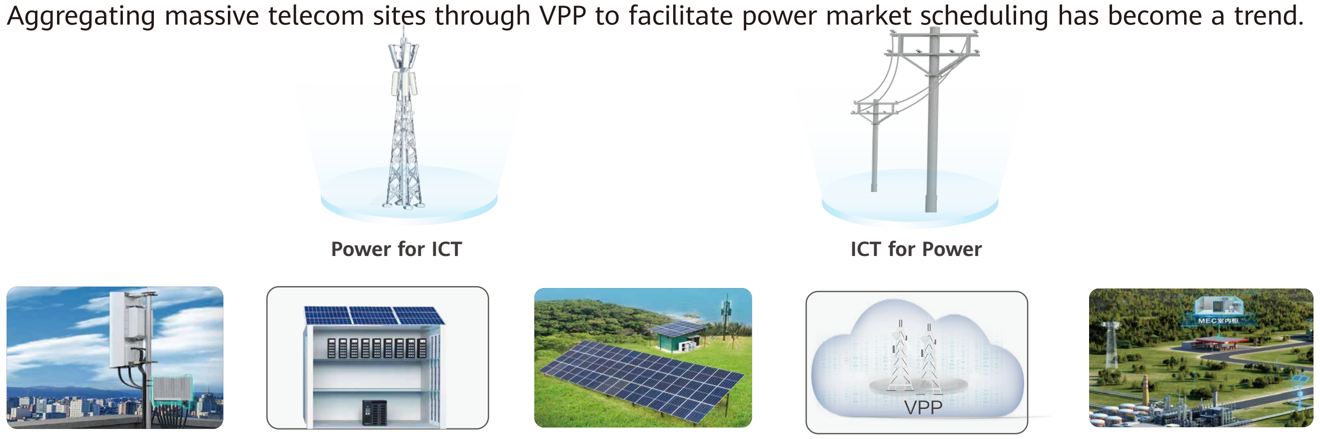
This trend drives operators to try to aggregate massive distributed site resources through VPP to facilitate power market services, reducing electricity fees and building an energy-efficient and low-carbon society.

In 2023, a European operator used site resources to facilitate the ancillary power service market of the country. By participating in peak staggering and frequency regulation services, the operator improved stability of the power grids and obtained considerable revenue. According to released data, the revenue of the operator reached 50% of its electricity fees, helping society reduce carbon by millions of tons.

In 2023, a large tower company in China also used telecom sites to facilitate ancillary power services. Released data shows that by June 2023, 4000 sites had participated in power markets through VPP. By the end of 2023, 10,000 sites have accessed the VPP.

In 2023, a large grid company in Latin America promoted operators to participate in power market transactions.

Aggregating massive telecom sites through VPP to facilitate power market scheduling has become a trend.



Operators contributing themselves to carbon neutrality

3.2 Modes and Business Types of Operators' Distributed Energy Storage Resources in Power Markets

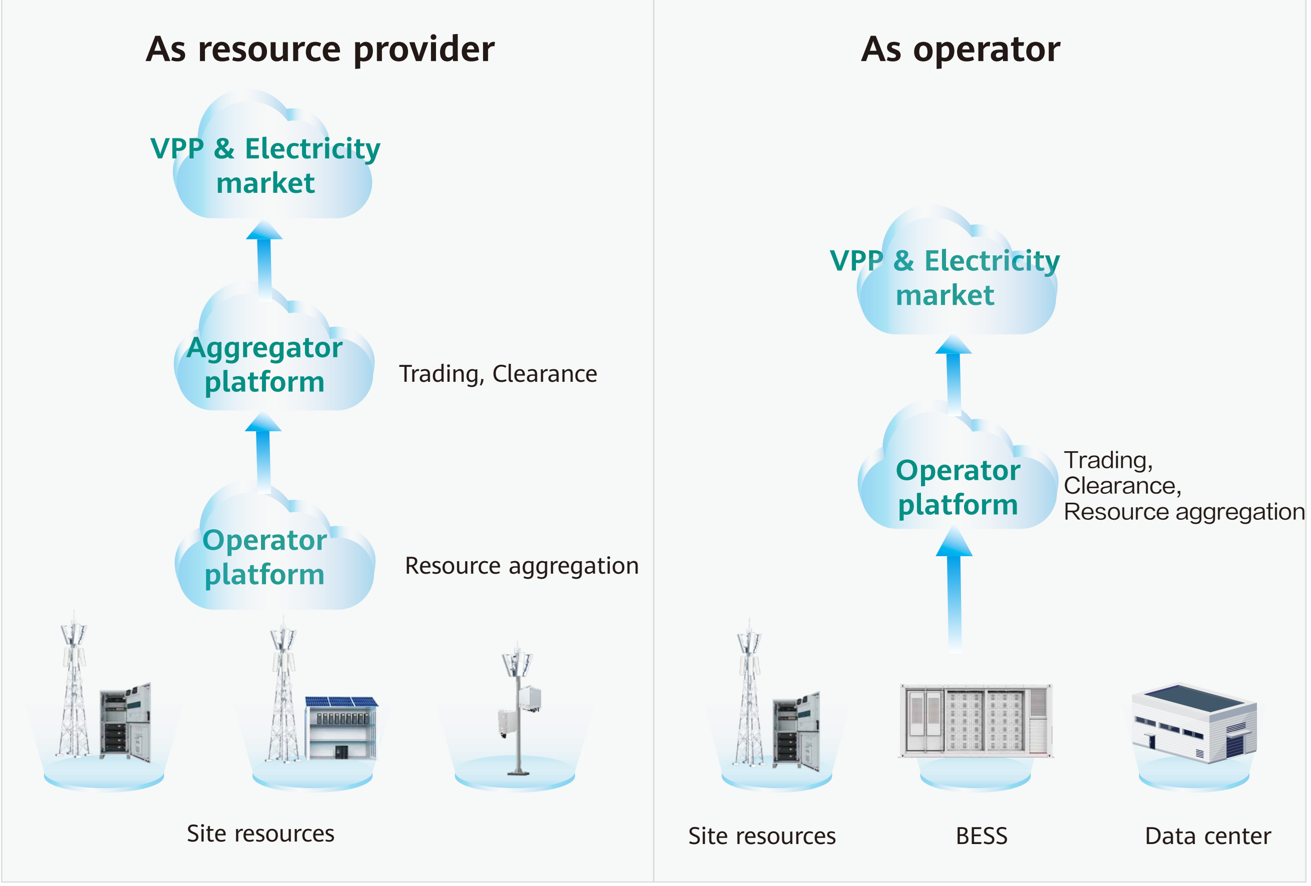
Operators can participate in VPP aggregation in various modes.

As resource providers: Operators provide massive sites as resources to VPP aggregators. The VPP aggregators use these sites to participate in power market services. In this mode, operators mainly provide site energy storage devices.

This mode is simple and requires only hardware and a little software investment with low operational risks. However, this mode is limited to the scheduling capability of aggregators. Therefore, the scheduling is passive and the benefits are limited.

As aggregators: operators build and operate the aggregation platform. They can aggregate not only their own site resources, but also other resources, such as C&I energy storage resources and air conditioners in buildings.

By operating the VPP by themselves, operators can schedule resources and control services more accurately. However, power service access often requires certification, operation risks are multiplied, and investment is large.



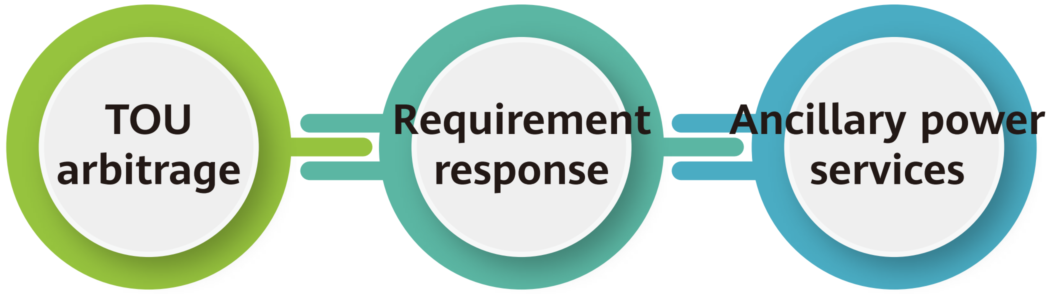
Operators participating in power market scheduling as resource providers or aggregators

Operators' distributed energy storage resources can participate in multiple power market services.

TOU arbitrage: With the implementation of peak and valley electricity prices, as large electricity users, operators can obtain benefits based on TOU electricity prices. They charge batteries when the electricity price is low and discharge batteries when the electricity price is high, thereby reducing electricity fees.

Demand response: Operators can increase or decrease site load power to respond to demands of electric power enterprises and obtain benefits. The main service type is day-ahead peak shaving.

Ancillary power services: Through power market scheduling, loads can participate in day-ahead and intraday peak shaving and frequency regulation of power grids to balance the power grids. For day-ahead and intraday peak shaving, operators reduce power consumption during peak periods and increase power consumption during off-peak periods to improve utilization of power grids. For frequency regulation, operators use their energy storage devices to stabilize grid fluctuations at any time. Service types and indicators vary in different countries.



Operators participating in multiple power market scheduling

3.3 Advantages of Operators' Participation in Power Markets

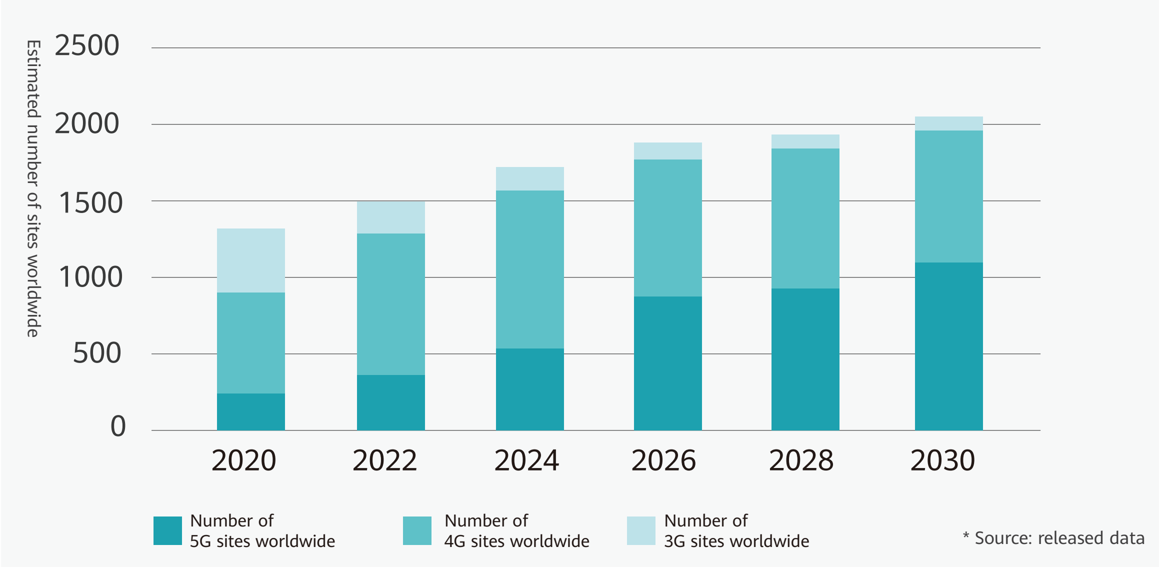
The ICT industry is the foundation of digitalization. Operators have unique advantages in participating in VPP services:

First, massive idle energy storage resources.

Operators have massive batteries. According to released data, the distributed adjustable capability in Europe can reach 15 GWh, while there are 2.6 million 5G sites with a better adjustable capability in China.

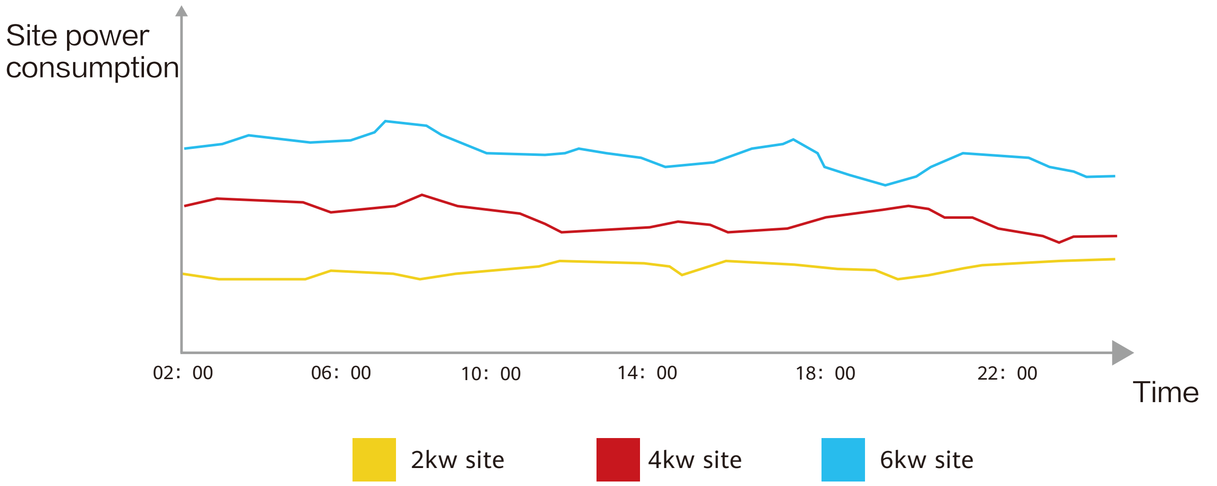
In the 4G/5G era, operators deploy a large number of lithium batteries to gradually replace lead-acid batteries. Lithium batteries have long lifespan, large charge and discharge rate, and are easily controlled through digital means. They can meet the requirements of multiple power market service indicators.

Operators' batteries only provide backup power for telecom sites. At present, for regions with stable power supply where the annual average power outage duration is short, batteries are idle for most of the time. By using intelligent technologies to pool lithium batteries, the lithium batteries can easily facilitate the power market scheduling.



Number of sites worldwide

Second, stable and reliable high-power consumption loads. Operators' energy consumption mainly comes from communications devices, which keep running uninterruptedly and are less sensitive to different time periods. It is estimated that by 2030, the total power consumption of operators will reach 3% of the total power consumption of the society. Based on stable loads and flexible and controllable site batteries, operators can accurately control the site capability. When providing resources for power market scheduling, operators can report more accurate capabilities.



Simulation of load power consumption of sites in an area

Third, simple and fast deployment.

Thank to the following advantages, operators can simply and fast deploy sites to participate in power scheduling services. (1) Operators have sites and do not need to apply for new sites.

(2) Telecom sites accessed the VPP are distributed. The power of a single site is limited. Operators do not need to reconstruct power grids and deploy additional transformers.

(3) Telecom site batteries adopt natural cooling without cooling devices, reducing energy consumption.

(4) Additional networks are not required because sites have sufficient network resources

3.4 Concept and Measurement Factors for Operators Using Distributed Energy Storage Resources to Participate in Power Markets

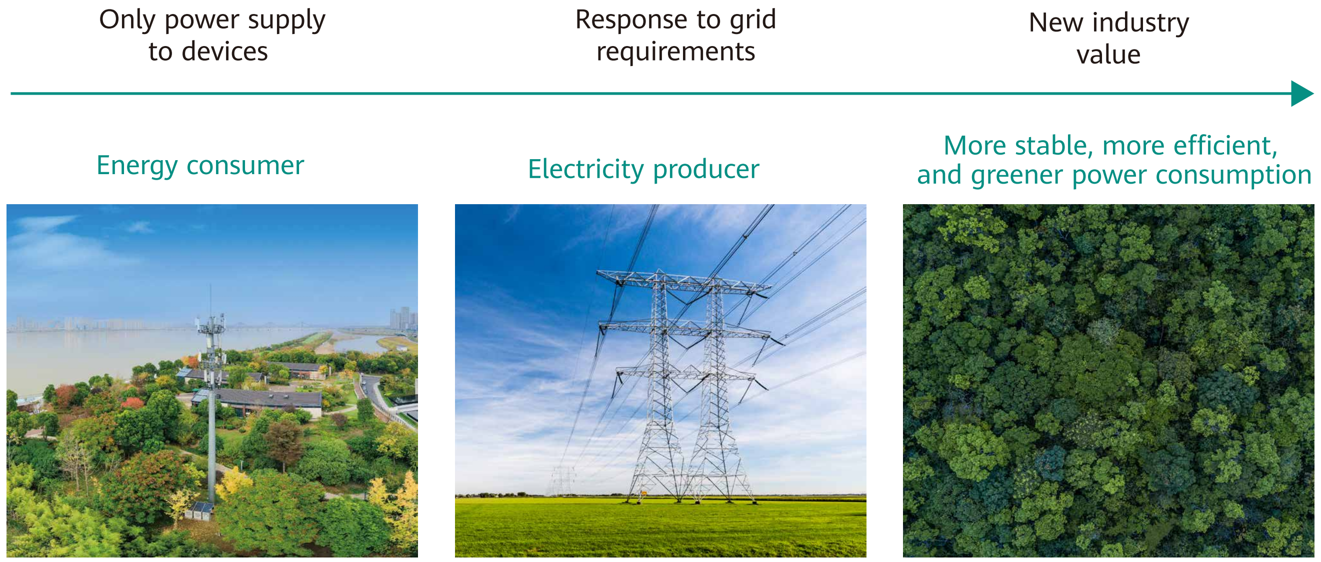
3.4.1 Concept: Evolving from Consumers to Prosumers and Achieving Bidirectional Energy Flow

Traditionally, operators use power grids only to supply power to devices at sites. The devices do not interact with power grids. From the perspective of power consumption, the operators are energy consumers.

If operators participate in power markets through VPP, telecom sites need to interact with the power markets and adjust their power consumption according to the instructions of the power markets. With regular deployment of green power, green power is also used for site power supply, finally realizing generation-grid-load-storage synergy.

In this case, operators become energy operators. They produce green power and collaborate with power grids. In the future, the operators' power may feed grids. For power consumption, the operators become energy producers.

Therefore, it is an important concept for operators to participate in VPP construction from unidirectional energy flow to bidirectional energy flow, and from energy consumers to prosumers.



Single → dual services, unidirectional → bidirectional energy flow

3.4.2 Value Measurement Factors: Cleanliness and Low Carbon, Security and High Efficiency, Flexibility, and Intelligent Convergence

To participate in the construction of a VPP service system, operators need to ensure the following value elements:

Cleanliness and low carbon: The system shall be simple with less implicit costs such as engineering costs. The system shall improve the utilization of green power, new energy storage resources, and existing power grids to achieve cleanliness and low carbon.

Security and high efficiency: telecom services and electric power services are important services for the national economy and residents. They have high requirements on stability and robustness. Therefore, secure software and hardware, and certified devices and vendors are required for a secure and efficient system.

Flexibility: Operators' sites are distributed. When site batteries and power supply devices collaborate with power grids, the capability of a single site is limited. Massive sites need to be aggregated into a large-capacity resource pool. Flexible construction and auto scaling will be an important measurement factor.

Intelligent convergence: The system must support multiple power market services and be applicable to future multiple scenarios, such as BESS access and data center energy storage access.

3.4.3 Evaluation Factors: Massive, Fast, and Precise Scheduling and Convergence

Power market services require large-scale resources, fast response, and high precision. Therefore, operators shall be evaluated from the following aspects for power market access.

Massive scheduling: In China, the peak shaving market access in many places requires 5 MW power. The frequency regulation market access in many European countries requires more than 1 MW power. Generally, the load power consumption of a site ranges from 3 kW to 6 kW. If the average power consumption is 4 kW, aggregation of 1 MW requires about 250 sites and aggregation of 5 MW requires about 1300 sites. If redundant sites are included for backup, 500 to 1000 sites are required for 1 MW and about 2000 sites are required for 5 MW. In addition, each operator usually has thousands to tens of thousands of sites.

Therefore, the capability of aggregating and managing massive sites is an important evaluation factor.

Fast scheduling: Ancillary power services require end-to-end fast response of the system. For example, the FCR service in a European country requires the system to respond within 10 seconds, and some services even require the system to respond within 1 second.

Therefore, fast system response is an important evaluation factor.

Precise scheduling: Power grids are high-precision operation systems. The frequent and subtle fluctuations require high-precision regulation capability of resources. In Europe, the aFRR service requires a regulation precision of higher than 90%, and the FCR service requires a regulation precision of higher than 95%.

Therefore, the high-precision adjustment capability of operator systems is an important evaluation factor.

Convergence: Most countries have multiple power market services. For example, there are three frequency regulation markets (aFRR, FCR, and mFRR) in Spain. At present, the peak shaving market is the mainstay in China, and the research on secondary frequency regulation is also carried out in various places in China. Different services have different indicators. One system that can meet the requirements of multiple services and support smooth service evolution is an important evaluation factor.

	Access Capacity	Regulation Speed	Precision
aFRR	≥1MW	5min	10%
FCR	≥1MW	7.5s	5%

FCR-D: Frequency Containment Reserve
aFRR: Automatic frequency restoration reserve

Some indicators of power market services in Europe

	Access Capacity	Response Time	Regulation Speed	Precision
Demand -side response	≥5MW	≤60s	60s	80~130%

Some indicators of power market services in China

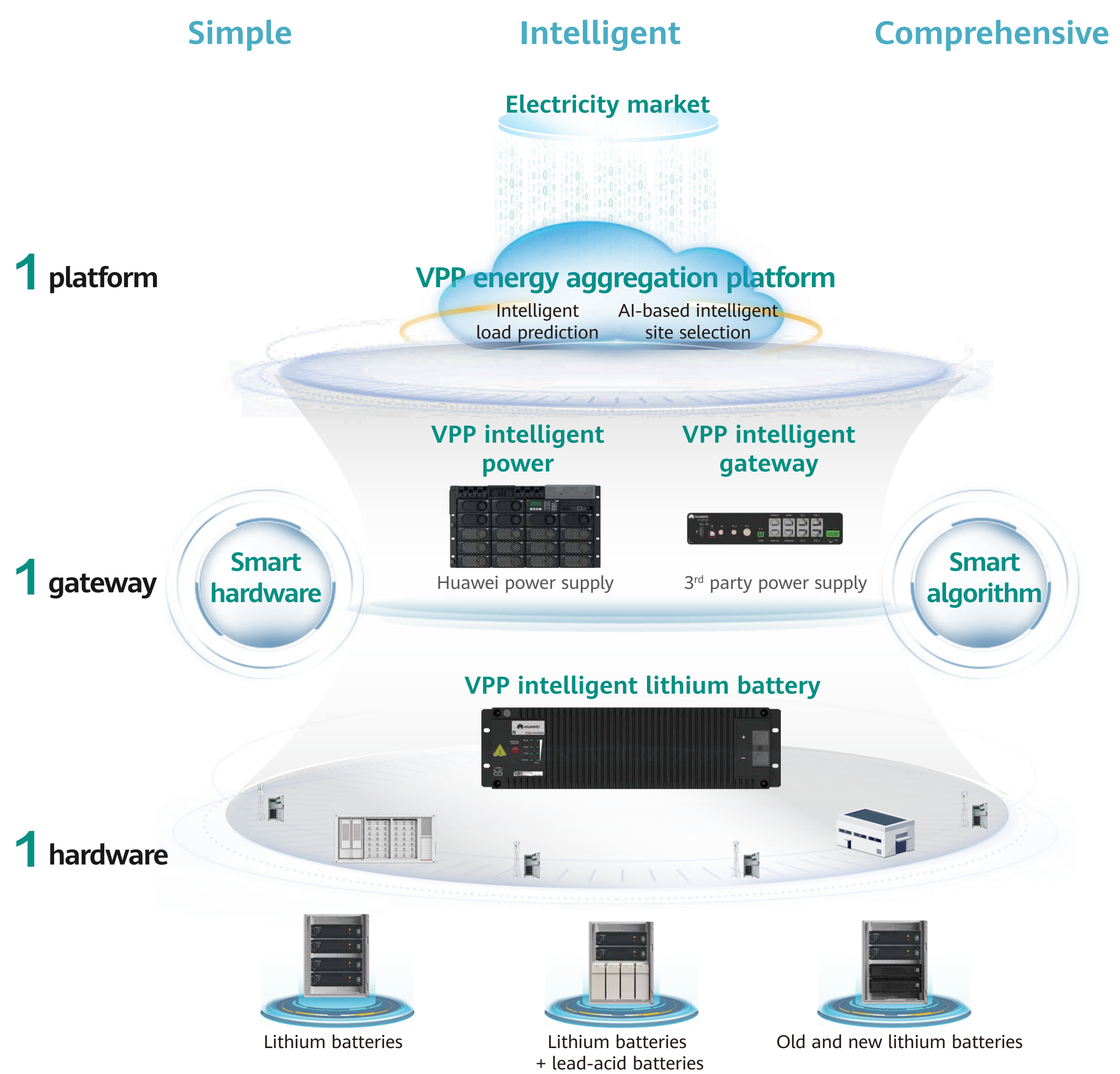
04
Huawei Site VPP Distributed Energy Storage System (DESS) Solution

Huawei proposes the DESS solution to drive operators' transition.

4.1 Optimal Simple Design

Huawei Site VPP DESS solution is an end-to-end solution that includes an energy aggregation platform, intelligent gateway, intelligent power supplies, and VPP CloudLi.
Hardware: VPP intelligent Lithium Battery (VPP CloudLi)
Gateway: VPP intelligent gateway and VPP intelligent power supplies
Platform: VPP energy aggregation platform (EAP)

Their functions are as follows:
VPP CloudLi: As an energy storage device for service scheduling in power markets, VPP CloudLi can provide capacity for scheduling and reserve a certain proportion of capacity to provide backup power for telecom sites.
VPP intelligent gateway and VPP power supply: Provide site energy storage aggregation and optimization services, and serves as an information transmission channel. It is a key node for the upper-layer platforms to deliver instructions and for transmitting battery response. Support Huawei power supplies and third-party power supplies.
VPP energy aggregation platform (EAP) : EAP is the general aggregation and scheduling center of operators' VPP sites. It connects to resource aggregators at the upper layer and connects to the VPP intelligent gateway at the lower layer to aggregate operators' telecom sites or other accessible resources. The EAP is an energy management and capability reporting system. It obtains and delivers instructions of the power markets through aggregator systems, selects optimal sites based on energy storage and gateway information, and reports the adjustable capability.
Huawei DESS solution is based on Huawei's leading intelligent hardware, algorithms, AI, power electronics, and information communication technologies. It features simplicity, intelligence, and multi-service convergence, helping operators easily, quickly, and securely develop site VPP services.



4.2 Features and Value: Simple, Intelligent, Comprehensive

Huawei DESS solution featuring simplicity, intelligence, and comprehensiveness bring value from multiple aspects.

4.2.1 Simple

Simplicity has the following characteristics:

(1) Service decoupling and full-scenario adaptation: The solution enables devices to decouple from the existing services and does not require specific power supplies, thereby adapting to all scenarios.

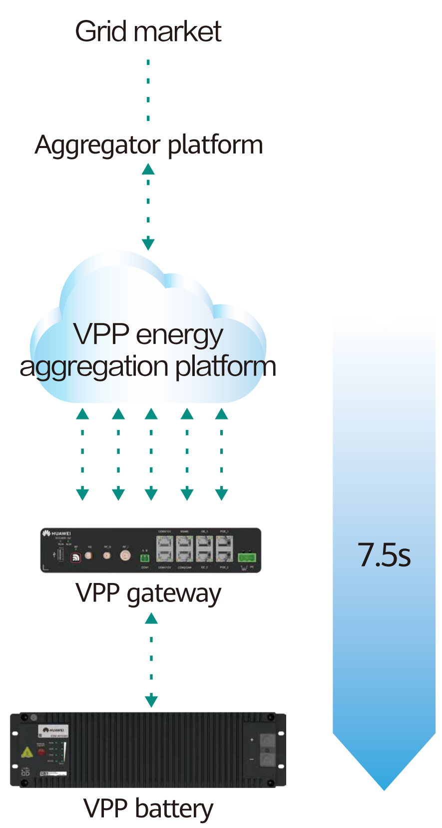
(2) Simple configuration and asset reuse: VPP CloudLi can be used together with batteries on the live network.

(3) Simple engineering and O&M, and ultra-short time to market (TTM): New devices can be installed easily without modernizing existing devices. Remote maintenance eliminates manual site visits.

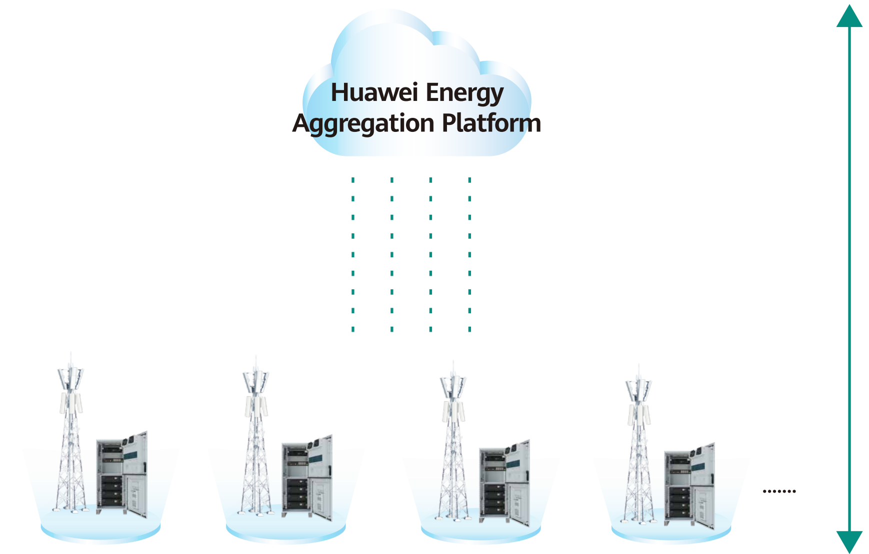
4.2.2 Intelligent

Huawei DESS solution uses multiple intelligent technologies to achieve massive, fast, and precise scheduling.

- Massive scheduling: the solution can aggregate up to 30,000 sites at the initial stage, meeting requirements on the quantity of connected sites, facilitating capacity expansion, and preventing customers from deploying multiple platforms in the future.
- Fast scheduling: The solution supports the end-to-end ultra-fast response within 7.5s. One system can meet scheduling requirements of multiple services in power markets, such as the peak shaving service and multiple frequency regulation services. This prevents operators from deploying multiple systems for multiple services.
- Precise scheduling: The system scheduling precision is higher than 95%, meeting requirements of multiple services in power markets.



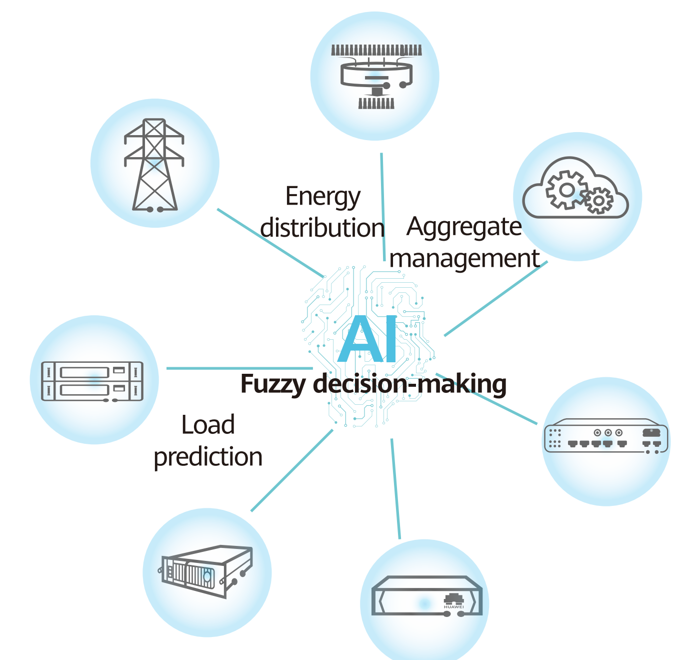
End-to-end ultra-fast response



Aggregation of massive sites, end-to-end fast and precise response

44.2.3 Comprehensive

Huawei DESS solution uses one system to support multiple services in power markets, such as peak shaving and frequency regulation in the ancillary power service market and peak staggering in the electric energy market. In addition, the solution supports service optimization, which enables the system to automatically evaluate service benefits and prioritize and report services to achieve best benefits. In addition, the system software can be custom for smooth evolution and reducing investment.



Convergence of multiple advanced technologies for DESS solution

4.3 Convergence of AI, Power Electronics, and Information Communication Technologies for Advanced DESS Solution

Huawei DESS solution converges power electronics, information communications, and AI technologies to help operators participate in power market scheduling.

4.3.1 Distributed Site Synchronous Communication Technology

Individual sites have small capacity and are distributed. When the sites are scheduled, they need to connect to each other and connect to an energy scheduling platform.

The energy scheduling platform sends real-time power adjustment commands to energy storage devices at more than 10,000 sites. The sites must respond and report power adjustment results to the platform at the same time.

This is a great challenge for distributed sites and requires ultra-fast system response.

Currently, most O&M platforms of telecom operators only monitor and diagnose basic device running status and do not support real-time energy scheduling. If energy scheduling commands are sent by the O&M platforms, the response time is too long to meet response requirements of power grids.

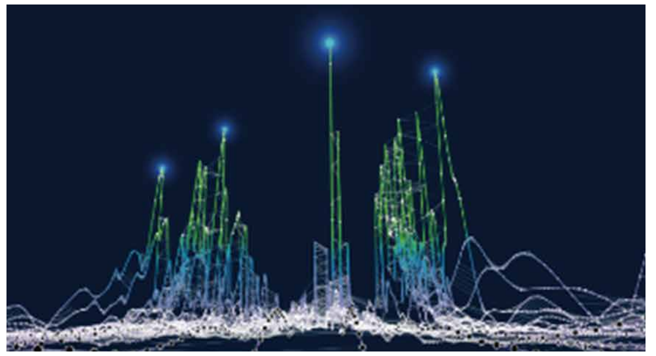
Huawei DESS solution builds a new energy scheduling platform for telecom sites based on the cloud-native super parallel computing technology. It supports synchronous communication with sites and energy scheduling management.

4.3.2 Fast and Accurate Site Load Forecast Technology

The power grid scheduling center needs to forecast power generation and power consumption of sites in power markets to formulate a balanced power consumption plan and make demand analysis in advance. Therefore, accurate load forecast is a basic requirement for telecom sites to participate in power scheduling.

Currently, although site loads are stable, little attention is paid to load power forecast, and this field faces great challenges. For example, the load power of a single site and multiple adjacent sites varies respectively depending on the time and the number of users. The energy storage resources at each site also vary. These factors affect load power forecast for more than 10,000 sites.

Huawei DESS solution can fast and accurately forecast load power at more than 10,000 sites and accurately analyze and report data based on advanced algorithms.



4.3.3 Accurate Evaluation of Energy Storage Adjustment Capability

When the power scheduling center makes a scheduling plan, sites need to report their adjustment capability in each specific period in the future. When operators evaluate the adjustment capability of sites, the operators shall consider changes in load power and site power backup requirements to ensure that the reported adjustment capability does not affect power supply for the sites.

Huawei DESS solution uses combined optimization algorithms to accurately evaluate the site adjustment capability and meet power backup requirements based on data, such as site power backup requirements, grid adjustment requirements, and lithium battery status.

4.3.4 Coordinated Scheduling of Site Energy Storage Resources

Site scheduling must be accurate and fast to meet grid requirements. The system must quickly select which sites can participate in scheduling and site energy storage resources must accurately and quickly respond to allocation requirements. Massive sites have different situations such as site communication failures, and different capabilities in terms of backup capacity and accuracy. As a result, how to quickly select stable and reliable sites to meet scheduling requirements is a great challenge. In addition, a large number of lead-acid batteries on the live network raise reliability requirements.

Huawei DESS solution ensures the accuracy of site selection and energy collaborative scheduling based on AI collaboration, load fluctuation forecast, and AI distribution algorithms without affecting the reliability of lead-acid batteries on the live network.

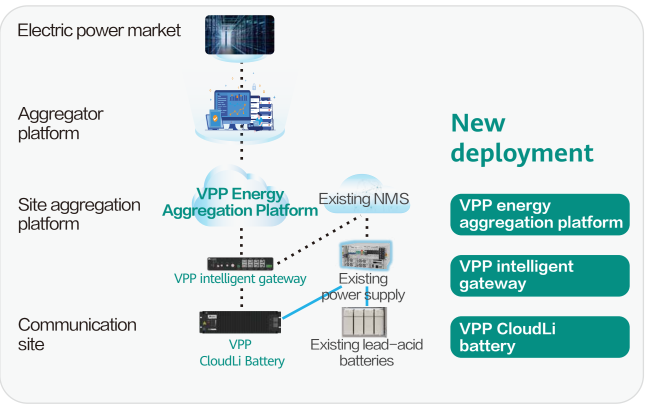
4.4 All-Scenario Deployment

Huawei DESS solution supports all-scenario deployment without requirement on specific power supplies.

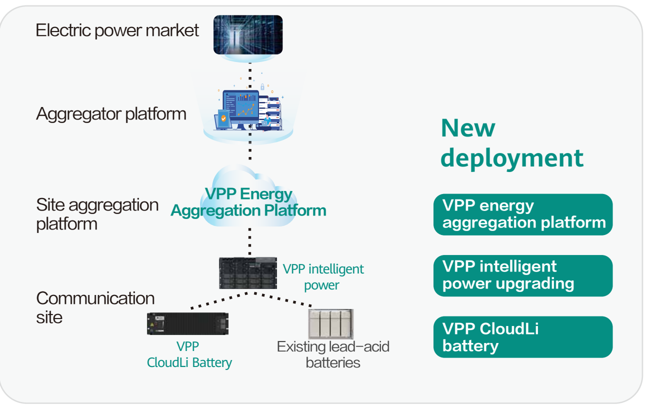
1, Hybrid use of new batteries and existing batteries

A large number of lead-acid batteries or non-intelligent batteries exist on the live network. These batteries are difficult to schedule and manage in VPP services. In addition, new lithium batteries deployed for the VPP conflict with existing batteries in terms of charge and discharge, affecting service running. With the intelligent energy balance, Huawei DESS solution can use new lithium batteries and existing batteries together. In this scenario, the existing batteries cannot participate in VPP services but can provide backup power. The new lithium batteries can provide the VPP scheduling capability and power backup capability. The solution supports intelligent optimization to achieve optimal allocation and use.

Existing battery scenario:
Deploying Huawei Dess at 3rd party power site



Existing battery scenario:
Deploying Huawei Dess at Huawei intelligent power supply site

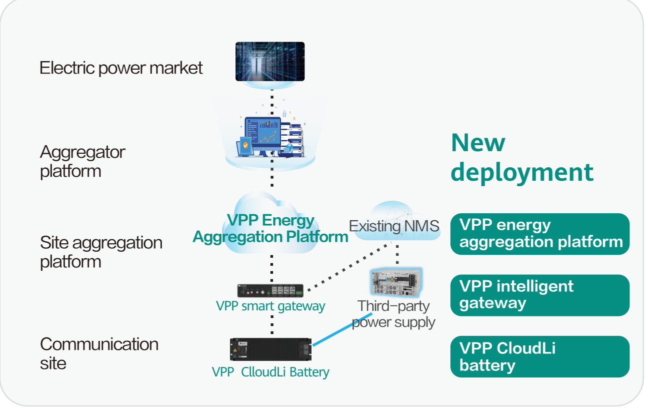


Hybrid deployment in Huawei DESS solution

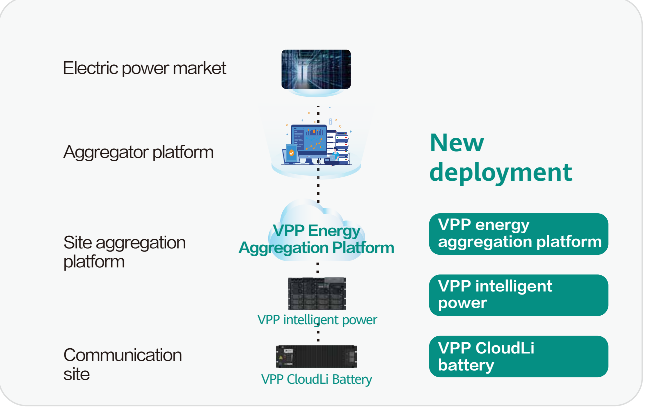
2, New Lithium Battery Deployment

New lithium batteries are deployed at sites for VPP scheduling and power backup. Operators can use intelligent optimization algorithms to achieve optimal allocation of the batteries.

New deployment scenario:
Deploying Huawei Dess at 3rd party power site



New deployment scenario:
Deploying Huawei Dess at Huawei intelligent power supply site

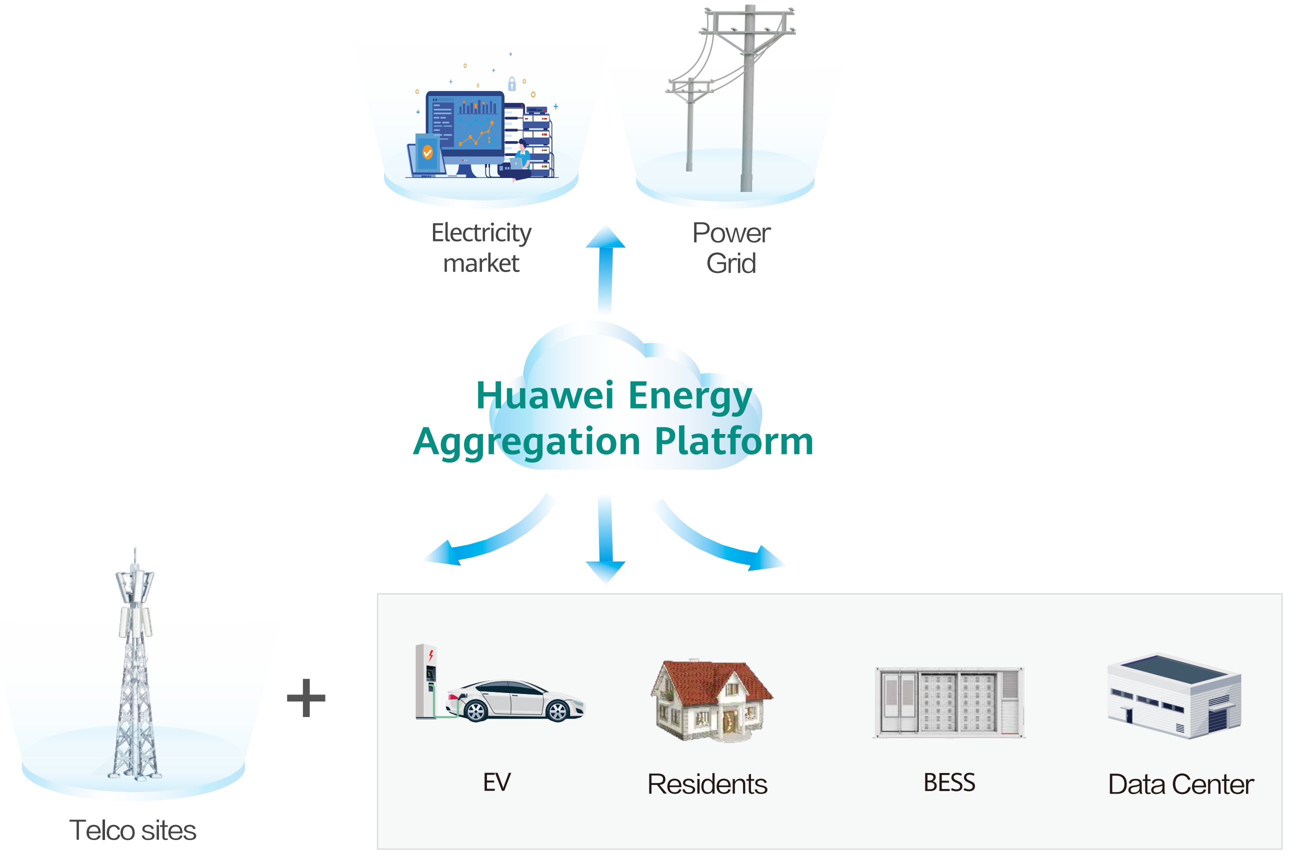


New Lithium Battery Deployment in Huawei DESS solution

4.5 Diversified Evolution of Distributed Energy Storage

Power grid indicators are applicable to all loads for power market scheduling. However, the massive sites involved in scheduling have different response speed and precision, and are difficult to manage. These characteristics require technologies that are applicable to all scenarios.

Huawei DESS solution supports management of massive sites and features fast response, high precision, and optimization. It supports evolution for diversified distributed energy storage scenarios. In addition to sites, energy storage resources in data centers, C&I scenarios, and charging stations owned by operators can also be involved in the solution for scheduling.



Future evolution for diversified scenarios

05
Green End of Power Consumption

Sites are the end of power consumption, which is an unobtrusive part. However, it is important to aggregate them because the number of sites is huge and keeps growing rapidly.
We believe that in the context of carbon neutrality, operators will increasingly aggregate their resources through VPP to participate in power market scheduling.
Balance power grids, save energy, and reduce carbon emissions.
According to the calculation, every 10,000 sites can provide 125 MW power for scheduling. The scale effect is obvious and the adjustment capability is equivalent to that of seventeen 100 MW thermal power plants. The social benefits are remarkable.
We sincerely invite you to build a low-carbon and green society.

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

One cabinet per site	One blade per site	Grid + solar power
700,000	**2.6 million**	**700 MW**

900 million kWh	**33.89 billion kWh**	**16.2 million tons**	**21.99 million trees**
green power generated	electricity conserved	carbon emissions reduced	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