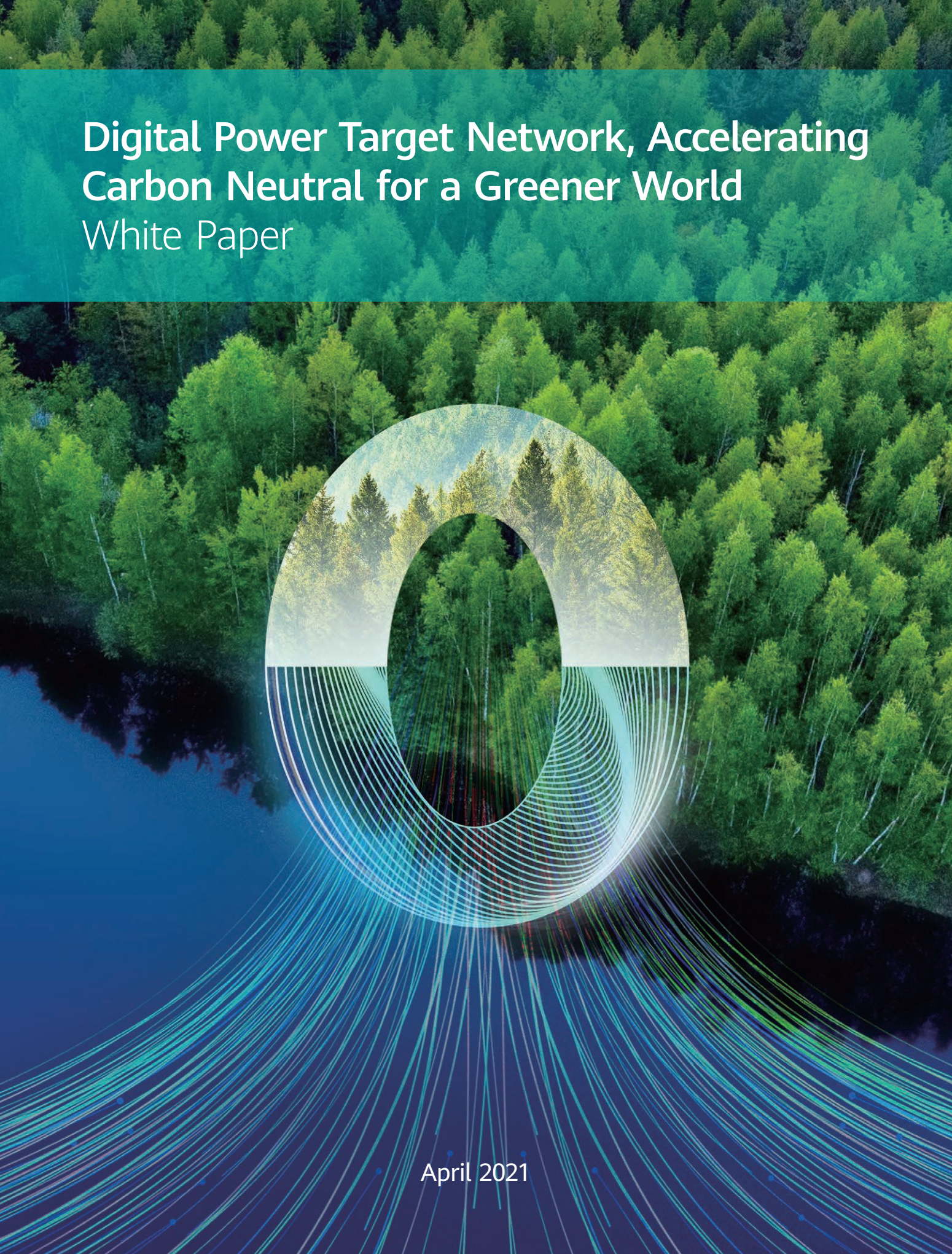
Digital Power Target Network, Accelerating Carbon Neutral for a Greener World

White Paper



April 2021

Executive Summary

In 2020, as the world marks the 5th anniversary of the landmark Paris Agreement on Climate Change, a promising carbon neutral movement is emerging.

At present, more than 110 countries around the world have committed themselves to the "carbon neutral" goal. On September 22, 2020, China explicitly proposed at the 75th UN General Assembly, that china will aim to hit peak emission before 2030, and strive to be carbon neutral by 2060. On 4th of March 2020, the EU published a draft European Climate Code, which decided to legislate to be carbon neutral by 2050. In October 2020, Japan and South Korea had announced the goal of achieving carbon neutrality by 2050.

While providing high-quality ICT services, carriers also regard setting carbon neutral targets as an important strategic goal. For example, Vodafone and Orange have proposed 'net zero' carbon emissions by 2040, while Telefonica has moved net zero emission target by 2030. In addition, Google proposes to achieve 24x7 carbon-free energy in all of its data centers and campuses around the world by 2030. Microsoft has pledged to be a carbon negative by 2030 and by 2050 Microsoft will remove from the environment all the carbon the company has emitted either directly or by electrical consumption since it was founded in 1975.

Operators existing energy infrastructures are facing enormous challenges and need to be changed. Traditional site energy construction mainly involves auxiliary equipment, which brings high energy consumption and high OPEX. Take example of "carrier A" in china, according to the 5G construction plan in the next five years, it is predicted that the traditional energy construction will increase OPEX by 34%, with electricity fees being the main growth factor. In addition, data centers consume more than 160 billion kWh of power

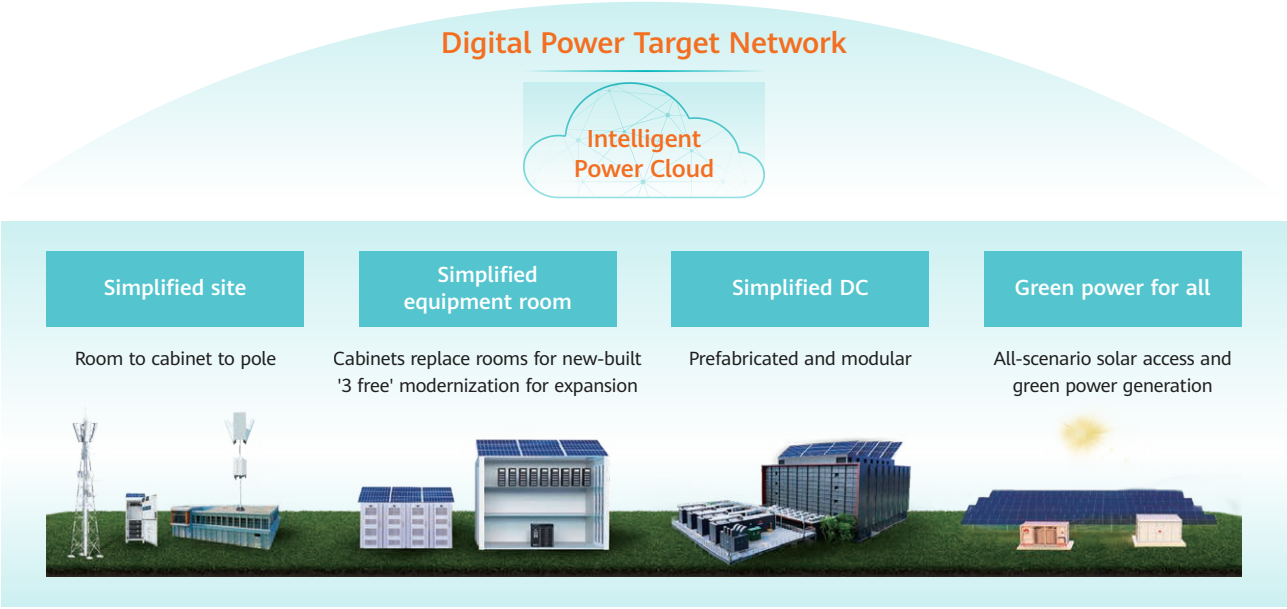


Figure 1 - Digital Power Target Network

in China in 2018, which is equivalent to the total annual power consumption of a large city. Cities such as Beijing, Shanghai, and Shenzhen have introduced low Power Usage Effectiveness (PUE) standards to reduce data center power consumption. In addition, electricity fees account for more than 60% of the Total Cost of Ownership (TCO) in 10 years, which has become a key factor in data centers lower profitability. However, traditional data center construction adopts the fragmentary construction mode, which leads to high PUE, high energy consumption, and long construction period. Therefore, it is imperative to change the data center construction mode.

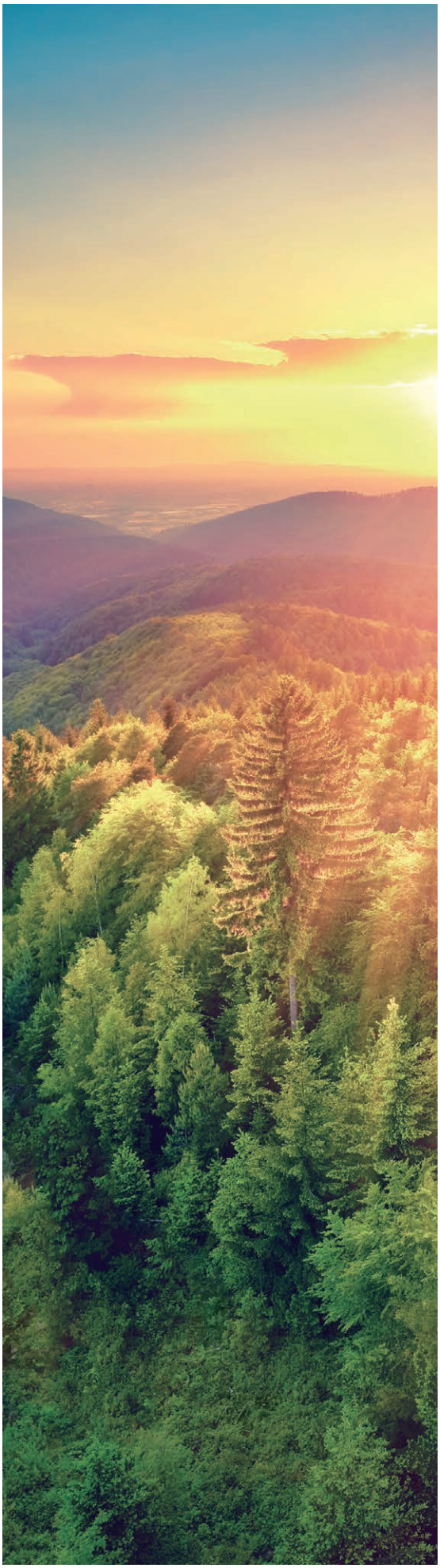
To help operators accelerate the carbon neutral progress, Huawei propose a digital power target network including five key solutions:

1. Simplified site
2. Simplified equipment room
3. Simplified data center
4. Green power for all
5. Intelligent power cloud.

Firstly, the construction of simplified sites, simplified equipment rooms, and simplified data centers helps operators improve energy efficiency and reduce energy waste.

Secondly, use operators' own sites, equipment rooms, and campuses to deploy solar PV, and thus transforming “energy consumers” to “energy producers” with green energy, and achieving ubiquitous green electricity.

Finally, energy infrastructure is a digitalized and with the use of advance cloud, Smart energy cloud improves energy efficiency and O&M efficiency and reduces energy consumption and O&M costs.



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Simplified site

Traditional base stations are mostly built in indoor equipment rooms and require air conditioners to for cooling the equipment's. Moreover, the Site Energy Efficiency (SEE) is only 60%, and the power consumption, civil engineering and rental costs are high.

A simplified site uses cabinet to replace room (one site, one cabinet) and pole to replace cabinet (one site, one blade). This further reduces air conditioner electricity costs, site energy consumption, and rents.

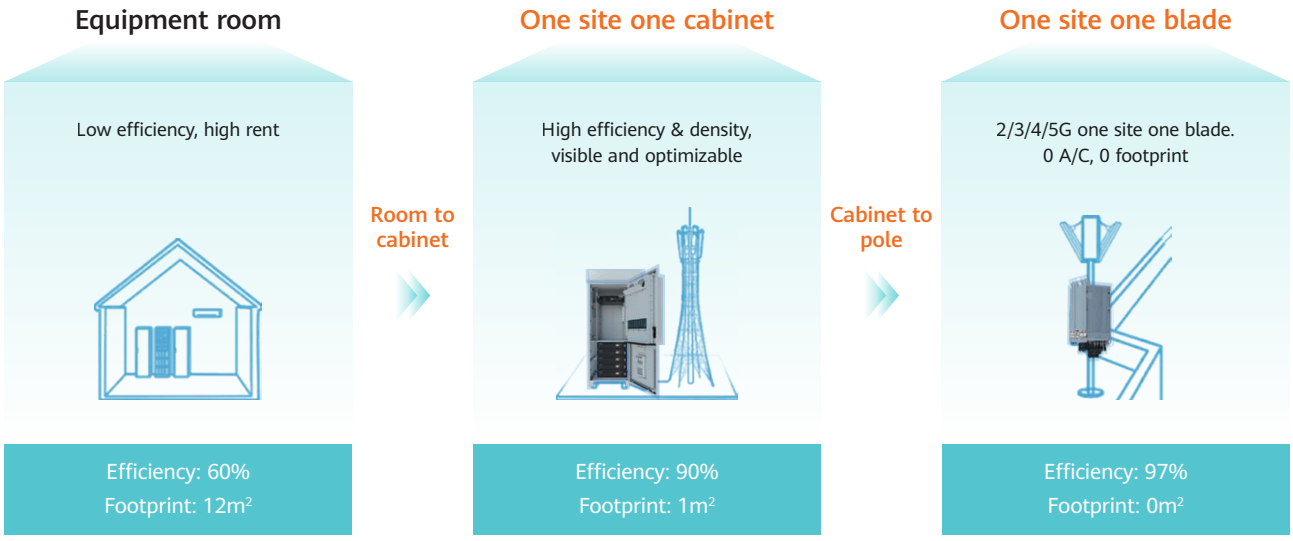


Figure 2 - Simplified Site Evolution from Equipment room to Cabinet and Cabinet to Pole

One site one cabinet

Huawei's one site one cabinet solution uses high-density power supply and lithium batteries. Compared with the traditional solution, the power supply and battery capacity of a single cabinet are doubled. Therefore, cabinet can be used to replace equipment room. First, the outdoor cabinet has smaller space and less heat leakage, and the cooling efficiency of the air conditioner is higher. In addition, the site uses ultra-efficient modules with 98% efficiency, which reduces energy consumption by 30% and Site Energy Efficiency up to (SEE) 90%, compared with indoor equipment room. Second, the site area is reduced from $12m^2$ to $1m^2$, which effectively saves the site rent. Moreover, the intelligent power supply integrated with intelligent circuit breakers enables visualized and remote control of the power consumption of each load at a site, thereby optimizing the power consumption of the site and effectively reducing site O&M costs.

In Guizhou, China, after the site reconstruction, one cabinet is replaced three existing cabinets on site, which effectively reduce the monthly rent and electricity cost by roughly $680, and the O&M cost is reduced by 75%.

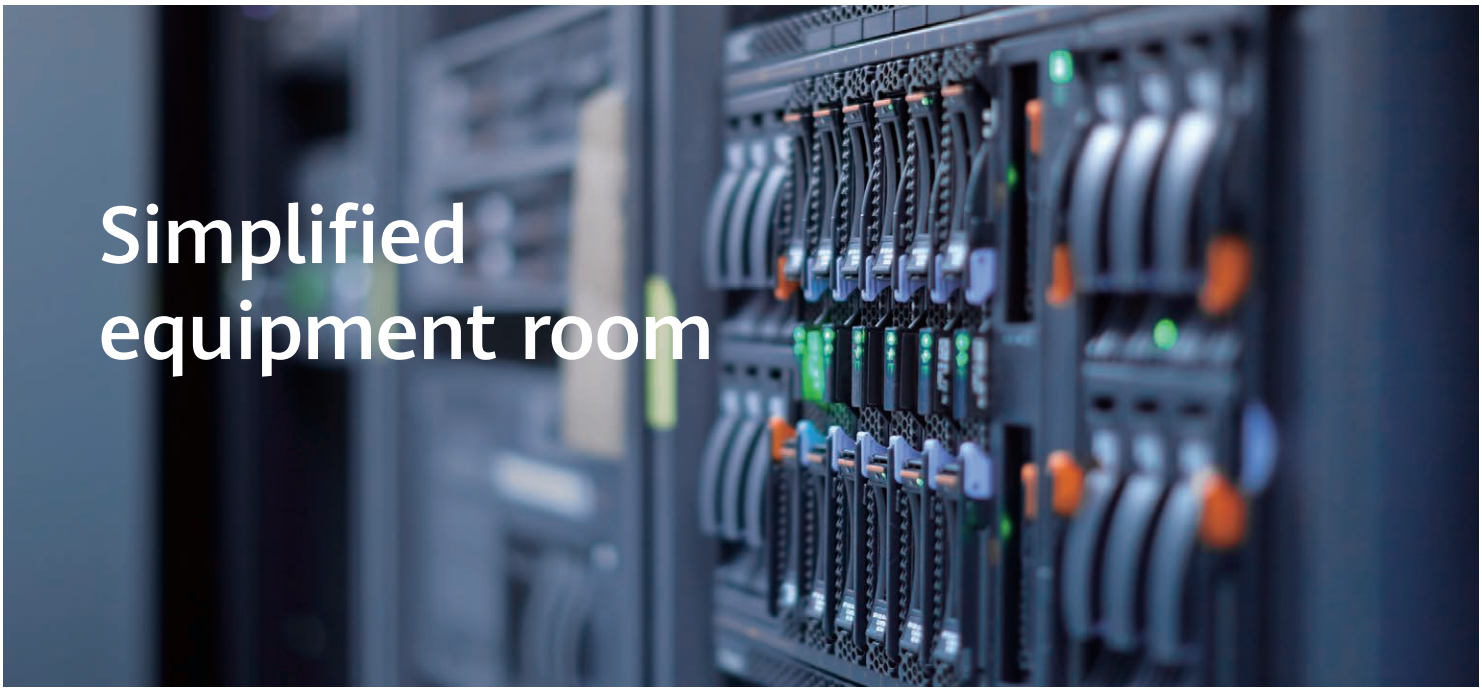
One site one blade

Based on the one site one-cabinet solution, Huawei further simplifies the site with one site, one blade solution. The blade power system uses a bionic endothermic root design to achieve natural heat dissipation, without air conditioners, eliminating noise and additional energy consumption caused by traditional fan heat dissipation. The Site Energy Efficiency (SEE) reaches up to 97%, which reduces energy consumption by 37% compared with traditional sites. Additionally, the entire site is deployed on poles, which ensures “0 footprint” and thus “0 rent” making site deployment extremely profitable. Finally, Huawei blade power system provides a maximum of 18 kW power, meeting the power supply and backup requirements of the entire site, achieving 2G/3G/4G/5G power supply.

In Japan, the one Site, one blade solution is widely used for site construction. Compared with traditional cabinet sites, the site rent is reduced by 90% (that is, $7,000 per site per year) and the electricity fee can be reduced by $900 per site per year.

Figure 3 - One Site One Cabinet

Figure 4 - One Site One Blade



Simplified equipment room

With the growth of services in the 5G era, equipment room resources are required. Existing equipment rooms are needed to be reconstructed. Restricted by the traditional energy infrastructure, the network access, aggregation, and core equipment rooms have problems such as low efficiency, large footprint, and difficult upgrade and reconstruction. In addition, if the equipment room on the live network cannot be upgraded, a new equipment room needs to be constructed which requires high investment, long period, and low energy efficiency.

Simplified equipment rooms include capacity expansion and new deployment, reducing investment costs and saving energy, space, and engineering.

Capacity Expansion Scenarios of Existing Equipment Rooms

There are a large number of existing equipment rooms on the live network. The efficiency of old power supplies is only 85%. In addition, the power supply, backup power, and heat dissipation capabilities of the equipment rooms are insufficient. During capacity expansion, there are many problems such as, high energy consumption, a large number of devices, complex engineering reconstruction, and insufficient space. Simplified equipment room solution, is free of new equipment room addition for capacity expansion on the live network.

The simplified equipment room solution uses advance lithium batteries and high efficiency rectifiers with 98% efficiency to reduce heat consumption and power consumption of air conditioners, improving the equipment room energy efficiency from 55% to 75%, and reducing power consumption by 20%. In addition, the solution uses the high-density and convergent central office power supply (CO-eMIMO) + intelligent voltage boosting (57 V) + CO CloudLi architecture to achieve "3 free" reconstruction.

Figure 5 - Simplified Equipment room

- **Free of new equipment room:** The existing 11 cabinets in the equipment room are replaced by 3 cabinets with high-density and convergent power supply. One central office power battery cabinet and two high-density BBU housing cabinets are used. Removing the traditional infrastructure, including multiple BBU housing cabinets, 48 V DC power, AC power, 24 V DC power, and multiple lead-acid batteries on the live network, saving 70% of the space and thus supporting the deployment of more new devices.
- **Free of cable modernization:** Intelligent voltage boosting increases the output of PSUs and lithium batteries to a constant 57 V, increasing equipment room cable capacity by 30%, and thus meeting power supply requirements after load expansion.
- **Free of new Air conditioners:** CO CloudLi are used to replace lead-acids batteries. The traditional lead-acid batteries are required to operate at lower temperature about 25°C. However, the advance lithium batteries operate at 35°C, so with the lithium batteries the temperature of air conditioners in the equipment can be adjusted from 25°C to 35°C. Rectifiers with 98% efficiency are used to reduce heat consumption of the power system and cooling energy consumption of air conditioners, achieving precise heat dissipation and resolving heat dissipation problems in the equipment room.

An equipment room in Shenzhen, China was reconstructed with a simplified equipment room solution. 11 cabinets were replaced with 3, saving 70% of the space and saving $5,300 per site per year.

New Equipment Room Construction Scenario

Traditional equipment rooms have low energy efficiency and complex site deployment. Additionally, with ICT convergence requirements multiple sets of power supplies are required. Huawei launched iSuperSite solution. Cabinets are used instead of equipment rooms, improving energy efficiency from 60% to 90% and reducing energy consumption by 30%. In addition, no equipment room is required and hence it will reduce civil work, saving 72% of the investment and 83% of the construction period. In addition, new sites use the ICT converged power supply architecture to support ICT converged power supply and evolution, making the scenarios more diversified.

A carrier in Mexico used iSuperSite instead of traditional equipment room. The investment of a single site is reduced from US$100,000 to US$20,000. The TTM is shortened from 30 days to 5 days, greatly reducing the site investment and construction period.

Figure 6 - iSuperSite Solution

Simplified data center

As digital transformation accelerates, data centers serve as the foundation of an intelligent world. Cloud DCs become larger and edge DCs become smaller. The IT power density keeps increasing, resulting in huge energy consumption. According to the prediction of *Digital Power Industry Work Group Expert Committee*, the global data center energy consumption will increase rapidly from 670 billion kWh in 2020 to 950 billion kWh in 2025, accounting for 3% of the global total electricity consumption.

The simplified data center solution uses prefabrication and modularization to reduce power consumption and accelerate the construction of next generation data centers.

Huawei has changed the traditional data center construction mode by **reshaping the architecture, cooling, power and Operation & Management** to reduce power consumption, shorten the TTM, and build simple, green, smart and reliable next generation data centers.

Reshape Architecture

Traditional data centers are constructed in the fragmentary mode, components are purchased separately and integrated onsite. The construction period lasts more than 20 months, and the actual PUE cannot reach the designed PUE. With prefabricated and modular solutions, Huawei reduce the construction period from 20 months to 6 months, ensuring that the actual PUE is consistent with the initial design. The recycling rate of steel structures exceeds 80%, saving 80% of water for construction, and implementing the concept of green environment protection. In addition, the Lego like design concept of one DC is used to build on demand, further implementing vertical elastic capacity expansion and reducing customers' initial investment.

In Shenzhen, the 1000 cabinet data center was delivered in only six months. In addition, Huawei preconfigured modular construction mode is used to implement flexible and online capacity expansion, reducing customers' initial investment by 40%. Modular data centers are preconfigured, reducing TTM by 50%.

Figure 7 - Modular Prefabricated Data Center with 1000 Cabinets

Reshape Cooling

The cooling system of a traditional data center uses the chilled water solution, which consists of 7 components and requires 4 times heat exchange, causing severe energy loss during heat exchange. In addition to the power consumption of IT devices, the cooling system of the data center accounts for more than 70% of the power consumption. The engineering is complex, the cooling efficiency is low, and the water consumption is high.

Huawei introduced Indirect Evaporative Cooling (IEC) solution and iCooling solution to maximize the use of natural cooling sources. Digital intelligent optimization to save energy and reduce emissions at cooling side.

- **In the indirect evaporative cooling solution,** the heat exchange rate of the temperature control system is reduced from 4 times to 1 time, which fully utilizes available natural cooling sources, shortens the working time of the compressor, and greatly reduces the power consumption of the cooling system.
- **Digital intelligent optimization iCooling solution,** collects cooling system parameters using a large number of sensors, uses neural network deep learning algorithm to perform data modeling and inference, and provides the optimal optimization solution in real time, reducing the PUE of large data centers by 8 to 15%.

In Beijing, the data center adopts Huawei's indirect evaporative cooling + iCooling solution to replace the traditional chilled water system, saving 42% of the refrigeration system and saving 40% of the cost.

Figure 8 - Indirect Evaporating Cooling and iCooling Solution

Reshape Power

The power supply system of a traditional data center uses distributed component integration, which occupies a large area, has low efficiency, and has low reliability. Huawei launches a full-chain converged, high-density, high-efficiency, and energy-saving power supply solution. Through innovation in power supply and distribution and backup energy storage systems, data center power supply is highly efficient and achieves significant energy-saving.

- The efficiency of the traditional UPS solution in the industry ranges from 95% to 96%. In addition due to the link loss of low-voltage power transformation and distribution, the system efficiency of the entire link cannot reach 94%. **Huawei's intelligent power module solution** integrates the entire power supply and distribution link from low-voltage power transformers to IT devices, implementing a one-line power supply architecture. Working with Huawei's intelligent online mode, the power supply and distribution efficiency reaches 97.6% while reducing the footprint by 40%. Efficient power supply and distributed devices can reduce power consumption by 3% to 4%, saving energy and reducing emissions on the power supply and distribution side of the data center.
- The traditional backup solution uses lead-acid batteries, which are large in size and with few charging and discharging cycles. The life cycle of the battery is only 3 to 5 years, far less than the life cycle of the data center which is 10 to 15 years. The battery needs to be replaced two to three times during the life cycle of the data center. Huawei's Lithium for all approach, utilizes advanced lithium batteries the energy density of **lithium batteries** is much higher than that of lead-acid batteries, saving 70% of the energy storage space. The recharge and discharge times of lithium batteries are 10 times that of lead-acid batteries. In addition, the life cycle of lithium batteries can reach more than 10 years, matching the life cycle of data centers. The smaller battery size and fewer replacements allow the production of batteries with lithium battery energy storage solutions to have much lower carbon emissions than lead-acid solutions.
- In terms of reliability assurance, **Huawei's iPower** has more than 200 built-in sensors in the power module and supports full-link visualization and management, implementing passive response to proactive and predictive maintenance, ensuring data center security and reliability.

Figure 9 - Huawei iPower POD solution

The Suzhou data center in Jiangsu, china uses Huawei's smart lithium battery solution, which saves 70% of the space occupied by backup power and improves the power supply efficiency by 2%.

Reshape O&M

After the data center is delivered, each module cannot work in the optimal state for a long time. Therefore, the data center needs to be continuously optimized and maintained. Traditional data centers rely on manual O&M, resulting in low O&M efficiency and resource utilization. **Huawei iManager** solution is based on digital visibility, integrates expert O&M experience databases, and uses intelligent robot automatic O&M to implement "data center autonomous driving", and effectively reducing O&M costs by more than 35% and improving data center resource utilization by 20%.

In Wuhan, Huawei's intelligent O&M solution improves data center O&M efficiency by 35%, shortens root cause time by 60%, and improves rack utilization by 20%.

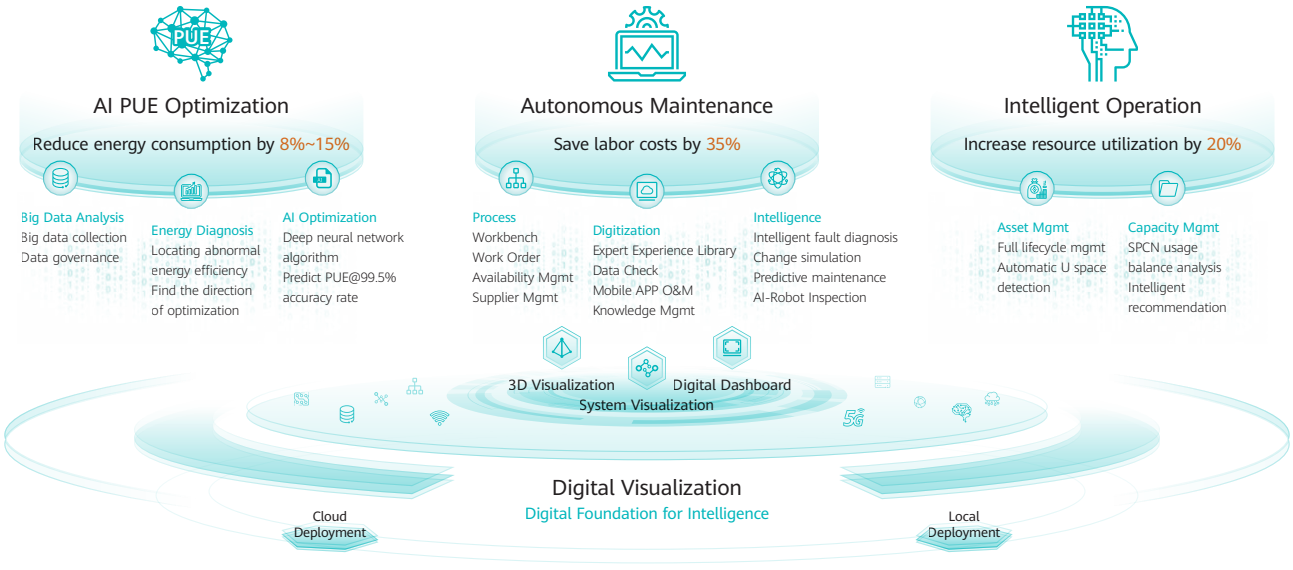


Figure 10 - Data Center Autonomous Driving

Solutions such as simplified sites, simplified equipment rooms, and simplified data centers can greatly reduce energy waste, reduce the energy consumption, and efficient energy utilization. But to achieve the ambitious goal of carbon neutral, green energy needs to be applied into the entire network.

Green power for all

The Green Power Ubiquitous Solution introduces green power generation to all scenarios, achieving ubiquitous green power, and further helping the operators to accelerate carbon neutral progress.

Figures from the International Renewable Energy Agency's (IRENA) 2019 Renewable Generation Cost Report show that photovoltaic costs have fallen by 82% since 2010. Photovoltaic power generation has entered the era of "equivalent access" and has been widely used around the world.

Deploy solar PV using existing resources.

Carriers can deploy solar PVs based on existing sites, equipment rooms, data centers, and community rooftops, and use existing energy storage resources for self-use, reducing mains usage and saving electricity fees. Huawei provides industry green power solutions to effectively reduce power consumption costs. First, industry green power solutions use component-level optimizers to increase energy yield by up to 30%. In addition, the

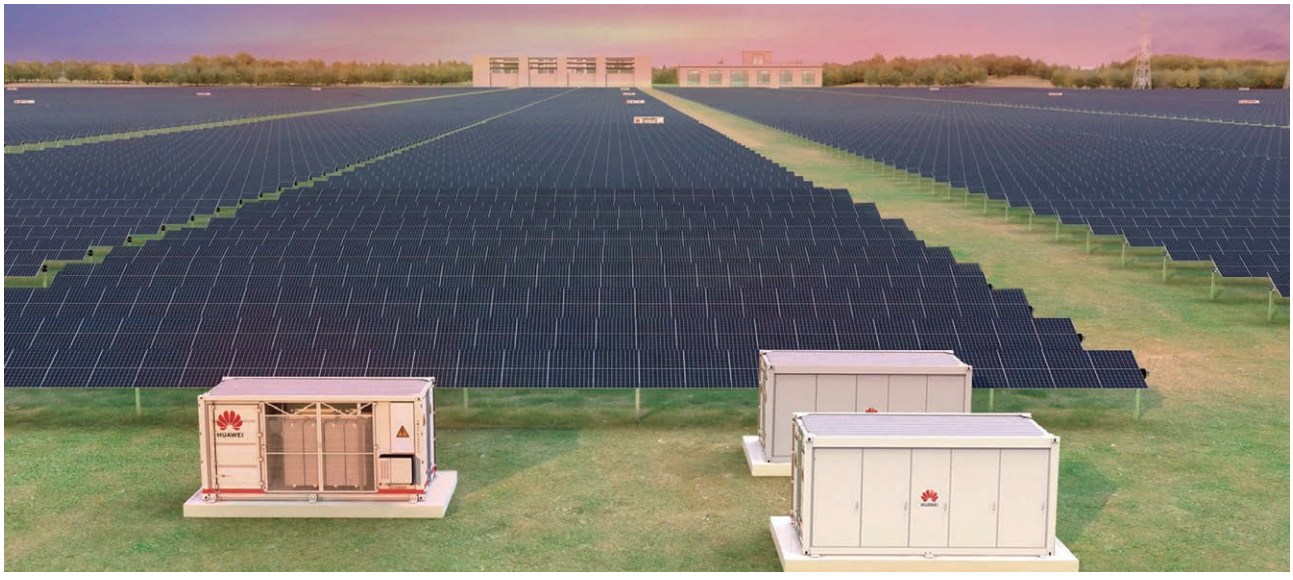


Figure 11 - Solar Panels and Storage Convergence for Higher energy yield

intelligent string-based energy storage system fully unleashes the capabilities of each energy storage module, helping the industry achieve 100% green energy. In rooftop PV applications, absolute safety is also required. Huawei's Green Power Solution provides the industries highest-level Active Arc Fault Circuit Interrupter (AFCI). When an arc is generated, it can be quickly cut off the circuit within 0.5s to prevent fires.

Purchase/Co-construction

If operators have difficulties in deploying their own resources such as sites, equipment rooms, data centers, and campus rooftops or have insufficient power requirements, they can **jointly build PV plants with power operators or purchase green electricity** to achieve 100% clean power supply and reduce power consumption costs. In large-scale terrestrial power plant scenarios, Huawei leads string inverters with advanced multi-channel MPPT, high-efficiency conversion, and smart tracking technologies, improving system energy yield by over 3% compared with traditional centralized solutions. This year, Huawei will launch an intelligent string-based optical storage system that supports DC-coupled architecture, reducing power consumption by 7% compared with traditional devices.

- *In Greece, after the existing base station was introduced with solar power access and after replacing equipment room with cabinet, the operator reduced the mains power usage by 51%, saved 14,500 kWh per year, and reduced 10 tons of carbon emissions per site per year*
- *In Zhuhai, China, solar power access is applied to the equipment room, achieving 100% green power supply.*
- *In Dongguan, China, a 17.5MW rooftop solar plant can generate 21.18 million kWh of electricity per year. Saving 70% of the mains*
- *In Qinghai, China, the data center is powered by 100% green energy to help achieve the goal of green data center.*

Green power for all: all-scenario with solar access and green power generation, helps to achieve carbon neutral

Figure 12 - Solar for All Ensures Green power in all Scenario

Intelligent power cloud

The smart energy cloud solution helps carriers reduce energy consumption costs and improve energy efficiency by integrating source-network-load-storage smart energy.

First, in the traditional energy infrastructure construction mode, the source-grid-load-storage construction is independent and lacks unified management and coordination, resulting in low energy efficiency and high energy consumption costs. The smart energy cloud uses digital technologies to implement efficient device management, energy scheduling, and energy efficiency management for the entire energy infrastructure target network through integrated collaboration. It builds an integrated smart energy system from green power generation to efficient power consumption, achieving optimal overall energy efficiency and greatly improving energy utilization efficiency. Reduce energy costs.

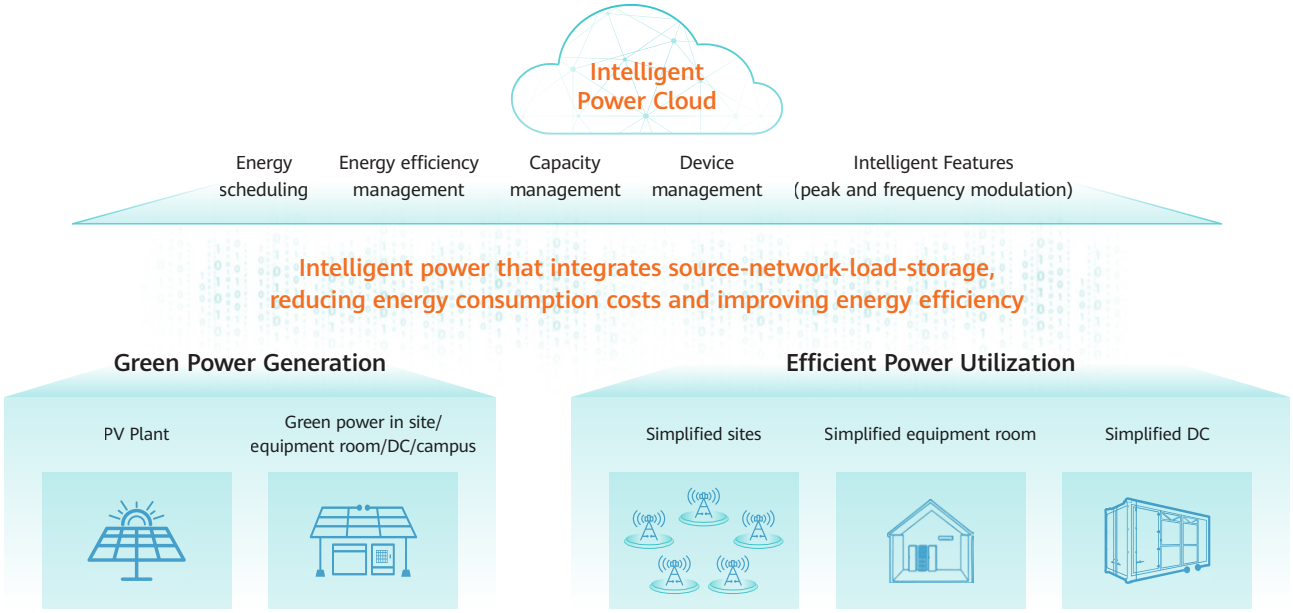


Figure 13 - All-scenario collaborative energy management network

Second, the smart energy cloud uses digital technologies to replace traditional manual O&M with Intelligent unmanned O&M. This resolves the inefficient problem caused by manual dependence on power production, device O&M, and energy use in traditional modes and improves O&M efficiency.

Third, comprehensive applications, such as peak adjustment and frequency modulation and cloud-based peak staggering, implement unified management of the energy network, further improve energy efficiency and reduce OPEX.

At a site in Zhejiang, China, Cloud staggering function of the intelligent energy storage system enables the energy storage system to charge during the mains supply trough and peak hours, reducing electricity costs by nearly 17%.

Key Points

With the rise of the global carbon neutral movement, the transformation of energy structure is accelerating. Digital power integrates power electronics and advance digital technologies such as big data and cloud.

Simplified site, simplify the site form from indoor site to outdoor site to outdoor blades. In this way, rooms can be transformed into cabinets and cabinets into poles, reducing power consumption, electricity costs, and rents.

Simplified equipment room, are replaced by cabinets in new deployment scenarios. In capacity expansion scenarios, new equipment rooms, cables modernization, and new air conditioners are not required, saving energy consumption, space, and engineering.

Simplified data center architecture is reconstructed through prefabricated and modular construction, shortening the construction period from 20 months to 6 months. Reconfigure power supply by integrating high-density and energy-efficient solutions, improving efficiency and implementing predictive maintenance. Indirect evaporative cooling and iCooling solutions are used to reconstruct cooling, reducing energy consumption by 17% compared with the traditional chilled water solution. The intelligent O&M solution is used to reconstruct O&M, improving O&M efficiency by 35%.

Green power for all introduces green power to sites, equipment rooms, and data centers to implement solar panel in all scenarios, building green connections and green computing

Finally, the intelligent power cloud integrates the intelligent management of source, network, load, and storage, greatly reducing power consumption costs and improving energy efficiency and O&M efficiency.

Conclusion

Carbon neutral is most pressing mission for the mankind. The carbon in our atmosphere is one of the key element changing the world's climate. Already, the planet's temperature has risen by 1 degree centigrade. If we don't act together to cut the carbon emissions, the results will be catastrophic for our future generation.

Carriers are providing advance technologies but there, the energy infrastructure is lagging behind. To achieve a goal of carbon neutral, the energy infrastructure must be transformed.

Digital power is designed to help carriers by transforming advance digital technology to power domain .Green power for all sites, equipment rooms, and data centers will build green connections and green computing, it will build a green forest of ICT network element.

To help operators to accelerate the carbon neutral includes efficient planning and green energy application in the entire life cycle from generation, distribution, storage and consumption. We will continue to innovate and make a greener planet.

List of Figures

Acronyms and Abbreviations

Acronym and Abbreviation	Expansion
AFCI	Arc-fault Circuit Interrupter
BBU	Baseband Band Unit
CO	Central Office in the core equipment room
DC	Data Center
eMIMO	Energy Multi-input Multi-output
ICT	Information and Communication Technology
IEC	Indirect Evaporative Cooling
MPPT	Max Power Point Track
PUE	Power Usage Effectiveness
PSU	Power Supply Unit

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