

# The Function and Application Prospect of Energy Storage in the Ubiquitous Power Internet of Things

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**Abstract.** Building a ubiquitous power Internet of Things is a key measure to achieve “three-type and two-network”. After long-term development, energy storage devices have become an indispensable part of the power grid. The number of electric vehicles in the country is strongly supported, and the number of uses is also increasing year by year. Based on this, the deep integration of energy storage and ubiquitous power Internet of Things is discussed. The role of energy storage in ubiquitous power Internet of Things is analyzed from three aspects: hub-type, platform-type and shared grid. The application in the ubiquitous power Internet of Things is not broad enough. Finally, the future energy storage in the sensing layer, network layer, platform layer and application layer is further involved in the ubiquitous power Internet of Things, and the energy storage safety is improved. The electric vehicle charging service market under the power Internet of Things was analyzed.

## Introduction

In March 2019, China state grid put forward the concept of “ubiquitous power Internet of things”. According to the construction outline of ubiquitous power Internet of things issued by state grid corporation of China, “ubiquitous power Internet of things” refers to the information connection and interaction between any time, any place, anyone and anything[1]. “Ubiquitous power Internet of things” connects power users and their equipment, power grid enterprises and their equipment, power generation enterprises and their equipment, suppliers and their equipment, as well as people and things, to generate Shared data and serve users, power grid, power generation, suppliers and the government and society; With the power grid as the hub, we will give play to the role of a platform and sharing platform to create greater opportunities and provide valuable services for the development of the entire industry and more market players.

According to zhongguancun energy storage industry technology alliance (CNESA) project of the incomplete statistics, as of the end of December 2018, the world has been put into operation energy storage project of the cumulative size of 180.9 GW, year-on-year growth of 3%, among them, the cumulative installed the largest pumped storage, 170.7 GW, up 1.0% from a year earlier, the electrochemical energy storage and molten salt storage and cumulative installed size, followed by 6.5 GW and 2.8 GW, respectively, year-on-year growth of 121% and 8% respectively. In 2018, the global installed capacity of new energy storage projects was 5.5GW, among which the new capacity of electrochemical energy storage was the largest, 3.5GW, with a year-on-year growth of 288%[2].The rapid development of energy storage lays a foundation for its wide application in the ubiquitous power Internet of things.

## Why Develop the Ubiquitous Power Internet of Things

“Ubiquitous Internet of things” means the information connection and interaction between any time, any place, anyone and anything. The Internet of things was added an attribute "power", indicating that it is the specific manifestation and application of ubiquitous Internet of things in the power industry.

Building a ubiquitous power Internet of Things is an important part and key link to promote the construction of “three-type and two-network”. “Two networks” include “smart grid” and “ubiquitous power internet of things”. The “smart grid” is based on UHV transmission lines, and the “ubiquitous power Internet of Things” is the neural network. At present, China has made a very significant development in the power system in all aspects of “source-network-load-storage”, but at present there is no state of business synergy and data integration. Therefore, it is necessary to build a “new ubiquitous power Internet of Things” to connect all aspects of power generation, transmission, distribution, and electricity to create a new type of grid with business coordination and data integration.

### **Energy Storage Will Play a Role in the Ubiquitous Power Internet of Things**

The construction of ubiquitous power Internet of things is to build a pivotal, platform and Shared power grid.

Building a pivotal power grid means to break through the information barrier between the power generation side and the demand side through the ubiquitous power Internet of things, and coordinate the comprehensive utilization of various types of energy while providing clean and safe electricity for the demand side. Energy storage plays an important role in improving the comprehensive utilization of energy, improving the grid-connected capacity of new energy and enhancing the reliability of power supply[3-4]. Especially in the process of China's transition to clean energy, with the continuous improvement of new energy penetration rate, energy storage is an important means to ensure the stability of the power system. The advanced energy storage technology plays an important role in the multi-energy complementary system and has a large development space. Renewable energy, such as solar energy and wind energy, has the characteristics of intermittency and volatility. By connecting the energy storage equipment in the system, the output fluctuation of renewable energy power generation can be smoothed, randomness can be reduced, and the difficulty of access to the power grid can be reduced. The development of heat and hydrogen storage technology provides a way for the transfer of electric energy to different energy forms such as heat and hydrogen in the integrated energy system. At present, China has carried out comprehensive energy demonstration projects.

To build a platform-based power grid, the first is to establish a trading platform for the power market, which means to strengthen the communication channels of all participants in the power system[5]. The commodity property of electric energy is restored. Under the power market mechanism, the power generation side, demand side and service side exchange economy and service through electric energy. Energy storage is an integral part of the electricity market. China have to widely carry out energy storage auxiliary thermal power units for AGC frequency modulation and other ways to participate in the power market auxiliary services, and achieved good auxiliary effect[6]. Energy storage is of great significance on the premise of providing fast and high-quality auxiliary power generation and auxiliary services for the power market. Second, in the current energy storage system, the simulated energy flow and the digital information flow exist and operate independently on different spatial and temporal scales, lacking the deep integration of the energy flow and the information flow on the same scale. Therefore, it is necessary to establish a big data platform for energy storage and operation, to collect and upload the real-time big data platform for the running conditions of energy storage in the network. And through the data platform to master real-time energy storage capacity, so that the unity of energy flow and information flow. The construction of the three-platform power grid is bound to produce a large number of data centers. In order to ensure the power supply safety of the data center, the uninterruptible power supply (UPS) battery needs to be widely used, which is the external guarantee measure of energy storage for the construction of the platform power grid[7].

To build a Shared power grid, a large number of terminal devices need to be connected to the interconnection system. By the end of 2018, there were more than 2.61 million new energy vehicles in China, accounting for 1.09 percent of the total, an increase of 1.07 million vehicles or 70 percent

compared with 2017, according to the ministry of public security's traffic management bureau. Meanwhile, the average estimated driving distance of vehicles per day is 52.92 km, so the driving time is less than one hour[8]. Therefore, it can be said that a car spends most of the day in a parking lot or family garage. Therefore, a large number of new energy vehicles, as potential service providers and consumers of the ubiquitous power Internet of things, are of great significance for the extensive access and flexible regulation of the ubiquitous power Internet of things.

## How Does Energy Storage Participate in the Construction of Ubiquitous Power Internet of Things

### The Perception Layer

It is necessary to strengthen the access ports of energy storage equipment and electric vehicles, especially the construction of energy storage charging stations, realize the bidirectional flow of electric energy, and expand the access number of energy storage equipment in the ubiquitous power Internet of things. Meanwhile, real-time monitoring of energy storage is strengthened. Taking full account of the complexity of large-scale energy storage systems/household energy storage systems and a large number of electric vehicles and their network topologies, a large-scale energy storage power station and a large number of electric vehicle/household storages with centralized management and subsystem partition autonomy are proposed. The optimized monitoring architecture of the device can comprehensively improve the comprehensive monitoring capability of the energy storage system.

### The Network Layer

In the network layer, it is necessary to connect the energy storage device and the BMS of electric vehicles through Internet technology, and upload the energy status, safety information and other important information of the access equipment to the platform layer through wired or infinite communication technology. With the rapid development of 5G technology, 5G technology will also have a good application effect in the ubiquitous power Internet of things.

### The Platform Layer

In the energy storage platform layer, through the construction of energy storage platform, the application of big data technology, the collection and analysis of the massive energy storage data uploaded by the network layer, the real-time monitoring of the equipment operation information, active power, reactive power, SOC, SOH and alarm information of the energy storage unit, provides the data basis for the application layer to make decisions. In electricity market ancillary services platform layer, China is now mostly with the method of peak valley when the share price, auxiliary platform construction should speed up the perfect electric power market, build based on real-time electricity price of power market ancillary services, electricity spot market for thermal power unit, natural gas, hydropower, wind turbines, energy storage power station of power supply in the system such as bidding transaction, finally according to the kind of ancillary services offer the lowest and the optimal effect, determine who provide electricity. When large-scale energy storage power stations and a large number of household energy storage/electric vehicles that can be flexibly connected to the grid can participate in the spot market, it is beneficial to the suppression of price fluctuations and the safety of power grid operation. As long as market-based pricing and services are provided, there will be more room for energy storage development. Data center is the foundation of platform layer construction. To ensure the security of data center power supply, uninterruptible power supply (UPS) should be installed in data center. But data centers don't often have power outages. A lot of UPS is sitting idle. How to apply UPS to participate in peak load cutting and other ancillary services to obtain certain economic benefits on the premise of ensuring the reliability of UPS 'available power supply, And when the data center needs UPS for emergency power supply, how UPS quickly switches from the auxiliary service mode to the emergency response mode needs further study.

## The Application Layer

With the access of a large number of terminal devices, the traditional manual scheduling method cannot meet the needs of rapid and accurate scheduling. So need to apply the artificial intelligence and cloud computing technology, in view of the battery energy storage power station combined with different types of generator, and a large number of electric cars, time-sharing access problem, consider intelligent operation scheduling, security and stability control, multi-objective control management, the most superior running benefit, the various requirements put forward under the different integration architecture of battery energy storage power station, and household energy storage equipment and electric motor multi-objective collaborative optimization control method, crack is different form the battery energy storage system power management and scientific control problem.

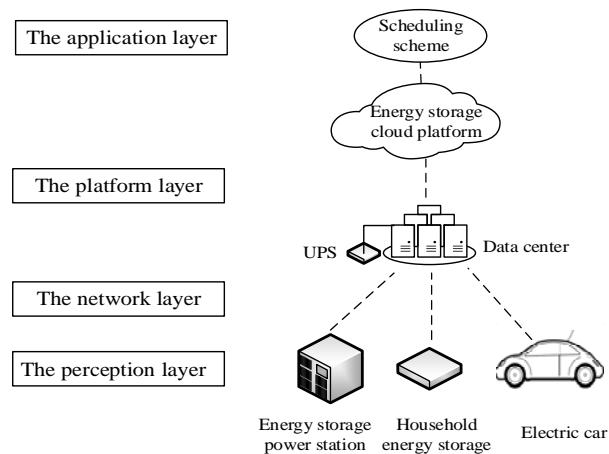


Figure 1. Topology diagram of energy storage network under the ubiquitous power Internet of things

## Security Issues

Although energy storage devices have been used for many years, energy storage safety accidents often occur at present, for example Table 1. Therefore, we should pay full attention to the safety of battery from the design, integration, installation, operation, monitoring and other production and operation process of energy storage battery. First, strengthen the manufacturing capacity of energy storage core equipment, improve energy storage performance, and improve thermal and dynamic stability of energy storage. Second, the method of energy storage integration should be improved from analysis planning, energy management, coordination control and other aspects to improve the effect of energy storage application. The third is to strengthen the construction of energy storage installation standards, the energy storage land, layout methods, etc. At the same time, improve the operation and maintenance management system, improve the operation and maintenance standards. Fourthly, it is necessary to improve energy storage monitoring ability, timely track energy storage working status, establish reasonable decommissioning mechanism of energy storage power station, and avoid uncertain safety risks under long service cycle. Fifth, the evaluation standard construction should be carried out in terms of safety, fire protection, environmental protection and social and economic benefits.

Table 1. Safety accident statistics of some electrochemical energy storage power stations worldwide

| Time      | Country           | Energy storage projects  | Energy storage type            |
|-----------|-------------------|--|--------------------------------|
| 2019      | The United States | Public service corporation program in the phoenix suburb of west valley, Arizona | The lithium battery            |
| 2017-2019 | South Korea       | 21 energy storage power stations   | The lithium battery            |
| 2019      | China             | Energy storage at a hotel in Beijing   | The lithium battery            |
| 2018      | China             | A certain energy storage power station in Yangzhong, Jiangsu province            | Lithium iron phosphate battery |
| 2017      | Belgium           | A lithium ion battery energy storage project in Belgium                          | The lithium battery            |
| 2017      | China             | An energy storage power station in Shanxi  | Ternary lithium battery        |
| 2011      | Japan             | Japan NKG energy storage power station   | Sodium sulfur battery          |

## Ev Charging Service Market

The highest charging power of domestic mass production passenger vehicles has reached 150kW, while that of commercial vehicles generally ranges from 200-350kw to 500kW. At present, the mainstream 60-100kw charging pile cannot meet the development needs of the industry. Thirdly, there is an urgent need to significantly improve the charging efficiency. However, the realization of rapid charging puts forward higher requirements for the whole vehicle, power battery, charging pile and power grid, which cannot be met in the short term. Car owners often need to spend a lot of time cost. Therefore, it is very important to accelerate the construction of charging piles and energy storage charging stations. At the same time, a variety of ev charging service modes should be explored. For example, ev charging service combining charging and changing can be carried out. For car owners with sufficient time, charging service can be selected. At the same time, how to better improve the ev charging service market needs further research.

## Summary

In the context of the ubiquitous power Internet of things, different forms of energy are no longer independent of each other. As the physical basis and landing form of the energy Internet, multi-energy complementarity has also attracted a lot of attention. Starting from the significance of building ubiquitous power Internet of things, this paper introduces the role of energy storage in ubiquitous power Internet of things, and analyzes the important role of energy storage in each target based on the goals of hub, platform and sharing power grid construction. In addition, the development prospect of energy storage in the ubiquitous power Internet of things is described, and the key development direction of energy storage in the perception layer, network layer, platform layer and application layer in the future is described in particular, and how to improve energy storage security and the market construction of electric vehicle charging service is analyzed.

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