Research on Key Technologies of Data Collection for Energy Storage Power Station Based on "Multi-Station Fusion"

Peng Wang¹, Jinsong Yang¹, Jing Chen², Ruixiang Guo¹, Desheng Yang¹ and Zheng Guo¹

¹Anhui Jiyuan Software Co., LTD, State Grid Communication Industry Group CO., LTD, Hefei, AnHui, 230088, China;
²Beijing Electric Power Economic and Technological Research Institute, Beijing, 100055, China

*Corresponding author’s e-mail: wp9031@163.com

Abstract. In view of the current situation of energy storage power station management and data collection, this topic takes the data collection of energy storage power station as the main research object. By analyzing the problems of localized management and inconsistent data collection standards of energy storage power station, an efficient and accurate data collection and lean management mode is explored. It lays a foundation for promoting the construction of "Multi-Station fusion" and provides technical support for the management decision-making of "Multi-Station fusion".

1. Introduction

In 2019, the two sessions of State Grid Corporation put forward the strategic goal of building a world-class energy Internet enterprise with "three types and two networks", give full play to the pivotal role of power grid in energy collection, transmission, conversion and utilization, gather all kinds of resources with the support of energy Internet, establish the sharing concept of "co construction, CO governance and win-win", and build a strong smart grid and ubiquitous power IOT Net. As the basic supporting condition of ubiquitous power Internet of things, Multi-Station fusion is an important measure to realize the goal of "three types and two networks". "Multi station fusion" is based on the "three stations in one", that is, energy storage power station, substation and data center station, and integrates various sites such as 5G base station, Beidou ground enhanced station, photovoltaic station, integrated energy station, to form multi site spatial interconnection, logical fusion and data horizontal connection, so as to realize the high efficiency, complementarity, saving and sharing of multi energy, and comprehensively support the defensive battle of green water and green mountain.

Energy storage, as a key component of "Multi-Site fusion", is the link between multiple sites to achieve energy fusion and complementation and data fusion. It plays a vital role in the smart energy system, and give full play to its role as buffer, aggregator and stabilizer in Multi-Station fusion. However, at present, there is no unified collection device and unified acquisition specification for data acquisition of energy storage power station. At the same time, the distribution of each station is relatively wide, the location is not centralized enough, and there are large or small differences among the stations. All of these have brought great challenges to the data acquisition of the energy storage power station, as well as the centralized management and control and remote guidance of the...
energy storage power station. Therefore, how to quickly and efficiently collect the production data of the energy storage power station, better carry out the demand response, clean energy consumption, unified coordination, scheduling and management, realize the unified access, unified monitoring and unified service of "Multi-Station fusion", and finally form the energy ecosystem, are the urgent problems to be solved.

In view of the difficulties encountered in the data acquisition process of the energy storage power station, and at the same time, the state monitoring and control of the energy storage power station mainly depends on the station monitoring system, which leads to the opaque control and non sharing of data among the stations, and the unified and standard management cannot be formed. State Grid Corporation of China (SGCC) organized the research project of "Multi-Station fusion key technology and business model". According to the research results and related literature, this paper carried out targeted research, designed and implemented the data acquisition system of energy storage power station. Through the research on the key technology of data acquisition of energy storage power station, a set of unified data protocol and acquisition specification for energy storage power station was established. Through the energy storage router, using big data[5-6] and edge computing[7] and other technologies, we can realize the centralized collection of production and operation data of each energy storage station, and transmit it to the "Multi-Station fusion" data center. After high-precision analysis and processing, it can accurately and efficiently guide the healthy and orderly operation of "Multi-Station fusion".

2.Research purpose and significance
This topic explores the management trend of "Multi-Station fusion". Taking the unified data acquisition of energy storage power station as the research object, the innovative management mode of energy storage power station and "Multi-Station fusion" is explored. At the same time, taking the data collection of each energy storage power station as the breakthrough point, the data acquisition interface service specification is unified to ensure the safe, reliable and efficient operation of the energy storage power station, and promote the fusion of "Multi-Station fusion" data, and improve the overall management level of "Multi-Site fusion". The specific goals are as follows:

1) Promoting the construction of "Multi-Station fusion"
Through the centralized collection and accurate analysis of energy storage data, promote the collaborative work among the "Multi-Station fusion" sites, realize the deep fusion of energy flow and information flow in business, so as to improve the efficiency of resource utilization, promote cross-border business fusion, and realize open sharing and deep collaborative resource and data services.

2) Improve the comprehensive management level of "Multi-Station fusion"
With the help of the data center station, the holographic perception capability of "Multi-Site fusion" is improved, and establishing the overall monitoring and operation evaluation model of "Multi-Site fusion" is promoted, and the high fusion, horizontal comparison and comprehensive analysis of operation data among multiple stations are realized, the equipment safety monitoring, operation status evaluation and management ability of energy storage power station are strengthened, and the energy demand analysis of "Multi-Station fusion" is promoted. These can ensure the stable energy supply of energy storage power stations and improve the overall operation and management level of "Multi-Station fusion".

3) Promote further application
Aiming at the difference of energy storage power stations, the energy storage data protocol and acquisition specification are unified to form a set of feasible and reproducible experience, which can guide and simplify the data access workflow of other stations, and promote data sharing and fusion among "Multi-Station fusion".
3. Research on key technology of data acquisition in energy storage power station

3.1. Specific methods

![Diagram of data acquisition and processing process]

The whole process of data acquisition and processing of energy storage power station mainly includes: acquisition layer, transport layer, data layer, platform layer, application layer and visualization layer. In the acquisition layer, through the energy storage router embedded with encryption chip, the data collection of each secondary system in the station is realized, and the edge data center is formed in the data center station. The collected data are processed and edge calculated, and the data protocol and collection specification are unified. The data is transmitted to the "Multi-Station fusion" data center in the cloud through power line or mobile network. Big data storage and other technologies are used for data storage to fully guarantee the integrity, security and reliability of energy storage data, support the upper level applications such as energy storage cloud platform and "Multi-Station fusion" monitoring system, and display them by means of web, large screen and app, which can effectively guide actual production and improve the data sharing value of "Multi-Station fusion".

3.2. Technology roadmap

Through the research on the management, data acquisition, daily maintenance and other requirements of the energy storage power station, a unified data acquisition and analysis standard is established, and a set of complete, efficient, safe and reliable data acquisition technology route is formed based on the spatial separation characteristics of each energy storage power station, and the edge computing and data collaboration advantages of "Multi-Station fusion" are fully utilized to improve the energy storage power station in order to achieve the efficient fusion and utilization of energy storage resources, and ultimately promote the implementation of "Multi-Station fusion" innovative management mode.

1) We will establish a unified protocol conversion model supporting multiple transmission protocols, and use edge computing technology to realize intelligent data acquisition, processing and transmission of energy storage power station with low power consumption and low delay, improve the business requirements of intelligent analysis and local processing, and realize the ubiquitous interconnection of energy storage power stations in the "Multi-Station fusion".

2) We conduct preprocessing, anomaly check, overrun judgment, data calculation, data statistics and other operations on the collected real-time running data, complete the data screening and reconstruction, and ensure the integrity of data in the process of collection and transmission. At the same time, we use big data storage and analysis technology to build a distributed storage system to...
fully guarantee the safety, stability and reliability of data, and provide reliable technical support for data penetration and sharing.

3.3. Working steps

Aiming at the huge and complex structured and unstructured data generated in the operation and production process of energy storage power station, the edge computing technology is used to transmit and receive the data, and the big data processing technology is used to process, analyze and store the collected production data. The work steps of data acquisition mainly include: the energy storage router equipped with encryption chip collects energy storage data from each subsystem of the energy storage power station side, and transmits it to the data aggregation server of the data center station through the forward isolation device, and transmits it to the "Multi-Station fusion" data center; at the same time, the video server collects and receives the video data of the video monitoring system of the energy storage power station, and transmits it to the "Multi station fusion" data center. Finally, the energy storage business data fusion is formed in the "Multi-Station fusion" data center.

1) A star network (shared or switched Ethernet) is used for communication between EMS, PMU and other systems and energy storage routers. The data aggregation server and video server collect real-time production data of the energy storage power station in a full/incremental manner. Among them, the installation of a security chip energy storage router and a forward isolation device are used to effectively ensure the safety of data in the collection and transmission process. The collected data mainly comes from the EMS, PMU, electric energy measurement system, fault recording system, power quality online monitoring system, intelligent auxiliary control system, video monitoring system, etc.

- **EMS**: It mainly collects various telemetry, remote signaling, remote pulse and remote control index information including BMS and PCs;
- **PMU**: It mainly collects phase voltage phasor, phase current phasor, voltage positive sequence phasor, frequency offset and frequency change rate;
- **Electric energy metering system**: It mainly collects the information of total charge / discharge, positive / negative active / reactive power and peak / Valley charging / discharging;
- **Fault recording system**: It mainly collects fault recorder header file, configuration file, data file and information file, etc;
- **Power quality online monitoring system**: It mainly collects power quality related data such as frequency, fundamental voltage, fundamental current, voltage imbalance, current imbalance, harmonic voltage of different frequency, harmonic current of different frequency, voltage flicker, etc;
• Intelligent auxiliary control system: It mainly collects temperature, humidity, light, sound, fire and other environmental and fire information of energy storage power station;
• Video monitoring system: mainly collects the video stream recorded by each camera.

2) The data aggregation server pushes the data to the "Multi-Site fusion" data center through ETL and big data transmission technology, and processes and analyzes the data through big data processing technology, and finally stores it in a real-time/statistical database. The video server pushes the video data to the "Multi-Site fusion" data center through video streaming technology, and analyzes the video through video analysis and image recognition technology to effectively guide actual production.

3) The data center station stores and preprocesses the data uploaded from the secondary systems locally. The local storage mechanism includes regular storage and permanent storage. Users can flexibly choose the storage mechanism according to their actual needs.

3.4. Related application scenarios
1) Establish the "Multi-Station fusion" energy service platform: It can promote the collection and fusion of energy storage business, power transformation business, Beidou business and other related data, and realize data sharing and collaborative management and control among multiple stations, and promote the economic, safe and stable operation of "Multi-Station fusion", and realize cost reduction, efficiency increase and sustainable development;

2) Establish the big data intelligent analysis platform: It can conduct in-depth analysis and application of the monitoring data of the connected energy storage power station, and help the decision-making and management to fully grasp the overall operation of the power station, and comprehensively support the operation management and decision-making of "Multi-Station fusion" based on effective experience;

3) Construction of operation and maintenance management platform: It improves the planning and coordination of operation and maintenance work, strengthens the coordination and linkage between remote management and on-site operation and maintenance personnel, improves the operation reliability and operation efficiency of the power station, promotes the centralized operation and maintenance ability of "Multi-Station fusion", and reduces the overall maintenance cost.

4. Innovation and technical difficulties
1) Standardized process management
We establish a set of efficient data acquisition standards and standards for energy storage power station, form a unified data acquisition process of energy storage power station, realize comprehensive improvement in real-time, accuracy and integrity, fully support the management of energy storage power station and "Multi-Station fusion", fundamentally solve the problem of wide distribution of energy storage power station, only localized management, and inconsistent management standards, so as to realize energy storage Power station and "Multi-Station fusion" information, professional and refined management laid the foundation.

2) Data acquisition of energy storage power station based on edge computing
We carry out the research on the mapping and interaction technology of distributed and centralized energy storage data multi domain access and multi class transmission protocols in accordance with the data interaction specification of the Internet of things, establish a unified protocol conversion model supporting multiple transmission protocols, give full play to the advantages of data center station, realize the local processing and edge calculation of energy storage data, improve the efficiency of data operation and response, and realize energy storage power The ubiquitous interconnection of the stations improves the holographic sensing ability.

3) Data processing and storage based on big data technology
Aiming at the mixed data content of multi-source heterogeneous structured data and unstructured data among various energy storage power stations, we use big data technology to quickly acquire, transform and load, build a diversified, fragmented and unstructured data distributed virtualization storage framework, and use mainstream big data access tools to improve storage
efficiency for the subsequent big data analysis and mining of energy storage power stations provide data content that can be read directly. At the same time, it can be extended to receive "Multi-Station fusion" operation data, providing reliable technical support for data sharing.

5. Conclusion
Aiming at the problems of inconsistent data acquisition standards, localized management and inconsistent standards of energy storage power stations, this paper studies and determines the data acquisition, transmission, storage and application mode of energy storage power station under the background of "Multi-Station fusion" by combining edge computing, big data processing and storage technology, which helps to change the traditional single station management and control, territorial operation and maintenance management mode, and effectively improve the storage. At the same time, it can reduce the overall operation cost.

Acknowledgments
At this point, I would like to thank my friends and colleagues, who have given me a lot of useful materials in the process of writing my thesis, and they have also provided warm help in the process of typesetting and writing! At the same time, I would also like to thank all the scholars' monographs cited in this paper. Without the inspiration and help of these scholars' research results, I would not be able to complete the final writing of this paper.

This work is supported by State Grid Corporation Science and Technology Project (Research on Key Technologies and Business Models of Multi-Station Fusion, 5200-201941477A-0-0-00)

References
[1] Xu W.B., CHENG H.F., BAI Z.H., Miao C.H., Sun F.C. (2019) Optimal design and operation of energy storage power station under multi-station fusion mode[J]. Distribution & Utilization, 36(11):84-91.
[2] Sun C.L., Wen X.M., Lu Z.M., Sheng W.X., Zen N., Li Y. (2017) Energy Efficiency Optimization Based on Storage Scheduling and Multi-Source Power Supplying of Data Center in Energy Internet[J]. Journal of Computer Research and Development, 54(04):703-710.
[3] Li J., Zhu Y.J., Ma J.K. (2019) Development of a Storage Energy Data Center System for Monitoring Jiangsu Energy Storage Power Station[J]. Modern Computer, (29).
[4] Li J.L., Huang J.Y. (2020) New technology and application of energy storage power station[J]. Distribution & Utilization, 37(02):2+1.
[5] Wu Z.Y., Wang Y., Fu J.Y., Qu S.J. (2019) Application of Big Data Technology in Energy Internet[J]. Jilin Electric Power, 47(03):1-4.
[6] Gu D.H. (2019) Large scale battery energy storage system management based on big data - review of "Application of big data technology in large scale energy storage system"[J]. BATTERY BIMONTHLY, 49(06):536-537.
[7] Qi B., Xia Y., Li B., Shi K., Xue M.F. (2018) Family Energy Management System Based on Edge Computing: Architecture, Key Technology and Implementation[J]. Electric Power Construction, 39(03):33-41.