Constructing a Data Middle Platform for Promoting Renewable Energy Accommodation Capacity

Xin Jiang1, *, Yuxiang Cai1, Liang Shen2, Xiangzhou Chen2, Liang Lan3 and Qifan Yang1

1Information and Communication Branch of State Grid Fujian Electric Power Co., LTD, Fujian, 350000, China
2Big Data Center, State Grid Corporation of China, Xicheng District, Beijing, China
3State Grid Information and Communication Industry Group Co., Ltd., Changping District, Beijing, China

*Corresponding author e-mail: jiangxin@epri.sgcc.com.cn

Abstract. Constructing a data middle platform for renewable energy accommodation can provide essential support for the safe and efficient accommodation and the orderly development of the renewable energy industry. Based on the connotation and technical characteristics, the data middle platform is constructed for renewable energy accommodation from four dimensions: data source layer, data asset layer, analysis layer and application layer. Furthermore, the paper analyses the application scenarios and corresponding key technologies of the data middle platform, which plays a vital role in the critical reference for promoting the accommodation of renewable energy.

1. Introduction
How to promote the efficient accommodation of renewable energy will be regarded as one of the urgent problems in the operation of power grid [1]. The emergence of data middle platform technology offers a global and intelligent multi-functional platform for grid companies, comes up with a digital solution to address this limitation, and improves accommodation capacity relying on big data, which is an effective way to alleviate the issue of accommodation. In recent years, great progress has been made in the architecture design, business application and key technologies of the data middle platform, but the renewable energy accommodation has been a largely under explored domain. The application of the data middle platform sheds new light on promoting the digital and intelligent transformation of power grid companies, as well as making improvement in the level of data sharing service and the degree of data reuse.

2. The connotation and technical characteristics of data middle platform
At present, the data middle platform is mainly used in the field of the Internet, business service, new media and so on. There are some significant advantages as follows:

2.1. Improve the efficiency of data development
The data need to be re-collected, analyzed and mined during application development in traditional data platform. Therefore, data processing analysis has low efficiency and long cycle, and the data
development speed cannot match the application development speed. Through the fusion processing and classification labeling of multi-source heterogeneous data, the construction of data middle platform can form a data asset with unified standard and clear functions, which offers some important insights into data reuse and speed of data development to quickly respond to the application development and business innovation.

2.2. Reduce the cost of construction of the platform
For one thing, the data asset organizes various data sets for business scenarios because construction of the data middle platform is oriented by application value. In the next data processing, the corresponding data sets can be reused through matching scenarios to cut down the cost of repeated construction, without rebuilding a special independent business system data platform. The data middle platform decreases data redundancy and saves storage space due to storing reasonably, which reduces the cost of storage.

2.3. Effectively break data barrier
As constructing the traditional data platform, each system forms a monolithic application centered on its own subject, which is likely to contribute to information islands due to barriers such as profession and business. The data middle platform refines and integrates common data, which has flexible and powerful shared service capability for construction the front-end business application or data analysis to directly call. Data interconnection can be realized to improve cross-border capacity in data application effectively.

3. Research on the framework of data middle platform

3.1. The architecture design of the data middle platform
Data access and integration should be carried out in a targeted manner based on analysis of the functional requirements of scenarios to build data middle platform for renewable energy accommodation, which can promote standardized management of data. Paying attention to value mining and providing analytical services, which can internally support enterprise decision-making analysis and professional lean management, as well as provide government decision-making and form high-value data asset externally.

According to the four dimensions of data source layer, data asset layer, analysis layer and application layer, the architecture of the data middle platform for renewable energy accommodation is constructed, as shown in Figure 1.

![Figure 1. Schematic diagram of the overall architecture of the data middle platform for renewable energy accommodation](image-url)
3.1.1. Construct a cross-domain data source layer. The data source layer realizes the stereoscopic integration of multi-source and multi-dimensional data through open data acquisition and storage in multiple subjects, and then breaks down the barriers between multiple-source data.

3.1.2. Construct a data asset layer for lean management. The data asset layer can actualize differentiated and lean management of data by constructing public data modules or extracting data modules, so as to fulfil the co-construction and sharing of enterprise-level data and improve the level of lean management of enterprise data.

3.1.3. Construct an analysis layer that cultivates the value density of data [2]. The analysis layer aims to quickly elicit deep knowledge from the data and put it into engineering applications. The analysis layer finds out potential laws from the data based on application demands, achieves the effective and reasonable utilization of data resources, which supports multi-dimensional lean applications.

3.1.4. Construct an application layer of services for internal and external enterprises. Internally, the application layer can promote managements and operations of the enterprises, such as power grid planning, power grid operation, and customer service. Externally, it provides a basis for the government to formulate policies of renewable energy accommodation, recommends the government to make decisions efficiently and accurately, and serves other related services such as trend prediction, precision marketing, and business location planning for other related external companies.

3.2. Analysis of the application scenarios of the data middle platform in renewable energy accommodation

Construction of the data middle platform can successfully alleviate the main problems faced by the accommodation of renewable energy, which can be used in different application scenarios. New ideas for solving the problem are given from data utilization, resource integration, information sharing and so on.

The data middle platform achieves the interconnection and intercommunication of various links through the data collection, sharing and reuse of "source network load storage" of the power system, and further boosts fast and highly efficient coordination and interaction capabilities of the power system source network, which optimizes dispatching to stimulate the availability of accommodation.

3.2.1. The scenario of renewable energy planning. In the scenario of renewable energy planning, the data middle platform performs catalog searches at the data asset layer, which can obtain data information of resources of wind energy, solar energy, and fossil energy through index positioning. Utilize the analysis layer to spread out relationship analysis, spatial and time series analysis, study the spatial distribution and time series changes of energy reflected by these data, conduct regional resource development potential analysis and feasibility analysis of renewable energy planning, and then calculate the accommodation capacity of different regions by big data analysis and data mining through using the data of equipment operation, regional load and meteorological, which can acquire data support and suggestions for renewable energy power station planning, site selection, and installed capacity[3] by combining existing information of grid planning.

3.2.2. The scenario of state monitoring and early-warning. In the state monitoring and early-warning scenario of renewable energy units, the data middle platform operates the data source layer to attain protection signal data, tripping data, overload data, bad working condition data and other information when the system is abnormal or faulty, as well as integrates and produces an early-warning data system in the data asset layer. Combined with the analysis of device status evolution process and trend of real-time status change data in the analysis layer[4], it can timely feedback the real-time operating status of renewable energy power generation equipment, which advances the timeliness and accuracy of equipment status evaluation, makes the operation of renewable energy power generation equipment in
an optimal state by awareness and early warning, guarantees stable and controllable renewable energy power generation, and achieves the maximum productivity of the stable grid-connected accommodation of renewable energy power generation.

3.2.3. The scenario of grid dispatching. In the scenario of grid dispatching, the data middle platform examines forecast deviation of the renewable energy power based on historical data of actual and predicted power of renewable energy generation, comprehensively considers the entire network load information, transmission power information, and demand-side controllable resource information, calculates the renewable energy accommodation space in different regions, the transmission capacity of the grid channel, and the peak shaving capacity of thermal motor units combined with the data related to the structure of the power grid. Through fast and accurate analysis and information sharing, the overall situation of the grid is realized, and the dispatch centre is guided to make optimal scheduling decisions at different time scales and contribute a dynamic optimal dispatching scheme, which makes the optimal allocation of a wide range of resources, ensures the safe, economical, and environmentally friendly operation of the power grid a reality, as well as maximizes the utilization of wind power and other renewable energy sources.

3.2.4. The scenario of policy proposal. In the scenario of policy proposal, the practice effect of policies in renewable energy is affected by the social psychology of the resource endowment, energy production and application participants in each region. Based on historical and current data, the data middle platform looks for the internal relationship of various influencing factors, and gives suggestions for the optimization of the government's renewable energy policy mechanism. Such as, through forecasting renewable energy power generation, regional load demand, and accommodation margins in each region to promote the flexible electricity price mechanism and the cross-provincial and cross-regional trading mechanism for renewable energy; According to the load situation and the power grid's peak-shaving capacity, large users are encouraged to consciously use peak-shaving power by direct purchase mechanisms and generation right trade transactions, which can formulate market rules for peak-shaving auxiliary services, establish the subsidy mechanism, increase the enthusiasm of power generation companies to participate in peak-shaving and relieve the pressure of peak-shaving, thereby promoting the accommodation of renewable energy.

4. Key technologies of data middle platform

4.1. Data capture and collection
Data middle platform for renewable energy accommodation requires massive amounts of scattered data from different systems and fields as data supporting and foundation. Therefore, data capture and collection play a vital role in the construction of the data middle platform. When capturing data, the data middle platform must not only ensure the integrity and comprehensiveness of the data, but also the efficiency and stability for the uncertainties and suddenness of the operating data of renewable energy power generation equipment and fault information. Thus, the data middle platform can capture log data by Kafka, Flume, Scribe, Chukwa and other data collection engines, apply distributed crawler, intelligent collection scheduling and data acquisition agent to capture network data in target, and through coupling multiple collection techniques with flexible data capture strategies to achieve high reliability and high fault-tolerance capability in date capture and collection from various channels for renewable energy accommodation.

4.2. Improve the data value density
The data types stored in the data source layer include texts, charts, and videos with a wide range of sources and various forms, which faces the risk of partial data loss, errors, and redundancy. The value density of date is relatively low. The data middle platform needs to capably enhance the data value density through data cleaning, data conversion, data classification, fast data recovery, data correctness
verification, and data backup to lay the foundation for the externalization of data value. Disordered data at the data source layer is identified and filtered through data cleaning technology to clean useless, duplicate or erroneous data, which can remove data with large deviation through outlier detection and make use of intelligent analysis to automatically extract effective information elements. According to the requirements of different application scenarios, the data is converted into a suitable format. Then, as claimed by the data content, data fusion and merging are carried out through information measurement, rough set theory and D-S evidence theory to improve data availability. Finally, use intelligent labeling technology to classify the data, and practice incremental real-time indexing technology to create a catalog and index for the processed standardized data for the purpose of achieve rapid retrieval of data at the data asset layer.

5. Conclusion
Constructing a data middle platform is an important direction for the digital transformation of grid companies and an effective way to address the problem of renewable energy accommodation. The article analyzes the connotation and technical characteristics of the data middle platform, and elaborates the structure of the data source layer, data asset layer, analysis layer, and application layer combined with the key issues of renewable energy accommodation. Finally, the possible application scenarios of the data middle platform in the accommodation of renewable energy are researched. The data middle platform for renewable energy accommodation can help the power grid make progress in data management, improve the efficiency and capacity of renewable energy accommodation, and serve the sustainable development of the energy sector.

Acknowledgments
This work was financially supported by Science and Technology Project of SGCC (Research on key technology of data center design and realization) (SGFJXT00WLJS1900278).

References
[1] Ma Ziming, Zhong Haiwang, Xia Qing, Kang Chongqing, Jin Liming. Constraint relaxation-based day-ahead market mechanism design to promote the renewable energy accommodation [J]. Energy, 2020, 198.
[2] Li Bingsen, Hu Quangui, Chen Xiaofeng, GAO Bingqiang. Research and Design of Data Platform for Power Grid Enterprise [J]. Electric power information and communication technology, 2019, 17(07): 29-34.
[3] Li Xinpeng, Liu Wei, Yang Zhiping, Sheng Pengfei. Research on Data Mid-Platform Scheme of Power Grid Enterprises [J]. Electric Power Information and Communication Technology, 2020, 18(02): 1-8.
[4] Li Zhi, Fei Xiaolu, Guo Zhen. Research on data asset management method of power enterprises based on data center [J]. Electric power information and communication technology, 2020, 18(07): 76-81.