Research on the Current Situation of Data Governance in the Wind Power Industry

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Abstract. Digital transformation is currently at the forefront of China's wind power industry and even the entire manufacturing industry. Comprehensive research on data governance in the wind power industry, is of significant theoretical guidance importance for the digital transformation of the wind power industry. This article analyzes the development of China's wind power industry, and outlines the current situation of data governance of the wind power industry, and give a detailed description on several difficult issues, such as the inadequacy of data governance architecture and standards in the wind power, suboptimal data storage quality, and a noticeable shortage of specialized talent in data governance of the wind power. It also provides relevant recommendations in areas such as data standards, management systems, management implementation, personnel fostering, and technology-assisted platforms.

Keywords: Digital Transformation, Wind Power Data Governance, Data Standards

1 Introduction

With the development of technology, industries around the world have entered the digital age, when industrial digitization is an irresistible trend. In the process of digitization, the importance of data is increasingly evident, and the value of big data is gradually being recognized.[1] However, in the process of industrial digitization, data governance still faces many challenges.[2-5]

Reference [6] proposes that enterprises in the power industry should not rely solely on technical methods to govern equipment data but should also establish professional organizations, improve data governance systems, and establish corresponding safeguards, while continuously carrying out data governance.

For the wind power industry, data governance is the foundation for digitization and intelligence, which involves many aspects, such as data collection, data transmission, data processing, data storage, and data applications, and requires the cooperation of various units and departments, such as component suppliers, equipment manufacturers, construction units, and on-site control centers.[7]

Currently, the wind power industry faces the following challenges in data governance: First, the relevant standards and systems for data governance in the wind power

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industry need further improvement; Second, the quality of data storage on wind power sites is not ideal, with serious issues such as data missing and data exception. Third, low data quality seriously affects the development of intelligent operation and maintenance in wind farms.

Based on the above, this paper proposes the following recommendations: first, establish relevant standards and systems for data governance in the wind power industry; second, establish relevant management systems to further guarantee the quality of on-site storage data; third, formulate corresponding implementation methods to ensure the data quality within the management system; fourth, expand the pool of relevant professionals and enhance the expertise of data governance personnel; fifth, develop relevant platforms and algorithms to monitor and manage real-time data quality as a supplementary means.

2 Analysis of Existing Circumstance in Wind Power Industry

2.1 Large Capacity in the Wind Power Industry

2.2.1 Global Wind Power Newly Capacity Increases Year by Year.

Under the global trend of low-carbon economy and energy revolution, the international community has paid more attention to energy security and ecological environment. Therefore, reducing the combustion of fossil fuels and accelerating the development and utilization of renewable energy, has become a universal consensus and collective action around the world. In 2015, the new capacity of renewable energy electricity generation globally exceeded that of conventional energy electricity generation for the first time, which marks a structural transformation in the construction of global power systems. Thanks to the advancement of wind power technology and the innovation of business model, the wind power industry has entered a period of rapid development, with increasing capacity in global wind power. [8]

2.1.2 China's Wind Power Industry is Developing Rapidly, and Gradually Becoming the World's Largest Capacity Country.

During the 13th Five-Year plan period, China's wind power industry has gradually implemented a quota system and a green certificate policy, issued the direction and basic objectives of the national five-year wind power development, and clarified that the scale of wind power development will enter a period of stable and sustainable growth. Currently, China has become the world's largest market for wind power generation in terms of scale and growth rate. According to statistics from the China Wind Energy Association, in 2022, China's new capacity has reached to 48.8 GW, with 43.6 GW onshore wind power and 5.2 GW offshore wind power, and maintains high-speed growth for consecutive years. [9]

2.1.3 Wind Power Become a Significant Source of Electricity in China.

In 2022, China's non-fossil generated electricity capacity historically exceeded coal-fired electricity, accounting for 49.6% of the total electricity generation, ap-

proaching 50%. Among them, wind power generation has reached 614.5 billion kilowatt-hours, accounting for approximately 8% of the total electricity generation. Wind power, as an important non-fossil energy electricity generation method, still has significant room for growth in the future. [10]

2.2 Digitization and Intelligence Have Become Trends

With the increasing capacity, digitization and intelligence have become a major trend in the development of the wind power industry [11]. In site-selection for wind farms, intelligent site-selection models based on high-tech such as medium-scale modeling technology, satellite remote sensing physical modeling technology, and high-precision micro-site selection technology, are gradually replacing the inefficient and time-consuming traditional methods. In turbine operation, with the assistance of existing technology, by perceiving and predicting the environmental changes, the system can automatically adopt different control strategies to achieve load reduction and lifespan extension, and to improve power generation efficiency. In maintenance, by installing condition monitoring and fault diagnosis systems in wind farms; combining the concept of asset integrity management, fault repairing has shifted from post-event to pre-event, and gradually moving towards preventive maintenance. These measures effectively promote the wind power generation efficiency and the overall reduction of costs, and gradually become a key focus for the quality enhancement of industry development in the future.

3 Problems of Data Governance in Wind Power Industry

3.1 Inadequate Standards for Data Governance in Wind Power Industry

The wind power industry consists of numerous equipment manufacturers. Taking the equipment manufacturers of wind turbine as an example, there are multiple manufacturers, such as Goldwind, Envision, Mingyang, Sany, Dongfang Electric, Huadian, and Xiangdian, covering various turbine types such as direct-drive, semi-direct-drive, and doubly-fed. Each equipment manufacturer also has several different types of products; even for the same type of product, major components such as generator, gearbox, transformer, and control cabinet may come from different suppliers, which increases the difficulty and complexity of data management.

For example, there are two kinds of cooling system, air-cooling and water-cooling. For different cooling system, and the measurement points and related variables are different. Even for the same measurement point, different supplier products have different measurements, which are not comparable.

In SCADA systems, different turbine manufacturers have different numbers and variable names. Additionally, wind turbines in the field often undergo regular upgrades in SCADA system, which often leads to changes in the variables, and further complication of the data governance work in the field, especially for early-developed projects whose SCADA systems is imperfect, which will exacerbate the operational management problems.

3.2 Insufficient Quality of Data Storage, Especially Data Missing and Data Anomalies

There are often issues with field SCADA data, such as missing key variables, inconsistent data time resolution, data duplication, complete data record loss, partial variable record loss, data exceeding normal ranges, and variable displacement, which severely affect the analysis of data.

There are different kinds of reasons which can result in data loss, data displacement, and abnormal data parsing, such as power outages, server failures, abnormal PLC voltage, PLC module failures, sensor failures, loose data cables, inadequate storage capacity, and so on.

Temperature is an important reference for assessing whether the control components are operating normally and whether there are any safety issues, so anomalous measurements related to temperature measurement points can pose significant safety hazards to turbines, and make it difficult to detect many turbine malfunctions in time, and even cause false alarms.

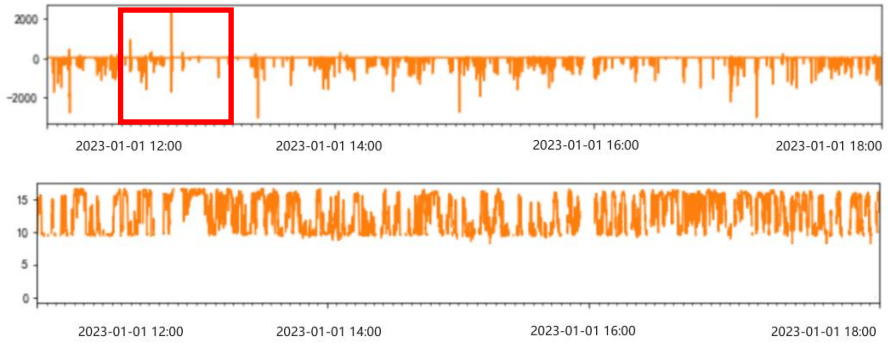

Fig. 1. Bad measurement of rotor speed (v.s. good)

Figure 1 shows that the measured value of rotor speed for a turbine reaches 2000/-2000, which obviously exceeds the normal range (usually 10-18), while the turbine is actually running normally with all other measured values being normal.

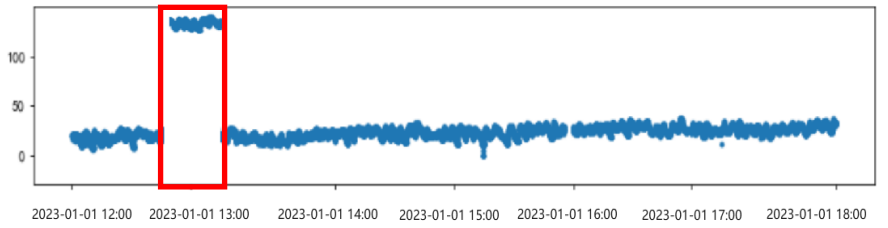

Fig. 2. Bad temperature measurement of the main control cabinet of a certain unit (over 150°C)

Similarly, figure 2 takes the temperature measurement of a control cabinet as an example, and shows a bad measurement value of 150°C. Such situations greatly hinder the use of data and can cause false alarms in turbine monitoring.

3.3 Data Quality Problems Severely Hinder the Intelligent Operation and Maintenance in Wind Farms.

Data governance is the foundation for achieving digitalization and intelligence in the wind power industry. Taking turbine assessment as an example, problems of data missing and data anomalies severely impact decision-making related to wind turbine power generation evaluation, reliability analysis, operation and maintenance, technological upgrades, and decommissioning. Prolonged data loss makes it impossible to trace the true operating conditions of the turbines during that period, which hinders the ability of development companies and maintenance personnel to quickly understand the actual operating status of the turbines. When using SCADA data for fault diagnosis and prediction, data quality problems introduce uncertainties to the modeling work, and make it difficult to discover the underlying patterns contained in the models. This can cause notable discrepancies between analysis results and actual conditions, and even lead to results that contradict the actual situation.

4 Recommendations

4.1 Accelerate the establishment of relevant standards and systems for data governance in the wind power industry.

First, standardize the coding and models in various regions and farms, and achieve the standardized naming management at the regional-site-turbine level. Based on this, establish enterprise-level data asset modeling standards, such as standardizing the data storage, unifying the turbine measurement points, and gradually forming corresponding enterprise-level data standards.

At the same time, classify data into three storage levels based on sampling frequency: millisecond-level CMS vibration data, second-level real-time measurement data, and 10-minute-level average data.

In addition, divide the data measurement points into two categories: turbine status information and turbine measurement information. For turbine status information, develop corresponding enterprise standards and implement unified coding for all types of turbine statuses to avoid confusion caused by inconsistent turbine coding from different manufacturers; for turbine measurement information, store turbines based on major sub-components to achieve hierarchical management of measurement points and gradually establish an enterprise-level equipment asset model. [7]

4.2 Establish management systems to guarantee the quality of on-site storage data.

Ensure the quality of on-site storage data from three dimensions: data integrity, reliability, and timeliness.

For data integrity, we should improve staff's sense of responsibility, refine management systems, and strengthen the management of indicator data; otherwise, we can set non-null constraints in the database to ensure the completeness of data entry.

For data integrity, we can perform manual filling. For data reliability, we can specify the valid range of indicator data, and judge the validity of data based on fluctuation indicators of operating data, and statistically analyze data distribution, assess the data rationality, and filter, correct or eliminate the unreasonable data. Periodically organize domain experts and professionals to analyze key indicators with long-term problems, identify causes, and make corrections.

For data timeliness, we can formulate and improve corresponding management systems, and establish periodic data reporting to ensure the timeliness of indicator data in the database. For the statistical indicators, timely updates should be made based on the update cycles of other data, and reasonable calculation cycles with appropriate parameter settings should be established to improve the timeliness of the indicators' data.

4.3 Formulate corresponding implementation methods to ensure the data quality and its management system.

It is of significance to develop implementation and management methods for each unit and department so that we can strengthen the data management. On the one hand, turbine manufacturers should cooperate with development companies to maintain and update the software systems, and fix the system vulnerabilities promptly to improve system stability. In addition, we should maintain server rooms regularly, which consists of clearing unused caches, and backing up historical data automatically. On the other hand, related companies should strengthen inspections of hardware sensors throughout turbines, so that we can identify and replace the faulty hardware sensors timely. Additionally, external protection work for wind farm substations or control centers should be well-implemented to ensure an adequate power supply and smooth network connections.

4.3.1 Expand the pool of relevant professionals, and enhance the expertise of data governance personnel.

Data governance is widely applied in such as the internet, finance, and healthcare, so the technology is relatively mature. Units within the wind power industry can selectively recruit relevant professionals from the areas above-mentioned, and apply their technologies to the wind power industry, thereby improve the expertise of on-site data governance personnel. For example, major state-owned enterprises and government agencies in China often adopt the DAMA Data Management Certification System [12,13] as the guidance for implementing data governance. This system can be adopted or adapted for the wind power industry to standardize data management systems in the industry.

4.3.2 Develop relevant platforms and algorithms as auxiliary means, to monitor and manage the data quality in real-time.

With the aid of the comparison chart of data distribution, anomalously distributed data from specific turbines or specific time intervals can be adaptively identified (fig-

ure 3). Besides that, we should also develop relevant models for the fault detection, so that we can trace the origins based on the detection results, and discover the data anomalies effectively in the field. With these models, we can comprehensively pinpoint the data issues, and achieve "smart operation and maintenance" of wind turbine units more efficiently.

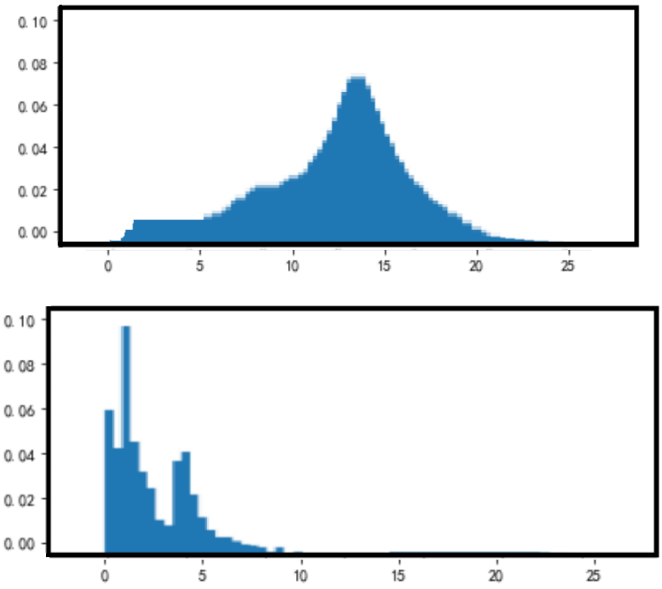

Fig. 3. A comparison hist chart of data distribution, with which shows the difference between the good data (the upper figure) and bad data (the lower figure)

5 Conclusion

This article analyzes the current development situation of the wind power industry and emphasizes that wind power has become an important source of electricity in China. Therefore, digitization and intelligence in the wind power industry is of crucial significance. Furthermore, the article highlights the importance of data as the foundation for digitization and intelligence, which underscores the necessity of data governance. The main problems in wind power data governance are explored from the perspectives of data standards and data quality. Based on these challenges, several recommendations are provided regarding data standards, management systems, implementation methods, talent development, and technology-assisted platforms.

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