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Research and Application of New energy Digital System Based on BIM

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Abstract. With the continuous development of new energy technology, the installed scale of new energy is getting bigger and bigger, the market competition is becoming increasingly fierce, and the cost control of investment units, reference units and manufacturers in all aspects of new energy construction is becoming more and more strict. Promoting the application of BIM in new energy engineering projects can effectively reduce the cost in the design and construction stages, and more importantly, improve the efficiency of long-term operation of new energy power stations, and reduce capital investment. This paper focuses on the definition and development of BIM, key technologies and BIM-based new energy digital system, which manages the information model of new energy power generation projects, provides more effective and accurate management, and improves project operation efficiency.

Keywords: New energy, BIM, full life cycle.

1. Introduction

In September 2020, China announced the strategic goal of achieving carbon peak before 2030 and carbon neutrality before 2060. By the end of December 2022, the total installed capacity of renewable energy in the country exceeded 1.2 billion kilowatts, accounting for more than 46% of the installed capacity, and the installed capacity of wind power and solar power generation in the country was about 370 million kilowatts and 390 million kilowatts, respectively, an increase of 11.2% and 28.1% year-on-year, maintaining rapid growth and providing greener impetus for China's economic and social development.

The National Energy Administration issued the "2023 Energy Work Guidelines", which clearly pointed out that the transformation of the energy structure has been further advanced, the proportion of non-fossil energy power generation has increased to about 51.9%, and the proportion of wind power and photovoltaic power generation in the total social electricity consumption has reached 15.3%, steadily promoting the replacement of electric energy in key areas. At the same time, vigorously develop wind power and solar power generation, promote the first batch of large-scale wind power photovoltaic base projects focusing on deserts, Gobi and desert areas to be put into operation, steadily build offshore wind power bases, and plan to start the construction of offshore photovoltaics. Vigorously promote the construction of distributed onshore wind power and distributed photovoltaic power generation projects.

BIM technology has developed rapidly in China's construction industry, but its application in the field of new energy is still rare and immature.

With the rapid development of new energy, market competition is becoming increasingly fierce, and investment units, reference units, and manufacturers are becoming more and more strict in controlling the cost of all aspects of new energy construction, resulting in a lower and lower proportion of the cost of BIM in the design and construction stages of new energy stations. After the construction of new energy projects, the construction period is relatively short, can not refer to large-scale long-term projects, there is no obvious design stage, construction stage and operation stage, the operation stage and the construction stage overlap in time, usually the stage is connected to the grid, resulting in the construction phase and the operation phase intersection, in the BIM application has its own characteristics, long design stage, construction stage, long operation time.

By promoting the application of BIM in new energy engineering projects, improve the maturity of BIM applications, reduce the cost in the design and construction stages, and more importantly, improve the cost input of new energy power stations in the long-term operation stage。.

2. Definition and development of BIM

In 1975, the "father of BIM" Dr. Chuck Eastman of the Georgia Institute of Technology in the United States will develop a class of computer systems that can intelligently simulate the whole process of project construction, which will be a building description system (Building Description System), which is also the first time the concept of BIM was proposed. In 1986, as one of the early advocates and pioneers of BIM, Robert Aish proposed the concept of "Building Information", which is based on the construction method of architectural model and management model based on system theory, improves the overall coordination of the combination of building data and model, promotes the unification and mutual recognition of BIM standards in various countries, and promotes the application and development of BIM technology around the world [1-3].

In 2002, Autodesk released the Building Information Modelling White Paper, which for the first time referred to "Buliding Information Modeling" as "BIM" and introduced BIM technology and design concepts.

In 2006, the National Institute of Standards and Technology (NIST) began to formulate the National BIM Standard (NBIMS) based on IFC (Industry Foundation Classes) standards, clearly describing the actual connotation and value significance of BIM, indicating that BIM is a digital expression of the physical and functional characteristics of facilities; BIM is a shared knowledge resource, a process of sharing information about a facility to inform all decisions made throughout the life cycle of a facility, from concept to demolition. With the development of BIM technology, countries have defined BIM [4-7], although countries and institutions have defined BIM, but to a certain extent there is a consensus: BIM not only means a data model containing important information of an engineering project, but also a process of generating building information and applying it to industrial design, construction and operation stages, or a digital management method used in the whole life cycle of an engineering project.

With the development of information technology, big data, artificial intelligence and other technologies, BIM is the basis for digitalization, digital twin, cyber-physical systems and other applications, integrating 3D models of engineering equipment and components with attribute information and production operation data, and applying them in the whole life cycle of project design, construction, operation, operation and maintenance.

3. Key technologies for BIM in the field of new energy power generation

3.1. BIM Standard System for New energy Power Generation Engineering

Although new energy is booming, in the application of BIM technology, not only lack of a large number of unified BIM technology standards, but also very lack of application experience[8,9]. For the deep integration of BIM technology and new energy production, operation and maintenance, it is necessary to establish perfect BIM standards, draw on BIM data wind power coding standards, formulate general data standards, professional data standards, delivery standards, application standards, etc. in new energy fields such as onshore wind power, offshore wind power, and photovoltaic, clarify the model information, attribute information, storage standards, classification standards, digital transfer processes, etc. at each stage of the project, form a new energy power generation engineering BIM standard system, and ensure accurate interaction of information and data.

Provide assurance for information sharing and collaboration throughout the life cycle of engineering projects.

3.2. New Energy Digital Design Software

The new energy digital system based on BIM needs to meet the management and operation of the whole life cycle including project design, construction, operation and maintenance, operation, etc., and meet the multi-disciplinary and multi-cross key technologies involving BIM+GIS, computer technology and new energy business from the new energy digital design software, while the terrain of the new energy station is becoming more and more complex, the requirements for resource and environmental protection are getting higher and higher, and the requirements for cross-professional and interdisciplinary business functions are getting higher and higher.

3.3. BIM Lightweight Technology

With the increasing installed scale of new energy stations, the BIM model of the new energy station that integrates model elements such as wind turbines/photovoltaic modules, converters, lines, roads, and booster stations must be a giant platform model that integrates big data, and the integration of the giant three-dimensional model into the GIS platform makes it more difficult to operate collaboratively, and engine lightweight has become a key technology that has to be solved.

3.4. BIM Model and GIS Multi-source Heterogeneous Data Integration and Fusion

Due to the low energy density and large footprint of new energy, the BIM application of new energy power generation engineering is inseparable from the application of GIS[10]. However, BIM and GIS belong to different technical fields[11], BIM model data is large, while GIS platform focuses on the characteristics of spatial scene display, BIM and GIS model data organization form, storage mode and expression mode are different BIM and GIS data fusion key technology research], the integration and integration of multi-source heterogeneous data based on multi-professional and multidisciplinary is the key foundation for the successful application of BIM+GIS in new energy power generation engineering.

4. Digital system of new energy power project

Based on BIM technology, this paper studies the new energy digital system, aiming to solve the problems of information loss, repeated construction, and inefficient operation and maintenance of new energy projects in all aspects of the project, realize the high Sharp management of new energy projects, improve project quality and efficiency, and improve the benefits of new energy power generation projects. The following focuses on the overall architecture, system architecture, functional architecture and application scenarios.

4.1. Overall Architecture

Basic data layer: contains geographic information data and wind power professional data, of which geographic information data includes image, terrain, vector, geology, disaster points, residential areas and other data, wind power professional data includes wind tower, wind turbine foundation, booster station model, wind turbine model, pole tower model and other data, providing basic data for the algorithm layer.

Algorithm service layer: contains the result data after professional calculations such as wake calculation, load calculation, noise calculation, power calculation, wind resource analysis, and AI recognition, which can be used for visual display in the system.

Design application layer: including the scheme data of various specialties after analysis and calculation through the user operation platform, such as fan layout scheme, noise reduction scheme, load reduction scheme, road line selection scheme, collector line scheme, etc.

Achievement data layer: Based on BIM localization specifications, export and include the result data calculated by various specialties, such as wind turbine ranking data, line path data, road path data, booster station data, wind resource map data, engineering quantity data, cost data, etc.

4.2. System Architecture

Based on the application framework of BIM localization specifications, the system integrates the micro-site selection of wind resources, road and collector line design, electrical, civil engineering and other specialties of each business of the wind farm, and exchanges the design achievement data with external platforms through the BIM localization specifications. The overall architecture of the platform adopts a combination of CS and BS, the database is deployed in the information intranet, and the system is mapped to the external network through the security isolation device to realize the simultaneous access of the system in the internal network and external network environment, and the CS design results can be seamlessly connected to the BS system based on BIM localization specifications to meet the needs of different designers for different design depths of the scheme, realize the same source and mutual compatibility of data, and realize the synchronous application of PC and mobile field applications.

4.3. System Architecture

The main functions of the new energy digital system based on BIM include micro-site selection, basic design, road design, collector line design, substation design, technical disclosure, smart construction site, asset management, visual operation and maintenance, etc., and the functional architecture is shown in the figure1.

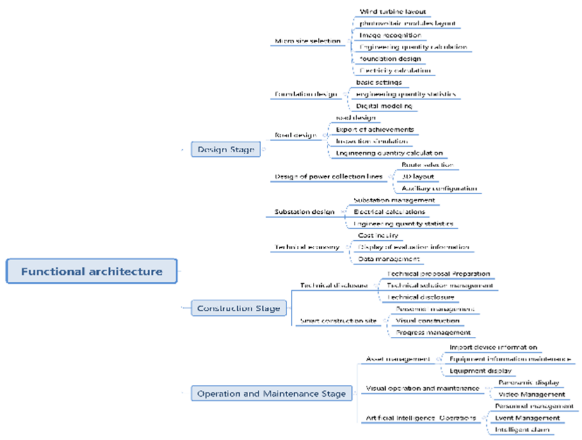

Figure1. New energy engineering digital system architecture diagram

4.4. Application Scenarios

According to the operation and management of the whole life cycle of new energy projects, the application of BIM technology is mainly distributed in the design stage, construction stage and operation and maintenance stage.

4.5. Application scenarios in design phase include:

Resource assessment, through the collection of regional meteorological data, topographic data, land use data and other relevant information; Adjust the number of wind turbines, layout, height, speed and other parameters to optimize the design scheme and determine the appropriate site selection and capacity configuration of new energy projects.

Microscopic site selection, collection of wind farm regional meteorology and wind measurement, topographic maps, engineering geology and hydrogeology, wind turbines and other data; The wind turbine location adjustment is carried out through the wind farm information model, and the site selection is comprehensively determined with the goal of optimal power generation and optimal economy.

Scheme comparison, collect early design models, design data, document data, compare the feasibility, functionality, economy and other indicators of each design scheme model, and determine the optimal design scheme and model.

4.6. Application scenarios in construction phase include:

The goal of visualization technology disclosure is to use 3D visualization to visually express and guide construction work, such as large-volume concrete foundation and tower pouring, component installation accuracy, lifting control, steel-concrete connection and embedded parts.

The goal of the construction organization design application is to associate the construction organization and construction process information with the construction model, and then simulate it, optimize it according to the simulation results, and generate analysis reports and visualize construction guidance documents.

The goal of progress management is to use the characteristics of three-dimensional visualization of the model to simulate the construction progress, so as to formulate, adjust and reasonably arrange the progress work in advance.

4.7. Application scenarios in O&M phase include:

The goal of asset management is to correlate the asset information of wind farm facilities and equipment based on the operation and maintenance model to assist in cost management, maintenance and maintenance planning.

The goal of operation monitoring is to associate the monitoring information of on-site monitoring equipment, automatic inspection equipment, and sensing equipment with the information model, and manage the operation, maintenance, shutdown and other status of the equipment.

The goal of technological transformation is to model the technical transformation scheme based on the operation and maintenance model, and form a technical transformation model to guide the technical transformation.

Is shown in the Table 1.

Table 1. Application Scenarios

NO.	stage	Application scenario
1	Design phase	Resource evaluation and optimization
2		Macroscopic location selection
3		micro-location
4		Construction condition analysis
5		Scheme comparison
6		Program review
7		Engineering quantity statistics
8		Construction organization design
9		Visualization application
10	Construction phase	Visualization technology disclosure
11		Construction organization design
12		Schedule management
13		Quality control
14		Safety management
15		Quantity management
16		Equipment and materials management
17	*O&M* phase	Asset management
18		Simulation and training
19		Operation monitoring
20		Visual management
21		Technological transformation

5. Conclusion

This paper focuses on the development of BIM technology and key technologies, and develops a new energy digital system based on BIM technology, carries out research on the application of new energy three-dimensional design and digital technology, realizes the efficient creation and dynamic display of multi-scale, multi-level and multi-element BIM models of new energy power generation projects, solves the problems of information loss, repeated construction, inefficient operation and maintenance in all aspects of the project, realizes the high Sharp management of new energy projects, improves project quality and efficiency, and improves the benefits of new energy power generation projects.

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