Analysis of Overseas UHV DC Project Construction Management Experience

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Abstract. Overseas UHV project construction faces complex and differentiated environmental challenges. Continuously summarize the practical experience of UHV DC project construction management in overseas regions and transform it into a guiding management model, which will help improve the quality and efficiency of overseas UHV DC project management. This study summarizes the typical construction management practices of State Grid Corporation of China's overseas UHV DC projects, and refines the typical experience in project construction management from five aspects: strategy, technology, management, risk, and brand, laying the foundation for the institutional solidification of management experience.

Keywords: Overseas Regions, UHV DC, Construction Management, Experience Analysis.

1 Introduction

At present, the dual pressures of global energy security and green transformation are highlighted. With its core advantages of long distance, large capacity, low loss and high efficiency, UHV DC transmission technology has become a key means to solve the problem of reverse distribution of global energy resources and load centers. Chinese enterprises have carried out extensive UHV project construction practices in overseas regions, and have achieved positive results in professional management and construction methods. They have greatly improved the safety, stability and power supply reliability of local power grids, and achieved breakthroughs in the "going out" of UHV technology. To adapt to the changes in the complex and ever-changing overseas UHV project construction environment and face the increasing demand for overseas UHV DC project construction, it is necessary to strengthen the research and summary of excellent overseas UHV DC project management practices in recent years, form and promote relevant construction management experience, so as to better cope with the difficult challenges of overseas UHV DC project construction.

Sun Haiyou et al. (2025) analyzed world-class demonstration projects such as the ± 1100kV UHVDC "Changji-Guquan" project and the 1000kV AC "Ximeng-Shandong" project, and distilled the advantages of these projects in terms of standard

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setting, equipment manufacturing, and engineering construction[1]. Zheng Huazhen et al. (2024) took the process of 220kV line protection renovation at the 220kV L substation in the Democratic Republic of the Congo as an example, to introduce the issues and experiences that should be noted in the design, setting, and construction and commissioning of line protection renovation in overseas EPC projects[2]. Zhang Aiwen (2024) summarized 40 years of engineering practice in China's Central Plains and proposed a "one-stop" engineering management system covering the entire life cycle of projects, including site selection, design, construction, commissioning, and operation and maintenance services[3]. Hu Haibo et al. (2023) summarized the achievements and experiences of major overseas engineering projects by Chinese enterprises and proposed a major project management theory system that is both universally applicable and characteristic of China[4]. Jiang Tao (2023) analyzed the successful experiences and lessons learned from completed engineering projects in Tanzania, starting from the management ideas and goals of the projects[5]. Zhang Hongmei et al. (2022) analyzed the key technologies of ± 800kV UHVDC transmission line construction and introduced the application of related technologies abroad[6].

This study summarizes the excellent practices of overseas UHV DC project construction management, refines useful experience in project construction management, and supports the high-quality construction and high-level management of overseas UHV DC projects.

2 Common and Excellent Practices in the Construction and Management of Overseas UHV DC Projects

Six typical projects were selected, including the Belo Monte Phase I/II in Brazil, the Kurukshetra UHV project in India, and the Saudi Smart Grid UHV Demonstration Project, to summarize the common and excellent practices of State Grid Corporation of China in promoting various projects.

2.1 Build a "localization + internationalization" collaborative cooperation system

In overseas projects, the cooperation strategy of "localization as the main component and internationalization as the supplement" is commonly used to effectively break through entry barriers and reduce operational risks. The first is the localization of equity cooperation, by forming joint ventures with leading energy companies in the country where the project is located. For example, the Brazilian project cooperates with the Brazilian National Electric Power Company to share equity and risks, and use the political resources of local companies to speed up the approval process. The second is to localize the management team and recruit local professionals into core management positions. For example, local employees account for more than 60% of the middle managers of Brazil State Grid Brazil, ensuring that decision-making complies with local market rules. The third is to internationalize partners and integrate high-quality global resources, such as hiring internationally renowned environmental impact assessment agencies to conduct ecological

assessments, cooperating with European and American engineering consulting companies to optimize construction plans, and improving the international level of projects.

2.2 Implement the collaborative overseas strategy of the entire industry chain

Relying on the advantages of the domestic UHV industry chain, an integrated overseas model of "design-manufacturing-construction-operation" has been established to form core competitiveness. In the design process, an international technical team was formed to carry out customized design based on the natural conditions and standard requirements of the country where the project is located. For example, the Brazilian project optimized the equipment anti-corrosion plan for the rainforest climate and optimized the tower structure for the mountainous terrain. In the equipment supply chain, we integrate the resources of domestic leading enterprises and establish a "centralized procurement + unified distribution" mechanism to ensure the quality and delivery cycle of core equipment such as converter valves and control and protection systems. The localization rate of the core equipment of the Beautiful Mountain Project reaches 100%, and the price is 15%-20% lower than similar products in Europe and the United States. In the construction process, the "Chinese general contracting + local subcontracting" model is adopted, with Chinese personnel responsible for core technical work and local subcontractors responsible for basic construction, which not only ensures construction quality but also promotes local employment. In the operation process, a remote operation and maintenance center was established to realize real-time data exchange between domestic and overseas projects and improve operation and maintenance efficiency.

2.3 Establish a full life cycle risk management and control mechanism

In view of the complex risk characteristics of overseas projects, a full life cycle risk management and control system of "pre-event assessment - in-process control - post-event review" has been established. In the pre-assessment stage, a country risk research team was formed to establish a risk assessment indicator system from political, economic, legal, ecological and other dimensions. An 18-month comprehensive risk assessment was carried out in the early stage of the Brazilian project, and core risk points such as environmental protection and policy changes were identified and response plans were formulated. During the control stage, a dynamic risk monitoring platform was established to track policy adjustments, exchange rate fluctuations and other risk factors in real time. For example, in response to fluctuations in the Brazilian real exchange rate, exchange risks were reduced through foreign exchange hedging, localized financing and other methods. In the post-review stage, risk assessment reviews are carried out every quarter, experiences and lessons learned are summarized, and the risk management and control plan is updated. The risk management and control experience of the Beautiful Mountain Project has been incorporated into the State Grid Corporation of China's overseas project management manual.

2.4 Promote green, low-carbon and sustainable construction concepts

Insert the concept of green development throughout the entire life cycle of the project and regard it as one of the core competitiveness of overseas projects. The first is to put environmental protection first, and carry out ecological environment surveys

simultaneously during the project planning stage. The Beautiful Mountain project took 26 months to complete the survey and protection plan for 936 species of animals and 60 species of endangered plants along the route. The second is to green the construction and adopt environmentally friendly construction technologies, such as promoting the use of miniaturized construction equipment to reduce vegetation damage, and using drone patrols instead of manual patrols to reduce interference to the ecological environment. The third is to make operations low-carbon, establish a green operation indicator system, and monitor equipment energy consumption and pollutant emissions. The converter station of the Beautiful Mountain Project adopts high-efficiency energy-saving equipment, and the energy consumption is reduced by more than 10% compared with traditional converter stations. The fourth is to promote the export of green standards and integrate China's UHV green construction standards with local standards. The environmental protection practices of Brazilian projects have become a reference benchmark for local large-scale projects.

2.5 Deepen local talent training and technology integration

We will regard talent localization as the core support for long-term project operation and establish a talent training system of "technical training + career development + cultural integration". The first is customized training. Special training on UHV technology has been carried out in response to the talent needs of Brazil, India and other countries. The Beautiful Mountain Project has trained more than 2,000 local technicians and trained the first batch of UHV live work teams in Brazil. The second is the construction of career development channels to provide local employees with a clear promotion path. For example, Brazil's State Grid Brazil Control Company has set up a "localization technical expert" position, giving the same remuneration as Chinese experts. The third is technological integration and innovation, encouraging Chinese and foreign technical personnel to jointly carry out research and development, such as cooperating with the Brazilian Electrical Research Institute to overcome the localization problem of UHV live work and promote the organic combination of Chinese technology and local experience. In addition, the cohesion of Chinese and foreign employees is enhanced by carrying out cultural exchange activities, such as the "China-Brazil Cultural Exchange Exhibition Center" and "Chinese Culture Month".

3 Typical Experience in High-quality Construction and Management of Overseas UHV DC Projects

3.1 Adhere to "long-termism"and "local integration"

The construction of overseas UHV projects is characterized by large investment scale, long cycle, and high risks. Short-term speculative thinking is difficult to achieve sustainable development. The practical experience of State Grid Corporation of China shows that the "long-termism" strategy is the prerequisite for project success. The Meilishan project lasted nearly 10 years from the preliminary investigation to the second phase of operation. State Grid Corporation of China has always adhered to the long-term positioning of "deeply exploring the Brazilian

market". It not only completed the project construction, but also achieved sustained profits through subsequent operations. In 2023, it successfully won the bid for the new energy transmission UHV project in northeastern Brazil, achieving a virtuous cycle of deep market penetration. "Localization integration" is the core implementation path of the long-term strategy, and its core lies in the realization of "three integrations": First, integrating into the local energy strategy, the Belo Monte project is accurately aligned with Brazil's "Northern Power Transmission to the South" energy plan, becoming a core component of Brazil's national backbone transmission network, and has won long-term support from the local government; second, integrating into local social development, through the construction of people's livelihood projects, driving employment (the Belo Monte project has created a total of more than 15,000 local jobs), The third is to integrate into the local industrial ecology, drive local building material suppliers and construction companies to participate in project construction, cultivate local UHV supporting industries, and form an industrial synergy pattern of "Chinese leadership, local participation".

3.2 Build a technical system of "standard leadership + innovation adaptation"

China's global leadership in UHV technology is the core support for the success of overseas projects. State Grid Corporation of China has achieved sustainability in technology output through "standard leadership + innovative adaptation". In terms of standards leadership, relying on domestic technology accumulation in the past 20 years, China's UHV AC 1000 kV and DC ±800 kV standards were adopted by the International Electrotechnical Commission as international standards. 72% of the world's UHV technology patents are held by Chinese companies. The Beautiful Mountain project fully adopts Chinese standards, and at the same time promotes the integration of Chinese standards and local Brazilian standards. For example, the ultra-high voltage live work standard has been certified by the Brazilian Ministry of Labor, realizing the localization of Chinese standards. Innovative adaptation is the key guarantee for technological output, and customized technological innovation can be carried out according to the natural conditions and technological needs of different regions. The first is environmental adaptation innovation. The Brazilian project developed anti-corrosion converter valve equipment for the high temperature and high humidity environment of the rainforest. For the mountainous terrain, it innovatively adopted "modular construction" technology to shorten the on-site construction period. The second is functional adaptation innovation, combined with Brazil's new energy development trend, a new energy grid-connected interface is reserved in the second phase of the Belo Monte project to improve the project's adaptability to the future energy structure. The third is innovation in operation and maintenance adaptation, developing a multi-language remote operation and maintenance platform, enabling domestic experts to provide remote technical support to Brazilian projects, and solving the problem of insufficient local operation and maintenance technology.

3.3 Establish a "full life cycle + refined" management model

The complexity of overseas UHV projects requires the establishment of a full life cycle management model. State Grid Corporation of China divides project management into three stages: "preliminary planning - construction implementation - operation and maintenance", and implements refined management and control at each

stage. In the early planning stage, we focused on "risk assessment + feasibility demonstration" and established a cross-field expert team (covering politics, law, technology, environmental protection and other fields) to conduct comprehensive research. The preliminary research on the Beautiful Mountain project took 2 years and completed more than 500 feasibility analysis reports. During the construction implementation stage, "matrix management + digital control" was implemented, and a three-level matrix management system of "headquarters coordination, regional responsibility, and project execution" was established to clarify the rights and responsibilities of all parties; a digital construction platform was built to realize real-time monitoring of construction progress, quality, and safety. The Belo Monte project used the digital platform to control the construction error within ±5 mm, which is three times higher than the local Brazilian standard. During the operation and maintenance phase, a "preventive maintenance + emergency response" system was established to achieve early warning of faults through the equipment status monitoring system. Since the Belo Monte project was put into operation, the equipment availability rate has remained above 99.8%, which is higher than the average level of similar projects in Brazil.

3.4 Form a risk prevention and control system of "accurate identification + multiple responses"

The complexity of overseas project risks requires the establishment of a systematic risk prevention and control system. The experience of State Grid Corporation of China can be summarized as a closed-loop mechanism of "accurate identification - classified management and control - dynamic optimization". In terms of accurate identification, a "country risk database" has been established to cover political, economic, legal and other risk data in more than 20 key markets around the world, and a combined "quantitative + qualitative" assessment method has been adopted. For example, policy risks in the Brazilian market have been quantitatively assessed using the "Policy Stability Index", and geopolitical risks have been qualitatively assessed using expert scoring. In terms of classified control, differentiated response strategies are adopted for different types of risks: political risks are addressed through "equity cooperation + policy insurance", such as the joint venture with local enterprises in the Brazilian project and the purchase of political insurance from the China Export & Credit Insurance Corporation (Sinosure); economic risks are dealt with through "diversified financing + foreign exchange hedging", such as the adoption of a combined financing model of "local loans + international syndicated loans" and the use of foreign exchange forward contracts to hedge against exchange rate risks; environmental risks are managed through "preliminary assessment + technological innovation", such as the environmental investment in the Belo Monte project accounting for 8% of the total project investment, which is much higher than the industry average. In terms of dynamic optimization, a monthly risk screening and quarterly assessment mechanism is established, and response plans are adjusted in a timely manner according to risk changes. For example, after the change of the Brazilian president, the project team quickly interpreted the new government's energy policy and adjusted the project operation strategy.A

3.5 Create an international image of "responsibility + people-to-people connections"

Overseas UHV projects are not only technical projects, but also brand projects. State Grid Corporation of China has built a good international brand image through "responsibility + people-to-people connections". In terms of responsibility, the focus is on "green responsibility" and "social responsibility": In terms of green responsibility, the environmental protection practices of the Beautiful Mountain Project have become a benchmark for large-scale projects in Brazil and have won multiple international environmental awards; in terms of social responsibility, public welfare activities such as aiding poor communities and educational support are carried out along the project line, such as funding the Youth Symphony Orchestra in the Malé slums and building brackish water desalination facilities. Connecting people is the core path of brand building, and emotional identification is achieved through "cultural exchange + benefit sharing". In terms of cultural exchanges, activities such as the "China-Brazil Sports Exchange Competition" and "Chinese Culture Month" were held, and the "China-Brazil Cultural Exchange Exhibition Center" was established to enhance local people's understanding of Chinese culture and enterprises; in terms of benefit sharing, local people were able to obtain actual benefits from the project through localized employment and cultivating local suppliers. The income of residents in the communities along the Belo Monte project in Brazil increased by an average of 12% compared with before the project construction, forming a virtuous cycle of "project construction-community benefits-public support". This brand building model not only enhances the international reputation of State Grid Corporation of China, but also lays a good foundation for subsequent market expansion.

4 Conclusion

Overseas UHV DC project construction is a landmark project of my country’s "One Belt, One Road" initiative, a core hub for energy interconnection, and an important carrier for the output of technical standards. Promoting high-quality project management is of great practical significance. This study summarizes and analyzes the construction management work of multiple key projects and proposes useful experiences to improve the quality and efficiency of related work.

In the next step, it is necessary to strengthen the promotion and application of typical experiences in high-quality construction management of overseas UHV DC projects, solidify the work measures with good implementation results into systems, and comprehensively improve the level of scientific management.

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