Main Problems and Solutions for UHV Project Construction in Remote Areas

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Abstract. Under the extraordinary development stage, UHV construction in remote areas faces increasing difficulties and challenges. Systematically analyze typical problems in UHV project construction management in remote areas, and propose management model optimization plans with promotion value, which will help improve the quality and efficiency of UHV project management. This study analyzes the main problems faced by UHV project construction in remote areas in terms of technology, management, resources, and ecology, and puts forward strategic suggestions from four aspects: building a technological innovation system, a management framework, a resource guarantee system, and an ecological management and control system.

Keywords: Remote Areas, UHV Projects, Construction Management, Problem Analysis.

1 Introduction

As the core carrier of the "West-to-East Power Transmission" and "North-to-South Power Supply" strategic energy channels, the UHV project is a key support for building a new power system. My country's remote areas contain abundant wind power, photovoltaic, hydropower and other clean energy resources, such as solar resources in the Qinghai-Tibet Plateau, wind energy resources in Inner Mongolia, and hydropower resources in southwest China. The reserves account for more than 70% of the country's total clean energy reserves. However, these areas generally face problems such as poor natural environment, weak infrastructure, and relatively lagging economic development, which makes the construction of UHV projects face many challenges that ordinary people cannot imagine. There is an urgent need to analyze the difficulties and challenges of UHV project construction in remote areas, and study standardized management models that adapt to extraordinary development needs, so as to provide a theoretical reference for major project management research in similar extreme environments.

Zhang Guangyu (2025) combined the actual data and cases of new energy base construction in major cities and prefectures in Gansu to analyze the model and benefits of

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the construction of the "Shagehuang" new energy base, and put forward policy recommendations to further promote the construction of the "Shagehuang" new energy base[1]. Zhang Xinyi (2025) combined the characteristics of the new energy project in Shagehuang Base and used methods such as risk identification, big data quantitative analysis, scenario analysis and digital monitoring to deeply analyze the causes of risks and their impact mechanisms[2]. Cheng Bo et al. (2025) introduced the "source grid load storage" microgrid demonstration project in the Ejina area of Inner Mongolia Power Grid, and proposed an integrated "source grid load storage" solution with network-type energy storage as the core[3]. Tian Haifeng et al. (2024) proposed a cost rationality assessment method for transmission technical renovation projects in high-altitude areas, and put forward management optimization suggestions[4]. Luo Dehong et al. (2023) analyzed the difficult challenges in the development of the Shagehuang new energy base and proposed a path to promote the high-quality development of the desert new energy base[5]. Luo Dehong (2022) analyzed the difficulties existing in promoting the "new energy + ecological governance" model in the development of the "Shagehuang" large base, and put forward targeted strategic suggestions[6].

This study analyzes the main problems existing in the construction and management of UHV projects in remote areas, and puts forward strategic suggestions for solving the problems to support high-quality construction and high-level management of UHV projects in remote areas.

2 Core Difficulties in the Construction of UHV Projects in Remote Areas

2.1 Technical Difficulties

One is the problem of equipment adaptability. High-altitude and low-pressure environments will reduce the insulation performance of electrical equipment. Conventional UHV equipment is prone to insulation breakdown in areas above 3,000 meters above sea level. High-cold environments can cause equipment seals to age and hydraulic systems to freeze. For example, converter transformers are difficult to start normally below -30°C. Under complex geological conditions, tower foundations need to bear greater horizontal loads, and conventional foundation forms are prone to overturning.

The second is construction technical difficulties. The working efficiency of personnel in high-altitude areas is greatly reduced. The efficiency of work on level ground is only 60% of that in plain areas, and the efficiency of high-altitude work is less than 50%, and it is easy to cause health risks such as altitude sickness. Concrete construction in alpine areas needs to solve the problems of anti-freeze and early strength, and conventional maintenance methods cannot meet the strength requirements. In the construction of pole and tower foundations in complex geological areas, technical difficulties such as cave treatment and slope support are extremely difficult. For example, in a UHV line project in Liangshan, Sichuan, 30% The tower foundation needs to deal with cave issues.

The third is debugging and operation and maintenance problems. Transportation in remote areas is inconvenient, and the transportation and on-site calibration of precision instruments required for equipment debugging are difficult. It is difficult to monitor the operating status of equipment in extreme environments. For example, icing monitoring equipment in alpine areas is easily affected by low temperatures and fails. The cost of permanent operation and maintenance personnel is high, and the technical level cannot meet the operation and maintenance needs of UHV equipment.

2.2 Management Difficulties

First, the problem of progress control. The natural environment has strict restrictions on the construction window period. The effective construction period in high-altitude areas is only 5-6 months. Construction in alpine areas is impossible in winter. Complex geological areas are prone to suspension of work due to geological disasters during the flood season. The material transportation cycle is long. For example, in the Liangshan UHV project in Sichuan, it takes more than 20 days to transport large converter transformers from the manufacturer to the construction site, and is easily delayed due to weather effects.

The second is the problem of quality control. The technical level of construction teams in remote areas is uneven, and some local laborers lack UHV engineering construction experience; quality control of raw materials is difficult, and there are few local building materials suppliers. Building materials transported from other places are prone to quality degradation due to improper protection during transportation; quality testing standards are unclear in extreme environments. For example, there is no unified standard for concrete strength testing in high-altitude areas, and the accuracy of testing results is difficult to guarantee.

The third is the problem of safety management and control. Construction workers in high-altitude areas are at high risk of altitude sickness and are prone to safety accidents such as syncope and pulmonary edema; construction in complex geological areas is faced with risks of geological disasters such as landslides and mudslides, which require real-time monitoring and early warning; medical rescue conditions in remote areas are poor, and it takes an average of more than 4 hours to get from the construction site to the nearest tertiary hospital, and emergency rescue response lags behind.

2.3 Resource Difficulties

First, there is a shortage of human resources. The population density in remote areas is low and the local labor force is insufficient. Construction workers need to be recruited from other places, and the transportation and resettlement costs are high. Highly skilled talents required for UHV projects are scarce and must be deployed from first-tier cities, resulting in a high risk of brain drain.

Second, there are difficulties in material support. The local supply capacity of building materials in remote areas is insufficient. Basic building materials such as sand, gravel, and cement need to be transported from hundreds of kilometers away, and the transportation cost is more than 50% higher than in plain areas. The transportation of large equipment is restricted by terrain. For example, the weight of a single UHV tower exceeds 10 tons. Highway transportation in mountainous areas requires special reconstruction of roads, and the reconstruction cost is as high as 200,000 yuan per kilometer. Extreme weather can easily cause transportation interruptions.

Third, the capital investment is huge. The unit cost of UHV projects in remote areas is much higher than that in plain areas. The unit cost of line projects in high-altitude areas is about 1.8 times that in plain areas, and up to 2.2 times in complex geological areas. Project construction requires the construction of temporary roads, power supply, communications and other facilities, with supporting investments accounting for 15%-20% of the total investment. Later operation and maintenance costs are high. For example, equipment maintenance costs in alpine areas are more than 40% higher than in plain areas.

2.4 Ecological Difficulties

First, ecologically sensitive areas are strictly controlled. Remote areas are mostly special areas such as ecological reserves and natural heritage sites, and project construction must comply with strict ecological protection requirements. For example, large-scale earth excavation is prohibited in the Sanjiangyuan Protection Area, and line projects must bypass core protection areas, resulting in a 10%-15% increase in line length.

Second, ecological restoration is difficult. The ecosystem in remote areas is fragile, and it is difficult to restore vegetation after it is destroyed during construction. For example, it takes more than 10 years for natural restoration of meadow vegetation in the Qinghai-Tibet Plateau. The soil layer in some areas is weak, and it is easy to cause water and soil erosion after excavation. For example, construction in the karst area of Liangshan, Sichuan requires special water and soil conservation measures.

Third, environmental compliance requirements are high. Project construction requires strict environmental impact assessment, involving the protection of rare animals and plants, water source protection and other aspects; the environmental protection acceptance standards are strict. For example, the environmental protection acceptance of the Qinghai-Tibet Interconnection Project involves more than 20 indicators, and all standards must be met before it can be put into operation.

3 Measures to Optimize the Construction of UHV Projects in Remote Areas

The first is to build a targeted technological innovation system. Taking the adaptation needs of extreme environmental engineering as the core, we will establish a technological innovation mechanism with in-depth collaboration between "industry, academia, research and application", focus on core technical bottlenecks in scenarios such as high altitude, high cold, and complex geology, and concentrate on breakthroughs in key technologies and special equipment research and development. Promote the upgrade of the technical standard system, iteratively improve the technical standards for ultra-high voltage engineering in extreme environments based on practical results, and form a standard system covering the entire life cycle. Deepen the integration and application of digital and intelligent technologies, build a digital management and control system for UHV projects, promote the large-scale application of technologies such as BIM， drone inspections and digital twins, and improve the intelligent level of project construction and operation and maintenance.

The second is to build a management framework that combines standardization and flexibility. Based on practical experience, we will refine and form core standards for UHV project construction management in remote areas, build a standardized management system covering the entire process of planning, design, construction, operation and maintenance, and clarify differentiated regional management requirements. Establish a flexible management and control system adapted to extreme environments, optimize the construction organization model based on the characteristics of the natural environment, dynamically adjust resource allocation and schedule arrangements, and improve the anti-interference ability of the management system. Improve the collaborative linkage mechanism of "government, enterprise and people", strengthen the collaboration of multiple entities in planning and site selection, technical research, land acquisition coordination, etc., and form a management pattern of multi-dimensional and co-governance.

The third is to optimize the diversified resource guarantee system. Build a talent guarantee system of "localized cultivation + professional introduction", strengthen the construction of UHV talent cultivation carriers in remote areas, improve the talent incentive and sharing mechanism, and solve the problem of shortage of high-skilled talents. Create a material support network of "regional coordination + three-dimensional transportation", integrate regional resources to establish an intensive reserve platform, build multiple transportation channels suitable for extreme environments, and improve the stability and efficiency of material supply. Expand a diversified green financing system, actively strive for policy funding support, innovate the application of green financial tools, establish a linkage mechanism between project revenue and local development, and alleviate financial pressure.

The fourth is to establish an ecological management and control system that coordinates development and protection. Strengthen ecological front-end management and control, incorporate ecological impact assessment into the core process of project approval, optimize route and station site selection plans, avoid ecologically sensitive areas, and promote ecologically friendly design standards. Improve the ecological management and control mechanism during the construction process, establish a full-process management and control system of "ecological supervision + process inspection + acceptance evaluation", strictly implement the minimum operating area, immediate repair and other control requirements, and reduce the disturbance of the ecological environment caused by construction.

The fifth is to improve systemic policy support and collaborative governance mechanisms. Improve the top-level policy support framework, and relevant ministries and commissions will jointly issue special support policies for UHV projects in remote areas, and clarify differentiated policy requirements in terms of ecological management and control, tax incentives, and approval services. Increase fiscal and financial support, set up special subsidy funds, guide financial institutions to launch adaptive financial products, and reduce project investment and financing costs.

4 Conclusion

As power grid construction enters an extraordinary development stage, more and more UHV projects will be deployed in remote areas of my country. Discovering the main problems in the construction of UHV projects in remote areas and making targeted strategic suggestions play an important role in promoting high-quality construction of projects. This study adheres to a problem orientation, analyzes the main problems in technology, management, and ecological aspects of UHV project construction in remote areas, and puts forward strategic suggestions for solving the problems.

In the next step, it is necessary to formulate detailed work plans based on UHV project construction measures in remote areas, strengthen the implementation of the work plans, continue to accumulate experience, and solidify effective measures into a normal long-term mechanism.

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