Research on Optimization and Development Strategy of Industrial Chain of "Wind-Solar Hydrogen Storage Vehicle" in Ordos City

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Abstract: Ordos City, as an important energy base, is committed to building the full industrial chain of "wind-solar hydrogen storage vehicles" to achieve the green and low-carbon transformation of resource-based cities. However, this industrial chain still faces challenges in resource integration, technological innovation, and market competitiveness. This study thoroughly analyzes the current situation of the "wind-solar hydrogen storage vehicle" industrial chain in Ordos City, identifies the main development bottlenecks, and proposes corresponding optimization strategies. The study emphasizes the importance of strengthening industrial chain collaboration, enhancing technological innovation and research and development capabilities, and optimizing the market and policy environment. To address the intermittency and volatility issues of renewable energy generation, suggestions are made for energy storage technology integration, smart grid technology application, and the construction of multi-energy complementary systems. Additionally, specific solutions are proposed for the imbalance of new energy installation layout, lagging grid infrastructure construction, economic efficiency issues of new energy enterprises, technological and economic challenges of the hydrogen energy industrial chain, insufficient application of energy storage technology, the need for professional talents and technical safety standardization, as well as the perfection of policies and market mechanisms. The research results not only provide a new perspective for theoretical exploration but also offer practical guidance for Ordos City's development in the new energy industry, with significant academic value and application prospects.

***Keywords*:** Ordos City; wind-solar hydrogen storage vehicle; industrial chain; optimization strategy; development research

1. Introduction

Against the backdrop of global energy structural transformation and increasing environmental protection awareness, the rise of the new energy industry has become an irreversible trend. Especially in China, with the introduction of the "peak carbon dioxide emissions" and "carbon neutrality" goals, the clean energy industry represented by wind and solar energy has ushered in rapid development opportunities. Ordos City, as a key national energy and strategic resource base, seizes the opportunity of the "dual carbon" strategy, regards new energy as the main direction to adjust the energy structure, and leads the transformation of industrial structure and economic structure with energy structure transformation. It is fully committed to building the full industrial chain of "wind-solar hydrogen storage vehicles", opening up new paths for the green and low-carbon transformation of resource-based cities. However, the current industrial chain still faces problems such as insufficient resource integration, technological innovation lag, and weak market competitiveness, urgently requiring optimization and enhancement. Therefore, this study aims to thoroughly analyze the current situation and existing problems of the "wind-solar hydrogen storage vehicle" industrial chain in Ordos City and propose targeted optimization and development strategies. It has important theoretical significance and practical value for promoting the development of Ordos City's new energy industry and advancing energy structure transformation and upgrading.

2. Ordos City Wind-Solar Hydrogen Storage Vehicle Industry Development Foundation

Ordos City, with its unique natural conditions, abundant water resources, advanced experience in photovoltaic sand control, solid foundation in power installation, perfect grid construction, strong industrial base, and robust production capacity, has provided a solid foundation for the rapid development of the new energy industry.

2.1 Natural Conditions and Resource Endowment

Ordos City possesses unique natural advantages for developing the new energy industry. The region's annual solar total radiation ranges from 5,600 to 6,000 megajoules per square meter, with an average annual sunshine duration of up to 3,100

hours. Additionally, the area boasts abundant wind energy resources characterized by high wind energy density, numerous effective wind hours, high stability, and good continuity, providing ideal conditions for constructing large-scale wind power bases.

With vast territory and extensive desert areas, Ordos City has a large amount of unused land as well as coal mining subsidence areas, reclamation areas, and mine waste disposal areas, providing excellent conditions for constructing large-scale photovoltaic power generation bases and tens of millions of kilowatts-level large-scale wind power bases. Ordos City has over 43,300 square kilometers of desertified land, including most areas of the Kubuqi Desert and the Maowusu Desert, providing ample space for the construction of photovoltaic power generation bases. It is estimated that in addition to the existing, under construction, and planned new energy bases, the city still has a potential for new energy development exceeding 240 million kilowatts, including approximately 200 million kilowatts for photovoltaics and about 40 million kilowatts for wind power. Considering the effect of photovoltaic sand control on ecological governance and restoration, exploring new energy + ecological governance pilot demonstrations within the ecological red line, the Kubuqi Desert region also has the potential to develop 140 million kilowatts of new energy.

2.2 Water Resource Guarantee

In terms of water resources, the total water resources in the city amount to 28.6 billion cubic meters, with a usable amount of 22.5 billion cubic meters and water consumption of 16.9 billion cubic meters, sufficient to support the development and construction of new energy bases, ecological governance, and water demand for hydrogen production.

2.3 Photovoltaic Sand Control Experience

Ordos City has accumulated rich experience in sand control and desertification prevention, forming a photovoltaic sand control model with Kubuqi characteristics, providing practical cases for the organic integration of the new energy industry and ecological governance.

2.4 Power Installation Foundation

With sufficient thermal power support and rapid increase in new energy installation, by the end of 2023, the city's total installed power capacity reached 45.99 million kilowatts. Among them, thermal power installed capacity was 35.59 million kilowatts, accounting for 77.4% of the total installed capacity, and renewable energy installed capacity was 10.4 million kilowatts, accounting for 22.6% of the total installed capacity. In recent years, the city has accelerated the development of the new energy industry and is gradually becoming one of the national tens of millions of kilowatts-level large-scale wind and photovoltaic bases. Five projects have been included in the national "Shaguang Desert" major base list, with a total planned scale of 34 million kilowatts, all planned to be put into production during the "14th Five-Year Plan" period.

2.5 Grid Construction

Ordos City has established a relatively strong backbone grid and transmission and distribution network, forming a radiation-supply grid structure centered on 500-kilovolt substations and mainly composed of 220-kilovolt lines, providing basic conditions for supporting the access of large-scale new energy. The Shanghai Miao to Shandong ultra-high-voltage direct current and Mengxi to Tianjin South (and Mengxi to Jinzhong) ultra-high-voltage alternating current dual "point-to-grid" ultra-high-voltage transmission channels have been completed, with a total designed transmission capacity of 18 million kilowatts; promoting the construction of the Mengxi to Beijing-Tianjin-Hebei direct current transmission channel and the Kubuqi to Shanghai direct current transmission channel.

2.6 Strong Industrial Base and Good Absorption Conditions

As one of the four national modern coal chemical industry demonstration zones, Ordos City has the most complete categories and the largest scale of modern coal chemical pilot demonstration projects in the country, forming multiple industrial chains such as coal-to-oil and gas, coal-to-methanol-olefin, coal-to-ethylene glycol, and coal-based new materials, with an annual production capacity of nearly 20 million tons. In recent years, the city has continuously focused on the new energy equipment manufacturing industry, vigorously promoting the development of the full industrial chain of the "wind-solar hydrogen storage vehicle." By the end of 2023, it had formed a production capacity of 5 gigawatts for wind power equipment, 25 gigawatts for monocrystalline silicon rods, 23 gigawatts for silicon wafers, 11.5 gigawatts for photovoltaic modules, 10.5 gigawatt-hours for power and energy storage batteries, over ten thousand sets of hydrogen fuel cell systems, and 40,000 new energy vehicles.

3. Overview of the Wind-Solar Hydrogen Storage Vehicle Industry Chain in Ordos City

In recent years, Ordos City has been committed to building a complete chain industry cluster of "wind-solar hydrogen storage vehicles" that integrates energy production, equipment manufacturing, and application demonstrations. It has implemented the construction of 51 major projects with an investment of over 100 million yuan, and successively introduced a large number of leading enterprises in the new energy equipment manufacturing industry, such as Longi, Guohong, and SAIC Red Rock. It has initially formed several industry chains, including:

Battery and energy storage industry chain led by Vision Farasis, with Hua Jing, Wan Lithium Tai, and Rong Lithium as supporting companies.Photovoltaic industry chain led by Longi.Hydrogen fuel cell and green hydrogen equipment manufacturing industry chain led by Meijin Guohong and Xin Xin Group.New energy vehicle manufacturing industry chain led by SAIC Red Rock and Jie Hydrogen Technology.The city has completed the construction of wind turbine equipment with a capacity of 5 gigawatts, photovoltaic cells and components totaling 22.5 gigawatts, energy storage batteries of 10.5 gigawatts-hour, 5,000 hydrogen fuel cell stacks, and 11,000 sets of systems.

4. Challenges Facing the Development of the Wind-Solar Hydrogen Storage Vehicle Industry Chain in Ordos City

In the process of promoting the development of the "wind-solar hydrogen storage vehicle" industry chain, Ordos City faces a series of challenges, mainly including:

4.1 Intermittency and Volatility of New Energy Generation

New energy generation, especially wind and solar energy, exhibits significant intermittency and volatility characteristics. This characteristic makes it unable to provide stable power output comparable to traditional fossil energy generation, posing challenges to the stability of the grid and the continuity of power supply. To address this issue, in-depth research is needed to optimize grid scheduling strategies and explore the integrated application of energy storage technology to smooth out the fluctuations in new energy generation and ensure the stable operation of the power system.

4.2 Imbalance in the Layout of New Energy Installation

Currently, there is a phenomenon of reverse distribution between new energy installations and power loads. This imbalance in layout leads to insufficient capacity for large-scale integration of new energy into the grid, thereby increasing the risk of curtailment.

4.3 Lagging Grid Infrastructure Construction

The construction speed of the grid and its supporting facilities has failed to keep pace with the speed of new energy generation enterprises' production, resulting in restricted channels for outward transmission of new energy electricity and insufficient local consumption capacity.

4.4 Economic Efficiency Issues of New Energy Enterprises

Due to the limitation of grid integration capacity, new energy enterprises cannot achieve full-capacity grid-connected power generation, directly affecting the economic efficiency of enterprises and leading to resource wastage.

4.5 Technological and Economic Challenges of the Hydrogen Energy Industry Chain

Hydrogen energy, as a clean energy source, plays a key role in energy transformation and has significant development potential. However, the development of the hydrogen energy industry faces dual challenges of technological bottlenecks and cost control in key areas such as preparation, storage, and transportation. To promote the commercialization of the hydrogen energy industry, it is necessary to achieve efficiency improvement and cost reduction in hydrogen energy preparation and application through technological innovation.

4.6 Insufficient Application of Energy Storage Technology and Late Start of Energy Storage Industry Development

Energy storage technology plays an important role in solving issues such as curtailment of wind and solar energy and peak load regulation. However, Ordos City currently lacks sufficient application of energy storage technology, especially in addressing issues such as curtailment of wind and solar energy and peak load regulation.

The energy storage industry in Ordos City is still in its infancy and needs to be accelerated through policy support and market mechanism improvement. The economic and environmental benefits of energy storage projects need to be

comprehensively evaluated through the establishment of an evaluation index system. Additionally, the identity and business model of energy storage are not yet clear. The independent identity of energy storage and the business model for market participation are still being explored, lacking effective profit methods and a unified evaluation index system.

4.7 Demand for Professional Talents and Technical Safety Standardization

The current energy storage industry faces a shortage of professional technical talents, and the safe operation of electrochemical energy storage stations is also restricted by the imperfection of existing technical safety standards. The frequent occurrence of fires and explosions in electrochemical energy storage stations further highlights the urgency of strengthening the formulation and implementation of safety standards. Therefore, the development of the energy storage industry urgently requires optimization of education and training mechanisms and improvement of safety standards to address the shortage of professional talents and technical safety challenges.

4.8 Demand for the Perfection of Policy and Market Mechanisms

The market and price mechanisms of the energy storage industry are in the development stage and need to be improved through policy guidance and market mechanism innovation. Currently, inadequate policy support and unclear market mechanisms restrict the attractiveness and healthy development of the energy storage industry. Therefore, to promote the sustainable development of the energy storage industry, it is necessary to provide a more clear and favorable external environment for the commercialization of energy storage technology through continuous optimization of policies and innovation of market mechanisms.

5. Optimization and Development Strategies for the Wind-Solar Hydrogen Storage Vehicle Industry Chain in Ordos City

5.1 Optimization Strategies for the Intermittency and Volatility of New Energy Generation

Integration of Energy Storage Technology: Develop and integrate large-scale energy storage systems such as Battery Energy Storage Systems (BESS) and Compressed Air Energy Storage (CAES) to balance the intermittent output of wind and solar energy.

Smart Grid Technology: Utilize smart grid technology for real-time monitoring and dynamic adjustment to optimize the allocation of power resources and enhance the grid's adaptability to fluctuating power sources.

Multi-Energy Complementary Systems: Construct multi-energy complementary systems combining wind, solar, energy storage, and traditional energy sources to form a stable power supply system.

5.2 Optimization Strategies for the Imbalance in the Layout of New Energy Installation

Regional Coordinated Planning: Strengthen regional energy coordination planning to optimize the layout of new energy installations and achieve a reasonable match with power loads.

Inter-Regional Power Transmission: Construct inter-regional power transmission networks to enhance the cross-regional dispatching capacity of new energy electricity and reduce curtailment phenomena.

5.3 Optimization Strategies for the Lagging Grid Infrastructure Construction

Accelerate Grid Upgrades: Increase investment and accelerate the upgrading of grid infrastructure to enhance the grid's capacity for new energy integration and power transmission efficiency.

Demand-Side Management: Implement demand-side management strategies to guide users to use electricity rationally through price mechanisms, load control, etc., to balance supply and demand.

5.4 Optimization Strategies for the Economic Efficiency Issues of New Energy Enterprises

Policy Support and Incentives: The government provides policy support such as financial subsidies, tax incentives, etc., to improve the economic efficiency of new energy enterprises.

Market Mechanism Improvement: Improve the electricity market mechanism to ensure fair participation of new energy generation in market transactions and enhance its market competitiveness.

5.5 Optimization Strategies for the Technological and Economic Challenges of the Hydrogen Energy Industry Chain

Promote Technological Innovation: Increase investment in hydrogen energy technology research and development to promote breakthroughs in key technologies such as hydrogen production, storage, and transportation.

Integration of Industry Chains: Integrate upstream and downstream resources of the hydrogen energy industry chain to

achieve synergies, reduce production costs, and improve overall economic benefits.

Demonstration Project Promotion: Conduct demonstration projects for hydrogen energy applications to explore effective ways to commercialize hydrogen energy through practice.

International Cooperation: Strengthen cooperation with advanced international hydrogen energy industries to introduce advanced technologies and management experience, accelerating the development of the hydrogen energy industry.

5.6 Optimization Strategies for the Insufficient Application of Energy Storage Technology and Late Start of Energy Storage Industry Development

Technology Research and Integration: Increase investment in energy storage technology research and promote innovation and integration of local energy storage technologies, such as lithium-ion batteries, flow batteries, etc.

Demonstration Projects and Pilot Programs: Implement demonstration projects and pilot projects for energy storage technology to explore energy storage solutions suitable for local conditions through practice.

Policy Incentives: Formulate preferential policies such as tax exemptions, financial subsidies, etc., to incentivize the construction and operation of energy storage projects.

Market Mechanism Construction: Establish and improve mechanisms for energy storage participation in the market, clarify the market positioning and business models of energy storage projects.

Benefit Evaluation System: Construct a comprehensive benefit evaluation system for energy storage projects, including economic benefits, environmental benefits, and social effects, etc.

5.7 Optimization Strategies for the Demand for Professional Talents and Technical Safety Standardization

Talent Cultivation and Introduction: Cooperate with universities to establish courses and majors related to energy storage technology to cultivate local talents; meanwhile, introduce high-end talents externally.

Safety Standard Formulation: Formulate and implement safety standards and operating procedures for electrochemical energy storage stations to improve the safety of energy storage systems.

Emergency Response Mechanism: Establish an emergency response mechanism for energy storage station accidents to improve the ability to respond to emergencies.

Technical Training and Certification: Conduct regular safety and technical training for practitioners and implement a professional certification system.

5.8 Optimization Strategies for the Demand for the Perfection of Policy and Market Mechanisms

Improvement of Policy Framework: Formulate a comprehensive policy framework to clarify the development goals, support measures, and regulatory requirements of the energy storage industry.

Innovation of Price Mechanisms: Innovate the electricity price mechanism for energy storage projects, such as implementing peak-valley electricity prices, demand response, etc., to improve the economic efficiency of energy storage projects.

Market Access and Transaction Rules: Clarify the market access conditions and transaction rules for energy storage projects to promote the market-oriented operation of energy storage projects.

Investment Incentives: Incentivize private individuals and enterprises to invest in energy storage projects through measures such as financial subsidies, interest subsidies for loans, green credit, etc.

Cooperation and Exchange Platform: Establish a cooperation and exchange platform for the energy storage industry to promote information sharing, technical exchange, and collaborative innovation.

6. Conclusion

This paper provides an in-depth analysis of the current status and challenges of the "Wind-Solar-Hydrogen-Energy Storage Vehicle" industry chain in Ordos City. It proposes a series of targeted optimization strategies and development paths. The research results demonstrate that by strengthening industry chain collaboration, technological innovation and research and development, as well as optimizing market and policy environments, the overall competitiveness and sustainable development capabilities of the industry chain can be significantly enhanced.

Looking to the future, the development of the "Wind-Solar-Hydrogen-Energy Storage Vehicle" industry chain in Ordos City still requires continuous exploration and innovation. It is suggested to continue to focus on the advancement of new energy technologies, changes in market demand, and adjustments in policy environments to adapt to the constantly changing external conditions. Moreover, it is recommended to enhance interdisciplinary and cross-industry cooperation to promote

the deep integration and coordinated development of various links in the industry chain. Through these efforts, Ordos City is expected to achieve greater success in the field of new energy industries and contribute to China's and even global energy transition and sustainable development.

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