Research on New Energy Industry Clusters Promoting High-Quality Economic and Social Development in Xinjiang

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Abstract. Developing new energy industry clusters is an effective measure for building a new-type power system, transforming the development mode and energy use mode, and helping to achieve the "dual carbon" goals. It is also an inevitable choice for releasing Xinjiang's energy development potential, promoting high-quality economic and social development, and improving people's livelihood. Under the preliminary framework of industrial cluster and regional sustainable development theory, this paper elaborates on the significance of new energy industry clusters for Xinjiang's high-quality economic and social development, deeply explores the opportunities and challenges it faces, and puts forward more targeted countermeasures and suggestions. The aim is to provide a reference for further cultivating and strengthening new energy industry clusters and promoting Xinjiang's high-quality economic and social development.

Keywords: New energy industry; Industrial cluster; Economic structure optimization; High-quality development.

1. Introduction

Energy is a global concern related to economic and social development, and it is of great significance to the long-term stability of the national economy and social progress. The National Development and Reform Commission, the National Energy Administration, and the National Data Bureau have all implemented General Secretary Xi Jinping's important expositions on national energy security and jointly released the "Action Plan for Accelerating the Construction of a New-Type Power System (2024-2027)" (hereinafter referred to as the "Action Plan"). Based on the 20-character principle of "clean and low-carbon, safe and sufficient, economical and efficient, coordinated supply and demand, flexible and intelligent", the plan promotes the development of a new-type power system. Xinjiang is identified as a national strategic priority area for energy resource security. Therefore, it focuses on national needs and its own supply capacity. In the context of "meeting national needs with Xinjiang's strengths", Xinjiang develops new energy industry clusters, promotes the planning, design, and construction of large-scale wind power and photovoltaic power generation bases in deserts, Gobi, and wastelands, and advances the construction of a new-type power system adapted to the increasing proportion of new energy. This system promotes the achievement of high-quality economic and social benefits and transforms resources into products that meet national needs [1].

2. Current Status and Significance of Xinjiang's New Energy Industry Cluster Development

At the symposium on the development of the western region in the new era, General Secretary Xi Jinping pointed out that the western region should further enhance its position and role in the national important energy resources and strengthen its security support capacity in this field. Focusing on building the core area of the Silk Road Economic Belt and the "Three Bases and One Corridor", Xinjiang has concentrated resources on developing new energy industries and upgrading traditional industries. By the end of 2024, the total installed capacity of new energy in Xinjiang had exceeded 100 million kilowatts, making it the first province in northwest China to achieve an installed capacity of over 100 million kilowatts. Among them, the installed capacity of wind power reached 47.08 million kilowatts, and that of photovoltaic power reached 56.75 million kilowatts. In 2024, the newly

added installed capacity of energy in Xinjiang was 42.11 million kilowatts, ranking first in the country for the year. In the first five months of 2025, the newly added installed capacity was 26.88 million kilowatts, accounting for 60% of the region's total installed power capacity by the end of May 2025 [2].

2.1. A Strategic Measure for National Energy Security

General Secretary Xi Jinping emphasized that we must firmly hold the energy rice bowl in our own hands. China's total energy consumption accounts for about 25% of the world's total. As we comprehensively advance Chinese-style modernization on a new journey, the demand for energy consumption in China will continue to grow rigidly. Therefore, energy security must be ensured with higher standards and stricter requirements. Adhering to oil and gas as the key, coal as the foundation, and new energy as the direction, Xinjiang comprehensively promotes the construction of the national "Three Bases and One Corridor" in the new era. It has focused on building three 100-million-kilowatt-level new energy bases in Hami, Zhundong, and the southern Xinjiang region around the Tarim Basin. In 2024, the amount of "Xinjiang's electricity transmitted to other provinces" reached 126.4 billion kilowatt-hours. The construction of the world's largest single-unit hydrogen storage project has started, and the cumulative installed capacity of new-type energy storage that has been built and connected to the grid has reached 10 million kilowatts, ranking among the top in the country. At present, a power grid pattern of "four internal supply loops and four external transmission channels" has been formed. Xinjiang is accelerating the construction of supporting facilities for new energy grid connections and cross-regional power transmission, continuously enhancing the reliability of energy supply and strategic support capabilities.

2.2. A Necessary Requirement for Implementing "Dual Carbon" Goals

Vigorously developing new energy and promoting the green and low-carbon transformation of the economy and society is a global consensus on addressing climate change. Generally speaking, China's industrial structure is still dominated by heavy industry, the proportion of fossil energy in total energy consumption is still relatively high, and carbon emissions from energy production account for a large proportion of the country's total carbon dioxide emissions. In the future, China must not only pursue high-quality economic growth but also fulfill the goals and responsibilities of the "dual carbon" initiative. This urgent need stems from the requirement of the energy revolution: developing green, clean, and renewable energy such as wind power and photovoltaic power, and reducing the proportion of fossil energy power generation to achieve the goals of carbon emission reduction and carbon neutrality. Xinjiang is a major large-scale energy base in China. Among the "Xinjiang's electricity transmitted to other provinces", one out of every three kilowatt-hours are green electricity, which helps reduce carbon dioxide emissions and contributes to the optimization of the national power structure and the achievement of the "dual carbon" goals [3].

2.3. Releasing Resource Potential and Promoting High-Quality Development

Energy resources are Xinjiang's most significant advantage and an important support for its high-quality economic development. In recent years, Xinjiang has accelerated the construction of major projects, strengthened the guarantee of factors such as capital, land, and energy use, and leveraged the driving role of fixed asset investment in the economy. From 2020 to 2025, the cumulative investment in Xinjiang's new energy sector exceeded 500 billion yuan, driving the development of industrial chains such as equipment manufacturing, energy storage, and power grid support, and directly creating more than 200,000 jobs. The proportion of taxes related to the new energy industry in local fiscal revenue has steadily increased. This aligns with the core proposition of industrial cluster theory, which holds that geographical agglomeration and industrial interconnection can effectively reduce transaction costs, promote knowledge spillovers, attract professional talents, and thus form regional core competitiveness [4]. Specifically, in 2023, 182 new energy projects were launched with a total installed capacity of 58 million kilowatts, and investment in wind and photovoltaic power

generation grew by 230%, effectively forming a positive pattern of promoting industries with resources, driving development with industries, and boosting employment with development.

2.4. Strengthening Ecological Civilization and Enhancing People's Well-being

Xinjiang is an important ecological barrier in northwest China. Strengthening the construction of wind and photovoltaic power plants in deserts and Gobi areas can not only play a positive role in improving the local ecological environment quality but also serve as a powerful means to prevent ecological damage and promote the green and low-carbon transformation of energy. In addition, energy-related industries have a significant impact on people's livelihood through employment. In recent years, China has increased investment in the construction of energy projects that are beneficial to the people and easy to use, which not only improves the level of energy utilization for people's livelihood but also drives economic growth and creates jobs through new energy projects. Taking the Gobi, the largest desert area in China, as an example, the photovoltaic project covers an area of 76 square kilometers, including a sandy area of 17.2 million square meters. It is expected to generate 6.9 billion kilowatt-hours of electricity annually, which will reduce carbon dioxide emissions by 5.71 million tons and achieve significant ecological, economic, and carbon reduction effects [5]. The new model of photovoltaic sand control has built a "greener" Great Wall on the edge of the desert and put a "greener" scarf around the Taklamakan Desert.

3. Opportunities and Challenges Facing the Development of Xinjiang's New Energy Industry Clusters

3.1. Abundant energy resources, broad prospects for new energy industry development

Xinjiang is rich in wind and solar energy resources north and south of the Tianshan Mountains. Xinjiang's wind energy resource reserves rank second in China, mainly distributed in nine major wind energy zones: Alashankou, Laofengkou in Tacheng, Ertix River Valley, Santanghu-Naomaohu, Southeast Hami, Shisanjianfang in Hami, Xiaocaohu in Turpan, Dabancheng, and Lop Nur, showing great potential for wind energy development. Xinjiang is also rich in solar energy resources, with most areas belonging to the first-class solar energy resource zone. The average annual sunshine hours range from 2,500 to 3,500 hours, and the theoretical reserves of solar energy resources account for 40% of the country's technically exploitable amount, ranking first in China. Energy development in Xinjiang focuses on the utilization of wind and solar energy. By leveraging its advantages in wind, solar, and "desert, Gobi, wasteland" resources, Xinjiang is further accelerating the construction of a new-type power system with new energy as the main body and striving to build a large-scale, optimized-structure, advanced-technology, and stable-supply clean energy base.

3.2. Obvious locational advantages, great potential for internal and external energy cooperation

Energy cooperation is a key field of the "Belt and Road" Initiative. In the ten years since the initiative was proposed in 2013, China has carried out green energy cooperation with more than 100 countries and regions, and investment in green and low-carbon energy has exceeded that in traditional energy. Located in the golden channel of Eurasia, Xinjiang is a bridgehead for China's westward opening-up. Its unique geographical location is conducive to the eastward and westward radiation of new energy. In recent years, Xinjiang has continuously strengthened the construction of "one port, two zones, five major centers, and the port economic belt", promoted the connectivity of infrastructure, and focused on building a highland for inland and border opening-up. As the joint construction of the "Belt and Road" enters a new stage of high-quality development, cooperation in the energy field, infrastructure construction, and economic and trade exchanges will continue to deepen, providing new opportunities for the cultivation and development of Xinjiang's new energy industry and the promotion of high-quality economic and social development.

3.3. Accelerated construction of a new-type power system, increased demand for new energy transmission and consumption

The "Action Plan" proposes to "increase the proportion of new energy power in transmission channels, carry out the application of advanced technologies in new transmission channels, and realize large-scale and high-proportion new energy transmission". External transmission is one of the important directions for Xinjiang's power consumption and a strategic mission to ensure national energy security. Relying on the power grid pattern of "four internal supply loops and four external transmission channels", the amount of electricity transmitted from Xinjiang to other provinces increased from 300 million kilowatt-hours in 2010 to 126.4 billion kilowatt-hours in 2024, of which one-third is new energy power. The target provinces and cities have expanded from the initial 7 to 20, including Chongqing, Jiangsu, Hunan, and Sichuan. With the implementation of the "Action Plan" and the orderly construction of large-scale wind and photovoltaic bases in "desert, Gobi, wasteland" areas and integrated hydro-wind-solar bases, the transmission and consumption of Xinjiang's new energy will further increase.

3.4. Policy Dividends Injecting New Momentum

The Development and Reform Commission of the Xinjiang Uygur Autonomous Region and State Grid Xinjiang Electric Power Co., Ltd. jointly issued the "Notice on Improving the Resilience of New Energy and Accelerating the Construction of a New-Type Power System", focusing on the core goals of "three invariants and two guarantees" (maintaining the strategy of vigorously developing new energy unchanged, keeping the target of newly installed new energy capacity unchanged, adhering to the direction of market-oriented electricity price reform unchanged, ensuring the income of new energy enterprises, and guaranteeing a high-quality business environment for new energy). The notice puts forward 21 policy measures in 6 aspects, making joint efforts from multiple dimensions such as improving industrial policies and stabilizing market expectations to accelerate the construction of a new-type power system. With the implementation and effectiveness of these policy measures, the development achievements of the new energy industry will be further consolidated, providing strong support for ensuring national energy security and promoting high-quality economic and social development.

3.5. Challenges and Risks

While recognizing these opportunities, it is crucial to realize that the development of Xinjiang's new energy industry still faces multiple and complex challenges.

On the one hand, the systemic consumption problem of new energy power remains prominent. Affected by meteorological factors, wind and solar power have obvious intermittent and fluctuating characteristics. In 2024, although the curtailment rates of wind power and photovoltaic power in Xinjiang dropped to 7.8% and 6.6% respectively, they were still higher than the national average. The underlying reasons are as follows: First, the bottleneck of power grid infrastructure. Some areas are rich in new energy resources, but the construction of supporting power transmission and transformation projects lags behind, resulting in physical congestion where "power can be generated but cannot be transmitted". Second, insufficient system regulation capacity. Xinjiang's power supply structure is dominated by thermal power, which has poor flexibility. The construction of flexible regulation resources such as pumped storage and gas-fired power stations is slow, which cannot fully offset the output fluctuations of new energy. Third, the imperfection of the market mechanism. The construction of inter-provincial and inter-regional electricity spot markets and auxiliary service markets is still in the exploratory stage, and it has not yet effectively guided the investment and dispatch of flexible resources such as energy storage and interruptible loads through price signals [6].

On the other hand, the construction of a multi-energy complementary comprehensive energy system is a long and arduous task. With the development of various new energy sources such as wind, photovoltaic, hydrogen, and biomass, how to make full use of the complementarity of natural resources, give play to the advantages of various new energy sources, and improve the utilization

level and efficiency is a problem that needs to be solved in the development of Xinjiang's new energy industry. The specific challenges are as follows: First, the technical difficulty of coordinated control. Different energy forms have different output characteristics and response speeds, and achieving accurate prediction, coordinated optimization, and real-time control of the "source-grid-load-storage" system puts forward high requirements for algorithms and computing power. Second, economic barriers. For example, the current production cost of green hydrogen is not competitive compared with gray hydrogen and blue hydrogen, and the investment return period of energy storage facilities is long, which limits the pace of their commercialization and large-scale application.

Furthermore, the deep-seated risks in the industrial chain and potential ecological impacts deserve attention. Although Xinjiang's new energy equipment manufacturing industry has developed, it still relies on imports for key components such as high-end bearings and core control units, and the resilience and security level of the industrial chain need to be improved. In addition, the large-scale development of "desert, Gobi, wasteland" base projects covers a wide area, which may disturb the fragile regional ecosystem, such as changing the surface albedo, affecting the local microclimate, and interfering with biodiversity. However, the long-term monitoring and evaluation system for related ecological effects is not yet sound [7].

4. Countermeasures and Suggestions for New Energy Industry Clusters to Promote High-Quality Economic Development

Green development is the inherent requirement of high-quality development. The development of the new energy industry is a concrete practice of China's promotion of green and low-carbon transformation, which originates from the economies of scale and comparative advantages accumulated over a long period. As a major clean energy alternative base in China, Xinjiang should give full play to its advantages in energy resources and location, focus on the construction of large-scale wind power and photovoltaic power generation bases, explore the development potential of desert and Gobi areas, cultivate a clean, low-carbon, safe, and efficient energy system, and contribute to building a beautiful China with blue skies, green lands, and clean waters.

4.1. Coordinated Construction of Major Projects and Supporting Infrastructure

Centering on the "dual carbon" goals and tasks and giving full play to the driving role of investment in economic development, Xinjiang should take advantage of the rich wind and solar energy resources in deserts, Gobi, and wastelands, as well as the favorable construction conditions and low impact on land use in these areas. It should continue to promote the construction of large-scale wind power and photovoltaic power generation bases in areas such as Zhundong, Northern Hami, the Tarim Basin surrounding area in Southern Xinjiang, and Ruoqiang. At the same time, power grid planning must be closely integrated with project development to strengthen the guarantee of factors such as land, capital, and grid connection, and promote rapid approval, development, construction, and commissioning of new energy projects, so as to realize the coordinated and harmonious development of new energy and the ecological environment. While coordinating the local consumption and external transmission of new energy, Xinjiang should actively promote the completion of the third "Xinjiang electricity transmission to other provinces" channel (Hami-Chongqing) and the construction of the fourth "Xinjiang electricity transmission to other provinces" channel (Xinjiang to Sichuan-Chongqing Project), integrating them into the national unified market. This will not only effectively safeguard national energy security but also play a positive role in promoting economic development and increasing employment. Xinjiang should promote the high-quality implementation of all distribution network development tasks, vigorously develop smart microgrids, optimize energy distribution, accelerate the implementation of integrated "source-grid-load-storage" projects, and promote the efficient coordination of all links in the "power source, grid, load, and storage" system, so as to realize the effective generation and utilization of new energy.

4.2. Cultivating an Independent and Controllable New Energy Industry Cluster

The new energy industry cluster is one of the "ten major industrial clusters" that Xinjiang is vigorously developing. Adhering to the orientation of "gathering industrial chains into clusters and forming development momentum from clusters", Xinjiang should vigorously promote the extension, supplementation, strengthening, and expansion of the new energy industrial chain. It should continue to promote the upgrading of the new energy equipment manufacturing industry, give play to the advantages of mineral resource endowments and the power generation market, and vigorously cultivate the entire industrial chain from upstream to downstream, including silicon-based new materials and supporting components, as well as the R&D, production, and operation and maintenance services of wind power and power transmission and transformation equipment. In particular, for the weak links in the industrial chain, such as wind turbine main bearings, IGBT chips, and high-end control systems, Xinjiang should achieve technological breakthroughs and localized production through targeted investment promotion and joint research. It should also coordinate the construction of new energy and new materials industry clusters and wind and photovoltaic equipment manufacturing bases, and promote the high-end, intelligent, and green development of the industry. In addition, Xinjiang should actively promote the coupling and linkage between the new energy industry cluster and other industrial clusters such as energy storage, coal chemical industry, mineral resource development, and new energy vehicles. It should focus on building a green computing power cluster, explore a direct green power connection model suitable for the computing power industry, and increase the proportion of new energy consumption.

4.3. Deepening the Technology Revolution and Market Mechanism Reform

Xinjiang should strengthen innovation-driven development, adopt a problem-oriented and demand-oriented approach, and actively promote major breakthroughs in key technologies such as high-efficiency photovoltaics, large-capacity wind power, smart grids, and advanced energy storage. Specifically, it should increase investment in R&D and promote the application of cutting-edge technologies that are conducive to maintaining grid stability and improving system flexibility, such as grid-forming energy storage, virtual power plants, and long-duration energy storage, so as to accelerate the advancement of energy technology. At the same time, Xinjiang should deepen the market-oriented reform of new energy on-grid electricity prices, promote the implementation of the "Implementation Plan (Trial) of the Xinjiang Uygur Autonomous Region on Deepening the Market-Oriented Reform of New Energy On-Grid Electricity Prices", realize the market-oriented operation of all new energy sources including wind power and photovoltaics, accelerate the establishment of a sustainable new energy price mechanism, and reasonably determine the scale and price level of the mechanism.

4.4. Strengthening International Cooperation and Standard Output

Guided by the joint construction of the "Belt and Road", Xinjiang should give play to its location advantage of "five ports connecting eight countries" and rely on the construction of the "Desert, Gobi, Wasteland New Energy Demonstration Base" to build an international cooperation platform. It should summarize the experience of photovoltaic sand control in the Taklamakan Desert, establish an internationally recognized "Xinjiang Green Energy Standard System" covering carbon footprint accounting and ecological impact assessment, and promote it to become a replicable standard for "new energy + ecological restoration" in Central Asia and the Middle East. Based on the case of green electricity-based ethylene production in Dushanzi Petrochemical, Xinjiang should jointly build a cross-border green electricity certification platform with the EU's Carbon Border Adjustment Mechanism (CBAM) to serve the transformation of high-carbon industries along the "Belt and Road". By drawing on the experience of the Kuqa green hydrogen project, Xinjiang should explore the export of electrolysis technology and hydrogen-powered heavy trucks to Central Asian countries and build a regional hydrogen energy corridor. Through the coordinated output of technologies, standards, and

business models, Xinjiang is expected to shift from exporting energy products to exporting energy solutions, enhancing its strategic position in the global green economy.

4.5. Strengthening Diversified Financial Guarantees

The construction of large-scale wind and photovoltaic bases and the development of advanced equipment manufacturing industries require large-scale investment in R&D and equipment. Banking financial institutions should closely align with the development needs of the new energy industry, dynamically optimize and adjust credit policies and support strategies, establish a database of major projects, and actively support new energy projects undertaken by central and state-owned energy groups. They should innovate service models, vigorously develop emerging businesses such as green bonds and green leasing, and expand financing channels. In addition, Xinjiang should actively explore the establishment of special industrial funds or angel investment funds focusing on new energy technology start-ups and weak links in the industrial chain to guide social capital to invest accurately. At the same time, it should establish and improve an evaluation and compensation mechanism for the long-term ecological benefits of new energy projects to ensure the sustainable operation of the projects.

5. Conclusion

In summary, vigorously developing new energy industry clusters is a key path for Xinjiang to promote high-quality economic and social development based on its own resource endowments and in line with the overall national strategy. At present, Xinjiang's new energy industry is developing with strong momentum, and has achieved remarkable results in ensuring energy security, optimizing the energy structure, promoting green transformation, and improving people's well-being. It is also facing major historical opportunities such as overlapping policy dividends and a broad market space.

However, behind the achievements and opportunities, the challenges cannot be ignored. The systemic consumption problem caused by the high proportion of new energy, the technical and economic barriers in the construction of a multi-energy complementary system, and the deep-seated issues such as industrial chain security and potential ecological risks together constitute bottlenecks restricting the development of Xinjiang's new energy industry. The complexity and systematic nature of these challenges require us to adopt more comprehensive and forward-looking response strategies beyond single-dimensional thinking.

Looking forward to the future, Xinjiang needs to adhere to a systematic perspective, coordinate the construction of major projects and the upgrading of power grid infrastructure; adhere to innovation-driven development, focus on breakthroughs in core technologies and the improvement of market mechanisms, and cultivate an independent and controllable industrial chain; and adopt a broader international perspective to promote the transformation from product output to standard and solution output. Through the implementation of multiple measures, Xinjiang can not only transform its advantages in wind and solar energy resources into strong economic momentum but also is expected to contribute a unique and important "Xinjiang strength" in exploring the path of Chinese-style modernization in energy transformation and promoting global green and sustainable development.

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