

# Selection of New Energy Development Models in Rural Jilin Province under Different Situations

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**Abstract:** Jilin Province's vast rural areas are endowed with abundant new energy resources, which provide a fundamental condition for the development of new energy in rural Jilin. This paper will explore the various possibilities of new energy development in rural Jilin under the background of grid infrastructure construction, the deepening of electricity market reform, the modernization of agriculture and rural areas, and the transformation of energy. It will draw conclusions on the reasonable development models of new energy in rural Jilin under different scenarios, providing a reference for the development of new energy in rural Jilin and rural revitalization.

**Keywords:** Rural revitalization; Rural areas; New energy

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## 1. Introduction

As an agricultural province, Jilin has rich wind, light, water, and biomass energy in its rural areas. There are about 2 billion kW of potential wind energy development in the western part of the province, and the potential development capacity of photovoltaic energy is about 96 million kW. In the eastern part of the province, the theoretical storage capacity of pumped hydropower of various water systems exceeds 30 million kW, and there is also abundant shallow geothermal energy. If fully developed, it can save about 36.54 million tons of standard coal per year. These rich new energy resources have laid a resource foundation for the development of new energy in Jilin Province. By analyzing the development models of new energy in rural Jilin under different scenarios, the theoretical system of integrated development of rural revitalization and new energy in Jilin can be improved, and it can play a reference role in the development of new energy and the construction of rural revitalization in rural Jilin.

## 2. Development of new energy in rural Jilin under different situations

### 2.1. Continuous improvement of power grid infrastructure

During the "14th Five-Year Plan" period, Jilin Province has built a power grid system that is mutually

supportive and coordinated at all levels, including the construction of ultra-high voltage channels connecting to other provinces, several 500 kV grid main structure constructions within the province, and dozens of 220 kV grid constructions to support the development of new energy. Additionally, there is an investment of 6.18 billion yuan in the construction of 66 kV grids and 8.64 billion yuan in the construction of distribution grids below 10 kV. Under the background of the continuous improvement of the power grid construction, the development of new energy in rural areas of Jilin Province can be carried out through the model of “power generation and grid connection, unified dispatching”<sup>[1]</sup>.

A strong, reliable, and adaptable power grid structure with clear hierarchical and zoning divisions can provide a strong guarantee for the access and consumption of new energy in rural areas, which is conducive to the “power generation and grid connection, unified dispatching” of new energy in rural areas. The power grid infrastructure construction in Jilin Province is in the process of continuous improvement, which will provide a stable infrastructure guarantee for the multifaceted use of new energy in rural areas. By the end of 2020, there were 17 500 kV substations in Jilin Province, with a transformation capacity of 26.86 million kVA and a line length of 5,740 km. This means that the preliminary formation of the “two horizontal and two vertical dual ring network” main grid structure in Jilin Province. During the “14th Five-Year Plan” period, Jilin Province still plans to strengthen the main grid structure, with 242 new and renovated 66 kV substations, an additional transformation capacity of 63.14 million kVA, 3,091.5 km of new and renovated 66 kV lines. Additionally, there will be 11,054 new and renovated 10 kV distribution transformers, an additional transformer capacity of 13.14 million kVA, and 31,042.1 km of new and renovated lines below 10 kV. It is expected that during the “14th Five-Year Plan” period, the total investment in the distribution network will be 15.4 billion yuan, and by 2025, the problems of weak grid structure, insufficient transfer capacity, and low reliability will be resolved. The gradual improvement of the grid structure at all levels is conducive to the development of new energy in the vast rural areas. Simultaneously, it is conducive to the connection between the provincial grid and the ultra-high voltage channel, achieving efficient and flexible allocation of power resources across regions. The continuous improvement of the provincial power grid facilities can promote the integration of urban and rural power distribution, optimize the power supply and distribution capacity in rural areas, and provide a stable infrastructure guarantee for potentially huge new energy exports.

Jilin Province’s power production has always been greater than its consumption, and the construction of inter-provincial power transmission channels is conducive to the effective utilization of new energy in rural areas of Jilin Province. Jilin Province is currently accelerating the construction of power transmission channels, and based on achieving full additional transmission of Lu Gu Direct Current, it actively promotes the “Ji Electricity South Delivery” ultra-high voltage transmission channel starting from the western region of the province. Jilin Province has abundant wind and light energy in rural areas, so the export of new energy in rural areas should first encourage rural communities to participate in new energy projects. Furthermore, improve the support and participation of rural areas in new energy projects through the benefit-sharing mechanism, and then promote the participation of rural areas in cross-regional power supply through traditional thermal power and new energy bundled sales policies, energy storage, microgrids, and other technologies, green certificates, fixed grid connection electricity prices, and other market mechanisms, to achieve “power generation and grid connection, unified dispatching” of new energy in rural areas.

How to properly develop and dispose of the rich new energy resources in the province is an important issue. On the one hand, the industrial and residential electricity consumption structure in Jilin Province is stable and has reached saturation. In 2023, the total electricity consumption in Jilin Province was 92.824 billion kWh, of which the demand for new energy power generation was only about 20 billion kWh, and the developable

installed capacity in Baicheng City alone is comparable to the installed capacity of the Three Gorges Hydropower Station. Thus Jilin Province cannot achieve a balance of supply and demand for new energy through provincial self-use. On the other hand, the North China region has a large electricity consumption, and to cooperate with the national dual carbon targets and sustainable development strategy, the pressure on its power generation has increased, and it has become a necessary trend to transfer electricity from other regions. Hence the export of abundant new energy in rural areas of Jilin Province has become inevitable, and the construction of export channels is the key to “Ji Electricity South Delivery”.

## **2.2. Deepening of the electricity market reform**

The deepening construction of the electricity market is conducive to the active participation of rural new energy in the market, promoting the development of rural new energy towards a market-oriented model. Jilin Province established the Jilin Province Power Medium and Long-term Trading Market in 2017, and after five years of operation, it officially formulated the “Jilin Province Power Medium and Long-term Trading Rules” in 2021, marking that the power medium and long-term electricity market in Jilin Province has matured.

By the end of 2020, the cumulative electricity trading volume of the Jilin Province Power Medium and Long-term Market had reached 28.2 billion kWh. As of May 15, 2024, the members of the Jilin Province Power Trading Center included 101 power generation companies, 20 electricity sales companies, and 20 electricity users. The participation of renewable energy such as wind power and photovoltaic power generation in the market has attracted many new energy-related companies to participate in the market. The new energy power generation companies involve solar power, hydropower, and wind power, including small power generation companies with an installed capacity of 100,000 kW and large power generation companies with an installed capacity of more than 10 million kW. There are both private enterprises and large subsidiaries of central and state-owned enterprises such as Datang Group. These power generation companies have concentrated on developing new energy in the vast rural areas of Jilin Province and have connected to the Jilin Province Power Trading Market, selling through electricity sales companies or directly to electricity users to achieve the consumption of new energy power in rural areas.

The development of new energy in the vast rural areas can be led by the government, financed by private capital, and assisted by the industry, forming more small new energy power generation companies based on townships to participate deeply in the power trading market. From one perspective, it can carry out pilot projects for distributed power generation market transactions, allowing rural new energy projects to sell electricity directly to users through a “direct sales model” and “regional sales model”<sup>[2]</sup>. From another perspective, it can use competitive electricity prices and medium and long-term trading mechanisms to enable rural new energy to participate in peak and frequency adjustment and other auxiliary service markets, and cross-regional power trading markets under the “wind and fire bundle” and other models, expanding the market scope of rural new energy, and obtaining benefits by providing what the power market needs to achieve effective development and allocation of new energy.

## **2.3. Modernization of agriculture and rural areas**

The rural revitalization strategy is a national strategy of great practical significance and profound historical significance. To accelerate the transformation and development of rural energy and help rural revitalization, in 2022, the Energy Bureau of Jilin Province issued the first provincial-level “New Energy + Rural Revitalization” plan in the country: “Jilin Energy Bureau’s 2022 Work Plan for Promoting New Energy Rural Revitalization Project”, which mainly emphasizes the development of new energy such as wind and solar energy in rural areas

of the province. Compared with the centralized urban areas, the rural areas have a variety of environmental changes, and the economic conditions are underdeveloped. Therefore, different development models should be adopted according to different conditions when developing, and at the same time, scholars have proposed three implementation paths when solving the problem of development funds: government-funded, enterprise-funded, and government-enterprise joint venture<sup>[3]</sup>.

Based on the natural environmental conditions of Jilin Province, the development pattern of agriculture and rural areas in Jilin Province is a natural coincidence with the development model of new energy. Different regions in the province have different actual conditions, so when analyzing the development model of new energy in rural areas under the modernization of agriculture and rural areas in Jilin Province, it should not be generalized and should be analyzed specifically according to the environment.

In the western region where wind and solar energy are abundant, the government can take the lead in establishing a series of “green energy” industrial parks. These parks will adopt nearby wind power, photovoltaic, and other new energy to directly supply the park’s electricity, combined with the current situation of local agriculture and rural areas. It can also introduce township agricultural enterprises supported by governments at all levels or enterprises involving the processing of livestock, poultry, meat, milk, and processing enterprises with livestock by-products as raw materials to settle in. This “new energy + park” model not only promotes the intensive and modern transformation of the primary and secondary industries in the western rural areas of the province but also can provide a large number of stable job positions for local residents, improving people’s sense of acquisition and happiness.

In the central grain-producing areas, the vast plains can produce more than 40 million tons of grain crops such as corn, soybeans, and rice every year. A large amount of straw forms biomass energy, and the rich water energy resources of the Songhua River system make it possible for the modern agricultural power distribution and use in the central region to transform into green energy, that is, the “agriculture-environment-energy-agriculture” circular development model. Through the government’s formulation of relevant policies and regulations, appropriate subsidies for farmers and related enterprises, strengthening social propaganda for environmental protection, creating efficient straw recovery channels, and introducing the industrial chain of comprehensive utilization of biomass energy. Biomass power generation is put into rural infrastructure, agricultural production construction, and other measures to achieve the “agriculture-environmental protection-energy development” three-in-one model development.

In the eastern region where water energy is abundant, geothermal energy is rich, and the cost of power supply from the grid is relatively high, the “new energy + tourism” development model is feasible. The geothermal resources in the eastern mountainous areas are mostly manifested in the form of shallow surface hot springs, so large-scale geothermal power generation is not realistic<sup>[4]</sup>. The unique culture and forest sea snowfield and other tourism resources in the eastern region have become the innate advantages of the eastern rural areas for the development of tourism projects, so the entertainment development of geothermal energy is undoubtedly feasible. Concurrently, some rivers and reservoirs in the eastern mountainous areas have large drops, and the water energy resources are rich and suitable for the development of pumped storage power stations. Cities (prefectures) such as Yanbian and Hua have a theoretical storage capacity of more than 30 million kW. Jilin Province has planned more than 20 medium and long-term construction pumped storage projects in the eastern region, with an installed capacity of more than 20 million kW. This hydropower can help the development of tourism in the eastern region, and achieve rural revitalization in the eastern region through the “new energy + tourism” model.

## 2.4. Energy transition and transformation

A clean, low-carbon, safe, and efficient energy system is not only an essential safeguard for achieving the national sustainable development strategy but also a fundamental condition for maintaining national economic security and continuous, healthy operation. Since the “13th Five-Year Plan,” Jilin Province has continuously promoted the transformation and upgrading of energy, with increasing investment in projects, accumulating to approximately 120 billion yuan. Under the transformation of energy, all aspects of rural areas, including heating, power supply, transportation, and production, will participate in the “New Energy +” model. According to the research by Song and other scholars on rural carbon emissions and estimation, the per capita living energy consumption carbon emissions in rural areas of China had reached 0.74 tons/person by 2017. The main sources of rural carbon emissions come from the agricultural system, the construction process of building projects, the energy consumption of building operation and management, and the energy consumption of transportation. Therefore, energy transformation is equally important for rural areas, and the application and popularization of new energy in rural areas are also indispensable <sup>[5]</sup>.

Under the background of dual carbon goals, rural construction is bound to regard the construction of new energy as a significant construction point <sup>[6]</sup>. Heating is one of the most important livelihood projects in Jilin Province. Unlike the centralized urban heating model, heating in rural areas is small-scale, decentralized, self-sufficient, and low-environmental traditional heating. Different regions of Jilin Province contain different types of new energy, and each place should develop the “New Energy + Heating” model according to local conditions. In addition to heating, the concept of “New Energy + New Rural Construction” can also be promoted, enabling new energy to play a significant role in rural construction. For example, applications such as “Photovoltaic + Street Lights,” solar power broadcasting, solar large screens, as well as “Photovoltaic + Propaganda,” “New Energy + Canteen for the Elderly,” “New Energy + Disaster Relief Station,” represent various types of new rural construction in the new era. These innovations can significantly improve the living and production environment in rural areas and enhance the quality of life for rural residents.

New energy, as a new quality of productive forces, will also play an important role in the development of rural industries. “New Energy + Agriculture” and “New Energy + Tourism” will provide new ideas for rural development. For example, in the central grain planting areas such as Siping and Jilin, winter solar greenhouses, wind-powered water lifting, solar irrigation, etc., can increase the annual grain output and achieve modern agricultural development. In the western region of the province, the construction of unique low-carbon tourist towns, new energy agritourism, and other tourism sightseeing belts can promote the development of the tertiary industry in rural areas and also bring stable wealth opportunities for rural residents.

## 3. Suggestions for the selection of new energy development models in rural jilin

Under different restrictive conditions, the successful development models of rural new energy are not the same, mainly depending on three factors: local resource advantages, policy inclination, and the application of technology.

### 3.1. Fully integrate local resources

The development strategy of resources according to local conditions is the premise for the selection of the new energy development model in rural Jilin. Different regions have different resource advantages. For example, the western region is rich in wind and solar energy resources and should focus on the development of wind power and photovoltaic power generation. The central region is rich in biomass energy and should consider the development of biomass power generation. The eastern region is rich in water energy resources and should



focus on the development of hydropower. For example, places like Baicheng and Songyuan have vast wetlands, grasslands, lakes, and other agricultural resources. Yanbian, Jilin, and other places have ice and snow as well as Korean, Manchu, and other cultural tourism resources. Changchun, Siping, and other places have advantages in the industrial foundation, and each place can achieve the development model of “New Energy + Agriculture,” “New Energy + Service Industry,” and “New Energy + Industry” according to local conditions.

### **3.2. Reasonably utilize policy incline**

Policy inclination provides security for the selection of the new energy development model in rural Jilin. The favorable policies for the development of new energy in rural Jilin include but are not limited to financial and financial support, energy structure guidance, infrastructure construction, and market scheduling mechanisms. For example, during the “14th Five-Year Plan” period, the construction of grid infrastructure can improve the access and consumption capacity of new energy in rural areas. The construction of inter-provincial transmission channels will send the rich new energy power of Jilin Province to other regions, helping new energy to “generate electricity and connect to the grid, unified dispatching,” and achieving the optimal allocation of new energy resources. In promoting new energy into the power market, policies such as market access and electricity price systems can enhance the competitiveness of new energy power generation in rural areas, solving the urgent needs and future concerns for the integration of rural new energy into the new power market.

### **3.3. Actively encourage technological innovation and application**

The application of technology has injected momentum into the exploration of new development models for rural new energy. The development and consumption of new energy resources in rural areas are characterized by being small-scale and dispersed. How to utilize rural new energy in a scaled and efficient manner hinges on the research and development, innovation, and practical application of new energy technology. Technology is crucial for improving the efficiency and economic viability of new energy power generation in rural areas. For instance, the development of “New Energy + Energy Storage” models, such as wind and photovoltaic energy, is key to the development of rural new energy. Technology can also explore the integrated application of new energy with other industries. For example, biogas power generation technology supports the circular development model of “agriculture-environment-energy-agriculture” in central regions, while shallow geothermal energy ground source heat pump technology has spurred the promotion of “New Energy + Tourism” models in the eastern regions, achieving diversified industrial development. Technology can also enhance the support and participation of rural areas in new energy projects. For example, technologies such as microgrids, electricity to heat, and electricity to gas can promote the development of the “New Energy + Park” model, facilitating the intensive and modern transformation of the primary and secondary industries in rural areas.

## **4. Conclusion**

With the continuous exploration and practice of new energy development models in rural areas of Jilin Province, we will continue to witness significant achievements in promoting regional economic development, improving the rural ecological environment, and enhancing the quality of life for residents. The promotion of new energy has not only facilitated the energy transformation in rural areas but also created new employment opportunities locally, promoting the modernization of agriculture and the implementation of the rural revitalization strategy. However, the improvement of new energy development models still faces challenges in various aspects, including technology, funding, and policy. In the future, we look forward to further promoting the sustainable development of new energy in rural areas of Jilin Province and throughout the country through continuous

technological innovation and policy support. This is a responsibility to the environment and a commitment to the future. Let us work together to embrace a green, clean, and efficient new era of energy.

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## Disclosure statement

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