

Study on the Path of Energy Development in Sichuan Province under the Background of "Carbon Peak and Carbon Neutrality"

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Abstract

In accordance with the requirements of a clean, low-carbon, safe, and efficient energy system put forward by the "Carbon Peak and Carbon Neutrality," We analyze the current situation of the development of various energy sources in Sichuan Province, combine the current situation with the study of the energy development path in the province, and put forward five emission reduction path programs. These include strengthening energy control, optimizing energy consumption patterns, promoting power system reform, and accelerating the construction of Sichuan power transmission channels. Combined with the "Carbon Peak and Carbon Neutrality," it offers a reasonable outlook for energy development in Sichuan Province.

Keywords

Carbon Peak and Carbon Neutrality; Sichuan Province; Energy Development.

1. Background and Significance of the Study

Carbon emissions are now recognized as one of the leading causes of global warming, and the issue of climate change has become a significant challenge faced by all humankind. As one of the world's largest emitters of carbon dioxide, China has proposed a "dual-carbon" strategy of achieving carbon peak by 2030 and carbon neutrality by 2060.

China's economic and social development has entered a new stage and has begun to move towards high-quality development, i.e., from the expansion-oriented plane development to the three-dimensional depth of the development that pays more attention to the quality and the construction of a "clean, low-carbon and high-efficiency" energy system is the goal of the subsequent energy development path. The subsequent energy development path aims to construct a "clean, low-carbon, and efficient" energy system. Due to its energy distribution characteristics and the formation of a non-fossil energy-based power supply structure, Sichuan Province is the first in the country to achieve a clean energy-led energy production and structural adjustment. The province is the first in China to realize energy production and restructuring led by clean energy. Due to the initial stage, the development of the clean energy-led energy structure has been hindered. Therefore, exploring the scientific development path of energy in Sichuan Province plays a vital role in realizing the goal of "double carbon" at an early date, accelerating the process of energy revolution and promoting the development of clean energy.

2. Current Situation of Energy Development in Sichuan Province

Sichuan Province is one of the most critical economic inland areas of China, with abundant hydropower, solar energy, wind energy, biomass energy, and other renewable energy resources, mainly characterized by "abundant water, coal, gas, oil shortage." The main characteristic is "abundant water, little coal, enough gas, and lack of oil." In the past decade, Sichuan Province has

been developing rapidly in non-hydropower renewable energy, forming a power supply structure dominated by non-fossil energy and taking the lead in realizing energy production and structural adjustment dominated by clean energy in the country. The first in the country to realize clean energy-led energy production and restructuring. This paper describes the current status of energy development in Sichuan Province from both fossil energy and new energy perspectives.

2.1 Analysis of the Status of Fossil Energy

2.1.1 Gradual Reduction in the Share of Coal

Regarding fossil resources, Sichuan Province has always been in short supply of coal and petroleum resources. Currently, the accumulated resource reserves of coal in Sichuan province are 15.7 billion tons, accounting for about 1.4% of the national total reserves. This is about 1.4% of the national total reserves. The scale of coal resources in Sichuan is relatively tiny compared to that of the country.

Thanks to the unique distribution characteristics of energy resources in Sichuan Province, the current development and utilization of hydropower and natural gas, the share of coal has been gradually reduced to less than 30%. Specifically, it decreased from 90.27 million tons in 2010 to 55.36 million tons in 2017. Sichuan Province is gradually weakening the dominant position of coal in its energy consumption.

2.1.2 Bottlenecks in the Development of Natural Gas

Sichuan Province has a long history of natural gas extraction. As of the end of 2017, Sichuan Province had a staggering 3.97 trillion cubic meters of natural gas reserves, including 365 million cubic meters of conventional and tight gas and 0.32 billion cubic meters of shale gas. This considerable reserve provides a strong foundation for Sichuan's continued development and utilization in the natural gas sector and energizes the transformation of the region's energy structure and sustainable development.

While strengthening the comprehensive development and utilization of natural gas, the exploration and development of natural gas face considerable challenges - the development technology needs to be overcome urgently, and the development cost is difficult to control effectively. At the same time, the development of the social environment and urban and rural planning, as well as the contradiction between supply and demand in the market, have also imposed restrictions on the exploration and development of natural gas. This, coupled with the fact that the province has yet to build underground gas storage and lacks sufficient peaking capacity, has led to a severe lag in the development of the natural gas market.

2.2 Analysis of the Status of New Energy

As a significant renewable energy province in the western region of China, Sichuan Province is well known for its abundant new energy resources. There are a wide variety of new energy resources here, including but not limited to hydropower, wind power, solar power, etc., forming a diversified energy pattern. This diverse new energy layout provides a solid foundation for the transformation of Sichuan's energy structure and sustainable development while also energizing western China's leadership in the clean energy sector.

2.2.1 Highlighting the Problem of "Water Abandonment"

Sichuan Province is born from its numerous water sources, and hydropower generation has a unique advantage here. According to the survey, Sichuan Province is very rich in hydropower resources, with 148 million kilowatts of technically exploitable hydropower resources and 145 million kilowatts of economically exploitable hydropower resources. This indicates that Sichuan Province has an advantage in hydropower generation, and also indicates that Sichuan Province has enormous potential for hydropower generation, providing a solid foundation for a sustainable supply of clean energy, both of which are in the first place in the world. Due to industrial and economic restructuring, the electricity demand growth rate in Sichuan Province has slowed down. However, hydropower supply has been increasing yearly, and the average annual growth rate of hydropower generation in Sichuan Province alone reached 14.37% between 2001 and 2015, from 42.2 billion kWh to 276.7 billion kWh.

The mismatch in hydropower demand and supply has led to an oversupply of electricity in Sichuan Province and the need to seek markets to accept excess power.

Due to various reasons, such as the difficulty of consuming hydropower in the province, mismatch of hydropower demand-supply, and obstruction of outgoing channels, hydropower water abandonment has been severe in Sichuan Province in recent years. In 2017, the amount of water abandonment from peaking alone reached 14 billion kWh. It is estimated that the actual average water abandonment may be much higher than the official release data.

2.2.2 Faster Development of Wind Power Generation

Thanks to the geographical advantage of Sichuan Province, the windy period in Sichuan Province is mainly concentrated in the winter and spring seasons, which is just to make up for the power generation gap during the dry period of estuaries in the province and form a complementary advantage with hydroelectric power generation. The province's wind energy resources are mainly distributed in the western region of Sichuan, combined with the current level of equipment and technology, it is initially estimated that the actual amount of wind energy resources in the province can be developed into more than 20 million kilowatts. During the period of 2013-2016, wind power generation in Sichuan Province has been developed rapidly, with an average annual growth rate of 101.74%. The average annual growth rate reached 101.74%.

2.2.3 Rapid Growth of Photovoltaic Power Generation

The distribution of solar energy resources in Sichuan Province shows an obvious imbalance: poor in the east and rich in the west. The province's solar energy is mainly distributed in the western Sichuan plateau, becoming one of the richer solar energy resources in the country. The province's solar energy is mainly distributed in the western Sichuan Plateau, making it one of the more affluent solar resource regions in China. This geographical difference makes the availability of solar energy significantly different within the province, providing more favorable conditions for western regions such as the Western Sichuan Plateau and laying the foundation for it to become a hotspot for solar energy development. According to data from the Sichuan Energy Bureau, as of the first half of 2018, 79 PV power generation projects have been filed in the province, with a total installed capacity of about 1,784,410,000 kilowatts. This indicates that within a short period, PV power generation projects in Sichuan have seen significant growth, fully demonstrating the province's active efforts and good momentum in promoting clean energy.

3. Study on the Path of Energy Emission Reduction in Sichuan Province

3.1 Enhancing Energy Controllability

3.1.1 Greatly Enhance the Utilization of Wind, Light and New Energy Sources

With their clean and renewable nature, new energy sources are widely distributed and can be developed in large quantities, making them an essential energy source for realizing the goals of "carbon peaking" and "carbon neutrality." However, new energy sources are characterized by high randomness, intermittency, and volatility. In addition, new energy resources in Sichuan Province are mainly concentrated in the western region of "three states and one city," which creates challenges in the supply of new energy. For example, the output of wind power is more prominent in the nighttime when the electricity consumption is low.

Under the current stage of the energy status quo, there is an urgent need to improve the controllability of new energy sources through technological innovation in order to meet energy demand better. For example, by investing in and supporting new scientific and technological research and development in order to improve the predictability and regulation of clean energy, effectively mitigating the volatility of wind and light energy by means of large-scale energy storage facilities, and improving the efficiency of energy storage and the flexibility of its release through the promotion of the research and development and application of battery technology and energy storage systems.

3.1.2 Strengthening the Coordination of New Energy Sources, Power Grids, Pumped Storage, Energy Storage and Distributed Regulators

In order to cope with the fluctuating and intermittent nature of new energy sources, it is necessary to strengthen the ability to regulate new energy sources and conduct in-depth studies of sending out programs. This includes supporting the construction of pumped storage, new types of energy storage, reactive power regulation, and other equipment to enhance the peak capacity of new energy. In Sichuan Province, multi-energy complementary incentive allocation and other aspects of the arrangements, the need for integrated planning of new energy development timing, layout, as well as related grid projects, in particular, to strive for 500 kV and above grid projects into the planning.

Through such initiatives, we have promoted the coordinated construction of new energy sources, power grids, pumped storage, energy storage, distributed regulators, and other facilities and enhanced the role of new energy sources in supporting the power supply. This will help to promote better consumption of new energy, realize the goal of "volume rate integration," promote the scientific development of new wind and solar energy, and improve its complementary function in the power system.

3.2 Optimizing Energy Consumption Patterns

As mentioned above, there is an imbalance between the supply and demand of hydropower generation in Sichuan Province, with the supply of hydropower far exceeding the electricity demand, and a large amount of hydropower is challenging to be consumed by itself, leading to a large amount of "water abandonment" in the province. Therefore, it is recommended to optimize the province's energy consumption structure and increase the demand for electricity by changing the mode of production and lifestyle to enhance the consumption capacity of clean energy in the province.

3.2.1 Optimization of the Electrical Energy Mix

Upgrading the level of rural electrification, increasing the demand for electricity for residential and agricultural use, and promoting the prosperity of the rural electricity market. In the industrial sector, energy-saving upgrades have been implemented, and electric boilers and kilns have been promoted to reduce energy consumption and improve production efficiency.

3.2.2 Promotion of New Energy Vehicles

Increasing support for the new energy vehicle industry, including providing policy incentives and financial support and accelerating the construction of charging pile infrastructure, has led to new energy vehicles gaining a larger market share in the transportation sector. This will help promote the automobile industry's development towards clean energy and reduce tailpipe emissions.

3.2.3 Optimizing the Use of Natural Gas

Extending the natural gas industry chain and increasing the proportion of natural gas consumption in civil use, transportation, power generation, and industry. Through the broader application of natural gas, dependence on traditional coal and oil combustion can be reduced and the use of clean energy promoted, while the added value of the natural gas industry chain can be increased.

3.3 Promote Reform of the Electricity System

The analysis shows that the power supply and demand in Sichuan Province has yet to reach equilibrium, and the balance of power supply and demand directly affects the development and implementation of future energy decisions in Sichuan. Therefore, there is an urgent need to actively promote the reform of the power system to facilitate a more effective absorption of clean power and to resolve the current contradiction between power supply and demand. This reform effort aims to build a flexible and efficient power system to better accommodate the demand for large-scale access to clean energy, thereby promoting the optimization of the overall energy structure and the broader application of clean energy and laying a solid foundation for the future sustainable development of Sichuan Province.

3.3.1 Accelerating the Construction of Power Trading Centers

Promote the construction of power trading centers to achieve more direct transactions between power producers and users. Establishing a more flexible and efficient market mechanism will lead to a more active power market and provide more cooperation opportunities for power generators while promoting the expansion of Sichuan's power in both domestic and international markets.

3.3.2 Promoting Reform of the Electricity Sales Side

The market-determined pricing mechanism will be explored by gradually deregulating electricity prices to make the electricity market more competitive. The aim of this move is to promote the healthy development of the electricity market by lowering the price of electricity and increasing the incentives for enterprises and residents to use electricity.

3.3.3 Establishment of a Guarantee Mechanism for New Energy Generation

This paper proposes the establishment of a new energy guarantee mechanism to include wind power and photovoltaic power into the scope of priority power generation guarantee. To realize the priority of new energy power online to avoid excessive "water abandonment" brought about by hydroelectric power generation, thus ensuring the adequate consumption of clean power, and help promote the proportion of clean energy in the energy structure to increase. In turn, this will help Sichuan Province to realize the "dual-carbon" goal further.

3.4 Accelerating the Construction of Sichuan Power Transmission Channels

In the above analysis of hydropower generation, it was mentioned that the backwardness of Sichuan's power transmission equipment has led to the recipient government's weak willingness to accept Sichuan's power, thus further exacerbating the problem of the difficulty of consuming hydropower generation. With the continuous commissioning of large hydropower, the ability to send out electricity faces limitations, resulting in a mismatch between the power source and the grid sending out, leading to the advantages of the original energy structure in Sichuan Province not being realized. At the same time, the mismatch of power grid construction has become a significant constraint on the development of new energy. New energy alone sent out there are great difficulties.

3.4.1 Accelerating the Construction of Power Transmission Corridors

To solve the problem of energy shortage, Sichuan Province can actively promote the construction of power transmission channels, including upgrading power transmission lines and improving power interconnection equipment. Accelerate the construction of the Yazhong-Jiangxi UHV DC project, vigorously push forward the construction work of the Baihetan-Jiangsu and Baihetan-Zhejiang UHV DC projects, and synchronize the construction of transmission corridors in the province to meet the needs of Sichuan's clean energy for preferential domestic consumption and outbound transmission. This will help to send excess hydropower and clean energy pipeline to other regions and improve the construction of power transmission corridors.

3.4.2 Promoting "New Digital Infrastructure" in the Energy Sector

Strengthen the construction of "two new and one heavy" (new infrastructure, new urbanization, and significant projects such as transportation and water conservancy), accelerate the promotion of "digital new infrastructure" in the field of energy, promote the transformation and upgrading of the traditional power grid to the Internet of Energy, and actively cultivate new businesses and new modes of operation. The company will continue to make efforts in comprehensive energy services, extensive energy data application, and electrification of transportation, driving the upstream and downstream of the industry chain to develop together and make positive contributions to the construction of the "5+1" modern industrial system in Sichuan.

4. Conclusion of the study

As a region rich in hydropower, wind, and solar energy resources, the core of energy development in Sichuan Province needs to shift to clean energy and take advantage of clean resources. Focus on how

to make good use of new energy to promote the vigorous development of hydropower, wind power, solar energy, and other clean energy to solve the current energy utilization dilemma in Sichuan Province, such as the province's hydropower being challenging to consume, hydropower development and electricity demand mismatch, the transmission channel is blocked and other issues. Through vigorously enhancing the wind, light, and new energy utilization, strengthening the new energy, power grid, pumped storage, energy storage, distributed regulator, and other coordinated construction, optimize the energy consumption pattern, promote the reform of the electric power system, accelerate the construction of the Sichuan power transmission channel construction and other ways to optimize the existing energy development path in Sichuan Province.

At the same time, corresponding feasible solutions are proposed. For example, in solving the problem of new energy with strong randomness, it is proposed to combine scientific and technological research and development, build an intelligent grid system, and use extensive data analysis to optimize energy dispatch. Following the requirements for developing a clean, low-carbon, efficient, and safe energy system, the innovation-driven development strategy and supply-side structural reform have been implemented in depth. Through the reform, promote the transformation of a resource-based economy to clean, green, and sustainable development. Strive to be the front-runner in the national energy revolution, actively respond to the national energy policy, and become a pioneer and demonstration area for the country's clean energy development. Through forward-looking planning and pragmatic actions, it will lead the direction of national energy development and positively contribute to the energy revolution in the new era.

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