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China's Low-carbon Energy Transformation: Development of Renewable Energy

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Abstract: In recent years, as the world's population continues to increase, it has brought a series of pollution problems, which causes global warming intensified. In order to solve the problem of climate warming, the development trend of low carbon and environmental protection is gradually becoming the keynote of global social and economic development. At the same time, due to the excessive reliance on energy consumption for the development of China's economy in the past, the problems of energy shortage and environmental degradation have become more and more serious in China in recent years. Therefore, the carbon emission reduction index has become one of the important assessment indicators for the development of China's economic quality and an unavoidable key task for economic development. Energy is the basis of economic and social development, in the process of economic development, China will inevitably encounter energy shortages, environmental pollution problems, the development of renewable energy has become a general trend, the transformation and optimization of the traditional energy structure is an effective way to achieve this goal and an important means. This paper analyzes and puts forward suggestions on the current situation of China's energy transition, factors affecting energy transition and future development trends through the literature review method and comparative analysis method.

Keywords: climate change, bicarbon, energy mix.

1. Introduction

With global warming and resource shortages becoming more and more serious, structural transformation of the energy industry has become an important path to achieve the "dual-carbon" goal, and energy transformation is also an important driving force for the development of human civilization. President Xi Jinping announced at the 75th session of the United Nations General Assembly that he would strive to achieve carbon peak and carbon neutrality by 2030 and 2060, respectively, in order to take the path of sustainable development. At present, China's carbon emissions rank first in the world, and coal is the most important source of carbon emissions. With the implementation of the national "dual-carbon" strategy, China's economic and social development will face serious challenges in the future. On the one hand, global climate change has exacerbated the risk of uncertainty faced by the energy sector; on the other hand, as China's economy enters a slow phase and the "dual-carbon" goal is approaching, the transformation of the energy structure will inevitably have a huge impact on the country's economic and social development, so the transformation of the energy structure has become a hot topic of concern for the whole society.

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1.1. Background of the study

China's energy production and consumption is mainly divided into the following three important stages:

The first stage: the stage of rough utilization of energy (1952-1977)

In the absence of reform and opening up of the background, the amount of energy consumption can only rely on the country's own production, so China's energy production and consumption of the number of changes in the trend of China's energy production and consumption before the reform and opening up of the country's energy basically belongs to the self-production and self-marketing;

The second stage: energy market-oriented reform stage (1978-2002)

After the reform and opening up, in the "economic construction as the center" of the party's basic line of impetus, the establishment of the socialist market economic system of institutional reform goals, and further promote the total amount of energy consumption began to constantly exceed the total amount of energy production;

Stage III: Rapid development of renewable energy (2003-present)

Since China's accession to the WTO, economic development has been in full swing, and the amount of energy production and consumption has shown an almost exponential upward trend.

Below is a graph showing the trend of energy production and consumption in China after the new China:

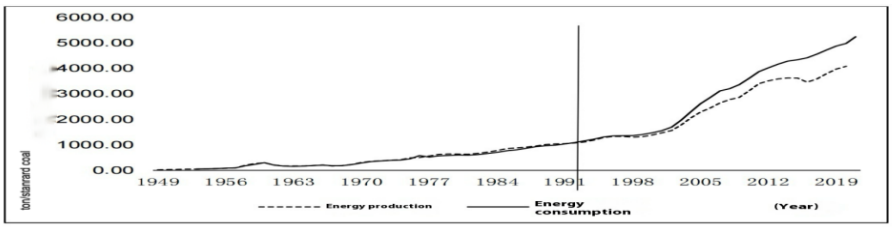

Figure 1: Energy production and consumption trends since the founding of New China
Source: CEIC Macroeconomic Database

By 2021, more than 130 countries and regions around the world have proposed targets for achieving peak carbon and carbon neutrality, and low-carbon development has become a universal consensus. 2020 was the end of the year when Xi Jinping made an important speech, "By 2030, China's carbon dioxide emissions per unit of gross domestic product (GDP) will be reduced by more than 65% compared with 2005, and the proportion of non-fossil energy in primary energy consumption will reach about 25%". By 2030, China's carbon dioxide emissions per unit of GDP will be more than 65 percent lower than in 2005, and the share of non-fossil energy in primary energy consumption will reach about 25 percent. This is a solemn promise made by China to all mankind, demonstrating its determination and confidence in further addressing climate change and promoting green and low-carbon transformation. As a large carbon emitting country, if we take the risk of adjusting the energy structure, it will lead to an imbalance between energy supply and demand in China's energy industry, therefore, China needs to formulate corresponding policies to support the promotion of renewable energy development, so as to realize the transformation of China's energy structure on schedule.

1.2. Research significance

In the social aspect, it aims to improve environmental protection and health, employment and industrial transformation, and energy utilization efficiency; in the economic aspect, it aims to improve the economy and competitiveness, reduce the cost of energy saving and emission reduction, and

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promote the development of new industries; in the political aspect, it enhances the international influence, and improves the government's governance ability and decision-making level is the primary goal.

1.3. Research Objectives

Explore the impact of various influencing factors on energy transition, and further propose measures that can promote energy transition, the research in this paper can make future policy formulation and implementation more targeted, in order to achieve the goal of carbon neutrality at an early date.

1.4. Research Methodology

1.4.1. Literature Review Method

For the article theme "analysis of China's energy transition", "dual-carbon" policy text, China's energy resource endowment, production, utilization and other related literature, a large number of domestic and foreign literature reading, sorting, summarizing and synthesizing, in many scholars on the basis of research Determine the research content of this paper to enrich the issue of carbon emission reduction.

1.4.2. Comparative Analysis Method

The United States and China are the world's two largest economies and energy-consuming countries, and their energy policies and actions have a significant impact on the global energy market and climate change. By comparing the energy transition process of these two countries, the changes and trends in the global energy landscape can be more clearly understood. And the energy policies, regulations and market mechanisms of the United States and China are significantly different. By comparing their practices in renewable energy support policies, carbon emission limits, energy efficiency standards, etc., we can deeply analyze the impacts of different policies on the speed and effectiveness of energy transition.

1.5. Innovative Points

After reading a lot of literature on energy transition at home and abroad, the author found that most scholars explore energy transition through quantitative analysis and the use of models, so this paper is unique in that it adopts a combination of literature review and comparative analysis to analyze China's energy transition, aiming to comprehensively understand the complexity and diversity of China's energy transition in terms of multiple dimensions and the experiences of multiple countries, and to provide targeted advice to the Chinese government. The aim is to fully understand the complexity and diversity of China's energy transition from multiple dimensions and country experiences, and to be able to provide targeted policy recommendations to the Chinese government, including technological innovation support, market mechanism optimization, and environmental governance measures. In addition, a large number of scholars' studies on energy transition are based on the perspective of developed countries, and there are few studies on China, and the few studies on China's energy transition are stuck in the pre-New Crown Epidemic period, so a lot of data could not be updated in time, and there are gaps in the research, which is an innovative point of this paper's research.

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2. Literature Review

Since the 20th century, with the concept of sustainable development, people gradually realize the indelible harm caused by environmental pollution, Steckle et al. According to the measurement and analysis of the development trend of carbon dioxide emissions in our country, it is believed that our country's carbon dioxide in the world's carbon emissions accounted for a large proportion of the carbon dioxide emissions, producing carbon dioxide emissions are more harmful to the global harm[1]. Johnston D. believes that reducing carbon emissions from housing and homes will help lower carbon emissions[2].Kojj.Shimada, Stern pointed out that The development of low carbon economy is a necessary way to develop the economy in the future[3].

With the growing concern for the environment, American economists Grossman and Krueger put forward the Kuznets curve hypothesis[4].Thereafter, Petrovic-Randelovic scholars examined the causal relationship between economic growth and carbon dioxide emissions in the BRICS countries, and found that, except for Russia, there is a unidirectional causal relationship between economic growth and carbon dioxide emissions in several other countries[5].Nawaz Muhammad Atif et al used the QARDL model to analyze the relationship between economic growth and carbon emissions in the BRICS and OECD regions and showed that there is a correlation between economic growth and carbon emissions in the economies[6]. Du scholars through the study of the relationship between economic growth and carbon emissions in China's construction industry found that most provinces have a positive correlation between the level of economic development and carbon emissions[7].

In 2003, the British government put forward the definition of "green economy", and with the overseas green economy research fire, domestic scholars have been actively exploring the road of low carbon economy development, from the introduction of green economy to the shaping of green ecological and harmonious development strategy, and gradually improve the connotation of green economy. Xu Ya equivalent believes that low-carbon economy is an economic development model that realizes low-carbon development in the whole process of production, consumption and waste recycling[8].Wu Lei believes that the high-carbon energy structure will not change much in the short term, and China should set up the idea of energy transition centered on energy security and environmental protection before the arrival of the energy peak[9].

Energy is the basis for the development of human society, at present, for the use of new energy is also concerned by scholars, Vaclav energy structure transition is considered to be the new energy in the total energy consumption share of the increase in the proportion of the energy structure to reach 5% is considered to be the beginning of the energy structure transition, more than 50% is considered to be the success of the energy structure transition mark. On the path of China's energy transition, Ahmad scholars found that On the study of China's energy transition path, Ahmad scholars found that there is a positive bi-directional causality between China's energy investment and economic growth, and a negative bi-directional causality between energy investment and pollutant emissions[10].In China, the energy resource endowment is ‘rich in coal, low in oil, and low in gas’. Some experts and scholars have analyzed the core technology and application of high-efficiency coal washing, and Guo Pibin scholars have clearly put forward the research framework of ‘Influencing Factors - Driving Force System - Rectification of Existing Policies’, which makes it clear that the driving factors for the social development and socio-technical changes of energy transformation, and points out the relevant rectification of existing policies[11].Zhou Yanxia and others pointed out that continuous innovation of low-carbon technology is the main focus of future green economy development Power[12].Erik scholars have found that the market, institutional environment, legal environment, social policies, and the environment have a negative causal relationship[13]. Lee et al. found that although innovation in low-carbon technologies may lead to a decrease in short-term performance of enterprises, it can bring long-term benefits to them[14].

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3. Factors affecting China's energy transition

3.1. Economic Dimension

Energy cost and efficiency: efficient energy utilization and low-carbon energy development can reduce production costs and improve energy utilization efficiency, thus enhancing economic competitiveness.

Market Demand and Consumption Upgrade: As people's living standards improve and consumption upgrades, concern for environmental protection and sustainability increases. Clean energy is gradually becoming the preference of consumers and enterprises, driving the market to shift to low-carbon energy products and services.

3.2. Social Level

Environmental pollution and health issues: China has long faced serious air and water pollution and other problems, posing a threat to environmental quality and public health. Promoting clean energy transition can reduce pollution emissions and improve the quality of life and health of residents.

Social stability and public security: The stability and security of energy supply is critical to social stability. Import-dependent traditional energy sources face geopolitical and other risks, while a high degree of self-sufficiency in clean energy helps maintain national energy security and social stability.

3.3. Government Level

International Commitments and Global Responsibility: China has been actively participating in international climate change cooperation and is committed to achieving peak carbon and carbon neutral targets. To fulfill its international commitments, the Chinese government has adopted a series of policy measures to promote the application and development of clean energy in the country.

Energy security and security of supply: In the face of the need for diversification and security of energy supply, the government promotes the development and utilization of clean energy in order to enhance the country's energy security and stability of supply.

To summarize, the three dimensions of economy, society and government work together to promote the transformation of China's energy structure towards renewable energy. This transition is not only in line with the long-term interests of economic development, but also responds to social needs and international environmental commitments, and is an important measure to promote sustainable development.

4. Lessons from the U.S. Energy Model

The following figures show the energy consumption of the United States respectively:

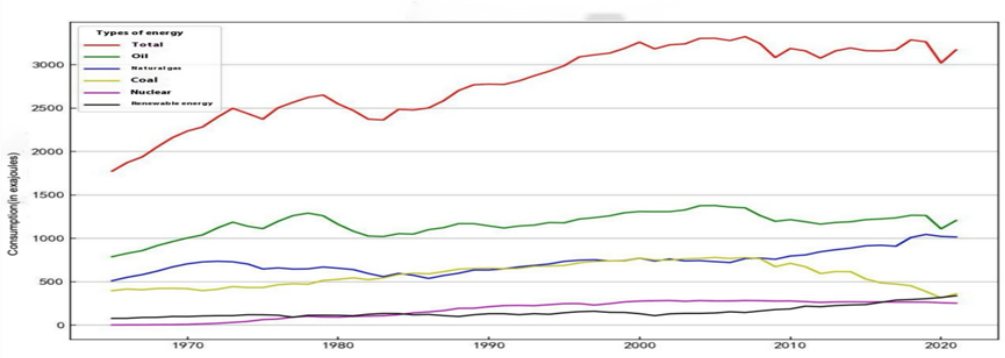

Figure 2: US energy consumption

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As can be seen from Figure 4, unlike China's coal-dominated energy model, oil has always been the number one consumed energy source in the United States, but natural gas consumption has grown rapidly in recent years, to the point where it is basically equal to oil consumption.

The experience and practice of the United States in energy transition has a multifaceted reference for China's energy transition, mainly in the following aspects.

4.1. Technological innovation and research and development

The U.S. has rich R&D experience and innovations in renewable energy technologies, energy efficiency and energy storage technologies. China can learn from the U.S. success stories in technological innovation, market application and commercialization to accelerate the progress and application of its own renewable energy technologies.

4.2. Policy and regulatory development

The U.S. has relatively mature experience in energy policy development and implementation, including tax incentives, energy market reform, and environmental regulations. China can learn from the U.S. policy path and legal framework in promoting renewable energy development, establishing carbon markets and reducing environmental impacts.

4.3. Marketization and private sector participation

The U.S. energy market is relatively more open and competitive, and the private sector has played an important role in promoting clean energy marketization. China can learn from the U.S. experience in market mechanism construction, energy investment and project financing to promote the healthy development of the domestic renewable energy market.

5. Difficulties in China's energy transition

5.1. Lack of technological innovation

Although China's renewable energy industry has made great progress, there is still some dependence on imports in the field of key technologies and core equipment. Lack of independent innovation and core technology, as well as the degree of standardization is not high

5.2. Unreasonable energy structure

According to China's energy structure map found that the more polluting coal is still China's main energy source, coal accounted for about two times the global average, natural gas accounted for only 1 / 3 of the global average.

5.3. Uneven spatial and temporal distribution

China's renewable energy is mainly distributed in the west and north, while the electricity load is mainly concentrated in the east, central and other densely populated and industrial areas. The uneven spatial and temporal distribution of renewable energy has led to the phenomenon that the energy generated cannot be fully consumed, resulting in the abandonment of wind and light.

6. Conclusion

Although China is currently accelerating the transition from a coal-based energy structure to a cleaner energy source, there is still a big gap between achieving the "double carbon" goal by 2060 and the

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"double carbon" goal by 2060, given the characteristics of the energy resource endowment of "coal-rich, oil-poor, and gas-poor", as well as the reality of the production and consumption of traditional fossil energy sources. There is still a big gap in realizing the goal of "double carbon" before "2060".

Carbon peak, carbon neutral work, not only to recognize the difficulty of energy transformation, but also to establish the determination of energy transformation, can be transformed confidence and transformation of perseverance, and then spend another 40 years to complete the transformation of the energy system. A clean, low-carbon, safe and efficient energy system should be built in a comprehensive manner, so as to make a new contribution to the country's vision of a carbon-peak and carbon-neutral goal.

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