

Research on China's Renewable Energy Policy System Under the Background of "Dual Carbon"

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Abstract. In order to promote the development and utilization of renewable energy and improve the energy structure, China has issued a series of energy industry policies. Although China's renewable energy development has achieved remarkable results, the current level of renewable energy development is still far from achieving the "dual carbon" goals. Therefore, it is necessary to optimize the existing energy policy system and further promote the development of renewable energy in China. Based on the evolution path of China's renewable energy policy, this paper grasps the impact mechanism of renewable energy policy on the "dual carbon" goals, and analyzes and compares the policy differences between China and other countries. In view of the shortcomings of China's current system policies, this paper puts forward suggestions for improvement, in order to help achieve the "dual carbon" goals.

1. Introduction

Renewable energy policy refers to a set of guidelines and strategies developed by a country or international organization around the production, supply and consumption of renewable energy. China's renewable energy includes non-fossil energy such as wind, solar, hydro, biomass, and geothermal energy. Renewable energy is a green and low-carbon energy source, an important part of China's multi-wheel drive energy supply system, which is of great significance for improving the energy structure, protecting the ecological environment, and responding to climate change. In 2020, China's renewable energy generation reached 2,214.8 billion kWh, a year-on-year increase of about 8.4%. By the end of 2020, China's installed capacity of renewable energy power generation reached 934 million kilowatts, a year-on-year increase of about 17.5%.

With the impact of global climate change on human society, more and more countries have elevated "carbon neutrality" to a national strategy and put forward a low-carbon and carbon-free vision. At present, more than 120 countries and regions in the world have committed to carbon neutrality and set target deadlines. Earlier in 2020, China announced that it would strive to peak carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060 (hereinafter referred to as the "dual carbon" goals)^[1]. This shows the world China's firm determination to reduce carbon emissions. Achieving the

"dual carbon" goals has become a major strategic deployment for China to build an energy power. Increasing the proportion of renewable energy, and further improving the renewable energy policy system are the inevitable choices for China to achieve the "dual carbon" goals on schedule^[2].

In order to promote the development and utilization of renewable energy and improve the energy structure, China has issued a series of energy industry policies, which have promoted the rapid development of renewable energy in China. Nevertheless, the level of development of renewable energy in China is still far from the level required to achieve the "dual carbon" goals. As of 2021, China's renewable energy consumption accounted for 7.2%, which is still significantly lower than developed countries such as Europe and the United States, such as Denmark at 35.8% and Germany at 18.0%^[3]. Therefore, it is of practical significance to optimize China's renewable energy policy system and achieve the "dual carbon" goals by sorting out the evolution path of renewable energy policy^[4], grasping the impact mechanism of renewable energy policy on the "dual carbon" goals, comparing the policy differences between China and countries with relatively advanced renewable energy development, and putting forward suggestions for improving China's renewable energy policy system.

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2. The evolution path of China's renewable energy policy

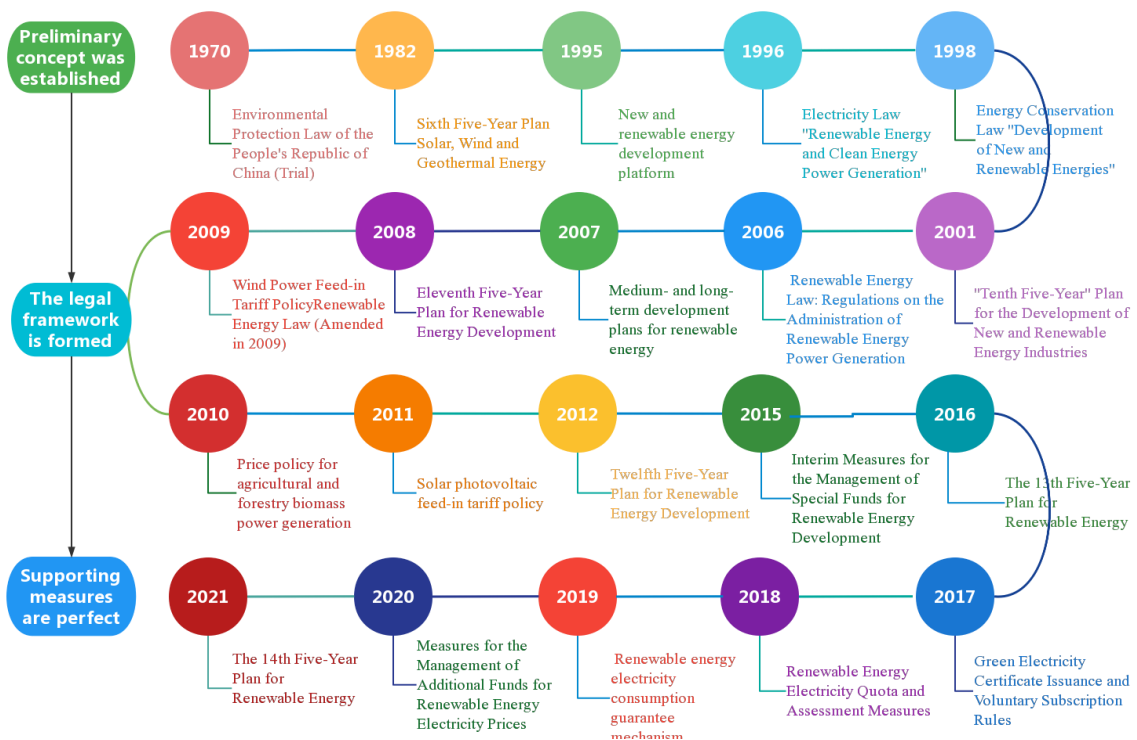


Figure 1. The evolution path of China's renewable energy policy

2.1 Policy evolution path

China's renewable energy policy has changed from "preliminary conceptual mention" to "legal framework formation"^[5], and then to "perfect policy supporting measures", showing the distinctive characteristics of policy content from "simple and rough" to "specific and meticulous", and the type of policy from "single form" to "rich and complete", as shown in Figure 1.

2.1.1 Preliminary concept mentions

China's policy of mentioning renewable energy can be traced back to 1979, when the Standing Committee of the Fifth National People's Congress passed China's first environmental protection law, the Environmental Protection Law of the People's Republic of China (for trial implementation), which for the first time mentioned in the form of laws and regulations "vigorously develop and utilize coal gas, liquefied petroleum gas, natural gas, biogas, solar energy, geothermal, and other non-polluting or less polluting energy sources", laying the foundation for the subsequent promulgation and implementation of laws and regulations on renewable energy. In 1995, China formulated the Outline for the Development of New and Renewable Energy for 1996-2010, which called for accelerating the pace of industrial construction of new and renewable energy^[6].

2.1.2 The legal framework is formed

In the 21st century, China has paid more attention to the development of renewable energy, forming a policy system based on the Renewable Energy Law and supported by a number of policies such as price control and fiscal and tax support. In 2006, China formally implemented the Renewable Energy Law, which established a legal framework for renewable energy. In the same year, the Regulations on the Administration of Renewable Energy Power Generation and the Trial Measures for the Management of Renewable Energy Generation Prices and Costs were issued successively, detailing the management of renewable energy power generation projects and electricity prices. In 2007, the Medium and Long-term Development Plan for Renewable Energy was formulated, promising to establish a sound renewable energy technology and industrial system by 2020. In 2008, renewable energy was officially included in the "Five-Year Plan", elevating renewable energy development to a national strategic position. In order to cope with the high cost of renewable energy power generation and the difficulty of connecting to the grid, the on-grid tariff and subsidy policies for wind, photovoltaic and biomass power generation were implemented from 2009 to 2011, realizing economic incentives for the development of renewable energy. In order to further standardize the management of special funds and improve the effectiveness of the use of funds, the central government issued the Interim Measures for the Management of Special Funds for Renewable Energy Development in 2015.

2.1.3 Supporting policies and measures are perfect

Due to the uneven distribution of renewable energy resources in early China, the lag in the construction of transmission networks, and insufficient consumption, China's renewable electricity abandoned wind and light, resulting in huge waste of resources. In order to solve the phenomenon of abandoning wind and light, in 2016 China formulated the Administrative Measures for the Full Guaranteed Acquisition of Renewable Energy Power Generation, which stipulates in detail the specific measures for priority on-grid and guaranteed purchase of renewable energy, ensuring the purchase of renewable electricity. In 2017, the National Energy Administration successively organized the construction of multiple batches of wind price grid projects to guide and promote the sustainable and healthy development of the renewable energy industry, which kicked off the prelude to the subsidy parity of renewable electricity. In 2019, China issued the Notice on Establishing and Improving the Guarantee Mechanism for Renewable Energy Electricity Consumption, which promoted the local

consumption of renewable energy and realized the optimal allocation across provinces and regions through a market-oriented approach, and guided the healthy and sustainable development of renewable energy electricity in various regions. In 2022, China issued the Medium- and Long-term Plan for the Development of Hydrogen Energy Industry (2021-2035), deploying important measures to promote the high-quality development of the hydrogen energy industry and goals at various stages of industrial development, providing strong support for the realization of the "dual carbon" goals.

2.2 Existing policy system framework

At present, China has formed a renewable energy policy system with the Renewable Energy Law as the core and covering policy measures such as target planning, fiscal and taxation finance, electricity price control and consumption guarantee, which provides strong support for promoting the steady development of renewable energy, as shown in Figure 2.

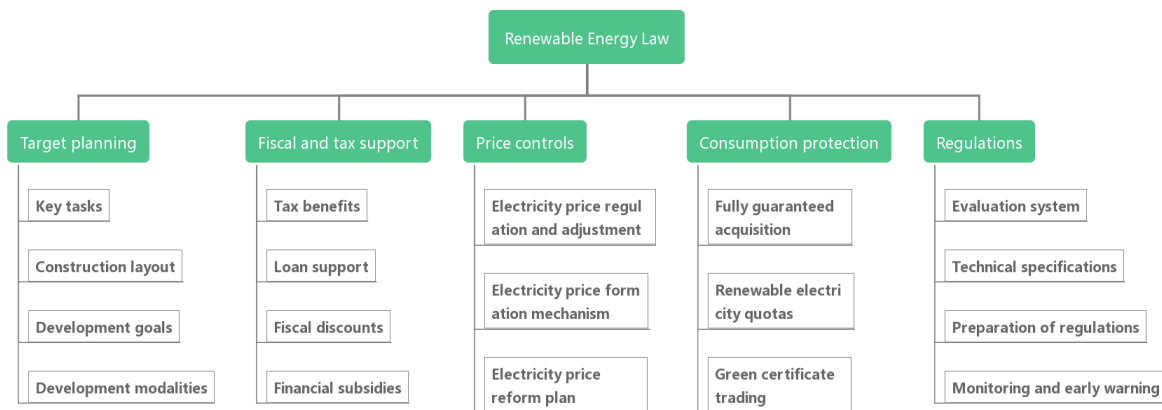


Figure 2. China's renewable energy policy framework

2.2.1 Target planning policy

Target planning policy refers to the policy of setting specific strategic objectives and development planning for the development and utilization of renewable energy resources. Such policies set development goals, construction layouts, key tasks and innovative development methods for the renewable energy industry in a certain period of time in the future, such as power generation equipment production, infrastructure construction, power generation planning and grid-connected utilization, and are the programmatic policies for China's renewable energy development. Such as the "13th Five-Year Plan for Renewable Energy Development", "14th Five-Year Plan for Renewable Energy Development" and "Medium and Long-term Development Plan for Renewable Energy".

2.2.2 Fiscal and tax support policies

Fiscal and tax support policies refer to policies that support the development of renewable energy from fiscal

and financial aspects through fiscal discounts, tax incentives, capital subsidies and loan support. Whether it is building a clean energy system, developing green and low-carbon technologies, and the transformation and upgrading of energy-related industries, it is inseparable from the effective guidance and support of fiscal and taxation policies^[7]. By reducing the production cost and investment and financing threshold of the renewable energy industry, this type of policy alleviates the problem of high cost of early renewable energy development, and promotes the development of renewable energy industry, especially manufacturing small and medium-sized enterprises^[8]. For example, the "Opinions on Financial Support for Carbon Peaking and Carbon Neutrality" and the "Interim Measures for the Management of Special Funds for Renewable Energy Development".

2.2.3 Price control policy

A price control policy is a regulation or scheme formulated for the adjustment of feed-in tariffs or feed-in tariffs for different renewable energy technologies and

power generation projects over a certain period of time. It also includes policies on renewable electricity price formation mechanisms, electricity price reform schemes and grid transmission and distribution. For example, the "Trial Measures for the Management of Renewable Energy Power Generation Prices and Costs", "Notice of the National Development and Reform Commission on Improving the On-grid Tariff Policy for Wind Power Generation" and "Notice of the National Development and Reform Commission on Improving the On-grid Tariff Policy for Solar Photovoltaic Power Generation".

2.2.4 Consumption protection policy

The consumption guarantee policy is the relevant measures and methods formulated for the grid connection, dispatch support, and promotion of consumption of renewable electricity. Such policies aim to increase the share of renewable energy in total energy consumption and ensure that the expected tasks and commitments set out in targeted planning policies are met. The Administrative Measures for the Full Guaranteed Acquisition of Renewable Energy Generation and the Guarantee Mechanism for Renewable Energy Electricity Consumption fall within the scope of such policies.

2.2.5 Manage prescribed policies

Management regulations and policies refer to the rules and regulations or management measures formulated to regulate the resource development of renewable energy, the process of grid connection, and the production and operation process of renewable energy products and their supporting infrastructure. Such policies not only involve the monitoring and early warning, regulation preparation and evaluation system of the industry, but also cover the technical specifications and standards of the basic links of the industry, which is the basis for ensuring the sustainable and healthy development of renewable energy-related industries. Such as the "Regulations on the Administration of Renewable Energy Power Generation".

3. Impact mechanism of renewable energy policy

Clarifying the impact mechanism of renewable energy policies on the "dual carbon" goals is an important prerequisite for accurately improving the effectiveness of renewable energy policies. This section will systematically explore the impact mechanism of different types of renewable energy policies on the realization of the "dual carbon" goals from the aspects of low-carbon energy transformation, low-carbon industrial development and low-carbon technology innovation, as shown in Figure 3.

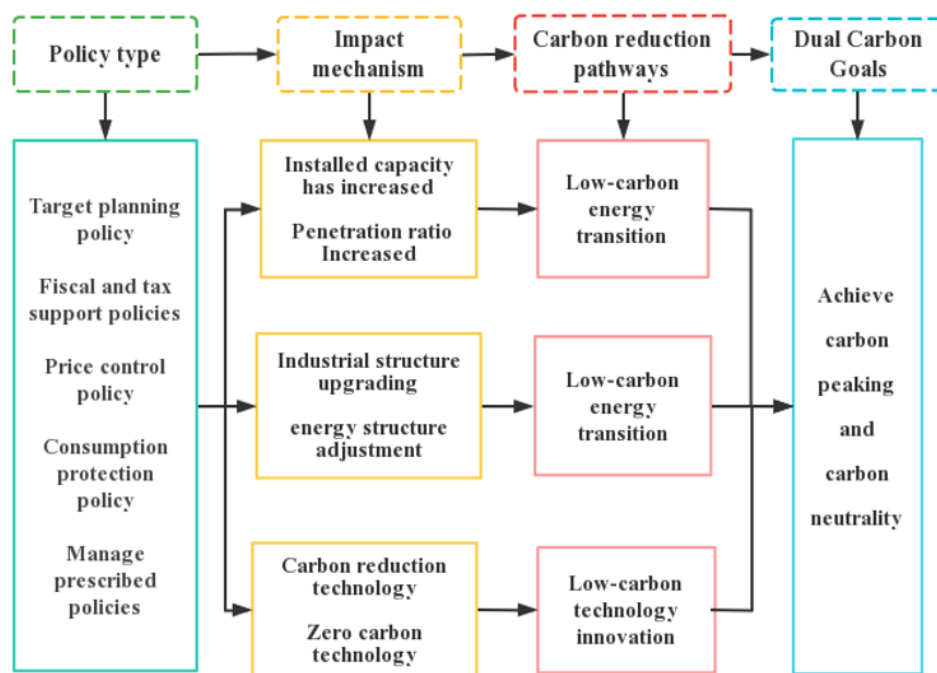


Figure 3. Impact mechanisms of renewable energy policies

3.1 Renewable energy policies promote a low-carbon energy transition

Renewable energy policies promote low-carbon energy transformation and achieve carbon emission reduction by

increasing the installed capacity of renewable energy and generating electricity. On the one hand, in order to cope with the high cost of renewable energy power generation, the government has introduced support policies such as feed-in tariffs, which have reduced the gap between renewable energy and fossil energy power generation

costs, guaranteed renewable energy power generation revenues, and promoted the increase of renewable energy installed capacity^[9]. On the other hand, through the implementation of policies such as consumption guarantee and management regulations, the penetration rate of renewable energy in total energy consumption has been improved, and low-carbon energy substitution has been achieved. Under the constraints of renewable energy quota standard policy and consumption guarantee policy, the willingness of power grid companies to purchase green electricity is enhanced, and the proportion of renewable energy in energy consumption is increased^[10].

3.2 Renewable energy policies guide low-carbon development of industries

Renewable energy policies promote low-carbon transformation of industries by influencing energy consumption structure and industrial structure to achieve carbon emission reduction. On the one hand, electricity price control policies, RPS and other consumption guarantee policies help promote renewable energy consumption and reduce fossil energy consumption. Relevant policies can promote the optimization of energy dispatch, improve the utilization efficiency, grid connection rate, penetration rate and market demand of renewable energy facilities, thereby promoting the energy consumption structure of the industry to shift to low-carbon and promoting the low-carbon transformation of the industry. On the other hand, fiscal and tax support policies such as green finance not only help to form a financing penalty effect and investment inhibition effect on heavily polluting enterprises, eliminate energy-consuming industries, but also help reduce the agency cost of green industry investment, guide capital flow to resource-saving low-carbon industries, promote industrial structure upgrading^[11], and promote industrial low-carbon transformation^[12].

3.3 Renewable energy policies promote low-carbon technology innovation

Renewable energy policies promote low-carbon technology innovation and achieve carbon emission reduction by attracting investment and reducing the cost of technology research. On the one hand, renewable energy policies attract investment through policies such as green finance and green certificate trading, promote energy-saving equipment transformation, improve energy efficiency and total factor productivity, and promote carbon emission reduction. On the other hand, fiscal and tax support and R&D subsidies can effectively reduce the sunk cost of technological research, reduce the risk of technological innovation, attract more R&D investment, and ultimately induce more renewable energy technology innovation, promote technological innovation and large-scale application of renewable

energy, and then promote carbon emission reduction. In addition, renewable energy policies can help promote the development of carbon-negative technologies such as CCUS. To achieve the "dual carbon" goals, it is necessary to promote the adjustment and reconstruction of the traditional energy structure, promote the integration of low-carbon technology innovation, and build a new modern energy system^[13].

4. International comparative analysis of renewable energy policies

4.1 An international comparative analysis of the evolving characteristics of renewable energy policies

Compared with countries with relatively advanced renewable energy development, China's environmental policy intensity and renewable energy R&D subsidy intensity are relatively low, and the feed-in tariff mechanism started late^[14], but the number of policy promulgations is growing the fastest. The United States was an early adopter of renewable energy policy. According to the policy database released by the International Energy Agency (IEA) in 2022, the United States first enacted policies such as the Geothermal Energy Research, Development and Demonstration Act and the Solar Research Act in 1974. Subsequently, in 1976, Denmark enacted the Electricity Supply Act and the Energy Research Plan. In 1991, Japan promulgated the Renewable Resources Utilization Promotion Act and the Enforcement Decree of the Renewable Resources Promotion Act. In 2000, Germany enacted the Renewable Energy Act, one of the first countries in the world to initiate the energy transition. In contrast, China only promulgated the Renewable Energy Law in 2005, which shows that China's renewable energy policy started late.

Since 2005, the number of renewable energy policies in China has increased year by year, especially from 2010 to 2017, and the total cumulative number of policies ranks first in the world. However, compared with developed countries such as Europe, the United States, and Japan, the policy termination rate is also the highest, as shown in Table 1. As of July 2022, the total number of renewable energy policies in China is as high as 146, which is significantly higher than that of major developed countries such as Europe, the United States and Japan. There are many renewable energy policies in China, which may be due to overlapping effects between different policies or the coordination between policies needs to be improved^[15]. At the same time, the termination rate of China's renewable energy policy is as high as 45.9%, indicating that China's renewable energy policy is not stable enough, the policy implementation cycle is short^[16], and there is no long-term mechanism.

Table 1. Renewable energy policies issued by major countries from 1974 to July 2022

Country	Enforce policies		Termination Policy		Total amount of policy
	Amount	Implementation rate	Amount	Implementation rate	
America	98	69.0%	44	31.1%	142
British	59	72.0%	21	25.6%	80
Germany	50	75.8%	16	24.2%	66
Denmark	23	62.2%	14	37.8%	37
Japan	30	56.6%	21	39.6%	51
China	79	54.1%	67	45.9%	146

Source: IEA (2022) Policy Data

4.2 Comparative analysis of the impact of renewable energy policies in different countries

Due to the early formulation and long implementation time of renewable energy policies in developed countries such as Europe, the United States and Japan, both the installed capacity of renewable energy and the proportion of consumption in primary energy consumption have long been in the forefront of the world. However, with the formulation and implementation of a large number of renewable energy policies in China, the installed capacity, power generation and consumption of renewable energy in China have grown rapidly, and gradually surpassed developed countries such as the United States and Germany to become the first in the world. However, due to China's large primary energy consumption and long-term focus on coal, the proportion of renewable energy consumption (7.2%) as of 2021 is still lower than the average of developed countries such as the United States, the United Kingdom, Germany, Denmark and Japan (18.3%)^[5]. There is a big gap between the proportion of renewable energy consumption and the realization of China's high proportion of renewable energy and large-scale development goals.

Compared with developed countries such as Europe, the United States and Japan, the rapid increase in the number of renewable energy policies in China has limited effect on China's carbon emission reduction. From 1974 to 2020, carbon emissions in developed countries such as the United States showed a steady or declining trend, while China's carbon emissions showed a growth trend of varying degrees. From 2011 to 2021, with the formulation and implementation of a large number of renewable energy policies in China, the installed capacity, power generation and consumption of renewable energy in China showed a rapid upward trend, and the growth rate of carbon emissions slowed down. Due to the small proportion of consumption in China, renewable energy has a very limited role in reducing total carbon emissions, and its role in reducing China's carbon intensity is relatively limited. Therefore, in order to promote the realization of China's "dual carbon" goals in an orderly manner, it is necessary to further improve China's renewable energy policy system and promote the large-scale, high-proportion, market-oriented and high-quality development of renewable energy.

5. Suggestions for improving China's renewable energy policy system

5.1 Strengthen the forward-looking planning of targets and shorten the lag in policy release

Targeted planning policies have laid the core tone and guidance for renewable energy development in the coming period, but there is still a lag in the formulation and release of such policies in China^[16]. China's 11th Five-Year Plan, 12th Five-Year Plan and 13th Five-Year Plan for renewable energy development are lagging behind by 3, 2 and 1 year respectively. The 14th Five-Year Plan for Renewable Energy Development was postponed to the public until June 2022 by nine departments, including the National Development and Reform Commission, the National Energy Administration and the Ministry of Finance. The issuance of target planning policies is not timely, which can easily lead to ineffective investment. At the end of the planning period, local governments are still opportunistic in order to achieve development goals. Therefore, it is necessary to strengthen the forward-looking nature of policy formulation and formulate or shorten the lag time of policy release in advance.

5.2 Streamline redundant policies and improve policy coordination

Streamlining redundant policies, forming a clear system, and improving the coordination of renewable energy policies are important prerequisites for reducing the cost of policy implementation and enhancing the implementation effect. Although China's renewable energy policies were formulated and implemented later than those of countries such as Europe, the United States and Japan, the number of policies issued and the termination rate were higher than theirs, reflecting the duplication and redundancy of China's renewable energy policies. The lack of coordination between the objectives and requirements of regions, sectors, stages and categories of policies weakens the effectiveness of policy implementation. Therefore, it is urgent to strengthen the coordination between regional renewable energy policies and between renewable energy policies and other policies through phased and focused policies, so as to promote the high proportion of renewable energy consumption and high-quality development.

5.3 Improve precise and efficient support and empower breakthroughs in key core technologies

Breakthroughs in key core technologies are an important foundation for the large-scale and high-quality development of renewable energy under the "dual carbon" goals, and are also the key to improving the stability and reliability of China's power system. Support policies such as electricity price control and fiscal and tax support can reduce sunk costs and input risks, which can inject new momentum into them. However, with the decline in the cost of renewable energy generation, the relevant support is gradually weakening, which contradicts the demand for high-end technology for the large-scale and high-quality development of renewable energy under the "dual carbon" goals. Therefore, China needs to seize the favorable opportunity of the 14th Five-Year Plan, and on the basis of strengthening energy conservation and emission reduction, solving the problem of green power integration and consumption, and improving energy infrastructure construction^[18], further improve the policy system on renewable energy technology research and development policies, improve precise and efficient support, and empower breakthroughs in key core technologies such as ultra-large offshore and high-altitude high-power electric wind turbines.

5.4 Plan the 2060 target and draw up a 100% renewable roadmap

Formulating long-term renewable energy development plans and formulating long-term strategic guidance policies are particularly important for achieving China's "dual carbon" goals on schedule. Although China formulated its Medium- and Long-Term Development Plan for Renewable Energy in 2007, it has yet to issue the next long-term development plan. The 14th Five-Year Plan for renewable energy development mainly focuses on the 14th Five-Year Plan period (2021-2025), and has not yet formulated a 2060 target for renewable energy development, let alone a vision of 100% renewable energy. In China's renewable energy system, it is necessary to clearly formulate a long-term development plan for renewable energy in 2060 that is compatible with the goal of carbon neutrality as soon as possible, and further draw up a long-term plan for the development of 100% renewable energy.

6. Conclusions

In recent years, China has introduced a series of renewable energy industrial policies, which have effectively promoted the development level of renewable energy in China. China's renewable energy policy has changed from "preliminary conceptual mention" to "legal framework formation", and then to "perfect policy supporting measures", showing the distinctive characteristics of policy content from "simple and rough" to "specific and meticulous", and the type of policy from

"single form" to "rich and complete". These policies have promoted the realization of the "dual carbon" goals from three aspects: low-carbon energy transformation, low-carbon industry development, and low-carbon technology innovation. However, compared with developed countries such as Europe, the United States and Japan, China's renewable energy policy started late, the termination rate of the policy is high, and the proportion of renewable energy consumption is low. It can be seen that China's current level of renewable energy development is still far from achieving the "dual carbon" goals. Therefore, this paper puts forward the following four suggestions: First, strengthen the forward-looking nature of policy formulation, formulate policies in advance or shorten the lag time of policy release. Second, streamline redundant policies, strengthen coordination between regional renewable energy policies, and coordinate between renewable energy policies and other policies, and promote a high proportion of renewable energy consumption and high-quality development. Third, increase support for the research and development of renewable energy technologies, and promote breakthroughs in key core technologies such as ultra-large offshore, high-altitude and high-power wind turbines. Fourth, formulate a long-term development plan for renewable energy in 2060 as soon as possible, and further draw up a roadmap for the development of 100% renewable energy in the long-term plan.

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