How Will China's Clean Energy Industry Develop?

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Abstract. This paper mainly takes China's clearer energy industry as the research object, and adopts the methods of literature analysis, comparative analysis and data analysis. The research compares and analyzes the current situation and evolution of the global and Chinese clearer power profession, and draws out the overall characteristics of the evolution and development of China's clean energy industry. From three different levels of clearer power types, it specifically analyzes three major clean energy industries: solar energy industry, clean coal industry and fuel cell industry. The study found that with the continuous development of energy technology and profession, China's clean energy industry is gradually opening up, and clean power discourse in the international market will continue to improve. Based on these conclusions, China's clean energy industry needs cooperation, especially exploring the mode of mixed ownership between private and state-owned enterprises. By lowering the threshold for market access, it will greatly encourage entrepreneurship and innovation in the energy field, and jointly promote the globalization of China's clean energy industry.

Keywords: Clean energy; solar energy industry; clean coal industry.

1. Introduction

Countries worldwide now recognize the importance of developing renewable energy sources and prioritizing energy efficiency. The global energy landscape is entering a new phase, marked by an emphasis on high efficiency, clean energy, and diversification. Investment focus has shifted towards green and clean energy, leading to an expansion in installed capacity for green power generation. Consequently, global electricity generation from green energy has significantly increased. According to the International Energy Agency's (IEA) World Energy Outlook 2022, an increasing number of countries are accelerating their energy transition. The global clean energy industry is experiencing rapid growth, with renewable energy generation projected to rise by 20% in 2022. In contrast, global carbon dioxide emissions are expected to grow by only 1% this year, down from 4% in 2021.

In China, green energy contributes significantly to the country's energy supply and will play a crucial role in its future energy mix. With vast development prospects and investment potential, green energy can effectively protect the environment and provide long-term benefits to various industries, making it a sustainable choice for businesses. In recent years, energy enterprises have increasingly entered the new energy sector, focusing on clean and low-carbon solutions for future growth. China State Grid has issued a "carbon peak, carbon neutrality" action plan, aiming to establish a diversified clean energy supply system. The Chinese government will set further goals for new energy development, including promoting large-scale, high-quality, market-oriented growth of renewable energy. Efforts will be made to increase new energy consumption and storage capacity and develop a power system primarily based on new energy sources. Additionally, the implementation of renewable energy substitution initiatives will be accelerated [1].

This study examines the development of China's clean energy industry by comparing its history and current situation to those of other countries. It identifies the key characteristics of China's clean energy industry development and analyzes three sub-sectors: solar energy, clean coal, and fuel cell industries. Despite facing challenges, these industries hold considerable potential for growth [2].

2. Literature Review

China will set additional goals for the development of new energy in the following phase, including fervently promoting the high-proportion, large-scale, high-quality and market-oriented growth of renewable energy in the new era. The government will work to increase the new energy consumption and storage's capacity and actively develop Green energy new power system as the primary component. It will also expedite the implementation of renewable energy substitution actions. [3].

Miao improved the DEA model to study the investment benefit and comprehensive efficiency of clean energy industry under the background of green finance. The study found that the economic pullulate level and resource endowment vary greatly between regions in China, and the comprehensive efficiency of clean energy depends not only on the economic level, but also on the sustainable resource endowment. Therefore, by giving up the traditional development mode of high consumption and high pollution, depending on green finance, and vigorously developing the clean energy industry, it is possible to effectively achieve the balanced and sustainable development of resources, environment, and economy [4].

Generally, the three major clean energy industries include solar energy industry, clean coal industry and fuel cell industry. Wang and Du analyzed the pullulate scenario of China's solar thermal power market, studied the China's solar thermal power generation's evolution from 2015 to 2022, and found that solar thermal power generation business in China will start on a large scale in 2022, and analyzed the factors affecting China's solar thermal power generation business evolution [5].

Based on the noise control project of air separation system in Tianjin Huaneng coal gasification power plant demonstration project, Nie studied the noise control project of air separation system in large coal gasification (IGCC) power plant. It found that coal gasification technology is an important development direction of clean coal technology, which has promoted the development of clean coal technology in China, and has far-reaching significance for the sustainable evolution of coal and electric power business [6].

The core of measuring the development level of hydrogen energy industry lies in whether the core technologies related to hydrogen energy and fuel cell industry can be localized, rather than just assembling imported core components. There are still bottlenecks in the progress path of fuel cell industry in China. It has many advantages of high efficiency, clean and environmental protection, and hydrogen fuel cell vehicle. Hydrogen fuel cell has multiple advantages over fuel cell and lithium battery [7].

3. Analysis of China's Major Clean Energy Industries

Energy that does not emit pollutants and can be used immediately in production and daily living is referred to as clean energy, also known as green energy, which includes renewable energy. Green energy is typically used to allude to renewable energy sources like water, biological, solar, wind, geothermal, and ocean energy. Due to a minimal pollution, this energy usage can be replenished. In a broad sense, clean energy refers to the choice of low-pollution or pollution-free energy sources during the process of power production and usage, such as natural gas, clean coal, and nuclear energy. The term "new energy" alludes to secondary energy technologies that have emerged recently, like fuel cells and new secondary batteries. This paper will take one of the three types of clean energy to explore their industrial development and future trend.

3.1. Solar Energy Industry

China's solar photovoltaic business has ripened rapidly. Many key production technologies and production equipment in the solar photovoltaic industry have been thoroughly studied. But the industry chain has been uncoordinated and the problem of higher energy consumption. The commercial prospect of solar power is always controversial, but these problems still effectively promote the progress of photovoltaic power industry. However, compared with developed countries,

there is still a big gap: the distribution is not even, the intensity of research is insufficient, and the experimental conditions are limited [8].

In 2021, China's photovoltaic power generation ushered in a period of significant development opportunities. The major national strategic goal is to provide broad prospects for the development of the photovoltaic industry. After carbon neutrality is proposed, the country has formulated a series of policies and built a complete policy system. China Central Economic Work Conference proposed that the new renewable energy consumption would not be included in the total energy consumption control. With the further promotion of the goal of carbon neutrality, the development income of photovoltaic power generation faces the risk of fluctuation in the short term. With the gradual release of expanded silicon production capacity in mid-2019, silicon supply will increase significantly by the second half of 2022, and the mismatch between industrial supply and demand is expected to be alleviated. In addition, many provinces put forward the photovoltaic power generation projects that are included in the scale of the guarantee power grid, and also require the allocation of energy storage devices in a certain proportion. It is difficult to effectively reduce the land cost, non-technical cost financing, power grid delivery and other aspects in the short term, and the investment income of photovoltaic projects faces short-term fluctuation risks [9].

3.2. Clean Coal Industry

Clean coal is used in the process of energy manufacture and consumption, which is low pollution or no pollution to the ecological environment. China’s resource endowment of "rich in coal, short of oil and short of gas" determines that modern coal chemical industry has a very important strategic significance to ensure national energy security. Modern coal chemical manufacture should adhere to the goals of clean transformation, efficient utilization and sustainable development in the production process, and promote the green transformation evolution of high-carbon energy. However, there are still many challenges in how to break through the bottleneck of key technologies such as high-power consumption, high water consumption and high emissions.

During China’s "14th Five-Year Plan" period, modern coal chemical industry will enter a new stage of high-quality development. However, as an unfinalized industrial system, modern coal chemical industry's connotation and extension are constantly changing, and its future development will face many challenges: energy security situation is more severe, carbon emission reduction pressure is more prominent, environmental constraints are more stringent, market competition is fiercer, and innovation requirements are more urgent.

Therefore, facing with more complex industrial policies, internal and external environment, market competition and other challenges, the modern coal chemical industry needs to further strengthen the layout of science and technology, and take the transformative technology and break through the business barriers to promote multi-energy integration between various energy types and industries across the field. These measures will promote the high-quality development of the industry.

To build a green, low-carbon, safe and efficient modern power system, the government not only need to promote technologies in various fields, but also need to break the barriers between various energy types and related energy industries, and break through the key technical bottlenecks and core technologies of multi-energy integration and complementarity and supporting industrial process reengineering in key energy-related industries across fields. Therefore, for the high-quality development of modern coal chemical industry, China should further strengthen the layout of science and technology, and give full play to the material resource attributes of coal. Take the original innovation and change technology are vital important for clean coal industry. For sustainable development, it is essential to break through the industry plate barriers, technical bottlenecks and institutional barriers. The government should encourage the implementation of multi-energy integration, optimize the allocation of resources, and promote the comprehensive upgrade of energy system and industrial structure [10].

3.3. Fuel Cell Industry

Fuel cell is a secondary energy technology developed in recent years, which also belongs to a kind of premium new energy. As early as in 1950s, China started the research on fuel cell, and made a lot of breakthroughs in the innovation of key materials and technologies of fuel cell. The government attaches great importance to the research and pullulate of fuel batteries, and has successively developed 30kW hydrogen oxygen fuel electrode and fuel batteries electric vehicle. Through the research and development of the leading enterprises of fuel cell, the fuel cell technology has been developed rapidly. At present, the main manufacturers in the fuel cell industry in China are Yihuatong, Shanghai Remolding, Guohong Hydrogen Energy, Jiangsu Qingneng, Dayang Electric, Zhongyu Power, etc. (see Table 1).

Table 1. The main manufacturers in the fuel cell industry.

Manufacture	Production capacity
Sinohetec	2000 sets/year at present, and will be 10,000 sets/year in 2024
Refire	5000 sets/year in the first phase
Sinosynergy	5000 pcs/year
Dongfang Electric Corporation	1000 pcs/year
Sunrise Power	1000 pcs/year
Jiangsu Qingneng	2000 pcs/year
Troowin	2000 set/year

Data source: Qianzhan Industrial Research Institute.

The shipped power of fuel cells in China showed an overall upward trend from 2.7MW to 87MW during 2010-2020. In 2019, the average installed power of fuel cell buses in China was 46kW. In the first half of the year, the installed force was concentrated between 30-45kW, and in the second half of the year, the installed power was mostly between 45-60kW. The rated power of logistics vehicle system was mainly concentrated in 32kW, 40kW, 40.5kW and 60kW. In 2020, due to the impact of the pandemic and policies, the installed capacity of fuel cells in China was only 87MW, of which about 80MW was used in the field of fuel cell vehicles (see Figure 1).

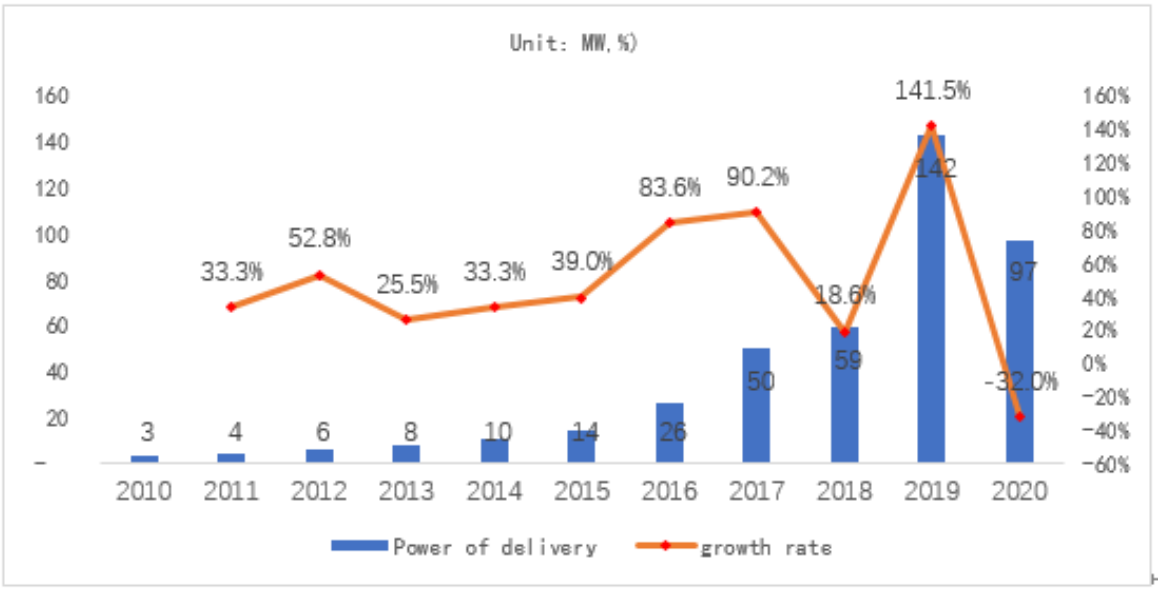

Fig 1. Shipment power and growth rate of fuel cells in China from 2012 to 2020.
Data source: Qianzhan Industrial Research Institute.

According to the relevant data of the U.S. Department of Power, combined with the average sales unit price of fuel cell enterprises in China, the price of fuel cell in China showed a downward trend from 40,000 yuan/kW to less than 20,000 yuan/kW during 2010-2020. According to the calculation

based on the installed capacity of fuel cells, the fuel cell market scale in China increased from 100 million yuan in 2010 to 1.5 billion yuan in 2020 (see Figure 2). Based on China's development plan of fuel cell industry in the future, it is expected that the market size of fuel cell industry will continue to rise and exceed ten billion yuan by 2026 [11].

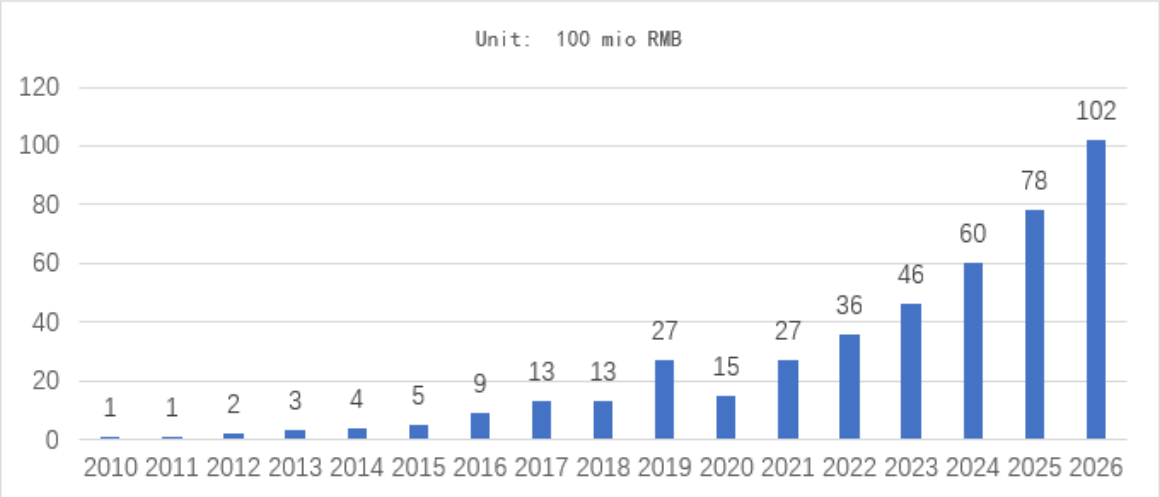

Fig 2. Statistics and forecast of China's fuel cell industry market size from 2010 to 2026. Data source: Qianzhan Industrial Research Institute.

4. Conclusion

The pullulate of China's clean energy industry is the primary topic of discussion in this study. In this paper, the development history and current state of the clean energy sector in China and abroad are introduced and contrasted, which leads to a discussion of the general trends in the growth and development of China's green power industry. The solar energy industry, clean coal industry, and fuel cell industry are three clean energy industries that are examined from three distinct levels of clean energy types. Despite the struggles, these industries all have a wide range of growth opportunities. China has made rapid advancements in both energy output and consumption, and it has rich experience in the transition from dirty, high-carbon energy to clean, low-carbon energy. With the rapid development of industrial technology and equipment manufacturing capabilities, China's clean energy will continue to have a greater sales volume in the international market. By 2050, with the completion of the green transformation of the power structure, China's power industry will achieve zero CO_2 emissions, thus contributing to the fulfillment of China's "carbon neutrality by 2060" commitment.

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