

Research on the economic security application of energy economy in a low-carbon sustainable development society

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Abstract. Research on the economic security application of energy economy in a low-carbon sustainable development society is an important research field. Its purpose is to explore how to achieve the safe development of the national economy in the context of low-carbon sustainable development, including economic structural adjustment, green technology innovation, resource conservation and recycling, environmental protection, etc. This article explores how to ensure green and sustainable development of energy security and the security risk assessment of green energy economy.

1. Introduction

In recent years, global temperature and environmental changes have attracted widespread attention. Since the Industrial Revolution, in order to rapidly develop the economy, countries around the world have continuously increased their consumption of fossil fuels, resulting in greenhouse gas emissions such as carbon dioxide exceeding the sum of the past few thousand years in a short period of time. In order to reduce carbon emissions, countries around the world have taken multiple measures, including signing the Paris Agreement to achieve carbon neutrality goals [1]. In order to achieve these goals, scientists from multiple countries have conducted relevant research on energy economy and carbon emissions, in order to develop and promote near zero emission energy systems. John Doe conducted a comparative study on the energy economic security strategies of multiple countries, focusing on exploring the differences in energy supply, demand, markets, and policies among different countries, as well as their impact on economic security. He pointed out that energy economic security and low-carbon are inseparable communities in today's society, and we must develop energy economic security in the form of low-carbon and environmental protection. Jane Smith studied the impact of climate change on energy economic security. Analyzed the causes and trends of global climate change, as well as its impact on energy demand, supply, and market [3]. Li Zhang conducted an evaluation and policy optimization study on China's energy economic security. He constructed an evaluation index system for China's energy economy and security, and evaluated and predicted China's energy economy and security [4]. An overview of the main research directions in the field of energy economy and security was provided. Firstly, the importance of energy economic security in modern society was emphasized, and the factors that affect energy economic security, such as energy supply security, energy demand security, energy market stability, energy policy formulation, energy technology innovation, energy storage and transportation, were pointed out. Suggestions for future research directions were also proposed [5]. By utilizing high-

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tech, improving energy utilization efficiency, developing new clean energy, changing energy structure, and achieving sustainable development of energy, environment, and economy, problems such as environmental pollution and energy supply and demand imbalance can be solved. This requires changing traditional lifestyles and production methods, and developing sustainable values.

This article analyzes the current development status and problems of the energy economy, and proposes relevant solutions. While ensuring normal economic development, reducing environmental pollution and resource waste to meet the requirements of sustainable energy and economic development. This will promote the development of national economic security and ensure the country's economic security and social stability [6].

2. Analysis of the development status and problems of energy economy in society

In order to cope with challenges such as global climate change and energy security, developing a low-carbon society has become an important issue. Research on the economic security application of low-carbon sustainable development of the energy economy in the national economy is an important research field. Its purpose is to explore how to achieve the safe development of the energy economy in the context of low-carbon sustainable development, including economic structural adjustment, green technology innovation, resource conservation and recycling, environmental protection, etc[7].

2.1 The development status of energy economy in society

At present, the world mainly relies on the burning of fossil fuels (such as coal, oil, and natural gas) to meet its energy needs. However, high energy consumption has serious implications for sustainable development, as the burning of large amounts of fossil fuels contributes to environmental problems, especially climate change. In addition, fossil fuels are non-renewable resources that will be depleted. China, the United States, India, the Russian Federation, Japan, Iran, Germany, South Korea, Saudi Arabia, Indonesia and other countries are the world's largest carbon emitters, accounting for 69 percent of global carbon emissions. In order to study the impact of economic development, energy consumption, population size and technology level on carbon emissions, we selected the above countries as research objects, and analyzed the impact of total population, per capita GDP, per capita income, innovation index, energy consumption, per capita carbon emissions, global innovation index, and the proportion of domestic research and development in total expenditure on carbon emissions. See Figure 1 for detailed analysis results [8].

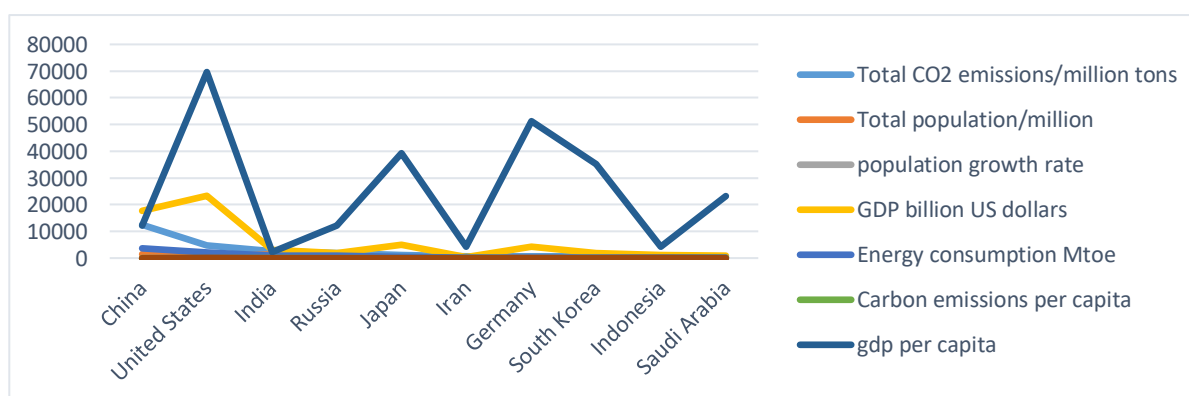


Fig. 1. Energy consumption index of various countries in 2022

The relationship between energy consumption and carbon emissions:

The Figure 2 shows the relationship between energy consumption and carbon emissions.

The regression equations $y = 3.0615x - 1E + 06$ and $R^2 = 0.7358$ indicate a positive linear relationship, with R^2 values representing approximately 73.58% of the data changes explained by the model.

This means that as energy consumption increases, carbon emissions also increase accordingly.

The relationship between the total population at the end of the year and carbon emissions:

The Figure 3 shows the relationship between the total population at the end of the year and carbon emissions.

The regression equation is a cubic polynomial $y = 6E - 06x^3 - 2.624x^2 + 358911x - 2 + 10$, with a fit of $R^2 = 0.8085$, indicating that the model explains approximately 80.85% of the data variation.

From the chart, it can be seen that the growth of population is accompanied by an increase in carbon emissions, but the relationship seems more complex, and there may be different growth rates at different population levels.

The relationship between urban and rural market transaction volume and carbon emissions:

The Figure 4 shows the relationship between urban and rural market transaction volume and carbon emissions.

The regression equation $y = 9.7855x + 68344$ and $R^2 = 0.772$ indicate a positive linear relationship, where the R^2 value indicates that the model explains approximately 77.2% of the data changes.

This indicates that with the increase of trading volume in urban and rural markets, carbon emissions are also showing a growing trend.

In summary, these charts demonstrate the impact of energy consumption, population, and urban-rural market transactions on carbon emissions. Both linear and polynomial regression models show a positive correlation trend, indicating that as these economic and social indicators grow, carbon emissions will also increase. These analyses can provide a basis for assessing security risks in the green energy economy and formulating policies and measures to reduce carbon emissions.

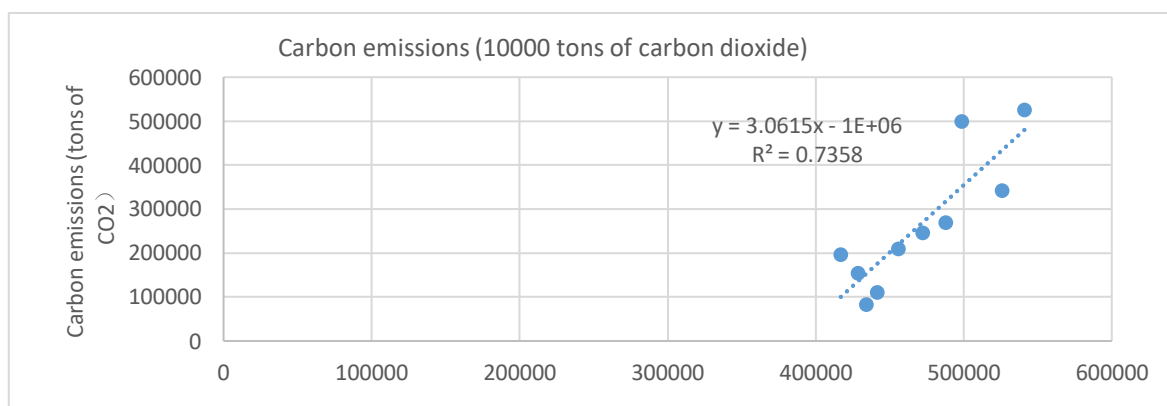


Fig. 2. Total energy consumption (10,000 tons of standard coal)

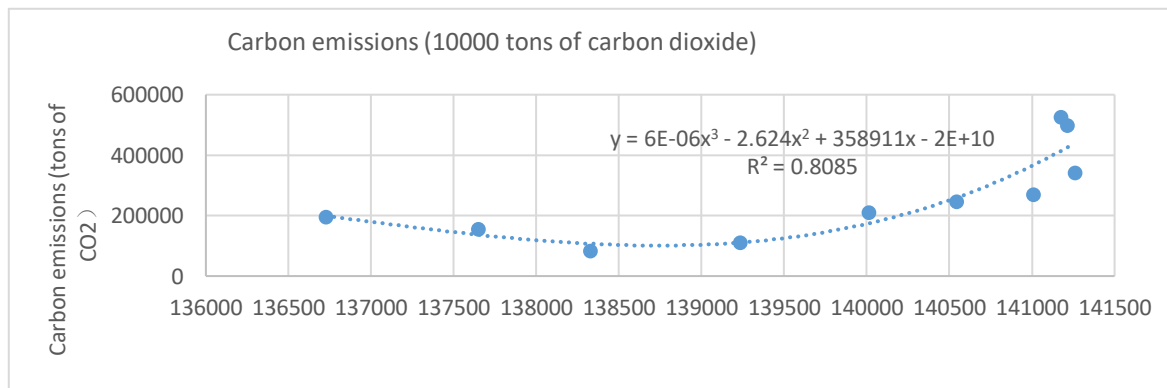


Fig. 3. Total population at the end of the year (10000 people)

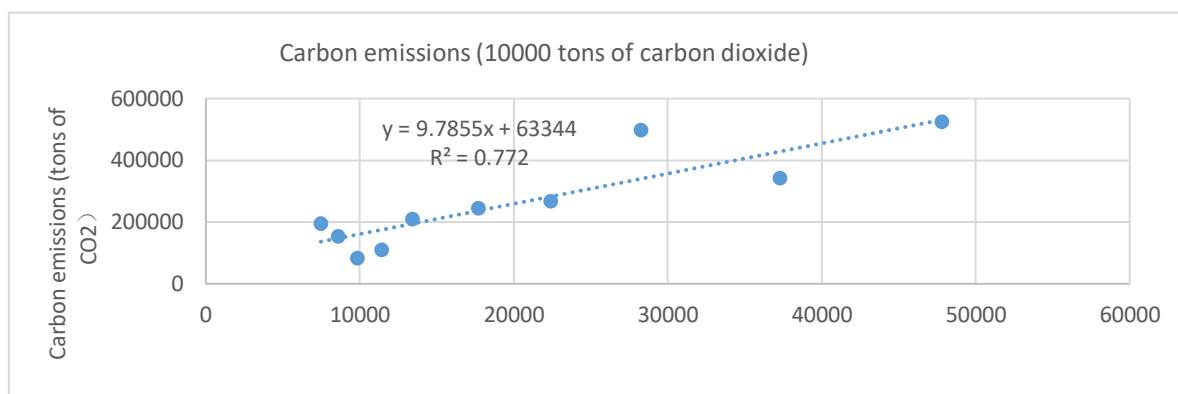


Fig. 4. Technology market transaction volume (100 million yuan)

Take China as an example. In 2021, China's foreign dependence on crude oil will reach 72%, and its natural gas dependence on foreign countries will reach 46%. China's energy security issues are prominent. China's carbon emissions are shown in Figure 5 below.

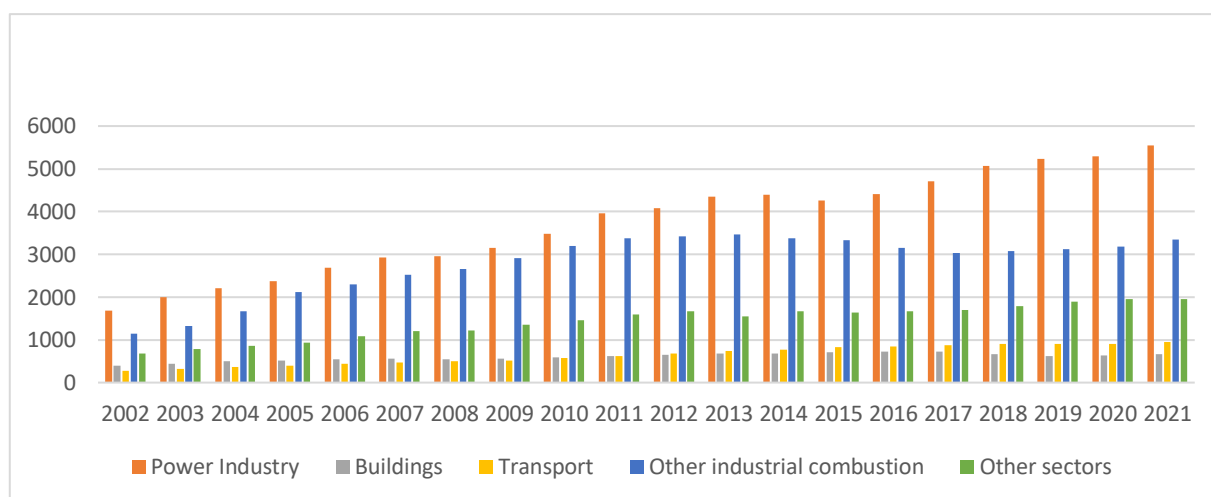


Fig. 5. Fossil carbon dioxide by sector in China

Analyzing the CO₂ emissions in the above figure, it can be concluded that China's energy and mineral endowments are characterized by abundant coal, scarce oil, and limited gas, leading to a high degree of external dependence on energy, especially oil and natural gas. The development of renewable energy is slow, and new energy sources such as solar, wind, and hydropower have not yet been widely applied, resulting in low conversion efficiency and requiring significant investment and technical support. Although the government promotes the development of clean energy, innovation and intelligent management still need to be reformed to improve energy efficiency. With economic development and changes in energy consumption structure, coal remains the main energy source, but the development speed of clean energy is accelerating, gradually occupying market share[9]. China's energy economy faces multiple challenges and opportunities, including the supply and demand situation of traditional energy, the development of clean energy, the relationship between energy efficiency and the environment, energy policies and national strategies, etc. These aspects promote and rely on each other, laying the foundation for the sustainable development of China's energy economy and achieving sustainable development of green economy energy.

2.2 Development issues of energy economy in society

Energy is the lifeline of the national economy and is crucial for the modernization of the country and society. The energy consumption is directly proportional to the gross domestic product, so as a pillar industry, the energy economy is related to national prosperity, people's lives, and social stability.

However, due to national development needs, the energy structure consumption is unreasonable. Although the government controls the use of traditional energy and promotes the development of clean energy, with the rapid growth of population and energy demand, traditional energy remains the main source of consumption and poses security issues. By analyzing Figure 6, it was found that the energy sector is the main source of carbon dioxide emissions, and industrial combustion is the second largest emission sector. Therefore, controlling the use of industrial energy and adopting low-carbon clean energy are the key to reducing carbon dioxide emissions.

Measures need to be taken to address energy issues, including promoting clean energy development, improving energy utilization efficiency, and strengthening industrial energy management. This will help achieve sustainable development and reduce carbon dioxide emissions, promoting the sustainable use of energy in society [10].

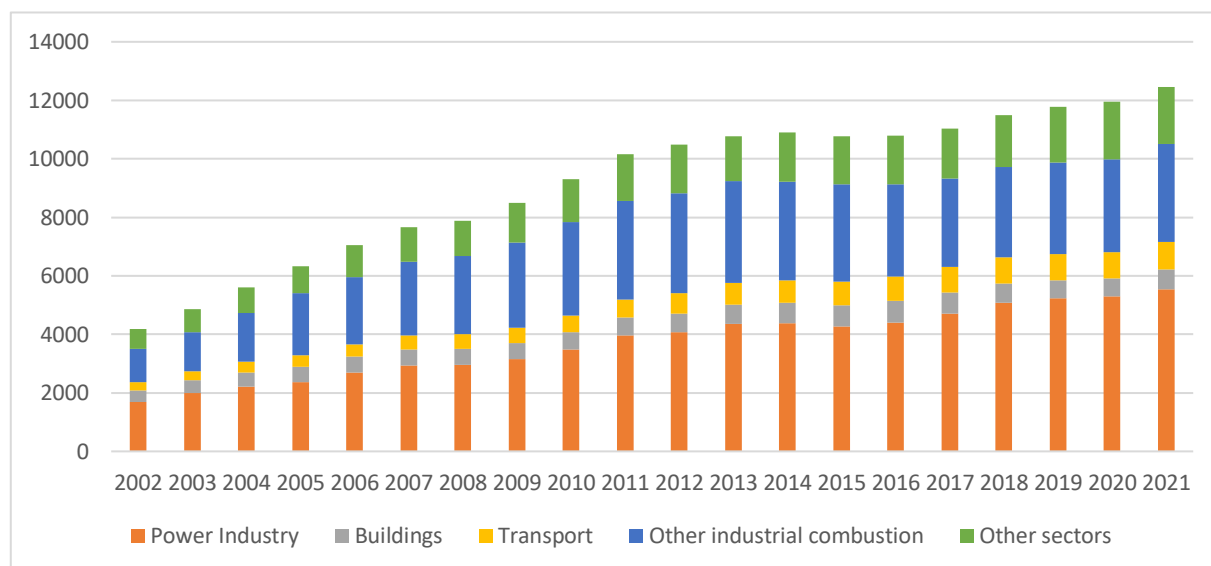


Fig. 6. Accumulation chart percentage of fossil carbon dioxide in various industries in China

Secondly, the way of development and utilization of energy resources is unreasonable. Analysis Figure 6: The way of development and utilization of energy resources in my country is unreasonable and lacks refined management, so it has a serious impact on energy waste and environmental pollution. The reason for this phenomenon is that the laws and regulations in the energy industry are not perfect enough, and there are loopholes and deficiencies in energy management and procurement. Finally, our country has problems such as huge investment and technical difficulties, which force our country's energy transformation to face many problems. Although the world is promoting energy transformation, my country's large population base requires a lot of technological innovation and R&D investment, and technical bottlenecks still exist.

3. Impact of sustainable energy development on national economic security issues

As the global climate change problem becomes increasingly serious, green, low-carbon and sustainable development has become the consensus of countries around the world. In this context, how to ensure the security of the national

economy and achieve green, low-carbon and sustainable development has become an important issue. Low-carbon sustainable development also has issues regarding national economic security that need to be addressed.

3.1 Transformation and security of energy structure

The energy structure is directly related to national energy security and is an important part of national economic security. The energy structure issue is a global issue and is related to global energy issues. Countries have been working hard to find a reasonable energy structure configuration. Different energy structures have different impacts on the country's energy supply, energy consumption and energy reserves. The rationality of the energy structure directly affects the sustainable utilization of resources and the sustainable development of the environment. Green, low-carbon and sustainable development requires the transformation and development of the energy structure to reduce dependence on traditional fossil energy. Therefore, developing new energy and increasing the proportion of renewable energy has become one of the important directions for the transformation of energy structure [11]. However, there are still some safety risks in the development and utilization of new energy, such as technical risks, market risks, etc. How to ensure the safety of new energy development and utilization has become an important issue. In order to build a reasonable energy application system, the following figure studies China's energy structure through the numerical changes in carbon content of major energy sources in the past two decades.

Table1. Fossil Emissions by Category

Year	Non-carbonized fossil emissions	Coal	Oil	Gas	Flaring	Other
2002	7172.77	2641.64	2834.57	1338.93	81.48	58.88
2003	7546.83	2870.76	2914.75	1386.86	81.71	60.15
2004	7815.69	2967.14	3013.78	1434.82	88.37	63.06
2005	8082.59	3150.47	3040.23	1468.52	94.19	65.99
2006	8349.65	3326.65	3069.41	1502.95	94.67	68.95
2007	8599.01	3487.00	3079.60	1554.08	99.34	70.76
2008	8757.05	3600.65	3070.78	1600.52	102.09	70.85
2009	8614.64	3552.52	3001.35	1569.86	103.55	66.48
2010	9105.99	3800.93	3100.40	1690.87	104.16	67.13
2011	9412.39	4022.14	3108.10	1737.69	101.06	75.01
2012	9554.11	4072.81	3150.03	1774.18	103.81	75.41
2013	9639.52	4100.57	3173.16	1785.62	105.77	80.27
2014	9710.03	4107.95	3187.44	1816.20	105.87	83.21
2015	9704.85	4014.76	3255.91	1852.64	104.68	82.63
2016	9695.47	3919.38	3281.61	1903.29	103.27	81.91
2017	9851.73	3959.33	3341.33	1950.03	106.98	82.50
2018	10050.90	4024.79	3347.71	2055.09	112.48	82.55
2019	10120.79	4019.10	3369.45	2087.21	119.88	83.69
2020	9624.48	3868.60	3054.53	2062.31	111.24	80.87
2021	10132.06	4088.32	3230.67	2162.07	113.68	80.83

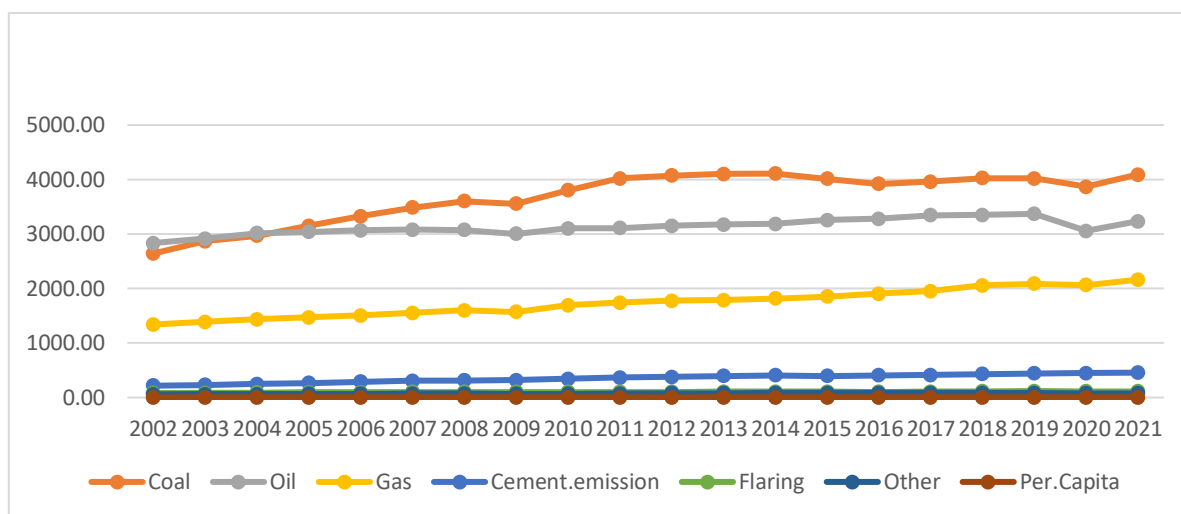


Fig. 7. Global Carbon Project 2022 (Fossil Emissions by Category)

By analyzing Table 1 and Figure 7, we conclude that coal, oil, and natural gas are the main fossil fuels that release carbon dioxide and other carbon containing gases. From the proportion of energy carbon dioxide emissions over the years, it can be seen that since 2005, countries around the world have mainly used coal energy in their economic development. This may be due to the international turmoil in Iraq and the Middle East, which led to a surge in international oil prices in 2004. Therefore, carbon emissions trading is an important means to promote green and low-carbon development [12]. However, there are market and policy risks in China's carbon emissions trading market. How to ensure the stability and safety of the carbon emissions trading market has become an important issue. In addition, green, low-carbon and sustainable development has a profound impact on international trade and competition. Some countries protect their industries by implementing green trade barriers, while others enhance international competitiveness by developing green industries and improving environmental protection levels. Therefore, how China maintains its own interests and ensures national economic security in international trade is an important issue that urgently needs to be addressed.

3.2 Suggestions on the sustainable development of energy for national economic security

Green, low-carbon and sustainable development has an important impact on national economic security. In terms of energy structure transformation, carbon emissions trading market and international trade, scientific and reasonable policies and measures should be adopted to ensure national economic security and green, low-carbon and sustainable development:

Improve the energy policy system, ensure the safety of energy structure transformation, formulate scientific and reasonable energy policies, and encourage the development and utilization of new energy. The government can take a series of measures, such as providing financial subsidies and prioritizing new energy projects, to promote the development of new energy. In addition, the research and development and innovation of new energy technologies should be strengthened to improve the safety and reliability of new energy development and utilization.

Establish and improve the carbon emissions trading market mechanism to ensure the safety and stability of the carbon emissions trading market, establish and improve the carbon emissions trading market mechanism, and promote the reduction of carbon emissions and the improvement of the environment. The government can take a series of measures, such as formulating carbon emissions trading regulations and establishing a carbon emissions trading platform, to promote the healthy development of the carbon emissions trading market. At the same time, the supervision and

management of the carbon emissions trading market should be strengthened to prevent market risks and policy risks. Strengthen international trade cooperation, safeguard the interests and security of the national economy, strengthen international trade cooperation, and jointly respond to global climate change issues. The government can take a series of measures, such as participating in international negotiations and strengthening international cooperation, to safeguard the interests and security of the national economy. At the same time, the development and technological innovation of the domestic environmental protection industry should be strengthened to improve the level of environmental protection and international competitiveness.

4. Conclusion

This study evaluated the green economy and low-carbon energy, and analyzed the causes of related issues. The results indicate that green, low-carbon and sustainable development at the social level can ensure national energy security. By developing renewable and clean energy, the country can reduce its dependence on fossil fuels, reduce the proportion of imported energy, and promote social harmony and stability. In order to achieve low-carbon sustainable development and ensure social and economic security, China should establish a sound carbon emissions trading market mechanism, adjust energy structure and trade prices through market means, optimize resource allocation, improve energy utilization efficiency, and reduce carbon emissions.

At the same time, we will strengthen technological exchange and cooperation with other countries, share clean energy and energy-saving technologies, and promote the optimization and upgrading of energy structure. This will promote the improvement and development of the carbon emissions trading market mechanism, promote the development of industrial chains such as clean energy, energy conservation and environmental protection, improve energy utilization efficiency, reduce energy consumption, reduce environmental pollution, and enhance the competitiveness of the national economy. By addressing the economic security issues of energy economy in low-carbon and sustainable development, ensuring social energy security, achieving sustainable energy development, and increasing the gross domestic product of the national economy

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