

Analysis of China and the World's Energy Security Issues

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Abstract — Energy security is an important part of the national security system. Affected by global geopolitics and the spread of the novel corona virus pneumonia, China's energy security is facing severe challenges. Energy is the most basic driving force for the development and economic growth of the whole world, and it is the basis for human survival. The issue of energy security has arisen since the Industrial Revolution. With the increasing demand for energy in human society, energy security has been gradually getting closely linked with political and economic security. By the middle of the 21st century, or around 2050, oil resources will be exhausted, and prices will rise substantially, according to a common estimate by economists and scientists. If the new energy system is not established at this time, the energy crisis will sweep the world, especially the developed countries that strongly depend on oil resources. How to comprehensively and efficiently utilize domestic energy resources, control and reduce the scale of oil and gas imports, and ensure energy security are still urgent research issues for China's high-quality and sustainable development.

Index Terms: energy security, energy revolution, energy system.

I. INTRODUCTION

Energy security is not only a simple atomic state-to-state relationship, but also a strategic issue concerning national stability, regional coordination, economic structure, and personal development. In today's world, energy has become the currency of political and economic power, a determinant of power hierarchies between nations,

and even a new bargaining chip for success and material progress.

The energy security issues facing the world nowadays are characterized by new features, which are significantly different from those observed during previous oil crises [1]. Current issues of energy security embrace not only the security of energy supply, but also the security of energy demand, energy prices, energy transportation, energy use, and other security risks and threats. Both developed and developing countries regard energy security as the primary goal of their national energy strategies. The per capita energy consumption of developed countries is high, and substantial imports are required to cover the shortage of domestic energy resources. Therefore, in addition to domestic resource factors, energy development strategies pay great attention to the influence of international factors related to the development and utilization of foreign resources, and even give attention to changes in energy demand in other countries, the impact on the international energy market, and the degree of the impact. Developing countries are at a disadvantage in international competition and place more emphasis on establishing their national energy security system.

Studies have shown that stabilizing traditional energy production, ensuring the security of imported oil and gas supply, implementing multi-energy complementarity, increasing the proportion of renewable energy consumption, improving energy technology level, accelerating energy technology innovation cooperation, and improving energy development systems and mechanisms are necessary measures for the energy development in China [3].

As an important part of the national security system, energy security has always been an issue of high concern in the countries of the world. At present, China has become the world's largest primary energy consumer, but it is difficult for the domestic energy production to meet consumer demand. The limited space for increasing domestic fossil energy production is not only the core issue facing China's energy security, but also the main factor leading to a gradual decline in energy self-sufficiency rate.

Affected by resource constraints, some of China's energy products are highly dependent on the imported resources, such as oil, which reached 72.5% in 2019. Against the

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backdrop of increasingly complex global geopolitics and the spread of the novel coronavirus pneumonia, China's energy security has to deal with severe challenges.

At the same time, environmental protection and climate governance have also put forward higher requirements for China's energy industry. At present, although China's economic development has entered a new normal, and the growth of energy resource demand has slowed down, the total demand still remains at a high level. China's total energy consumption is estimated to be about 5.9×10^9 tce (peak). Studies have shown that there is still room for growth in natural gas production, but coal and oil production have reached or are close to their peaks [4]; wind and solar energy resources are abundant, but due to resource storage and development technology costs and other factors, China still needs to take a long-term view and make long-term plans. The balance brings challenges, and it is not enough to undertake the mission of the main energy in the short term. How to ensure energy security while controlling and reducing the scale of oil and gas imports is still a major issue facing China's high-quality and sustainable energy development.

China's domestic academic circles have carried out a lot of research on the concept of energy security, energy security evaluation index system, fundamental issues of energy security, and strategies to ensure energy security and cope with climate change. Based on the macro background of China's economic development entering a new stage, and considering the industry trends of gradually strengthening environmental protection and climate governance, this paper defines the energy security concept of China from multiple perspectives and proposes measures to ensure energy security. The research on the energy development strategy provides theoretical reference.

In order to avoid the above dilemma, many countries actively develop new renewable energy sources such as solar energy, wind energy, and ocean energy (including tidal energy and wave energy). They also focus their attention on new fossil energy sources such as seabed combustible ice (hydrated natural gas). At the same time, fuels such as hydrogen and methanol have also received extensive attention as substitutes for gasoline and diesel.

At present, some renewable energy utilization technologies have made great progress and found wide application in the world. The utilization technologies of biomass energy, solar energy, wind energy, hydroelectric power, and geothermal energy have been applied.

The International Energy Agency (IEA) has conducted a study on international electricity demand from 2000 to 2030, which shows that the average annual growth rate of total power generation from renewable energy will be the fastest. IEA research believes that in the next 30 years, power generation from non-hydro renewable energy will grow faster than power generation from any other fuel, with an annual growth rate of nearly 6%, and its total power generation will increase fivefold between 2000 and 2030.

The proportion of renewable energy in primary energy is generally low. On the one hand, this is related to the importance and policies of different countries. On the other hand, this is associated with the high cost of renewable energy technology, especially the high-tech solar energy, biomass energy, wind energy, and others. According to a forecast study by the IEA, the cost of electricity generation from renewable energy will drop significantly over the next 30 years, but its competitiveness will rise. The cost of renewable energy utilization is related to many factors, which is why the cost forecast has uncertainty. These forecasts however point to a downward trend in the cost of renewable energy technologies.

China is the world's largest energy producer and consumer. The continuous growth of energy supply in the country provides important support for its economic and social development. The rapid growth of China's energy consumption has also created a broad development space for the world energy market. Currently, China has become an indispensable and important part of the world energy market, and is playing an increasingly important and active role in maintaining global energy security.

II. ENERGY STRATEGIES OF DIFFERENT COUNTRIES

With the changes in the development needs over time, the concept of energy security has been continuously enriched and improved. In the 1970s, the fourth Middle East war triggered the oil crisis, and the world's major oil consuming countries established the International Energy Agency (IEA) and put forward the concept of national energy security for the first time. Early energy security research focused on energy supply and energy price stability, and focused on a relatively single energy type and dimension.

Since the 1980s, the energy security concept has gradually developed in various directions such as supply stability, cost-effectiveness, diversity of energy types, and safety of use. The dimensions of environmental security and economic security have been added. In the 21st century, the world's energy security will expand in the direction of broader social, economic, environmental, climate, and consumer security, covering more dimensions such as energy availability, affordability, sustainability, energy governance, and international cooperation. Since different countries have different resource storage, economic, and environmental needs, the priorities and measures of their energy security strategies are also different. Therefore, we should study and define the energy security concept in various countries according to their actual development stage and following the requirements of economic and social development, and environmental capacity.

Let us consider energy security strategies of different countries.

The national energy security strategy formulated by the United States mainly includes energy conservation, improvement of mechanisms, flexible financial support,

and maximum utilization of renewable energy. The core of the recent strategy is to provide energy self-supply and reduce external dependence. For example, in January 2017, the United States issued an “Energy Independence” executive order and the “America First Energy Plan,” which was launched to reduce energy costs and maximize the use of domestic energy resources, especially traditional fossil fuels [2].

Most of Japan’s oil and gas supply relies on imports, and has always attached great importance to cooperation with oil and gas producing countries and use of local oil and gas reserves. The long-term goal of the Japanese energy strategy is to achieve energy transformation and build clean, low-carbon, high-efficiency, and smart new models of systems for energy supply through various channels to ensure sustainable development.

Germany’s energy security strategy is centered on renewable energy and supported by improving energy efficiency. In September 2010, the German Federal Ministry of Economics and Technology released the long-term strategy of the “Energy Plan,” which clearly states that the development of renewable resources is the primary target before 2050, and the corresponding strategic goals are economic feasibility, supply security, and environmental friendliness [3].

At present, the world economy, science and technology, culture, security, and politics are undergoing adjustments, changes in the development environment are also occurring in China. The country has proposed promoting a new development pattern with the domestic cycle as the main body, and the domestic and international dual cycles to promote each other. Energy is the source of power for economic development, and its field development should implement the new energy security strategy of “four revolutions and one cooperation” (i.e., consumption, supply, technology, institutional revolution, and international cooperation). In other words, the concept of China’s energy security can be divided into the following five aspects.

Sustainable Development:

The CO₂ and pollutants emitted from energy production and utilization have caused global warming, climate problems, and air pollution problems. In China, the extensive economic growth in the past brought serious environmental problems and increased social governance costs. In the future, energy security must pay close attention to the environment and sustainable development. On the one hand, China has to undertake the obligation to peak CO₂ emissions by 2030 and achieve carbon neutrality by 2060. On the other hand, the country must ensure that residents enjoy their due rights in energy development and meet the growing needs for a better life. Then, China should focus on the carbon emissions per unit of gross domestic product (GDP), energy consumption, per capita carbon emissions under the carbon emission reduction target, and make policy adjustments and changes based on

these values.

Guaranteed Supply:

Energy supply security suggests improving the availability of energy; establishing a diversified energy source system, diversified energy import channels, and reliable energy transportation methods; and providing a better replacement and coordinated development mechanism between traditional energy and new energy. This can ensure sufficient and continuous energy supply to the greatest extent, reduce the risk of energy supply failures, and ensure the smooth development of economic activities. The major influencing factors of energy supply security include the degree of resource security, energy import channels, and energy strategic emergency reserves.

Technological Support:

Research shows that scientific and technological progress is the fundamental driving force for promoting energy efficiency, improving energy structure, and reducing energy and environmental conflicts. Science and technology security refers to the scientific and technological capabilities required to formulate and implement the national energy security strategy involving energy production, transportation, consumption and other links, including energy conservation, the ability to popularize and apply mature technologies, the research and development of short-circuit technologies, high-end technology reserves and cooperation capabilities, corresponding standard systems, energy information collection and application capabilities, and others.

Affordability:

China needs to consider the coordinated development of the economy and energy. Important indicators to measure China’s energy and economic security include the impact of energy industry and energy prices on the national economy, the impact of energy imports on international trade, and the ratio of per capita energy consumption to income.

Guaranteed System:

Energy system and mechanisms are an important part and institutional guarantee of energy security. In the context of China’s energy revolution and energy transformation, the energy system mainly involves energy diversification management and supervision and incentive mechanism, energy market and price mechanism, reform mechanism, energy-related laws and regulations, management regulations, and global new energy governance system.

III. CHINA’S ENERGY SECURITY SITUATION

A. Sustainable Security

At present, China ranks first in the world in terms of total energy production, total consumption, and coal output. Although energy utilization efficiency has been continuously improved and energy structure has been optimized, there are still great environmental and climate governance pressures. In 2019, the total energy production

in China was 3.97×10^9 tce, of which coal accounted for 69.2%; the total energy consumption was 4.86×10^9 tce, of which coal accounted for 57.7%.

Although China's current energy intensity is relatively high, and the carbon emissions and energy consumption per unit of GDP are much higher than those of developed countries and regions such as the United States, Europe, and Japan, the per capita carbon emissions and energy consumption levels are far lower than those of developed countries, and there is greater room for improvement. Thus, under the circumstance of environmental capacity constraints and the global response to climate change requiring low-carbon energy development, China should make major adjustments to the future energy utilization direction and consumption structure.

B. Supply Security

The distribution of fossil energy resources in China is very uneven: most of the energy resources and production are concentrated in the western region, while energy consumption is concentrated in the economically developed regions along the eastern coast, and is inversely distributed with the resource-bearing areas [5]. The current evaluation of domestic fossil energy resources shows that, while there is room for growth in natural gas production, coal and oil production have both approached or reached their peaks, which is the main reason for the annual decline in self-sufficiency.

Data shows that in 2019, China's dependence on foreign crude oil exceeded 70%, and its dependence on natural gas was close to 45%. Compared to developed countries, China has fewer oil and gas strategic reserves and emergency reserve facilities, and its emergency reserve system is weak. This results in China's weak ability to adjust to fluctuations in the international oil and gas market, which also has a significant impact on the safe and efficient operation of the pipeline network.

C. Technology Security

China's energy industry has accumulated relative advantages in the field of engineering science and technologies, some of which have reached or approached the world's top level, but the overall technological level of the industry is not enough to support the needs of energy structure transformation and upgrading. There is still a gap in some directions between China and developed countries. Therefore, the country has a lot of room for development in the independent research, enhancement of core technologies, and the introduction and absorption of external technologies.

Some of the problems that still exist in the field of engineering science and technology in China are summarized as follows:

1. The technology is not advanced enough in the coal industry, where most of the geophysical technology and equipment, including the manufacturing process,

materials, assembly, sealing, machining accuracy, automation technology, coal quality improvement, and processing of mining equipment, require upgrading;

2. In the oil and gas industry, the accumulation of cutting-edge technologies such as deep water, shale oil and gas, tight oil, and natural gas hydrate ones is insufficient, and the technical level of oil and gas development and large-scale liquefied natural gas (LNG) development under low temperature environment still need to be improved;
3. In the field of electric power, the manufacturing capacity of key components of high-end power equipment is relatively weak, and the technology for application of offshore wind power system, intelligent distributed power supply and micro-grid still needs to be improved.

In the free trade environment, China can solve the above problems through the global industrial division system and industrial chain formed by the exchange of goods and the comparative advantage, but it is relatively easy to be influenced by geopolitics, and China is experiencing unprecedented challenges. In other words, China needs to strengthen the independent research and development of core technologies and products in the energy industry, gradually reduce and eventually get rid of the dependence on imported technologies and products, and effectively enhance the key supporting role of science and technology in the energy industry.

D. Economic Security

The energy industry plays an important role in China's GDP and international trade, and energy imports affect economic security. In recent years, China's energy has included mature categories such as coal, oil, natural gas, electricity, and renewable energy, and has built a relatively complete energy supply system.

For a long time, energy trade has had a great impact on China's international trade. Since China is a net energy importer, and energy trade is mainly related to oil and natural gas imports, based on the historical total trade data published by the General Administration of Customs, an autoregressive model is used to predict China's long-term net exports of goods, and based on the international long-term forecast of China's energy trade according to 2018 World Energy Outlook released by the IEA, it can be found that China's energy imports offset the surplus in trade in goods [3].

Compared to developed countries such as the United States, the United Kingdom, Germany, and Japan, China's current per capita GDP is still relatively low, and comprehensive energy prices are also relatively low. In the future, with the development of China's economy and the continuous improvement in per capita GDP, the domestic affordability of comprehensive energy prices will also exhibit an upward trend. In addition, due to China's high dependence on foreign oil and gas, "black swan"

and “grey rhino” events such as the normalization of the new coronavirus pneumonia epidemic also have a certain impact on energy security.

IV. KEY MEASURES OF CHINA’S ENERGY SECURITY STRATEGY

A. Stabilizing the traditional energy production

Although China is rich in coal resources, it is still necessary to scientifically plan production capacity, increase the proportion of production capacity of large mines, and meet the basic needs of domestic demand for coal. At the same time, it is also necessary to maintain the basic stability of coal import volume and import sources, and focus on meeting the coal consumption needs of the southeast coastal areas.

In terms of oil, China needs to intensify the exploration and development of marine and unconventional oil, improve the recovery rate, and slow down the rate of decline in the production capacity of old oil fields. It is also necessary to strengthen the technical reserve and transformation of shale oil development, and build production capacity as soon as possible. Internationally, China needs to deepen international cooperation to make up for the operating pressure of domestic inefficient production capacity on oil and gas companies.

Driven by the dual driving effects of air pollution prevention and low-carbon and clean energy transformation, China’s natural gas consumption will continue to grow. China should attach equal importance to conventional gas and unconventional gas; implement technical research and technical transformation in tight gas, shale gas, natural gas hydrate, and others; and maintain stable growth of domestic natural gas production.

B. Enhancing the level of energy technology

To ensure the security of energy supply, the key is to rely on scientific and technological progress. China should strengthen the research and development of cutting-edge energy technologies, promote the development and application of advanced and applicable energy technologies, and improve the development capabilities of major energy technologies and equipment. China should accelerate the development of new and clean energy such as solar energy, wind energy, and biomass energy through scientific research and innovation; increase the research and development of future new energy sources such as ocean energy and nuclear fusion energy; and establish a new energy structure for China’s sustainable development.

The most important point is that China must find a path that suits its development and continue to increase the promotion and application of mature technologies such as industrial energy conservation and building energy conservation; strengthen the research and development of new energy-saving technologies for energy production and utilization; and improve energy utilization efficiency.

C. Improving the energy development system

Promoting China’s energy market-oriented reform and increasing the degree of openness of the energy market, promoting energy price reform, further improving the construction of a market mechanism conducive to the development of new energy, and improving a long-term stable system to provide the advancement of renewable energy are the tasks China should do now.

Many developed countries such as Europe and the United States have formulated relevant laws and regulations on energy supply and storage in order to ensure the safety of energy economic operation. There are still many deficiencies in China’s current energy legislation. In order to cope with the increasingly severe international energy security situation, it should actively learn from foreign energy legislation experience.

D. Strengthening international cooperation

The current international environment is relatively complex. China must correctly study the impact of geopolitical conflicts on global energy security and avoid risks to ensure the national energy security.

In terms of scientific and technological innovation cooperation, it is necessary to rationally increase investment, strengthen the integration of the energy industry with advanced information technologies such as artificial intelligence and big data, optimize energy development and utilization methods, and promote the transformation of traditional “advantageous production capacity” to “new production capacity” of scientific and technological innovation.

China should actively participate in the international energy market price system and increase the right to speak in pricing. With the further expansion of demand for oil in China, being a major global oil consumer, and the improvement in its participation in the international market, China’s position in the international oil pricing power still has a lot of room for improvement.

V. CONCLUSION

In terms of energy security factor, there are significant differences in the sustainability indicators of energy development across provinces. The indicators of resource-based provinces in China are significantly higher than those of other regions such as Inner Mongolia, Shanxi, Shaanxi, and Xinjiang. These provinces are rich in energy reserves, stand out in energy production capacity, account for a large proportion of their energy, have a high degree of energy security, and are less affected by the energy situation in other regions. However, most provinces in China lack energy resources and have to rely on energy supply from other regions to meet their demand. This dependence makes these provinces potentially risky in terms of energy, therefore, their energy development has low sustainability indicators in terms of security factors.

From the perspective of social factors, Chinese

provinces have a relatively good level of sustainable energy development. There are no major differences among regions. The country is in a period of rapid social development, and social construction has achieved phased results. The implementation of national policies in all regions is generally consistent and certain results have been achieved.

In terms of ecological factors, the sustainable development index has a good national average value, but there are significant differences among regions. Inner Mongolia, Ningxia, Shanxi, Shaanxi, Xinjiang and other resource-based provinces have very low ecological indices. The ecological issue of resource-based provinces has become a problem that cannot be ignored. In China, the use of clean energy is relatively small, and the main energy source is coal, which causes high CO₂ emissions. This makes ecological issues crucial for China's energy sector.

Chinese provinces are already well placed in terms of the social aspects of energy sustainability. On the premise of ensuring a stable energy supply across the country, the production and emission of carbon dioxide will be strictly controlled.

The following recommendations can be made based on these investigations:

1. Adjust the industrial structure and promote the optimization and upgrading of the industrial structure. When the government and energy production departments formulate energy consumption and production plans, they must follow the laws of the market and fully consider the impact of changes in industrial structure on energy consumption.
2. Increase investment in science and technology to improve energy utilization. Adhere to the policy of prioritizing energy conservation, strive to reduce energy consumption and improve energy utilization efficiency.
3. Optimize the energy consumption structure and increase the development and utilization of new energy. At the same time, it is necessary to increase capital and technical investment in new energy, especially clean and renewable energy.
4. Strengthen the government's macro-control. The government must not only invest in energy-saving and new energy technologies, but also strengthen administrative legislation.

In the context of global response to climate change, low-carbon economy has become the general trend of world economic development. Clean utilization of traditional fossil energy and increase in the proportion of non-fossil energy in a country's energy consumption structure have become an inevitable choice. As a growing developing country, China needs not only to ensure a stable energy supply at a reasonable price to support rapid economic development, but also to reduce energy consumption and carbon emissions related to economic development, and increase the proportion of clean energy use to combat

climate change.

In terms of economic security and energy development, energy security under low carbon economy requires the country to improve its energy structure (increase the proportion of renewable energy, use coal cleanly, and vigorously develop unconventional natural gas), promote energy conservation and emission reduction. Briefly, the arrival of the low-carbon era actually brings about a new context for the national energy strategy and energy security. China will face pressure from traditional energy security and challenges from non-traditional energy security, and it is unlikely that all energy security goals will be achieved at the same time.

REFERENCES

- [1] H. Meng, Y. Chen, "Energy and CO₂ Emissions Status, the Counter measures to Slow Down Climate Change in the United Kingdom and Their Enlightenment to China," *Chinese Soft Science*, pp. 25–35, 2010.
- [2] N. Wang, "Main measures and enlightenment of developing renewable energy in Denmark," *Economic Review Journal*, pp. 111–120, 2019.
- [3] C. Wang, L. Wang, S. Dai S, "An indicator approach to industrial sustainability assessment: the case of China's capital economic circle," *Journal of Clean Production*, vol. 3, no. 194, pp. 473–482, 2018.
- [4] Y. L. Yu, D. Q. Zhao, Y. Chen, "On a sustainability indicator system for regional energy development," *China Opening Journal*, vol. 3, pp. 63–66, 2011.
- [5] W. B. Jiang, H. Q. Chai, T. W. Feng, J. L. Wang, "A research on evaluation of the decision-making efficiency for governance and optimization of regional ecological economy," *Science Research Management*, vol. 10, no. 39, pp. 40-49, 2018.
- [6] <https://data.worldbank.org/>. Accessed on Apr. 29, 2022.
- [7] <https://www.iea.org/>. Accessed on May 03, 2022.



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