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Institute of Economics and
Administration
Field of study
Master's degree programme

Department of Sociology, Economic
Theory and International Processes
38.04.01 Economics
International Economics and Business

GRADUATION THESIS

on

Impact of oil and gas trade on China's energy security

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Institute of Economics and Administration
Department of Sociology, Economic Theory and International Processes
Field of study 38.04.01 Economics,
Master's degree programme International Economics and Business

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ASSIGNMENT
FOR THE GRADUATION THESIS OF

Master's degree student Song Yiping, group 23ЭЭВам1, full-time mode of study

1 The topic of the graduation thesis: "Impact of oil and gas trade on China's energy security"

was approved by the university order

dated «____» _____ 20____ no. _____

2 The deadline for the Master's degree student to complete the graduation thesis is 11.06.2025.

3 The input data for the graduation thesis is the regulatory and legal framework, scientific literature and reference books, and Internet data.

4 The list of issues to be studied includes current situation of energy development in China, driving force of energy diversification, international oil and gas trade status, development trend of the international energy, the influence of network stability on energy security.

5 The list of visuals contains tables and figures.

6 The date of setting the assignment is 7.09.2023.

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The assignment was accepted by Master's degree student _____ / Song Yiping /
(signature) (full name)

Schedule for completing the graduation thesis

№ п/п	Content of the thesis	Deadline for completion	Due date, signature of the academic adviser
First year of study			
1	Substantiating of the research topic and methodology, subject and object of research	1.09.2023 – 31.10.2023	
2	Framing the scientific concept of research	1.11.2023 – 18.12.2023	
3	Collection of scientific literature for the thesis	19.12.2023 – 15.01.2024	
4	Substantiating the relevance, concept, and novelty of the research	16.01.2024 – 19.02.2024	
5	Framing of a detailed plan and layout of the research	20.02.2024 – 12.03.2024	
6	Studying new literature sources within the topic of the thesis	13.03.2024 – 26.03.2024	
7	Conducting theoretical research within the first chapter of the thesis	27.03.2024 – 30.04.2024	
8	Preparing the first chapter of the thesis	1.05.2024 – 30.06.2024	
Second year of study			
9	Conducting analytical research within the second chapter of the thesis	1.09.2024 – 22.10.2024	
10	Preparing the second chapter of the thesis	23.10.2024 – 24.12.2024	
11	Conducting analytical research within the third chapter of the thesis	25.12.2024 – 25.02.2025	
12	Preparing the third chapter of the thesis	26.02.2025 – 21.04.2025	
13	Preparing the introduction and conclusion	22.04.2025 – 12.05.2025	
14	Completing the graduation thesis	13.05.2025 – 26.05.2025	
15	Handing in the thesis for compliance control and antiplagiat	27.05.2025 – 9.06.2025	
16	Getting acquainted with the feedback and review	10.06.2025	
17	Presenting the written thesis	11.06.2025	

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The assignment was accepted by Master's degree student _____ / Song Yiping /
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Summary

The graduation thesis comprises 71 pages, 3 chapters, 17 figures, 2 tables, 61 sources.

ENERGY COOPERATION, ENERGY RESOURCES, CHINA, ENERGY TRADE, ENERGY SECURITY

The object of this research is energy markets. The subject of this thesis is impact of China oil and gas international trade on its energy security.

The research purpose is to analyze the current state of China's international energy trade and its impact on energy security.

The methodological framework of the paper is formed by system approach, analysis and synthesis, statistical and comparative methods. To display identified economic dependencies graphical method was applied.

The results of research include: current situation of energy development in China was studied, driving force of energy diversification was introduced, international oil and gas trade status was examined, development trend of the international energy was determined, the influence of network stability on energy security was analyzed.

The novelty of the work is trends and prospects for the development of energy trade cooperation of China and strategies to strengthen China's relationship with energy trading partners are revealed.

The theoretical and practical significance of the research is that the conclusions made in the thesis form the basis for further research of energy cooperation of China. The results of the research can be used in the teaching of educational disciplines World Economy, International Economic Relations, International Trade.

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Introduction

Energy is an important material basis for the survival and development of human society. Throughout the history of human social development, every major progress of human civilization has been accompanied by the improvement and replacement of energy. The development and utilization of energy have greatly promoted the development of the world economy and human society. The concept of national energy security encompasses the following two meanings: First, economic security, which refers to maintaining a mutually balanced state between energy supply and demand, and meeting the normal needs of the country's survival and development under the premise of ensuring a stable energy supply. The second is the safety of energy use, that is, the consumption and use of energy should not pose any threat to the survival and development environment of human beings themselves. Energy security is an important support for national security, a comprehensive and strategic issue related to the country's economic development, and the foundation for security in other fields. It is of vital importance to the country's prosperity and development, the improvement of people's lives, and the long-term stability and security of life.

As emerging markets and developing countries lead the growth of global energy demand, the international energy trade pattern is changing rapidly. With the development of fossil fuel extraction technologies such as shale oil and natural gas hydrates, the international fossil energy trading center shows a trend of movement and increase. The trade lines have become more complicated. International energy trade is influenced by more non-economic factors. Against the backdrop of the reduction in fossil energy

reserves, the expansion of consumption, the escalation of geopolitical conflicts, and the weighted effects of global climate change, there will be more uncertainties regarding the aim of building a safer and more sustainable energy system. These continuous and profound changes will affect the geopolitical situation of energy and bring more challenges to the world's energy security cooperation order.

In recent years, with the advancement of China's industrialization process, energy consumption and the degree of dependence on foreign oil and natural gas have been continuously increasing. China is the country that imports the most energy and has a high degree of dependence on foreign energy in the world. To a large extent, it is affected by changes in the international energy market on energy security. Energy, as the most important bridge connecting the friendship between China and Russia, especially now that I am studying in Russia, a major energy country, I have developed more intimate feelings when researching energy issues. Moreover, the issue of energy security is a very interesting topic. It not only enables us to understand the current status and development level of China's energy, but also allows us to further understand the current situation of world energy development. This master thesis analyzes the connotation and extension of energy security, the content of maintaining energy security, the characteristics of the energy security situation under the background of economic globalization, the relationship among energy security, economic security and national security, as well as how to study energy security in the context of the integration of the world economy.

The object of this research is energy markets. The subject of this thesis is impact of China oil and gas international trade on its energy security.

The research purpose is to analyze the current state of China's international energy

trade and its impact on energy security.

In order to achieve the goal it is necessary to complete the following tasks:

- to introduce the importance of energy trade to China's economy;
- to examine primary energy production in China and describe the energy demand structure of China;
- to overview the current state of China's energy trade;
- to study the influence of network stability on energy security;
- to discuss the prospects and countermeasures for the transformation of domestic energy consumption structure in the future and analyze the strategies to strengthen China's relationship with energy trading partners.

The novelty of the work is trends and prospects for the development of energy trade cooperation of China and strategies to strengthen China's relationship with energy trading partners are revealed.

The theoretical and practical significance of the research is that the conclusions made in the thesis form the basis for further research of energy cooperation of China. The results of the research can be used in the teaching of educational disciplines World Economy, International Economic Relations, International Trade.

The work structure is determined by the purpose and tasks decided in the work. Chapter 1 introduces the basic knowledge of energy and analyzes the current development status of energy security in China. Chapter 2 analyzes the changes that have occurred in the current international energy market from a global perspective. Chapter 3 starts with the energy trading network, draws conclusions and puts forward policy suggestions. After systematic analysis, this paper holds that the number of countries participating in

international oil and gas trade has increased. Energy suppliers and demanders have become more diverse. The efficiency of international oil and gas trade has improved. China has closer ties with other countries in the international oil and natural resources network and has developed some new trade relations. The imports of both oil and natural gas have shown a huge and significant trend of diversification. China is one of the major energy importers and re-exporters. The growth of energy demand has prompted China to maintain the stability of the international oil and gas trade network. It is highly necessary for China to explore and exploit domestic oil and gas resources and expand emergency reserves. It is necessary to promote the diversification of sources, means and transportation routes. China should not only strengthen cooperation with its trading partners in the field of oil and gas, but also deepen economic exchanges in other fields. Expand RMB settlement in international oil and gas trade, prevent the uncertainty of the US dollar settlement system being affected by international relations, and enhance China's initiative and priority.

Chapter 1 Current situation of energy security in China

1.1 Current situation of energy development in China

As the world's largest energy consumer, China has long been dominated by traditional energy sources, mainly coal, oil and natural gas. Traditional energy sources mainly include coal, oil and natural gas. China is rich in coal resources, ranking third in the world in reserves, and the remaining proved recoverable reserves account for about 13 % of the world. Coal occupies a dominant position in China's energy structure, and the traditional energy represented by coal will still occupy a dominant position in the next 10–15 years [5, p. 143–145]. Despite the rapid development of renewable energy, traditional energy is still the core support for economic development. Coal has long been the ballast stone of China's energy, accounting for about 56 % of primary energy consumption in 2022, mainly for power generation and industry. The following table 1.1 shows the total production of major energy varieties from 2014 to 2023.

Table 1.1 – The total production volume of major energy varieties from 2014 to 2023

Year	Raw coal output (billion tons)	Crude oil production (million tons)	Natural gas production (billion cubic meters)	Power generation (billion kWh)
2014	38.74	21142.90	1301.57	57944.57
2015	37.47	21455.58	1346.10	58145.73
2016	34.11	19968.52	1368.65	61331.60
2017	36.98	19150.61	1480.35	66044.47
2018	36.98	18932.42	1601.59	71661.33
2019	38.46	19162.83	1753.62	75034.28
2020	39.02	19476.86	1924.95	77790.60
2021	41.26	19888.11	2075.84	85342.48
2022	45.59	20472.24	2201.10	88487.12
2023	47.10	20902.60	2324.30	94564.40

By the end of 2024, China's raw coal production reached a record high. Advanced coal production capacity was released in a steady and orderly manner, and coal played a full role in ensuring the bottom line. The output of industrial raw coal above designated size reached a record high of 4.76 billion tons, an increase of 1.3 percent over 2023. The following shows the national raw coal output and growth rate from 2014 to 2023 (figure 1.1).

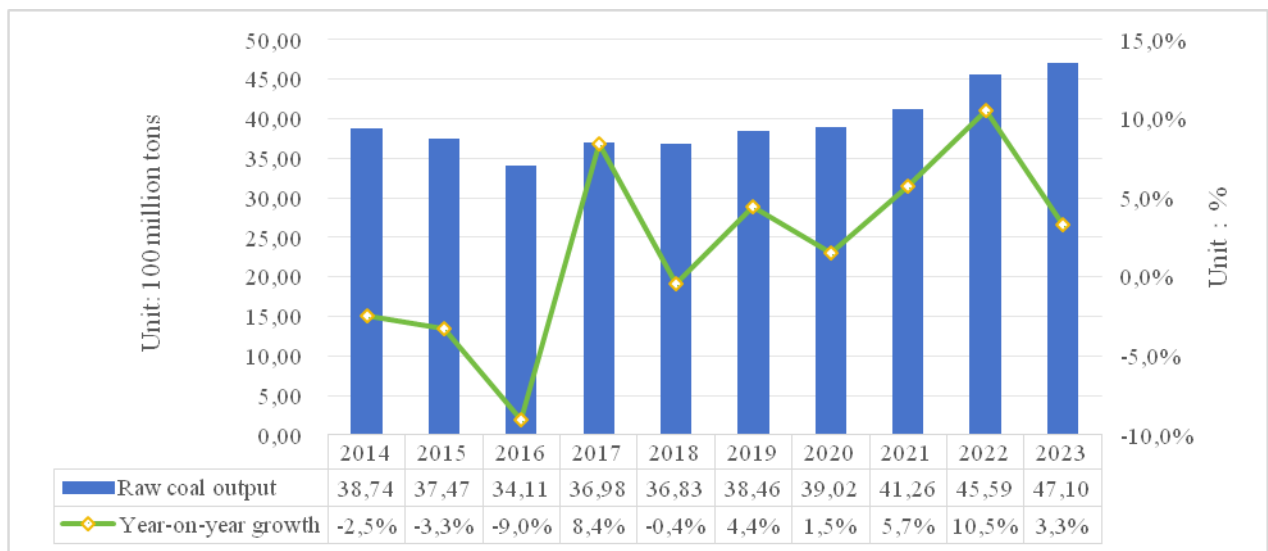


Figure 1.1 – National raw coal output and growth rate from 2014 to 2023 [20]

Further progress was made in increasing oil and gas storage and production. The steady increase of oil and gas production is good, and the level of independent supply is steadily increasing. In 2024, the output of industrial crude oil above designated size will reach 210 million tons, an increase of 1.8 percent over 2023, and the output of crude oil will be more than 200 million tons for three consecutive years. The following picture shows the crude oil production and growth from 2014 to 2023 (figure 1.2) and it shows the crude oil import volume and growth situation from 2014 to 2023 (figure 1.3).

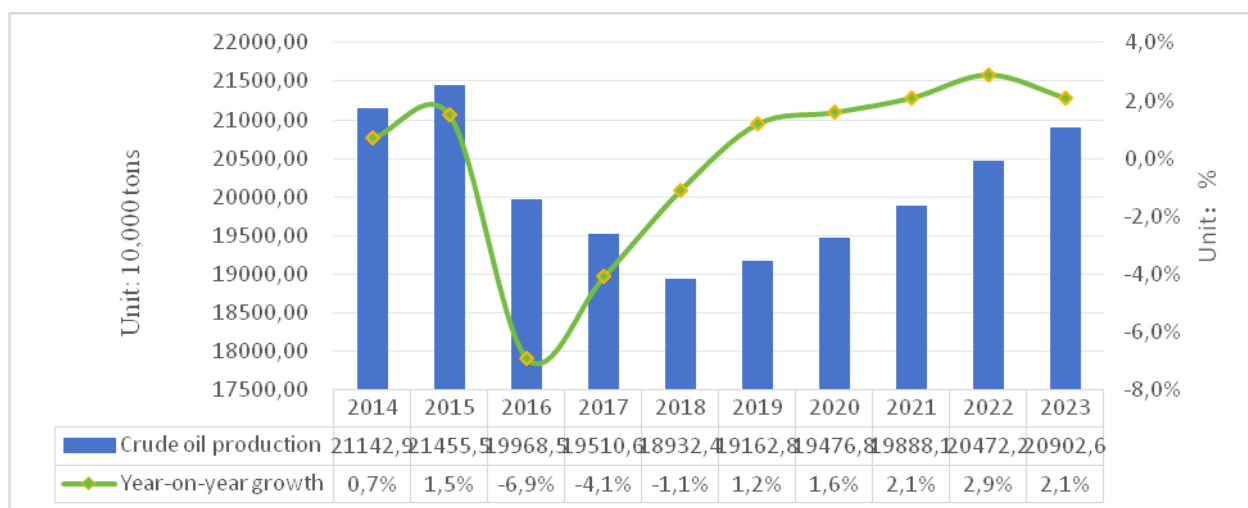


Figure 1.2 – Crude oil production and growth situation from 2014 to 2023 [20]

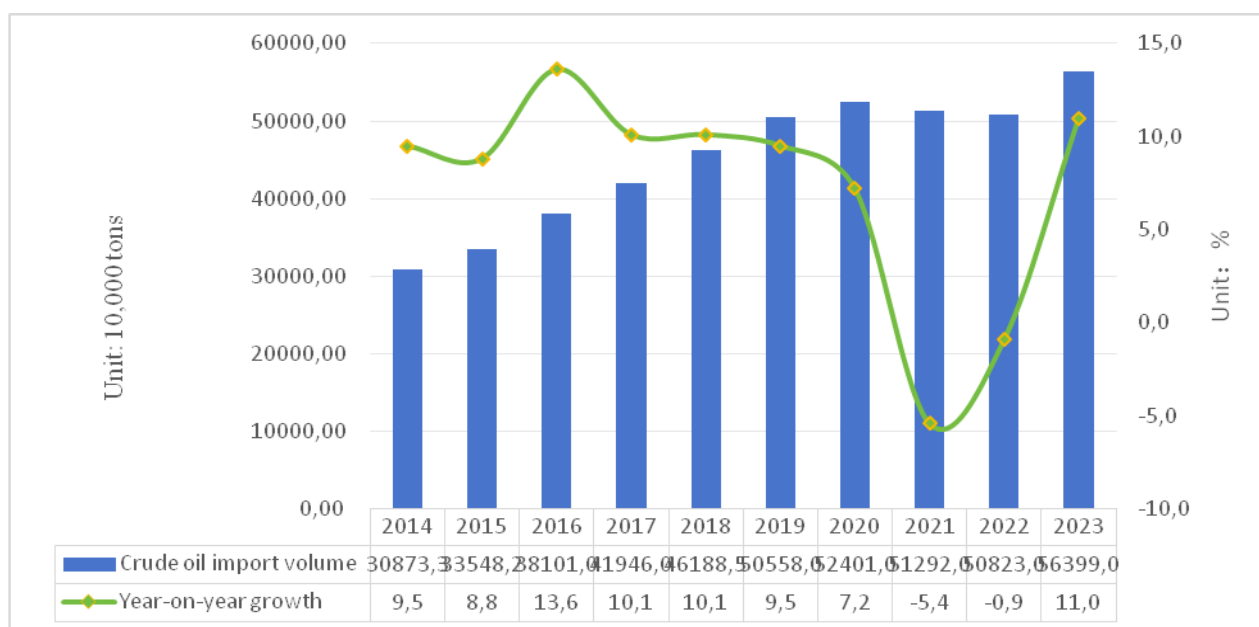


Figure 1.3 – Crude oil import volume and growth situation from 2014 to 2023 [20]

Industrial natural gas output above designated size was 246.4 billion cubic meters, an increase of 6.2 % over 2023, and an increase of more than 10 billion cubic meters for eight consecutive years. The following picture shows the natural gas production and growth from 2014 to 2023 (figure 1.4), and natural gas import volume and growth from 2014 to 2023 (figure 1.5).

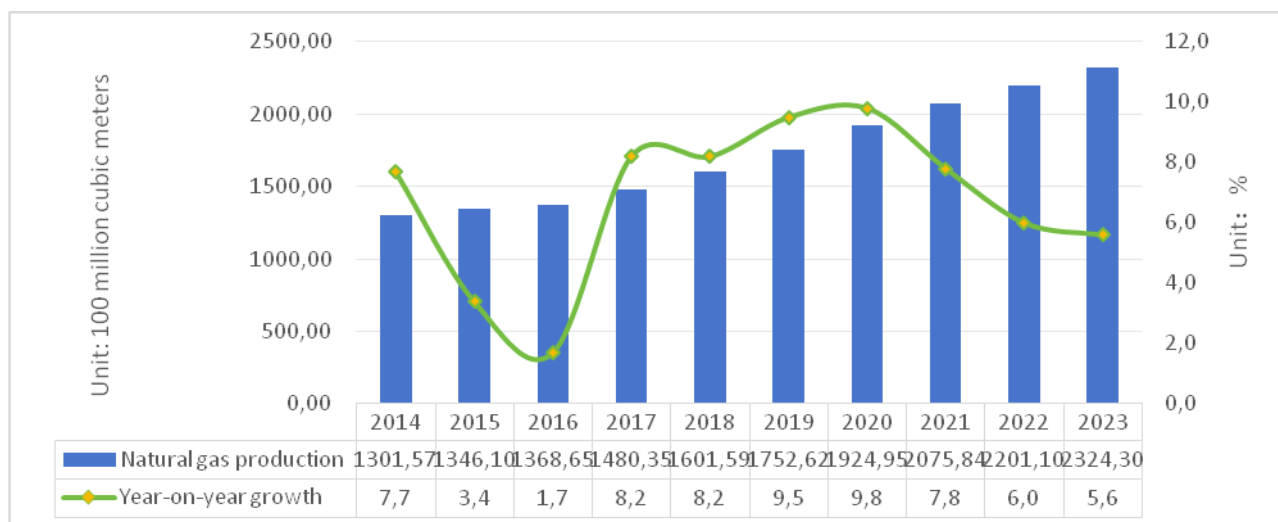


Figure 1.4 – Natural gas production and growth from 2014 to 2023 [20]

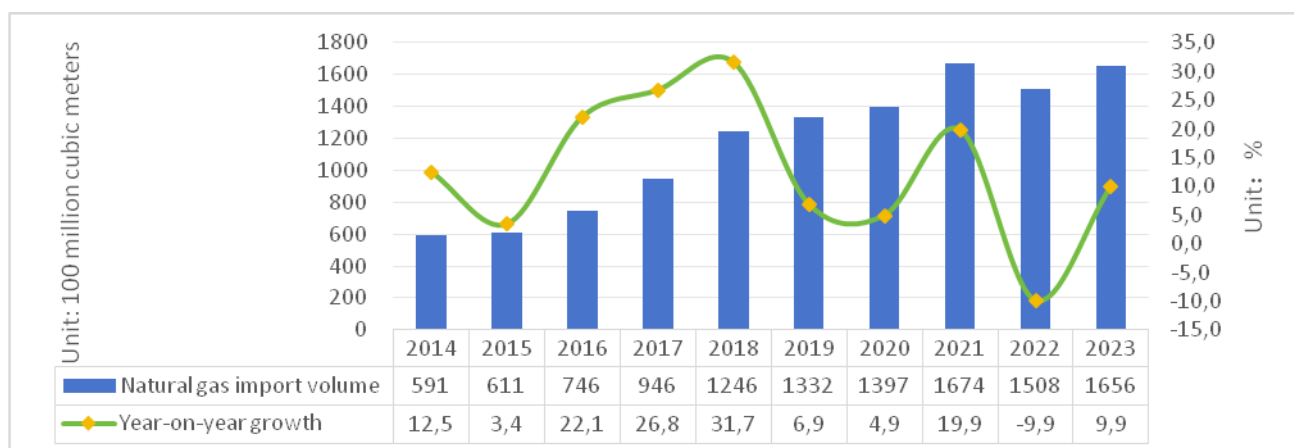


Figure 1.5 – Natural gas import volume and growth from 2014 to 2023 [20]

China witnesses rapid development of renewable energy now.

Hydropower: the world's first installed capacity (more than 400 million kilowatts in 2023), concentrated in the Yangtze River, Yellow River basin (such as the Three Gorges, Baihetan hydropower station). Wind power and photovoltaic: new installed capacity has been leading the world for many years. In 2023, the total installed capacity of scenery exceeded 1 billion kilowatts, and the power generation accounted for more than 15 %. China's installed renewable energy capacity reached 1.73 billion kilowatts, an increase of 25 percent year-on-year, accounting for about 54.7 percent of China's total installed

capacity [17, p. 127–128]. Among them, the installed capacity of wind power is 480 million kilowatts, and the installed capacity of solar power is 770 million kilowatts, and the total installed capacity of wind power photovoltaic power generation exceeds that of coal power, and the target of reaching 1.2 billion kilowatts of total installed capacity of wind power and solar power in China by 2030 promised by China at the Climate Ambition Conference is completed more than six years ahead of schedule. Data show that by the end of 2024, China's total installed power generation capacity is about 3.32 billion kW, generating 10 trillion KWH, an increase of 5.7 % [3, p. 29–31]. The construction of a new power system has been accelerated, with more than 60 million kilowatts of new energy storage being built. Innovations in new energy storage technologies continue to emerge, and the capacity for scheduling and operation continues to be enhanced. More than 12 million charging infrastructure units have been built, and more than 95 % of highway service areas have charging capacity. Figure 1.6 shows the power generation structure of non-fossil energy.

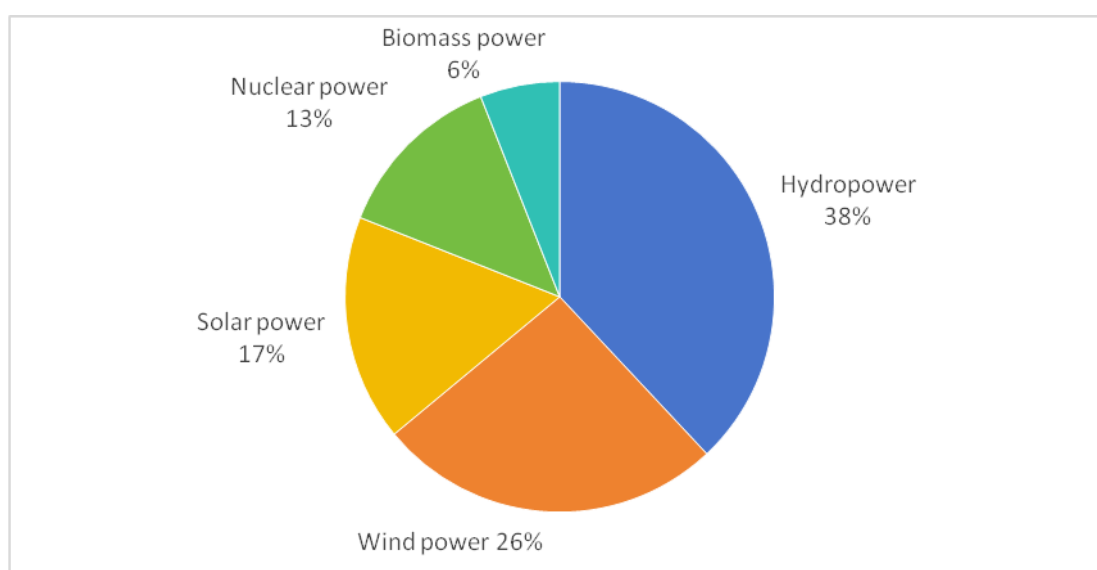


Figure 1.6 – The power generation structure of non-fossil energy [20]

Nuclear power: the largest number of units under construction in the world (such as Hualong One), in 2024, China has approved a total of 5 nuclear power projects, a total of 11 nuclear power units, the country is in operation and approved nuclear power units under construction, the installed capacity of 113 million kilowatts, the scale rose to the world's first. Figure 1.7 shows the installed power structure of China from 2013 to 2024.

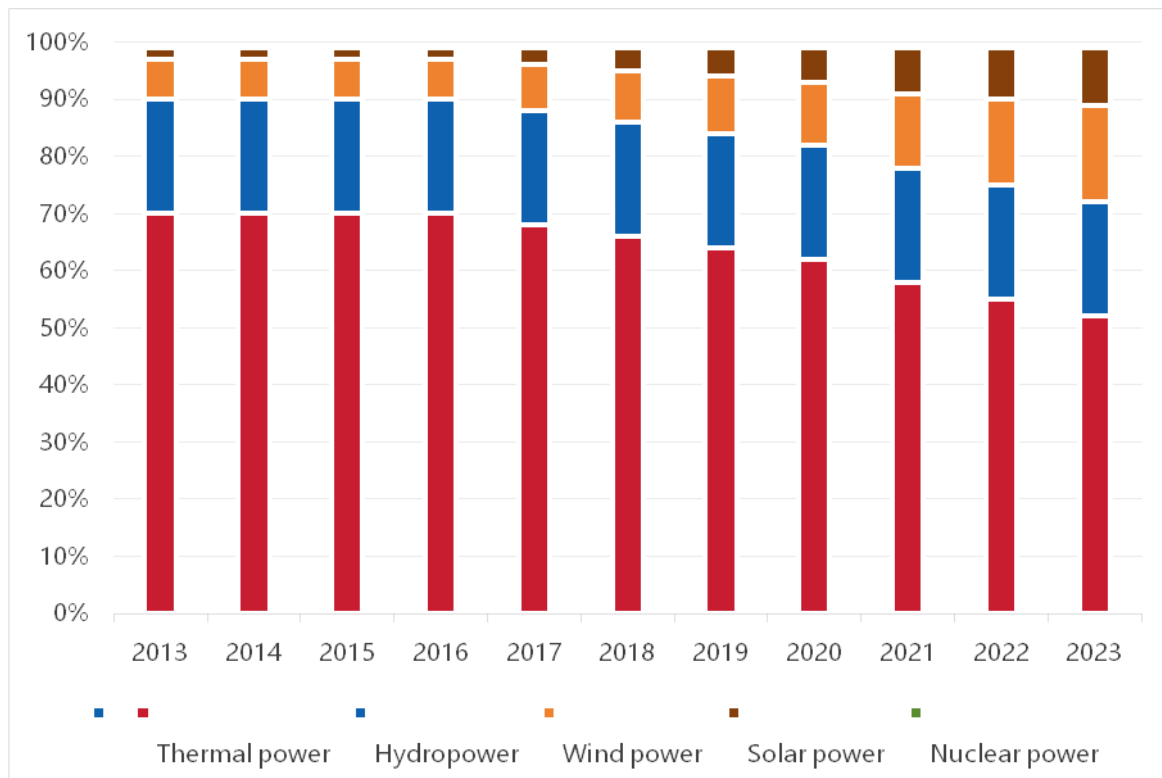


Figure 1.7 – China's power installed capacity structure from 2013 to 2024 [20]

In the context of the global energy transition, the rapid development of China's new energy industry has not only led the trend of sustainable economic development, but also become an important pillar in combating climate change [1, p. 55].

In the field of new energy, the photovoltaic industry has been attracting attention. In recent years, with the continuous progress of technology and policy support, China's

photovoltaic industry has made remarkable development achievements. From large-scale photovoltaic power plants to distributed photovoltaic systems, to innovative applications such as photovoltaic building integration, China's position in the global photovoltaic market is increasingly secure. In the future, with the continued strong demand for clean energy, the photovoltaic industry is expected to usher in a broader space for future development [12, p. 35–36].

As of October 2024, China's installed photovoltaic power generation has reached a staggering 480GW, with a year-on-year growth rate of up to 30 %. The new installed capacity is mainly concentrated in large centralized photovoltaic power plants and distributed photovoltaic power generation systems, of which the development of distributed photovoltaic is particularly eye-catching. In Shandong, Hebei and other places, many industrial and commercial enterprises have installed photovoltaic power generation systems on the roof of the factory, not only actively responded to the call for energy conservation and emission reduction, but also through the grid to sell excess electricity to obtain additional income [8, p. 145–147]. At the same time, household photovoltaic has also been widely promoted in rural areas. Taking a county in Anhui province as an example, the government and enterprises have worked together to provide preferential policies and technical support for farmers, and have successfully promoted the installation of household photovoltaic systems for more than 5,000 households, with an annual increase of 3,000 yuan per household. The following chart shows the new installed capacity of different energy sources from 2013 to 2024 (figure 1.8).

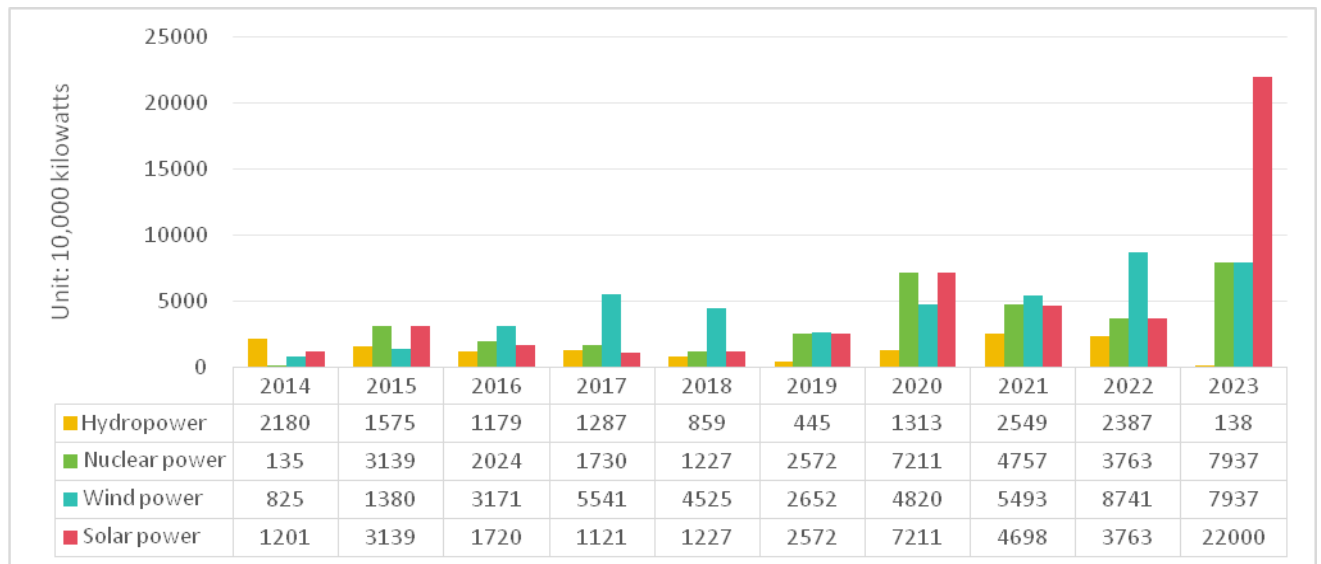


Figure 1.8 – The new installed capacity of different energy sources from 2013 to 2024 [20]

High efficiency crystalline silicon battery technology continues to develop, the conversion efficiency of P-type batteries has approached the 23 % mark, and N-type battery technologies such as TOPCon and HJT have also matured and begun mass production. At the same time, cutting-edge technologies such as perovskite batteries have also made significant progress, and the laboratory conversion efficiency has exceeded 25 %. Longi Green Energy and other leading enterprises continue to refresh the world record for the conversion efficiency of high-efficiency single crystal cells, which has effectively promoted the technological innovation of the photovoltaic industry and laid a solid foundation for the further and future reduction of the cost of photovoltaic power generation [15, p. 22–23].

The field of energy storage technology is diverse, lithium-ion battery technology currently occupies a leading position, but pumped storage, compressed air energy storage and flywheel energy storage technologies are also continuing to improve. At the same

time, new technologies such as sodium-ion battery energy storage and solid-state battery energy storage are in an important stage of research and development and demonstration [11, p. 17–18].

In the field of hydrogen production, renewable energy electrolytic water hydrogen production technology is increasingly perfect, and its cost has been reduced by about 40 %. At the same time, hydrogen fuel cell technology has also made major breakthroughs, the pile power density has been increased to more than 4kW/L, the durability has been significantly enhanced, more than 10,000 hours, and the localization process of key materials is accelerating. It is particularly worth mentioning that Yihuatong has made important progress in the research and development of hydrogen fuel cell engines, and its self-developed engines have been successfully applied to a number of fuel cell vehicles, which has strongly promoted the development of China's hydrogen fuel cell vehicle industry [2, p. 10–11]. The following chart shows the hydrogen production and growth rate in China by the end of 2023 (figure 1.9).

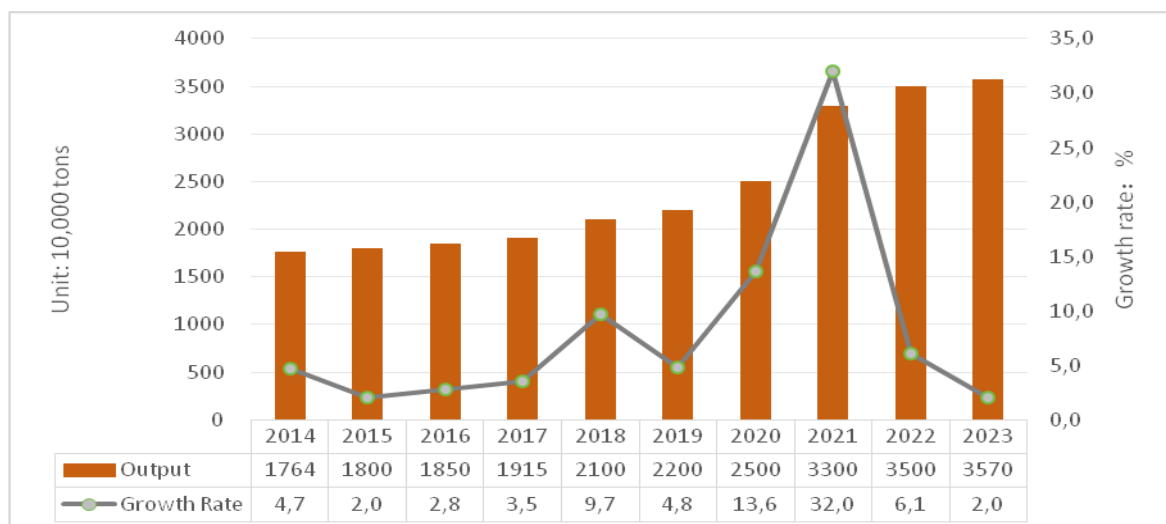


Figure 1.9 – China's hydrogen production and growth rate by the end of 2023 [20]

China's offshore wind power installed capacity continues to grow at a rapid pace, with the new installed capacity reaching 6GW in 2023 and the cumulative installed capacity exceeding 30GW. The following picture shows wind power installed capacity and growth rate from 2013 to 2024 (figure 1.10).

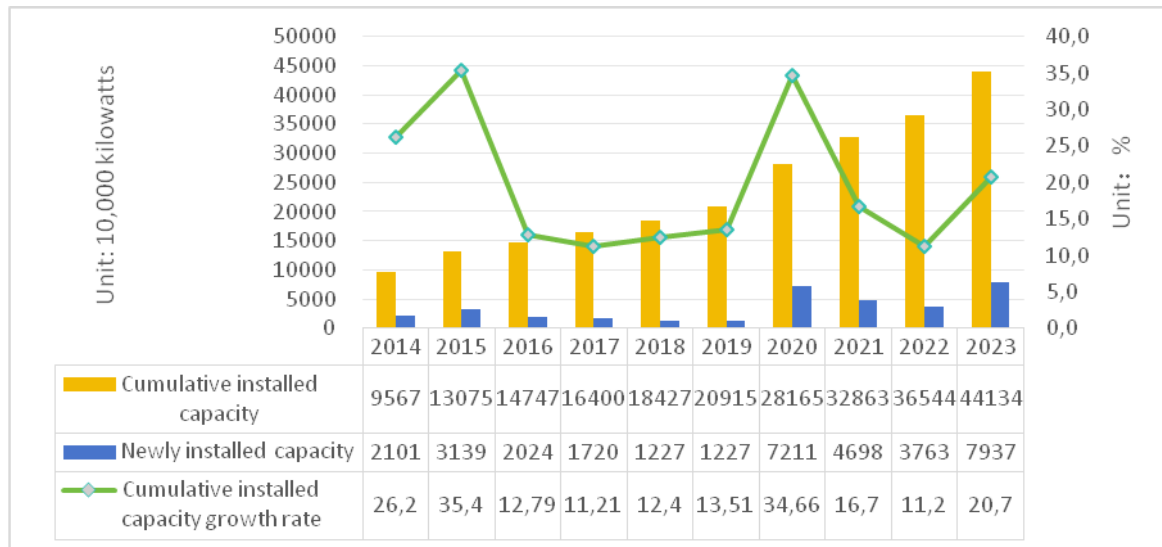


Figure 1.10 – Wind power installed capacity and growth rate from 2013 to 2024 [20]

Large capacity offshore wind turbines, such as 8MW, 10MW and above, are constantly coming off the production line and entering actual operation. Taking Mingyang Intelligent as an example, its production of 10MW offshore wind turbines has been successfully connected to the grid in a wind farm in Guangdong, with excellent technology and stable performance, effectively improve the efficiency of offshore wind power generation, and reduce the cost of KWH by about 20 %.

1.2 Driving force of energy diversification

Coal, oil and other traditional energy in the process of use will produce a lot of carbon dioxide and other pollutants, causing serious pollution to the environment. Long-term reliance on coal leads to serious air pollution (such as PM2.5, acid rain), threatening public health and ecological balance. Reducing reliance on coal can alleviate the smog problem and improve residents' quality of life. Moreover, as the world's largest carbon emitter, China has proposed the goal of carbon peak by 2030, carbon neutral by 2060 and must reduce greenhouse gas emissions by developing clean energy (wind, solar, nuclear, etc.) instead of fossil energy. As the world's largest carbon emitter, China needs to fulfill its obligations under the Paris Agreement, improve its international image and participate in global climate governance [14, p. 11–12].

The benefits of diversification can be seen in the following aspects. The first one is reducing external dependence: China is highly dependent on oil and gas imports (over 70 % and 45 % in 2023, respectively), and geopolitical risks (such as the Malacca dilemma and the Russia-Ukraine conflict) threaten the security of the energy supply chain. The development of indigenous renewable energy can enhance autonomy. The second one is resource endowment optimization [19, p. 9–11]. China is rich in coal resources but has large environmental costs, and has huge potential for westerly wind and solar energy resources. The third one is reasonable development and balanced regional energy distribution. For example, the Jiuquan wind Power base in Gansu Province is one of the largest onshore wind power clusters in the world, with an installed capacity of more than 16 million kilowatts, reducing coal consumption and boosting local employment. The

fourth is price volatility: international oil and gas prices are affected by war, serious market speculation (such as the 2022 energy crisis) and other factors, and a diversified energy structure can cushion the shock. Conventional energy sources such as oil and gas are finite resources that will eventually run out. Solar, wind and other new energy sources are renewable resources and meet the requirements of sustainable development [4, p. 55–56]. By vigorously developing new energy, we can realize the sustainable use of energy. At the same time, energy diversification can reduce dependence on a single energy source and reduce the risk of energy supply disruptions. Through the diversification of energy supply, it can be ensured that when a problem occurs in one energy source, other energy sources can be supplemented in time, thus ensuring the stability and security of energy supply.

China's support policies for energy cover multiple dimensions including laws and regulations, fiscal incentives, market mechanisms, technological research and development, and industrial opening up, aiming to promote green and low-carbon transformation and the optimization of the energy structure. The following are the specific manifestations and policy basis.

1 Legal, Regulatory and Institutional Guarantees.

The first one is renewable Energy Law. Clarify the development goals of renewable energy, establish a fully guaranteed purchase system, and force power grid enterprises to give priority to purchasing renewable energy power generation. The supporting policies include a mandatory quota system, requiring energy enterprises to assume the responsibility of consumption.

The second point is green power direct connection policy. Allow new energy to

supply power to a single user through direct power lines, achieve physical traceability, and support green power direct supply for new infrastructure and integrated source-grid-load-storage projects. In response to international rules such as the EU's carbon border mechanism, provide green power certification support for enterprises. The National Energy Administration attaches great importance to the positive interaction between energy and economic development. In the Guiding Opinions on Vigorously Implementing the Renewable Energy Substitution Action (Development and Reform Commission Energy No. 1537), it is proposed to «support the development of green power direct supply and source-grid-load-storage integrated projects in new infrastructure». In the «Guiding Opinions on Supporting the Innovative Development of New Business Entities in the Power Sector», it is proposed to «explore the establishment of a mechanism to increase the green power supply of enterprises through direct connection of new energy». In the «Guiding Opinions on Energy Work in 2025», it is proposed to «study and formulate policies and measures for direct connection of green electricity». The release of the energy document actively responds to social concerns and demands as well as industry development suggestions and opinions. It proposes an operational plan for green power direct connection projects and clarifies the policy goal of green power direct connection to meet the green energy demands of enterprises and enhance the local and nearby consumption level of new energy.

2 Financial and Tax Incentives.

The first one is direct subsidy. Provide construction subsidies for wind power, photovoltaic and other projects to reduce the initial investment cost.

The second point is tax preference. The policy of immediate refund of value-added

tax and three years of exemption and three years of reduction by half for enterprise income tax has been implemented to alleviate the operational burden on enterprises.

3 Innovation of Market-oriented Mechanisms.

The first one is green certificate trading and quota system.

Implement the renewable energy power quota system and require energy enterprises to complete the consumption targets. Open the green certificate trading market, and enterprises can achieve their emission reduction targets by purchasing certificates.

The second point is participation of private enterprises. Support private enterprises in investing in projects such as pumped storage, geothermal development, nuclear power participation, and new energy storage, and eliminate access discrimination. Encourage private enterprises to participate in the construction of charging infrastructure (such as V2G, integrated photovoltaic storage and charging) and smart microgrids.

4 Technological Research and Development and Industrial Upgrading.

The first one is specialized scientific research support. Establish a national key research and development program to fund the research and development of photovoltaic efficiency improvement, energy storage technologies (such as flow batteries and hydrogen energy storage), and offshore wind power equipment.

The second one is the integration of digital and green. Combining the advantages of the digital economy, we will promote the iteration of new energy technologies (such as leading the world in wind power and photovoltaic power).

The third point is economic transformation and technological progress. The development of new energy has become a new economic growth point: The new energy industry (photovoltaic, wind power, electric vehicles) has become the new engine of

China's economy. For example, China's photovoltaic module production capacity accounts for more than 80 % of the world, and exports and technology exports have brought huge benefits.

The next one is employment and technology spillover: the renewable energy industry chain is long, covering manufacturing, installation, and operation, creating millions of jobs, while promoting energy storage, smart grid and other related technological innovation [6, p. 6–7].

Another important point is reduction energy costs: the cost of wind power has been lower than thermal power (the cost of onshore wind power in 2023 is about 0.2 yuan/degree, and the cost of photovoltaic is 0.3 yuan/degree), which can reduce the energy cost of the whole society in the long run.

Through policy support, such as differentiated energy technology planning to overcome hydrogen energy storage, fourth-generation nuclear reactors, UHV transmission technology, etc., to reduce dependence on Western technology.

Form the advantage of the whole industrial chain in the field of new energy, and enhance the international discourse power [7, p. 9–10]. Such as: Ningde Times and BYD: the world's leading power battery technology, supporting China's new energy vehicles accounted for 60 % of the global market. Grid intelligent demand: the proportion of renewable energy connected to the grid is high, the need for intelligent scheduling, energy storage system and other supporting technologies, forcing the reform of the power system.

1.3 Energy development challenges

Wind power and photovoltaic power generation are greatly affected by seasons and weather. For example, wind power is concentrated in spring and winter, photovoltaic is concentrated in summer and autumn, and the annual utilization hours of wind power fluctuate by more than 20 %, and photovoltaic fluctuations by about 10 %. This instability leads to the prominent contradiction between power supply and demand, and even the phenomenon of abandoning wind and abandoning light and power supply tension coexist [18, p. 36–37]. The problem of lagging energy storage and smart grid construction has always existed, the current energy storage facilities and smart grid are still in the planning or pilot stage, the technology accumulation is insufficient, its stability and economy have not been fully verified, it is difficult to effectively support the large-scale grid connection demand of new energy.

The next problem is traditional energy structure and transition pressure and resource endowment constraints. China's energy structure of rich coal, little oil and lack of gas is difficult to change in the short term, the traditional energy dependence is high, and the new energy supply capacity has not fully matched the continuous growth of energy consumption demand [16, p. 5–6].

Although the proportion of installed renewable energy has exceeded 50 %, the problem of heavy industrial structure and low energy efficiency is still prominent, and multiple obstacles such as technical, economic and social costs need to be overcome to achieve the double carbon goal.

The next problem is insufficient carrying capacity of power grid infrastructure and

distributed energy access challenges. The surge in photovoltaic installations has led to transformers running at full capacity, and many power grids have been forced to limit distributed photovoltaic access. In terms of supply and demand space-time mismatch, photovoltaic power generation day and night and weather fluctuations lead to transformer idle and overload alternately, simply adding transformers cannot solve the fundamental problem, and it is necessary to combine energy storage technology to achieve peak cutting and valley filling, but the cost is higher [13, p. 10–11].

The next challenge is technological innovation and industrial collaboration weaknesses and insufficient cultivation of new quality productivity.

Although China has international competitive advantages in the field of photovoltaic and wind power, key core technologies (such as efficient energy storage and hydrogen energy) still need to be broken through, and there is insufficient coordination between the innovation chain and the industrial chain, which restricts industrial upgrading. Unbalanced regional development has always been a prominent problem, the distribution of new energy resources does not match the load center, the western landscape resources are rich but the consumption capacity is limited, the eastern demand is strong but the local resources are insufficient, and the construction of trans-regional transmission channels needs to be accelerated.

The next problem is policies and market mechanisms to be improved, because the market adjustment mechanism is not perfect.

The lack of flexible market-based pricing mechanism for new energy consumption and the lack of flexible resources in the power system (such as peaking power supply) make it difficult to meet the needs of a high proportion of renewable energy connected to

the grid. In terms of investment and cost pressure, although renewable energy investment exceeds 769.7 billion yuan in 2023, the high cost of supporting technologies such as energy storage and hydrogen energy may weaken the new energy economy, requiring policy guidance and financial support [25, p. 7–8].

The core contradiction facing China's energy development is the dual challenge between traditional energy dependence and green transformation demand and new energy scale expansion and insufficient system adaptation capacity. The solution path needs to focus on technological innovation, power grid upgrading, energy storage supporting, market mechanism reform and other directions.

China's energy development is in a critical period of transition from high carbon to low carbon and from scale expansion to quality and efficiency. In the future, China will build a modern energy system around the direction of clean, low-carbon and intelligent, while strengthening international cooperation to address the challenge of global climate change.

The next problem is the impact of the carbon peaking and carbon neutrality goals on energy security.

First, the heavy task of reducing emissions and the short transition time to carbon neutrality have increased the pressure and risks of industrial and energy structure adjustment. This is reflected in the following aspects: First, the task of carbon emission reduction is arduous. In 2019, China's carbon emissions accounted for 28.8 % of the global total, approaching the combined total of the United States, India, Russia and Japan, which ranked second to fifth, and far exceeding the share of approximately 18 % of the population and GDP. The second is that the transition time from carbon peaking to carbon

neutrality is short. China has only three decades to transition to carbon neutrality, and the tasks of adjusting its economic and energy structures are arduous. Thirdly, the relatively high proportion of manufacturing and the arduous tasks of economic development have restricted the space for the decline in energy intensity. Fourth, the energy transition is constrained by the resource endowment bottleneck of abundant coal, scarce oil and limited gas. Coal accounts for as high as 60 % of China's primary energy consumption structure. The consumption of oil and natural gas is highly dependent on imports, and the risk of energy supply security is relatively high [10, p. 125–126]. The development space of clean energy such as hydropower and nuclear power is limited. Although the development momentum of photovoltaic power generation and wind power is rapid, their proportion is low. There is little room for maneuver in adjusting and optimizing the existing energy structure. For a relatively long period of time in the future, coal will still play the role of the main energy source and provide a safety net.

Chapter 2 International oil and gas trade status

2.1 New changes in international energy market

In recent years, the international political and economic landscape has been in turmoil, and the supply and demand relationship, transportation channels, competition pattern and energy structure in the global energy market have entered a period of profound adjustment. Correctly evaluating the impact of future changes in the world energy pattern on China's economic situation is an important part of safeguarding national economic security [31, p. 157–158].

New progress in the evolution of global energy pattern Since 2023, new changes have occurred in the international energy market. The global supply and demand of crude oil and natural gas are generally loose, and the traditional energy market has entered short-term equilibrium after turbulent adjustment. Opec + continued to reduce production to stabilize oil prices, and the US crude oil market share further improved in the context of the slow recovery of the global economy, in the first half of 2023, oil supply rose, demand slowed down in major developed economies, crude oil supply and demand situation eased, and benchmark prices continued to fall. In order to safeguard its own interests, Opec + continues to cut production. On April 2, 2023, the Opec + producers announced a voluntary production cut of 1.66 million barrels per day between May and December, in addition to the November 2022 production cut agreement. The following chart shows the changes in global oil supply and demand from 2022 to 2023 (figure 2.1) and the changes in oil demand of various countries from 2021 to 2024 (figure 2.2).

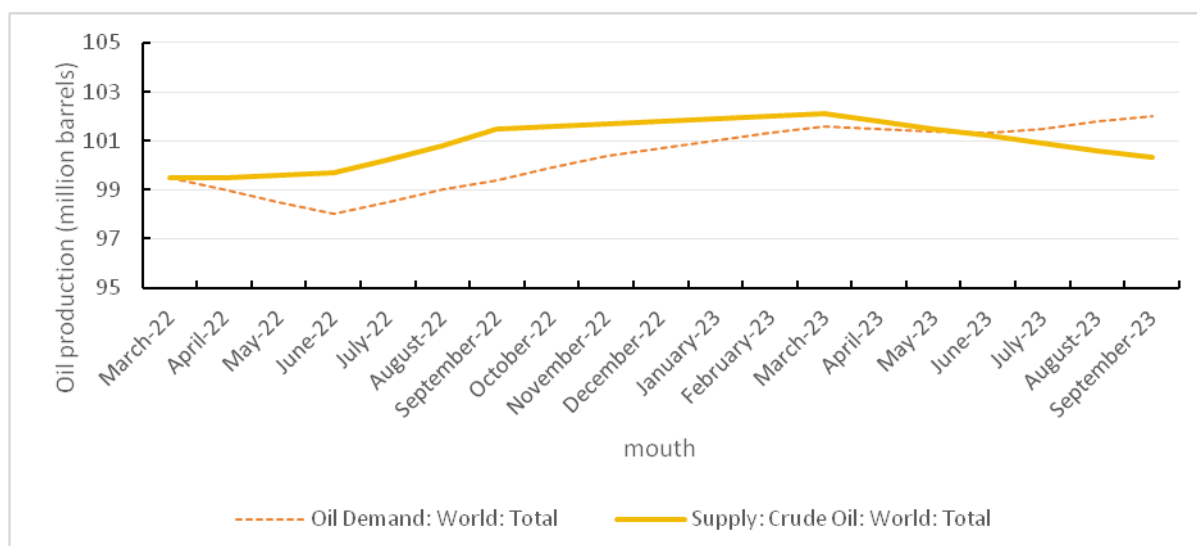


Figure 2.1 – World Oil Supply and Demand Changes Chart 2022–2023 [44]

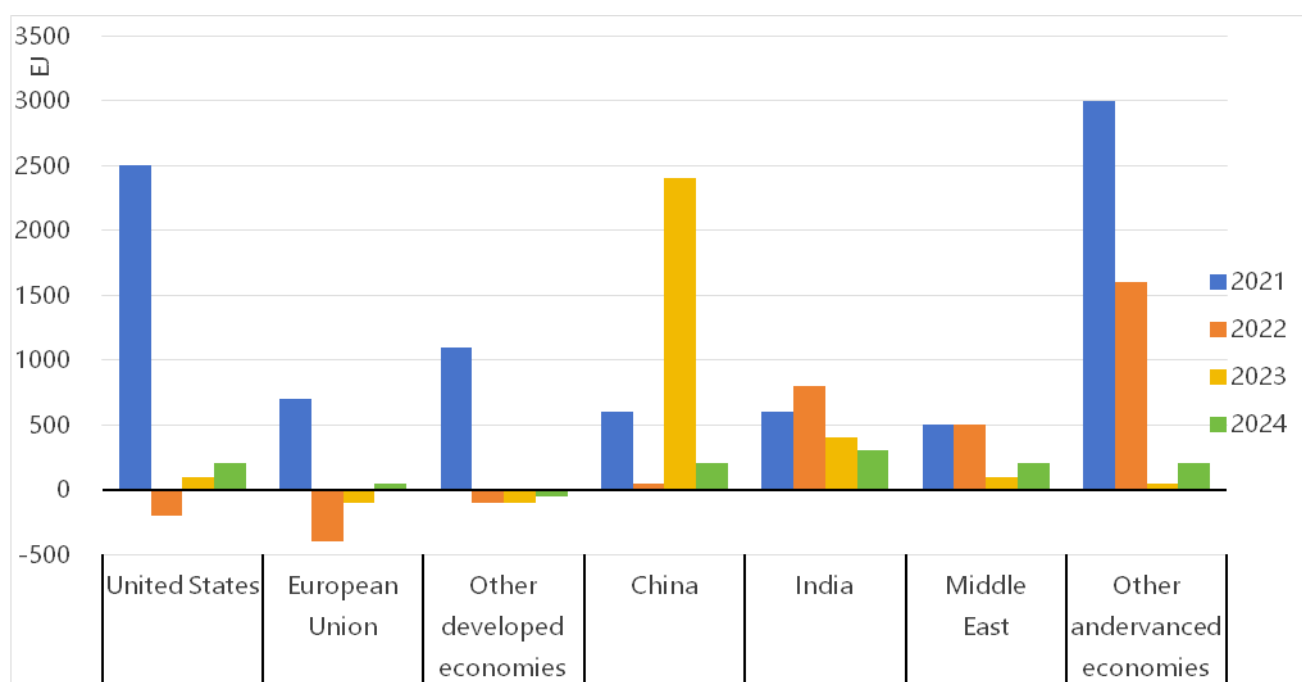


Figure 2.2 – Change in oil demand by region, 2021–2024 [44]

In early June 2023, Opec + announced a new round of production cuts, extending oil production cuts until 2024. Among them, Saudi Arabia decided to cut production by

another 1 million barrels starting in July 2023. After two production cuts, Saudi crude oil production has fallen to 906 million barrels per day in September 2023 [36, p. 36–37]. In September 2023, Russia further supplemented its decision to reduce oil exports to the global market by 300,000 barrels per day voluntarily until the end of 2023. Under the dual impact of Opec + continuous production cuts and global economic recovery, international oil demand exceeded supply in July 2023. After the Opec + additional production cut in July 2023, international oil prices began to rebound to 89.24 dollars per barrel in September 2023, which played a role in boosting oil prices. During the same period, crude oil production in non-OPEC + countries such as the United States continued to increase. Between December 2022 and July 2023, the United States increased from 12.138 million barrels per day to 12.991 million barrels per day, an increase of 7 percent. According to Eurostat, by the end of 2022, the United States had replaced Russia as the largest supplier of crude oil to the European Union. Throughout 2022, Russian oil's share of the EU market fell from 31 percent to 4 percent, while U.S. oil's share increased significantly from 13 percent to 18 percent [41, p. 11–15]. The following shows the oil production of major oil-producing countries and the price trend of WIT (figure 2.3).

The overall supply and demand pattern of the natural gas market is loose, and the regional market tends to be short-term balanced.

Starting in 2023, gas prices in Europe and East Asia continued to fall below 2,000 dollars per million British thermal units, with fluctuations but generally stable fluctuations.

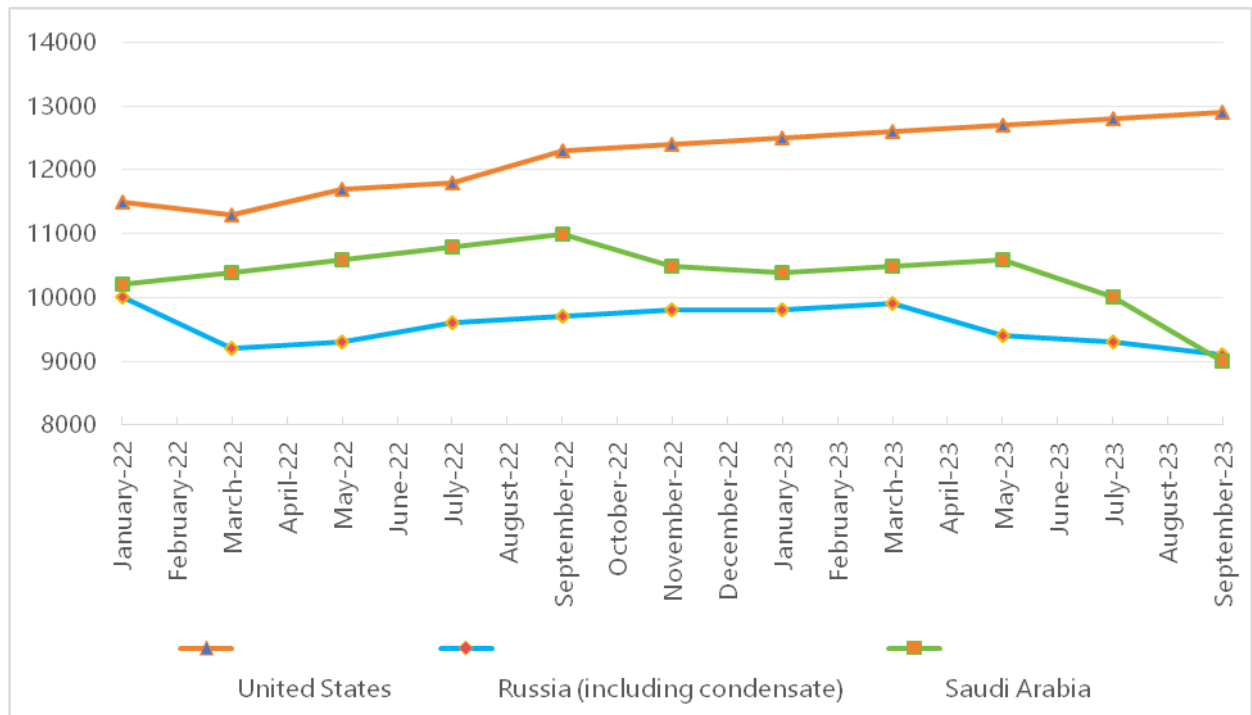


Figure 2.3 – The oil production and WIT price trends of major oil-producing countries [44]

From the perspective of supply and demand, since 2023' the supply and demand pattern of the global natural gas market has been relatively loose, and the natural gas market has tended to be short-term balanced [40, p. 77–78]. First, the tight supply and demand situation in Europe will be greatly improved in 2022, the market adjustment will be stable, and the United States will replace Russia as the largest liquefied natural gas (LNG) supplier in Europe. After experiencing a gas shortage in 2022, the EU mandated that member states must have a gas storage rate of 90 percent. As of September 2023, the level of EU gas stocks has reached 94.3 %. From January to June 2023, Europe imported 59.2 million tonnes of LNG, an increase of 1 %. Among them, 27.5 million tons of LNG was imported from the United States, an increase of 8 %, accounting for 47 % of the total import, becoming the largest LNG supplier in Europe. Second, China's natural gas demand

has rebounded and LNG imports have increased. Pipeline natural gas imports were 32.193 million tons, up 5 % year on year; LNG imports reached 45.51 million tons, up 12.1 % year on year. Among the source countries of LNG imports, Australia is the largest source country of LNG imports to China, importing 15.59 million tons in the first half of the year, an increase of 1.6 %. It was followed by Qatar, which imported 11.38 million tons of LNG, up 8.1 percent. Third, US natural gas production has remained at a high level and LNG exports have picked up. In the first seven months of 2023, total U.S. natural gas production was 616.1 billion cubic meters, an increase of 5.7 %. In the same period, US LNG exports also gradually recovered, reaching 44.06 million tons, an increase of 800,000 tons, mainly sold to the European market [45, p. 65–67]. According to the forecast of the International Energy Agency (IEA), the whole year of 2023, the global demand for natural gas will mainly come from the Asia-Pacific market represented by China, while the demand for natural gas in Europe will show a small decline, and because the supply of natural gas producers represented by the United States continues to grow, if there is no sudden international conflict, the overall supply and demand situation will remain stable throughout the year. Prices will also remain in a tight range [53, p. 234–235]. The graph shows the changes in natural gas demand in regions from 2000 to 2024 (figure 2.4).

Nuclear reactor construction starts by national origin of technology. Due to external factors, global coal consumption will increase significantly in 2021. In particular, the Russia-Ukraine conflict has led to a serious imbalance in fossil energy supply and demand, and many countries have begun to restart coal-fired power plants and delay coal phase-out plans. World coal consumption will increase by 6.9 percentage points in 2022 compared to 2020.

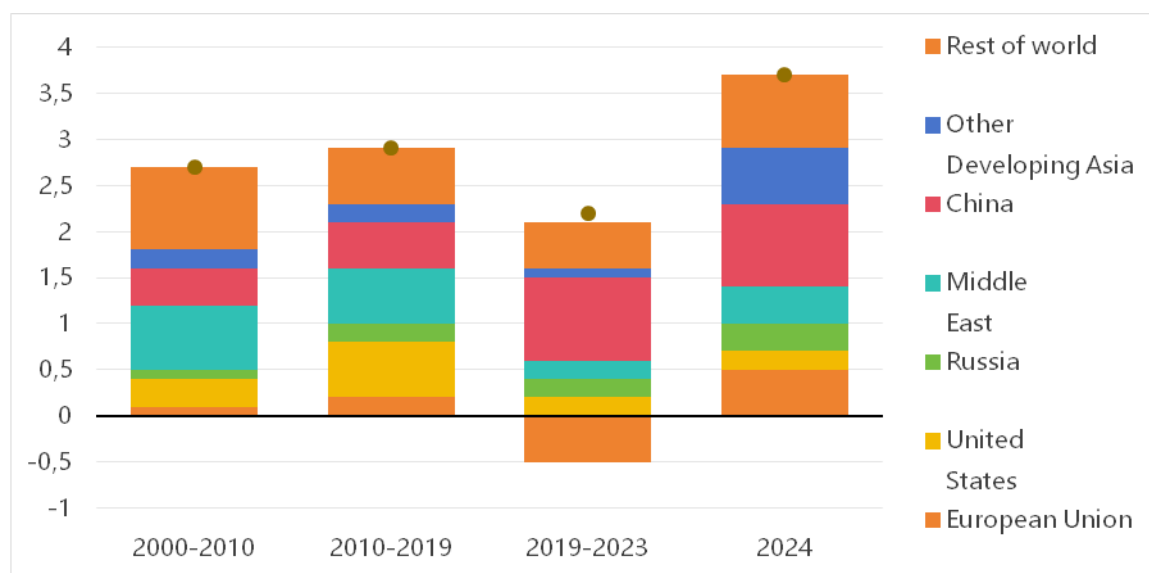


Figure 2.4 – Change in natural gas demand by region, in 2000–2024 [44]

As the Russian coal ban caused a short-term shortage of nearly 50 % of coal in the European Union, coal prices began to fluctuate significantly in 2022, at one point rising to more than 430 dollars per ton, reaching an all-time high. Although the global energy and commodity markets are stabilizing in 2023, coal prices are gradually recovering, but compared with before the conflict between Russia and Ukraine, the price is still in the high range of 100–150 US dollars per ton, and the range is larger. From a long-term trend point of view, since 2008, global coal consumption has generally entered a growth plateau. Although the turning point has not yet occurred, the decline in world coal consumption has become a general trend due to aggressive coal removal policies and specific coal power phase-out plans in major countries. The following figure shows the Change in coal demand in EMDE (figure 2.5).

China and India are still in the phase of coal consumption growth, and China in particular is affected by energy endowments.

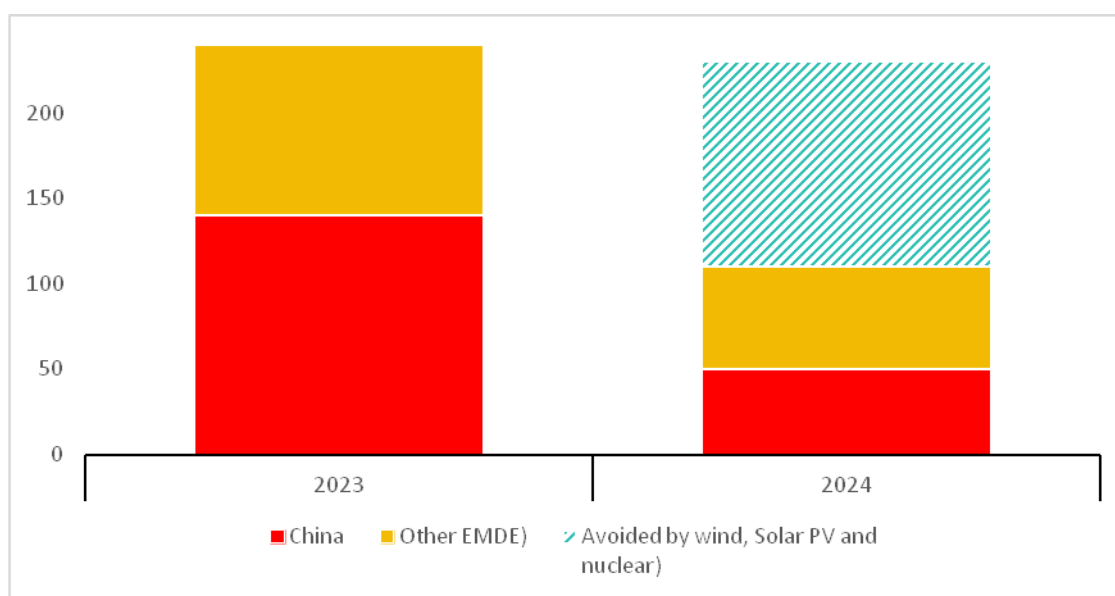


Figure 2.5 – Change in coal demand in EMDE [44]

In the current energy transition period, coal still has to play the role of ballast in a specific stage to ensure energy security, and it is objective and reasonable that coal consumption fluctuates frequently and even rises to a certain extent. Since 2023, global investment in clean energy has maintained rapid growth. Renewable energy and electric vehicles are the main areas of investment. According to Bloomberg New Energy Finance statistics, from January to June 2023, global renewable energy investment reached 358 billion dollars, an increase of 22 %. Investment in new large-scale renewable energy projects reached 246 billion dollars, up 14 percent from a year earlier. Investment in large and distributed PV projects grew to 239 billion dollars, accounting for two-thirds of total investment in the first half of 2023, and is expected to reach 380 billion dollars for the full year, surpassing upstream oil investment. Investment in wind power reached 94 bn dollars, down 8 per cent year on year. Offshore wind emerged as the new area of wind investment, growing 47 percent year on year, while onshore wind investment has declined for four

consecutive quarters [51, p. 279–280]. In the first half of 2023, China remained the world's largest market for renewable energy investment, with new investment reaching 177 billion dollars, up 16 %. The United States added 35 billion and Germany 11.9 billion. With the deepening of the energy transition process, clean energy investment will continue to grow, and the investment scale of traditional fossil energy will enter a plateau. The following figure shows the share of increase in global electricity generation, 2003–2024 (figure 2.6).

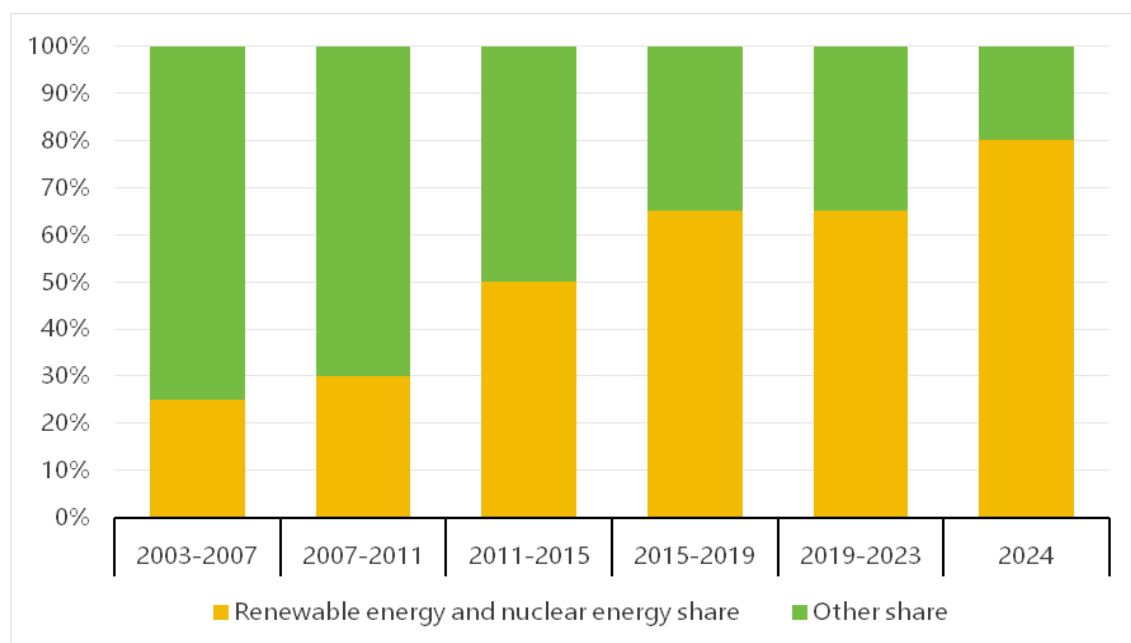


Figure 2.6 – Share of increase in global electricity generation, 2003–2024 [44]

According to the World Energy Investment Report 2023, global investment in the energy sector will reach 2.8 trillion dollars by 2023. At present, the investment ratio of clean energy to fossil energy has expanded to 1.7 to 1. According to the data, 5.8 million electric vehicles were sold worldwide in the first half of 2023, and sales are expected to continue at more than 14 million throughout the year, with investments in many areas such as electric vehicles, batteries and charging supply chains reaching 130 billion dollars.

Since 2020, the global battery energy storage market led by China and the United States has maintained rapid expansion and rapid growth. Investment almost tripled in a few years. In 2021, the global installed capacity of energy storage will be 29gwh, and the installed capacity of new energy storage projects will be 30.7GW in 2022, an increase of 98 % year-on-year. The global energy storage market will continue to grow in 2023. From January to June 2023, the global energy storage market as a whole still maintains a growth trend. Storage battery shipments were approximately 87 GWH and are expected to reach 230 GWH for the full year. Mainly industrial and commercial energy storage and power storage growth exceeded expectations. With the support of policies, China's large-scale energy storage market has maintained a high growth trend, and energy storage projects have accumulated 18gw from January to August 2023 [48, p. 33].

Due to the impact of the Fukushima nuclear accident, the development of global nuclear energy has been stalled, among which the EU countries have been the most affected. Until the conflict between Russia and Ukraine aggravated the global energy supply crisis, the major countries of the European Union had to adjust their nuclear energy strategy appropriately and restart some nuclear power plants. So far, not only traditional nuclear power countries, but also some non-traditional nuclear power countries and non-nuclear power countries in Eastern Europe, the Middle East, Southeast Asia and South America have begun to put forward nuclear power plans. In February 2022, France announced that it would build six new European pressurized water reactors, while studying the feasibility of building eight more nuclear reactors, and no longer shut down existing nuclear reactors that meet safety conditions. On a global scale, the development of nuclear energy has generally maintained an increasing trend year by year. Under the

constraints of the dual goals of energy shortage and net zero emissions, global nuclear energy development has accelerated from 2021, and by the end of 2022, a total of 422 nuclear power units in the world are in operation in 33 countries and regions, with a total installed capacity of 378.314 million kilowatts [42, p. 29–32].

Eighteen countries have 57 nuclear power units under construction, with a total installed capacity of 58.858 million kilowatts. In 2022, global nuclear power generation will reach 2.55 trillion KWH, accounting for about 9.6 %.

2.2 Development trend of the international energy

The impact of the Russia-Ukraine conflict on the international energy market will be greater than the market expects, and the damage will be greater and last longer. Although the global energy market has entered short-term balance in 2023, unstable factors still exist. However, from the trend point of view, the scale of new energy continues to expand, gradually replacing traditional fossil energy. The global energy market game will continue to expand from the traditional oil and gas field to new energy and industrial and mining fields closely related to new energy.

The future global market will form a new pattern of the supply of oil and gas, look from the supply structure, traditional represented by Opec oil supplier will face comes from the United States, Saudi Arabia, Russia, constitute the challenge of global oil and gas supplies triangle. In 2022, the United States crude oil production accounted for 18.9 % of the world's total oil and gas production, has become one of the world's largest oil and gas producers, is an important pole of the world's oil and gas supply, and constantly squeezing

Opec and Russia's market share. The International Energy Agency (IEA) predicts that the United States will account for nearly 75 percent and 40 percent of global crude oil and natural gas growth, respectively, through 2040. In the next decade, Russian crude oil production will fall from 11.2 million barrels per day in 2022 to 5 million to 8 million barrels per day [33, p. 12–13].

Over the next decade, 50–60 % of the increase in global LNG supply will come from U.S. exports, and the share of the U.S. and the Middle East (primarily Qatar) in global LNG supply will rise from around 35 % in 2022 to around 50 %. Under the new supply pattern, the production coordination mechanism of the traditional energy market will face challenges, so in the next decade, the supply and demand of the international oil market will generally tend to be loose and balanced, but there will still be price fluctuations caused by supply fluctuations in the short term. In the transportation sector, the share of oil still reaches 50 %, but the growth rate of demand is gradually declining. In addition to aviation, navigation, cargo and other fields, the decline in passenger car oil is very obvious. By 2030, electric vehicles will account for 90 % of new car sales, and the share of electric vehicle inventory will increase from about 15 % in 2022 to about 30 % in 2030, and declining oil use has become an inevitable trend. From the perspective of oil and gas consumption countries and regions, the growth of crude oil consumption is mainly contributed by developing countries and emerging countries. The following picture 2.7 shows nuclear reactor construction starts by national origin of technology.

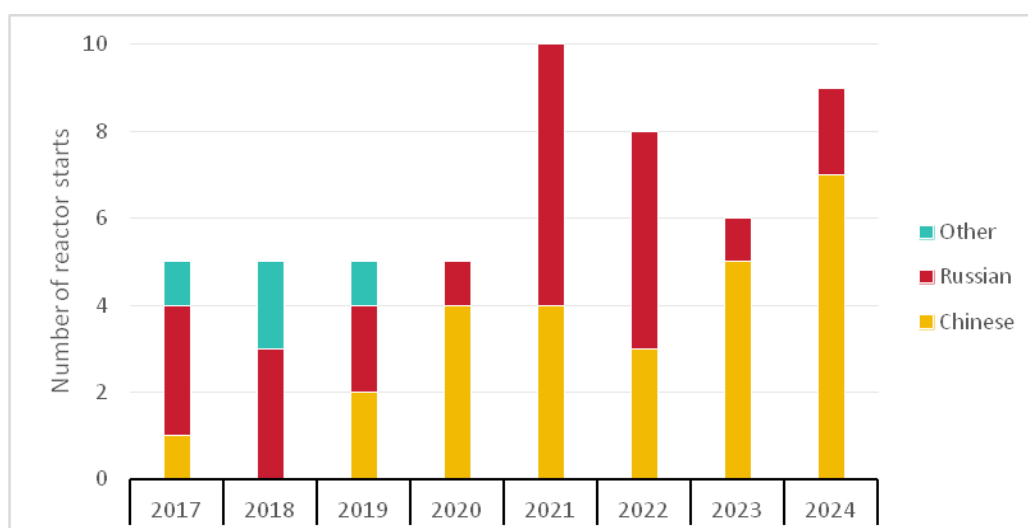


Figure 2.7 – Nuclear reactor construction starts by national origin of technology, 2017–2024 [44]

By 2022, the share of crude oil consumption in North America and the European Union will fall to 22 % and 11 %, respectively. Crude oil consumption in major developed countries such as the United States, Germany, the United Kingdom and Japan will steadily decline. The share of crude oil consumption in the Asia-Pacific region has risen to around 40 %, and consumption in China and India is still rising. The center of world oil consumption and trade continues to shift eastward. Oil consumption by developing and emerging economies in the Asia-Pacific region, led by China and India, is supporting new global oil demand. From the perspective of the distribution of the world's natural gas consumption countries and regions, in addition to the United States, the consumption of natural gas in North America and Europe has remained basically stable. China, India and other emerging Asian countries in the Asia-Pacific region due to the reduction of coal consumption and continued industrialization, natural gas consumption in the next ten years will maintain a high growth rate, the proportion of total natural gas consumption in the

world's total consumption will rise from 23 % in 2022 to about 30 % in 2030 according to forecast [28, p. 47–50].

Under the influence of geopolitical factors, the flow of international energy trade will undergo fundamental changes. Since the outbreak of the conflict between Russia and Ukraine, the global energy trade integration pattern, which has been dominated by economic factors for a long time, has undergone important changes. Russia will export more to Asia and less to Europe. Crude oil exports from the United States, the Middle East and Africa to Europe increased, while crude oil exports to Asia decreased. The eastward shift of Russian energy has brought good news to Asian markets such as China and India. The oil-producing countries of the former Soviet Union, represented by Russia, are rich in resources and have large production capacity, which can just meet the market demand of the new oil and gas consumption center. New energy development under the Carbon neutral goal will profoundly affect the global energy landscape Under the global action on climate change, 139 countries and regions have announced carbon neutral goals. In order to achieve the goal of carbon neutrality, countries have formulated renewable energy development targets and low-carbon transition policies. In the United States, Germany, the United Kingdom, China and Japan (after 2012), the proportion of non-fossil energy consumption increased rapidly, and the pace of energy transformation was significantly faster than that of other countries. With the continuous improvement of cost competitiveness, the scale of wind power and solar power generation will continue to maintain rapid growth in the next decade, energy storage technology is very likely to make a breakthrough, wind energy, light energy and other volatile energy will usher in a period of rapid growth [57, p. 20–21].

The deep adjustment of the energy structure will have an external impact on the traditional global energy pattern. First of all, the resource competition in the international energy market has gradually evolved into the new energy industry competition between countries. In the future, the role of science and technology and high-end manufacturing in the global energy pattern will gradually emerge, and the key mineral resources related to the new energy industry have become strategic resources of great concern to all countries after oil. With the widening gap between supply and demand of global mineral resources, frequent fluctuations caused by short-term supply and demand imbalance may be an important feature of the global key mineral resources market [22, p. 38–50]. The distribution concentration and monopoly degree of key metal ores are higher than that of oil and gas resources, and the global competition is more intense.

2.3 Impact of changes in global energy pattern on China

The global energy market dispute will gradually expand from the dispute over energy resources to the dispute over energy resources, the dispute over technology, the dispute over key minerals and the dispute over new energy industry chain. At present, many core technologies in China's new energy industry chain cannot be controlled independently. In the field of nuclear power, the technology of some nuclear-grade pumps, valves and related materials has not yet been broken through, and independent localization has not yet been achieved. Second, the risk of key mineral resources. The rapid development of renewable energy, hydrogen energy, new energy vehicles and energy storage industries has increased the demand for key minerals such as lithium, cobalt and

nickel. Many key ores are more concentrated and monopolized. For example, the world's cobalt resources are highly uneven, with Congo, Australia and Cuba accounting for 68 % of the world's total reserves. China's cobalt reserves account for only about 1 % of the world's reserves of about 80,000 tons, most of the cobalt raw materials imported from the Democratic Republic of Congo. At present, among the 15 core minerals needed by China's new energy industry, the external dependence of aluminum, copper, lithium, cobalt, nickel and manganese exceeds 70 %. Among them, 80 % and more than 90 % of lithium and cobalt raw materials are imported from abroad. 60 % of lithium feedstock is imported from Australia, and more than 60 % of copper concentrate is imported from Chile and Peru [26, p. 18–19]. The following figure shows the situation of China's energy imports from 2013 to 2024 (table 2.1).

The supply and demand pattern of mineral resources intensifies the concern and competition of all countries for resources. Moreover, some of China's scarce mineral resources are at the mercy of these European and American competitors. International competition between major powers in the field of strategic minerals is inevitable and can easily be used as a weapon by some countries to rise to the geopolitical level.

Energy cooperation is uncertain. After the outbreak of the conflict between Russia and Ukraine, the traditional fossil energy pattern was reconstructed. However, Sino-US friction and its continued evolution and escalation will remain an important part of the international political scene in the future.

In recent years, the United States has frequently created trade frictions and economic disputes, and constantly repressed and contained China in new energy, high-tech and other fields.

Table 2.1 – China's energy import situation from 2013 to 2024 [20]

Year	Coal and lignite (10,000 tons)	Crude oil (10,000 tons)	Natural gas (100 million cubic meters)	Electricity (100 million kWh)
2014	29122	30837	591	68
2015	20406	33548	611	62
2016	25555	38101	746	62
2017	27092	41946	946	64
2018	28210	46189	1246	57
2019	29977	50568	1332	49
2020	30361	54201	1397	48
2021	32327	51292	1675	-
2022	29320	50828	1508	-
2023	47442	56399	1656	-

Various schemes keep emerging to disrupt China's Belt and Road Initiative. At present, China is in a critical period to achieve the goal of dual carbon, which is inseparable from international cooperation and exchange in tackling climate change and carbon peak carbon neutrality. In particular, in the construction of the basic industrial chain of the new energy system, it is necessary to strengthen foreign cooperation in hydrogen energy, nuclear energy, energy storage, chip manufacturing, integrated circuit industry and other fields, and attract and guide foreign investment in the clean and low-carbon energy industry [38, p. 51–53].

Opportunities and challenges coexist in the new energy industry. In order to achieve the goal of keeping the global average temperature rise within 1.5 ° C set by the Paris Agreement, it is necessary to accelerate the development of new energy sources, mainly renewable energy, and promote the world energy transition. China is the largest and fastest growing country in renewable energy investment and construction, and the largest exporter of photovoltaic products. The renewable energy industry has strong international competitiveness and is an important force to promote the formation of a new pattern of the global energy market. At present, the production scale of China's wind turbine equipment and polysilicon, silicon wafers and photovoltaic cells ranks first in the world. Looking at the future global energy market from the perspective of energy transformation, global renewable energy production capacity products and installed capacity will enter a stage of rapid growth. For China, the huge global new energy market is not only a favorable condition for the development of the new energy industry, but also an important opportunity for China to deeply participate in the reconstruction of the global market pattern and maintain the stability of the global energy market [56, p. 25–26].

The competition between China and Europe and the United States in the field of carbon emission reduction and new energy industry is bound to intensify. According to EU Customs statistics, in the first seven months of 2023, China's electric vehicle exports increased by 112 %. According to the European Commission, the market share of Chinese electric vehicles in Europe has risen to 8 percent and could increase to 15 percent by 2025. In the face of China's new energy vehicle export situation, the EU even launched an anti-subsidy investigation into Chinese electric vehicles. In addition, the future of the EU carbon border regulatory tax industry and product scope gradually expanded, if the lack of

a complete domestic carbon market and carbon price formation system, China's new energy products may face new trade barriers due to the carbon footprint of the whole industry chain [29, p. 14–15].

In the face of the new global energy pattern that may be formed in the future, China must not only guard against the security risks of the traditional energy market, play the role of the world's major energy consumers, but also pay attention to the high-quality development of domestic new energy. Accelerate the pace of energy transition.

First, strengthen exchanges with developed countries in the field of new energy and seek win-win cooperation. In the current turbulent international energy market adjustment process, China should not only actively participate in the international oil and gas market governance, promote the restoration of international market order, but also seek cooperation with the United States and Europe in the field of new energy, and promote the formation of long-term stable trade pattern as soon as possible. We will continue to go global for Chinese products and support the export of photovoltaic and other products by Chinese enterprises. We will encourage new energy and high-tech enterprises from the US and Europe to enter the market, and support Chinese enterprises to cooperate with the US and Europe in equipment, standards, technologies and markets in the fields of energy storage, electric vehicles, hydrogen energy and fuel cell vehicles, nuclear power and hydrogen energy [47, p. 10–11].

Second, strengthen more pragmatic policy communication and coordination with countries in Asia, Africa and Latin America, create expectations for peace, stability and cooperation, and reduce other geopolitical risks other than US-led. Actively rely on the Shanghai Cooperation Organization, BRICS mechanisms, China-Arab States Cooperation

Forum, China-Arab States Cooperation Forum, China-Africa Cooperation Forum, China-Asean economic and trade cooperation mechanism, etc., to strengthen consensus, formulate practical cooperation plans, and form a closer long-term cooperative relationship [59, p. 2803–2816].

Strengthen international cooperation in traditional oil and gas fields, base on global resources, adhere to the strategy of diversifying oil and gas imports, and ensure energy security under the condition of achieving a higher level of opening-up. We will ensure diversified oil and gas import channels from the Middle East, Africa, Australia and South America, and carry out dialogues and exchanges in the field of energy with countries with potential for cooperation. We will explore forms of LNG cooperation that meet the common interests of both sides and optimize the structure of offshore LNG imports. With the exception of a few countries trying to profit from de-globalization, most countries are hoping that the global energy market will be restored to balance on a global scale. At present, as a major economic power and energy consumer in the world, China still advocates peace and stability from the international political level, promotes the easing of international conflicts, and fundamentally promotes the return of the global energy pattern to the direction of integration [34, p. 80–85].

China is in the critical period of transformation from the traditional energy system to the new energy system, and the institutional obstacles restricting the large-scale utilization of new energy are becoming increasingly prominent. It is necessary to deepen reform, carry out institutional innovation in key links, break the institutional bottleneck of new energy development, and realize the low-carbon transformation of the power system. First, accelerate the establishment of new energy systems and mechanisms to adapt to the

characteristics of new energy. Further optimize the power market design to fully reflect the flexibility and value of distributed energy. Accelerate the construction of spot market and auxiliary service market for electricity, enhance the flexibility of the power system, so that different power market players can adjust market behavior according to market price changes. The second is to change the mode of intermediate supervision and promote the transformation from asset type to service type by adjusting the incentive mechanism, we can promote the transformation of the profit model of intermediate public utility companies. The third is to follow the principles of fairness and neutrality, and formulate regulatory rules that can reflect energy costs and realize the value of resources. The development of new energy has entered the stage of scale expansion to scale absorption, and the cost of renewable energy power generation based on wind and light energy is close to the cost of coal power generation, and it also has a certain market competitiveness. Fourth, improve China's ability to allocate strategic mineral resources globally. First, formulate a national security strategy for strategic mineral resources. Elevate important mineral resources into a national security strategy [37, p. 219–220].

Establish a modern mineral resource industrial system covering the whole industrial chain of upstream exploration and exploitation, midstream smelting and processing, and downstream recycling and utilization. We will further improve the policy support system for key national mineral resources. Fifth, establish a reserve system for rare earth, titanium and natural graphite mineral resources [43, p. 85–87]. Further improve the strategic reserve management system of mineral resources. We call for strengthening cooperation between mineral resource exporting countries and importing countries to promote the formation of a reasonable international supply and demand pattern and price level. Support

domestic mining enterprises to make full use of international innovation resources and enhance independent research and development and innovation capabilities. Support domestic enterprises to form technical alliances, carry out international operations, jointly develop overseas mineral resources, and enhance international competitiveness and market influence.

Chapter 3 The influence of network stability on energy security

3.1 Supply chain continuity and price stability

The stability of the international energy supply chain is crucial to China's energy security. Energy supply chain covers the whole process from energy production, transportation to consumption, and its stability is directly related to the reliability and economy of energy supply [60, p. 93–94]. In recent years, global geopolitical conflicts, trade protectionism and black swan events such as extreme weather have occurred frequently, posing a serious threat to the stability of the energy supply chain.

A stable international energy supply chain can ensure that China has sufficient access to traditional energy resources such as oil, gas and coal from the global market. For example, by establishing long-term energy supply contracts with multiple countries, China has reduced the risk of supply disruptions due to market fluctuations or geopolitical conflicts.

The stability of the energy supply chain helps maintain the relative stability of international energy prices, thereby reducing China's energy import costs. In recent years, sharp fluctuations in international energy prices have had a significant impact on China's energy economy. By strengthening the resilience of the supply chain, China can avoid economic risks from price fluctuations to a certain extent.

Promoting energy transformation and technological innovation. A stable supply chain supports China's energy transition. As the global energy transition accelerates, the development of new and renewable energy technologies requires a stable supply of raw materials and international cooperation. China has formed a relatively complete industrial

chain in photovoltaic, wind power and other fields, and a stable supply chain will help further enhance its competitiveness in the global energy transition [60, p. 93–94].

By maintaining the stability of the global energy supply chain, China actively participates in international energy cooperation, promotes multilateralism, and opposes trade protectionism and decoupling and chain breaking. Such cooperation will not only help ensure China's energy security, but also enhance China's influence in global energy governance.

The instability of the international energy supply chain for China's energy security challenge.

1 Geopolitical risk. China is highly dependent on imported oil and natural gas, and China is the world's largest crude oil importer (about 72 % of crude oil in 2022), and natural gas external dependence exceeds 40 %. Major sources include the Middle East (Saudi Arabia, Iraq), Russia, Africa (Angola) and Latin America (Brazil). International geopolitical conflicts could cause energy supply disruptions or price spikes. For example, after the Russia-Ukraine conflict, the supply pattern of the global energy market has changed, and China's energy imports from the Middle East, Africa and Russia are facing new uncertainties [46, p. 53–54].

2 Market fluctuation risk. Sharp fluctuations in international energy prices will directly affect China's energy import costs and economic stability. In recent years, the global energy market has repeatedly experienced high price fluctuations due to COVID-19, conflicts and other factors, increasing the difficulty and cost of China's energy procurement.

3 Transport channel risk. The security of energy transportation channel is an

important part of supply chain stability. For example, about 80 % of China's crude oil imports pass through the Strait of Malacca, a choke point that could directly threaten energy transport security if it is restricted by conflict or blockade (such as the potential risk in the context of the US-China game).

4 Technology and market dependence risk. The rapid development of new and renewable energy technologies has put new demands on the global energy supply chain. China still relies on imports of some key technologies and scarce materials, which may become a bottleneck restricting the energy transition.

5 Energy cost affects industrial competitiveness. As a large manufacturing country, energy costs account for a high proportion of total costs in China. A prolonged period of high energy prices due to unstable international supply chains could undermine export competitiveness.

6 New risks in the renewable energy supply chain. Although China occupies a global leading position in photovoltaic, wind power and other fields, some key materials (such as poly silicon for photovoltaic and lithium resources) still rely on imports. For example, the dependence on lithium resource imports exceeds 70 %, mainly from Australia and South America, and if supply constraints may affect the expansion of the new energy industry [21, p. 56–57].

Strengthening energy supply chain resilience. Improve the stability and flexibility of the energy supply chain by optimizing the energy transport network and strengthening infrastructure construction such as pipeline transportation.

Let us have a look at possible strategies.

1 Promote diversification of energy sources and import sources. We will accelerate

the development of new and renewable energy and reduce our dependence on traditional fossil fuels. At the same time, expand the sources of energy imports and reduce dependence on a single country or region.

2 Deepen international cooperation. Actively participate in global energy governance, promote multilateral cooperation mechanisms, and strengthen cooperation with other countries in energy technology, market and supply chain.

3 Improve energy finance and pricing capabilities. Strengthen the construction of the energy financial system, increase China's stake in the international energy market, and hedge the risk of price fluctuations through financial instruments.

4 Strengthen the construction of energy reserve system. Establish a sound strategic energy reserve system and enhance the ability to cope with fluctuations in the international energy market.

The stability of the four, the conclusion of the international energy supply chain has a profound influence on China's energy security. A stable supply chain can ensure the reliability of energy supplies, reduce import costs, and promote the energy transition. However, factors such as geopolitical conflicts, market volatility and transport corridor risks continue to pose challenges to China's energy security. In the face of multiple risks, China has strengthened its resilience through multi-dimensional means such as diversified supply, independent strategic reserves of technology and regional cooperation, but changes in the global political and economic landscape and uncertainties in the energy transition will continue to test its ability to cope. In the future, improving the autonomous controllability and resilience of the supply chain will be the core task [23, p. 128–129].

The impact of stable international energy prices on China's energy security.

The positive impact of stable international energy prices on China's economy:

1 The stability of international energy prices will help reduce the uncertainty of the Chinese economy. As the basic factor of economic development, energy price fluctuation will directly affect production cost and consumption expenditure. Stable energy prices can reduce the fluctuation of production costs of enterprises, maintain the continuity and stability of industrial production, and thus ensure the steady growth of the economy.

2 Stable energy prices provide favorable conditions for industrial restructuring. Sharp fluctuations in energy prices may lead to a sharp rise in production costs for energy-intensive industries, thus inhibiting their development. The stable energy price environment is conducive to promoting the transformation of traditional industries to low-carbon and efficient directions, while promoting the development of new energy and renewable energy industries.

3 Stable energy prices help reduce the cost of living of residents and reduce the loss of social welfare caused by rising energy prices. The study shows that the fluctuation of international energy prices will directly affect household consumption, especially the consumption expenditure of middle and high income households. Stable energy prices can ensure people's living standards and reduce social instability [27, p. 50–52].

4 Stable energy prices provide a predictable economic environment for the energy transition. In the process of energy transition, the research and development and application of new energy technologies need stable market expectations. The stability of international energy prices can reduce economic risks in the process of energy transition and promote the development and utilization of renewable energy and new energy.

The potential challenge of stable international energy prices to China's energy

security:

1 Although stable international energy prices help the economy, China's dependence on the international energy market remains high. Oil and natural gas are highly dependent on foreign countries, and any fluctuations in the international market may still be transmitted to the domestic market through trade channels, affecting the security of energy supply.

2 Lack of energy pricing power International energy prices are mainly determined by the international futures market, and China is relatively weak in energy pricing power. Even if international energy prices are stable, China may still face higher energy costs due to an unreasonable pricing mechanism.

3 Stable energy prices may, to some extent, weaken the market's drive for new and renewable energy. If the price of traditional energy remains stable for a long time, it may lead to a decline in the market's enthusiasm for investment and research and development of new energy, delaying the process of energy transformation [30, p. 74–75].

Conducted analysis allows us to make policy suggestions.

1 We will establish and improve a strategic energy reserve system and be better able to cope with fluctuations in the international energy market. Through the reserve mechanism, domestic market supply can be stabilized in times of energy price fluctuations.

2 Promote energy diversification and transformation Accelerate the adjustment of the energy structure, reduce dependence on traditional fossil energy, and vigorously develop new and renewable energy. We will increase the share of new energy in energy consumption through technological innovation and policy support.

3 Actively participate in the international energy market, promote the development of the energy futures market, and strive to get more say in the international energy pricing.

4 Strengthen international cooperation and market monitoring. To deepen cooperation with energy producers and consumers and establish diversified energy supply channels. At the same time, the monitoring and early warning mechanism of the international energy market should be strengthened to respond to potential risks in a timely manner [24, p. 16–18].

The stability of international energy prices has an important impact on China's energy security. Stable energy prices help ensure economic stability, promote energy transformation and maintain social stability, but they may also bring about problems such as market dependence and lack of pricing power. Therefore, China needs to further enhance the resilience of energy security and achieve sustainable development through measures such as strengthening energy reserves, promoting energy diversification and improving pricing power.

3.2 Energy diversification and energy security

With the evolution of the global energy pattern, the world energy has shown a diversified development trend, which has a profound impact on China's energy security.

The world's energy diversification of China's energy security positive effect:

1 Reduce reliance on traditional fossil energy. The world's energy diversification has promoted the development of renewable energy (such as solar energy, wind energy, water energy, etc.) and new energy (such as nuclear energy, hydrogen energy, etc.). As

one of the world's largest energy consumers, China is highly dependent on traditional fossil fuels, especially oil and natural gas.

2 The development of energy diversification enables China to gradually reduce its dependence on imported fossil energy and reduce supply risks caused by fluctuations in the international energy market and geopolitical conflicts. In the transportation sector, for example, growth in China's demand for oil has slowed significantly with the spread of electric vehicles. This not only relieves the pressure on oil imports, but also improves the resilience of the energy system [35, p. 532–533].

3 Enhance the stability of energy supply. Globalization means diversifying sources of energy supply. China can develop a stable and reliable energy supply system by developing a variety of energy forms. For example, when the supply of traditional energy is limited due to the unstable international political situation, renewable energy and domestically produced energy can be used as a supplement to ensure the continuity of energy supply. At the same time, energy diversification also promotes the upgrading and optimization of energy infrastructure, such as the construction of smart grids, and improves the operational efficiency and anti-risk capability of energy systems.

4 Enhance the energy experience. With the continuous progress of renewable energy technology and the emergence of scale effects, its cost is gradually reduced. This provides a more economical option for China's energy consumption and reduces the burden of energy costs on the economy.

5 In addition, energy diversification also provides China with more bargaining space in the international energy market, helping to solve the Asian premium problem of energy imports.

6 Promote energy technology innovation and industrial upgrading. The development of energy diversification in the world has stimulated innovation and competition in the field of new and renewable energy technologies. As a global leader in new energy equipment manufacturing and technology research and development, China has made remarkable achievements in photovoltaic, wind power and other fields [32, p. 8–10]. This has not only enhanced China's competitiveness in the global energy sector, but also promoted the development of related industries and injected new impetus into economic growth.

7 Diversify geopolitical risk. The supply of traditional energy sources (e.g., Middle Eastern oil, Russian gas) is vulnerable to the international situation. In the context of energy diversification, China can reduce the risk of supply interruption caused by a single regional conflict through multiple import channels (such as Central Asian natural gas, new energy cooperation in Africa) and technical cooperation (such as hydrogen energy development in Europe).

The world's energy diversification of China's energy security challenge:

1 The geopolitical risk is still there. Although energy diversification has reduced reliance on traditional fossil fuels, global oil and gas production and supply are still concentrated in a few regions. Geopolitical conflicts could disrupt energy supplies in these regions, affecting global energy markets, and China would not be immune. Technology and market risks of new energy development. The development of new and renewable energy still faces technical bottlenecks and market uncertainties. For example, the intermittency of solar and wind energy needs to be solved through energy storage technology and smart grids. In addition, the international monopoly of new energy

technology and trade barriers may also limit the development of China's new energy industry.

2 System security risks in the process of energy transition. Energy diversification and energy transition require greater flexibility and resilience in energy systems. In the process of transformation, the stability of the energy system may be challenged, such as the adaptability of the grid and the coordination of energy supply [58, p. 39–40].

3 The transformation pressure of the traditional energy industry. Coal accounts for 56 % of China's energy consumption, which is difficult to completely replace in the short term.

4 Problems such as insufficient consumption of new energy connected to the grid and bottleneck of energy storage technology may lead to periodic energy supply fluctuations, such as structural contradictions exposed by the power rationing event in local areas in 2021.

5 The new energy industry chain relies on strategic resources such as lithium, cobalt and rare earth. Although China dominates the rare earth processing field, its dependence on lithium resources imports exceeds 70 % (mainly from Australia and South America). Intensifying global competition for resources may lead to green resource nationalism.

6 Rising energy finance risks. Increased volatility in the international energy futures market (such as the Russia-Ukraine conflict resulting in a spike in natural gas prices), China, as the world's largest energy importer, needs to deal with the impact of price transmission on the domestic economy, and the 34 % increase in crude oil import costs in 2022 is a warning.

We can enumerate the following strategies:

1 We will strengthen the strategy of energy diversification. We will further optimize the energy mix and vigorously develop renewable and new energy sources. At the same time, continue to promote the diversification of fossil fuel imports and reduce dependence on a single country or region.

2 We will enhance our capacity for energy technology innovation. We will increase investment in research and development of new energy technologies, and make breakthroughs in key technologies such as energy storage and smart grids. Strengthen international cooperation, actively participate in the formulation of global energy technology standards, through overseas investment (such as Gangrene Lithium acquisition of Argentina salt lake) and domestic salt lake lithium extraction technology breakthrough, reduce the dependence on key minerals. Promote a circular economy and build a power battery recycling network (with a recovery rate of 50 % by 2025).

3 Enhancing the resilience of energy systems. We will promote the modernization and intelligent construction of energy infrastructure. Strengthen the construction of energy reserve system and improve the ability to cope with emergencies.

4 Deepen international cooperation. We will actively participate in global energy governance, promote the building of a clean, efficient and secure global energy supply system, and strengthen cooperation with major economies on energy transition and climate change.

5 We will improve risk early warning and emergency response mechanisms.

6 Establish a red, yellow and blue energy security early warning system to dynamically monitor global supply chain risks (such as the Malacca Strait transport route).

Increase the size of the strategic Petroleum Reserve (currently about 70 days of imports, below the International Energy Agency standard of 90 days).

7 Build a multi-energy complementary system. Short-term: Optimize the clean use of coal and increase natural gas storage capacity (such as the expansion of coastal LNG terminals). Long-term: Accelerate the construction of wind water storage integrated base, the goal of 2030 non-fossil energy accounted for 25 %.

The world's energy diversification for Chinese is both stress tests and strategic opportunities. China needs to balance the pace of withdrawal of traditional energy and replacement of new energy with the idea of first establishment and then destruction, and build an independent and controllable modern energy system through technological innovation, international cooperation and institutional design. In the future, energy security will depend not only on physical supplies, but also on global competition in technical standards, financial rules, and governance capabilities [39, p. 403–404]. In this process, China is expected to transform from an energy catch-up to a rule leader. China should make full use of the positive impact of energy diversification, actively respond to challenges, enhance energy security and promote economic and social development through technological innovation, industrial upgrading and international cooperation.

3.3 Geopolitical and environmental impact

The impact of international geopolitics on China's energy security is complex and far-reaching, which is mainly reflected in the stability of energy supply, the security of transportation channels, the ability to obtain resources and the change of international

cooperation pattern. The article will be from the following from the multi-dimensional analysis.

Challenges of international geopolitics to China's energy security.

China is highly dependent on imported oil and gas, especially from regions such as the Middle East, Africa and Russia. Geopolitical conflicts can lead to energy supply disruptions or price fluctuations. The situation in the Middle East: China relies on the Middle East (Saudi Arabia, Iran, Iraq, etc.) for about 50 % of its crude oil imports. Instability in the region, such as the civil war in Yemen or the confrontation between the US and Iran, could trigger supply disruptions or sharp price swings. For example, the attack on Saudi Aramco's oil facilities in 2019 led to a 19 percent one-day jump in international oil prices, directly affecting China's import costs.

The knock-on effects of the Russia-Ukraine conflict: Western sanctions on Russia have forced Russian energy to shift to Asia, and Chino-Russian energy cooperation has deepened (such as the Power of Siberia 2 gas pipeline), but long-term dependence may face technical limitations (such as the Arctic LNG project requires Western equipment) or geopolitical balance risks (excessive dependence on a single partner).

Resource nationalism looked up some resources through nationalization, raise import or export restrictions to strengthen control, such as Indonesia banned nickel exports to domestic processing industry, impact China's stainless steel and battery industry chain. Congo (DRC) imposes a windfall tax on cobalt mines, increasing the cost of Chinese new energy enterprises.

Energy transport security: vulnerability of critical corridors.

Maritime transport risk choke points. Malacca dilemma: 80 % of China's oil imports

pass through the Strait of Malacca, which is under the influence of military powers such as the United States and India. If a conflict breaks out, the risk of a blockade could pose a serious threat to energy security [49, p. 16–20].

South China Sea disputes: U.S. freedom of navigation operations have increased regional tensions and may interfere with the passage of Chinese liquefied natural gas (LNG) vessels, such as the incursion of U.S. vessels into waters near China's islands in the South China Sea in 2021.

Assistantship economic corridor (port of radar) and Myanmar's oil and gas pipelines to bypass the Malacca, but political instability in Pakistan, Myanmar civil war could threaten project operation. For example, the political changes in Myanmar in 2021 led to the security pressure of China-Myanmar oil and gas pipeline is increasing sharply.

Key lithium mineral supply chain be politicized rare earth and other new energy resources become a superpower game key focus. The United States has promoted the Mineral Security Partnership (MSP) in an attempt to build supply chains that exclude China. Australia, as the largest supplier of lithium ore to China (accounting for 60 % of imports), if it follows the United States to restrict exports, it will affect the Chinese battery industry.

United ally limiting exports to China of high-end energy technologies, such as shale gas equipment, nuclear reactor components), hinder China's energy structure to upgrade. The EU's Carbon Border Regulation Mechanism (CBAM) forces China's new energy products to meet its standards, increasing the cost of exports.

Dollar hegemony and energy financial risk, the international energy trade settled in dollars, U.S. sanctions against other countries (such as Iran) by SWIFT system may be

affected Chinese energy companies. China promotes yuan oil futures (such as the Shanghai INE crude futures), but accounts for only 6 % of global trading volume in 2023, far less than Brent and WTI.

Differentiation of multilateral mechanisms

Measures such as the OPEC+ production cut agreement and the G7 price limit on Russian oil have changed the rules of the global energy market. China needs to balance its position between the global South and developed countries, such as India's cheap purchase of Russian oil to squeeze China's bargaining space.

China's response strategy and effectiveness

Diversified energy supply and transport network. Import sources: Expand oil and gas imports from Russia and Central Asia (Russian oil will account for 18 % of China's imports in 2023), and explore new channels in Latin America (Brazil's pre-install oil fields) and Africa (Angola, Nigeria) [52, p. 20–21].

The construction of the China-Russia East Route natural gas pipeline and the second phase of the China-Kazakhstan crude oil pipeline will increase the proportion of land transportation. Developing Arctic shipping routes (the Ice Silk Road) to reduce dependence on traditional routes.

Strengthen strategic reserves and emergency response capabilities

China's strategic petroleum reserve is about 70 days (IEA recommends 90 days), with plans to increase to 100 days by 2030; expand the LNG receiving station (such as the receiving capacity of 120 million tons/year by 2025), and improve the natural gas peak load capacity.

Breakthrough technology bottleneck and industrial chain autonomy.

Work on shale gas extraction technology (filing shale gas field accounts for 60 % of the country's output) and the fourth-generation nuclear power (Huang Showmanship high-temperature gas reactor) to reduce external dependence.

Layout of lithium resource replacement technology: The cost of lithium extraction in Qinghai Salt Lake is reduced to 30,000 yuan/ton (2023), and the recovery rate of power batteries is targeted to reach 50 % in 2025.

Deepen international cooperation and rule-shaping.

Leading the BRICS energy cooperation platform and promoting local currency settlement (for example, RMB accounts for 34 % of energy transactions between China and Russia) It has participated in the formulation of international green hydrogen standards, launched the Belt and Road energy partnership (which has been joined by 30 countries), and exported UHV and smart grid technologies [55, p. 3–4].

Future challenges and trends include:

1 Climate issues are intertwined with geopolitics.

The EU carbon tariff and the US Clean Competition Act bind competition in the new energy industry to emission reduction, and China needs to deal with "green barriers" and technical standards.

2 Reconstruction of new energy geopolitical pattern

The competition for future energy technologies such as hydrogen energy and controlled nuclear fusion has intensified, and the joint research and development of the United States, Europe and Japan may form a technological monopoly, and China needs to strengthen investment in basic research.

3 Non-traditional security threats are on the rise.

With cyber attacks likely to cripple energy infrastructure (such as the 2022 European LNG terminal hack), China needs to improve its energy system cybersecurity.

Conclusion

The extensive utilization of energy is an important feature of modern civilization. It has not only promoted the development of human civilization but also brought challenges to humanity. For more than 100 years, developed countries have successively completed industrialization, consuming a large amount of natural resources on the Earth, especially energy resources. At present, some developing countries are entering the industrialization stage, and increasing energy consumption is an inevitable result of economic and social development. After being hit by multiple energy crises, major countries around the world have all regarded energy security as an important part of their national security strategies. In the era of economic globalization, national security is reflected in maintaining the speed and stability of economic development. Maintaining energy security is an important guarantee for the sustainable development of the economy and society.

Since 2013, China became the world's biggest energy producer and consumer. The continuous growth of energy supply has provided important support for the development of China's economy and society. Meanwhile, the rapidly growing energy consumption has brought broad development space to the world energy market. China has become an indispensable and important part of the world energy market and is playing an increasingly significant and positive role in maintaining global energy security. The changes in the international energy situation have brought both opportunities and challenges to China's energy diplomacy. This paper analyzes the changes and impacts of the international energy network, identifies the problems that the changes in the energy network may bring

to China's energy security, and puts forward suggestions to promote China's energy security, thereby conducting in-depth research and analysis on the current situation and development trend of China's energy security. Chapter One introduces the current situation of China's energy development. It presents the current situation of China's energy development from three major aspects: the dominant position of traditional energy, the driving force of energy diversification, and the challenges faced by energy development. Meanwhile, the current situation is described in detail from aspects such as the dominant position of traditional energy, the rapid development of renewable energy, the development of new energy, environmental and social responsibility, energy security and policy support, economic transformation and technological progress, and the insufficient stability of new energy supply. Chapter Two describes the current changes in the international energy market from three aspects: the changes in the international energy situation, the development trend of international energy, and the impact of the changes in the international energy situation on China's energy security. The development and changes of the international energy market were introduced in detail from aspects such as the stability of international energy prices, the loose overall supply and demand pattern of the natural gas market, and the short-term balance of regional markets. Chapter Three starts from the energy trade network and discusses the impact on energy security from aspects such as the continuity of supply, the stability of prices, energy diversification, energy security, geopolitics and the environment.

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