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Field of study	38.04.01 Economics
Master's degree programme	International Economics and Business

GRADUATION THESIS

on

Specific features of ensuring China's energy security under contemporary conditions

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ASSIGNMENT
FOR THE GRADUATION THESIS OF

Master's degree student Lin Hui, group 24ЭЭвам1, full-time mode of study

1 The topic of the graduation thesis: "Specific features of ensuring China's energy security under contemporary conditions"
was approved by the university order
dated «___»_____20__ no. _____
2 The deadline for the Master's degree student to complete the graduation thesis is 15.06.2026.
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 the demand situation for energy in China; the significance of energy trade for China; the problems existing in China's energy trade; the development prospects of China's energy trade impact on China's energy security issues; countermeasures and recommendations for enhancing China's energy security.
5 The list of visuals contains tables and figures.
6 The date of setting the assignment is 8.10.2024.

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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	1.09.2024 – 31.10.2024	
2	Framing the scientific concept of research	1.11.2024 – 18.12.2024	
3	Collection of scientific literature for the thesis	19.12.2024 – 15.01.2025	
4	Substantiating the relevance, concept, and novelty of the research	16.01.2025 – 19.02.2025	
5	Framing of a detailed plan and layout of the research	20.02.2025 – 12.03.2025	
6	Studying new literature sources within the topic of the thesis	13.03.2025 – 26.03.2025	
7	Conducting theoretical research within the first chapter of the thesis	27.03.2025 – 30.04.2025	
8	Preparing the first chapter of the thesis	1.05.2025 – 30.06.2025	
Second year of study			
9	Conducting analytical research within the second chapter of the thesis	1.09.2025 – 22.10.2025	
10	Preparing the second chapter of the thesis	23.10.2025 – 24.12.2025	
11	Conducting analytical research within the third chapter of the thesis	25.12.2025 – 25.02.2026	
12	Preparing the third chapter of the thesis	26.02.2026 – 21.04.2026	
13	Preparing the introduction and conclusion	22.04.2026 – 12.05.2026	
14	Completing the graduation thesis	13.05.2026 – 27.05.2026	
15	Handing in the thesis for compliance control and antiplagiat	28.05.2026 – 11.06.2026	
16	Getting acquainted with the feedback and review	13.06.2026	
17	Presenting the written thesis	15.06.2026	

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Summary

The graduation thesis comprises 65 pages, 3 chapters, 23 figures, 1 table, 62 sources.

ENERGY COOPERATON, ENERGY RESOURCES, CHINA, ENERGY TRADE, ENERGY SECURITY

The object is China’s energy security.

The research purpose is to analyze specific features of China’s energy security provision.

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: the demand situation for energy in China was studied; the significance of energy trade for China was examined; the problems existing in China's energy trade were revealed; the impact of energy trade on China's energy security was examined.

The novelty of the study consists in identifying the specific features of China’s energy security that emerge from the simultaneous pursuit of carbon neutrality and the maintenance of stable economic growth in a rapidly transforming global energy landscape. The work reveals the interaction between the domestic structural duality of coal and renewables and the new vulnerabilities generated by supply chain interdependence, technology gaps, and critical mineral availability.

The research deepens the theoretical understanding of the trade–security nexus by revealing feedback loops between import dependency, technological constraints, and the pursuit of strategic autonomy. In doing so, it bridges classical energy geopolitics with the political economy of clean energy transitions.

Practical significance is that this research helps Chinese decision-makers identify the weakest points in energy supply, transportation, and technology. It offers concrete, evidence-based recommendations for improving energy security in the medium and long term.

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Introduction

Energy security is an important component of a country's economic security system and serves as the foundation for maintaining stable economic development and social stability. The issue of energy security is a cornerstone of national economic stability and strategic autonomy. For China, the world's largest energy consumer and importer, this problem acquires unique features under contemporary conditions shaped by the accelerating global energy transition, heightened geopolitical tensions, and deep domestic structural reforms. China's energy system is caught between traditional supply-demand imbalances and new vulnerabilities arising from the decarbonization agenda. Meanwhile, the national commitment to peak carbon emissions by 2030 and achieve carbon neutrality by 2060 compels a fundamental reconfiguration of the energy mix away from coal toward renewables, nuclear, and advanced storage. This transition, vital for climate goals, introduces intermittency, grid stability challenges, and critical mineral supply risks, thereby expanding the concept of energy security beyond physical availability to include technological sovereignty, and environmental sustainability. Furthermore, the Belt and Road Initiative adds an external dimension: overseas energy infrastructure investments serve as both a means to diversify supply routes and a source of political and financial risk. The US-China rivalry, export controls on advanced energy technologies, and the reshaping of global energy governance demand a thorough reassessment of China's strategies. Consequently, identifying the specific features of China's energy security policy in this dynamic environment – such as the dual reliance on coal and renewables, state-led technological leapfrogging, and an integrated internal-external security logic – is both timely and academically significant. A comprehensive analysis of these features is essential for formulating effective countermeasures and recommendations to safeguard China's long-term development amid unprecedented uncertainty.

In the context of a globalized market, oil and gas trade is merely a single commodity transaction; it also involves multiple factors such as supply, transportation, prices, politics. From a social perspective, stable oil and gas trade can maintain the stability of social livelihoods, meet all aspects of residents' lives and the production of society. Stable input

of oil and gas supply can ensure the continuous supply of domestic oil and gas consumption, prevent price hikes, production stagnation, and social problems due to energy shortages, and maintain the normal order of people's lives.

The object is China’s energy security.

The subject comprises the specific features that characterize the process of ensuring China’s energy security under contemporary geopolitical, technological, and ecological conditions.

The research purpose is to analyze specific features of China’s energy security provision.

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

– to examine the dynamics of energy demand in China and to determine the systemic significance of international energy trade for the country’s economic stability and resource sufficiency;

– to analyze the current supply situation of oil and natural gas in China, identifying the key structural imbalances and import dependencies that shape the resource base;

– to evaluate the specific risks embedded in oil and gas transportation routes and trade mechanisms, including maritime chokepoints, geopolitical disruptions, and contractual vulnerabilities;

– to reveal and classify the market limitations and technological constraints that reduce China’s position in international energy markets;

– to forecast prospective trajectories of China’s energy trade and to assess how these trends influence the country’s energy security, exposing the specific features that distinguish China’s current situation;

– to synthesize the findings into a set of targeted countermeasures and evidence-based recommendations for strengthening China’s energy security, taking into account the identified distinctive features and contemporary global challenges.

The novelty of the study consists in identifying the specific features of China’s energy security that emerge from the simultaneous pursuit of carbon neutrality and the maintenance of stable economic growth in a rapidly transforming global energy landscape. The work reveals the interaction between the domestic structural duality of coal and

renewables and the new vulnerabilities generated by supply chain interdependence, technology gaps, and critical mineral availability.

The research deepens the theoretical understanding of the trade–security nexus by revealing feedback loops between import dependency, technological constraints, and the pursuit of strategic autonomy. In doing so, it bridges classical energy geopolitics with the political economy of clean energy transitions.

Practical significance is that this research helps Chinese decision-makers identify the weakest points in energy supply, transportation, and technology. It offers concrete, evidence-based recommendations for improving energy security in the medium and long term.

The work structure is determined by the purpose and tasks decided in the work. Chapter 1 establishes the analytical foundation of the study by examining the scale, structure, and dynamics of China's energy demand. It traces the main drivers of consumption growth across industrial, residential, and transportation sectors and then demonstrates the pivotal role international energy trade plays in bridging the gap between domestic resource endowment and the needs of a continuously expanding economy. Chapter 2 provides a systematic diagnosis of the vulnerabilities and structural imbalances embedded in China's current energy trade. It first analyses the supply situation for oil and gas, highlighting import dependency ratios, geographical concentration of suppliers, and domestic production constraints. The chapter then maps the specific risks along transportation corridors – maritime chokepoints, pipeline geopolitics, and exposure to regional conflicts – as well as commercial and logistical risks in trade operations. Chapter 3 shifts from diagnosis to forward-looking assessment and synthesis. It forecasts the development prospects of China's energy trade under competing scenarios (decarbonisation pressures, technological breakthroughs, shifting global alliances) and evaluates how these trajectories shape the distinctive contours of China's energy security.

Chapter 1 Overview of China's international trade

1.1 The demand situation for energy in China

The impact of oil and gas on national development cannot be ignored. Energy resources have always been the main pillar and driving force of a country's economic development. Historically, the extraction and utilization of oil enabled the United States to rise, while it also limited the strategic space of Germany and Japan. As one of the world's largest energy producers and consumers, China's energy demand not only affects its own economic development, but also some minor changes can affect global energy trade and the strategic development of various countries' markets. Given the actual national conditions, such as: promoting the process of the dual carbon target, the transformation of the energy economy, and the reorganization of industrial scale, China's energy has shifted from traditional energy to clean energy. The overall energy demand is still growing steadily, and the focus of demand has also changed [35]. It is no longer the model of developing countries that is dominated by industrial energy demand, but rather pays more attention to low-carbon and environmentally friendly energy demands, while closely integrating with the current international situation and the supply and demand pattern of global energy trade. Figure 1 shows China's crude oil import volume from 2015 to 2020.

Figure 1 – China's crude oil import volume from 2015 to 2020 (unit: billion tons) [5]

As can be seen from the figure, from 2015 to 2020, China's crude oil demand continued to grow rapidly. There was a slight decline from 2021 to 2022. In 2023, the trend rebounded and the crude oil import volume reached 564 million tons. In 2024, it slightly decreased, but soon in 2025 it reached a new high in the past decade, with the crude oil import volume reaching 578 million tons [30].

Figure 2 gives us information on annual natural gas imports in China.

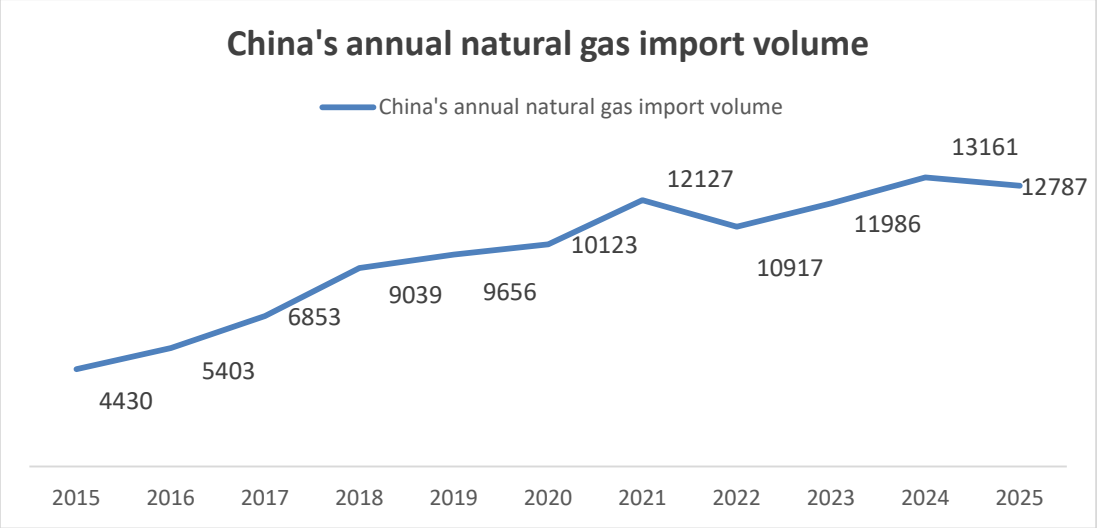

Figure 2 – Annual natural gas imports in China from 2015 to 2025 (unit: thousand tons) [5]

As can be seen from the graph, China's natural gas production experienced a negative growth for the first time in 2022. This was due to the sharp increase in international gas prices, which led to a decrease in domestic demand for natural gas in China.

The demand for energy in the industrial structure.

From the perspective of industrial consumption demand, as China's economy continues to recover, its energy demand remains in a stable growth trend. According to relevant data from the National Energy Administration, in 2024, China's total energy consumption exceeded 5.9 billion tons of standard coal, with a growth rate that has accelerated compared to previous years. The year-on-year growth rate was 4.3 %. When manufacturing shifts from auxiliary processing factories to main producers, and when

society's towns develop and various digital economy and emerging technology industries are implemented, this further stimulated energy demand [31].

Figure 3 shows proportion of oil consumption by industry.

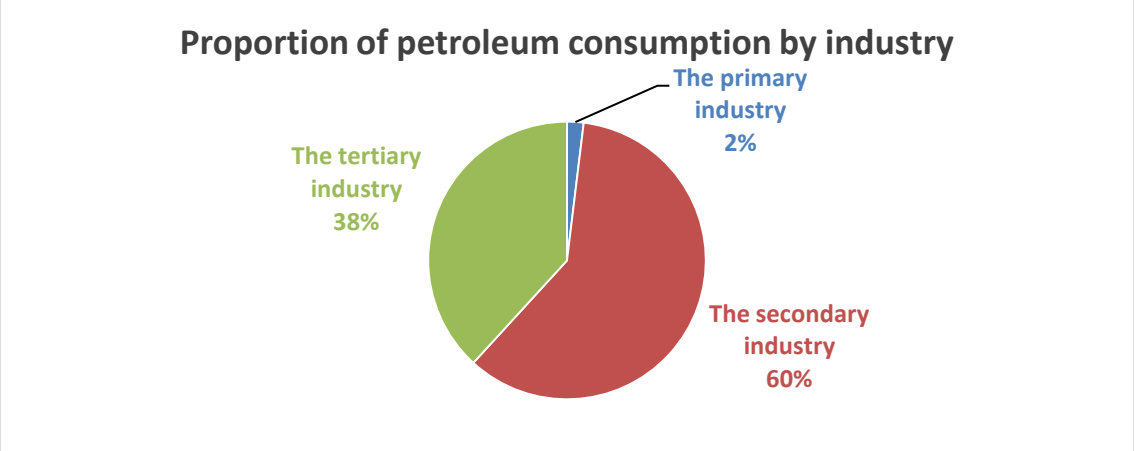

Figure 3 – Proportion of oil consumption by industry from 2015 to 2025 [55]

The energy demand of China's primary industry accounts for a relatively small proportion of the total energy demand of the entire society [21]. Agriculture is gradually shifting from traditional manual and animal-powered operations to mechanization and electrical intelligence. The main reason for this is that the energy demand of mechanical equipment is higher, such as temperature control systems for greenhouses, field irrigation, agricultural product harvesting and drying processing, as well as cold chain storage and transportation, which mainly rely on electricity, solar energy and natural gas, with clean energy being the main source. A large amount of recyclable energy is applied to agricultural production, thereby replacing traditional petroleum products like diesel and gasoline. Therefore, with the development of China's rural revitalization and agricultural modernization, the target energy demand of the primary industry is mainly clean, circular and renewable environmentally friendly energy. This not only increases agricultural product output but also meets the requirements of low-carbon and environmental protection.

Figure 4 shows proportion of gas consumption by industry from 2015 to 2025.

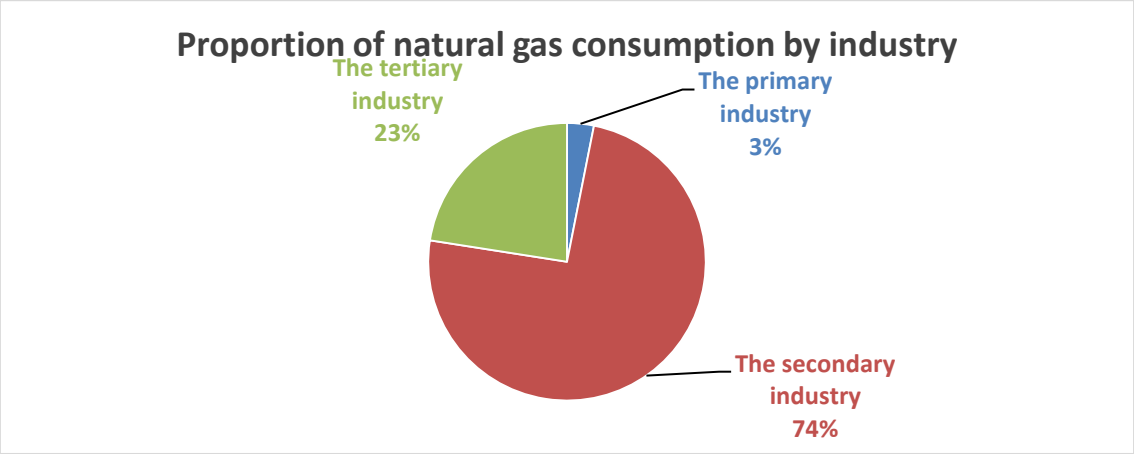

Figure 4 – Proportion of gas consumption by industry from 2015 to 2025 [55]

The secondary industry in China is the main driving force behind the growth in energy consumption demand. It accounts for more than two-fifths of the total energy consumption in society. With the development of high-tech and technology manufacturing industries, the energy consumption demand in these sectors has increased. On the contrary, the growth rate of energy demand in high-energy-consuming industries has slowed down. Currently, the energy demand of the industrial sector is concentrated in high-energy-consuming industries such as steel, chemical engineering, building materials, and equipment manufacturing. Electricity, oil, coal, and natural gas are the main fuels. In summary, the energy demand of the industrial sector is relatively large, but its energy consumption intensity has decreased. From the improvement in energy utilization rate, it can be seen that the use of traditional energy is more reasonable, with the aim of using energy as little as possible while maximizing its utilization. Figure 5 shows China's crude oil consumption from 2015 to 2025.

China's crude oil consumption has shown an upward trend from 2015 to 2025. As can be seen from this figure, a new growth point emerged in the past decade in 2020, reaching 737 million tons. There was a slight decrease from 2021 to 2022, but it rebounded to 773 million tons in 2023. From 2024 to 2025, it began to level off.

The energy demand of China's tertiary industry is growing rapidly. With the development of the digital economy, the proportion of the tertiary industry in the total energy consumption of the entire society continues to rise.

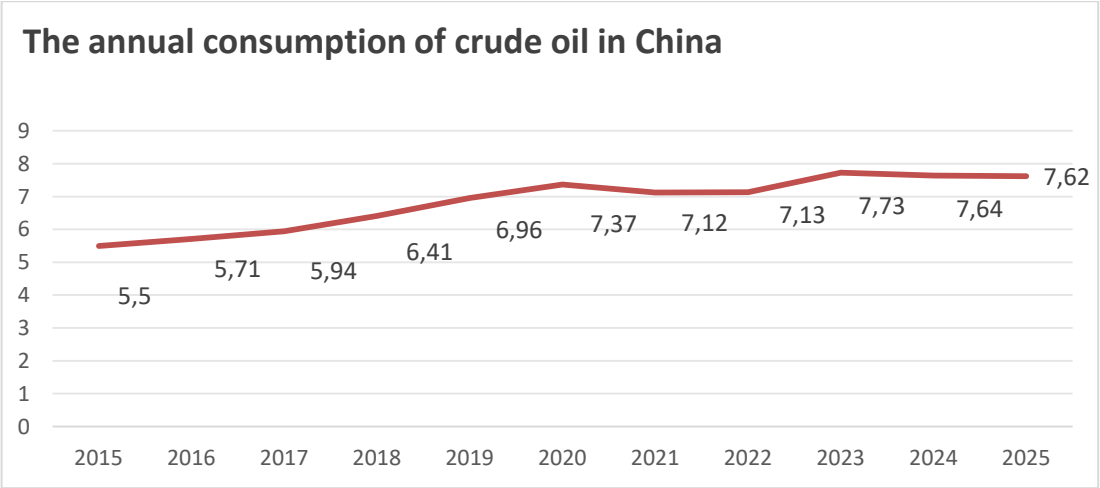

Figure 5 – China's crude oil consumption from 2015 to 2025 (unit: billion tons) [55]

Facilities and equipment such as data centers, 5G base stations, transportation logistics and commodity trading services have led to an increase in the total electricity consumption of society. This mainly includes transportation, warehousing and logistics, data services, commodity retail, and labor services, etc. As consumers' purchasing power increases, the energy demand mainly consists of electricity, refined oil, and natural gas. The energy usage speed of these industries closely related to consumption has accelerated, and energy consumption also increases accordingly as the consumption situation changes.

Since the founding of the People's Republic of China, coal has long been regarded as the fundamental energy source of the country. It holds a dominant position in the national energy consumption market and plays the role of a balancing stone in China's energy security issues [1]. With the global warming and the dual carbon goals, the concept of energy conservation and emission reduction, as well as green energy [51], the demand for coal in China has shown a trend of increasing year by year but at a slow pace [25]. Compared to a decrease of over 10 percentage points ten years ago, this can directly reflect that China is accelerating its transition from traditional fossil and non-renewable energy sources to clean and low-pollution fossil energy sources [33]. The consumption of fossil energy such as coal has gradually changed from an increase in overall demand to a decrease in demand. Currently, China's energy structure has shifted from being dominated by coal to a diversified mix of clean and renewable energy. This transformation strategy has also led to a rapid increase in China's demand for clean energy, making it a direction

for the future energy development towards renewable and low-pollution fuels.

Figure 6 gives us information on annual coal consumption in China.

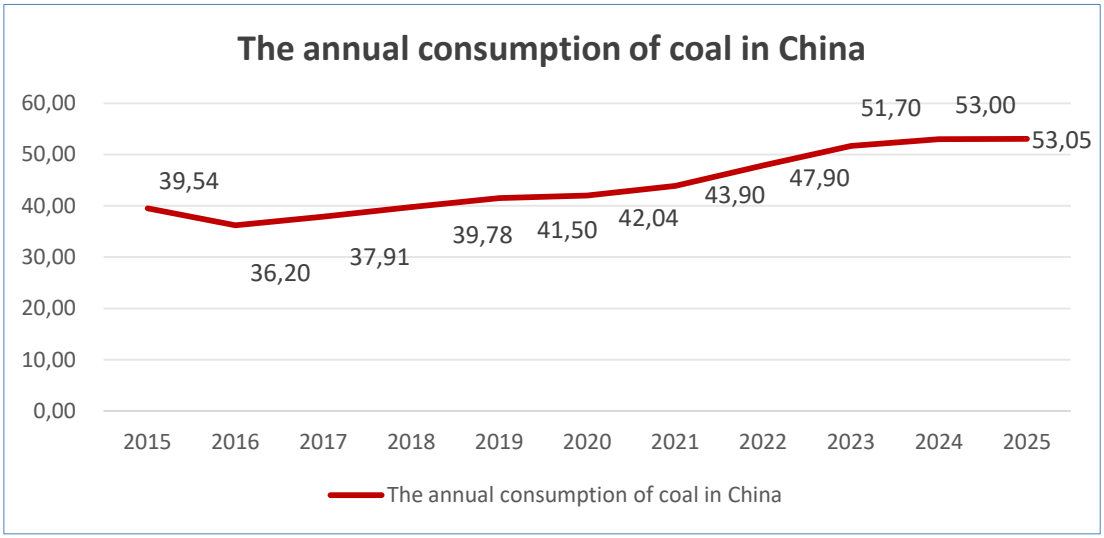

Figure 6 – Annual coal consumption in China from 2015 to 2025 (unit: billion tons) [36]

As can be seen from the graph, the overall consumption volume shows a gradual upward trend. From 2015 to 2016, the consumption volume declined due to production capacity constraints. It reached a low point of 3.620 billion tons in 2016, but from 2017 to 2025, it showed an upward trend. The total consumption of coal energy in China can be divided into three stages. From 2015 to 2020, it showed a steady growth; from 2021 to 2023, the growth was relatively significant; and from 2024 to 2025, it was basically at a stable level [30].

During the period from 2015 to 2016 when China was in the initial stage of replacing coal with gas, the demand for natural gas in China grew at a slow pace. From 2017 to 2021, due to the implementation of relevant policies, the demand for natural gas increased rapidly, with an average annual growth rate of around 15%. In 2022, the consumption first showed a negative growth, with a consumption volume of 366.3 billion cubic meters (figure 7).

Due to its advantages such as low carbon emissions and environmental friendliness, natural gas, as a representative low-pollution fossil energy among traditional energies, is leading the growth in demand for traditional energy. According to data from relevant

departments, the consumption of natural gas will increase by approximately 7 % in 2024.

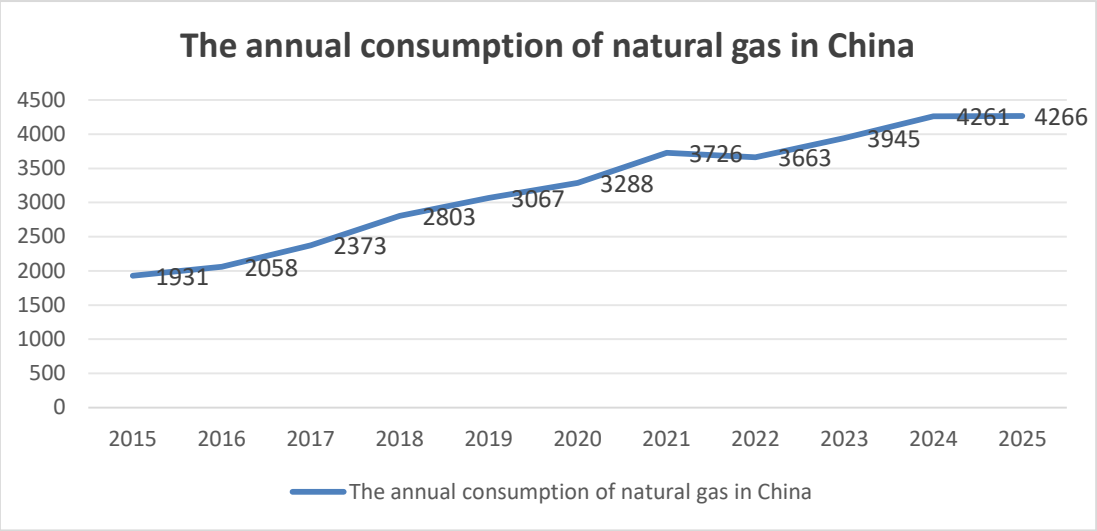

Figure 7 – Annual consumption of natural gas in China from 2015 to 2025 (unit: billion cubic meters) [55]

It is widely used in power generation, heating, industrial fuel, and residential water and electricity supply, among other areas. Most traditional energies are mainly composed of non-renewable fossil fuels, including coal, oil, natural gas, nuclear fission energy, and hydropower. Except for hydropower, most of them are classified as unsustainable resources and will release a large amount of pollutants into the environment. When these resources are exhausted, the energy supply will be directly interrupted, affecting the security of a country's energy.

Natural gas, leveraging its own advantages, plays a crucial role as a transitional energy source in the energy transition [46]. China ranks first in the world in terms of installed capacity of renewable energy sources such as hydropower, photovoltaic power, and wind power. Considering the data from 2024, the proportion of non-fossil energy consumption has increased by more than 19 %, surpassing oil to become the second-largest energy consumption type in China. Renewable energy is gradually replacing traditional high-pollution energy sources, shifting from a supplementary and auxiliary role to a main energy role. At the same time, the construction of wind power, photovoltaic power stations, and nuclear power plants in China has become a solid foundation for this

transformation. From the perspective of the consumer market, China has seen the popularization of new energy vehicles, and public transportation and service facilities encourage the use of new energy power generation, resulting in a decrease in oil demand and a slower consumption rate [15]. In 2024, oil consumption decreased slightly compared to the previous year, shifting from the previously common energy consumption structure to fields that cannot be replaced by alternative fuels such as chemical raw materials and aviation fuel.

The industrial sector has always been the main consumer of energy, accounting for about 60 % of the total energy consumption in society. Considering China's national conditions, it can be seen that the target demand for industrial energy has shifted from high energy consumption to high efficiency, and from high pollution and high emissions to low pollution and low emissions. The formulation of industrial strategic goals affects the changes in energy demand. In high-end manufacturing industries, the derived materials of petroleum can have characteristics such as high temperature resistance, high strength, or special chemical stability, enabling the aviation and shipping sectors to still rely on aviation kerosene and heavy oil. In the future, the demand for this fuel may decline somewhat, but its unique chemical value still exists for a long time. In recent years, in the transportation sector, the change in energy demand has been the most significant. The advent of new energy vehicles has reduced the dependence of new energy vehicles on petroleum fuels, but the existing market for fuel vehicles remains large [27]. The construction and popularization of corresponding supporting facilities such as charging stations and refueling stations will gradually replace highway gas stations with new energy sources like electricity and hydrogen, resulting in a year-on-year decrease in the demand for petroleum in the transportation sector [17]. In terms of residential life, the demand for water, electricity, and gas for residents has steadily increased. Clean energy heating is being piloted for application. The consumption of coal for heating will continue to decline and eventually be eliminated [22]. The energy demand in terms of people's livelihood is moving towards a clean and sustainable direction. Therefore, the energy consumption structure in China is dominated by industry, with the growth rate of emerging energy industries supplementing it, and the demand for energy in people's livelihood is stable and

moderately increasing.

China's coal production fluctuated slightly from 2015 to 2017 but remained at a relatively high level during that period. From 2018 to 2021, the coal export volume continued to decline, and it soon resumed growth from 2022 to 2024 (figure 8).

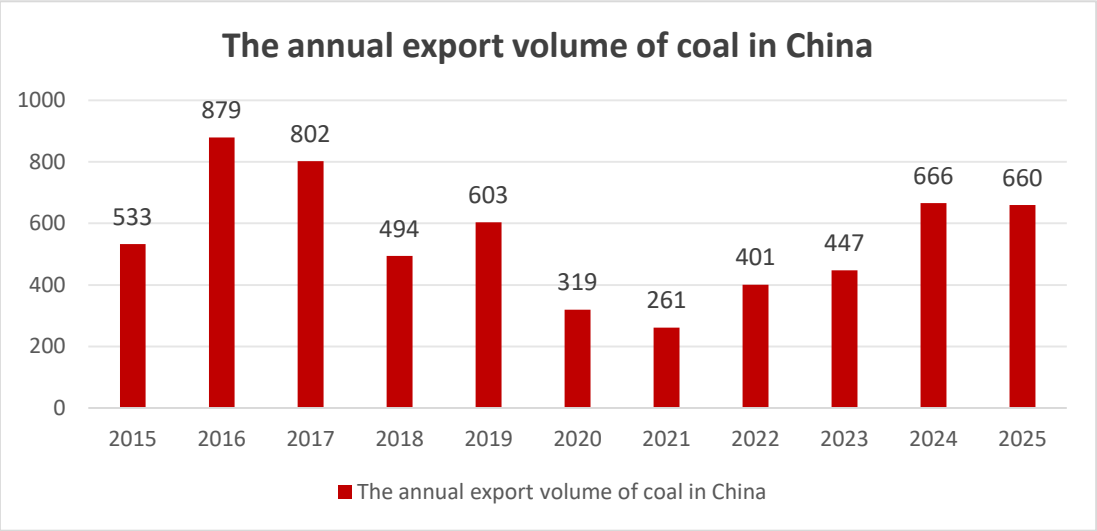

Figure 8 – Annual coal export volume of China from 2015 to 2025 (unit: million tons) [5]

China has a high dependence on energy imports, and structural contradictions still exist. To a certain extent, this reflects that energy security is prone to be affected by external factors, and the stability of energy supply is poor. China has sufficient reserves of coal resources, which can largely ensure self-sufficiency and provide guarantees for its own coal resources. At the same time, raw materials for non-fossil energy are installed on a large scale in China itself, that is, the total power generation of all power generating units in Chinese power plants operating at full capacity can basically enable the country to achieve self-supply [61]. However, China's own production of fossil resources such as oil and natural gas is difficult to achieve self-sufficiency. It needs to rely on imports to supplement the shortage of energy. As of now, China's dependence on oil imports exceeds 70 %, and its dependence on natural gas imports exceeds 40 %. This proportion can reflect that China is the largest crude oil importer and natural gas importer in the world. Russia, the Middle East, and Africa are the main sources of oil and gas imports for China. Due to

strong dependence on imports, China's energy demand is interdependent with global oil and gas trade. International situations, global supply chains, fluctuations in crude oil prices, and other international external factors can all affect the stable supply of energy in China. There are both advantages and disadvantages. This characteristic has placed China in a major buyer position in the global oil and gas trade market, further promoting the development direction of the global oil and gas trade pricing mechanism and trade.

In summary, the energy demand in China shows the following trends: Firstly, the overall growth rate of energy demand is gradually slowing down, with an improvement in quality and efficiency. Along with the process of China's economic transformation and the popularization of energy-saving technologies, the overall growth rate of oil and gas energy consumption is slow, and the energy consumption per unit of GDP has been decreasing year by year. The energy utilization rate has reached the advanced level of the international market. Secondly, the application of clean energy in China is gradually becoming widespread, and the proportion of non-fossil energy has gradually increased in recent years. Relevant data statistics and estimations show that by 2030, the proportion of non-fossil energy consumption in China will reach 25 %, and when achieving the carbon neutrality goal in 2060, non-fossil energy will become the absolute main force [34]. This also means that in the future, the demand for coal and oil will continue to decline, while the demand for natural gas will remain at a stable level. Finally, electricity will continue to develop in the energy terminal market. The quantity of non-renewable resources worldwide is limited, and the annual consumption cannot keep up with the speed of energy reserves and regeneration. This makes the future energy demand more diversified, rather than relying solely on a single energy source as a raw material. New energy and clean energy will be gradually developed, utilized, and popularized, gradually replacing traditional energy and completing the energy renewal and upgrading.

1.2 The significance of energy trade for China

China has abundant coal resources, and the amount of coal can be used domestically while also being exported as an energy source. The distribution of coal mines in China

shows a pattern of more in the north and less in the south, and more in the west and less in the east. The scale of their development and production ranks first in the world. Over 90% of China's coal is concentrated in the north. Shanxi, Shaanxi, Inner Mongolia and Xinjiang are the regions with the richest coal reserves, with combined reserves accounting for more than half of the national total. Shanxi produces high-quality coking coal and thermal coal, while the Yulin and Shenfu mining areas in Shaanxi are the largest high-quality thermal coal mining areas in China [9]. The coal mining areas in Inner Mongolia mainly consist of lignite and bituminous coal. The coal resources in the southern regions account for only about 10 %, mainly concentrated in Guizhou, Sichuan and Yunnan provinces. The coal produced in these mining areas has average quality and the mining difficulty is relatively high. It is worth noting that Xinjiang is a strategic development priority in the future. It is predicted that the coal reserves in Xinjiang are 2.19 trillion tons, accounting for about 40 % of China's total coal production. However, due to the long distance for coal transportation in Xinjiang, a new railway trunk line is being constructed, so the goal of transporting coal from Xinjiang to the outside world in a short period of time is difficult to achieve. The old mining areas in the northeastern part of China have gradually depleted their resources due to long-term mining operations and have seen a decline in production year by year. Therefore, the coal mining areas in the east have shown a state of contraction and transformation, while those in the west are waiting for development. The distribution of China's coal resources is uneven but highly concentrated. The mining conditions in various mining areas vary greatly, and the coal-producing areas are mismatched with the consumption areas. This has led to an increase in the pressure for long-distance transportation, including railway and maritime transportation [12].

Oil and gas energy belongs to non-renewable fossil energy. Its formation and distribution conditions are influenced by strict geological conditions, plate movements, and sedimentary environments. The distribution of oceanic plates across the world is uneven, showing high regional concentration. It mainly has specific basin characteristics. At the same time, there are significant differences in the distribution of land and sea. Unconventional oil and gas, such as coalbed methane, shale gas, and tight oil, have distribution characteristics that complement those of conventional oil and gas. China's oil

endowment is relatively insufficient, with low reserves available per capita. The distribution of oil resources is dominated by land, supplemented by offshore areas. The western regions of China have more resources than the eastern regions, and the northern regions have more resources than the southern regions.

The distribution of China's petroleum resources, including onshore petroleum resources, is mainly concentrated in the Daqing Oilfield in the Northeast Songliao Basin, the Shengli Oilfield in the North China Bohai Bay Basin, the Southwest Oilfield in the Sichuan-Shaanxi Basin in the Northwest, and the Tarim Oilfield in the Xinjiang Tarim Basin. The Daqing Oilfield is the cradle of China's petroleum industry. Over the past several decades, it has consistently played the role of the main supplier of China's petroleum. Long-term exploitation has led to the decline in reserves and production, and the increase in production has become increasingly difficult to meet the demand. The Changqing Oilfield in the Ordos Basin is the largest oil and gas field in the country, mainly developing tight oil and conventional oil. The Tarim Basin mainly focuses on the exploitation of deep and ultra-deep oil fields, and the exploration of the Junggar Basin oil fields has also made some breakthroughs. These areas are important oil-producing regions in the Northwest.

The distribution of offshore oil resources mainly includes the Penglai Oilfield in the Bohai Sea, the Chunxiao Oil and Gas Field in the East China Sea, and the Yinggehai Basin in the South China Sea. Currently, the Bohai Oilfield has been developed into the largest offshore oilfield in China, with its production increasing year by year. Other oil and gas fields are also steadily increasing their output. However, due to the demanding exploration technology requirements and harsh mining conditions in the deep-sea area, it is difficult to compare the production with that of onshore mining in a short period of time. Therefore, it has been mainly carried out in a steady manner.

The distribution of natural gas resources in China is mainly concentrated in the western regions such as Tarim, Ordos and Sichuan Basin, as well as the eastern regions like Songliao, Bohai Bay and the offshore areas. Compared to oil resources, natural gas resources in China are relatively more abundant. However, they still cannot meet the demand of the population. The distribution of natural gas in China is mainly on land, with

the western regions being the main force. The offshore gas-producing areas serve as a supplement. The Sichuan Basin in China is the largest natural gas production base in the country. The storage capacity of conventional gas and shale gas in this region ranks first in the whole country. The large-scale development of shale gas in southern and eastern Sichuan can not only meet the gas demand in the southwestern region of China, but also transport the surplus natural gas to the central and eastern regions of China. Natural gas in the offshore areas is primarily distributed in the Yinggehai, Qiongdongnan, and Pearl River Mouth areas of the South China Sea, as well as the East China Sea Basin. The main reservoirs are deep-water and high-pressure gas reservoirs. At present, some gas fields have been put into use, providing clean energy for certain areas.

The scale of China's oil and gas enterprises is mainly led by China National Petroleum Corporation, which is one of the largest oil and gas producers in China. Their business covers exploration and development, refining and sales, new energy, etc. The headquarters is located in Beijing and it is a large state-owned enterprise directly managed by the central government. The structure and pattern of China's oil and gas industry are dominated by the Three Oil Giants – China National Petroleum Corporation, China Petroleum & Chemical Corporation, and China National Offshore Oil Corporation. Private enterprises and foreign capital gradually penetrate in specific fields.

The history of China's oil and gas development covers the ancient discoveries, the modern start-up, the breakthroughs after the founding of the People's Republic of China, and the formation of the modern system. Shen Ku in the Northern Song Dynasty was the first to propose the concept of petroleum and predict its uses. During the Northern and Southern Dynasties, oil was extracted in the most primitive methods in places like Jiuquan and Sichuan. The drilling technology of the Zhuangzi well was hailed as the father of modern Chinese oil drilling in the world. After the founding of the People's Republic of China, the Daqing Oilfield was discovered in 1959 and put into production in 1965, ending the title of a country lacking oil resources. In the 1980s, major production bases such as Daqing, Shengli, and Tarim were formed. In recent years, the total production of natural gas and oil in China has been basically balanced.

The development history of China's petroleum industry is an important part of

China's industrialization process. From the difficult initial stage before the founding of the People's Republic of China to becoming a major oil-producing country in the world today, it has undergone tremendous changes. Although China's oil production was only 120,000 tons before the founding of the People's Republic of China, and it was mainly concentrated in a few regions such as Yanchang in Shaanxi Province, Yumen in Gansu Province, and Dushanzi in Xinjiang Province, under the leadership of the Communist Party, China's petroleum industry gradually rose. In 1952, the national oil production reached 435,000 tons, and then it entered a stage of rapid development.

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Since the 1860s, China began importing oil. Until the 1950s, China was consistently labeled as a poor country with low oil production and experienced an oil import era that lasted for over 80 years. To rewrite history and provide a solid industrial foundation for the emerging People's Republic of China, the workers in China's oil industry made arduous and extraordinary efforts. With the development of the Yumen and Karamay oil fields in the 1950s, as well as the development of the Daqing and Shengli oil fields in the 1960s, and with domestic crude oil production exceeding 100 million tons in 1978, China entered the ranks of the world's major oil producers. In 2023, the total national oil and gas production exceeded 390 million tons, and natural gas and oil achieved balanced output. Over the past few decades, China's oil and gas industry has achieved remarkable accomplishments. It has not only become the world's fifth-largest oil producer, the largest refiner, and the second-largest ethylene producer, but has also formed a complete oil industry system.

In 1960, the discovery of the Daqing Oilfield marked a significant turning point in China's petroleum industry. It signified the centralized development of oil fields across the country and an increase in production capacity. Through a series of large-scale oil development operations, especially the development of the Daqing Oilfield, China's oil production experienced explosive growth in the 1970s, increasing from 31 million tons in 1970 to over 100 million tons in 1978, and it entered the ranks of the world's major oil producers.

Since the implementation of the reform and opening-up policy, China's petroleum industry has continued to thrive. From 1981 to 2010, the oil production increased from 100 million tons to 200 million tons. The rapid rise of emerging enterprises such as China National Offshore Oil Corporation which is dedicated to developing offshore oil and gas resources has further strengthened China's position in the global petroleum market.

From a global perspective, oil remains a crucial energy source for social and economic development. Since the 20th century, with the rapid growth of the global economy, the consumption of oil has significantly increased. In 2023, approximately one-third of the world's oil supply came from oil, indicating its importance in meeting global energy demands. Although China's annual energy demand is constantly increasing, especially during periods of rapid economic development, the scale of imports is also rising. However, China's own oil production capacity has established an important bottom line for the country's energy security.

China's petroleum industry not only promotes the development of the domestic economy, but also gradually assumes an important position in the global energy market. Enhancing its own independent research and development capabilities, rationally utilizing and developing domestic resources, and ensuring national energy security are the key tasks that China's petroleum industry needs to accomplish in the future.

The contributions of China's oil and gas resources to the world mainly lie in the following aspects.

Ensuring the stability of global energy supply and enhancing energy self-sufficiency. Through major discoveries such as the Daqing Oilfield and the Mahe Limestone Oilfield, China has achieved oil self-sufficiency and became the fifth largest

crude oil producer in the world in 2023, significantly reducing its reliance on external energy. Stabilizing global oil price fluctuations. As the world's largest energy consumer, China provides stable support for the global energy market through diversified energy supply, such as the China-Russia East Pipeline, Gwadar Port, and reducing dependence on Western markets. Promoting energy technology innovation and industrial upgrading, reflected in deep-sea and unconventional resource development. China has made breakthroughs in deep-sea mining and unconventional oil and gas resources, with its technological level ranking among the world's top, breaking the Western monopoly. Promoting the diversification of the global energy market and breaking the monopoly of Western markets. Through technological breakthroughs and diversified cooperation, China gradually weakened the control of Western countries over the global oil market through the financial system and maritime channels. Promoting the development of emerging markets. In deep-sea projects in countries like Brazil, it provides employment opportunities for the local population and vigorously promotes technology output and sharing, exporting exploration and development technologies and green energy solutions to other countries, promoting global energy technological progress and following a global energy sustainable development path. Assisting in the global green and low-carbon transformation. Promoting the optimization of energy consumption structure, China's refined oil consumption has entered a downward trend, providing a model for global climate change response. Through supporting the technological innovation and upgrading of renewable energy, China provides technical support and market experience for global clean energy transformation [50].

Through the Belt and Road initiative, the China-Russia East Pipeline, etc., China signs long-term energy agreements with many countries, enhancing its voice in global energy governance [41].

The rise of China's petroleum industry is attributed to the strong support from national policies and the continuous investment in technological innovation. In recent years, China's petroleum production has steadily increased, technological innovations have continuously broken through, and international cooperation has deepened. These factors have jointly contributed to China's leading position in the global energy market.

The smooth conduct of oil and gas trade can ensure the security of China's energy supply. Adequate energy supply can enable the stable operation of the national economy. This is also the significance of oil and gas trade for the stability of China's society. Based on its own natural resources, China conducts auxiliary oil and gas trade, which serves as a reliable way to address the contradiction between energy supply and demand. The output of China's oil and gas does not match the rapidly growing consumption demand, resulting in a gap between energy supply and demand. However, oil and gas trade can fill this gap, achieving a balanced overall energy supply. This directly relates to the continuity of a country's energy supply and can prevent the sudden impact on national industrial production, transportation, and people's livelihood security when there is a shortage of energy demand. It also protects the stable operation of China's society by safeguarding the raw materials needed.

Chapter 2 The problems existing in China's energy trade

2.1 Current supply situation of oil and gas in China

The main mode of transportation and import for China's oil and natural gas is by sea, with land transportation as a backup option. The trading model adopts long-term agreements and spot transactions. The supply of crude oil mainly comes from Russia, followed by Saudi Arabia, Iraq, and other places. At the same time, the influence of Shanghai crude oil futures has increased, and hedging was carried out using the equity oil acquired through overseas mergers and acquisitions to cope with price fluctuations. The crude oil trade between China and Russia, as well as between China and Iran, is settled in RMB [59]. According to data, in 2024, the transportation volume of natural gas pipelines increased by 13.1 %, and the import volume reached 55.04 million tons; the import volume of liquefied natural gas increased by 7.7 %, reaching 76.65 million tons. The receiving stations for liquefied natural gas are mainly located in Guangdong, Fujian, and Zhejiang in the southeast coastal areas of China. In 2017, the pilot zone for cross-border RMB settlement in the China Free Trade Zone in Zhejiang was officially launched, further promoting the process of RMB internationalization.

China's oil and gas imports by sea mainly rely on the following five straits. First, the Strait of Malacca, which connects the Indian Ocean and the South China Sea, is the most crucial. The daily transportation volume through this strait is approximately 24 million barrels, and over 80 % of China's oil and gas transportation needs to pass through here. Due to the narrow geographical conditions of this channel, it is vulnerable to political threats and military control from the coastal countries. Second, about 45 % of China's oil needs to pass through the Strait of Hormuz, which is the only outlet of the Persian Gulf. The daily transportation volume can reach 14 million barrels. 20 % of the global maritime transportation of oil and liquefied natural gas needs to go through this strait. All the liquefied natural gas exported from Qatar to China relies on this strait. However, the political situation in the coastal countries, such as Iran, can affect the release of ships for transportation. If there is military control, ships need to take a detour around the Cape of

Good Hope, increasing the voyage by 40 % and affecting the delivery time and increasing transportation costs. Third, the Strait of Mandeb and the Suez Canal, which connect the Red Sea, the Gulf of Aden and the Mediterranean Sea, are important hubs of the Eurasian transportation route. They provide a shortcut for the transportation of oil from the Middle East to Europe and North Africa. If there is military control, ships need to take a detour around the Cape of Good Hope, increasing the voyage by 40 %, affecting the delivery time and increasing transportation costs. Fourth, the Turkish Strait is the only channel for the transportation of water from the Black Sea to the Mediterranean Sea. The main supplying countries are Russia and Kazakhstan. However, during the Russia-Ukraine conflict, the transportation of oil and gas ships faces increased risks, directly leading to the instability of the safe transportation of oil from the Black Sea to the outside. Fifth, the Lombok Strait in Indonesia can provide an alternative channel for China's oil and gas supply, although its transportation volume is small and it is not the preferred choice.

The method of transporting oil and gas resources by land connects the oil and gas resources in the western regions of China, Russia, and Central Asia directly with the central regions of North China, East China, and Southwest China, improving the current situation of uneven distribution of China's energy resources, that is, transporting coal from the north to the south, and transporting natural gas from the west to the east [54]. The economically developed southeastern coastal areas of China have insufficient oil and gas energy resources. The construction of the land-based oil and gas resource pipeline network can balance the unbalanced distribution of domestic resources in China. With the continuous extraction of oil resources, global oil resources will reach their peak at some point in the future. The development and utilization of natural gas will meet market demand, responding to the calls for air pollution prevention and control and the dual carbon policy. A complete and precise land-based natural gas pipeline transportation network is conducive to achieving the goals of transporting natural gas from the sea to the land [18], transporting natural gas from the north to the south, and transporting natural gas from the west to the east, helping to convert natural resources into clean renewable energy, laying the foundation for the next stage of development [10].

The transportation of oil and natural gas in China adopts a combination of land

transportation and maritime transportation. Land transportation can bypass the key bottlenecks in the maritime shipping routes, making up for and reducing the deficiencies and risks of maritime transportation. At the same time, maritime transportation can address the limitation of relatively fixed transportation capacity of land transportation and promote the trade of bulk imported goods. These two methods complement and make up for each other's deficiencies, providing long-term stable support for China's energy supply. When transporting oil and natural gas to the destination, storage warehouses need to be set up to meet the needs of residents for immediate use and extraction. The scale of China's crude oil strategic reserves, underground natural gas reserves, and liquefied natural gas storage tanks has been continuously expanding, and they can already meet the needs of consumers, far exceeding the safety standard of 90 days of consumption stipulated by the International Energy Agency. This enables Chinese residents to escape the fatal drawbacks of peak electricity consumption periods and supply disruptions, thus enabling rapid peak load regulation and meeting the needs of consumers.

The main mode of transportation is by sea. The traditional sea routes include the Middle East route, which departs from the Persian Gulf, passes through the Strait of Hormuz, the Indian Ocean, and the Malacca Strait, and then reaches the South China Sea. This route accounts for the largest share of transportation volume; the African route starts from the Suez Canal, passes through the Red Sea, the Indian Ocean, and the Malacca Strait, and finally arrives at the South China Sea. This route is an important traditional channel for oil transportation; the Latin American or South American route, which passes through the Panama Canal or circumvents the South American continent, and some liquefied natural gas is imported through the North American route. Since it does not pass through the Malacca Strait, it directly travels from Vancouver to Shanghai, and this route has high transportation efficiency. The maritime transportation mode ensures the supply of oil through traditional routes such as the Middle East and Africa, with large transportation volume and relatively low costs, which can meet China's huge demand for oil imports.

Land transportation is a strategic supplement to the methods of oil and gas import [37]. The Northwest Corridor includes the China-Kazakhstan oil pipeline transportation, which connects Kazakhstan and Xinjiang, with an annual oil transportation volume of

approximately 20 million tons [7]; the Central Asia Natural Gas Pipeline transportation, whose sources mainly come from Turkmenistan, Uzbekistan and Kazakhstan, has a designed annual gas transportation volume of over 85 billion cubic meters, and is the main source of pipeline natural gas transportation. The Northeast Corridor mainly relies on the China-Russia oil pipeline, starting from the Black Sea and ending in Shanghai, with a designed annual gas transportation volume of 38 billion cubic meters, connecting China and the Russian Far East, with an annual oil transportation volume of approximately 30 million tons. At the same time, efforts are being made to develop land pipeline transportation between China and Kazakhstan, and between China and Russia. The Southwest Corridor mainly consists of the China-Myanmar natural gas pipeline, connecting Yunnan in China and Kyaukphyu in Myanmar, with a designed annual gas transportation volume of 12 billion cubic meters. This route mainly supplies Bangladesh Bay, and land transportation reduces China's reliance on the Strait of Malacca for oil and gas imports, actively expands new routes for liquefied natural gas imports, and increases oil and gas import routes to reduce the security issues of energy supply.

The establishment of the Shanghai Petroleum Futures Exchange in 2018 made Shanghai the third-largest crude oil futures market in the world, changing the trading principle dominated by the US dollar. The stable trading volume of this exchange has made it a reference option for pricing Asian crude oil. It was the first exchange to adopt the RMB as the settlement currency with countries such as Saudi Arabia, Russia and Iran. This effectively avoided the risks brought by Western sanctions and the fluctuations of the US dollar exchange rate, reduced the costs incurred by oil and gas trading enterprises during the transaction process due to currency conversion, promoted the process of RMB internationalization, and thus provided a reference for the implementation of future natural gas futures. This enabled China to no longer passively accept the pricing standards of the international market, achieving the goal of Chinese demand, Chinese pricing.

China is highly dependent on imports for its oil and gas trade. Over 72 % of its crude oil demand must be imported, and over 45 % of its natural gas is dependent on imported energy supplies. There is a significant gap in domestic self-sufficiency rates. On one hand, China's energy import sources are relatively concentrated, mainly in regions

with unstable situations, such as the Middle East, Russia, and Africa. For instance, conflicts in the Middle East and the war between Russia and Ukraine make it vulnerable to direct supply disruptions caused by international turmoil. On the other hand, China's strategic crude oil reserves and other resources exceed the safety standards of the International Energy Agency. However, relying solely on this strategic reserve of crude oil can only meet about 90 days of consumption, far below the standards of regions like Europe and the United States, which exceed 120 days. At the same time, 80 % of the crude oil transported by sea needs to pass through sea areas with frequent pirate activities and high geopolitical risks, and the ability for emergency peak shaving and filling is still in need of improvement.

2.2 Risks in oil and gas transportation and trade

Oil and gas can be transported by ultra-large oil tankers, which have a large transportation capacity. According to statistics, a single voyage of an ultra-large oil tanker can carry over 2 million barrels, which can meet China's huge demand for oil and gas imports. At the same time, the transportation scale is large and the operation efficiency is high. Moreover, the maritime transportation method has a more controllable initial cost investment compared to pipeline transportation. It does not need to bear the large construction costs of pipeline facilities like pipeline transportation methods. Only the loading and unloading facilities of each connecting port need to be renovated. Therefore, compared to other transportation methods, it is more reliable, has a shorter investment cycle, higher project delivery efficiency, and the unit cost of remote ocean transportation is lower than land transportation and pipeline transportation. Secondly, currently, there is an adequate professional and qualified oil tanker fleet worldwide, and the oil transportation system is mature. Combined with international oil prices, market demand, and geographical advantages, the oil tanker routes and import source countries can be flexibly adjusted. The loading facilities at various ports are gradually established, and the facilities for storing oil and gas are constantly upgraded. This improves the efficiency of cargo handling and does not rely on the restrictions of the land-based sector. It can flexibly

connect major supply sources such as South America, the Middle East, and Africa, and stably ensure the supply of energy.

There are also certain drawbacks in the maritime transportation of oil and gas. By looking at the routes, it can be seen that about 80 % of China's maritime transportation routes must pass through the Strait of Malacca, which can be regarded as a strategic sticking point for maritime transportation. It holds the key to maritime transportation. The safety of transportation is low. The geographical passage of the Strait of Malacca is affected by the situations of the coastal countries. Due to its unique geographical advantages, international disputes have a significant impact and can easily delay the transportation plan. On the other hand, due to the long transportation cycle, the maritime weather is highly variable, natural disasters, pirate attacks on ships, and other uncontrollable factors are prone to occur, and ships and goods are prone to risks. The Indian Ocean and the South China Sea have frequent typhoons, and transportation ships are prone to be stranded at sea. When the wind force is strong enough, it can easily destroy the ship and cause damage to personnel and goods [38]. In the Gulf of Aden and the Gulf of Guinea, pirates are rampant, and ship attacks occur frequently. Ship damage is likely to cause oil leakage, resulting in losses of goods, and it is difficult to deliver on time. For very large oil tankers and ships carrying liquefied natural gas, their own size is huge, and the driving is difficult. Mistakes in loading and unloading processes can delay the supply of oil and gas. When the importing country has an oil shortage domestically, due to the long maritime transportation cycle, it usually takes about 15 to 45 days from loading at the export port to unloading at the destination port. The speed of energy supply is slow, and the response speed to supply and demand regulation is slow, which can easily lose target customers.

On the one hand, the transportation of offshore oil and gas requires strict conditions for the destination ports. Oil and gas products are considered high-risk goods. Any accidents during unloading, loading, or during transportation, such as oil leakage, will cause serious marine pollution problems, damaging the environment that marine life depends on. The subsequent cost of cleaning up the pollution is high, and the ecological restoration task is arduous. Liquefied natural gas has even stricter transportation

requirements. It demands extremely strict sealing of the vessel and the insulation effect of the ship itself, as any leakage would trigger an explosion and cause safety accidents. On the other hand, the management of offshore transportation is very difficult. It requires coordinating with various supply ports in different countries. However, due to inconsistent port management systems, maritime laws, and customs policies among different countries, coordination is difficult and efficiency is low. At the same time, China's oil and gas supply sources are mainly located in the Middle East, Africa, Qatar, and Australia. If there is a situation of international unrest, the maritime transportation routes will be affected by the international situation. In some regions, even the ships transporting oil and gas will be subject to sanctions and interceptions. This will lose the flexibility of maritime transportation, affecting the supply of oil and gas and causing energy security issues.

The main mode of land transportation is cross-border pipeline transportation, while railway transportation serves as a supplementary option. The completely sealed transportation conditions make it possible to conduct transportation 24 hours a day without interruption, thereby enhancing the stability and reliability of the transportation process. Compared with sea transportation, there is no need to worry about the dangers brought by natural disasters such as typhoons and tsunamis, nor is there the uncertainty of pirate hijackings. This is the preferred mode of transportation for China's oil and gas, especially when domestic demand for natural gas and oil increases sharply in winter. The all-day transportation mode can stably guarantee the supply of natural gas and oil for people's livelihood and industrial needs.

Compared with maritime transportation, land transportation enables oil and gas to directly enter China's domestic pipeline network system from the supply countries. It eliminates the steps of transfer, loading and unloading, as well as the gasification process during storage. During the land transportation process, the loss of oil and gas due to external factors is relatively small. In the destination country, oil and gas can be put into use immediately upon arrival. This supply and demand response speed is very fast, without the need for a long transportation cycle. It can complete the transportation immediately and quickly match the supply and demand gaps within the importing country's region.

Land transportation bypasses important maritime transportation routes such as the Strait of Malacca, the Strait of Hormuz, the Strait of Mandeb, and the Turkish Straits, avoiding risks associated with key maritime choke points. It does not rely on shipping channels and jurisdictional areas controlled by other countries, thereby significantly reducing the impact of geopolitical conflicts and coastal situations on the transportation of oil and gas, and enhancing the stability of energy security. On the other hand, after the completion of cross-border pipeline lines, only daily operation and maintenance costs need to be borne. At this time, the costs are relatively fixed and controllable, and the transportation costs are long-term stable. There are no additional fluctuating costs such as tanker transportation fees, port handling fees, and vessel passage fees, and there are no additional costs. Moreover, most land transportation agreements are long-term agreements of 10 to 30 years, which is conducive to long-term cost accounting and the management of oil and gas trade.

After the construction of the sealed transportation pipeline, the risk of oil and gas leakage can be reduced to a certain extent. Only regular inspections and daily equipment maintenance are required. Compared with maritime transportation, the oil and gas leakage caused by maritime transportation and the pollution to the nearby marine environment are relatively less compared to the laying of land pipelines. The impact on the surrounding environment is smaller and it is more environmentally friendly. The probability of personnel and property suffering damage due to accidents is also lower. On the other hand, maritime transportation does not need to coordinate the ship scheduling at various ports, the cross-border customs clearance permits, and different port supervision issues as in the maritime mode. Its operation and maintenance process is simple and standardized, the training of personnel is less difficult, the management method is simpler and easier to implement, and compared with the maritime transportation mode, the labor cost and management cost are also relatively lower.

The initial construction of cross-border oil and gas pipelines on land involves an enormous amount of work. There are a series of technical challenges involved, including pipeline laying, site selection conditions, and geological exploration. This will require a significant investment of time and funds. The investment cost for a single main pipeline

can range from several billion to several hundred billion RMB. The construction period can last from 5 to 10 years. The cost and investment required for the preparatory work in the early stage of this method is very high. On the other hand, land-based pipeline transportation lacks flexibility. It is completely dependent on the supply from the neighboring countries' land. If there are international unrest, political conflicts, or deterioration of bilateral relations, the transportation of oil and gas will be affected by the situation of the supplying country, diplomatic relations, and geopolitical conflicts. The importing country will face the risk of energy supply interruption and will not be able to find alternative supply channels in a short period of time.

In terms of energy transportation, the land transportation method is fixed and monotonous, unable to achieve the global supply characteristics of maritime transportation. The completion of pipeline laying projects also indicates the fixed direction and transportation capacity of the pipeline. The coverage of oil and gas sources is limited, and the number of available suppliers is also limited. The designated neighboring supply countries cannot be freely adjusted, and changes in the energy production of the supplying countries cannot quickly increase the transportation volume to enhance the transportation capacity. This is not conducive to meeting diverse market demands and is also difficult to diversify supply risks. It is less flexible than shipping routes and sources.

Pipeline transportation is also affected by natural factors. The pipeline routes pass through various geological and topographical features, such as glaciers, mountains, plateaus and deserts. They are influenced by natural disasters like permanent permafrost melting, earthquakes and even landslides. On the other hand, there are also issues of human theft and abuse, but the locations where oil and gas pipelines are laid are mostly in remote uninhabited areas. When there are safety hazards, the maintenance difficulty increases. There is another mode of transportation, namely railway transportation. The main mode of transportation is through tanker trucks, but its transportation volume is relatively small and the unit transportation cost is high, making it unable to complete large-scale transportation tasks. The limited railway transportation capacity and cross-border railway customs clearance regulations make railway transportation a backup option for pipeline transportation.

2.3 Market and technology constraints

The characteristics of China's energy international trade are as follows: the main focus is on importing oil and natural gas and exporting coal. The trade deficit in energy mineral products has gradually expanded, but the trade structure has become more reasonable, and the degree of energy import dependence has deepened. The development of diversified trading partners has occurred, with the import sources expanding from a single country to a diversified range, reducing the risk of dependence on a single market. For example, in 2023, the proportions of traditional energy-exporting countries such as Russia and Saudi Arabia decreased, while the contributions of emerging markets such as Africa and Southeast Asia increased.

China's international trade of oil and gas energy is highly dependent on imports in terms of both imports and exports. The import demand exceeds the export volume. The main importing countries are Russia, the Middle East, and Central Asia. The trend of China's international energy trade development has shifted from a single source of imports in the past to a diversified model. This reduces dependence on a single market, thereby lowering the risk of energy supply and enhancing energy stability. Additionally, intelligent extraction technologies and the use of clean energy are employed to reduce China's reliance on imported energy, develop local renewable resources, and mitigate the impact of energy security issues caused by supply disruptions.

China has consistently ranked first in global crude oil imports and also ranks among the top three in global natural gas imports. This indicates that in the global market, China possesses extremely strong purchasing power, enabling it to hold a dominant position in international oil and gas trade. 50 % of China's crude oil imports mainly rely on the Middle East region, 30 % of the suppliers are from Russia, and another 20 % come from Latin America and Africa. For natural gas transportation, the main routes are the Central Asia and China-Russia lines. The main suppliers of liquefied natural gas are Qatar, the United States, and Australia. China's huge demand for oil and gas resources gives it the advantage of enjoying preferential bargaining power when signing purchase agreements, enabling it to sign long-term contracts and enjoy significant discounts, such as the long-

term price concessions for crude oil supply from China-Russia and the long-term discounts for natural gas supply from Central Asia. This saves China billions of dollars in import costs annually [24].

Figures 9–14 shows proportion of China's natural gas import sources in different years.

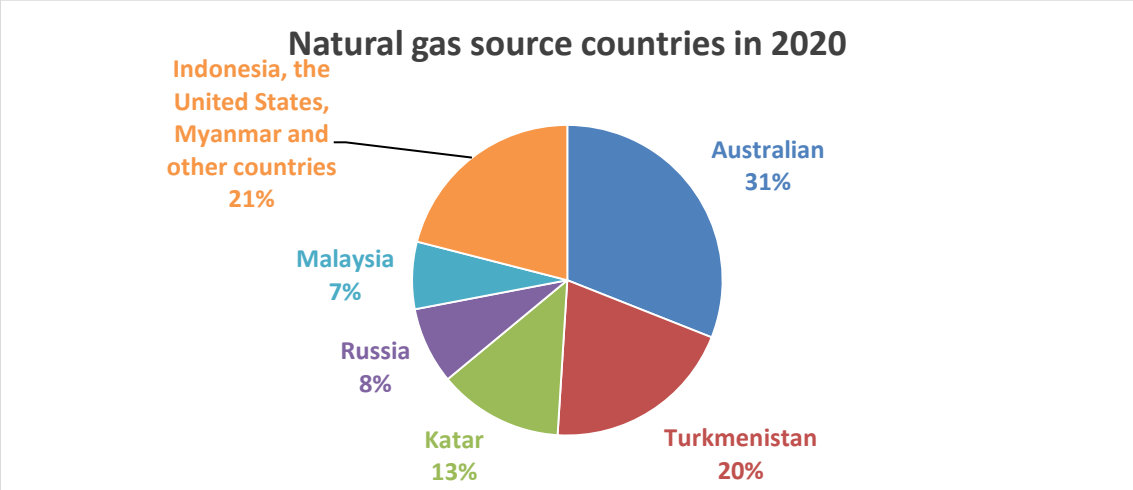


Figure 9 – Proportion of China's natural gas import sources in 2020 (total: pipelines + LNG) [5]

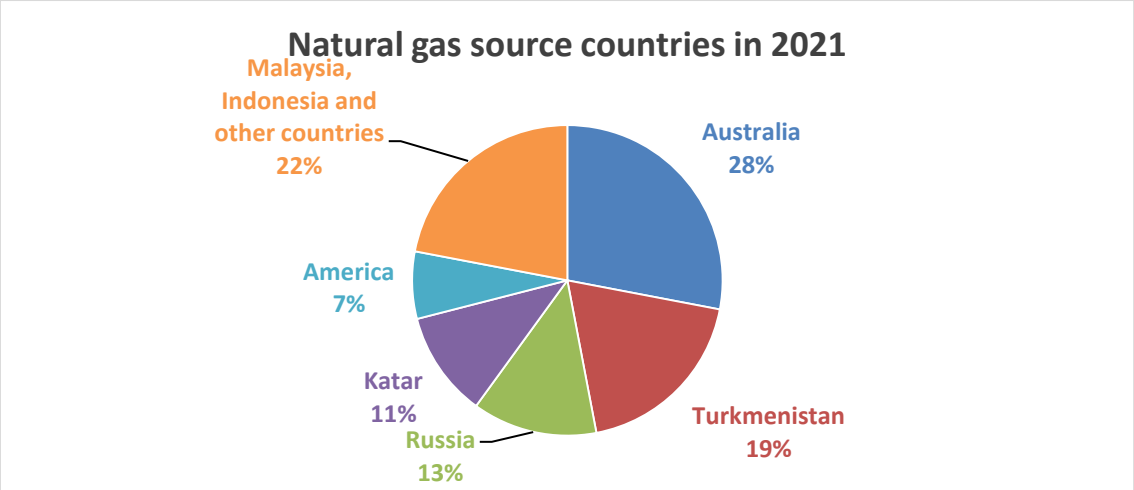


Figure 10 – Proportion of China's natural gas import sources in 2021 [5]

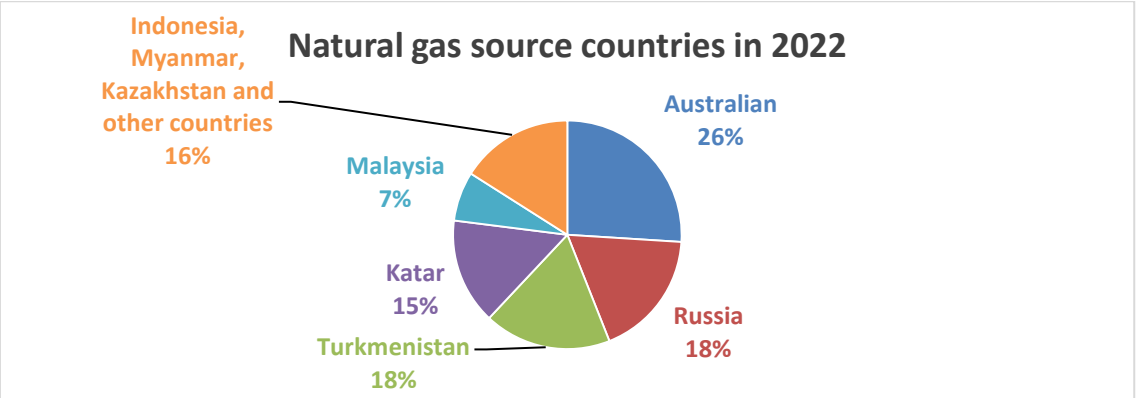


Figure 11 – Proportion of China's natural gas import sources in 2022 [5]

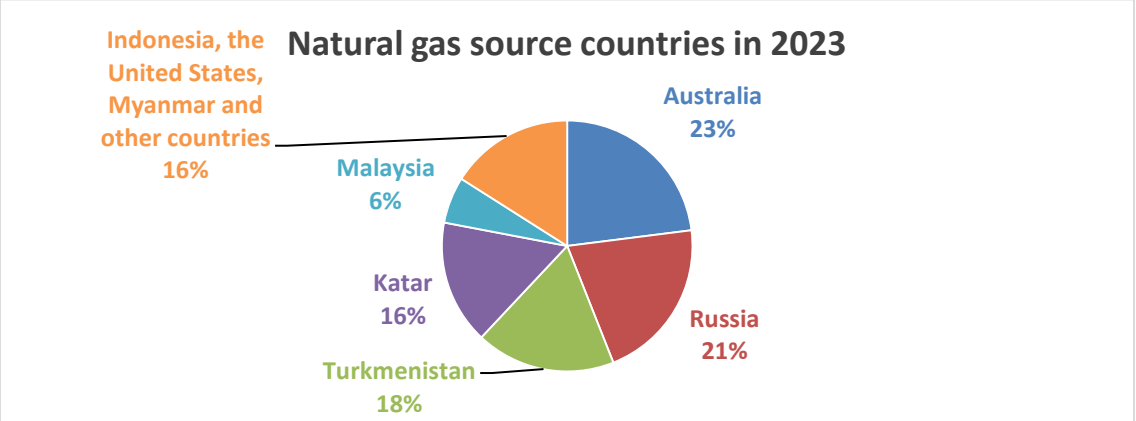


Figure 12 – Proportion of China's natural gas import sources in 2023 [5]

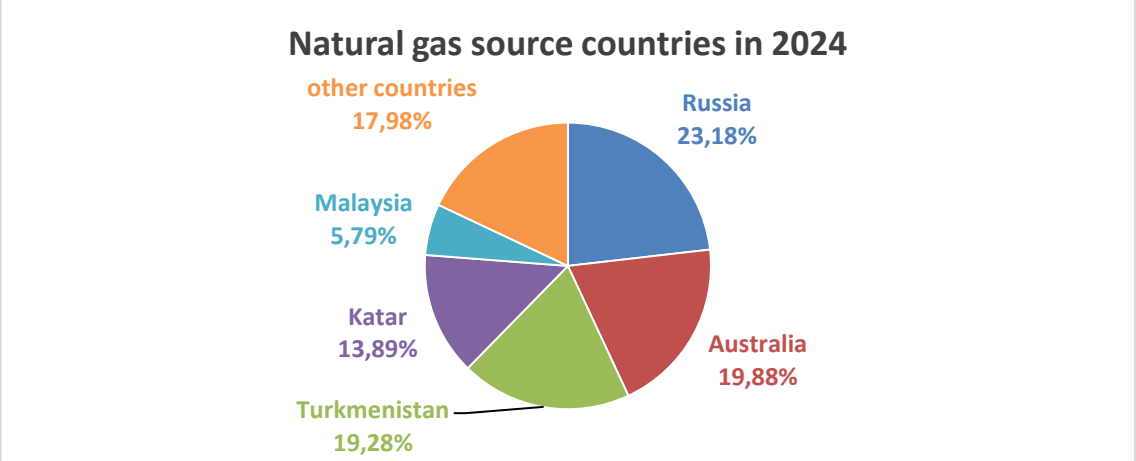


Figure 13 – Proportion of China's natural gas import sources in 2024 [5]

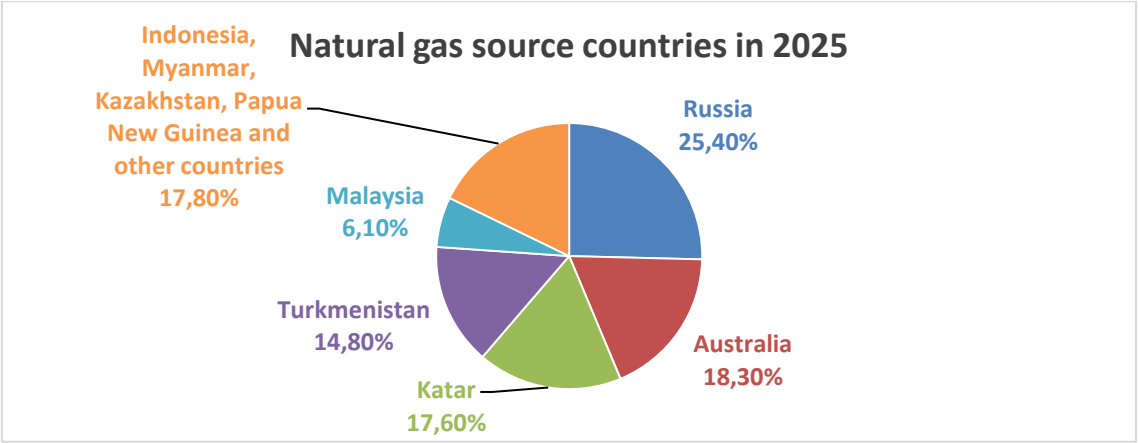


Figure 14 – Proportion of China's natural gas import sources in 2025 [5]

Russia has consistently ranked first among China's oil importers for several consecutive years. The supply methods mainly involve maritime transportation and pipeline transportation. The volume of pipeline transportation is approximately 40 million tons on average annually, while maritime transportation mainly consists of mixed crude oil from the ESPO (Eastern Siberian Pacific Ocean pipeline). The final destination is China's private refineries in Shandong. Additionally, in 2024, China imported approximately 30.55 million tons of natural gas from Russia, including about 8.31 million tons of liquefied natural gas and 22.24 million tons of pipeline natural gas. These are the top sources of China's imported natural gas. Secondly, in 2024, the average landed price of Russian oil was approximately 2 dollars per barrel lower than that of China. This indicates that China's import of oil from Russia is cost-effective and can also reduce energy consumption and costs during the refining process. In conclusion, importing oil and gas from Russia is beneficial for China to further enhance the stability of its overall energy supply.

Proportion of countries and regions from which China imported oil in different years are shown on figures 15–20.

Saudi Arabia supplies crude oil to China on a long-term basis and is China's major crude oil supplier. The oil transported from Saudi Arabia to China is mainly transported by sea, passing through the Strait of Hormuz and the Strait of Malacca for the import and export of energy.

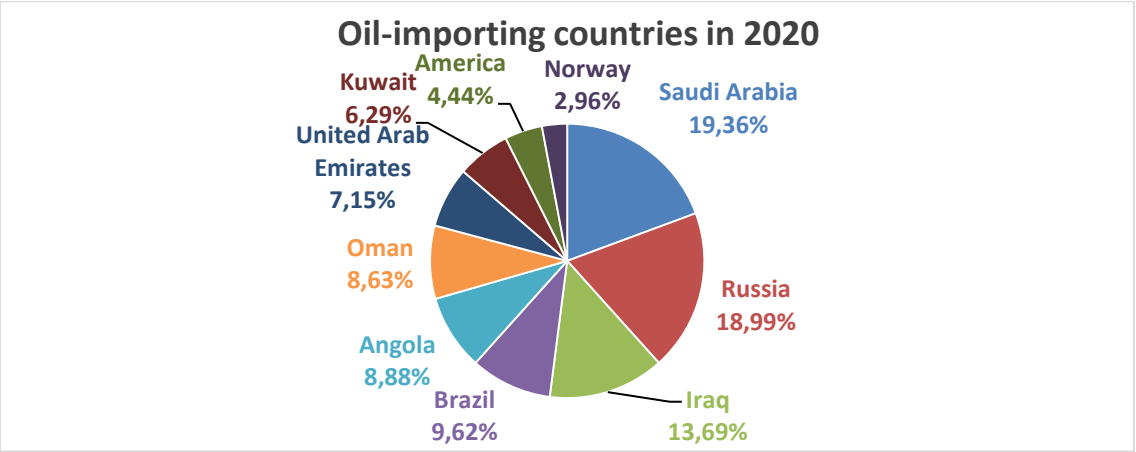


Figure 15 – Proportion of countries and regions from which China imported oil in 2020 (total import volume: 542 million tons) [5]

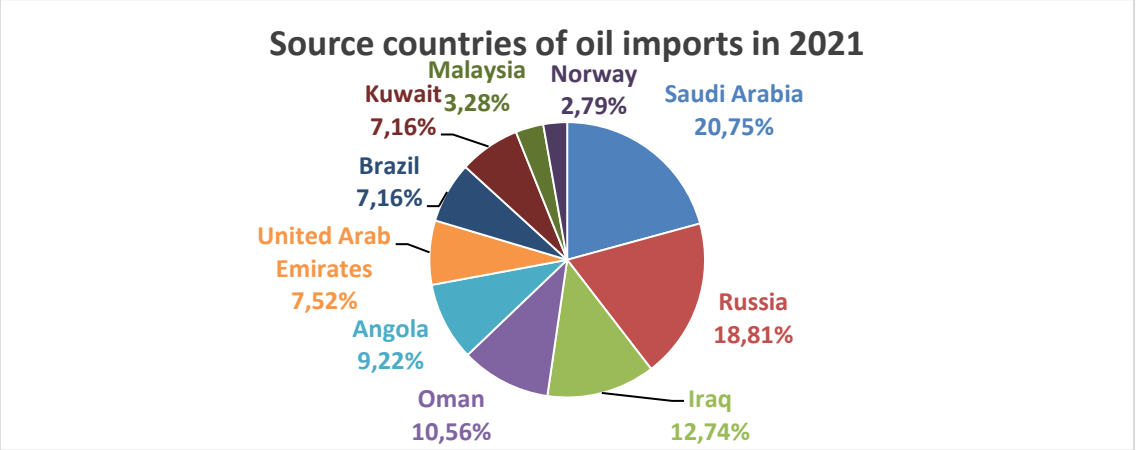


Figure 16 – Proportion of countries and regions from which China imported oil in 2021 (total import volume: 513 million tons) [5]

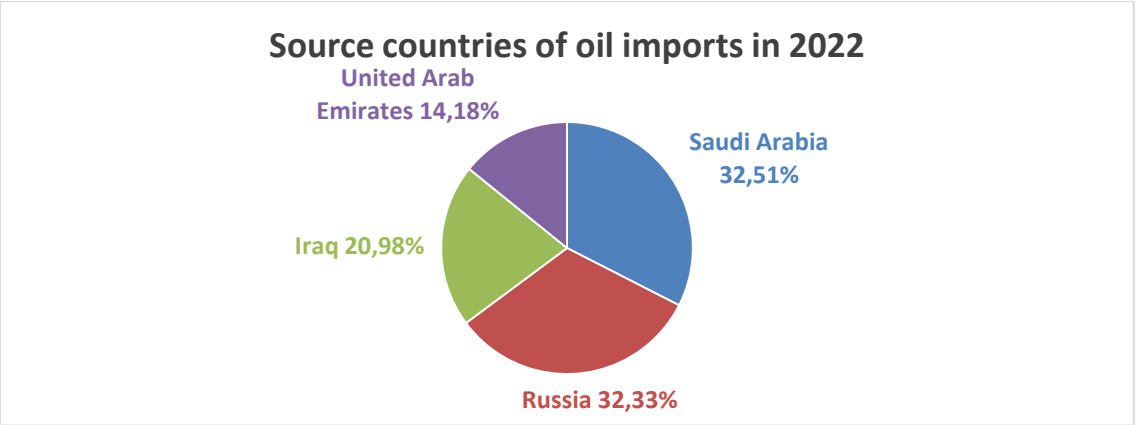


Figure 17 – Proportion of countries and regions from which China imported oil in 2022 (total import volume: 502 million tons) [5]

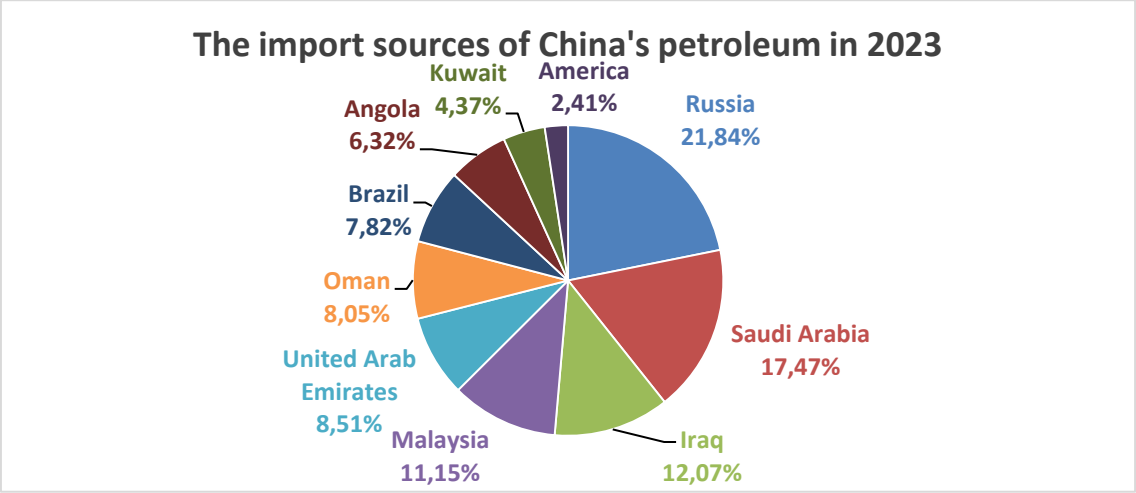


Figure 18 – Proportion of countries and regions from which China imported oil in 2023 (total import volume: 564 million tons) [5]

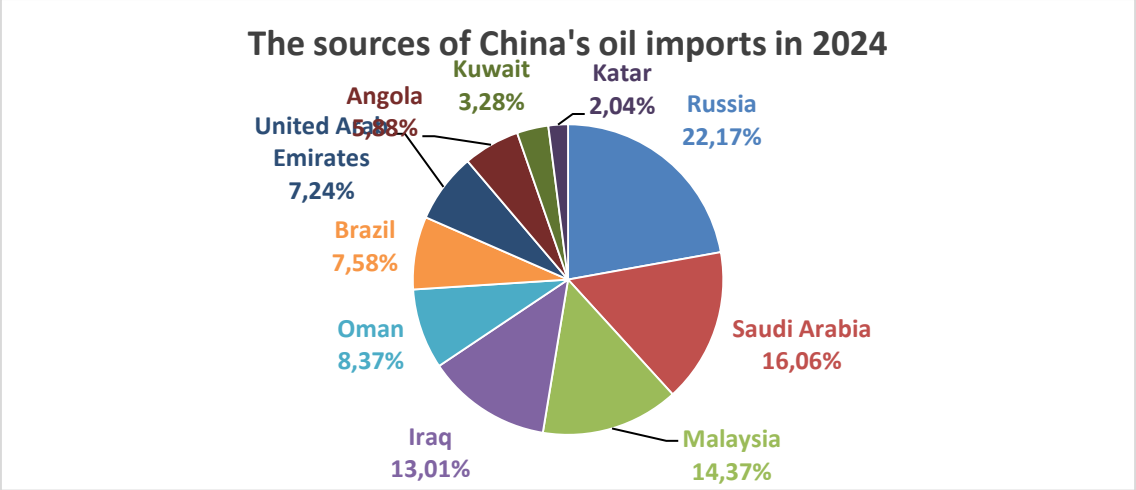


Figure 19 – Proportion of countries and regions from which China imported oil in 2024 (total import volume: 553 million tons) [5]

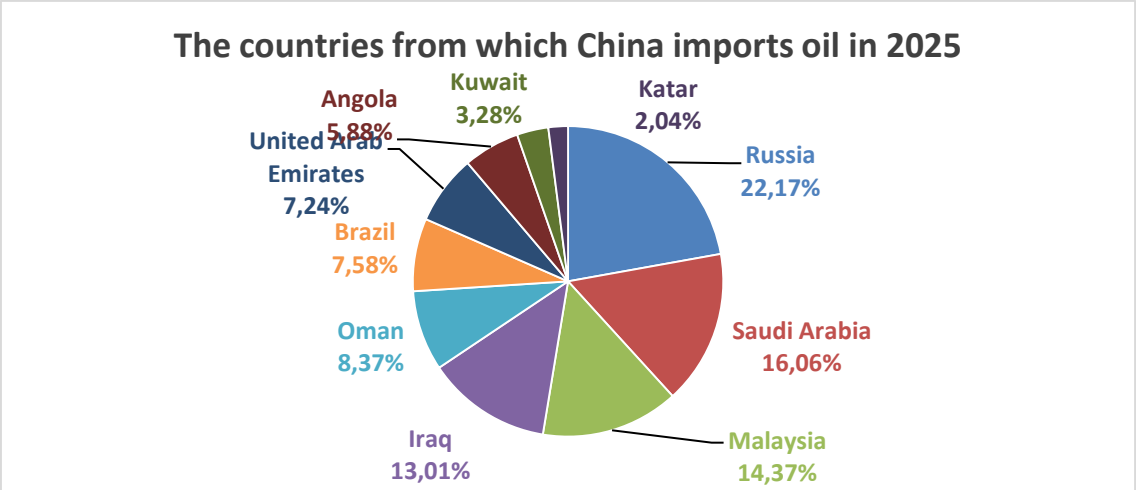


Figure 20 – Proportion of countries and regions from which China imported oil in 2025 (total import volume: 578 million tons) [5]

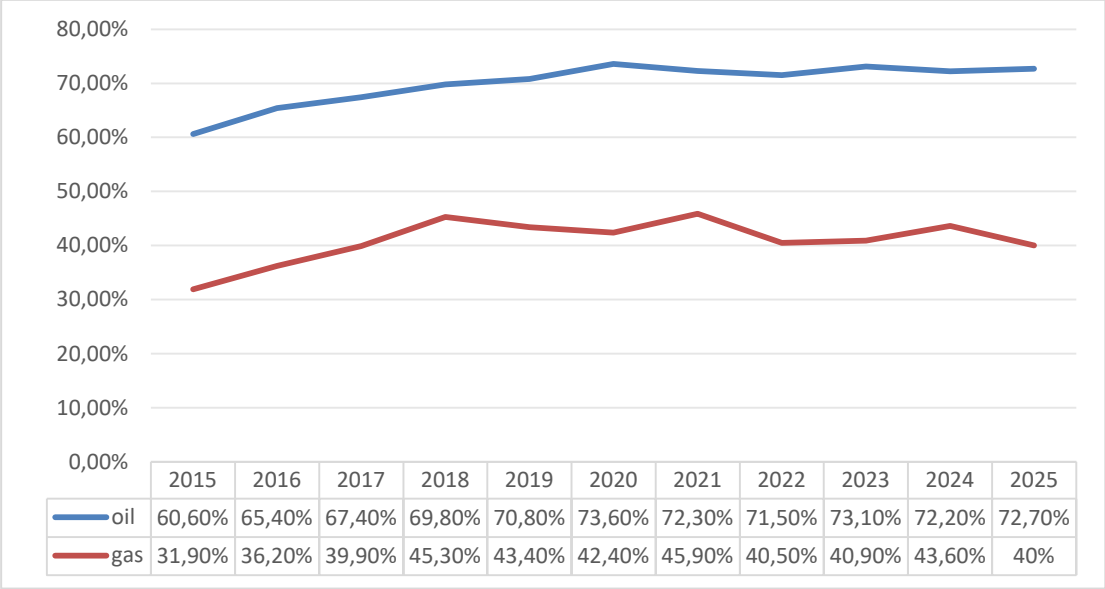
At the same time, apart from exporting crude oil to China, China and Saudi Arabia also cooperate with each other in the upstream, refining, engineering services and other industrial chains. For example, the implementation of the Yanbu Refinery project reduces Saudi Arabia's reliance on a single oil economy model and realizes mutually beneficial and win-win energy cooperation between China and Saudi Arabia.

Iraq is an important oil import supplier for China. In 2024, China imported approximately 63.83 million tons of oil from Iraq. The transportation of crude oil from Iraq mainly adopts a combined maritime and land transportation method. It is transported from China or other countries by sea to major ports in Turkey, and then transferred through customs clearance to Iraq. This route is currently the commonly used method for oil transportation between China and Iraq, suitable for large-scale oil trade, balancing the security of energy and the operational efficiency of transportation. Secondly, the cooperation between China and Iraq in the oil and gas sector mainly focuses on the development of oil fields. In recent years, projects such as Rumaila, Hafaraya, and West Qurna have been advancing steadily. However, there are some issues with China's oil imports from Iraq. For example, due to the increase in international oil prices, production quota agreements, and the conflicts and political instability in the Gulf region, in 2021 Iraq announced the freezing of the 14 billion oil supply agreement reached with China. If this agreement cannot be restored, it will cause a disruption in China's oil supply. When Iraq experiences a decline in oil production due to conflict issues, while the international oil prices start to rise significantly, since both China and Iraq need to settle their oil trade in US dollars, China has to bear more foreign exchange costs. For every 1 dollar increase in the oil price per barrel, China needs to pay an additional 600 dollars million. In conclusion, oil prices will affect the supply and demand relationship in the international market, and price fluctuations increase the risk of energy supply for exporting countries.

Brazilian crude oil exports to China are mainly carried out by sea, and almost all of them are transported on ultra-large oil tankers for long-distance ocean voyages. As of now, China absorbs approximately 40 % of Brazil's crude oil export volume, which has established China's dominant position in the Brazilian energy export market. Compared to issues of war and conflict in the Middle East, Brazilian long-distance maritime crude oil

transportation can be regarded as having low political risks and high strategic value. Due to Brazil's joining of OPEC+, it will deeply integrate with global oil supply and adjust its quotas and priority orders for China. Although there is no need for mandatory reduction of quotas for non-participating countries, the supply management and export rhythm of Brazilian oil will be affected by global circumstances, increasing uncertainty for Chinese buyers, and the risk of energy supply restrictions will increase.

On the one hand, the pricing power of international oil prices still lies in the hands of Western countries. The trade settlement method using the RMB as the settlement currency and replacing the US dollar has not yet been fully implemented. Therefore, Chinese buyers will be affected by the trade protectionist policies and technical barriers of some countries. At the same time, the fluctuations in the prices of shale oil and natural gas in the United States will reflect the increased uncertainty in importing oil and gas products due to oil price fluctuations. On the other hand, the supply of crude oil adopts a quota system, and the import quotas are strictly controlled. The quotas for non-state-owned refineries are very few, and the relevant policies limit the purchasing rights, squeezing the share of the supply market and affecting the possibility of enterprises' import and export trade (figure 21).



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
oil	60,60%	65,40%	67,40%	69,80%	70,80%	73,60%	72,30%	71,50%	73,10%	72,20%	72,70%
gas	31,90%	36,20%	39,90%	45,30%	43,40%	42,40%	45,90%	40,50%	40,90%	43,60%	40%

Figure 21 – Degree of China's Dependence on Foreign Oil and Natural Gas Energy from 2015 to 2025 [55]

From 2015 to 2020, the degree of China's oil import dependence continued to rise. In 2020, it reached a peak of nearly 73.6 % over the past decade. From 2021 to 2025, it remained stable at 71 % to 73 %. The degree of China's natural gas import dependence increased continuously from 2015 to 2018. From 2019 to 2025, it fluctuated between 40 % and 44 %.

In addition, the storage and transportation equipment for crude oil and underground natural gas, as well as advanced oil and gas exploration technologies, mainly rely on imported support. The ships used for transporting oil and liquefied natural gas also depend on imported vessels, and their transportation and storage capabilities are easily constrained by external factors. China is highly dependent on imports for oil and gas, and the sources of supply are relatively concentrated. When the geopolitical situation in these regions becomes unstable, it will directly lead to the instability of China's energy import security.

Meanwhile, on an international scale, Brent crude oil, West Texas Intermediate crude oil, and liquefied natural gas are the three core indicators in the international energy market. Brent crude oil and WTI crude oil are the two pricing benchmarks in the crude oil market, reflecting the energy price standards in Europe and North America. Liquefied natural gas has the characteristics of being environmentally friendly, having high energy density, and being a substitute for high-carbon energy. This makes it a representative of clean energy and reflects the pricing standard of the Henry Hub in the United States. In other words, the pricing at the Henry Hub refers to the pricing system based on the spot price of natural gas at the Henry Hub in the United States. Through the combination of futures contracts and the spot market, it has become the core standard influencing the pricing of global natural gas trade. In summary, it can be seen that China has no pricing power in the national oil and gas trading market and needs to passively accept external pricing and price increases. Although cross-border RMB settlement is being promoted, its acceptance in the global market is still low. Currently, it is only applied in a few regions such as China-Russia and China-Iran, with a relatively small coverage. Most regions still need to use US dollars for settlement. Fluctuations in the exchange rate between the RMB and the US dollar will directly increase the import costs of oil and gas, and locking the exchange rate for enterprises will also increase additional transaction costs [43].

Under the global dual-carbon goals, the consumption of oil and gas is restricted, and long-term trade assets may experience depreciation. Moreover, as the global environmental pollution control issues develop, many countries have set export quotas and tax quotas barriers due to environmental protection and ecological development issues, raising the trade entry threshold. Additionally, the majority of China's liquefied natural gas storage areas are concentrated in the eastern coastal regions. The domestic inland receiving capacity in China is weak, and the peak regulation capacity will also be weakened accordingly.

Chapter 3 The impact of energy trade on China's energy security

3.1 The development prospects of China's energy trade impact on China's energy security issues

Oil and gas energy is the core driving force of a country and also a core category in the global energy system. China is the world's largest importer of oil and gas [8]. Oil and gas trade is no longer just a simple business transaction; it concerns the livelihood security and industrial operation of this country. Therefore, stable and sustainable oil and gas trade plays a crucial role in the stability of China's economy. Under the guidance of the carbon neutrality goal, China's economic structure is undergoing transformation, and new energy is gradually being applied to daily life [31]. The demand for new energy vehicles is gradually increasing, while the consumption growth rate of fuel vehicles is gradually slowing down [28]. The government has introduced relevant reduction and national subsidy policies to encourage consumers to purchase new energy vehicles [49]. At the same time, the related work of converting coal to natural gas is being implemented. The demand for natural gas in urban, chemical, power generation gas and other fields is steadily increasing, especially in the heating of northern residents in severe winters, industrial green and low-carbon transformation, and gas power generation peak regulation. As a low-carbon fossil energy, natural gas plays a bridging role in the energy transition. Compared to crude oil, the demand for natural gas will steadily increase in the future and become the core category driving the scale of oil and gas trade [42].

The overall situation of China's oil and gas trade is unlikely to undergo significant changes. The demand for crude oil imports remains at a stable level, while the demand for natural gas imports continues to grow. In certain important sectors where clean energy cannot replace traditional energy sources, such as aerospace and precision instrument manufacturing, oil and gas trade remains an indispensable energy source for China. In the past, China's energy relied mainly on supplies from the Middle East, but these regions needed to pass through the Strait of Malacca, which was vulnerable to geopolitical threats

and could impact domestic oil and gas supplies. In the future, China will remove centralization and seek multiple energy supply bases, a complementary model of land and sea, and improve long-term supply agreements with oil-producing countries such as Saudi Arabia and Iraq. Russia, taking advantage of its unique geographical advantages, imports energy through the Chinese-Russian crude oil pipeline via land transportation, becoming China's largest crude oil import source country. Additionally, the proportion of crude oil imports from Africa, Central Asia, and Latin America has increased, fundamentally achieving the old saying in China, Don't put all your eggs in one basket, and mastering the dominance of oil supply.

Natural gas operates in a dual-track trading pattern of pipeline natural gas and liquefied natural gas. Central Asia, Russia and Myanmar implement land-based pipeline transportation, while liquefied natural gas covers multiple countries such as Qatar, Australia and Malaysia. The construction of receiving stations extends from coastal areas all the way to inland regions. The storage capacity of natural gas and the peak - shaving capability are continuously improving. The oil and gas transportation routes are arranged in a network pattern, extending north-south and east-west, covering the entire country. They complement the maritime transportation and fundamentally eliminate the risks associated with a single transportation route. This approach enhances the resilience of oil and gas trade against external risks. In the event that a certain region or transportation route experiences peak demand for gas or a pipeline gets blocked, the routes can be quickly switched to ensure uninterrupted energy supply. This is an important measure for the sustainable development of energy trade.

From the perspective of trade models, China's oil and gas trade will break away from the single buyer-seller relationship and seek new mutually beneficial and win-win cooperation models. It will shift from passively accepting international prices to striving for an international pricing position. Through the win-win model of trade + investment, Chinese oil and gas enterprises will not only be purchasers but also investors who can participate in overseas oil and gas field exploration and development, refining projects, and pipeline construction projects [19]. They will invest in the entire value chain to obtain overseas rights and interests in oil and gas and gain control of trade initiatives, reducing

reliance on spot purchases from the international market. As energy cooperation between various countries and China is settled in RMB, the oil RMB system is constantly improving. This can reduce the impact of fluctuations in the US dollar exchange rate on oil and gas trade and gradually break free from the predicament of being unable to conduct oil and gas trade without the US dollar. It also changes the past situation of passively following international oil and gas prices. China's oil and gas trade will upgrade from basic commodity transactions to a comprehensive profit model integrating finance, investment, and trade, improving the quality of trade and also enhancing China's international influence.

The global energy market is a unified entity, and no single country can remain unaffected. As the largest importer of energy, China's energy demand is in harmony with the global energy trade pattern. China has always held the noble vision of every form of beauty has its uniqueness; precious is to appreciate other forms of beauty with openness; if beauty represents itself with diversity and integrity, the world will be blessed with harmony and unity. It has deepened cooperation with countries along the Belt and Road Initiative, oil-exporting countries, and energy-consuming countries, established cross-border energy cooperation platforms, and actively responded to the challenges of global energy transformation and upgrading caused by global climate warming [6]. In the context of global advocacy for green energy, China's oil and gas energy combines traditional energy with new energy, ensuring stable energy supply while exploring new energy fields such as hydrogen energy, green refining, and CCUS with multiple countries [3]. China is committed to meeting its own energy supply needs and providing fair and reliable markets for global oil and gas exports, driving the development of energy trade and achieving a win-win global situation [13].

In conclusion, the future of China's oil and gas trade is full of opportunities and challenges. In the future, China's oil and gas trade will develop in the directions of innovative models, diversified layouts, security and resilience, and win-win cooperation. It will safeguard the most important line of defense for people's daily energy needs and actively seize China's international position in international trade. It will promote the development of global energy towards a safe, stable, and mutually beneficial path, and

improve the global energy supply system.

The definition of resource allocation is to reasonably distribute the limited human resources, material resources and financial resources to different places, industries and uses, so as to achieve the most effective utilization of resources. If energy is compared to the soil nutrients for a country's development, then the allocation of energy resources is the trunk that transports the nutrients, ensuring a stable and continuous transportation to enable the country's development to grow steadily. China is the world's largest energy producer and consumer. Therefore, the issue of energy security will be a core topic for a country's development, and it is necessary to combine the actual situation to find a path of energy economy and trade that is unique to China.

The distribution areas of China's energy resources and the regions with high energy consumption are not in alignment, which is one of the reasons why China must address its energy issues. China's coal and oil resources are mainly concentrated in the western and northern regions, mostly in the vast and sparsely populated northwest territory. In contrast, the end-users of energy are in the eastern coastal and central developed regions, where industries are dense, population density is high, and the social order relies on energy supply to function. Thus, the pattern of resources being concentrated in the west while demand is in the east requires a rational energy allocation to transfer a large amount of natural resources from the west to the east. In the early stage of China's development, a traditional transportation method of transporting coal from the west to the east and from the north to the south was adopted. This traditional method of relying on manpower and trucks would consume a large amount of logistics costs, cause significant energy loss and environmental pollution during transportation, resulting in a decline in the stability and economy of energy supply. In other words, the cost-effectiveness was low, and it was also an important problem in China's early energy issues.

In the early days of China, coal energy was the main source of energy, and oil and gas energy relied heavily on imports. A single energy structure could maintain stability when the market was favorable, but it was extremely vulnerable to fluctuations in the international energy market. Therefore, rational energy allocation is extremely necessary. We should no longer be limited to the traditional distribution of fossil energy, but instead

promote the diversified supply of various types of energy. At the same time, we should improve the shipping routes and routes for oil and gas imports, as well as domestic oil and gas exploration and development. By developing clean energy and widely applying clean energy, we can reduce excessive reliance on coal and oil energy, and allocate scarce and precious imported energy to areas where other resources cannot replace it, achieving the maximization of resource utilization.

The global economic crisis has indirectly led to fluctuations in international oil prices by affecting global oil demand. For instance, during the 2016 economic crisis, the oil price was below 100 dollars per barrel, which weakened protectionism in resource-rich countries and provided opportunities for Chinese oil enterprises to go global. In terms of corporate earnings and efficiency, oil price fluctuations directly affect the production costs and export revenues of Chinese oil enterprises.

During the economic crisis, low oil prices led to a decline in corporate profits, and companies had to respond by optimizing production or expanding markets. In the Sino-US trade dispute, commodity export restrictions and trade barriers, as well as US tariffs such as imposing a 25 % tariff on 500 billion US dollars worth of goods in 2018, directly restricted China's oil exports, especially after the reduction in China's reliance on US shale oil [11]. As a result, China's demand for US oil decreased. Due to the increase in import costs, there was a need for diversified demand. The US tariff on liquefied natural gas was raised, which had a limited short-term impact but a significant long-term effect. Additionally, China shifted to other import sources, promoting the diversification of China's oil trade and reducing its reliance on a single market.

The current global oil and gas market is open, and resource-rich countries are gradually opening up their markets, providing more international cooperation opportunities for Chinese oil enterprises. However, they need to deal with policy differences among different countries. According to China's long-term trends and strategic development, the continuous growth of the Chinese economy has driven the demand for oil, prompting China to shift from energy export to energy import and increasing its reliance on the international market. Facing fluctuations in international oil prices and trade frictions, China has strengthened the development of new energy sources, improved

the domestic pricing mechanism, and enhanced its energy security capabilities. Through deepening cooperation with regions such as the Middle East and the Americas, it has expanded unconventional oil and gas resources and reduced its reliance on a single energy source. The continuous growth of China's economy has driven energy demand, and it needs to ensure supply security by optimizing the energy structure and improving energy utilization efficiency. At the same time, the Chinese government has implemented policies including increasing coal production capacity, regulating the export of refined oil products, and encouraging overseas investment to cope with changes in the international environment.

In recent years, the international energy market has experienced fluctuations, and the supply and demand relationship has changed. The global energy market has been affected by factors such as the pandemic and geopolitics, leading to increased price volatility. China needs to address cost pressures by regulating import volumes and optimizing inventory management. Fluctuations in international oil prices have an impact on the Chinese economy through channels such as trade and investment. China needs to enhance the application of financial tools to stabilize energy costs. In the competition between China and the United States and the energy diplomacy game, carbon reduction and competition in the industrial chain, the competition between China and the United States in the fields of renewable energy and carbon technology has intensified. China is actively seeking cooperation while balancing the interests of enterprises and achieving a win-win situation for carbon reduction targets [32].

Geopolitical pressure has prompted countries to accelerate the development of domestic renewable energy sources and enhance the resilience of clean energy technologies and mineral supply chains. For instance, Japan sought an energy de-Russification transformation. Geopolitical games in the field of new energy have seen some countries competing through new energy technologies such as hydrogen energy to build political power, promote regional integration, but this has exacerbated the imbalance of camp politics [39]. Competition for transportation channels has intensified, and the construction of new energy transportation channels has triggered intense competition among countries over energy channel rights. Countries are accelerating the diversification

of energy sources and promoting regional energy cooperation to address the risk of a single supplier. At the same time, responding to geopolitical risks requires strengthening international cooperation, such as stabilizing the market through multilateral mechanisms. However, there is also a rising trend of unilateralism and protectionism, which affects global energy coordinated emission reduction.

In the context of economic sustainability and national security, energy security is the cornerstone for sustainable economic development, while geopolitical risks may have a negative impact on it. Therefore, balancing energy autonomy and market cooperation has become a strategic priority for all countries [44]. Geopolitics is both a challenge to international energy security and a catalyst for promoting energy transformation and strengthening cooperation [26]. Countries need to ensure energy security while flexibly responding to geopolitical changes in order to achieve sustainable economic and environmental development. Energy powers engage in strategic games by competing for energy sources in the Middle East and Africa, while the games between energy-exporting and importing countries directly affect the global energy security landscape [23]. The rise in geopolitical risks has led to a decrease in China's coal trade volume, an increase in prices, and a loss in the total value of oil and gas trade; although fluctuations in oil prices have not significantly affected trade volume, they have pushed up the total value of oil and gas trade. Adjustments in energy trade policies have a profound impact on the economies of various countries, such as the damage to China's coal trade and the loss suffered by the United States due to fluctuations in oil prices.

Due to risks such as military conflicts, political instability or sanctions, energy disruptions or price fluctuations may occur. In conflict areas, energy infrastructure is damaged, such as pipelines and ports. Exporting countries restrict energy exports, leading to global supply disruptions and increased trade costs. It accelerated the end of the era of energy trade liberalization, deepened regionalization and campaginization trends, and increased energy supply uncertainty. Energy trade policies are constrained by political factors, and the intensification of sanctions and countermeasures has pushed countries to seek diversified energy sources to reduce dependence [47]. Geopolitical risks cause energy price fluctuations, unstable market supply and demand relationships, and affect price

predictions and long-term cooperation trust. The control of resources in the Middle East, the political instability in the region has strengthened the West's control over oil resources, increasing the political risks for China's overseas investment and affecting the input of resources such as funds and manpower.

As China is the world's largest importer of oil and gas, global geopolitical conflicts will directly affect the stability of China's oil and gas import supply. Russia, the Middle East, and other regions are China's main oil and gas supply bases. When the international situation is unstable, some countries face economic and trade sanctions. As a result, oil and gas exports will become intermittent. This makes the stable supply of oil and gas a major challenge. Most of China's maritime oil and gas imports rely on strategic important waterways such as the Strait of Hormuz and the Strait of Malacca. Political conflicts and warfare among countries have led to a significant decline in the safety of these waterways. Oil tankers need to change their routes, resulting in longer transportation cycles and increased transportation costs. The time for oil and gas imports is delayed, and the pace of trade exchanges becomes slower.

The international situation is constantly changing. Even the slightest change can cause international oil prices to fluctuate frequently and become unstable. This will inevitably lead to panic among information users, causing oil prices to soar and directly increasing the cost of oil imports for countries. It will also increase the production costs of related industries. When the traditional energy market is tight, the supply of traditional energy such as oil and natural gas is significantly affected by geopolitics, with frequent price fluctuations, resulting in an increase in China's import costs. This further leads to problems in the balance between power generation and consumption of new energy, as well as a contradiction between the development speed of new energy and the stability of the power system. The frequent occurrence of extreme weather further exacerbates the shortage of energy supply.

The world's energy consumption is increasingly shifting towards renewable energy sources, such as solar and wind power, and moving towards a low-carbon trend. The global energy transition is accelerating the changes in China's energy demand structure. As one of the largest energy consumers in the world, China needs to adjust its energy

structure to adapt to the global trend to some extent. At the same time, it needs to balance economic growth and the pressure of emission reduction. The development of new energy technologies, such as nuclear energy and energy storage technologies, is affecting the traditional energy market. The promotion of technological revolution requires China to ensure energy security through technological upgrading [40].

In conclusion, the impact of the world economy on China's oil and gas trade is multi-faceted. It includes the indirect influence of economic cycle fluctuations, as well as the direct impact brought about by geopolitical factors and trade frictions among countries. Therefore, business leaders need to flexibly adjust their strategies in response to the complex environment based on the specific circumstances of international negotiations and the development of the overall situation. The world economy affects China's energy security through multiple dimensions such as technology, geography, and markets. China should respond to complex challenges through openness, cooperation, and strategic adjustments.

3.2 Countermeasures and recommendations for enhancing China’s energy security

There is an old Chinese saying, don't put all your eggs in one basket. Therefore, a single oil and gas supply model is extremely risky. When the global situation is unstable, there are geopolitical conflicts, trade sanctions, and fluctuations in the energy market, a single oil and gas supply structure will cause a fatal blow. Diversified supply represents a variety of energy sources in different forms, rather than simply seeking more international suppliers. Energy diversification can be divided by transportation methods, multiple channels, and diverse sources. It can also break down energy security issues at each link of the energy supply process, from the source, transportation, to storage. From the perspective of the source of supply, a diversified supply source can break China's dependence on a single country or region for energy supply, and directly avoid the problem of sudden energy supply interruption when the location of the supplier is involved in war or political conflict. Looking at the history of the world in the past, some countries

relied solely on the exports of oil and gas from a certain country. When facing trade sanctions and international turmoil, under hostile relations, they were extremely vulnerable to trade threats. The supply of oil and gas suffered a fatal blow of being cut off at the neck. In the long run, being subject to others' control would not be beneficial to the security of a country. Selecting supply countries from multiple regions globally, such as the oil and gas production areas in the Middle East, Russia, Central Asia, Africa, and Latin America, flourishing in multiple areas can alleviate the pain caused by the interruption of energy imports due to external situations.

From the perspective of the diversity of transportation methods, for suppliers, oil and gas transportation to the destination is the last line of defense. Oil and gas transportation mainly relies on methods such as maritime transportation, pipeline transportation, and railway transportation. Among them, maritime transportation has the highest risk. The maritime routes pass through strategic locations, straits, and canals, which are areas within the global maritime domain. If the shipping routes are blocked and intercepted, there will be a long-term supply disruption of energy. The Strait of Hormuz and the Strait of Malacca are the most famous and busiest oil and gas shipping routes in the world. Hundreds and thousands of ships pass through the ports every day. In the event of a military standoff, it will directly block the transportation of massive amounts of oil and gas, impacting the domestic energy supply of the importing countries. With multiple transportation methods combined, multiple shipping routes are opened, and multiple channels serve as backup options, allowing the initiative to be in one's own hands instead of passively waiting for changes in the situation. Eventually, this leads to a situation where the energy supply is powerless.

From the perspective of the supply model, traditional oil and gas are mainly traded through international spot markets. The trading rules are easily controlled by powerful countries, and the decision-making power lies in the hands of a few stakeholders, lacking autonomy. Supply can be implemented through various models such as long-term agreement trading, equity cooperation development, and cross-border oil and gas project investment. The buyer can transform into an owner, gaining the right to control the distribution and utilization of resources, reducing the passivity of oil and gas trading. The

new mutually beneficial model of oil replacement and energy trade cooperation, which is more reliable and secure than the traditional buying and selling model, is based on mutual benefit [56].

When the global oil and gas trading market encounters a crisis and all external import supply sources are interrupted, strategic reserve energy can immediately ensure the oil and gas demands of the general public and special industries, providing a buffer period for sudden crises, and the reserve system is designed to prevent a sudden and drastic supply disruption of energy in extreme circumstances. The reserve system is similar to the staple food kept at home, capable of responding to short-term energy security shocks during critical periods. Therefore, China should strengthen its energy reserve system [4]. Coal should establish a three-level reserve system at the national, local and enterprise levels, and stockpile in advance in key regions and during key periods to ensure the supply of coal for the general public and key industries. Oil reserves are divided into two systems: national strategic reserves and commercial reserves. The storage capacity of oil should be continuously expanded, the reserve layout should be optimized, and reserve rotation should be well managed. Natural gas reserves focus on underground gas storage facilities and LNG storage tanks, especially to make up for reserves during the peak winter gas consumption period, to avoid insufficient natural gas supply affecting the general public [5]. The significance of the improvement of the reserve system lies in being able to respond quickly to the demands of the general public's consumption during supply crises, ensuring the basic electricity and gas supply for the general public, and stabilizing social order.

Fossil energy is formed through the long-term decomposition and sedimentation of nature. It cannot be formed rapidly in a short period of time. Therefore, the rate of consumption will always be slower than the rate of formation. In the long run, to solve the energy problem, we still need to rely on energy transformation [60]. We cannot solely rely on non-renewable energy sources like fossil energy that require long-term sedimentation. Instead, we should shift to clean energy sources such as wind energy, water energy, solar energy, and nuclear power [57]. The acquisition conditions for these types of energy are relatively more favorable compared to traditional fossil energy. China has sufficient

endowment and can achieve autonomous control [52]. Annual photovoltaic power generation in China from 2015 to 2025 is shown on figure 22.

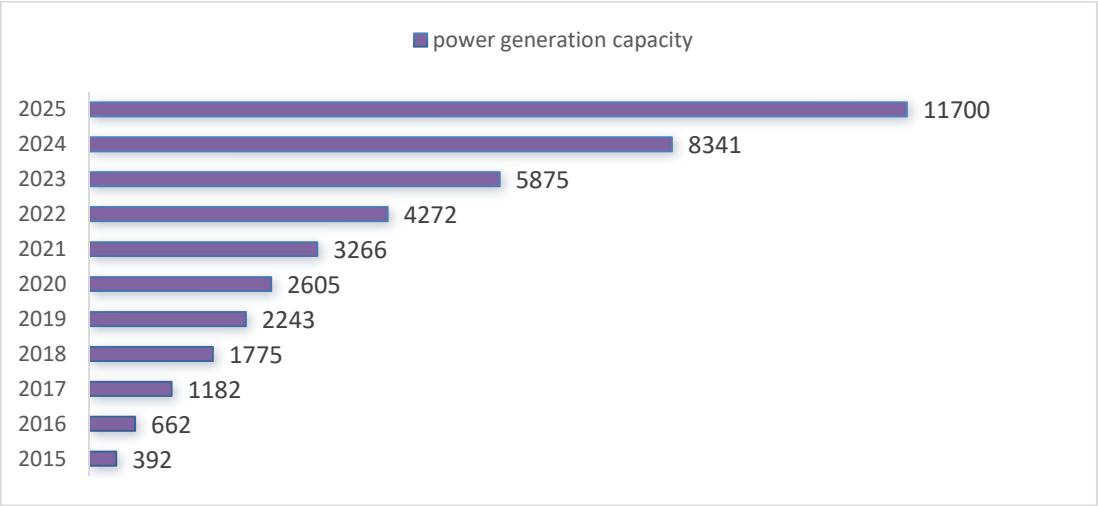


Figure 22 – Annual photovoltaic power generation in China from 2015 to 2025 (unit: billion kilowatts) [55]

From 2015 to 2018, the photovoltaic power generation volume saw an explosive growth, increasing by 50 % to 80 % year-on-year. From 2019 to 2020, the growth rate gradually slowed down. From 2021 to 2025, it began to grow at a high speed again (figure 23, table 1).

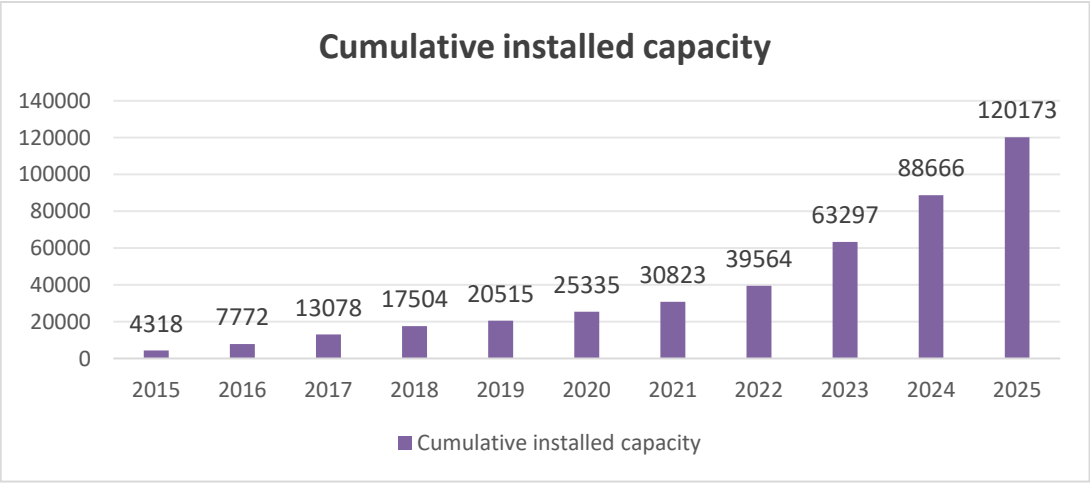


Figure 23 – Cumulative installed capacity of photovoltaic power in China by the end of 2025 (unit: million kilowatts) [55]

Table 1 – Annual Comparison Table of the Top 5 Countries in Global Photovoltaic Installation from 2020 to 2025 (Unit: GW) [55]

Ranking	2020	2021	2022	2023	2024	2025
1	China 254.4	China 308.5	China 392	China 646	China 886.7	China 1264.7
2	America 93.2	America1 23	America 111	America 155.6	America 177.5	America 222.5
3	Japan 71.4	Japan 78.2	Japan 78.8	Japan 84.9	India 97.4	India 146.4
4	Germany 53.8	Germany 58.5	Germany 66.5	Germany 74	Japan 91.6	Japan 97.3
5	India 39	India 49.7	India 62.8	India 79.1	Germany 89.9	Germany 110.9

China's installed capacity of photovoltaic and wind power ranks among the top in the world. It can continuously supply electricity. In the northwest region of China, photovoltaic power is combined with pastures. Solar panels are erected in the desert areas, forming a comprehensive model where photovoltaic panels generate electricity, grass is planted under the panels, and livestock are raised between the panels. The photovoltaic panels can provide shade and protection for the grassland, reduce water evaporation, and benefit the growth of grass. The grass can prevent the soil from being damaged by sandstorms, restore the ecology and improve the environment. Sheep grazing can control the height of the grass to reduce the risk of fires and also lower the cost of manual weeding. Sheep manure provides nutrients for the growth of grass and serves as feed for the sheep. This energy model achieves an ecological closed loop, driving economic benefits in multiple industries such as electricity, ecology, and animal husbandry [55]. At the same time, combined with energy sources like pumped storage and lithium batteries that can supply power independently without relying on weather changes, excess electricity is stored and released through the ultra-high voltage grid during peak electricity consumption periods, forming an internal self-energy supply system [48].

Energy is not merely a matter of surface resource supply, technical exploration, and infrastructure construction [53]. Energy risks run through every aspect of supply, production, transportation, and emergency response. This is because everything is

dependent on human control. The significance of risk management professionals lies in identifying, quantifying, and classifying risks at each stage to develop corresponding crisis handling plans. By analyzing and predicting global situation changes, changes in oil and gas export tariffs and trade policies of various countries, shipping and transportation risks, finding the safest and most reliable supply sources, and simultaneously assessing the domestic production safety margin of the country, they guide the scale of strategic energy reserves and the pace of energy release, avoiding direct impact of international prices and international situations on the energy supply of other industries and the livelihood of the people, and stabilizing the overall operation of the national economy [58].

Risk management professionals need to possess knowledge in various fields such as energy, economy, geography, and technology. They should be able to quickly handle sudden crises in situations of energy supply disruption, extreme weather, and cyber attacks, activate emergency plans, dispatch energy reserves from multiple locations, and replenish energy demands within a short period of time to minimize the impact on social life and industrial operations, ensuring the resilience of the energy system. Instead of passively waiting in the face of crises, they should address issues related to people's livelihoods. Through meticulous risk management, they can provide the most robust firewall for energy security.

Conclusion

China’s energy security paradigm has undergone a profound transformation in the twenty-first century, driven by the intersection of rapid economic growth, escalating import dependence, geopolitical volatility, and an ambitious decarbonisation agenda. The country’s transition from a net energy exporter in the early 1990s to the world’s largest importer of crude oil and natural gas has rendered external supply chains a strategic vulnerability. In the contemporary context, energy security is no longer conceived solely as the physical availability of resources at affordable prices; it now incorporates resilience against supply disruptions, technological sovereignty, and alignment with the dual-carbon goals of peaking emissions before 2030 and achieving carbon neutrality by 2060.

A foundational pillar of China’s strategy is the systematic diversification of import sources and transport corridors. Crude oil procurement has expanded well beyond the Middle East to include Russia, Central Asia, West Africa, and the Americas, reducing exposure to any single chokepoint. The Malacca dilemma – the dependence on the narrow Strait of Malacca for seaborne oil deliveries – has been partially mitigated through overland pipelines, notably the China–Myanmar oil and gas lines, the Central Asia–China gas pipeline network, and the Power of Siberia route from Russia. Simultaneously, the build-up of strategic petroleum reserves, now approaching the 90-day net-import coverage benchmark, and the rapid expansion of liquefied natural gas regasification capacity provide emergency buffers against short-term market turmoil.

Equally critical is the shift towards a more self-sufficient and technologically independent energy system, driven by the recognition that long-term security cannot rest on imported fossil fuels alone. Massive state-directed investment has made China the global leader in renewable energy capacity, with wind and solar installations accounting for over a third of the world’s total. The expansion of nuclear power, including fourth-generation reactors and small modular designs, further diversifies the low-carbon baseload. This transition is complemented by advances in ultra-high-voltage transmission lines, enabling the integration of remote renewable resources from the western provinces into eastern demand centres, and by a rapid scale-up of energy storage and smart grid

technologies. The domestic development of unconventional resources, such as shale gas and coal-to-liquids, though limited by geological and environmental constraints, remains a supplementary hedge.

A final dimension concerns the securitisation of clean-energy supply chains. China’s dominance in the processing of critical minerals – rare earth elements, lithium, cobalt, and graphite – and its control over photovoltaic and battery manufacturing value chains confer a new form of structural power. While this reduces vulnerability in the energy transition, it simultaneously creates interdependencies that Beijing can leverage. In parallel, the Belt and Road Initiative continues to embed Chinese energy investments within partner states, locking in long-term supply agreements and exporting domestic technical standards.

In conclusion, China’s contemporary energy security approach can be characterised as a multi-layered, adaptive strategy that balances immediate import needs with a far-reaching restructuring of the energy mix. The emphasis has decisively shifted from securing physical barrels and cubic metres to building a resilient, technology-driven, and increasingly electrified system. The principal tension remains the speed of the clean-energy transition versus the economy’s continued reliance on fossil fuels; managing this duality while navigating great-power rivalry, particularly over technology and maritime routes, will define the next phase of China’s energy security policy. The ultimate objective is not autarky but a state of managed interdependence in which critical vulnerabilities are neutralised and the decarbonisation imperative is turned into a source of strategic advantage.

Oil and gas energy is the lifeblood of modern industry, and stable oil and gas supply directly affects the security of a country's energy. This article discusses that energy security issues are influenced by the international trade environment, geopolitics and resource allocation. Due to its large population, China is the world's largest energy consumer and importer. China's coal resources can be self-sufficient, but its oil and gas resources need to rely more on imports, with a high degree of dependence on foreign sources. Therefore, it is necessary to solve the problem of energy supply and reduce the impact of the international environment on China's energy supply.

For the external environment, due to China's single energy supply source and the

relatively concentrated supply countries, the dependence on foreign oil and gas energy is high, making it vulnerable to geopolitical factors, fluctuations in international oil prices, transportation pipelines, and trade sanctions. There are many potential risks to energy security. As the largest importer of oil and gas energy, China is highly dependent on the international market for its energy resources. Any disturbance in the global trade market will be transmitted to the energy supply situation in China through the trade chain, demonstrating the vulnerability of energy security to the external environment. Therefore, China needs to find an energy supply model that suits its own characteristics. China can enhance its risk-resistance capacity by diversifying imports, building overseas oil and gas reserve bases, improving the energy reserve system, deepening strategic cooperation with oil-producing countries, and participating in international energy governance. From a single supply model to a diversified supply model, the diversification of transportation methods and channels, the selection of energy supply from multiple regions, improving the trade system with the RMB as the base currency, strengthening China's international status in energy trade, and mastering the leading position in trade.

Regarding the internal environment, China's oil and gas resources are relatively scarce, and it needs to rely heavily on imports to make up for the gap in energy demand. Therefore, it has inherent limitations. Long-term reliance on imported resources brings risks to energy supply. This article, in light of this situation, proposes some solutions to address the impact of China's energy security issues in international trade. The government encourages the widespread application of clean energy in the livelihood industries to replace traditional fossil energy. This can not only reduce the consumption of fossil energy but also be beneficial to the restoration of the environment. The scarce imported energy should be used in some indispensable fields to maximize the role of each type of energy. In the future energy sector, China will encourage energy transformation. The precision manufacturing chemical industry still relies mainly on oil and gas energy, while the livelihood and basic chemical industries vigorously develop the application of new energy to enable China's energy supply to follow a sustainable development path.Secondly, we should strengthen our own energy reserve system. When oil and gas resources are exported to China, China also needs a complete reserve system for storage and

preservation. During peak energy supply periods, we should quickly implement cross-pipeline dispatching to respond to energy demands promptly and stabilize the social operation order.

In conclusion, in the international oil and gas trade, China will seek diversified development, promote energy transformation, actively explore new types of cooperation + investment trade models, leverage its own advantages in new energy, ensure that more energy-importing countries have stable energy supplies, continuously import, promote the development of international energy, and enhance China's international influence.

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