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Original article

ENERGY SECURITY AND INTERNATIONAL COOPERATION OF CHINA

SEGURIDAD ENERGÉTICA Y COOPERACIÓN INTERNACIONAL DE CHINA

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Abstract

The energy situation constitutes an essential component in the progress of countries. Achieving a supply that meets normal survival and development needs is a permanent concern, aggravated by the current conditions of the international context and the effects of climate change. The article aims to analyze the current and future situation of energy security in China, achieving as a result of the search and processing of information related to the subject, evaluate the current situation of Chinese energy resources, supply, transportation, prices and the development of innovation. It also addresses international cooperation, current and future challenges, as well as measures that will ensure that this strategic objective is achieved.

Keywords: Energy security, energy resources, renewable energy, energy supply, energy transition, green energy

Resumen

La situación energética constituye un componente esencial en el progreso de los países. Lograr un suministro que satisfaga las necesidades normales de supervivencia y desarrollo constituye una preocupación permanente, agravada por las condiciones actuales del contexto internacional y los efectos del cambio climático. El artículo tiene como objetivo analizar la situación actual y futura de la seguridad energética en China, logrando como resultado de la búsqueda y procesamiento de la información

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relacionada con el tema, evaluar la situación actual de los recursos energéticos chinos, el suministro, la transportación, los precios y el desarrollo de la innovación. También aborda la cooperación internacional, los desafíos actuales y futuros, así como las medidas que garantizarán lograr este objetivo estratégico.

Palabras clave: Seguridad energética, recursos energéticos, energías renovables, suministro de energía, transición energética, energía verde

Introduction

The combination of rising hydrocarbon prices and the deterioration of the international geopolitical situation, especially in important regions and countries in the gas and oil market, as producers or transit countries, has generated a certain sense of urgency in the governments of consumer countries to face the challenges related to energy security.

Besides, the issues related to global warming have brought great risks for the survival and development of humanity. The energy industry and energy-intensive industries are considered the main sources of greenhouse gas emissions. For this reason, the transition towards a low-carbon economy has become the main theme of world energy development, which faces a double challenge: more supply compared to less carbon emissions and with the peculiarity that during the energy transition stage, Oil and gas will continue to be the main resources for world energy consumption and their supply will be increasingly vulnerable, with an impact on geopolitical relations, which will further aggravate the security of energy supply.

Achieving energy security under these conditions is of vital importance for China, which is in a period of industrialization and urbanization, with an expanding economy that will require energy consumption of more than 5,500 million tons in 2030. Therefore, ensuring Energy security under current conditions is of the utmost importance for the stability and development of the country.

The article aims to examine the situation of energy security in China, presenting an overview on the subject, the current situation, China's experience and international cooperation.

Materials and methods

For the development of the article, information search techniques were used, mainly framed in the documentary review, which implied the collection and consultation in a systematic and orderly manner, of a series of data on energy security, which served as references to analyze, verify, compare, show positions and reveal trends.

The following aspects were analyzed in depth:

1. Meaning of energy security (energy supply, energy price, energy transport, energy and environment).
2. Current situation of energy security in China (coal resources, oil resources, natural gas resources, challenges under the new situation)

3. China's experience and international cooperation (guaranteeing China's future energy security, China's international cooperation in renewable energy, global energy governance, and intergovernmental cooperation)

Results and Discussion

1. Meaning of energy security

Energy security is presented as a complex concept in which it is necessary to consider different dimensions, from the political and military, through the economic and social, to the environmental. In this sense, it is increasingly common to talk about the need for energy security to be considered not only as the affordable, reliable, diverse and comprehensive supply of oil and gas and the adequate infrastructure to deliver these supplies to the market, but also linked directly with sustainable development. Although it is true that energy security has different meanings according to the geographic location of the actor in question, its geological endowments, its international relations, its political system and its economic disposition, it cannot be left aside, as well as the need for any strategy used to be environmentally friendly.

For China, energy security constitutes a challenge that demands the management, knowledge and prediction of a set of external and internal factors with a direct incidence, among them are the secure supply, variations in energy prices, the transport and energy and environmental sustainability, which are essential variables for an analysis of the subject. Knowledge of energy sources and their availability constitutes another variable to be evaluated in any energy security analysis, their classification by type, characteristic, state of use, origin, and others.

Coal, oil and natural gas remain China's main energy sources, which are classified as non-renewable minerals, with a conventional use status, which continue to expand their production capacity despite facing ecological environmental pressure. growing, but its production does not meet the growing energy demands. Other resources such as natural gas, wind and nuclear power have the conditions for a relatively large increase in production, but their base is small, likewise the large-scale development of other new and renewable energies faces technical and economic.

1.1. Power supply security

The so-called security of energy supply, that is, the stability of supply, refers to the continuity and degree of guarantee of supply that meets the normal needs for national survival and development. Some authors recognize that security of supply is essentially a shortage of supply, caused by the unequal distribution of resources.[1] Despite the reintegration of the global energy industry chain, energy supply bottlenecks persist[2] and their removal will depend on:

- The global spread of the COVID-19 pandemic, which has forced countries to adopt lockdowns, strengthened border controls and home quarantines, has led to prolonged disruptions in global supply chains and a significant impact on key links such as production, shipping transportation and inventory in the supply chain, resulting in a shortage of energy products.

- The time of reintegration of the energy industry, where the bottleneck of the supply chain needs a long time to be repaired, and the establishment of a new supply relationship can increase the uncertainty of supply and affect the stable supply of energy.

- Relative labor shortages, sharp declines in potential labor in many countries, and increased obstacles to labor mobility between countries will be a major supply bottleneck affecting the development of supply chains for energy in developed countries.[3]

- Climate change, with extreme weather events such as excessive heat, ocean heat waves, and heavy precipitation occurring, increases the vulnerability of energy supplies. For example, in August 2021, the hurricane in the Gulf of Mexico disrupted oil and gas production in the region, and it was not until October of that year that original capacity was basically restored.[4]

The green energy transition is considered another factor that tests the stability and resilience of the energy supply, where:

- A change in the structure of the world energy market, where a shift from traditional fossil fuels to clean energies, such as wind and solar, are highly affected by the natural environment, easy to cause shortages due to instability in supply, caused by the characteristics of randomness, intermittent and volatility of these energies.

- In a short term, rising global energy consumption is still dominated by fossil fuels, but the scale of investment is declining, while renewable energy investment growth is relatively slow, which may affect future elasticity of the power supply.

Geopolitics is considered an influential factor in fuel supply, geopolitical games will exacerbate energy supply security problems. An example is the current Russian-Ukrainian conflict, where Germany announced the suspension of certification and commissioning of the Nord Stream 2 natural gas pipeline project, followed by British Petroleum, Statoil Equinor and others who have announced their withdrawal from the relationship. cooperation with Russian-related energy companies. Coupled with the launch of swift sanctions against Russia by the United States and Europe, future international energy trade with Russia may endure multi-layered uncertainty and face a number of risks and challenges, including payment and settlement. The deepening of sanctions against Russia will seriously challenge the world's energy supply, and will rebuild the world map of energy production.[5.]

1.2. Energy Price Security

In essence, energy is not a mere commodity, and not only can any geopolitical conflict have a significant impact on the price of energy, but even as small as the outbreak of a hurricane can have a major impact on the price of energy. Energy. The security of energy prices is of vital importance; their increase would imply:

- From the supply point of view, energy is considered an important element in economic and social development, its price increase will first lead to an increase in the cost of power generation and an increase in electricity prices., which will then raise the cost of production for the manufacturing industry as a whole. In addition, the increase in energy prices will also lead to an increase in the

production cost of pesticides, fertilizers and other products that use crude oil as a raw material, as well as the cost of logistics and transportation.

- From the demand side, the increase in energy prices will raise prices and have an impact on final consumption. Affected by the epidemic, the economic downturn of various countries, rising unemployment, declining income of residents, and the "helicopter money" type of fiscal stimulus in some countries is difficult to sustain, and the likelihood of recovery sustained global household consumption is not large. The increase in production costs caused by rising energy prices will be passed through to final consumer goods, which will be paid for by consumers, worsening already undervalued consumer demand.

International oil prices, already at a high level, are rising rapidly. On March 7, international oil prices reached a high point, with a new maximum since 2014. Brent crude prices closed at $139.13 per barrel, 62% higher than at the beginning of the year; those of WTI crude oil at $123/barrel, 63% more than at the beginning of the year and the price of OPEC crude was $127.9 per barrel, 64% more than at the beginning of the year.[6.]

1.3. Safety of energy transport

The influence of transport safety on the energy supply is significant and when analyzing the current situation, the following stand out:

- The diversity of energy sources and channels will inevitably cause energy transportation problems, where its stability will include the ability of the energy production area to guarantee a stable and sufficient supply, including whether energy is transported to the place of consumption in a timely manner. and safe.

- The substantial growth of world energy trade, where the volume of international oil and gas transportation has increased enormously, the supply chain has lengthened, and the security of international transportation channels has become increasingly prominent.

- The world energy market depends on reliable transportation routes, with 20% of the world's oil supply passing through the Strait of Hormuz, 80% of the oil supply from Japan and South Korea, and 60% of the supply China's oil passes through the Strait of Malacca. Sea transportation may be threatened by piracy and terrorist attacks, and China has no control over oil tankers and transportation routes, and once serious terrorist activities occur on sea routes, it will not be able to guarantee timely delivery and adequate supply of oil imported into China.[7]

- On September 25, 2019, the US Treasury Department listed Dalian COSCO Shipping Oil Shipping Company, a subsidiary of COSCO HG, on the list of specially designated countries and prohibited persons.[8] The company owns 26 super-large tankers, accounting for 2.7% of the world's total operating tanker capacity, and this event, together with the seasonal factor of the tanker market's peak season, has affected the supply capacity of the transportation of oil, causing a serious increase in transportation prices.[9]

- In October 2019, nearly 300 tankers were sanctioned by the United States[10] exacerbating panic, and daily revenues for super-large tankers on the Middle East to China route reached $300,000, a new high since 1990, corresponding to a freight rate of approximately $8.6/barrel, 4.78 times the pre-sanctions rate (approximately $1.8/barrel), which is 5.38 times the freight rate after the United States Department of Treasury announced the lifting of sanctions on Dalian Maritime Shipping on January 31, 2020. The freight rate/oil price ratio (spot Brent crude oil price) broke out of the normal range at 14%.

1.4. Energy and environmental security

Energy and environmental security means guaranteeing the sustainability of energy resources. Although China's current energy intensity, carbon emissions per unit of Gross Domestic Product (GDP), and energy consumption levels are much higher than those of the United States, Europe, Japan, and other developed countries and regions, emissions Carbon per capita and energy consumption levels are much lower than in developed countries, with more room for upward mobility. In the context of environmental capacity constraints and the global response to climate change that low-carbon energy development requires, the energy environment is also becoming increasingly important.[11]

The development and use of coal faces the large number of pollutants it possesses, sulfur dioxide, carbon dioxide, nitrogen oxides, carbon monoxide, soot and mercury, which are produced in the process of coal consumption, are the main causes of air pollution and acid rain. Coal causes damage to the ecological environment of the mine, during the mining process, threatening the biological habitat. It mainly includes surface damage, causing movement of rock formations, acid mine drainage, coal gangue accumulation, and methane emissions from coal seams.[12.]

Oil and gas exploration, exploitation, processing and utilization causes accidents, oil production wastewater, drilling wastewater, well washing wastewater and wastewater generated by manual injection in the process of oilfield exploration and production. The formation water produced during the extraction process of the gas fields contains sulfur, halogen, lithium, potassium, bromine, cesium and other elements, and its main danger is soil salinization. Offshore oil production has a serious impact on the marine ecosystem due to explosions, oil spills, capsizing of offshore oil production platforms, tanker accidents, etc. In addition, from exhaust emissions from motor vehicles in the transportation industry, such as carbon monoxide, hydrocarbons, nitrogen oxides, lead, and others.[13]

2. The current situation of energy security in China

The general characteristics of China's energy pose a country: rich in coal, with less oil, lack of gas and abundant water. By particularizing in these situations, it can be seen that energy reserves are dominated by coal, while those of oil and gas are relatively insufficient. Coal resources are relatively abundant and widely distributed. Oil reserves are scarce, and the overall growth of oil production is slower.[14.] When analyzing the distribution of energy resources, it can be seen that the main areas of energy consumption in China are concentrated in the southeastern coastal areas, while coal and oil are "more in the north and less in the south", and natural gas and hydropower are "more in the west and less in the east"[15]

Primary energy production in China, from 2014 to 2020, as a whole showed a first upward and then downward trend. China's single-use energy production in 2020 was 4.08 billion standard tons of coal, up

2.8% year-on-year. Since 2018, the growth rate of China's primary energy production has shown a downward trend, from 5.6% to 2.8%**.**

The composition of consumption **(Figure 1)** shows that the share of renewable energy in the national energy mix remains low.

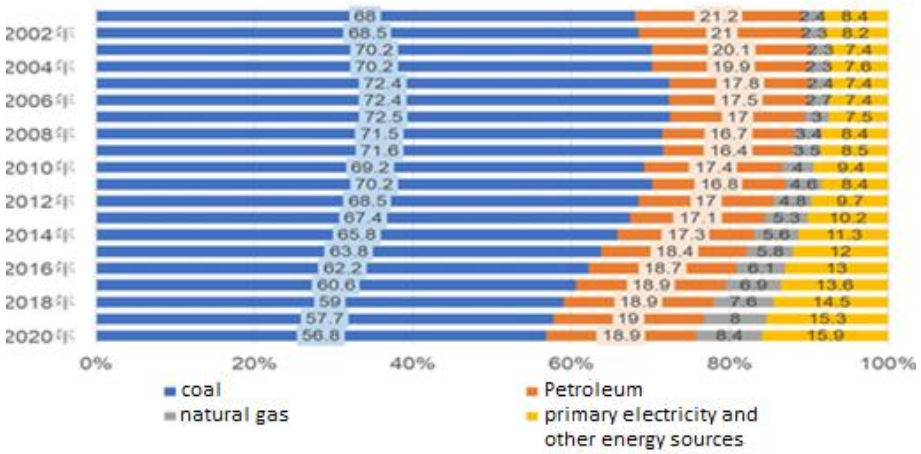

Figure 1. Composition of China's energy consumption

China's proven coal resources account for more than 90% of total primary energy, this dominant position in energy production and consumption, contributes to seriously polluting the environment.[16] In turn, per capita ownership of energy resources is low, at the lowest level in the world, since the Chinese are numerous. Per capita ownership of coal, hydropower and wind resources is equivalent to 50% of the world average, and per capita resources of oil and natural gas are only about 1/15 of the world average. Arable land resources are less than 30% of the global per capita level, constraining biomass energy development.[17]

Generally speaking, the basic characteristics of China's energy consumption structure can be roughly summed up in 6 words: "more coal, less oil and less gas". This is not reasonable enough, and coal accounts for a relatively high proportion, which has caused China's total carbon emissions to be high, and the formation of smog climate is easy. Changes in China's energy mix **(Figure 2)** until 2050 will behave as follows:

- China's total energy consumption will continue to grow, but at a slower rate.[18.]
- Coal will remain the most important energy source for a long time, but its share in the energy mix has been declining, and total consumption has peaked and then declined.
- The share of non-fossil nuclear, hydro, solar and wind power in the energy mix will increase significantly.
- Oil and gas consumption will increase further, but due to China's limited oil and gas resource reserves and production capacity, it may be difficult to fundamentally improve the situation of high dependence on foreign oil and gas resources. gas for a long time.

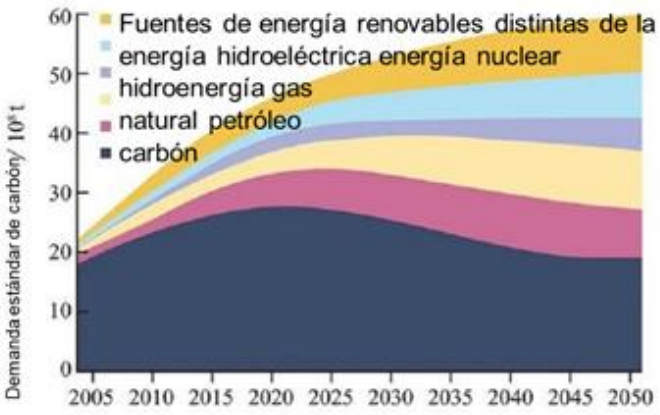

Figure 2. Behavior of the Chinese energy matrix until 2050

- The unequal geographic distribution of energy resources. China's energy resources are widely distributed, but uneven; hydropower resources are mainly distributed in the southwest region, coal resources are mainly allocated to north China and northwest China, and oil and gas resources are mainly allocated to the eastern, central and western regions and maritime areas.
- An energy consumption dominated by coal, where oil and gas resources are relatively scarce, causing environmental pollution to worsen and the supply of high-quality energy to be insufficient.
- Total energy consumption is growing and energy use is inefficient.

With the continuous expansion of the economy, China's energy consumption continues to show an upward trend, and in the future, China's oil, natural gas and other energy resources still need to rely on imports.[18.]

2.1. The current situation of China's coal resources

China is rich in coal resources, in 2016 the proven reserves were 1.6 trillion tons, accounting for 21.4% of the world,[19] ranking third in the world, its distribution shows the characteristics of " the north is rich and the south is poor, the west is more and the east is less". Coal production accounts for 45.1% of the world total, ranking first in the world. The coal-producing areas are mainly in the central and western regions, of which the coal production of the three provinces (regions) of Shanxi, Shaanxi and Mongolia accounts for more than 70% of the total national production.

The state of the east coast coal demand, the net transfer to the provinces are Shandong, Henan, Hebei, Anhui, Hubei, the three eastern provinces, Jiangsu, Zhejiang, Shanghai and the Pearl River Delta and other provinces or regions. The mismatch between supply and demand leads to transportation security risks.

At present China's coal consumption dependence on foreign countries is low, with strong independence and autonomy, China's external dependence on coal resources in 2020 will be about 15%. Affected by the emission reduction policy, China's coal consumption (**Figure 3**) has decreased after 2018, in 2020 it was 2,829 million tons, accounting for 56.9% of total energy consumption.[20]

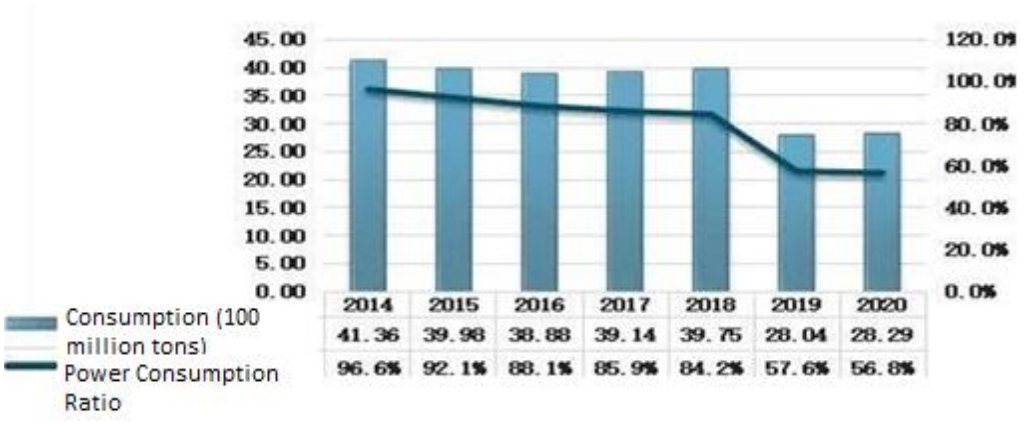

Figure 3. Coal consumption between 2014 and 2020

Coal imports since 2015 (total imported coal) have continued to increase, repeatedly reaching new highs, increasing in 2021. The monthly behavior between 2019 and 2021[21] in 2020, the volume of imported coal decreased by 4, 3% compared to 2019, but in 2021 it was 321.97 million tons, for an increase of 3.2% compared to 2020.

The main sources of China's coal imports are Indonesia, the Russian Federation, Mongolia, Australia, the United States and Canada. Taking 2021 as an example, China's coal imports from the above countries were 195.46 million tons, 56.76 million tons, 16.44 million tons, 11.71 million tons, 10.59 million tons, tons and 10.43 million tons, respectively. Among them, imports from the United States increased by 1021.7% year-on-year, and imports from Australia decreased by 84.89% year-on-year.[22.]

2.2. Current situation of China's oil resources

Oil reserves in China (**Figure 4**) have been growing since 2010, reserves of 3,170 million tons in 2010 have increased to 3,557 million tons in 2020, an increase of 10.8%. As of the year 2020, China's oil reserves have ranked 8th in the world and only account for about 1% of the world's proven reserves.[20.]

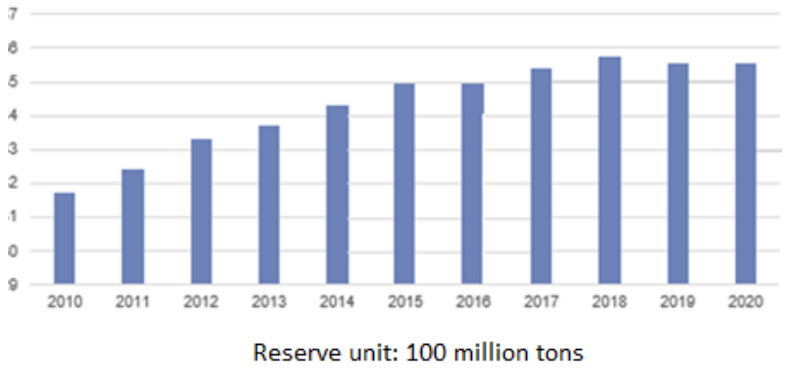

Figure 4. Behavior of Chinese oil reserves

China is a big consumer of oil, its consumption is increasing year by year, with a growth rate that fluctuates and changes and accounts for about 1/8 of the world. According to the latest data released by the China Petroleum and Chemical Industry Federation **(Figure 5),** in 2020, the domestic consumption

of crude oil was 736 million tons, an increase of 5.6% over the year. previous year, the growth rate was 1.7% lower than the previous year and the dependence on foreign countries was 73.5%.[23.]

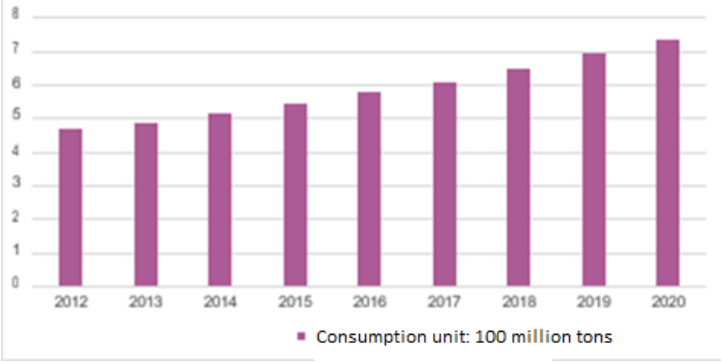

Figure 5. Behavior of Chinese oil consumption 2010-2020

As of 2021, China's crude oil imports **(Figure 7)** had increased for 20 consecutive years. In 2017, with an annual crude oil import volume of 420 million tons, it surpassed the United States by 395 million tons in one fell swoop, becoming the world's largest crude oil importer for the first time. China has been a major driver of global oil demand over the past decade, and even in 2020, when the pandemic hit it deeply, its crude oil imports increased by 7.3% compared to the previous year. External dependency reached 74%.[23]

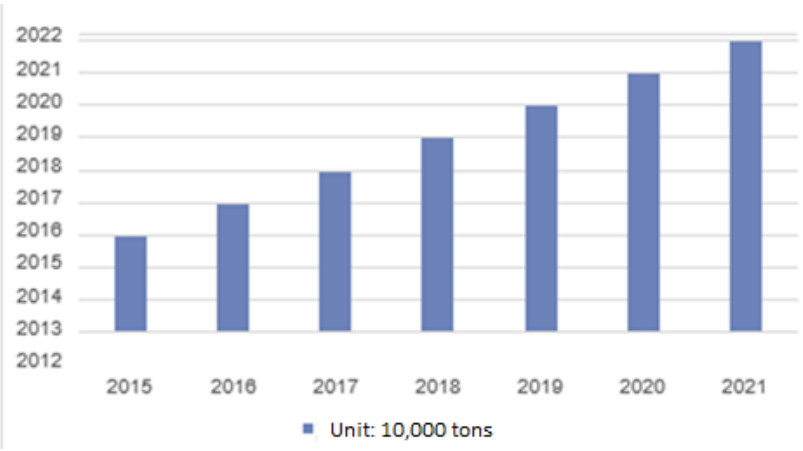

Figure 6. Behavior of oil imports in China 2015-2021

The main sources of Chinese oil imports are: Saudi Arabia, the Russian Federation, Iraq, Oman, Angola, the United Arab Emirates, Brazil and Kuwait. Taking 2021 as an example, China's imports into the main countries of origin were 87.57 million tons, 79.64 million tons, 54.08 million tons, 44.82 million tons, 39.15 million tons, 31.94 million tons, 30.3 million tons and 30.16 million tons, respectively. Among them, Oman's imports increased 18.32% year on year, and Brazil's imports decreased 28.26% YoY.

2.3. Current situation of natural gas resources in China

Currently, China's proven natural gas reserves account for about 2% of the world total. China's gas fields are mainly small and medium-sized, most have complex geological structures, exploration and

development are more difficult, and proven reserves are concentrated in 10 large basins, in order: Bohai Bay, Sichuan, Songliao, Junggar, Yinggehai-Qiongdongnan, Qaidam, Tu-Ha, Tarim, Bohai, Ordos. Among them, Tarim and the Sichuan Basin are the richest in resources, accounting for more than 40% of the total resources. China's proven natural gas reserves (**Figure 7**) in 2020 were 6,266,578 million cubic meters, an increase of 5% year-on-year.[24]

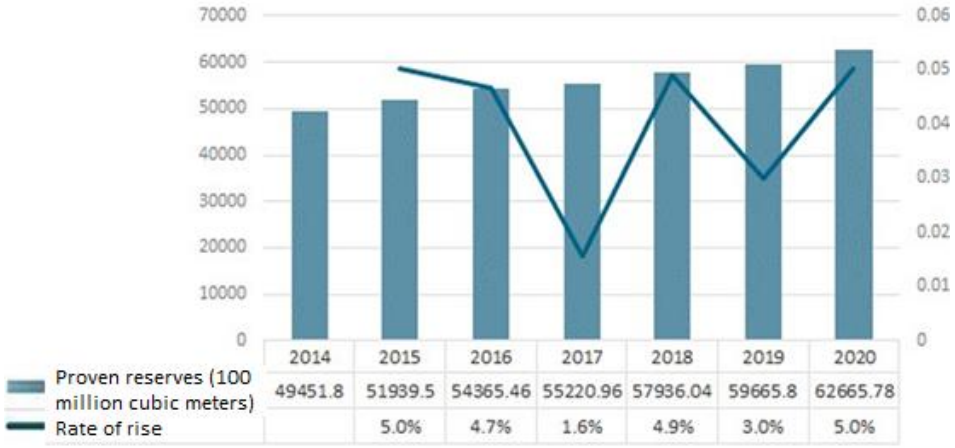

Figure 7. China's proven natural gas reserves 2014-2020

The consumption of natural gas in China **(Figure 8**), shows a tendency to increase annually, currently representing 1/20 of the world. In 2011, natural gas consumption was only 134.11 billion m3, and in 2020 it reached 324 billion m3, an increase of 58.6%. In 2020, China's natural gas dependence on foreign countries reached 43%.[25.]

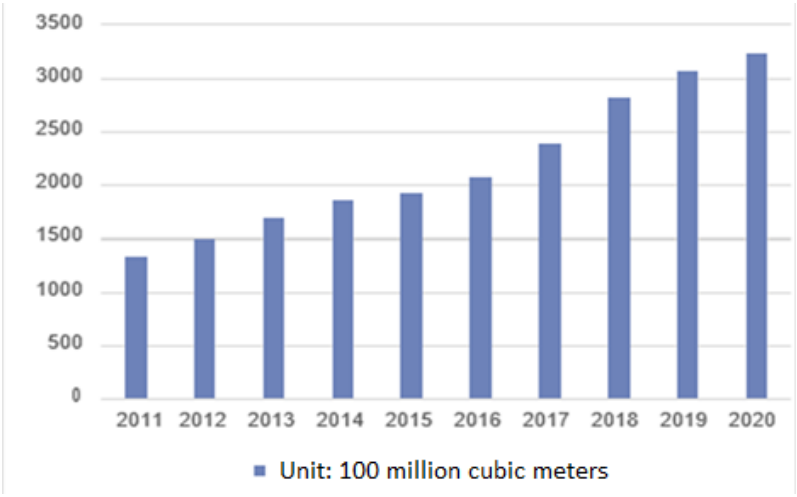

Figure 8. Behavior of China's natural gas consumption 2011-2020

China's natural gas imports have increased year after year, from 57.8 billion m^3 in 2014 to 126.2 billion m3 in 2018, with a compound growth rate of 22%. China's gaseous natural gas imports in 2021 were 42.43 million tons, down 36.8% year-on-year. LNG imports were 78.93 million tons, 17.6% more than the previous year.[26.]

Global natural gas supply features a "three world" pattern of the United States, Russia and Qatar. The United States and Qatar will become the world's two largest liquefied natural gas (LNG) export hubs with the two countries predicted to account for 40% of global LNG exports by 2040. At the same time, Russia is also Increasing natural gas exploration and development, trying to realize reserves as soon as possible, especially in recent years, vigorously developing liquefied natural gas projects for Asia-Pacific region, increasing its export volume year by year.

Global natural gas demand is strong, the Asia-Pacific market consumption increase will account for more than half of the global increase, and China will be the world's center of natural gas consumption. By 2025, the global LNG supply and demand situation is expected to gradually reduce from a surplus of 21 million tons in 2020 to a supply gap of 25 million tons. China's natural gas import resources include pipeline gas and liquefied natural gas (LNG). China's onshore oil and gas pipelines have basically formed a supply pattern of nationwide natural gas pipeline network connecting with foreign countries and covering the whole country, stretching across the east and west, and crossing the north and the South. Due to infrastructure and geographical conditions, China mainly imports natural gas through pipelines from leading countries such as Kazakhstan, Turkmenistan, Uzbekistan, Russia and other regions. LNG importers are mainly Australia, Qatar, Malaysia and other countries.[27]

2.4. Challenges to China's energy security under the new situation

Among the most significant challenges, which increase the pressure on the energy supply, the following stand out:

- The anti-globalization trend that is spreading, especially since the outbreak of the COVID-19 epidemic with many links in the supply chain of the global industrial chain blocked, a lack of trust and cooperation between countries has resulted to protectionism becoming more common.
- Global geopolitical tensions, intensifying global game, China's use of foreign energy has a short history, small scale, weak price affordability, weak military power protection force, small influence in the international market, for oil and gas commodities, China's lack of pricing power seriously affects industrial development, economic security and international competitiveness.
- The challenges, related to the limitations, derived from the reduction of greenhouse gas emissions, where:
  - ✓ China is a large emitter of greenhouse gases, and by 2030, China's greenhouse gas emissions will continue to grow, and in recent years, major countries in the world have attached great importance to climate change.[11.]
  - ✓ In 2014, in the Sino-US Joint Declaration on Climate Change,[28] China officially proposed for the first time that the country's carbon emissions are expected to peak around 2030.
  - ✓ On September 22, 2020, President Xi Jinping delivered a major speech at the general debate of the 75th session of the United Nations General Assembly,[29] noting the need to accelerate the formation of methods and lifestyles of green development, and build an ecological civilization and a beautiful earth. China will increase its nationally determined contribution, adopt stronger policies and measures, strive to reach peak carbon dioxide emissions by 2030, and strive to achieve carbon neutrality by 2060.
  - ✓ The Chinese government regards the reduction of greenhouse gas emissions as a conscious action and needs to make greater efforts to optimize the energy structure, due to constraints such as storage conditions, energy transition faces resource constraints and at the same time, you have to pay some affordable energy security costs.

- The limitations in the use of new energies, which are not enough to replace traditional energy systems, motivated by:
  - ✓ The development of China's new energy system has made great progress, but it is still small compared to the share occupied by traditional energy. Although the cost of new power generation has decreased in recent years, due to the randomness, volatility, and intermittent characteristics of new power generation, it is difficult to become a pillar power system under the current technical level and the application scale.
  - ✓ The new generation of energy, which must be used with storage technologies and current technology has many restrictions and high costs.
  - ✓ The innovation capacity in energy science and technology still has a long way to go, although energy technology has made great progress, there is a big gap compared with the requirements of energy development. In a context where the main countries of the world have launched a new energy technology competition, achieving multi-energy security is complicated and without synchronous development the world will continue to be in a passive situation, where it will be difficult to achieve through the support of science and technology, meet this goal.
- In addition, the limitations related to the strengthening of storage and transportation capacity, where:
- Construction of gas storage tanks is lagging behind, with gas volume only accounting for about 4% of gas volume sold, which is much lower than the world average of 12%.
- There is a lack of high-quality resources, the cost of building a reservoir is high, the natural gas resource area is separated from the main consumption area, and the construction resource distribution is uneven.
- Marketing is insufficient, seasonal prices and regulatory price caps have not yet been fully implemented, natural gas prices cannot reflect supply and demand in a timely manner, and the market-oriented operating space of deposits gas storage is limited.
- The technical standards and management system are still in the establishment and improvement stage, the gas storage information standards are not uniform, the functions are not perfect, the integration with the business is not close, the value of the data is not fully reflected and digital transformation is difficult.[30]

3. China's experience and international cooperation

3.1. Measures to ensure China's future energy security

Since the 18th National Congress of the Communist Party of China, General Secretary Xi Jinping, in coordinating the overall situation of the grand strategy of rejuvenation of the Chinese nation and the great changes in the world that have not occurred for a hundred years, has coordinated the two major domestic and international situations and security development, has put forward a new strategy of "four revolutions and one cooperation" for energy security, focused on promoting the revolution of energy consumption, the revolution of energy supply, the energy technology revolution and the energy system revolution, strengthened international cooperation in all directions and realized energy security in open conditions, introducing a series of new concepts, new views and new requirements. It has pointed the direction for the high-quality development of China's energy in the new era.[31.]

At the critical moment when China has entered the comprehensive construction of a modern socialist country, marching towards the goal of the second centenary, it is of great importance and far-reaching

influence to firmly stabilize the rice bowl of energy. Several deputies and members of the two sessions said that energy security is related to the destiny of the country, and in the context of the era of carbon neutrality, guaranteeing the supply is of great importance:

1. Strengthening the production of internal resources and stabilizing the energy rice bowl.
2. Promoting innovation in energy science and technology and promoting the efficient use of energy.
3. Constantly promoting the transformation of the energy structure and accelerating green and low-carbon development.
4. Optimizing the design of energy development and improving the optimal allocation of resources.
5. Expanding international energy cooperation and carefully build an international cooperation platform.

3.1.1. Strengthening the production of internal resources and stabilizing the energetic rice bowl

Since the "13th Five-Year Plan", China's energy self-security capacity has always been above 80%, the supply-demand ratio has continued to improve, and a coal, oil, gas power production system, electricity, nuclear power, new energy and renewable energy, has basically taken shape.[32.] In terms of external dependence, oil and gas exploration and development efforts have been continuously improved, and have maintained continuous growth since 2018, with new proven geological oil reserves of 1,322 million tons (2020) with an increase of 17 .7% year-on-year.

The new proven geological reserves of natural gas were 1,051,458 million m3, an increase of 30.0% year-on-year, of which there were 3 basins with new proven geological reserves greater than 100 billion m3. Data released earlier by the Operations Office of the National Development and Reform Commission showed that the domestic production of crude coal in 2021 was 4.070 million tons, an increase of 4.7% over the previous year, giving full play. to the "ballast stone" of coal and the basic energy regulatory role of coal.

Crude oil production of 199 million tons, an increase of 2.4% over the previous year, three consecutive years of stabilization, recovery, and oil dependence on foreign countries of 72%, 1.6 percentage points less than the year last. Natural gas production was 205,300 million m3, with an increase of 8.2% compared to the previous year, production increased by more than 10,000 million m3 for five consecutive years.[33.]

In terms of installed capacity, China's full-bore power generation installed capacity reached 2.38 billion kilowatts in 2021, an increase of 7.9% year-on-year. Among them, the installed capacity of hydropower is 390 million kilowatts, wind power is 330 million kilowatts, and solar power generation is 310 million kilowatts. The installed capacity of wind power, photovoltaic power generation, hydropower and biomass power generation has ranked first in the world for many consecutive years, with 71 nuclear power units under construction and approved and 76 million kilowatts installed, ranking second in the world.

In relation to the average rate of wind power across the country in 2021 was 96.9%,[34] an increase of 0.4 percentage points year-on-year; the national utilization rate of photovoltaic power generation was 98%, which was basically the same as the previous year. The utilization rate of hydropower in major river basins across the country was about 97.9%, an increase of 1.5 percentage points year on year, and the

amount of wasted hydropower was about 17, 5 billion kWh, 14.9 billion kWh less than the same period last year. The annual average hours of use of nuclear energy exceeds 7,700 hours.

Turning to the grid transmission, in 2021, the national power grid substation equipment capacity of 220 kV and above will total 4.94 billion kVA, an increase of 5.0% year-on-year. The length of the 220 kV and higher transmission line circuits amounted to 840,000 km, representing an increase of 3.8% year-on-year. The construction of the main transmission channels in China continues to progress, and by the end of 2021, a total of 33 UHV lines will be completed and put into operation. Among them, 15 AC UHVs are all in the state grid, completing 18 DC UHVs, 14 of which are from China and 4 are from the south.

And finally, in terms of building reserve bases, thanks to a series of strong and effective actions to increase reserves and production, China's energy reserve system has been continuously improved. Nine national oil reserve bases have been built, the construction of the natural gas production, supply, storage and marketing system has achieved initial results, the coordinated guarantee system for coal production and transportation has been gradually improved, the Safe and stable operation of electric power has reached the world's advanced level and the comprehensive power emergency support capacity has been significantly improved. With the completion of the construction of a number of large-scale coal storage bases such as Jingzhou City in Hubei Province, Jining City in Shandong Province, Shentie, Liaoning Province, etc., the regional and national coal supply guarantee capacity has been greatly improved, and the government's dispatch-able coal reserve capacity has reached 80 million tons.

3.1.2. Promoting innovation in energy science and technology and the efficient use of energy

On the basis of ensuring energy security, the government work report particularly emphasizes the need to "strengthen the clean and efficient use of coal, orderly reduce and substitute, and promote the transformation of energy conservation and carbon reduction, the flexibility transformation and the heating transformation of coal power". China's energy efficiency has improved significantly, since 2012, the cumulative energy consumption per unit of GDP has decreased by 24.4%, which is equivalent to reducing energy consumption by 1.27 billion tons of standard coal. From 2012 to 2019, the average annual growth in energy consumption of 2.8% supported the average annual growth of the national economy by 7%.[35.]

Strengthening the clean and efficient use of coal is inseparable from the research and transformation of key technologies. Since China's first CCUS demonstration project was commissioned in Shanxi in 2004, a total of 49 CCUS demonstration projects have been put into operation and under construction. According to China CCUS 2021 annual report, about 5.1 billion tons and 9 billion tons of carbon dioxide can be stored through carbon dioxide-enhanced oil and gas extraction technology, about 15,300 tons can be stored million tons through the use of depleted gas reservoirs, and the storage potential injected into the deep brackish water layer is greater. Filling the gap through CCUS will be an important technology option for China to achieve carbon neutrality.[36.]

China's coal-to-oil production capacity has reached 9.21 million tons/year, mastering the coal-to-oil and gas industrialization technology. Coal-to-natural gas production also increased from 2.16 billion m3 in 2016 to 4.7 billion m3 in 2020, with a CAGR of 21.45% from 2016 to 2020. The world's first set of industrial production equipment was built from coal to olefin of 600,000 tons / year, and the conversion

of the chemical industry from coal to petrochemical raw materials was carried out for the first time, and the current annual production capacity is more than 13 million.

The technical capabilities of oil and gas exploration and development have continued to improve, the efficient development of low-permeability crude oil and heavy oil, the new generation of compound chemical flooding and other technologies have led the world, the level of technology and the Shale oil and gas exploration and development equipment has been greatly improved, and the trial production of natural gas hydrates has been successful. The degree of mechanization of coal mining in large coal mines has reached 98%, and it has mastered the industrialization technology from coal to oil and gas.[37]

A large number of new energy technologies, models and formats, such as 5G "Internet +" smart energy, energy storage, block-chain and integrated energy services, are booming, effectively improving the overall operating efficiency and the security level of the energy system.

3.1.3. Promoting the transformation of the energy structure and accelerating green and low-carbon development.

In 2020, China's energy consumption structure (**Figure 9**) will continue to optimize, with the proportion of coal consumption falling further to less than 57%, down 10.8 percentage points from 2012. Clean energy consumption as natural gas and water nuclear photovoltaic and wind power has increased to 24.4% of total energy consumption, and the rapid development of new energy vehicles has reached 1.2 million and 3.8 million vehicles in 2019, which represents more than half of the world total.

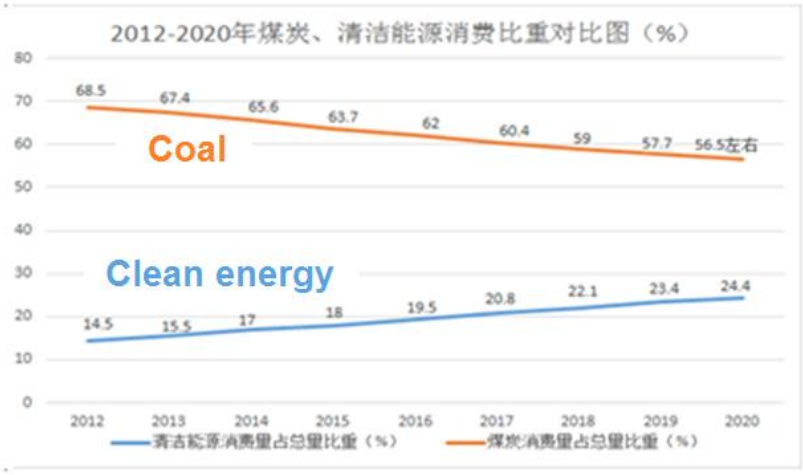

Figure 9. Relationship between coal consumption and clean energy 2012-2020

China regards the promotion of green energy development as an important measure to promote the building of ecological civilization, and resolutely fights the battle against pollution and wins the battle to defend the blue sky. In 2020, the scale of renewable energy development and utilization in China **(Figure 10)** will be equivalent to recovering nearly 1,000 million tons of coal, and the emission of carbon dioxide, sulfur dioxide, and nitrogen oxide will be reduced by about 1,790 million tons and 798,000 tons respectively providing a strong guarantee for the fight against air pollution.

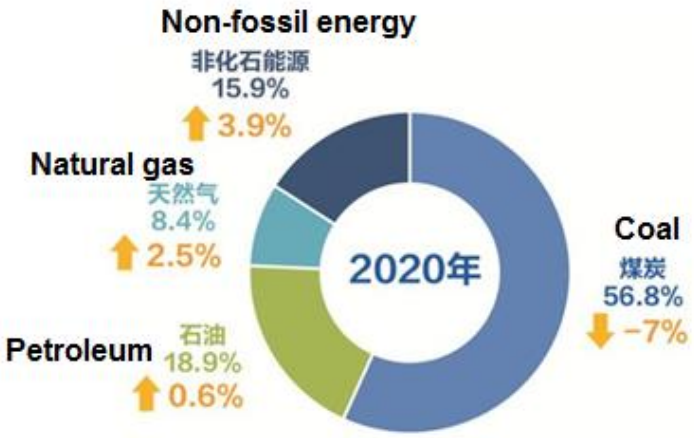

Figure 10. Distribution of China's energy sources in 2020

In terms of energy conservation and emission reduction, China has supported the economic growth rate of 6.5% per year with an average annual energy consumption growth rate of 3%, and the cumulative decline in energy consumption intensity. energy has decreased by 26.2%, which is equivalent to the use of 1.4 billion tons of standard coal and 2.94 billion fewer tons of carbon dioxide, and the decrease in the intensity of carbon dioxide emissions per unit of GDP has exceeded the self-contribution target.[38.]

Dealing with coal emission reduction, Sinopec achieved a coal emission reduction of 170.94 million tons of coal dioxide equivalent in 2020, with the highest score of 95. In terms of coal sinks, Sinopec has voluntarily planted 1.703 million of trees, absorbed 1,263 million tons of coal dioxide equivalent, and planted 2,811 million trees in the whole year, and is expected to absorb about 2,085 million tons of coal-dioxide.

3.1.4. Optimizing the design of energy development and improving the optimal allocation of resources

The latest “14th Five-Year Plan” issued by the National Energy Administration proposes to build a modern energy system, speed up the promotion of low-carbon and green energy transformation, optimize energy design, proposes to comprehensively promote large-scale development and high-quality development of power to adapt to large-scale new energy, improve the level of use of terminal power, accelerate the construction of power bases in the western region, improve the level of development of clean and low-carbon energy in the central and eastern regions and orderly expand the pilot scope of the electricity spot market.[39.]

Since the reform and opening-up, China has made great progress in the construction of oil and gas pipelines, and has successively built natural gas pipelines such as the West-East Gas Pipeline and Shaanxi-Beijing Second Line, China-Kazakhstan Crude Oil Pipelines and Lanzhou-Chengdu-Chongqing and other refined oil pipelines initially formed a crude oil and natural gas pipeline covering most of the country. Further speed up the planning and construction of the oil and gas pipeline network and supporting facilities, which will greatly assist in optimizing the structure of exploration, development, transportation and storage of oil and gas resources and the design of processing and utilization, realize rational allocation of oil and gas resources, and ensure national energy security and economic security.[40].

While strictly guaranteeing the security of energy reserves, Sinochem has further enhanced its national energy security capabilities and flexibility by optimizing the allocation of "two resources" and "two markets". Get resources through multiple channels to build resource assurance capabilities for energy security. The upstream exploration and development business continued to improve the ability to obtain resources, and oil and gas resources continued to grow. It has 22 blocks of oil and gas projects in 9 countries, including North America, South America, the Middle East, and Asia Pacific, and its products include various oil and gas resources, such as light oil, heavy oil, natural gas, and crude oil. of shale.

The Wudongde, Baihetan, Xiluodu, Xiangjiaba, Three Gorges and Gezhouba hydropower stations on the main stream of the Yangtze River constitute the world's largest clean energy corridor. The 6 cascade hydroelectric plants have put into operation 101 generator sets, with a total installed capacity of more than 62 million kilowatts, which represents about 16% of the country's installed hydroelectric capacity.

Cumulative power generation over the years has exceeded 3 trillion kWh, which is equivalent to saving about 910 million tons of standard coal and reducing carbon dioxide emissions by about 240 million tons, providing a strong impetus for China's green economic and social development. After the Baihetan Hydropower Station is fully operational, 110 hydropower units will be built and put into operation on the main stream of the Yangtze River, with a total installed capacity of 71.695 million kilowatts, which is equivalent to the installed capacity of the " Three Gorges".

The world's largest clean energy corridor has large total power generation and strong peak shaving capacity, which can effectively alleviate power shortages in central and eastern China, Sichuan, Yunnan, Guangdong and other provinces, and will play an important role in the safety and stable operation of the power grid and provide strong support to achieve the goal of peak carbon and carbon neutrality.[41.]

3.1.5. Expanding international energy cooperation and carefully building an international cooperation platform

Judging from the development of recent years, China's energy diplomacy has developed in a diversified direction. Around the world, the risk of energy security has become much higher than before, there are many unstable factors in the international energy order, and the probability of an energy crisis is greatly increased, so China needs to comprehensively improve its energy diversification. Boost and strengthen collaboration, promote the development of new international energy cooperation in a deeper direction.

China has successively established intergovernmental energy cooperation mechanisms with more than 90 countries and regions, and has jointly established the "Belt and Road" energy cooperation partnership with more than 30 countries. Four major strategic energy channels have been opened in the northeast, northwest, southwest and the sea, and China-Russia, China-Central Asia, China-Myanmar and China-Pakistan oil and gas pipelines have been built on the highways, forming a network of oil and gas pipelines that crosses east-west, north-south and connects abroad, highlighting[42]

1. The China-Russian oil and gas pipeline.

After 15 years of negotiations, the Sino-Russian oil and gas pipeline was finally completed in 2010. From the distribution station established by the Russian Far East Pipeline Skourokino, it passes through 13 cities and counties in Heilongjiang Province and the Mongolian Autonomous Region. Inland China, and

then comes to Daqing. The annual transportation of oil involved is 15 million tons, and the largest oil transportation can reach 30 million tons.

During the 20-year contract period, the oil and gas pipeline will supply more than 300 million tons of crude oil to China. The pipeline makes Russia, along with Saudi Arabia and Angola, one of China's top three suppliers of crude oil. The East China-Russia Natural Gas Pipeline runs from eastern Siberia, Russia, through Blavig, and into Heihe City, Heilongjiang Province, China. Signed in 2014, the term is 30 years. Officially announced in December 2019, the pipeline introduced 5 billion m3 of natural gas in one year and increased to 38 billion m3 per year, representing 30% of our total natural gas imports. The eastern route pipeline passes through 9 provinces, autonomous regions and municipalities in China. It will be built in three phases in the north, center and south. It is scheduled to be completed in 2025, benefiting 400 million people along the route. it is a world-class natural gas artery.[43]

2. The Central Asian oil and gas pipeline.

The Central Asia Oil and Gas Pipeline runs from the border of Turkmenistan and Uzbekistan, through central Uzbekistan and southern Kazakhstan, and into China from Khorgos, connecting the second line of the West-East gas pipeline in China, covering 25 provinces, municipalities, autonomous regions and users of the Hong Kong special district. It effectively connects Tajikistan, Kyrgyzstan, Turkmenistan, Uzbekistan and Kazakhstan, forming a China-Central Asia natural gas pipeline network that closely connects the five Central Asian countries with China.[44.]

3. The China-Myanmar oil and gas pipeline.

The China-Myanmar Oil and Gas Pipeline starts at Maday Island in Myanmar in the west and ends at Chongqing, China. Qilong starts at Tsangpiao Port in the west and ends at Nanning, Guangxi. The China-Myanmar Oil and Gas Pipeline began transporting gas along the entire line in 2013. It mainly transports crude oil and natural gas from the Middle East and Africa. The difference with the Central Asia Gas Pipeline and the China-Russia Oil Pipeline is that the purpose of the China-Myanmar Oil and Gas Pipeline is to bypass the blockade of the Strait of Malacca and directly transfer oil and gas resources from other regions through onshore pipelines. to China. This move may ease the situation in Malacca to some extent.[45.]

4. The China-Pakistan oil and gas pipeline.

Geographically, Pakistan borders the oil and gas producing areas of the Middle East and Africa to the west, Central Asia to the north, India and China to the east, and the crossroads of the Indian Ocean and Central Asia to the south. Important strategic energy position. Compared to the China-Myanmar pipeline, the China-Pakistan pipeline focuses on oil and gas resources in the Middle East. It has the functions of not only oil and gas channels, but also commodity trading, personnel exchanges, and capital export channels. In February 2013, China won the right to operate the port of Gwadar, Pakistan, 723 kilometers west of the Strait of Hormuz. Guarding the mouth of the Persian Gulf, it is Central Asia's closest outlet to the Indian Ocean, through which 40% of the world's oil is shipped to all parts of the world. Obtaining the right to operate the Port of Gwadar is of great value to China.

Chinese energy companies have actively responded to the Belt and Road Initiative, carried out comprehensive oil and gas cooperation with countries along the route, and promoted the integrated

development of oil and gas businesses. They have signed 115 oil and gas cooperation projects with 24 countries to become the leading force in the Belt and Road Initiative. Overseas in 2019, oil and gas rights and interests reached 210 million tons.

The production of infrastructure production capacity and import of resources widely cooperate with the Eurasian economic system to build more comprehensive energy sources and channels, and further stabilize China's energy fundamentals. Improve efficiency and increase production, complement each other, develop existing oil and gas resources and create synergies with each other at the same time[46] among this cooperation the following stand out:

- China-Saudi Arabia cooperation.

Saudi Arabia is the world's largest oil supplier and also China's largest oil supplier. After Biden came to power, the United States promoted an ecological transformation, and Saudi Arabia's position in the US diplomatic strategy has declined. In the future, Saudi Arabia will further strengthen cooperation with China. In fact, the security of China's oil imports and the security of Saudi Arabia's oil exports are interdependent and part of an energy security community. China and Saudi Arabia should actively carry out energy cooperation in various fields from a strategic height to achieve common development.[47]

- Cooperation with the countries of the Middle East.

At the same time, Iraq, Oman, Kuwait, the United Arab Emirates, Iran and other Middle Eastern countries are also China's important oil cooperation countries. At present, the Middle East countries are gradually adjusting their economic structures to reduce their dependence on the oil and gas industry for tax revenue, China and the Middle East countries can speed up the RMB settlement of oil and gas trade. reduce the correlation between the economy of the Middle East countries and the petrodollar.[48]

- Cooperation with Qatar.

Qatar is actively improving its liquefied export capacity, its economy ranks first in the international market, and it is extremely competitive in the international liquefied natural gas market. It is necessary to understand the contract cycle of signing a purchase and sale contract with Qatar, in order to achieve a mix of flexible prices in the short and long term, and to maximize the price advantage of Qatari natural gas.

- Cooperation with Iran.

Iran is very rich in natural gas resources. According to BP energy statistics, the remaining proven recoverable reserves of natural gas in 2020 are 32.1 trillion m3, second only to Russia, accounting for about 17% of the world's total reserves. Iran's natural gas reserves and production are relatively high and can be exploited for 165 years based on current production. Currently, 60% of Iran's natural gas is non-associated gas and most of it is undeveloped. However, Iran is currently not ideal in terms of natural gas exports, accounting for only 1.5% of the global natural gas market share. A large investment is still needed to increase natural gas export capacity. On March 27, 2021, China and Iran signed the "25-Year China-Iran Comprehensive Cooperation Agreement", and cooperation between the two countries in the energy field will reach a new level. Under the impetus of this agreement, we can increase investment in

Iran's natural gas export facilities, negotiate appropriate commercial natural gas prices, adjust China's natural gas import design, and import Iranian natural gas resources in a timely manner. and moderate.[49.]

3.2. China International Cooperation on Renewable Energy

The white paper "China's Energy Development in the New Era" pointed out that in recent years, China has strengthened international energy cooperation in a comprehensive manner, focusing on "One Belt and One Road" energy cooperation, "introducing" and " coming out" at the same time, and infrastructure interconnection continues to strengthen overseas production capacity and resource cooperation have achieved remarkable results, and the ability to participate in global energy governance has been continuously improved.

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China has carried out extensive cooperation with more than 100 countries and regions around the world in the fields of energy trade, investment, production capacity, equipment, technology, standards, etc. Chinese companies have built high-level power projects that meet urgent needs. of partner countries and helped locals to transform the advantages of developing resources, promote local technological progress, employment expansion, economic growth and improvement of people's livelihoods, as well as achieve complementary advantages and common development. Through third-party market cooperation, cooperate with some countries and large multinational companies in the field of clean energy, and promote the formation of an open, transparent, inclusive, mutually beneficial and win-win energy cooperation pattern.

3.2.1. Hydroelectric cooperation

Hydropower remains the world's largest renewable energy generation source, with total installed capacity reaching 1,308 GW in 2019, more than double the generation capacity of all other renewable energy sources combined, with 64 countries along the One Belt and One Road initiative and Africa that have become the most popular regions for investment in hydropower. Hydropower has strong market competitiveness in developing countries with rich hydropower resources. Areas rich in hydropower resources along the Belt and Road are mainly concentrated in the areas surrounding the Qinghai-Tibet Plateau, which includes Pakistan, Tajikistan, Kyrgyzstan, Kazakhstan and others. These countries are rich in hydroelectric resources, but the degree of development is low and the development potential is enormous.[50.]

From the distribution of hydropower installed capacity in various regions, East Asia and the Pacific Ocean are the regions with the largest hydropower installed capacity in the world, reaching 500.74 GW. Among them, China's hydropower installed capacity accounts for more than 3/4 of the region's total

installed capacity, Europe ranks second with a total installed capacity of 253.43 GW, and the total installed capacity of hydropower in other regions depends on 2.5.13 GW in Central and North America, 178.95 GW in South America, 156.26 GW in Central and South Asia, and 37.27 GW in Africa [51]

As of the end of 2020, Chinese companies have participated in a total of 416 international hydropower cooperation projects, including 39 cooperation projects in Myanmar and Pakistan. There are 24 cooperation projects and 55 cooperation projects in Laos. Among the international hydropower projects involving Chinese companies, the number of projects under construction accounted for 33.2%, the installed capacity accounted for 46.1%, the number of completed projects accounted for 66.8%, and the installed capacity represented 53.9%. In 2020, a total of 11 new international hydroelectric cooperation projects were signed, with a total installed capacity of 3,667.95MW. Among them, 9 conventional hydroelectric projects, total installed capacity 2167.95MW, 2 pumped storage projects with a total installed capacity of 1500MW. In terms of project distribution, there are 5 recently signed projects in Asia, with a total installed capacity of 2950MW; 3 recently signed projects in Africa, with a total installed capacity of 490.95MW; 1 in South America, Europe and Oceania, with an installed capacity of 35MW, 160MW, 32 MW.[52.]

China's international hydropower cooperation projects are mainly concentrated in the Asian region.[53.] At the end of 2020, there were 271 regional cooperation projects in Asia, with an installed capacity of 88.8GW, representing 64.8% of the total. There are 89 regional cooperation projects in Africa, with an installed capacity of 22.4 GW, representing 16.3% of the total. South America Region. There is a total of 39 cooperation projects, with an installed capacity of 24.2GW, representing 17.7% of the total. New signature projects in 2020 are distributed mainly in Asia (5) and Africa (3), the rest are distributed in South America, Europe and Oceania (1 each).

Among the major international cooperation projects could be found the Nam Ou River Cascade hydroelectric project in Laos, which marks the first time that a Chinese-funded company has won a large-scale hydroelectric project abroad. The project's total installed capacity is 1,272MW. On December 28, 2020, the handover ceremony for the construction-operation of the Nam Ou River Hydropower Stations 1, 3 and 4 in Laos was held. The Suapiti Hydropower Station located on the middle reaches of the Kongkure River in the west of the Republic of Guinea in West Africa is the largest hydropower station in the Conkure River Basin Cascade Development, and also the largest hydropower station with the largest installed capacity in Guinea, it is recognized by the people of Guinea as the "Three Gorges Project in Guinea". On November 8, 2020, the first unit of the Suapiti project was successfully completed, put to the test for 72 hours for power generation.[54] The Lower Kaifu Gorge Hydropower Station in Zambia is the first project invested in and developed by Zambia in the last 40 years. A large-scale hydroelectric project, the project is located in Kafu, 90 km southwest of Lusaka, the capital of Zambia on the Ai River, the installed capacity is 750MW. On November 2020, the project successfully stored water.

3.2.2. Wind cooperation

The development of China's wind power market has reached a record level and has become the driving force for the global growth of wind power, and the development performance of wind power in China is striking. In 2020 among the world's top 10 wind power developers, Chinese companies occupied 7 seats, namely Goldwind Technology (2nd, 3.06 GW) Envision Energy (4th, 10.35 GW), Mingyang Intelligent (6th, 5, 64 GW) Shanghai Electric (7th, 4.77 GW) Yunda (8th, 3.98 GW) CRRC Wind Power (9th, 3.84 GW) Sany Heavy Energy (10th, 3.72 GW). In 2020, China's wind turbine export will reach 22 countries,

reaching 1.1 billion US dollars, up from 900 million US dollars in 2019. In 2020, Goldwind Technology was the largest fan export manufacturer in the country, and its ventilator exports account for more than 50% of the country's total ventilator exports.

International wind energy cooperation projects are mainly concentrated in countries and regions along "One Belt and One Road", especially Southeast Asia and South America, the main contracted markets include Vietnam, Philippines, Argentina, Mexico, Brazil and other countries. In 2020, China financed companies strengthened their international cooperation in offshore wind power, a total of 7 projects successfully won the bid.[55.] The main international energy cooperation projects include:

- The Vietnam Binh Dae offshore wind power project, with an installed capacity of 310MW, which was contracted in March 2020 by a Chinese-funded company in the form of an EPC. The project is one of the first offshore wind power in Vietnam, once the project is put into operation, it will play an important role in improving the electrification level of the areas without electricity in Vietnam, promoting energy transformation and reducing the emissions and carbon emissions.[56]
- Jinou No.1 offshore wind power project and Shuozhuang No.4 offshore wind power project. The Ca Mau No. 1 and Soc Trang No. 4 offshore wind power projects are currently the largest intertidal wind power projects in Vietnam. After the power project is completed, it will add more than 1.1 billion kWh of power generation each year, save more than 450,000 tons of standard coal, and reduce more than 880,000 tons of carbon dioxide emissions. Greatly improve the current power shortage situation in Vietnam and the surrounding areas, and make positive contributions to sustainable development.[57]

3.2.3. Cooperation in photovoltaic solar energy

With its obvious advantages such as cleanliness, safety and inexhaustibility, solar photovoltaic power generation has become the fastest growing renewable energy source, China is one of the top three photovoltaic markets in the world. In the year 2020, the cost of new large-scale PV power plants in China, India, France and Spain, for the first time, is lower than the most advanced coal and gas power plants, making it the most competitive energy product. In the same year, the production capacity of PV modules in mainland China reached 244 GW, accounting for about 76.3% of the world's total production capacity, the export of equipment components and the establishment of overseas factories. they have become the main direction of international cooperation.

In the year 2020, the growth rate of the global PV market space slows down, but the investment of Chinese companies in overseas PV projects will continue to maintain steady growth. According to statistics, in 2020, Chinese companies participated in the investment of 7 overseas PV projects, for a total amount of USD 1.7 billion, a record. Chinese companies build factories abroad, the overseas production capacity of Chinese photovoltaic companies has surpassed technological transformation and new production lines. In 2020, China's PV enterprises have overseas production capacity exceeding 54 GW,[58] including 4.5 GW silicon wafers, 19.6 GW cells, 23.1 GW modules, and 6GW inverters.

China's 2020 export of photovoltaic products (silicon wafers, cells, modules) was approximately US$19.75 billion (**Figure 11**), a year-on-year decrease of 5%. Among them, the silicon wafer export value is 1.77 billion US dollars, the export volume is about 27 GW; the export volume of cells is about 9.9 billion US dollars, the export volume is about 9 GW, and the export volume of silicon wafers and cells suffered a slight decrease compared to the same period of the last year. Component exports amounted to US$16.99 billion, the export volume was about 78.8 GW, up 18% year-on-year, a new high.

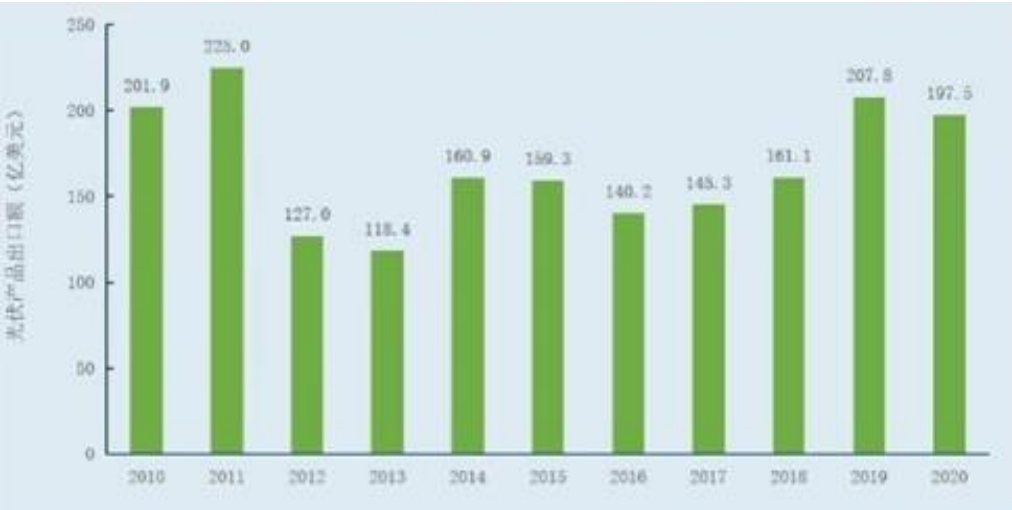

Figure 11. Chinese exports of photovoltaic equipment and components 2010-2020

Among the major international cooperation projects developed by China in 2020, the following stand out:

- In Qatar Halsa 800MW Photovoltaic Project Kalsa Power Station is the main service of the first photovoltaic power plant in Qatar, serving electricity for the 2022 World Cup. After the completion of the project, it is expected to meet 10% of the demand Qatar's maximum power supply will reduce 26 million tons of carbon dioxide, effectively helping Qatar achieve an annual reduction by 2022, the goal of 1 million tons of carbon emissions.
- The 100 MW photovoltaic power plant in Kaposvár, Hungary is one of the key projects for China and Hungary to strengthen exchanges and cooperation in the fields of green environmental protection and green development. built project.[59] Upon completion, it will become the largest installed capacity photovoltaic power plant in Hungary, which is of great importance for maintaining Hungary's national energy security and promoting clean energy development.
- The 300MW Photovoltaic Project in Cauchari, Jujuy Province, Argentina The Cauchari Photovoltaic Power Plant is located in Jujuy, an area of the Kauchari province.[60] The project site is more than 4,000 meters above sea level, and the sunlight resources are extremely superior. It is one of the most suitable regions for the development of photovoltaic power generation in the world.

3.2.4. Other renewable energies

The international community is actively seeking cooperation with China on various renewable energy sources, such as biomass power, hydrogen power, geothermal power, and solar heat. In recent years, China's cooperation with all parts of the world on renewable energy continues to expand.

In 2019, the China-Russia Energy Business Forum, the China-UK Energy Dialogue, the China-Pakistan Economic Corridor Energy Regulations, the China-Uzbekistan Energy Cooperation Subcommittee and other mechanisms have laid a solid foundation for deepening cooperation. Bilateral energy cooperation, among these are:

1. Energy storage, China Huaneng Group, using Sungrow Power Technology, developed the largest lithium battery energy storage project in Europe in Mendy, UK, which will be connected to the grid and commissioned in 2021. The start of construction of the Mendi battery energy storage project is a major achievement in service of the construction of the Belt and Road. China Huaneng and national equipment manufacturing enterprises "strong alliance, common sea", to promote China's energy storage technology and standards "go global" to provide a demonstration.[61.]
2. Biomass energy, where compared to the renewable energy cooperation between China and other ASEAN countries, the renewable energy cooperation is a highlight between China and Thailand. The government attaches great importance to residual power generation and places residual power generation at the top of priority grid connection for renewable energy. Since 2007, Hangzhou Jinjiang, Chinese companies such as China National Electric Engineering Corporation, Sanfeng Environment, Huaxi Energy and Yunnan Water Affairs have actively invested in waste-to-energy projects in the country, which not only contributes to local energy conservation and environmental protection, but also create considerable economic and social value for Thailand.

3.3 Global energy governance and intergovernmental cooperation

China's governance capacity has continued to improve, and it has successfully hosted the Belt and Road Energy Ministerial Conference, the International Forum on Energy Transformation, the Cooperation Organization Energy Ministers Meeting, the of Energy Ministers of the Group of Twenty and the Meeting of Energy Ministers of the BRICS countries. New advances in international cooperation in this field have been continuously made, laying a solid foundation for achieving energy security under open conditions and promoting global energy sustainability and building a cleaner and more beautiful world.[62.]

China actively participates in the work of international energy-related organizations in reforming and building the energy governance system. In recent years, the influence of China's industry is constantly improving, and it is changing from "active participation" to "active influence". He advocated the establishment of the “One Belt and One Road” energy association and presented a series of interesting proposals, such as the joint safeguarding of energy security, which have been recognized and responded to by the international community.

Table 1 shows examples of intergovernmental cooperation with China in the field of energy.

Table 1. Characteristics of the intergovernmental cooperation with China in the field of energy

Country/ Region	Characteristics
Denmark	In recent years, cooperation between China and Denmark in the fields of energy, environment and climate has continued to deepen. On June 24, 2020, the China-Denmark Renewable Energy Working Group held a meeting to reach consensus on strengthening cooperation in renewable energy planning, offshore wind power, renewable energy heating and other aspects, and we jointly promote the deep integration of the renewable energy industries of the two countries and sustainable and healthy development.
United Kimdom	In August 2020, the sixth meeting of the Sino-British Offshore Wind Industry Cooperation Steering Committee was held in Jinan, Shandong. The third-party market cooperation promotion conference was held in Beijing. The two sides discussed investment prospects in key regions of

	the third-party renewable energy market, the results of international cooperation and Exchanges, and in-depth discussions on typical cases, key directions, and important areas of cooperation.
Findland	In October 2020, the Finnish National Business Promotion Agency and the Institute of Energy Planning jointly held the China-Finland Smart Energy Forum to share research and development of smart energy technologies.
Pakistán	China and Pakistan uphold the principle of mutual trust, do a good job in relevant work under the energy framework of the China-Pakistan Economic Corridor, and ensure that energy projects in the corridor are smoothly implemented and promoted on time.
Myanmar	In order to effectively solve the problems of underdeveloped power infrastructure along the China-Myanmar Economic Corridor, in 2020, China and Myanmar jointly compiled the "Water Resources Comprehensive Planning Report for Sustainable Hydropower Development in Myanmar " to support and promote the development and construction of hydropower in Myanmar.
Nepal	Based on the "Memorandum of Understanding on Energy Cooperation" between China and Nepal, they will prepare the China-Nepal Energy Cooperation plan in 2020 to guide the orderly development of China-Nepal energy cooperation.
ASEAN	China actively participates in organizing and implementing energy construction activities, joint research and policy dialogue under the ASEAN-China, Japan, Republic of Korea and East Asia Summit regional energy cooperation. The high-quality promotion of regional energy cooperation has been deepened and consolidated, and remarkable results have been achieved. The 17th ASEAN Energy Ministerial Meeting and the 14th East Asia Summit, all parties paid great attention to China's 2060 carbon neutrality target and hoped to share relevant policies and experience.
European Union	On June 22, 2020, the National Energy Administration of China and the EU Energy Commission held the 9th China-EU Energy Dialogue to hear the progress of the first year of the EU-China Energy Cooperation Platform and exchange points of view on clean energy and green development, energy security and global energy markets, energy technology and innovation cooperation.
Sub-Region Gran Mekong	On October 15, 2020, the Greater Mekong Sub-Regional Energy Coordination Committee (TRAC) opened its 27th video conference, which was co-chaired by the National Energy Administration and the Asian Development Bank.

Conclusions

Energy security is related to development security and national security; To guarantee it, the real conditions of the country must be taken as a starting point, increase production capacity, strengthen reserves and promote other governance measures.

China's energy security strategy of "four revolutions and one cooperation" is focused on promoting the energy consumption revolution, energy supply revolution, energy technology revolution and energy system revolution, strengthening cooperation development in all directions and energy security under open conditions, which constitutes a pillar in the comprehensive construction of a modern socialist country, for which it is vital to firmly stabilize the rice bowl of energy and promote the era of neutrality of energy. carbon.

China has continuously achieved successes in energy governance capacity with new breakthroughs in international cooperation in this field, laying a solid foundation for achieving energy security, global energy sustainability, promoting renewable energy sources and contributing to building a cleaner and more beautiful world, with an open, transparent, inclusive and mutually beneficial pattern of energy cooperation, in which the One Belt and One Road Initiative facilitates those strategic objectives.

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Conflict of interests

The author declares no conflicts of interest