

# Under the Energy Transition, the Development Path of Chinese Low-carbon Energy

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**Abstract.** Low-carbon energy as a way to face the chemical energy threat and environmental crisis, develop and promote in the world. This paper analyzes the types of low-carbon energy and develops advantages and disadvantages of fossil fuel use and its harmfulness, explores the situation of Chinese fossil fuel and the development necessity of low-carbon energy. Research indicates that Chinese low-carbon energy development conforms to the times tide, conforms to the Chinese situation, can ensure the country's energy security, and is supported by sufficient technology. In the future, through encouraging company green innovation, optimize energy structure and strengthening policy support, Chinese low-carbon energy development will be continued to promote. A thorough analysis of the development path of China's low-carbon energy not only helps to reveal the internal mechanism of the energy system's transition from high-carbon to low-carbon, but also provides important theoretical support and practical reference for ensuring national energy security, fulfilling the "dual carbon" commitment, and seizing the commanding heights of global green technology competition.

## 1 Introduction

Global climate change has become one of the most several challenges that human faces in the 21st century. Scientific research that greenhouse gas emissions dominated by fossil fuel consumption are the main reason that causes global warming, the ecological crisis it trigger pose a threat to global environmental protection and renewable development. A low-carbon economy is a new economic develop pattern proposed by human society to face this reality threat, which can promote economic development and be friendly to the environment [1]. Develop low-carbon energy as one of the develop a low-carbon economy, all countries are pushing hard. Countries like America and Germany successively proposed a net-zero emission agenda, and have adopted policies such as the Carbon Border Adjustment Mechanism, making the climate topic deeply integrated into the future global economic and trade rules and industry competition pattern.

Nowadays Chinese has a great process in low-carbon energy technology research. In aspect of renewable energy technology, China not only has the largest wind power installation capacity, mature hydropower technology, but also has a lead position in efficient photovoltaic cell development and industrializing. In terms of energy storage, China takes

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dominating position in new generation energy storage technology such as Lithium-ion Batteries industrial chain, and positive develop Sodium-ion Batteries, flow batteries. In nuclear energy technology, Chinese automation technology like “Hualong-1” has achieved commercialization operation, and the forth generation nuclear power technology research and development has been in the forefront of the world.

This paper mainly analyzes the Chinese fossil fuel situation of base on oil and coal and highly depend on import, and feasibility for the low-carbon energy development and main path, to help the public better understanding the problem in Chinese energy.

## **2 The overview of low-carbon energy**

The main form of renewable energy is usually be solar energy, wind power, Hydroelectric and Oceanic Energy and so on, that can only produce few CO<sub>2</sub> when it be consumed. Water conservancy project Three Gorges Dam in China generate electric power primarily by water storage, then water drives the turbine’s rotation to produce mechanical energy, which is followed by connecting a generator to transform the mechanical energy to electric energy. Whole the process hardly produces greenhouse gases, and can adjust streams, effective mitigate flood peak.

Nuclear energy’s main form is usually nuclear fission, and nuclear fusion that could be develop in the future. Nowadays nuclear power stations mostly depend on nuclear fission, which refers to the power produced by the process that a nuclear reaction is a heavy atomic nucleus (primarily uranium and plutonium nuclei) splits into two or more smaller atomic nuclei. The operation of nuclear power stations is hardly produce carbon dioxide or other greenhouse gases, doesn’t contribute to global warming and climate change, nor does it emit air pollutants such as sulfur compounds, nitrogen oxides, or particulate matter, which can harm human health.

The main form of alternative fuels (energy carriers) is usually green hydrogen and synthetic fuel. The green hydrogen can produce electricity using renewable energy, produce hydrogen by electrolysis of water, during the process doesn’t bring carbon emissions. It can be used directly as energy, and also is an important industry raw material and the medium for storage energy. The liquid or gas fuel made by using green hydrogen and the CO<sub>2</sub> captive from the air for chemical synthesis, which can be called synthesis fuel, such as synthesis diesel oil, synthesis methane and so on. During the synthesis process, CO<sub>2</sub> will be consumed, and when it is used, CO<sub>2</sub> will be produced, from the academic angel that achieved the carbon round.

The fossil fuel after renovation, its main form is usually fossil fuel + carbon captive, utilization and storage (CCUS). The carbon captive technology refers to dividing captive CO<sub>2</sub> from relative energy of industry or energy produce, then utilization, or exporting it to a suitable place for storage, which is a technology system for CO<sub>2</sub> apart from the air and an effective path to reducing greenhouse gas [2].

## **3 The situation of Chinese energy**

### **3.1 The use of fossil fuel and import dependence**

In 2024, Proportion of Chinese fossil fuel consumption maintained above 80%, and the coal and oil consumption took up the lead. We can see from the Fig. 1 that, in the total energy consumption of China, the petroleum consumption takes up 32% of the total, the coal consumption followed by the petroleum consumption takes up 26%. Then add the natural gas consumption, the fossil fuel consumption takes up 81% of the all, non-fossil fuel only takes

up 19% of the all. This extremely unbalance indicated that today China has a highly dependence on fossil fuel, most aspects of lives still use the fossil fuel such as coal, petroleum. The popularity of non-fossil fuel is not high.



**Fig. 1.** Energy consume.

About 70% of Chinese fossil fuel depends in export, be enslave by foreign countries. In the data diagram that was published by the General Administration of Customs of China for the top 15 sources of China's crude oil imports in 2022, it can be seen that China imports crude oil from 48 countries in total, the total import volume achieved 508.276 million tons, the total money reached 365.512 billion dollars, that is 2.435 trillion yuan, has taken up 13% of the goods trade total imports. And Saudi Arabia and Russia as the biggest crude oil supplied countries of China, the import crude oil both exceed 85 million tons.

Since 2020, China has taken the lead in the development of low-carbon energy in the world. In 2022, exceeding 80% of the overall in the world for the relative patent application in this aspect from China [3]. To be specific, this series of innovations in China brought stage break. For instance, new lithium battery systems that navigate 400 kilometers just need to charge ten minutes, make it possible to achieve electrification of aviation and truck. Offshore wind turbine height as Eiffel Tower, can deliver desert photovoltaic power into coastal accretion centers away from more than thousands of kilometers away. With the help of its the advantage of mass production and the ability of system integration, Chinese new energy technology is taking step into the new development stage with more optimized, lower cost, higher accessibility [3-5].

## 4 Low-carbon energy develop necessity

### 4.1 Fossil fuel is harm to environment

The carbon emission volume that produced by fossil fuel consumed has continuous rising, and already severe harm to the environment. That causes a continuous rise in global temperatures, and leads to the produce of green house [6-9]. According to the report by the Intergovernmental Panel on Climate Change (IPCC, 2023), compared with the temperature pre-industrial Period, today's average temperature has risen by about 1.10°C [9]. That caused the frequent occurrence of extreme natural disasters and the situation of hydrological will change [9]. Meanwhile, the rising temperature would cause glaciers to melt and sea level to rise, it will severe threat to islands and coastal lowlands in the future if we don't take some action.

Fossil fuel consumed would produce air pollution, forming smog in city, harming to human health. During the process of fossil fuel consuming would produce a lot of air pollutants, for example Particulate Matter (PM)/Sulfur Oxides, Volatile Organic Compounds (VOCs). The research evidenced that there is a high relation between the prevalence of anemia in children and the continuous rising level of PM<sub>2.5</sub> [10]. Severe air pollution can even cause more than thousands of deaths and injures. In 19th, London, the birthland of the industry revolution and center of industry, took step into industry's rapidly develop stage. Fossil fuel consumption sustain rising, and due to London's industry produce and resident warming depend on burning coal to supply warm, the consumption of coal is rising especially rapidly. But fossil fuel burning releases abundant sulfur dioxide, dust and some other air pollutants, that caused shock smog, then combined with the windless climate in London, so the shock smog cannot disperse. London always under the smog and visibility is low than one meter. This event leads to 4000 deaths and about 8000 deaths because to corresponding disease after months.

Fossil fuel exploits, discharges and leaks, that will cause damage to surface vegetation, landslides, land subsidence, severe polluted water resources, and residual toxic substances in present, destroy creatures' habitats. Since 1931, there have been a lot of patients that suffer from "Itai-Itai disease". The symptoms manifest as neuralgia and bone pain in all parts of the body, have trouble in action, even when they breath with unbearable pain. If suffer for a long time, it will cause more terrible consequences. Through a long-term research by scientists, this disease is caused by eating rice that suffer cadmium polluted. Local mine waste water without handle discharging to the river, polluting it, then the river water irrigates the rice field, making the rice from the field become "Cadmium Rice", when it is eaten, the cadmium will accumulate, until it results poisoning. From it can see, the harmfulness from the fossil fuel will bring about a lot of disease that people cannot bear.

## **4.2 Low-carbon energy conform international and Chinese situation**

Green low-carbon energy is a core evaluation indicator that can promote industry to develop with high quality, push transform economic society, even have an impact on the political pattern of earth energy of global energy geopolitics [4]. So, international society published a series of policies to propose promote the development of low-carbon energy, to cope with change in the climate and push forward the green transform. In 2016, international society started "Vision 2030", devoted to reducing international petroleum dependence and increasing the security of energy, enhancing the leadership of renewable development [5]. Furthermore, international society through policy and economic means to positive popularize the application of renewable energy, for instance, subsidies, tax incentives, and loans and so on, to promote the development of wind power generation and photovoltaic power generation programs. The government of Australia since 2010, carried out "Appliance Subsidies" policy, in order to help the low income families to get rid of the financial pressure from the increasing costs of reducing carbon emissions. They took tax refunds and some other welfare policies, to supply necessary compensate for these families. In addition, some countries governments also push funding for action on climate change, aiming to the companies that be effected to cope with the challenge of increasing costs of environmental protection. In England, there are a series of policies that aim to promote low-carbon energy development. Among them, the most particular is the investor who cooperate with company and the government. This government-lead's investing pattern is to accelerate companies to develop low-carbon technology, then popularize it for the whole country to use.

In order to promote renewable development, China has carried out a series of political strategy to push forward low-carbon energy development. In September 2020, China claimed will achieve carbon dioxide emissions peak before 2030 and will through adjust energy

structure, technology revolution and ecology compensation to achieve carbon neutrality in the 75th Session of the United Nations General Assembly. To reach this dual carbon target, the optimize option is developing low-carbon energy. What's more, owing to "resource security" this concept is made up of energy security, water resource security, land resource security and other relative aspects, which is a matter part of the overall country security concept, so energy supply must be handed to China itself. But nowadays most of Chinese energy comes from international trade. This pattern has caused China trouble in maintaining long-term and sustainable trade partner relations [8]. That's why China should develop low-carbon energy, it can solve its energy supply problem, decrease the country's import dependence on fossil fuel, and ensure its energy security.

## 5 Main path

Optimize the energy structure, develop renewable energy on a large scale. For example, increase the construction volume of hydropower factories, change energy produced and consume structure, lower the dependence on the fossil fuel, raise the usage ratio of renewable energy. Under the situation of keeping humans safe, not damaging the natural and social environment, to research and develop nuclear power technology. Meanwhile, raise utilization effective of coal and petroleum energy, reduce energy waste.

The government should raise and strengthen green enterprise, encourage corresponding companies to carry on a green revolution, produce green goods, construct green industry chain which have global competitive. The country should enhance the publicize of green produce, give more eyes on green revolution corresponding companies, focus on promoting low carbon energy consuming, green production supply, comprehensively raise companies' "green content". Combined digital and low-carbon, with the help of digital advantage to server low-carbon better. Promoting industry, study and research integrate, data is constantly updated, improve effective of cooperation, to help the break of core technology [6].

The government also should open green passageway for low-carbon energy development, introduce relative policy and action, to lead social invest into low-carbon field. It can raise invest to green industry, carry out relative green industry tax refund, tax reduction and other welfare policy, to help companies reduce additional cost of the environmental protection that owing to green revolution, produce green goods. Such as green finance policy, that can help develop green programs, encourage green innovation, bring more resources invest into green industry programs [7]. And establish round green and low-carbon law, lay down strict emission standards and compulsory standards for pollution control, from another angel to promote companies' green development.

## 6 Conclusion

Under the global climate crisis and energy revolution, developing low-carbon energy is a necessary option for China to deal with environmental challenges and keep energy security. Today China has a high dependence on fossil fuel, the problem of carbon emissions and pollution stand out, urgent need to large scale develop renewable energy, cultivate green industry, establish round policy. These ways to promote energy transform. In the future, China should continuous push technology revolution and integrate with system to construct a modern energy system which is dominated by low-carbon energy, aiming to achieve dual carbon target, push forward economy develop with high quality, improve the quality of the environment.

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