Research on Existing Challenges and Possible Approaches to Achieving Carbon Neutrality in China

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ABSTRACT
Since fossil energy is not renewable, it will eventually be exhausted. At the same time, with the emission of carbon dioxide, the earth's temperature rises, resulting in the melting of glaciers, sea level rise and a series of environmental problems. This paper discusses the technical challenges and system establishment and implementation challenges to achieve carbon neutrality, and discusses some approaches to achieve carbon neutrality. In order to achieve carbon neutrality, China should fully develop the advantage of having the world's largest water energy reserves; Vigorously develop nuclear power by utilizing advanced nuclear power technology; Promote industrial structure adjustment actively at the national policy level; Promote carbon trading and promote the mature operation of carbon trading market. The conclusion is that replacing fossil fuels is technically feasible and requires international consensus on policy.

Keywords: *Fossil energy, Renewable energy, Carbon capture, Carbon neutrality, Carbon trading*

1. INTRODUCTION

In the long historical period before the widespread use of fossil energy, the amount of carbon dioxide in the earth's atmosphere was very stable. There were activities of various organisms including human beings, but carbon dioxide in earth's atmosphere is basically in a dynamic equilibrium state. Deforestation by humans to gain access to land was previously a major factor affecting carbon dioxide in the atmosphere, but the impact is much smaller than the current impact of fossil energy consumption.

Fossil energy mainly includes coal, oil and natural gas. In a large number of humans use of fossil energy, is locked in the carbon from the fossil energy, is a huge amount in the form of carbon dioxide emissions to the atmosphere, makes the dramatic increase in carbon dioxide in the atmosphere, and because of the greenhouse effect caused by the temperature rise, causing the melting glaciers, rising sea levels and the corresponding climate and environmental changes. At the same time, the earth's fossil energy will eventually run out. From both perspectives, alternative energy solutions and renewable energy solutions must be sought[2]. This paper studies the classification of energy sources and alternative energy solutions and technological levels as well as the current situation of major countries and China's future approach. This paper also discusses the national policies and international rules of carbon trading. In addition, this paper covers the statistical methods and approaches to carbon emission and the current situation and trend of international carbon capture. According to the history of human economic development and energy consumption and the world climate change, this paper summarizes the ultimate scheme of human energy. From the technical level, alternative energy can replace the fossil energy. Point out the rules of carbon trading and correct statistical methods of carbon emissions from the perspective of policy and international rules.

2. CLASSIFICATION OF EARTH ENERGY

Energy sources on earth fall into the following categories:

Energy sources derived directly or indirectly from the sun: a. Fossil fuels. Formed historically and non-renewable for a considerable period of time; b. solar energy, water energy, wind energy and biomass energy. These are renewable sources of energy over the life cycle of the sun.

Earth's own energy: a. geothermal; b. nuclear power. (Nuclear fission, nuclear fusion)

The drive to replace traditional fossil fuels with renewable energy comes from two sources. One is that fossil fuels will eventually run out. The second is

environmental pressure. The fundamental way to replace fossil energy with renewable energy is science and technology, which can reduce the cost of using renewable energy and improve its collection efficiency. Generally speaking, other than biomass energy, energy sources that generate carbon emissions are not renewable, so in addition to environmental factors, they will eventually run out of energy. In this regard, it must be replaced[6].

3. CHALLENGES TO ACHIEVING CARBON NEUTRALITY

To achieve carbon neutrality, on the one hand, people should reduce the use of fossil energy to reduce carbon emissions, and on the other hand, people should increase carbon capture to achieve dynamic balance. There are huge challenges on both fronts.

Human development is inseparable from the consumption of energy, especially since the Industrial Revolution, the consumption of energy, especially fossil energy consumption has increased sharply. The speed of economic development is almost in direct proportion to the consumption of energy. How to significantly reduce the consumption of fossil energy and get rid of the dependence on fossil energy while maintaining the speed of economic development is a great challenge faced by all mankind today.

For China, the challenge is even greater, mainly for the following reasons:

a. China's existing energy structure is heavily dependent on fossil energy.

b. The industrial structure, steel, cement, electrolytic aluminum and other industries are high energy consumption.

c. Due to the current situation of developing countries. China is a developing country, and there is still a lot of room for production and construction. It is bound to consume a lot of energy to reach the level of developed countries, and to achieve a well-off stage in national construction and the living standards of its people.

d. Huge population base.

e. Due to China's natural environment and technological limitations, it is difficult to improve the carbon capture rate and reduce the cost of carbon capture.

f. The technology of renewable energy utilization and carbon capture is relatively backward.

In recent years, China's energy consumption is still dominated by fossil energy, with coal and oil accounting for the highest proportion. The figure below (Fig.1) shows the changing trend of China's electricity energy sources from 2008 to 2020 (in billion KWH). (Energy consumption unrelated to power generation, such as cars, natural gas and heating, is not counted). Faced with such a situation, even with the most aggressive carbon capture, it is difficult to achieve equilibrium over a long period of time.

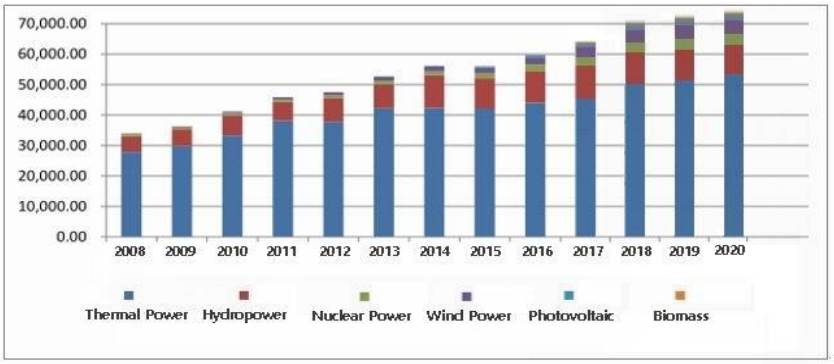

Figure 1 The changing trend of China's electricity energy sources

In 2020, China will emit about 10 billion tons of carbon dioxide, of which coal takes the first place, oil the second, and natural gas the third. As shown in Figure 2 (Fig.2), coal consumption accounts for 56.8% of primary energy, but its carbon dioxide emissions account for 67.4% (As shown in Figure 3). Natural gas accounts for 8.3% of primary energy consumption and 5.4% of carbon dioxide emissions. The carbon emission intensity of natural gas is lower than the average level, which can be used as an important variety in the transition period. Breakthroughs in oil and gas exploration and production technology to discover more oil and gas resources, enhance recovery, and reduce carbon emissions without reducing energy consumption are certainly one of the immediate solutions. As can be seen from the data, in 2020, fossil energy consumption accounted for 84%, and fossil energy carbon emissions accounted for 95.2%, which means that in the long run, it is very difficult to replace fossil energy with non-fossil energy[14].

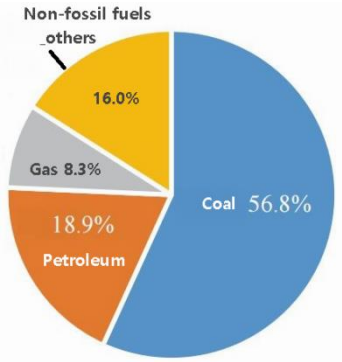

Figure 2 Energy structure

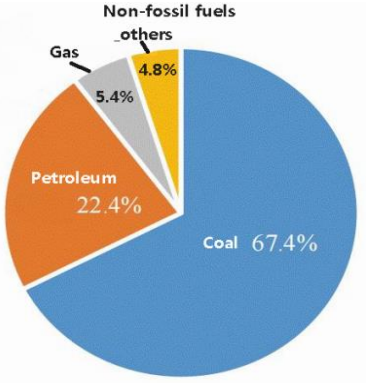

Figure 3 Proportion of carbon emission

Even compared with the energy structure of other countries in the world at the same time, the challenges to China's energy structure face are very urgent and huge.

Fig.4 shows the historical changes in the global energy consumption structure. Fig.5 shows the trend of the global power generation structure.

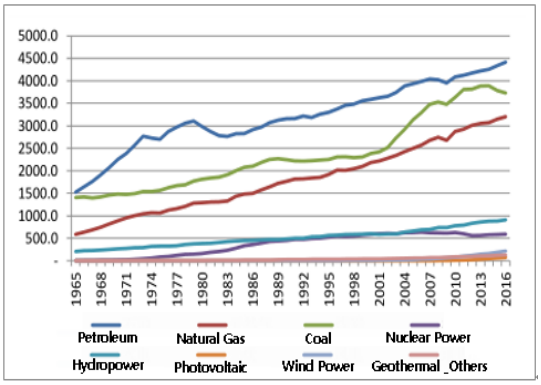

Figure 4 The historical changes of global energy consumption structure

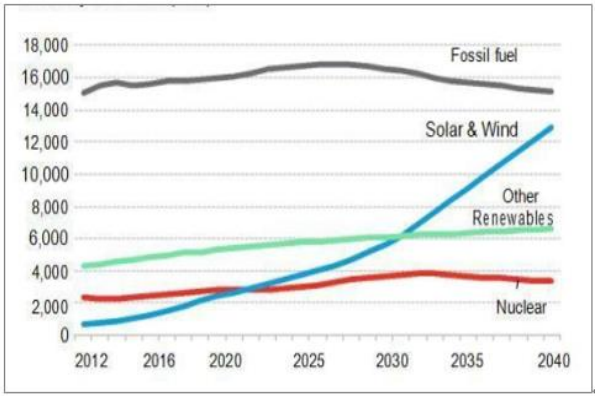

Figure 5 The trend of global power generation structure

Compared with the energy structure of developed countries, China must steadily promote the adjustment of energy structure. Figure 6 (Fig.6) shows the proportion of electrical energy in France in 2017. Fig.7 is the comparison of the average energy structure of China, the United States and the world.

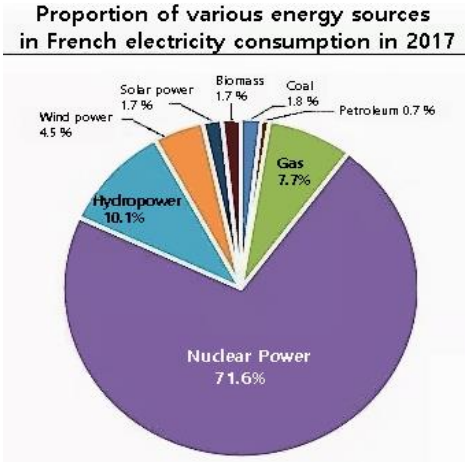

Figure 6 The proportion of electricity energy in France in 2017

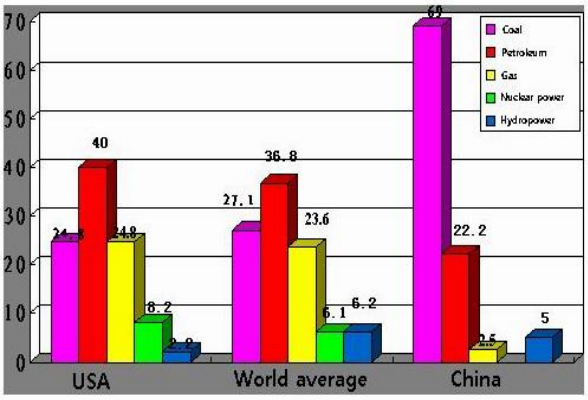

Figure 7 The comparison of the average energy structure of China, the United States and the world

As can be seen from the chart, China's energy structure is far from that of other countries in the world. The consumption of coal should be greatly reduced, and nuclear energy should be significantly increased. At the

same time, China, as the world's no. 1 country in terms of hydropower, hydropower proportion is obviously too low at present.

From the comparison of energy consumption per unit OF GDP and carbon emission per unit of GDP, China also faces severe challenges. Figure 8 shows energy consumption and carbon dioxide emissions per unit GDP of major countries in the world in 2020. This shows that China's energy efficiency and industrial structure have great room for improvement.

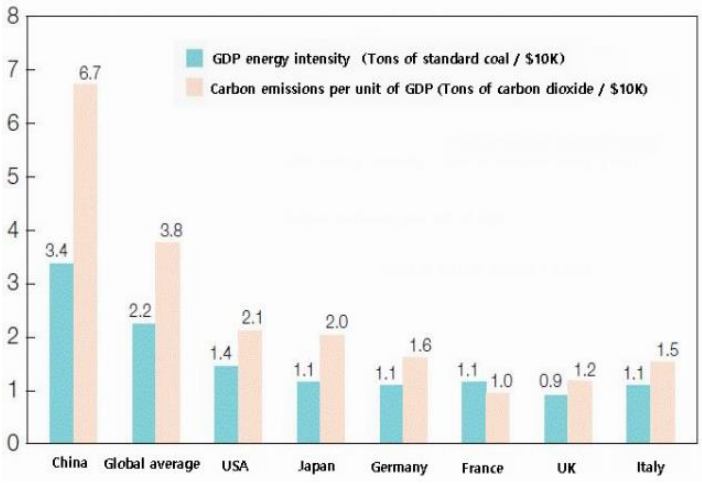

Figure 8 Energy consumption and carbon dioxide emissions per unit GDP of major countries in the world(2020)

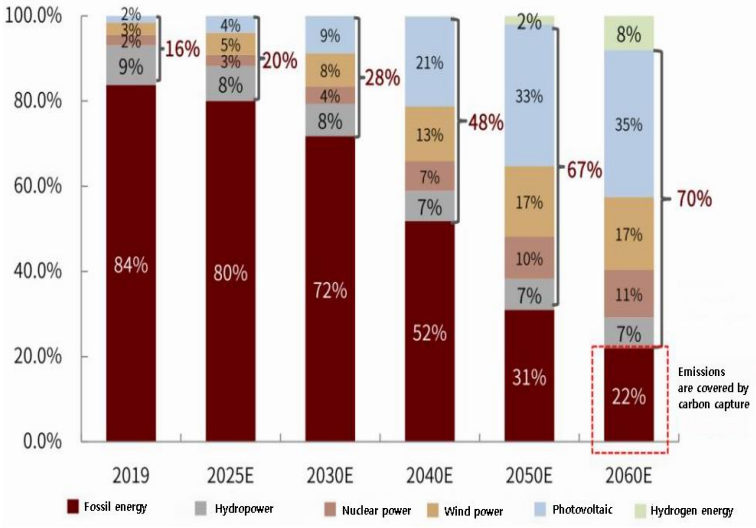

Figure 9 Planning map of China's energy structure (2019-2060)

Fig.9 is the planning map of China's energy structure (2019-2060). Over the next 40 years, nuclear, wind and photovoltaic will account for 63% of the total, up from 7% today.

From any of the above data, it can be concluded that China's current energy consumption and energy structure are indeed facing great challenges. At the same time, by comparing with other countries, on the one hand, people can clearly see the huge gap in energy consumption per unit GDP between China and other developed countries; on the other hand, people can also see that there is a huge room for improvement in energy structure, GDP energy consumption, carbon capture and other related fields.

4. WAYS TO ACHIEVE CARBON NEUTRALITY

For economic development and human survival, it is impossible to completely eliminate the dependence on energy, and it is impossible for human beings to return to the primitive agricultural society that only uses biomass energy directly. This requires relying on the basis of scientific and technological progress, plus the rules of carbon emissions and carbon trading between countries, reducing energy consumption per unit GDP, adjusting the energy structure and industrial structure, and using carbon capture as an auxiliary measure to achieve carbon neutrality. Non-fossil fuels are the ultimate route.

4.1. Adjusting the Energy Structure

Replace fossil fuels with non-fossil fuels. Fossil fuels are coal, oil, and natural gas. Non-fossil energy includes hydro energy, nuclear energy, wind energy, solar energy, biomass, geothermal energy, and so on. In non-fossil energy, although biomass energy also has carbon emissions, biomass comes from the photosynthesis of nature, and the production and consumption of biomass will reach a dynamic balance, which itself is a carbon-neutral process[12].

4.1.1. Fully Developing and Utilizing Water Energy Resources

Hydropower is an economical, clean and renewable energy source. China's theoretical reserves of hydropower resources are nearly 700 million kilowatts, accounting for 40% of conventional energy resources, the second-largest energy resource after coal, and the largest total water resources in the world. According to the survey design level, hydropower has 2.47 trillion kilowatt-hours (KWH) of technical development capacity (per year). If fully developed, it could provide energy from at least 1 billion to 1.3 billion tons of raw coal per year[1]. Therefore, the development of hydropower can effectively improve China's energy structure, making good use of abundant hydropower resources is the inevitable choice of energy policy. In the development of hydropower energy resources, we should reduce the number of super-large hydropower stations and increase the number of medium-sized hydropower stations, so as to reduce the impact on the environment, reduce investment and reduce relocation.

4.1.2. Actively Promoting the Use of Nuclear Energy

After decades of technological accumulation, China's nuclear power technology is in a leading position in the world, with advanced technologies in every link, including pressurized water reactors and nuclear fuel production (purification). China has cooperated with some developed countries such as the UK on many nuclear power projects. At home, we should vigorously develop nuclear power. China's share of nuclear power is too low compared with France's 71.6 percent. Part of the reason is related to the lack of understanding and one-sided understanding of nuclear power by most people in China, resulting in excessive concern about the safety of nuclear power. It is the domestic opposition of some individuals that have slowed down the nuclear plan. Therefore, in addition to nuclear power technology and safety protection technology, it is particularly important to communicate information to the public. Only in this way can unnecessary worries of the public be eliminated and the development of nuclear power ultimately be promoted. On the other hand, according to the latest science and technology report, artificial controllable nuclear fusion has also made exciting achievements. With the unremitting exploration of controllable nuclear fusion, controllable nuclear fusion will eventually be realized, which can be said to be an ultimate way to solve energy.

4.1.3. Actively Promoting the Use of Photovoltaics (pv)

China's leading solar technology and the world's largest production, installation and operation experience provide a technical guarantee for the continuous increase of photovoltaics. The areas with the most abundant radiation exposure mainly include the Qinghai-Tibet Plateau, northern Gansu, northern Ningxia, southern Xinjiang, northwestern Hebei, northern Shanxi, southern Inner Mongolia, southern Ningxia, central Gansu, eastern Qinghai, and southeastern Tibet. Areas with abundant radiation include Shandong, Henan, southeastern Hebei, southern Shanxi, northern Xinjiang, Jilin, Liaoning, Yunnan, northern Shaanxi, southeastern Gansu, southern Guangdong, southern Fujian, central and northern Jiangsu and northern Anhui.

Tibet's solar energy resources are of high value in development and utilization, with the total annual solar radiation equivalent to 240 billion tons of standard coal. Tibet is also rich in hydropower, solar energy, wind energy and geothermal energy resources. Rational development and utilization of these clean energy resources are expected to be the first in China to achieve carbon peak and carbon neutrality.

Inner Mongolia’s solar energy and wind energy are very rich, 10 meters, 50 meters high can be exploited to use the wind energy reserves of 101 million kilowatts, 202 million kilowatts, accounting for 40% of the national reserves, ranking the first in the country. Sunshine hours range from 2600 to 3400 hours, and most areas belong to the category of solar energy resources.

4.1.4. Attach Importance to the Application of Biomass Energy

Biomass energy, the most traditional energy, is itself a dynamic balance of carbon emissions, in addition to the natural decomposition of dead plants in the forest and grassland plants, the rest of the biomass energy is used to be very high utilization rate. Since the widespread use of fossil energy, the utilization rate of biomass energy in this part has gradually decreased. Unlike modern biomass power generation, previous biomass energy efficiency is high, but not high efficiency[8].

At present, biomass energy mainly includes household waste incineration power generation, agricultural and forestry biomass power generation and biogas power generation. In 2019, biomass generated

111.1 billion kilowatt-hours of electricity. China is a largely agricultural country with abundant biomass[9]. Improving the utilization of biomass energy is an important way to achieve carbon neutrality.

Efficient use of dead forest plants is another way. The natural decomposition of dead plants also releases solidified carbon back into the atmosphere.

4.2. Adjusting the National Policies

4.2.1 Reducing Energy Consumption Per Unit GDP

In addition to adjusting the energy structure, reducing energy consumption per unit of GDP is also a key link. No matter what kind of energy, we should reduce energy consumption through technological progress, and eliminate industries with low GDP/ high energy consumption through industrial restructuring. Third, improve energy efficiency through technological means; Reasonable layout and distribution, reduce transportation thus reducing energy consumption in the transportation process. Accurate carbon footprint tracking, refined to reduce energy consumption. Coal now accounts for a third of China's rail capacity.

4.2.2. Adjusting the Industrial Structure

In addition to adjusting energy structure and reducing energy consumption per unit GDP, adjusting industrial structure is an effective way to achieve carbon neutrality. Adjusting the industrial structure is to eliminate high energy consumption industries, such as steel and cement, so as to reduce energy consumption, and to develop the carbon capture industry.

If the total global demand for all kinds of products remains unchanged, but China's internal industrial structure adjustment does not change the global total industrial structure, then it is not of great significance for global carbon neutrality.

4.2.3. Supporting Carbon Capture

Carbon capture is the artificial solidification of carbon dioxide. At present, the main methods are afforestation and mineralization. Afforestation is a way to capture carbon (carbon solidification) over time but ultimately depends on where the trees end up: rotting, building, burning for electricity, and so on, and the scale is not infinite. And carbon dioxide mineralization is a permanent solution.

In Iceland, an international co2 sequestration plant has opened. A steady stream of co2 is being pumped underground. In less than two years, the co2 can be converted into underground rocks that will last for thousands of years. Since 2014, there are 70000 metric tons of carbon dioxide in the ground, in the form of a stone was "permanently stored in the underground," this is the Carbfix project when carbon dioxide dissolves in water, and then the water injection into the rock formations that are rich in carbon dioxide, carbon dioxide can react with active rock such as basalt, form stable minerals, these minerals can be stored permanently. In Carbfix, CO2 is mineralized in basalt formations at an astonishing rate, much faster than the researchers expected, with nearly 95% of co2 mineralized in less than two years, proving successful on an industrial scale.

The rock Carbfix uses is basalt, one of the most common types of rock on the earth's surface, covering 5% of the continent and much of the ocean floor, and storing carbon dioxide far more than is currently required to reduce the atmosphere's carbon footprint. Iceland's project alone has the capacity to produce more than 55 years of earth's emissions. Transporting co2 that causes only 3-6% of the carbon emissions to be processed. At the same time, on a global scale, the proper distribution of such plants close to high-carbon emission areas could improve carbon sequestration and reduce the energy and cost of transporting carbon dioxide.

4.3. Implementing A Reasonable Carbon Trading System

If science and technology are the means to realize the adjustment of energy structure and reduce energy consumption, it is a possibility; Then the formulation and implementation of international rules on carbon trading is an external constraint and a necessity.

A scientific and reasonable carbon trading system will help to achieve the goal of carbon neutrality. Because carbon neutrality is a joint effort of all countries, not just any one of them, it involves developing a carbon trading system that is accepted and implemented by all countries around the world. If carbon trading only operates within one country, it is not enforceable and unfair to countries with low carbon emissions. A reasonable carbon trading system must cover the historical situation, economic development level, population base, natural environment, technological level and many other factors of different countries. Another factor that should also take into account is the dialectical relationship between the generation of carbon emissions and the final consumption of carbon emissions. It is fair to calculate the final consumption of carbon emissions, that is, the person who is consumed by the product should pay for the carbon emissions caused by the production of the product, rather than the producer of the product.

5. CONCLUSION

This paper mainly studies the classification of energy; Alternative energy solutions and technological level as well as the current situation of major countries and

China's future approach; The national policies and international rules of carbon trading; Statistical methods and approaches to carbon emission and current situation and trend of international carbon capture. Carbon neutrality is a common challenge faced by all mankind. Therefore, technology sharing should be enhanced in all relevant fields to jointly promote the early realization of carbon neutrality. To achieve carbon neutrality, China needs to fully exploit the advantage of having the world's largest water reserves; Using leading technologies to develop nuclear power; At the level of national policy, people should actively promote industrial structure adjustment: promote carbon trading and promote the mature operation of carbon trading market.

The paper can still refine its forecasts with a deeper understanding and broader reading of existing policies. Future research may focus on the establishment of a carbon trading market and in-depth study of rules to promote enterprises to adjust industrial structure and reduce energy consumption. Only fair, reasonable, and feasible international carbon trading rules can promote every country to abide by.

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