Exploring the Current State of Development of Non-Renewable Resources and Sustainable Measures

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Abstract. Non-renewable resources are natural resources that have a very long formation cycle and are difficult to recover on a time scale relative to human history. With China's policy reforms, the energy structure has been continuously optimized and adjusted, and the pressure on the development of non-renewable energy sources, mainly coal, oil and natural gas, has increased dramatically. Therefore, this paper studies the advantages and disadvantages of non-renewable energy, analyses the impact of non-renewable energy on the current environmental situation, and researches the development trend of non-renewable energy and the direction of substitution. The study shows that renewable energy, nuclear energy and the current research of frontier technology is the basic direction of substitution of non-renewable energy. Adjusting the energy structure and reducing the environmental burden through emission reduction measures in the fields of industry, transport and construction. Government policy support and public education are ways to reduce carbon footprints and ease environmental pressure.

Keywords: Non-renewable resources, energy structure, development trend, sustainable measures.

1. Introduction

Since the beginning of the twentieth century, with the rapid development of science and technology and the deepening of mankind's exploration of the natural world, non-renewable energy resources, as a key force in promoting social progress and economic development, have long occupied a dominant position in the use of energy. With the growth of the national population, the acceleration of industrialization and socialization, and the improvement of living standards, the demand for energy has shown an exponential growth, which not only aggravates the consumption rate of non-renewable energy resources but also triggers a series of serious environmental and social problems. Non-renewable resources are natural resources that cannot be renewed in a short period of time, and their slow regeneration rate makes it difficult to meet the long-term energy needs of human beings. The limitations of non-renewable energy sources constitute the most fundamental challenge in the current energy mix.

China's energy structure is currently characterized by high carbon content, high carbon emissions from energy use, high external dependence on oil and gas, and low production and use of new energy sources, all of which are ‘three highs and one low’. China's current energy insecurity, mainly oil and gas dependence on foreign insecurity, needs underground coal oil and gas, shale oil and gas revolution; the future energy insecurity, which mainly is new energy key mineral imports of insecurity, need to increase the development of key minerals. To ensure China's present and future energy security, we should start from the ‘4 systems view’ of the whole coal system (surface and underground), the whole oil and gas system (conventional and unconventional), the whole energy system (fossil energy and new energy), and the whole carbon cycle system (carbon emission and carbon sequestration), and plan for the clean utilization of coal and the cost-effective development of unconventional oil and gas, the accelerated development of new energy, and the steady realization of carbon neutrality [1]. The current situation of Chinese energy development is that China has abundant energy resources, but the per capita share is relatively small; energy construction has been continuously strengthened, but the energy efficiency is still relatively low; driven by the rapid growth of demand, China's energy production is growing rapidly, and the growth of coal is particularly swift, which leads to the growth of ecological pressure [2,3].

This paper makes clear recommendations for the development of non-renewable energy sources and outlines specific measures to transform the energy structure and reduce the carbon footprint of China combined with China's national conditions, as well as an outlook for future development. This paper analyzes the proportion of non-renewable energy sources in China's energy structure and their strengths and weaknesses, emphasizes the harm that non-renewable energy sources bring to the environment, and identifies the future development trend of non-renewable energy sources and the direction of substitution in the light of the current situation of the development and the challenges faced by the country, as well as the multifaceted management of the energy application in order to achieve the dual-carbon goals of carbon peaking and carbon neutrality.

2. Status of non-renewable energy applications

2.1. Classification of non-renewable energy sources

China's resource endowment is relatively poor. There is a shortage of high-quality energy resources, such as oil and natural gas, and a high degree of dependence on foreign countries; coal resources are abundant, with proven reserves ranking second in the world; and uranium resources have great potential, but the degree of exploration is low, and the supply is insufficient. China's energy structure is seriously imbalanced, compared with the world average, China is overly dependent on coal, oil, and natural gas pillar role is insufficient, and the development of nuclear energy is relatively lagging behind [2].

Non-renewable energy is mainly divided into coal (solid fossil fuels formed by ancient plant life due to crustal movements), oil (liquid fuels formed by the remains of ancient organisms under high temperature and high pressure underground over millions of years), natural gas (the main component methane), nuclear energy (mainly derived from the release of energy from radioactive elements such as uranium through nuclear fission or fusion), oil shale (high-ash sedimentary rocks), chemical energy (energy released by certain chemical energy (energy released by certain chemicals under certain conditions), etc.

Coal is currently one of the world's most important fossil fuels, widely used in electric power production, iron and steel manufacturing, chemical industry, and other fields. China is rich in coal resources. Due to policy reasons, China's coal production continues to decline.

Petroleum is one of the most important sources of energy in the world and is mainly used in the fields of transport, chemicals, and electricity. Since the beginning of this century, petroleum prices have been rising. The rise in petroleum prices has had a large impact on the global economy, especially on the economies of petroleum-importing countries, and some countries have even experienced social unrest caused by the rise in petroleum prices, leading to economic slowdowns in major developed countries and global economic volatility [3]. China has low petroleum reserves and a huge shortfall in petroleum consumption. China's petroleum reserves are relatively low, and there is a huge shortfall in petroleum consumption. With the rapid development of the economy, China's demand for petroleum is increasing, and the degree of foreign dependence is also increasing year by year. In recent years, with the popularity of electric vehicles and the development of alternative energy sources, the demand for petroleum has gradually declined. The competitive landscape of the petroleum industry is also changing, with some countries increasing their petroleum production, while some OPEC+ organized countries are pushing up the price of oil by cutting production.

As a relatively clean fossil fuel, natural gas has been gaining ground in the energy market in recent years. Several countries are actively developing the natural gas industry and promoting the use of natural gas. China's conventional natural gas reserves are small, unconventional natural gas resources have huge potential and shale gas reserves are high. China's unconventional natural gas is still in the early stage of exploration, and with the deepening of exploration, the resource potential of China's unconventional natural gas will be further released [2].

2.2. Advantages

First, non-renewable energy sources, especially fossil energy sources (coal, petroleum, and natural gas), dominate the global energy supply and have an efficient and stable energy supply capacity. They provide a solid energy base for the development of human society with their huge reserves and efficient energy conversion rates. Nuclear energy, as a highly efficient form of energy, is particularly outstanding in its power generation capacity. The power generation capacity of a single nuclear power plant can often cover the energy needs of a large area, and the power generation process is relatively stable.

Secondly, non-renewable energy sources remain an important means of meeting rapid economic growth, especially for developing countries, given the relative maturity and low cost of the technologies for extracting, refining, and converting non-renewable energy sources compared to some renewable energy sources.

For non-renewable energy sources, especially fossil energy, there is a high energy density. This means that they are able to store and release more energy for the same volume or weight, which is particularly important in areas such as long-distance transport, heavy industry, and transportation.

In addition, non-renewable energy sources have a wide range of applications in several fields. For example, coal can be used for home heating, industrial production, and power generation; petroleum is not only the main fuel for transportation but also an important raw material for the manufacture of plastics, fertilizers, and other chemical products; and natural gas, because of its cleanliness and efficiency, has been widely and effectively utilized in cooking, heating and power generation. Nuclear energy is mainly used for power generation and scientific research.

2.3. Disadvantage

First of all, the biggest disadvantage of non-renewable energy is its limited resource reserves. Non-renewable energy sources such as coal, petroleum, and natural gas are formed in nature over billions of years, and their reserves are limited. With the continuous exploitation and utilization by human beings, the reserves of these energy sources are gradually decreasing and facing the risk of depletion. At the same time, as the resource reserves decrease, the difficulty of extraction gradually increases. This not only raises the cost of extraction but may also cause greater damage to the environment and ecosystems.

Currently, non-renewable energy sources dominate global energy consumption, and the economies of many countries are highly dependent on them. Therefore, any problems in energy supply or large price fluctuations could have a serious impact on economic development. In addition, owing to the limited reserves of non-renewable energy sources and the increased difficulty of extracting them, their extraction costs have shown a fluctuating upward trend. Factors such as volatility in international energy markets and geopolitical risks can also lead to sharp fluctuations in energy prices, thereby increasing the economic burden on businesses and individuals.

Secondly, the supply of non-renewable energy is often affected by a variety of factors, such as geological conditions, extraction technology, and political stability. As a result, there is a certain degree of uncertainty and risk in the supply of energy. In order to ensure the security of the energy supply, many countries need to adopt diversified energy strategies and establish energy reserve systems.

Finally, in the process of energy consumption, there are also certain safety risks, for example, the safe operation of nuclear power plants has always been one of the focuses of people's attention. In the event of a nuclear accident, it would not only cause devastating damage to the environment but could also have a long-term impact on human society.

3. Environmental issues arising from non-renewable energy sources

The burning and extraction of non-renewable energy sources pose a serious threat to the environment and human health. The pollutants they produce lead to air pollution and health problems, and the release of greenhouse gases triggers global warming and ecological damage.

First of all, the burning of coal, petroleum, and other non-renewable energy sources prod uces a large amount of sulfur dioxide, nitrogen oxides, and particulate matter, which have a serious impact on air quality and lead to air pollution, which can lead to respiratory disea ses, cardiovascular and cerebrovascular diseases, and other health problems. At the same tim e, particulate matter can also be suspended in the atmosphere for a long time, affecting visi bility and forming hazy weather.

Secondly, non-renewable energy sources such as coal, petroleum, and natural gas release large amounts of carbon dioxide, methane, and other greenhouse gases during the combustion process, creating a greenhouse effect in the atmosphere, leading to an increase in the earth's surface temperature, which in turn triggers global warming. Global warming not only leads to the frequent occurrence of extreme weather but also affects the melting of glaciers, sea level rise, and other ecosystem changes. Moreover, the emission of sulfur dioxide and nitrogen oxides will form acid rain in the atmosphere, causing serious damage to the ecological environment and affecting the acid-base balance of water bodies and soil.

In addition, the utilization of nuclear energy generates large quantities of radioactive waste, the improper disposal of which can have long-term effects on the environment and human health.

At the same time, the exploitation of non-renewable energy sources requires the occupation of large areas of land and the destruction of vegetation, causing irreversible damage to natural landscapes and ecosystems. Ecological damage can lead to problems such as loss of biodiversity and soil erosion, which in turn affect the stability of the entire ecosystem. The extraction and processing of non-renewable energy sources (e.g. coal mining, petroleum refining) may produce wastewater, waste residues, and other pollutants, which will be discharged directly into water bodies and soils if not properly treated. Soil and water pollution can disrupt the ecological balance, affecting the growth of crops and the safety of drinking water, and posing a potential threat to human health.

4. Future development of non-renewable energy sources

4.1. Challenges facing non-renewable energy sources

The Paris Agreement sets the goal of limiting global temperature rise to 2°C and aiming for 1.5°C, while the IPCC Special Report on Global Warming at 1.5°C states that limiting global warming to 1.5°C rather than 2°C or higher could avoid a range of climate change impacts [4]. The extraction and use of non-renewable energy sources can have serious environmental impacts and further contribute to warming. With increasingly stringent environmental regulations and a global focus on environmental issues, the development of non-renewable energy sources is facing unprecedented environmental pressures.

Non-renewable energy is a finite resource, and the problem of resource depletion is becoming increasingly serious as the amount of extraction increases. This has led to a gradual rise in the price of non-renewable energy and increased uncertainty about energy supply.

As the global energy transition accelerates, more and more countries have begun to emphasize the development of renewable energy. China has taken the initiative to put forward the “dual-carbon” goal, which promotes the upgrading of China's energy and related industries, realizes the long-term healthy and sustainable development of the national economy, and contributes to the gradual transformation of the energy structure from high-carbon to low-carbon or even carbon-free. Realizing the “dual-carbon” goal is a broad and profound systemic change, and the energy revolution will be the top priority of this systemic change. This poses a challenge to the non-renewable energy industry and promotes the restructuring and transformation of the energy mix.

4.2. Future Development Trends

The share of non-renewable energy sources in the energy market will gradually decrease as renewable energy technologies continue to advance and costs decrease. Especially in the power sector, renewable energy will gradually replace traditional energy sources such as coal and petroleum. The future energy market share will be more tilted to renewable energy, especially in the field of electricity. As the power system is closely related to the production, transmission, and consumption of renewable energy, the power system has a key role in ensuring the realization of the core indicators of the energy transition, so it is necessary to vigorously promote the transformation of the power system on the basis of technological development and innovation, transforming it from being dominated by fossil energy to being dominated by low-carbon renewable energy, and constructing a new-generation power system that serves as the core of the new-generation energy system. A high proportion of renewable energy sources and a high proportion of power electronic equipment are connected to the power grid to realize the integrated energy production and supply of multi-energy complementary, and to support the construction of the energy Internet on the basis of the smart grid [5].

To address the challenges facing non-renewable energy sources, many companies are engaging in technological innovation and creativity. For example, they are trying to extend the life of non-renewable energy sources and reduce environmental pollution by improving extraction efficiency, reducing production costs, and developing cleaner combustion technologies.

Under the background of the global energy transition, countries are actively seeking international cooperation to promote the adjustment and transformation of the energy structure. The non-renewable energy industry can also promote technological innovation and market expansion through international cooperation.

4.2.1. Renewable energy

Renewable energy is the main direction for replacing non-renewable energy sources, including solar energy, wind energy, and water energy (water energy, or hydroelectric power, is a way of generating electricity by using the potential and kinetic energy of water to convert it into electrical energy), biomass energy, geothermal energy, and oceanic energy (including wave energy, tidal energy, etc.) and many other forms. These energy sources are characterized by recycling, inexhaustible and inexhaustible, and are environmentally friendly as they do not produce harmful substances during use.

With the advancement of technology, the cost of solar power generation is gradually decreasing and its efficiency is constantly improving, making solar energy an important option for replacing non-renewable energy sources. Wind power is one of the most cost-effective renewable energy sources. In areas with superior wind resources, the cost of wind power generation is already cost-competitive with fuel oil or gas-fired power generation. With the development of technology and policy support, the wind power industry will usher in a new round of outbreaks. Hydropower is a low-cost, continuously renewable, non-polluting way of energy utilization. China is rich in hydropower resources and has good development prospects. Biomass energy is clean, environmentally friendly, and renewable, and will become an important energy source for transportation in the medium and long term. Geothermal resources are widely distributed and do not produce harmful substances during use. Ocean energy, including wave energy and tidal energy, has great potential for development. With the progress of technology and the continuous development of ocean engineering, ocean energy will become an important direction to replace non-renewable energy. As a clean, low-carbon, high-energy-density energy source, the advantages of nuclear power have not been shaken. The objective need to replace coal with a high proportion of non-fossil energy requires a combination of nuclear power with stable output and intermittent renewable energy.

4.2.2. Cutting edge technology

Carbon Capture and Storage (CCUS) technology aims to reduce greenhouse gas emissions by separating carbon dioxide from industrial emission sources and isolating it from the atmosphere over time through effective storage methods. Carbon capture technology is the key first step in achieving

CCUS. Its technical principle is mainly based on physical and chemical separation methods to efficiently separate carbon dioxide from flue gas by means of adsorption, absorption, and membrane separation. In this process, pre-combustion capture, post-combustion capture, and oxygen-enriched combustion capture technologies have their own advantages, which can be flexibly selected according to specific application scenarios and needs. Carbon sequestration technology is the key link to ensure the long-term isolation of carbon dioxide from the atmosphere. Geological storage, surface storage, and oceanic storage are the main storage methods at present. In terms of comprehensive technology application, carbon capture and storage technology needs to be deeply integrated with energy, chemical, and other industries. The economy and feasibility of CCUS technology can be continuously improved by optimizing the process flow, improving the efficiency of energy use, and developing new types of storage materials. The innovative application of this technology in petroleum engineering not only improves the environmental protection level of the petroleum industry but also provides strong technical support for energy transformation. By promoting the development of green and low-carbon energy, carbon capture and storage technology helps to reduce greenhouse gas emissions and alleviate the pressure of climate change. At the same time, the technology accelerates the adjustment and optimization of energy structure and promotes the sustainable development of the economy and society. In addition, CCS creates green jobs, promotes technological innovation and industrial upgrading, and lays a solid foundation for building a clean, low-carbon, and efficient energy system. In the future, with the continuous progress of the technology and the wide popularization of the application, carbon capture and storage technology will play a more important role in the energy transition [6].

Bio-energy refers to energy in the form of biomass, formed after solar radiation is processed and transformed by plant photosynthesis, which can be converted into conventional solid, liquid, and gaseous fuels by physical or chemical processes. Bio-energy is one of the important renewable energy sources, the only renewable source of carbon, and one of the most promising energy sources to replace petroleum. Bio-energy reserves are huge, and annual production far exceeds the world's total energy demand, equivalent to 10 times the world's total energy consumption[7]. Bio-energy is widely available, clean, efficient, green, and friendly, and is expected to be developed into a new type of fuel to replace non-renewable energy fuels and promote the transformation of the energy structure.

The hydrogen energy industry is a global emerging industry, governments and enterprises are actively carrying out international cooperation to jointly promote the development of the hydrogen energy industry. In particular, hydrogen energy (green hydrogen), which is obtained by electrolysis water powered by renewable energy, is regarded as an important direction for future energy development.

5. Managing energy applications to reduce carbon footprint

A carbon footprint is generally defined as the sum of greenhouse gas emissions and removals, expressed in carbon dioxide equivalents, for a specific object, including a product, person, household, institution, or business.

Managing energy applications to reduce carbon footprints is an important measure to address global climate change and promote sustainable development. The following are some effective strategies and methods: optimize the energy mix to promote renewable energy; improve energy efficiency and reduce energy consumption and waste through technological innovation and management innovation. For example, adopting efficient lighting equipment, energy-saving electrical appliances, and energy-saving buildings.

Energy-saving technological transformation of industrial equipment to improve energy efficiency and performance and reduce energy consumption and carbon emissions. Examples include the adoption of high-efficiency motors, energy-saving boilers, and waste heat recovery technologies. In the process of industrial production, promote the circular economy model to maximize the use of resources and minimize the emission of waste.

Give priority to the development of public transportation systems, improve the convenience and comfort of public transportation, encourage people to use public transportation for travel, and reduce the use of private cars and carbon emissions [8]. Actively promote new energy vehicles that do not produce tailpipe emissions and are friendly to the environment, such as electric vehicles and hydrogen vehicles, to replace traditional fuel vehicles.

Adopt green building materials and technologies in building design and construction to improve the energy efficiency and environmental performance of buildings. Examples include ultra-low energy buildings, carbon load reduction, building electrification and energy efficiency, on-site renewable energy utilization, resilience for high penetration variable renewable energy, and airborne carbon capture and utilization (DACCU), etc., to promote scientific and technological innovations for green carbon-neutral buildings based on China's national conditions[9].

The government should formulate and improve relevant policies to encourage and support the development of renewable energy, the R&D and application of energy-saving technologies, and the establishment of a carbon trading market. Maintaining strategic determination with a political stance, the layout should be laid out as early as possible, and the deployment of action programs should be accelerated in all localities and departments [8]. Strengthen the supervision and enforcement of energy use and carbon emissions to ensure that all emission reduction measures are effectively implemented [10].

Raise public awareness and consciousness of climate change energy saving and emission reduction through media publicity and community activities. Encourage the public to actively participate in energy-saving and emission reduction actions, such as using energy-saving products and reducing energy waste.

6. Conclusion

This paper examines the current status of non-renewable energy development and sustainable measures by summarizing the phenomenon and predicting the development trend. The advantages of non-renewable energy for energy supply capacityare strong, low cost, high economy, with high energy density. However, non-renewable energy resource reserves are limited, and difficult to extract, causing serious environmental pollution, strong economic dependence, and cost fluctuations. The impact of non-renewable energy on the environment is mainly reflected in the greenhouse effect and global warming, air pollution, acid rain deposition, soil and water pollution, resource depletion, ecological damage, and so on. Based on the pollution of non-renewable energy on the environment and the deterioration of the earth's environment, China has formulated relevant laws and regulations and carried out energy structure improvement and optimization. Renewable energy, cutting-edge technology and nuclear energy as an alternative direction have a good development prospect. In addition, in the future, through industrial emission reduction, building emission reduction, transportation emission reduction, as well as improving public education to improve the use of energy and reduce the carbon footprint can efficiently respond to China's carbon peak and carbon neutral dual-carbon policy. The solution to environmental problems is imminent, and improving the energy structure is a top priority for China and the world.

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