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The Carbon Peak and Neutrality Goals and China's New Energy Revolution

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Abstract

The goals of carbon emission peak and carbon neutrality will promote the new energy revolution and the diversification of energy structure. The non-fossil energy with photovoltaic energy as the core will gradually occupy a dominant position, the status of electric power will significantly rise, and the consumption of coal and oil will be significantly declined. The challenges presented to China by the goals of carbon peak and carbon neutrality are reflected in the enormous pressure on the adjustment to economic structure and energy structure, the growing manufacturing costs, the difficulty in the decommissioning of coal-fired power plants, the grid stability affected by the grid connection of photovoltaic power and wind power, and the risk in the supply of critical raw metals. The opportunities include the strong competitiveness in manufacturing of photovoltaic power and wind power equipment, the decreasing dependence on imported oil and gas as well as the acceleration of low-carbon transformation. China should strengthen the top-level design of the path to achieving the goals of carbon peak and carbon neutrality, encourage innovation in green and low-carbon technologies, accelerate adjustments to economic structure and energy structure, strictly control the construction of new projects with high emissions and high energy consumption, and steadily promote the adjustment and withdrawal of the existing projects with high emissions and high energy consumption.

The international community has reached a consensus on and also taken action for achieving carbon emission peak and carbon neutrality as soon as possible. As many as 130 countries have planned to achieve carbon neutrality by the middle of the 21st century, accounting

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for about 61% of global carbon emissions. Based on the new development stage and the concept that "lucid waters and lush mountains are invaluable assets", the Chinese government has made the strategic decision to achieve the goals of carbon emission peak and carbon neutrality after taking into full consideration the domestic and foreign environment and comprehensively weighing the advantages and disadvantages, which is crucial to the well-being of the Chinese nation and the green transformation of the economic and social development. As a large developing country with a relatively heavy industrial structure, great dependence on coal consumption for power supply, a relatively low energy efficiency, high risks for oil and gas supply and a strong manufacturing capacity of renewable energy equipment, China will adjust its economic structure and energy structure under the pressure of the goals of carbon peak and carbon neutrality.

1. Characteristics of the New Energy Revolution Amid the Goal of Carbon Neutrality

First, the energy structure tends to be diversified and non-fossil energy will gradually occupy a dominant position. The transition to carbon neutrality means an unprecedented diversification of the energy structure in the next two decades, which will be dominated by oil, natural gas, renewable energy and coal. With the acceleration of low-carbon transformation, the main sources of energy will gradually transform from fossil energy such as oil, natural gas and coal to renewable energy, and it is expected that non-fossil energy will be dominant in the early 2040s. The proportion of renewable energy in primary energy will rise from 5% in 2018 to about 50% in 2050, while the proportion of fossil energy will fall from 85% to around 30%.

Second, coal and oil consumption will fall significantly, while the demand for natural gas will remain relatively stable. It can be reflected as follows. First, the proportion of coal consumption will continue to fall significantly. According to the forecast of BP (2020), coal consumption will be likely to fall by 85-90% in 2050, and the proportion of coal in the primary energy will be less than 5%. The decline in global coal consumption will be driven by China. The power sector will see the greatest reductions, accounting for about two thirds of the drop in global coal consumption. Second, the global oil demand may have peaked. The automobile industry will no longer act as the engine of oil demand growth, due to the factors such as the improved energy

efficiency and strong growth in sales of electric vehicles. The global oil demand is likely to peak in 2019 and will find it difficult to recover to the pre-COVID-19 level. China's oil demand will peak in 2030. The global oil demand may fall by 30-55 million barrels per day in 2050 on average. Third, as a type of clean and transitional energy, natural gas demand is relatively stable and is expected to peak around 2035. The global gas consumption in 2050 is likely to fall back to what it was in 2018.

Third, the role of electric power and hydrogen energy in the energy structure has become significantly more important. Electric power will replace fossil energy as the most important source of energy, which means a marked increase in the level of electrification. Considering the intermittence and instability of renewable energy, the intelligence level of the power system in the future will be significantly enhanced. With the aid of modern technologies, such as the internet, internet of things, artificial intelligence, big data, and cloud technology, people, energy equipment and energy services will be interconnected, so that the power supply, grid, electric charges and energy storage will be well coordinated. The level of electrification will vary with different industries or sectors. It is difficult for some industries or sectors to achieve the electrification, such as the steel, cement and chemicals involving high-temperature production and processing, as well as heavy duty trucks, aviation and sea transportation involving long-distance transportation. Alternative low-carbon or zero-carbon energy sources must be adopted for the processes with difficulty in electrification.

Fourth, photovoltaic solar energy will occupy the central position in the energy system. In the past ten years, the cost of photovoltaic solar energy has decreased by 82% to 90%, which is lower than the cost of new coal-fired power plants or natural gas power plants in most countries. The annual newly added installed capacity of photovoltaic solar energy is expected to reach 250 gigawatt(GW) during 2021-2025 and reach 350 GW during 2026-2035, which is about 4 times and 6 times that of the newly added installed capacity of 60 GW since 2000, respectively. During 2030-2050, renewable energy represented by solar energy will gradually transition from alternative energy to principal energy, and solar energy will play a key role in the global energy system. It will help to form a new power system with new energy as the mainstay, and conventional thermal power generation will be converted from the base-load power to peak-

shaving power.

Fifth, the rapid development of renewable energy has led to a dramatic increase in long-term demand for critical metals. Different from traditional fossil-fueled power generation, photovoltaic power, wind power and electric vehicles require more metals. Lithium, nickel, cobalt, manganese and graphite are vital to the efficiency, service life and energy intensity of batteries. Rare-earth permanent-magnet materials are crucial for wind turbines and electric vehicles. Electrical grids require a large quantity of copper and aluminum, and copper is the cornerstone of the power system. An electric car uses six times as much metal as an oil-fueled car, and an onshore wind farm consumes 10 times as much metal as a natural gas power plant. The demand for metals for electric vehicles and energy storage batteries will increase at least 30 times by 2040. The demand for lithium will experience the most rapid growth, rising by more than 40 times by 2040. It is followed by graphite, cobalt and nickel, which will grow by about 20-25 times.

2. The Impact of Carbon Peak and Neutrality on China's Economic and Energy Systems

First, the challenging task of emission reduction and the limited time for transition to carbon neutrality have increased the pressure and risk of industrial and energy structure adjustment. It is reflected as follows. The first is the challenging task of carbon emission reduction. In 2019, China accounted for 28.8% of global carbon emissions, close to the combined share of the United States, India, Russia and Japan, which rank from second to fifth respectively. It is far higher than its share of about 18% in terms of population and GDP. The second is the limited time for transitioning from carbon emission peak to carbon neutrality. With only 30 years to transition to carbon neutrality, China is faced with the challenging task of adjusting the economic structure and energy structure. The energy transition means the direct entry into the era of renewable energy without completely experiencing the oil and gas era, which leads to the inherent shortage of flexible power resources. The third is the relatively high proportion of manufacturing industry, the demanding task of economic development, and the limited room for energy intensity reduction. The fourth is that energy transition is faced with the bottleneck of

resource endowment which features "abundant coal, lean oil and scarce gas". The proportion of coal in China's primary energy consumption structure is as high as 60%, and China is highly dependent on imported oil and gas. In addition to the soaring risk of energy supply security, the development room for clean energy, such as hydropower and nuclear power, is also limited. Photovoltaic power and wind power are developing fast, but their proportion in the energy structure remains low. There is still limited room to adjust and optimize the existing energy structure. In the long term, coal will still play the role of the main energy source which can guarantee the energy supply for China.

Second, the rise in energy and environmental costs has led to an increase in the cost of China's manufacturing industry and weakened its price competitiveness in the international market. Increasing the efforts toward carbon emission reduction will obviously increase the cost of enterprises and weaken the competitiveness of the manufacturing industry. The capacity limitations on high-emission industries such as coal, metal smelting, steel and cement will lead to the short supply and rising price for energy, metal raw materials and building materials. At the current stage, wind power and photovoltaic power have not been priced at a level comparable to hydroelectricity and thermal power, and the power system balance and integration cost caused by power fluctuation have not been taken into consideration. The carbon border tax adjustment, which is planned to be adopted by the EU in 2023, will have a negative impact on Chinese goods exported to the EU, especially on those industries, such as the machinery and equipment industry, metal products industry, and non-metallic mineral products industry.

Third, the expansion of the renewable energy industry will create more job opportunities, strengthen the international competitiveness of photovoltaic and wind equipment manufacturing, and help to gain the upper hand in international green technology competition. China is emerging as a leader in the development of renewable energy and green economy, such as solar photovoltaic cells, energy storage batteries, electric vehicles, 5G and artificial intelligence. From 2010 to 2019, China invested a total of USD 818 billion in the renewable energy sector, making it the largest market for photovoltaic power generation and solar thermal electric power generation. China has created 4.4 million jobs in the renewable

energy industry, accounting for about 38% of the jobs created worldwide. Moreover, China is a major renewable energy manufacturer and boasts 70% of the global photovoltaic power capacity and 40% of the global wind power capacity. The global goals of carbon emission peak and carbon neutrality will present a huge market opportunity to China's photovoltaic power generation and wind power equipment industry. However, compared with the advanced international standards, China has insufficient reserves of major green and low-carbon strategic technologies, which makes it "a follower" as a whole.

Fourth, the large-scale grid connection of wind power and photovoltaic power poses a threat to the safe operation of the power system, and the orderly decommissioning of coal-fired power plants is confronted with great challenges. The power industry is the main battlefield to achieve carbon emission peak and carbon neutrality. China's power industry faces two urgent issues: how to push forward the gradual and orderly decommissioning of China's more than 1,000 coal-fired power plants in service, while ensuring stable power supply and stable employment and minimizing the loss of early investments. Most of the existing coal-fired power plants in China were built after 2005, with decades of designed service life unfulfilled. The premature decommissioning will not only cause a huge waste in early investment but also result in the shortage of power supply. The second issue is concerned with how to tackle the impact of wind power and photovoltaic power on the security of the power system after large-scale grid connection and consumption in the future. The large-scale grid connection of wind power and photovoltaic power will pose intermittent challenges to the power system, such as overly high or low power generation in a certain period of time, which threatens the security of the power system and challenges the market mechanism design, planning design, production management and operation control of the power system. Moreover, due to the geographical separation between power production and power consumption in China, there is coexistence between the overall surplus of power supply throughout the year and a shortage of power supply at peak time.

Fifth, the development of renewable energy helps to reduce the dependence on imported oil and gas, but increases the potential supply risk of critical metals. Due to the resource endowment which features "abundant coal, lean oil and scarce gas", China's dependence on imported oil and natural gas has exceeded 70% and 40% respectively. Different from oil and

gas resources featuring imbalanced geographical distribution, the wind and solar resources on the earth are more evenly distributed, so the development of renewable energy can help to reduce the risk of oil and gas supply in China. However, the expansion of the renewable energy industry will drive the structural growth in the demand for metals such as copper and lithium, and the supply of metal ore resources is more monopolized than that of oil and gas. Therefore, the focus of energy geopolitics may shift from oil and gas to copper and lithium in the future, and the potential supply risks of critical metals will become even more prominent. The rapid growth in the demand for critical metals poses severe challenges to the accessibility and stability of supply. At present, the capacity and investment plans for some critical metals are far from meeting the need for the rapid deployment of photovoltaic panels, wind turbines and electric vehicles. The risk of metal supply will lead to a slower and more costly transition to clean energy, thus hindering global efforts to tackle climate change.

3. Policy Suggestions

Promoting carbon emission peak and carbon neutrality is an extensive and profound revolution covering the social, economic, and energy systems. Based on the new development stage and the concept that "lucid waters and lush mountains are invaluable assets", it is necessary to incorporate the goals of carbon emission peak and carbon neutrality into the overall planning of the economic and social development and ecological civilization construction, give full play to the unified leadership of the CPC and the state and the advantage of pooling resources to address major issues, and make coordinated use of domestic and international resources. With the comprehensive green transformation of the economic structure as the guidance and the green and low-carbon development of the energy sector as the key, the strategy of sustainable development must be deeply implemented so as to promote the comprehensive green transformation of economic and social development. The suggestions are as follows.

First, it is necessary to strengthen the top-level design and systematic planning of the path to achieving the goals of carbon emission peak and carbon neutrality. It is also vital to promote carbon emission peak and carbon neutrality with a step-by-step approach, maintain the balance between economic development, energy saving and emission reduction, strictly control the

construction of new projects with high emissions and high energy consumption, prudently promote the adjustment and withdrawal of the existing projects with high emissions and high energy consumption, as well as avoid making hasty mistakes and adopting one-size-fits-all approach.

The second is to vigorously promote industrial restructuring and upgrading. It is necessary to advance the supply-side structural reform, eliminate backward production capacity, reduce overcapacity, resolutely curb the disorderly and blind development of projects with high emissions and pollution, encourage the development of strategic emerging industries, accelerate the green and low-carbon transformation and digital transformation of the industry, and improve the low-carbon development in agriculture and services.

The third is to build a clean, low-carbon and efficient energy system. It is necessary to strictly control new coal-fired power generation projects, steadily promote the integration and orderly decommissioning of small coal-fired power plants, accelerate the development of wind power and solar power generation, greatly improve energy storage and peak shaving capabilities, and build a new type of power system with new energy as the mainstay.

The fourth is to increase investment in the innovation and research of green and low-carbon technologies. It is recommended to establish a number of national scientific and technological innovation platforms, launch a number of forward-looking and strategic research and development(R&D) and innovation projects related to low-emission technologies, increase the investment in the research and development of key core technologies such as energy efficiency improvement, smart grid, efficient and safe energy storage, hydrogen energy, and carbon capture, utilization and storage, as well as accelerate the development and large-scale application of low-carbon and zero-carbon technologies.

The fifth is to improve the supply security of critical metals for renewable energy. It is important to increase the investment in the exploration and development of domestic mineral resources, encourage the recovery and utilization of waste metals, and improve the domestic ability to supply critical metal resources. The stable supply of overseas metal resources should be maintained by expanding import channels and increasing overseas direct investment. It is also necessary to make full use of the advantages in rare earth resources and processing and metal

processing, so as to enhance China's bargaining power in the international metal resources market.

The sixth is to strengthen international exchanges and cooperation and policy coordination. It is recommended to actively participate in international cooperation on climate change, oppose the use of carbon emissions as a geopolitical bargaining chip or an excuse for trade barriers, and safeguard China's development rights and interests. China should get involved in the formulation of international rules and standards and promote the establishment of a fair and equitable global climate governance system featuring win-win cooperation. The green trade, investment and financing systems must be improved, and joint efforts should be made to build a green Belt and Road initiative.