China Council for International Cooperation on Environment and Development (CCICED)

Risk Prevention of Carbon Neutrality under the New Development Concept

Scoping Study for a CCICED Special Policy Study

CCICED

June, 2022

Scoping Study Members

Advisor*:

- *Liu Shijin, China Council for International Cooperation on Environment and Development, Chinese Chief Advisor*

Team Leader and Lead Author*:

- *Zhang Yongsheng, Research Institute for Eco-civilization, Chinese Academy of Social Sciences, Senior Research fellow, Director*

Special Policy Study Members*:

- *Yu Xiang, Research Institute for Eco-civilization, Chinese Academy of Social Sciences*
- *Li Hongyu, Research Institute for Eco-civilization, Chinese Academy of Social Sciences*
- *Zhang Zhuoqun, Research Institute for Eco-civilization, Chinese Academy of Social Sciences*
- *Zhu Shouxian, Research Institute for Eco-civilization, Chinese Academy of Social Sciences*
- *Ma Xuerui , Research Institute for Eco-civilization, Chinese Academy of Social Science*

Coordinators:

- *Xu Zhengxue, Research Institute of Eco-civilization, Chinese Academy of Social Sciences*

** The members of this SPS serve in their personal capacities. The views and opinions expressed in this SPS report are those of the individual experts participating in the SPS Team and do not represent those of their organizations and CCICED.*

Executive Summary

The *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy* issued in October 2021 pointed out that the work of carbon peak and carbon neutrality requires special attention to risk prevention and strike a balance between pollution prevention and carbon reduction, energy security, industrial chain and supply chain security, food security, as well as the normal life of the people.

This report aims to conduct preliminary research on the risk prevention of carbon neutrality in China from the perspective of new development concept, and provide preliminary support for the research work of the 7th CCICED.

Under the new development concept, this report reviews and analyzes the transition risks in the process of achieving the carbon neutrality goal. The report first reveals the essence of carbon neutrality and its implications to China's modernization, then conducts a general study and judgment on the risk of carbon neutrality, and analyzes specific risks, and then takes the prevention of major risks of carbon neutrality in key coal regions as an example. In this process, we conduct literature review from home and abroad. Finally, the report proposes the research directions and ideas for carbon neutrality risk prevention in the future.

Different development philosophies determine different understanding and response to carbon neutrality risks. How to recognize and prevent the risks in the process of carbon neutrality depends on the ability to fully and faithfully understand and implement the new development concept. At present, the prominent problem is to promote the work of carbon neutrality with the traditional development concept unconsciously. The consequence of this is the lack of accurate understanding and risk prevention.

From the perspective of ecological civilization, whether the new development concept is implemented in a full and faithful manner depends on how to recognize the relationship between the environment and development. If it is recognized that the relationship between the environment and development can be mutually promoted, it is a new development concept; otherwise, it is still a traditional development concept, because it views their relationship as conflicting, that is, grow first and clean-up later model. Therefore, it is difficult to understand the strategic opportunity and formation mechanism of carbon neutrality for China.

From the perspective of the new development concept, some of the risk perceptions under the traditional development concept in the past may be overestimated, or underestimated, or have not even been realized. The solutions of both concepts also differ greatly. In general, the traditional development concept deals with risks based on the recognition of the conflicting relationship between the environment and development, and the solution is to seek more compromise. However, the new development concept seeks solutions based on recognition of the mutually reinforcing relationship.

Regarding the risk prevention of the dual carbon goals, it is crucialto jump outside the traditional thinking of industrialization, reconsider and evaluate relevant risks under the new development concept, and put forward new risk prevention ideas and specific policy recommendations.

First is to research on the new discourse system and policy discourse related to carbon neutrality. Some of the current perceptions on carbon neutrality have largely failed to establish a discourse system and policy discourse on how carbon neutrality can promote economic development. It should be recognized that the biggest risk lies in no transition, and the historical opportunities that transition can bring for China to outpace others. In a complex and challenging situation, policymakers should maintain a strategic focus on carbon neutrality.

Second is to reconsider and evaluate the existing so-called transitional risks. Many of the transitional risks under discussion so far do not actually come from green transition, but rather from the inherent disadvantages of the traditional development model. Transition only exposes what has been temporarily masked. Therefore, the fundamental solution to these risks is to change the way of development, rather than no transition or delayed transition. Without transition, these risks will break out and be even more destructive. Many of the so-called transitional risks that we are worried about now have nothing to do with "dual carbon" goals. Attributing these risks to the carbon goals would have a profound negative impact on China. At the same time, some risks are greatly underestimated, for example the impact of carbon neutrality can be felt by many industries in terms of being broken down and re-established.

Third is to study the transformation of government functions in the context of carbon neutrality. Government function is largely defined according to the understanding of the market economy based on the traditional industrialization model. When the traditional industrialization model has toundergo green transformation because of unsustainability, the corresponding market and government functions should also undergo transformation.

Fourth is to study the market mechanism to reduce risks. A well-functioning market mechanism is one of the most effective means to avoid "dual carbon" risks. An effective market mechanism can not only reduce the occurrence of risks, but also diversify risks when they occur, improving economic resilience.

Fifth is to study pressing issues, policy pathways and mechanism design for promoting green transformation. The current "1+N" policy system needs a lot of in-depth and meticulous work in the implementation, including how to further put forward specific policy recommendations, how to give early warning to problems that may arise in the implementation process, and how to summarize experiences and lessons in a timely manner. In particular, risks arising from improper administration should be avoided, for example, a "one size fits all" policy for all regions and industries.

Sixth is to conduct key research on incorporating carbon goals into the overall layout of ecological civilization construction. On the one hand, since the realization of the carbon goals is systematic, it will be difficult to achieve such goals without incorporating it into ecological civilization. On the other hand, some single-minded thinking of achieving carbon reduction for the purpose of carbon itself fails to coordinate carbon reduction with ecological and environmental protection and resources, and in some cases even exacerbates unsustainability.

Seventh is to study the risk incentive mechanism of green technology innovation. Green transformation is a "0→1" process, and new technologies face "thrilling jumps" both in technology and in the market during the process of R&D and promotion. If there is no effective risk sharing mechanism, such as capital market mechanism design, insurance mechanism and social security mechanism, green transformation will not be realized due to high risks.

Keywords: New Development Concept, Carbon Peak, Carbon Neutrality, Green Transition, Risk Prevention

Contents

1.Research objectives and background 5
2.Understanding the major historical opportunities and challenges of carbon neutrality 8
3.Overall Judgment on the Risk of Carbon Neutrality.....10
4.Carbon neutrality and key risk prevention 20
5.Challenges and Risks of Green Transformation in Key Coal Regions 23
6.Future research topics and policy implications 25
Reference.....28

Risk Prevention of Carbon Neutrality under the New Development Concept

——Scoping Study for a CCICED Special Policy Study

1. Research objectives and background

This report aims to conduct preliminary research on the risk prevention for carbon neutrality in China from the perspective of new development concept, and provide support for the research of the 7th CCICED. Since President Xi Jinping announced the carbon peak and carbon neutrality goal at the 75th UN General Assembly on September 22, 2020, it has been actively implemented across the country. After a year of trial and practice, the "1+N" policies such as the Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy has been released in October 2021, which marks a new era for the full-fledged carbon goals. The Working Guidance emphasized that it is the top priority to prevent risks in promoting carbon peak and carbon neutrality, and to strike a balance between pollution prevention and carbon reduction, energy security, industrial chain security, food security and people's daily life, so as to effectively deal with the economic, financial and social risks that may accompany the green and low-carbon transition, prevent overreaction, and ensure safe carbon reduction.

How to recognize and prevent the risks in the process of carbon neutrality depends on whether the new development concept can be understood and implemented in a full and faithful manner. The prominent problem facing carbon neutrality at present is that in the process of implementing carbon neutrality, we unconsciously fall into the traditional development concept. The consequence of this is the lack of accurate understanding and prevention of risk. Some risks are often overestimated, or underestimated, and some are even neglected. Therefore, the new development concept is an important prerequisite for accurately understanding and preventing risks.

From the perspective of ecological civilization, whether the new development concept is fully and faithfully implemented depends on how to understand the relationship between the environment and development. The traditional industrialization model is based on the perception that the environmental protection conflicts with economic development. It is a model of

pollution first and treatment after. If we realize that environment and development can be mutually reinforcing, that is, more environmental protection will spur more development, we grasp the essence of new development concept. Otherwise, it is still a traditional development concept, unable to understand the strategic opportunities it brings to China and its formation mechanism.

Under the new development concept, this report reconsiders and analyzes the transitional risks in the process of achieving the carbon neutrality goal. The report first reveals the essence of carbon neutrality and its implications to China's modernization, then conducts an overall study and judgment on the risks faced by carbon neutrality, and analyzes specific risks, and then analyzes the main risk prevention in key coal areas. In this process, we have conducted literature review from home and abroad. Finally, the report puts forward research directions and ideas for carbon neutrality risk prevention.

Box 1: Key policy nodes for carbon peak and carbon neutrality

On September 22, 2020, President Xi Jinping announced the carbon peak and carbon neutrality goals (dual carbon goals) at the 75th United Nations General Assembly, which attracted wide attention in the international community and greatly boosted the global confidence in tackling climate change. At the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China at the end of October, the carbon goals were incorporated into the 14th Five-Year Plan and the 2035 Vision. At the Central Economic Work Conference in December 2020, the carbon goals were incorporated into eight key tasks for 2021. At the Two Sessions in March 2021, it has become a hot spot of public opinion.

In March 2020, the ninth meeting of the Central Finance and Economics Committee proposed that carbon peak and carbon neutrality should be included in the overall layout of ecological civilization construction.

On July 30, 2021, the Political Bureau of the Central Committee of the Communist Party of China held a meeting, which required that carbon peak and carbon neutrality be promoted in a coordinated manner. The meeting clearly expressed that we should avoid impulsive carbon reduction, establish the new before abolishing the old, and resolutely curb the blind development of high pollution and emission projects.

On September 21, 2021, President Xi Jinping attended the general debate of the 76th United Nations General Assembly by video, announcing that China will no longer build new overseas coal-fired power plants.

On October 12, 2021, President Xi Jinping issued the initiative to "start a new journey of high-quality development" at CBD COP15 Leaders' Summit, and announced that China will gradually build "1+N" policy system for the dual carbon goals.

On September 22, 2021, the Central Committee of the Communist Party of China and the State Council issued the *Opinions on Completely Accurately and Comprehensively Implementing the New Development Concept and Promoting Carbon Peak and Carbon Neutrality*[1]. Subsequently, the Action Plan for Carbon Peak Before 2030 was released, and "1+N" policies were introduced one after another, which marked a new era in facilitating the work of carbon peak and carbon neutrality. On the eve of UNFCCCCOP26, China's Achievements, New Goals and New Measures for Nationally Determined Contributions was issued.

On December 8 to 10 in 2021, President Xi delivered an important speech entitled Accurately Understand China's Major Development Theoretical and Practical Issues[2], stressing that we should understand carbon peak and carbon neutrality in a correct way. Many problems still exist. Some places rush to realize carbon goals, some are ap, some take the "one size fits all" approach, some start with carbon reduction campaign, and even switching off to restrict the use of power. All these measures are not in line with the spirit of the Party Central Committee. We should conduct scientific assessment, improve the dual control system of total energy consumption and energy intensity, create conditions to realize the transformation from "dual control" of energy consumption to "dual control" of total carbon emissions and intensity as soon as possible, and accelerate the formation of an incentive and restraint mechanism for reducing pollution and carbon.

2. Understanding the major historical opportunities and challenges of carbon neutrality

To understand correctly and prevent the risks of carbon neutrality, we must first recognize the major opportunities and challenges of carbon neutrality from a historical perspective. The “dual carbon goals” is a major strategic decision made by the central government after careful consideration, and it is the need for the great rejuvenation and sustainable development of the Chinese nation. The goal of dual carbon is a self-revolution of production and lifestyle, which is essentially a profound change in the development paradigm since the industrial revolution. It is not only an unprecedented challenge, but also a major strategic opportunity for China's development. When discussing the risks of green transition, we cannot simply discuss risks in terms of risks, but we must jump outside the traditional industrial way of thinking and narrow time and space constraints, and understand the strategic implications and significance of carbon neutrality in a historical context. Only in this way can we identify: (1) where are the opportunities or benefits from transformation and how big are they, and (2) where and how many risks are there. On this basis, policies can be applied to reduce risks and improve returns, and make objective risk-benefit analysis.

Carbon neutrality is not a multiple-choice question of "whether to do it", but an applied question of "how to do it." When discussing the opportunities and risks of carbon neutrality, it needs to be clear that carbon neutrality is not because the opportunities of carbon neutrality outweigh the risks, but because the current development model is unsustainable, and carbon neutrality is a goal with no alternative. The question we face is how to seize opportunities and reduce risks in the process of achieving carbon neutrality, in order to achieve carbon neutrality more effectively.

2.1 Global carbon neutrality consensus and actions marks a new era for green development

The global consensus and action on carbon neutrality is a revolutionary change in the development paradigm since the industrial revolution. First, more than 130 countries have committed to carbon neutrality. These countries account for about 90% of the world's carbon emissions and total economic output, and about 85% of the population (https://eciu.net/netzerotracker). Second, about 70 percent of these countries belong to developing countries. According to the development pathways of the developed countries, carbon emissions must first reach a peak and then decline, showing an “inverted U-shaped” curve as a whole. Now so many developing countries have committed to carbon neutrality and achieved economic take-off through a low-carbon model, which is a subversive change to the traditional development model and development theory, and an epoch-making change[3].

The development paradigm shift in the context of carbon neutrality is different from that discussed in the past. In the past, more emphasis was placed on efficiency improvement, industrial upgrading, and the "smile curve". It is true that a country can upgrade to the top of the industrial chain and reduce its carbon emissions on the production side by transferring high-emitting industries to other developing countries or regions. However, the carbon emissions on the consumption side affected by the large number of imported high-carbon products will not decrease. For global emission reduction and addressing climate change, this kind of industrial upgrading of a single country is of little substantial significance. Green transformation from the perspective of ecological civilization refers to a comprehensive transformation from development content to development method.

2.2 Starting a new journey of building socialist modernization in an all-round way coincides with the process of global carbon neutrality

In 2020, China has entered its second centenary period, starting a new journey of building socialist modernization in an all-round way. The second centenary goal is not a simple extension of the first centenary goal, nor is it simply catching up with the modernization of developed countries, but a redefinition of the concept of modernization established since the iindustrial revolution.

The concept of modernization that is widely accepted in the world is formed after the industrial revolution, and is mainly based on the modernization of a few developed industrialized countries as the standard. Although this kind of modernization based on traditional industrial civilization has greatly promoted the process of human civilization, and China is also one of the biggest beneficiaries of this modernization concept, this kind of modernization based on traditional industrialization mode has its inherent limitations. First, it will inevitably lead to an unsustainable ecological environment; second, it will lead to a departure from the purpose and means of development, and it will be difficult to ultimately achieve the fundamental purpose of development, which is to comprehensively improve human well-being; third, it is impossible to achieve the modernization of the common prosperity of all populations on the earth, not to mention the establishment of a community with a shared future for mankind. Therefore, it is far from enough to just think about how to realize modernization, and it is necessary to deeply reflect and redefine modernization, so as to establish a new discourse of modernization oriented towards the future and universal to the world.

People have also been trying to solve the problems caused by the existing modernization model. However, these ideas are more about seeking solutions to problems under the traditional thinking of green industrial civilization, failing to fundamentally reveal that the essence of these crises lies in the modernization paradigm, so it is impossible to truly overcome these crises. An

important feature of Chinese-style modernization is the harmonious coexistence between man and nature. This is a redefinition of the concept of modernization, jumping out of the narrow economic vision and traditional industrial civilization values, starting from the broader vision of human and nature and ecological civilization values, and establishing a new discourse on China's modernization that is future-oriented and globally applicable.

2.3 Global pandemic facilitates green transition

Global carbon neutrality is a correction to the traditional development model established after the industrial revolution, and to a certain extent, the global COVID-19 outbreak is also a correction to the traditional development model and a big test for green development. The development model formed after the industrial revolution is unsustainable, and the fundamental reason is that this model leads to the destruction of the relationship between man and nature, which is the cause of the COVID-19 crisis. The crisis due to man and nature imbalance may be manifested in the form of global warming, extreme weather, or the spread of virus from nature to human beings.

The correction of the shortcomings of the traditional industrialization model by COVID-19 is manifested in two aspects: one is the change in the concept and content of development. The epidemic has largely reshaped the concept of "good life" shaped by commercial forces in the traditional industrial era. The second is the change in the way of development. Due to the isolation of the epidemic, many economic activities and transactions are conducted online. The epidemic not only shows the direction of green development, but also a big test forthe feasibility of green development. When we reflect on the epidemic, we must fundamentally reflect on the shortcomings of the traditional development model formed after the industrial revolution, and find key solutions from ecological civilization.

Therefore, carbon neutrality is not just a simple issue of energy conservation, emission reduction and technological innovation, but the most comprehensive and profound paradigm shift in development since the industrial revolution. Only by understanding carbon neutrality from such historical background can we clearly recognize the historical trend represented by carbon neutrality, and maintain strategic focus and calmly deal with various transitional risks.

3. Overall Judgment on the Risk of Carbon Neutrality

Different development concepts determine different understandings of risks and solutions. From the perspective of the new development concept, some of the risk perceptions under the traditional development concept in the past may be overestimated, orunderestimated, and some are even neglected. When dealing with risks, the solutions with the old and new development concepts are also different. In general, the old development concept is to deal with risks based

on the recognition that environment conflicts with development, and the solution is to seek more compromise. While the new development concept is to seek solutions based on the mutually reinforcing relationship between the environment and development.

3.1 Research on the transitional risks and problems

Currently, there are two basic views on the perception of carbon neutrality risks. One is pessimistic, arguing that China's modernization and industrialization have not yet been completed, and it will only take 30 years from carbon peak in 2030 to carbon neutrality in 2060. Compared with about 70 years spent by many developed countries, the challenges and risks are particularly great. The other is optimistic, arguing that carbon neutrality will bring more than 200 trillion yuan of investment, which will stimulate China's economic growth. Both views are reasonable, but there are a certain bias in the understanding of carbon neutrality. In general, the current research on carbon neutrality risks has the following characteristics.

First, in terms of risk perception, because the traditional development concept is based on the perception of a conflicting relationship between the environment and development, the benefits of transformation are often underestimated and the risks are overestimated. In particular, when economic growth faced difficulties, it began to shake the determination of dual carbon goals, focusing on how to balance the relationship between "dual carbon" and growth. The premise of this discussion is the assumption that "dual carbon" hinders economic growth. Take climate change for example, in standard climate change analysis, the benefits of emission reductions are defined as the losses from climate change[4]. The cost is the investment in emission reduction. In fact, the benefits of emission reductions are not just avoided climate change losses, but more likely to enable the economy to jump to a more competitive structure, thus far greater than "climate change avoided losses". According to the Sixth Assessment Report (AR6) of the United Nations Intergovernmental Panel on Climate Change (IPCC, 2021), even if all countries can achieve the emission reduction targets they have committed to, the global temperature rise will reach 2.4°C by 2100, and there is still a big gap between the global emission reduction targets of the Paris Agreement.

Second, when dealing with risks, our way of thinking are more concerned with the traditional thinking framework which views the relationship of theenvironment and development as a conflict, and we often fail to see new opportunities for green transformation. We spent a lot of time discussing how to afford the cost of emission reduction[4]. And we go further to discuss how to reduce the impact on specific industries, regions and groups. The way of thinking is more about how to protect vulnerable groups in the process of change, not about compensation for damaged sectors under the framework of the overall Kaldor-Hicks improvement.

Third, there is a tendency to overestimate the risks faced by some specific sectors. Since the premise of achieving the dual carbon goals is to eliminate fossil energy, when discussing the risks of carbon neutrality, people pay more attention to the impact of unemployment, loss, and

deterioration of asset conditions caused by the withdrawal of fossil energy, and tend to exaggerate the impact of transformation on the fossil energy industry. According to relevant planning of China, renewable energy will reach 25% in 2030 and 80% in 2060. After the "dual carbon" goal was proposed, people's expectation for fossil energy has changed, and they seemed to regard fossil energy as non-performing asset overnight. However, the replacement of fossil energy by new energy does not mean that the fossil energy industry has become a non-performing asset since then. On the contrary, in the process of removing fossil energy, the fossil energy industry may still be profitable during its existence.

Fourth, the depth and breadth of the impact of carbon neutrality on industries is generally underestimated. Carbon neutrality and carbon peak are two different concepts. Carbon peak can also be achieved under the traditional development model, but carbon neutrality is a paradigm shift in development. It is a process of creative destruction, which means that many industries will be overturned. For example, when the automobile industry shifts from traditional fuel vehicles to electric vehicles, it does not simply replace internal combustion engines with electric motors, nor does it simply replace drivers with autonomous driving, but redefines the concept of automobiles and reshapes the industrial chain. Just as the function of mobile phones has been greatly expanded from the original single call function to smart phones, and the corresponding industrial ecological chain has undergone tremendous changes, many industries represented by the automobile industry and their industrial ecosystems will also undergo subversive changes. If this is not fully understood and estimated, it will be caught off guard against unexpected risks.

Fifth, in terms of risk, the focus of attention at the global and national level differs. At the global level, the mainstream analysis of climate change in the economics community is more about the uncertainty risk caused by non-transition[5], that is, the risk of acceleration of climate change caused by greenhouse gas emission reaching a tipping point (Tipping point). At the local or national level, the focus is more on the impact of transformation on specific industries, regions and groups.

3.2 Overall judgement on the green transition risks

The Working Guidance pointed out that in the work of carbon peak and carbon neutrality, risk prevention requires us to strike a balance between pollution prevention and carbon reduction and energy security, industrial chain security, food security, and t people’s daily life, and effectively respond to the economic, financial and social risks accompanied by green and low-carbon transformation, so as to prevent overreaction, and ensure safe decarbonization. We will make an overall judgment on the risks of green transition from the following aspects.

3.2.1 Relationship between pollution prevention and carbon reduction, and energy security

In the age of fossil energy, in addition to the unsustainable risks brought about by carbon emissions from fossil energy, oil and natural gas are highly dependent on imports, which also implies major security risks. At present, China's fossil energy accounts for about 85% , and the energy structure is featured by rich coal, a shortage of oil and natural gas, which makes China's external dependence on oil and natural gas as high as 70% and 40% respectively. From this perspective, energy transition can not only achieve sustainable development in China, but also reduce energy security risks. Potential risks of transition from fossil fuel to renewables are as follows.

The first is the risk of supply instability brought about by the characteristics of new energy. Risk reduction depends not only on technological progress (energy storage technology, grid technology, etc.), but also on new business models (for example, decentralized energy storage systems), electricity price reform to guide the distribution of energy consumption time points, the combination of new energy and thermal power, and so on. At present, how to maintain the stability of the grid with renewable energy as the main body is still a big technical challenge.

The second is the risk of relying on key metal minerals in the new energy era. The transition from carbon-intensive fossil energy sources to a metal-intensive energy system will witness a surge in demand for key metal minerals, leading to supply chain risks and geopolitical risks.

The third is the risk brought by the speed of energy transition. Energy transformation is not simply to fill the gap between total energy demand and new energy supply, but the transformation of a huge industrial system based on traditional fossil energy. A slow transformation will certainly lead to risks, so does the fast transformation which issimilar to shock therapy.

The fourth is the risks caused by the energy price mechanism. The large-scale switch off to limit the use of power in 2020 are related to the lack of a flexible electricity price mechanism and a flexible mechanism to achieve the "dual control" goal as well. It is not directly related to the dual carbon itself.

The fifth is the growth pathway of China's total energy demand in the future also determines the magnitude of energy risks. China's energy risks are magnified if energy demand expands unrestrictedly in accordance with the Western way of life. We should always adhere to the principles of saving priority and "dual control" of energy, and cannot simply follow the growth path of total energy demand in developed countries. Even if new energy is extremely cheap in the future, we should always save energy. For example, China's household electricity consumption and the growth curve of per capita car ownership can no longer follow the traditional pathway of developed countries in Europe and the United States.

Existing energy demand forecast and transition pathway design are more based on the past development experience and the relationship between economic growth and energy demand in developed countries[6]. However, when the traditional industrialization model has to be transformed because it is unsustainable, both the content and method of production will change, and the corresponding energy demand must also be actively adjusted. Under the direction of green development in the future, China's economic structure, consumption structure, urbanization mode, transportation mode will be quite different from those of developed countries. For example, the number of cars per thousand people in China is less than 200, compared with more than 800 in the United States; the per capita electricity consumption of the household sector in the United States is about 6 times that of China. Obviously, if the American way of life is replicated globally, global development cannot be sustainable. China cannot replicate America's high dependence on private car consumption patterns and lifestyles. In this way, the future demand for energy will undergo profound changes.

3.2.2 Relationship between carbon neutrality and green industrial chain security

Since China has global competitiveness in terms of renewable energy and new energy vehicles, global carbon neutrality provides a historical opportunity for Chinese industries to outpace others, but it also brings new global supply chain risks. In terms of new energy, China's photovoltaic industry supplies more than 60% of silicon materials, more than 90% of silicon wafers, about 89% of cells, and more than 70% of modules for the global market. At the same time, China is also the world's largest fan manufacturer, accounting for half of the world's output. China accounts for 10 among the market share ranking of the top 15 wind turbine manufacturers in the world. In 2021, China's investment in renewable energy will account for 35% of the world's total, accounting for about half of the total investment in the world's top ten investment countries. In terms of new energy vehicles, China also has great advantages. In 2020 and 2021, China's new energy vehicles will account for 41% and 53% of global sales, respectively. Among the world's top 20 new energy vehicle manufacturers, 12 are from China, 3 are from Germany and 2 are from the United States. In 2021, China's new energy vehicle exports will reach 310,000 units, a year-on-year increase of 304.6%.

First is the risk of international supply chains brought about by competition among major powers. In the past, the risks arising from the global industrial division of labor were controlled by the stable market contract mechanism and the multilateral trade cooperation mechanism (WTO). In recent years, non-market behaviors include trade wars initiated by individual major countries in the name of fair trade, breaking up supply chain in the name of security, and sanctions in the name of human rights issues. These two mechanisms are no longer as effective as in the past. At the same time, the global outbreak of the COVID-19 has a major impact on the

supply chain. Under such new conditions, how to establish an effective risk prevention mechanism has become a new challenge.

The second is the supply chain risk brought about by the comprehensive transformation of the energy system. As fossil energy shifts to a new energy system that is dense with key metal minerals, the demand for key minerals will soar, and the corresponding supply chain risks will also increase significantly. According to the forecast of the International Energy Agency, the demand for metal resources of photovoltaic power generation is 5 times that of gas power generation; the demand for metal resources of offshore wind power is 13 times that of gas power generation. The demand for metal minerals in electric fleets is 6 times that of gasoline vehicles. In the next 20 years, the total demand for metal minerals will increase sixfold. Among them, the demand for lithium has increased by 42 times, the demand of graphite has increased by 25 times, the demand of cobalt has increased by 21 times, the demand of nickel has increased by 19 times, and the demand of rare earth has increased by 7 times [7].

At present, the risks China faces in key metal minerals are generally controllable, but the risks continue to increase. Since China has begun to emphasize the full use of both domestic and international markets and the "going global" strategy earlier, it has already made a good layout in the world's key minerals. At present, China is relatively active in the supply of key minerals, and the supply is generally stable. However, due to global carbon neutrality and technological progress much faster than expected, global demand for key minerals will increase significantly, with corresponding supply risks and uncertainties. In particular, with the rapid expansion of China's new energy and electric vehicles in the global market, many key minerals that currently do not need to rely on imports will become key minerals that are highly dependent on imports and compete with each other.

China's demand for key minerals is not only to meet domestic product demand, but also to meet global demand. At present, China is the world's largest renewable energy market and equipment manufacturer. The photovoltaic industry supplies about 60% of polysilicon, 90% of silicon wafers, 75% of cells, and 70% of modules for the global market. At the same time, China is also the world's largest manufacturer of wind turbines, with more than half of the world's output, and the world's largest producer of smart electric vehicles. China is transforming and upgrading from a world factory in the traditional sense to a global green and intelligent manufacturing factory. Due to China's huge domestic market support and green development strategy, the expansion of the green industry system has unique advantages. It is expected that many products of China's green manufacturing will dominate the world in the future.

The superposition of domestic and foreign demand will bring about rapid growth in China's demand for key minerals, and some minerals will change from self-sufficiency to import dependence. Taking chromium as an example, after 2000, with the rapid expansion of China's global market share of stainless steel, China's demand for chromium has risen sharply. Many

key mineral needs related to high technology such as new energy and electric vehicles in China should follow this path to expand rapidly. Therefore, China must take precautionary measures to prepare for import dependence in the event of a substantial increase in demand for key minerals[8].

3.2.3 Dual carbon goals and food security call for new thinking

The so-called food security is the guarantee of food supply to meet food demand. However, there are two different criteria for food needs, one for commercial needs and the other for healthy nutritional needs. For a long time, food security has been defined more in terms of commercial needs, especially after basic food and clothing issues have been resolved. The growth path of food demand in developed countries in the past has become the main basis for estimating domestic food demand. However, because the dietary structure and agricultural structure of developed countries are more driven by commercial forces, this standard of total grain demand and structural demand based on commercial forces has brought a lot of health and environmental problems. The food supply and demand have been in a state of imbalance at any time for a long time. The current food security risks are largely embedded in this concept of food demand.

This logic of defining the concept of food security based on business needs is in line with the traditional industrialization logic behind it. The process of agricultural modernization is a process of being logically transformed by industrialization. If we examine from the two dimensions of production content (what) and production method (how), in the process of agricultural modernization, the production content of agriculture has changed from the past mainly plant-based output to animal-based output. The way is changed from the past ecological agriculture to industrialized agriculture, oil agriculture and single agriculture. The traditional industrialization model is unsustainable, and the agricultural development model formed under the logic of industrialization is also unsustainable.

According to the WHO's health nutrition requirements, the global food supply actually far exceeds the current food demand. However, the demand for food driven by commercial forces not only makes the demand for food continue to expand, but also promotes the transformation of the agricultural structure to the structure of animal products. In this process, the agricultural structure and the dietary structure promote each other, constantly deviate from the structure of healthy nutritional needs, and finally form a vicious circle of "diet structure-health-agricultural structure-environment". That is, a "modern" diet based on animal products brings a lot of health risks (the so-called "diseases of wealth) and medical expenses, and this modern diet corresponds to the supply structure of animal agriculture. Since the resource and environmental cost of animal products is far greater than that of plant products, this specific dietary structure and agricultural structure correspond to serious problems such as ecological environment resources

and climate change. For example, 77% of the world's agricultural land is used directly or indirectly for the production of animal products and about half of the food is used to feed animals (https://ourworldindata.org/land-use).

The root cause of these problems lies in the traditional industrialization logic and commercial forces. Modern agriculture is essentially high-carbon petroleum agriculture, and agriculture has become one of the major sources of environmental destruction. In terms of climate change, agricultural greenhouse gas emissions have not only become a driver (carbon source) of climate change, but agriculture itself has also become a victim of climate change. According to the IPCC Sixth Assessment Report[9], agriculture, forestry and other land use emissions accounted for 23%. Since modern agriculture is based on the logic of industrialization, its input, production, processing, sales and other links are highly dependent on the global division of labor and trade, so local agriculture is directly linked to global market risks.

If you compare the food production and health status of China, the United States and India, you can easily understand the vicious circle of "diet structure-health-agricultural structure-environment" (https://ourworldindata.org/agricultural-production). China and India have similar populations, and food production of India is less than half of that of China (food production of India is 308 million tons in 2020 and food production of China is 680 million tons in 2021, see the Figure 1.), however India is a major exporter of food, with rice exports accounting for 1/4 of global level. Since 2004, China has changed from a net exporter of agricultural products to a net importer. According to data from the General Administration of Customs, China will import 165 million tons of grain in 2021, accounting for 24.1% of China's total grain output. The external dependence of food is 19.4%. Among them, soybean imports were 96.518 million tons, and the import dependence was 85.5%. At the same time, although the incidence of cancer in China is significantly lower than that in the United States, it is higher than that in India and notably on a rapid upward trend (See Figure 2.). The incidence of cancer in each age group in China is on average several times higher than that in India (see the Figure 3.). The reason behind this is the vicious circle of "diet structure-health-agricultural structure-environment". The situation in the United States is even worse.

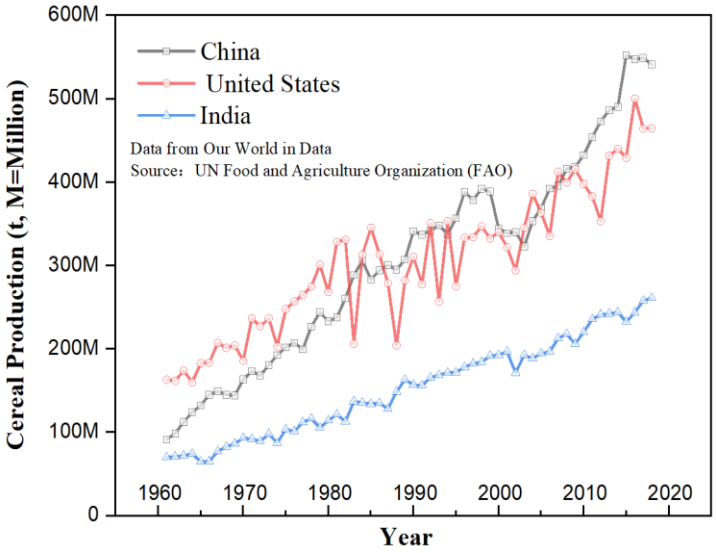

Figure 1. Creal Production Comparison of China, United States and India

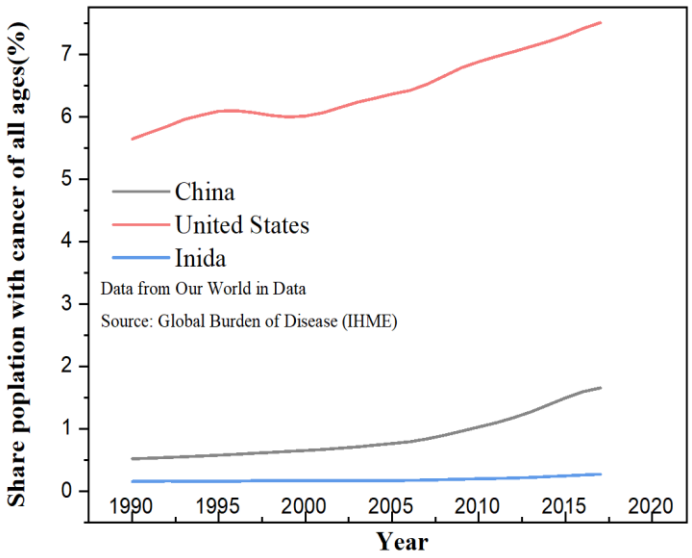

Figure 2. Cancer Percentage Comparison of China, United States and India

(Share of population with any form of cancer in Figure 2 and Figure 3 is measured as the age-standardized percentage. This share has been age-standardized assuming a constant age structure to compare prevalence between countries and throuh time.)

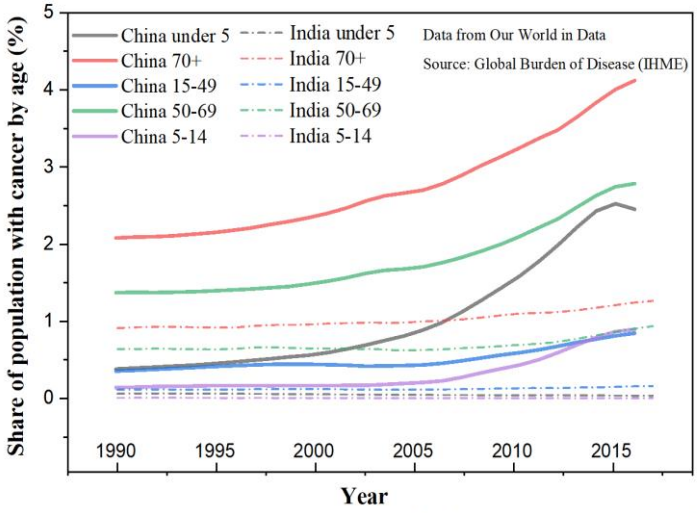

Figure 3.Share Comparison of Population with Cancer by Age, China and Inida

Therefore, to solve the problem of food security, it is necessary to redefine the concept of food security, rethink basic issues such as agriculture, diet, health, and the environment, and turn the vicious circle of "diet structure-health-agricultural structure-environment" into a virtuous circle. Under this virtuous circle, the demand for food returns to the normal demand for health, people's health status is significantly improved, and environmental problems are mitigated. At the same time, the mode of agricultural development shifts from petroleum agriculture to ecological agriculture, and modern agriculture is expected to transform from a carbon source to a carbon sink.

3.2.4 Relationship between the dual carbon goals and people's daily life

The fundamental purpose of dual carbon is to bring development back to the original aspiration that is, to improve people's well-being. "Dual carbon" requires a profound transformation of production methods and lifestyles. In the process of this transformation, people's daily life should be continuously improved. However, the transformation process of this development paradigm may have different effects on the production and life of specific groups of people at specific stages.

First, the direct content of the dual carbon goals is the transformation of the energy system. With the substantial reduction in the cost of new energy, the total energy cost will continue to decrease in the long run, thereby improving people's quality of life.

Second, since carbon neutrality is a process of reducing the proportion of fossil energy, it will impact some areas, industries and groups which are intensive in fossil energy. However, the reduction in the proportion of fossil energy does not necessarily mean that fossil energy has become a sunset industry or a non-performing asset. In the process of removing fossil energy, due to the controllable total energy supply, under the target of "2030 and 2060" roadmap, fossil

energy companies can still gain reasonable profit, thereby promoting the development of new energy. This means that the impact of carbon neutrality on some specific groups of people can be hedged through effective policy and mechanism design.

Third, about the argument that "dual carbon" affects people's daily life. Some people attribute the power cut in some areas in 2021 to "dual carbon", but in fact, it is mainly due to unreasonable coal power prices, resolving excessive coal capacity, export-driven, and high pollution and high emission projects launched locally, weather, and a lack of flexible implementation mechanism for the “dual control” goal. It has no direct link with the “dual carbon” work.

Fourth, in the process of implementing the "dual carbon" work in some places, they adopted a simple and rude "one size fits all" approach, such as closing factories at will, which affected the lives of some people. These are caused by the failure to fully and faithfully understand and implement the new development concept, and it is exactly what the central government wants to correct in the Working Guidance.

4. Carbon neutrality and key risk prevention

4.1 The biggest strategic risk is the misunderstanding of carbon neutrality

Global carbon neutrality is the result of scientific consensus. It is not a multiple-choice question of "do it or not", but an applied question of "how to do it", which is also a major strategic opportunity for China. The key to recognizing and seizing this opportunity is to fully and faithfully understand and implement the new development concept. The essence of the new development concept is to establish the understanding and mechanism of mutually reinforcing environment and development; the traditional development concept regards environment and development as a conflict, which is a development model of pollution first and treatment later. Without a deep understanding of the essence of carbon neutrality, it will be seen as a burden of development, or be reduced to a technical or energy issue, or even simply pursue carbon reduction for the purpose of carbon reduction., which will bring strategic risk.

4.2 The risk of absence of carbon neutrality in the overall planning of ecological civilization

Carbon reduction has double dimension, and it can be positive and negative to ecological environment protection and resource conservation. For example, reducing fossil energy can improve air quality and is good for health, but new energy will greatly increase the demand for key metal minerals, the entire life cycle of which, such as mining, smelting, processing, manufacturing, transportation, installation, maintenance, and end-of-life treatment, will cause a lot of pollution. If carbon reduction is for carbon reduction itself, without considering other

dimensions of risk, a single act of reduction may exacerbate ecosystem damage. Therefore, "dual carbon" should be incorporated into the overall layout of ecological civilization construction to achieve co-benefits of carbon reduction and ecological protection[10].

4.3 The impact of carbon neutrality on the key coal areas

Specifically, it includes the impact on the economy, employment, and finance. The development model of these coal-rich regions has two typical characteristics. First, in the past, it has always relied on the traditional path of industrialization to do coal mining and set up factories". Second, it not only relies heavily on resource endowment advantages, but also the economy lies in a high-carbon, low-value-added link in the industrial chain of the traditional industrialization model. Not only facing the problem of energy transformation, coal-rich regions require systematic transformation for the entire industrial base (including manufacturing, service), financial base, employment structure, etc. all of which are based on energy endowment. Take Inner Mongolia (IM) as an example, more than 80% of its industries are energy and raw materials, and the six high-energy-consuming industries account for about 90% of industries of IM. The energy consumption and the carbon emissions per unit of GDP is three times and four times the national average, respectively. At the same time, its scenery and other new energy resources and ecological culture and other resources are also very rich, but these have not been fully developed so far[11].

4.4 The impact of carbon neutrality on the key industries

Manufacturing has been the most important engine of China's rapid growth over the past 40 years and a major cause of China's environmental problems. The total industrial carbon emissions still account for more than 70% of the total carbon emissions of the whole society (about 40% of which are industrial electricity emissions), and the energy consumption accounts for more than 60% of the total energy consumption of the whole society. China acts like the world's factory, and about 20-30% of its carbon emissions are contained in exported products. Fossil energy industry should achieve carbon neutral first. The most prominent industries are electricity, steel, building materials, non-ferrous metals, petroleum and chemical industries with high energy consumption, whose carbon emissions account for about 80% of industrial carbon dioxide emissions. Considering that electricity accounts for about 40 percent of industrial carbon emissions, and that the output of these industries has reached or is close to peak, achieving industrial carbon peak by 2030 is not a difficult problem, but the biggest challenge is to achieve carbon neutrality goals. Carbon neutrality is a process of creative destruction, meaning a comprehensive reshape of economy. Many industries are facing the problem of transformation or even elimination. This in turn will bring about a large number of transitional justice issues, including re-employment, local taxation and other issues.

4.5 The impact of carbon neutrality on asset repricing

As the dual carbon goals has profoundly changed market expectations, under new constraints and development concepts, concepts such as cost, benefit, and optimal behavior have undergone profound changes, triggering the market to re-price assets in specific industries, especially fossil energy and its related industries. This will bring about major changes in the capital market, stock market, enterprises, households and the country's balance sheet, which will have a systematic impact on the economy[12]. This process, in particular, requires careful handling and risk management. However, we need to distinguish two different concepts, the sunset industry and the non-performing asset industry. It is true that carbon neutrality means the process of removing fossil energy, but this does not mean that the fossil energy industry will become a non-performing asset industry. Under the target of "2030 and 2060" roadmap, the proportion of fossil energy will continue to decline, but the fossil energy in the market (and overall energy prices) may remain relatively high. This can not only speed up the development of new energy, but also reduce the state's burden of supporting the transformation of the fossil energy industry.

4.6 The risks of green structural reform

A green transition is a jump from one structure to another, for example, jumping from traditional cars to electric cars, from traditional taxi mode to network platform sharing car rental mode, from chemical agriculture to Internet ecological agriculture. Although the returns will be higher under the new structure, since this jumping process may fail, if there is no corresponding risk aversion mechanism, the transformation will be difficult, and the economy will be locked in the traditional economic structure. Therefore, a "green insurance" mechanism needs to be established to facilitate this "0→1" structural jump. This mechanism can be similar to agricultural insurance, government subsidy, and new capital venture capital mechanism.

4.7 The risks of climate adaptation

Addressing climate change includes mitigation and adaptation. Agricultural scientists usually simulate the impact of climate change on agricultural yields based on crop models, while economists introduce the concept of a "smart farmer", revealing that farmers change their cropping patterns to adapt to climate change[13]. However, due to the complex price feedback mechanism in the market, changing the planting pattern will not necessarily increase income, and without doing so will not necessarily reduce income. Therefore, in many cases, decentralized market mechanisms are the most effective way for climate risk aversion.

5. Challenges and Risks of Green Transformation in Key Coal Regions

The dual carbon goals is a major historical opportunity for China's development, but it will also have a certain impact on some regions, industries, and groups. Inner Mongolia and Shanxi are major energy provinces in China, with coal output exceeding 1 billion tons, accounting for 30.71% and 35.27% of the national coal output respectively. For a long time, the two places have formed an economic structure, employment structure, fiscal and taxation income based on coal resource endowment. But at the same time, these two regions are rich in new energy resources, ecological and cultural resources, and have unique green development advantages. According to the 2021 Corporate Social Responsibility Report of the Coal Industry by China Coal Association, there will be nearly 2.85 million employees in the coal industry in 2020, including 2.1 million employees in large coal enterprises, accounting for 74%. Taking these two typical regions as examples, we conduct an overall study and judgment on the challenges faced by green transformation, and briefly reveal the main risks they face in terms of "establishment" and "breakdown".

5.1 Introduction

Inner Mongolia

Due to the advantages of coal resource endowment, Inner Mongolia has taken an unsustainable traditional resource-based development path to a large extent in the past, which has brought a lot of ecological and environmental problems while bringing economic development. Inner Mongolia emits 7.2% of the country's carbon dioxide to produce 1.7% of the country's total economic output. Energy consumption accounts for 5.2%, which is three times the national average. The per capita carbon emission level is nearly four times the national average. At present, the energy and raw material industries in Inner Mongolia still account for 82% of the increase in industries above designated size, and traditional high-energy-consuming industries such as electric power, chemicals, steel, nonferrous metals, petrochemicals, and building materials still account for 89% of industries above designated size. Inner Mongolia's external coal transportation volume is maintained at 550 million to 600 million tons, accounting for 1/3 of the country's inter-provincial coal transfer volume. Inner Mongolia's coal transportation to the whole country and the installed capacity of coal-fired power are the first in the country. The power transmission channel has always ranked first in the country, accounting for nearly 20%. At present, the overall pattern of Inner Mongolia's economic development over-reliance on energy-intensive industries has not been fundamentally reversed. In 2020,

investment in high-energy-consuming industries in the region will still account for more than 64% of manufacturing investment[11].

At the same time, the green resources of Inner Mongolia are also very prominent. Its wind energy, photovoltaic resources and ecological resources are quite rich. As an ecological security barrier in northern China, Inner Mongolia has a unique advantage in taking the transformation path of ecological first and green development. Inner Mongolia has 1.3 billion mu of grassland, 350 million mu of forest, more than 60 million mu of water surface and wetland. The area of grassland and forest ranks first in the country. It has the largest and most complete ecosystem in the north, is the source of many river systems, and the place where the northern continental monsoon pass through. It is an important ecological security barrier for this core area. In addition, Inner Mongolia is also rich in cultural resources.

Shanxi

Shanxi Province has coal reserves of 50.725 billion tons, accounting for 1/3 of the national total, making it the largest coal province in China. Accordingly, its economy is also based on coal. High energy-consuming industries account for about 70% of Shanxi's total energy consumption, and most of the energy products are transported outside the province. In 2021, Shanxi's external coal transfer will account for about 60% of the province's output, the power transfer will account for more than 30% of the province's power generation, and the external transfer of coke will account for 80% of the province's output. Regarding the status quo of Shanxi's coal-based industrial structure, it is especially necessary to "establish first and then break down" and seek progress while maintaining stability. The pressure of coal removal on the transformation of traditional industries must be properly handled to avoid affecting the national industrial chain and supply chain, and affecting the stable development of Shanxi's economy. Local fiscal revenue in coal-related fields accounts for more than 30%, and the stability of fiscal revenue must be fully considered. At the same time, Shanxi is rich in new energy resources and cultural resources, and has unique advantages in green development.

5.2 The challenge of breaking down

In terms of "breakdown", the common challenges in these places are mainly the impact of coal and coal-based industries, which will have impacts on employment, industry, local finance, social security, ecological environment, and asset re-pricing. However, since coal has not really entered the downward channel at present, the coal industry generally remains profitable at this stage. The difficulty of coal power is mainly due to factors such as the price mechanism, as well as the influence of its own operation.

Coal and coal-based industries (including coal chemical industry and coal power) have high debt ratios due to their high capital intensity and historical debt. Once shut down or limited production, it will bear greater debt risk. At the same time, due to the long service life of coal mines and coal-fired power units, high-input assets will be idle and wasted. However, since coal removal is an orderly and gradual process, rather than an industry-wide shutdown overnight, the actual risk release of the coal removal process is also a gradual process. In the process of coal removal, it is actually possible and necessary for coal prices to remain at a reasonable and relatively high level. As for the high asset-liability ratio of the coal-based industry, it is not directly related to the "dual carbon" goal. The "dual carbon" target only further exposes corporate risk. The coal industry and coal-based industry are major taxpayers in Inner Mongolia and Shanxi, accounting for more than 1/3 of local fiscal revenue. However, this effect is also not released immediately. Therefore, although these key coal provinces face great challenges in the process of achieving dual carbon" goals, as long as the "2030 and 2060" roadmap is steadily advanced, various challenges can be overcome.

5.3 The challenge of establishment

——The echelon of key coal regions in the national "2030 and 2060" roadmap.

——Further coordination is needed between new energy construction and national land and space planning.

——The issue of clean energy output remains to be resolved.

——Green investment has not yet formed a market-oriented approach and investment model, and the corresponding technology and talents are also lacking.

——The compensation mechanism for connotative emissions needs to be improved. Inner Mongolia and Shanxi are both major coal and coal-fired power exporting provinces. Although the production side has high carbon emissions, a large proportion of it is exported energy for the whole country. How to define the emission reduction responsibilities of connotative emission exporting provinces such as Inner Mongolia and Shanxi, and establish a regional cooperation mechanism for carbon peak and carbon neutrality, has become an important issue.

——In terms of green transformation, how to accurately define the functions of the central and local governments, including public investment, fiscal expenditure responsibilities, etc., need to be defined.

6. Future research topics and policy implications

There has been a lot of research on the risks of the "dual carbon" goals. What is most needed now is to jump outside the traditional industrialization thinking, reconsider and evaluate

relevant risks under the new development concept, and put forward new risk prevention ideas and policy recommendations.

6.1 Research on the new discourse system and policy discourse

Some of the current cognitions on carbon neutrality have largely failed to establish a discourse system and policy discourse to promote carbon neutrality. We should recognize the disadvantages of non-transition and the advantages of transformation, and have a better understanding of the severity and urgency of the global climate change crisis. In particular, we should reveal the harm of global climate change to China. It must be recognized that the biggest risk lies in no transition, and transition offers a historical opportunity for China to outpace others. In a complex and severe situation, policymakers should maintain a strategic focus on carbon neutrality.

6.2 Re-evaluate the transitional risks

Many of the transitional risks discussed so far do not actually come from green transition, but rather from the inherent disadvantages of the traditional development model. Transition only exposes what has been temporarily masked. Therefore, the fundamental solution to these risks is to completely change the way of development, rather than not transforming or delaying the transformation. Without transformation, these risks will break out and be even more destructive. In particular, existing so-called transitional risks need to be reassessed. Many of the so-called transitional risks that we are worried about have basically nothing to do with "dual carbon" goals. For example, power cut is not caused by "dual carbon". Attributing these risks to "dual carbon" goals would have a profound negative impact on China. Some risks are overestimated, or underestimated or even neglected.

6.3 Research on the transformation of government functions in the context of carbon neutrality

The current standard definitions of government functions are all defined under a market economy based on an industrialized model. When the traditional industrialization model must undergo green transformation because it is unsustainable, the corresponding market and government functions must also undergo transformation.

6.4 Research on the market mechanism to reduce risks

A well-functioning market mechanism is one of the most effective means to avoid "dual carbon" risks. An effective market mechanism can not only reduce the occurrence of risks, but also diversify risks when they occur, improving economic resilience.

6.5 Research on pressing issues, policy roadmap and mechanism design for green transition

The current "1+N" policy system needs a lot of in-depth and meticulous work in the implementation, including how to further put forward specific policy recommendations, how to make early warning to problems that may arise in the implementation process, and how to summarize experiences and lessons learned in a timely manner. In particular, risks arising from improper administrateon should be avoided, such as "one size fits all" approach for all regions and industries.

6.6 Key research on incorporating dual carbon goals into the overall planning of ecological civilization

On the one hand, since the realization of the "dual carbon" goals is a systematic work, if it is not incorporated into the overall layout of ecological civilization, it will be difficult to achieve[3]. On the other hand, the current simple thinking of reducing carbon for the purpose of carbon itself fails to coordinate carbon reduction with ecological and environmental protection, and even exacerbates unsustainability in some cases.

6.7 Research on the incentives for green technological innovation

Green transformation is a "0→1" process, and new technologies face thrilling jumps both in technology and in the market during the process of Research & Development and promotion. If there is no effective risk sharing mechanism, such as capital market mechanism design, insurance mechanism, social security mechanism, etc., green transformation will not be realized due to high risks.

Reference

[1]The Central Committee of the Communist Party of China, the State Council, 2021: Opinions on Completely, Accurately and Comprehensively Implementing the New Development Concept and Promoting Carbon Peak and Carbon Neutrality. http://www.gov.cn/gongbao/content/2021/content_5649728.htm.

[2]Xi Jinping，2022，Correctly Understanding and Grasping Major Theoretical and Practical Issues in Nationl Development (Part of the speech delivered at the Central Economic Work Conference on December 8, 2021), Seeking Truth, Issue.10.

[3]Zhang Yongsheng, Yu Xiang，2021: Strategy and Realization Path of China's Carbon Neutrality, edited by Xie Fuzhan, Analysis and Forecast of China's Economic Situation (Economic Blue Book), Social Sciences Literature Press.

[4]Nordhaus, W., 2019, “Climate Change: The Ultimate Challenge for Economics”, American Economic Review, Vol. 109, No. 6, June, pp. 1991-2014.

[5]Weitzman, M. L., 2011, “ Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change”, Review of Environmental Economics and Policy, volume 5, issue 2, summer 2011, pp. 275–292 doi:10.1093/reep/rer006.

[6]Lin Boqiang，2022，High-quality Growth of China's Economy in the Process of Carbon Neutrality, Economic Research, Issue 1.

[7]IEA,2021, The Role of Critical Minerals in Clean Energy Transitions, IEA, Paris https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions.

[8]Wang Peng, Wang Qiaochu, Han Ruru, et al. 2021: Review of Global Key Metal-Low-Carbon Energy Association Research and Its Enlightenment [J]. Resource Science, 2021, 43(4): 669-681.

[9] IPCC，2021，“The science of temperature overshoots Impacts, uncertainties and implications for near-term emissions reductions ”，https://www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_Full_Report_High_Res.pdf.

[10]Zhang Yongsheng, Why carbon neutrality must be included in the overall layout of ecological civilization construction: theoretical explanation and its policy implications", "China's Population Resources and Environment", Issue. 9.

[11]Bao Siqin，2021，Discussion on the Strategic Adjustment of Inner Mongolia's Industrial Structure under the Background of Dual Carbon, Inner Mongolia Social Sciences, Vol. 42, Issue.5.

[12]Zhu Min，2021: Carbon neutrality will trigger repricing of assets, https://www.yicai.com/news/101246964.html.

[13]Mendelsohn, R., Nordhaus, W.D., & Shaw, D.(1994). The impact of global warming on agriculture: A ricardian analysis. The American Economic Review, 84(4), 753-771.)

Acknowledgement

The team members are very grateful to the China Council for International Cooperation on Environment and Development (CCICED) for setting up and supporting the policy research project "risk prevention of carbon neutrality under the new development concept", which provides a platform for experts in the research group to fully discuss and communicate. Special thanks to Mr. Liu Shijin, the Chinese Chief Advisor of CCICED, Mr. Scott Vaughan, the Chief Foreign Advisor, Ms. Zhou Guomei, Director of the International Cooperation Department of the Ministry of Ecology and Environment, and Li Yonghong, Deputy Director of the Foreign Cooperation and Exchange Center of the Ministry of Ecology and Environment and Assistant Secretary General of CCICED, for the consultation and suggestions provided during the implementation of the project. Thanks to Mr. Zhang Huiyong, Director of CCICED Secretariat, Ms. Liu Kan, Deputy Director of CCICED Secretariat and Ms. Zhao Haishan, as well as the CCICED Secretariat and the International Support Office for their support to organization and coordination for this project and so on.