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Constructing a Chinese-Style Zero-Carbon Financial System: Theoretical Considerations and Policy Recommendations*

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Abstract

The Chinese government's "dual carbon" commitment to carbon peaking and carbon neutrality in September 2020 indicates that China will promote green economy transition and achieve high-quality growth in line with the New Development Concept. Definitely, both China's economic and financial development will undergo a paradigm shift. This paper reviews the evolution of global finance's role in supporting environmental governance, climate change and sustainable development, and proposes that the time has come to develop zero-carbon finance which should be closely aligned with the "net-zero emissions" requirement for achieving the global temperature target of the Paris Agreement. While the current policy frameworks for zero-carbon finance in major Western countries are useful references, they also have limitations. In order to build a Chinese-style zero-carbon financial system, China should integrate the experience of other countries and leverage both institutional advantages and green finance practices of own to the fullest extent possible. This paper goes into further detail about the concept of building a zero-carbon financial macro-management framework and a composite ecology of the zero-carbon financial market, and puts forward policy recommendations. The Chinese-style zero-carbon finance solution will also contribute to global carbon neutrality by enabling China to achieve carbon neutrality as soon as possible and providing countries with China's solution as reference.

Keywords: carbon peaking and carbon neutrality, paradigm shift, zero-carbon finance, financial support, policy framework

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I. Introduction

On September 22, 2020, Chinese President Xi Jinping announced at the 75th United Nations General Assembly that China would strive to peak carbon emissions before 2030 and achieve carbon neutrality before 2060.[1] China's "dual carbon" commitment reflects both its obligation as a major international player to address climate change and its strategic decision to support green transition and construct a fully modern socialist country. Achieving carbon peaking and neutrality is the practical goal of China's low-carbon sustainable transformation. It is the specific implementation and most important force for promoting high-quality development under China's New Development Concept. It is a broad and profound economic and social systemic change. The carbon neutrality goal signifies the formation of unprecedented global consensus and actions, and also implies a profound paradigm shift in the development of China and the world.[2]

The paradigm shift in China's economic development required by "dual carbon" goals undoubtedly supports the paradigm shift in China's finance development, which suggests an overall transition to "Zero-carbon Finance." Zero-carbon finance has broad and profound connotations, mainly covering: 1) establishing a zero-carbon investment and financing system aimed to support China's economic transition to carbon neutrality; 2) managing the risk of existing financial balance sheets when high-carbon assets are replaced by low-carbon assets; 3) building a zero-carbon financial macro-management framework; 4) developing a zero-carbon financial market in line with international standards; 5) completing the zero-carbon transition of Chinese financial institutions in the course of transition. China has a rare opportunity to build a financial system with zero carbon emissions, put the New Development Concept into effect and set a global standard. At the same time, China's financial sector will assume responsibility for helping to create the new global zero-carbon financial system.

In international studies, the significance of zero-carbon finance in carbon neutrality has gained growing attention. Though still in its infancy, there is general agreement that zero-carbon finance is fundamentally vital to assisting the economy to reach "net-zero."[3] The limitations of the current research can be summarized as follows.

First, theory lags behind practice. To maximize financial support for carbon neutrality, what are the key breakthroughs and directions of financial theory innovation and policy research? Second, there is a lack of extensive research on how the current financial concepts support the goal of carbon neutrality. Why are the issues of transition to a carbon-neutral economy so difficult for green finance, climate finance, and sustainable finance to adequately address?

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1 *People's Daily*, "Xi Jinping Delivers Important Speech at the General Debate of the 75th Session of the UN General Assembly."

2 Min Zhu *et al*., "Embracing the New Paradigm of Green Development: China Carbon Neutrality Policy Framework Research Report," pp. 1-47.

3 Mark Carney, "Fifty Shades of Green: The World Needs a New, Sustainable Financial System to Stop Runaway Climate Change," pp. 12-15; Nick Robins, "The Road to Net-Zero Finance," pp. 1-42.

What qualities should finance have in order to support carbon neutrality? Third, analyses of international zero-carbon financial policies are lacking. The United States and the European Union have constructed policy frameworks that are compatible with financial governance and climate governance, viewing the transition to a carbon-neutral economy as a crucial strategy for reaping economic rewards and taking the lead in the world. What lessons can be learned from their experience? Fourth, theoretical and policy research on the systematic construction of the zero-carbon financial macro-management framework and the corresponding ecology of the zero-carbon financial market is relatively rare. How can policy formulation and market coordination facilitate finance in serving the real economy's transition and technological innovation and help implement the dual-carbon goal as smoothly and early as possible?

Responding to these important concerns, this study develops the idea of zero-carbon finance in line with China's 2060 carbon neutrality target, and further suggests the building of a Chinese-style zero-carbon financial system in terms of the way the paradigm shift fosters innovative economic and financial theory as well as institutional change.

The paper is organized as follows: Section II reviews the development logic of global financial reform and puts forward the definition, characteristics, and connotations of zero-carbon finance. Section III analyzes the experience and lessons of the international zero-carbon financial system and financial transition. Section IV proposes preliminary ideas on building China's zero-carbon financial system, including zero-carbon financial macro-policy and regulatory systems, and zero-carbon financial market ecology. Section V puts forward several corresponding policy recommendations.

II. Evolution and Definition of Zero-Carbon Finance

Supporting a broad and profound paradigm shift to China's carbon neutrality requires a new financial revolution, which must go beyond the path of financial development and theoretical understanding anchored in Western industrial civilization. The new financial revolution will no longer allocate resources and prevent risks on the basis of the narrow view of material wealth and short-term marketism. It should shift away from supporting the unlimited expansion of production and consumption to support an overall transformation of "zero-carbon finance" with the goal of the harmonious coexistence of humans and nature.

1. Literature and historical logic on financial reform

The history of industrial progress demonstrates that financial and industrial revolutions always go hand in hand. Hicks points out that the ability of the financial system to finance major projects was an important factor in launching Britain's Industrial Revolution.[4] Almost all powerful economies in modern history built their financial systems through a financial revolution before taking the world by storm.[5] However, these financial revolutions were

4 John R. Hicks, A Theory of Economic History, pp. 1-192.

5 Richard Sylla, "Financial Systems and Economic Modernization," pp. 277-292.

not a product of markets alone. North and Weingast believe that the system of credible commitments built by the Glorious Revolution contributed to the financial development of Britain.[6] In the United States, the fact that Alexander Hamilton, the first Secretary of the Treasury, modelled the contemporary financial system on European experience was a key financial component of the quick ascent of American dominance. During his tenure from 1789 to 1795, Hamilton implemented a number of policies, including the consolidation of public debt, the founding of the First Bank of the United States, the issuance of US dollars, the establishment of the banking system, the encouragement of stock market activity, and the growth of limited liability companies. This was regarded as the purest and quickest financial revolution in American history. Sylla and Cowen summarize the financial revolution under six major headings: the public finance system, central banking system, monetary system, credit and commercial banking system, securities market, and enterprise groups.[7]

Similarly, China's reform and opening up over the past forty years has been accompanied by a financial reform promoted by government that provided large-scale resource mobilization, financing, and risk management support for China's industrialization and urbanization. Zhu Min summarized China's financial reform as a "miracle from scratch," transforming the unified financial structure of the People's Bank of China (PBoC) into a multi-level financial market system composed of banks, securities, insurance, funds, financial leasing, and other units.[8] According to the theory of financial development, the combination of an efficient financial system and sound financial policies can spur economic growth, and the more advanced an economy's development is, the more important finance becomes.[9] However, the traditional path of industrialization's financial prosperity and financial revolution have accelerated environmental degradation, ecological harm, and global warming. The traditional development paradigm is being critically examined by the entire society, and finance is once more seen as one of the key drivers promoting the change in the development paradigm.

Numerous financial concepts and initiatives, including environmental finance, sustainable finance, climate finance, green finance, etc., have evolved in tandem with the dynamic expansion of the world's green and sustainable development. It is challenging to close the gap in the enormous quantity of finance needed to address problems relating to sustainable development, such as global warming, ecosystem degradation, biodiversity, etc., because these ideas have not substantively departed from supporting the traditional development path of industrialization.

While theoretical research is still lagging in the global context of carbon neutrality, finance has moved on to the next phase of discovery: practice and rapid development aimed at

6 Douglass C. North and Barry R. Weingast, "Constitutions and Commitment: The Evolution of Institutions Governing Public Choice in Seventeenth-Century England," pp. 803-832.

7 Richard Sylla and D.J. Cowen, "Hamilton and the US Financial Revolution," pp. 10-15.

8 Min Zhu, *The Chinese Economy Emerging on the Global Horizon*, pp. 1-415.

9 John G. Gurley and E. Shaw, "Financial Structure and Economic Development," pp. 257-268.

fostering carbon neutrality.[10] How to inspire and steer a financial revolution that transcends existing paradigms and development trajectories, guides the flow of private capital, and handles carbon-neutral transition risks has become the frontier of theoretical innovation in economic and financial study.

2. Carbon neutrality drives the paradigm shift in finance

Carbon neutrality is the most fundamental transformation in economic development since the Industrial Revolution, necessitating major changes in the aim of development, sources of value, production and consumption patterns, business models, and policy frameworks.[11]

Since the Industrial Revolution, traditional economic progress has been built on rising resource investment, boosting output of material wealth, and upgrading material product consumption. Gross Domestic Product (GDP) focuses on measuring core output growth while ignoring social, environmental, and health opportunity costs and benefits during material production and consumption, leading to growing inequality and environmental damage and creating an unsustainable development model.[12] After the Paris Climate Change Conference in 2015, with its goal of global carbon neutrality, human beings have accelerated the exploration of a new development model and the search for a new economic paradigm.

From the standpoint of financial development, modern finance conducts financial activities and risk management characterized by intertemporal and cross-regional capital transfers and cost-benefit trade-offs on the theoretical foundation of the efficient market hypothesis, portfolio theory, and asset pricing models. Modern finance, however, is now unable to meet the demands of the transition to a carbon-neutral economy of growing wealth and well-being, since it must build new financial models, systems, and intellectual concepts.[13] The world needs a new, sustainable financial system to stop runaway climate change,[14] and to align with the new economic paradigm. This indicates that finance will inevitably move towards a new round of fundamental transition, forming the *paradigm shift* in finance.

Chinese finance must transition quickly to zero-carbon finance in order to achieve carbon neutrality before 2060. This financial transformation involves several key responsibilities.

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10 Richard Roberts and John Elkington, "Innovation and Transformation: What It Will Take to Finance Net Zero," pp. 1-40; Nicholas Stern, "A Time for Action on Climate Change and a Time for Change in Economics," pp. 1259-1289.

11 Nicholas Stern, "A Time for Action on Climate Change and a Time for Change in Economics," pp. 1259-1289; Nicholas Stern and Joseph Stiglitz, "The Economics of Immense Risk, Urgent Action And Radical Change: Towards New Approaches to the Economics of Climate Change," pp. 181-216; Min Zhu *et al*., "Embracing the New Paradigm of Green Development: China Carbon Neutrality Policy Framework Research Report," pp. 1-47.

12 David W. Pearce, Anil Markandya and Edward B. Barbier, *Blueprint for a Green Economy*, pp. 1-549; Donella H. Meadows, Jorgen Randers and Dennis L. Meadows, *The Limits to Growth: The 30-year Update*, pp. 1-338.

13 Benjamin N. Dennis, "Climate Change and Financial Policy: A Literature Review," pp. 1-172.

14 Mark Carney, "Fifty Shades of Green: The World Needs a New, Sustainable Financial System to Stop Runaway Climate Change," pp. 12-15.

First, financing the transition to a carbon-neutral economy with massive, long-term, highly unpredictable, and highly concentrated investment. In order to restructure the balance sheets of nations, industries, businesses, and citizens, it is also important to manage the financial restructuring risks associated with up to over 400 trillion yuan in stock financial assets that are undergoing valuation changes. Third, financing early-stage, high-risk technological innovation that is carbon-neutral. Fourth, provide financial initiatives to help high-carbon industries adjust to transitional policies that are carbon-neutral. Fifth, letting financial institutions actively engage in cutting-edge worldwide competition and collaboration to create zero-carbon financial standards and markets. Sixth, directing financial institutions to gradually transform so they can achieve their own net zero carbon emissions.[15]

3. Evolution of the concept of zero-carbon finance

(1) In the 1960s, the rise of the Western environmental protection movement gave birth to environmental finance

Early environmental finance emerged during Western industrialization, during which ecosystem destruction accelerated and large economic losses were generated. Environmental and human health have been significantly endangered by pollution from industrialized manufacturing, which has sparked a variety of green movements in Western nations who pushed for the passage of environmental and ecological legislation to improve environmental governance and oversight.

Environmental issues have also triggered market restructuring and changed global capital flows. For example, the USA promulgated the *Comprehensive Environmental Response, Compensation, and Liability Act* (known as CERCLA or Superfund) in 1980, to provide funds for environmental restoration, and put forward clear guidelines for banks' environmental responsibilities from the perspective of traceability. Through the financial decision-making process, environmental finance has had an impact on environmental protection and governance and has been considered as the key to maintaining the natural ecology.[16] The environmental economic paradigm emerged and was broadly applied in investment and financing activities, and market mechanisms such as financial derivatives, prices, and transactions were established to solve environmental problems.[17]

(2) Since the 1990s, the theme of sustainable development has driven sustainable finance

The need for cooperative social responsibility and governance from businesses, governments, and individuals has increasingly gained attention in the effort to solve environmental and ecological issues.[18] The United Nations first advocated the concept of

15 Min Zhu, "Paradigm Change: Long and High Tides of Carbon Neutrality" and "Building China's Zero Carbon Finance-Practicing the Road to Financial Development with Chinese Characteristics."

16 Mark A. White, "Environmental Finance: Value and Risk in an Age of Ecology," pp. 198-206.

17 Richard L. Sandor, *Good Derivatives: A Story of Financial and Environmental Innovation*, pp. 1-649; *How I Saw It: Analysis and Commentary on Environmental Finance (1999-2005)*, pp. 1-294; Hu Tao *et al*., "Environmental Finance: An Interdisciplinary Review," pp. 1-17.

18 Milton Friedman, "The Social Responsibility of Business Is to Increase Its Profits," pp. 173-178.

sustainable development in 1987, which also promoted the broader demand for sustainable finance. According to the definition of sustainable finance, it is necessary to consider economic activities' environmental (E), social (S), and governance (G) factors when making investment decisions, and guide more long-term investment.[19]

Sustainable finance is consistent with the 2030 Sustainable Development Goals (SDGs) proposed by the UN in 2015. It can also be explained as the collection of environmental finance, impact finance, and stakeholder finance corresponding to the dimensions of E, S, and G respectively (Environmental, Social and Governance or ESG).[20] Under the broad concept of sustainable finance, environmental finance here further covers the financial support for climate change mitigation, adaptation, and other environmental goals, such as biodiversity protection, pollution prevention and control, the circular economy, etc.[21] In short, the main purpose of sustainable finance is serving long-term financial needs under the SDGs framework, dealing with market failures such as risks and externalities, and improving the stability and efficiency of financial markets.[22]

(3) The 2015 Paris Agreement increased public awareness of climate financing and green finance

With the rising urgency of climate change issues, the global climate governance framework has put forward special requirements for financial participation, and climate finance has emerged to meet the gap. Guided by the global climate governance mechanism of the UN Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement, climate finance emphasizes developed countries' financial support to developing countries within the global cooperation framework. The Paris Agreement proposes that climate finance should be guided by the 1.5°C target and promote finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development.[23]

In the narrow sense, climate finance is referred to as "net climate-specific assistance,"[24] that is, the developed countries pledged at the Copenhagen Conference to jointly mobilize US$100bn annually by 2020 to support climate action in developing countries. In general, the meaning of climate financing is continuously evolving, from mitigation and adaptation to physical hazards to resilience in response to transition risks, to compensation for losses and damages, and is consistent with the SDGs as a whole.[25]

Green finance, another leading topic since the Paris Agreement, aims to support the low-

19 UN Environment Programme Finance Initiative (UNEP FI), "UNEP Statement by Financial Institutions on the Environment & Sustainable Development."
20 Alex Nicholls, "Sustainable Finance: A Primer and Recent Developments," pp. 1-51.
21 UN Environment Programme (UNEP), "Definitions and Concepts: Background Note."
22 The Group of Twenty (G20), "Sustainable Finance Synthesis Report."
23 United Nations (UN), "Paris Agreement."
24 Tracy Carty and Armelle L. Comte, "Climate Finance Shadow Report 2018: Assessing progress towards the $100 billion commitment," pp. 1-28.
25 UN Environment Programme (UNEP), "Adaptation Gap Report 2022: Too Little, Too Slow."

carbon and green growth of the economy. Green finance has a similar scope to environmental finance,[26] but the definitions of green finance at the international, national, and market levels are not uniform due to the different emphases of environmental protection policies in various countries. Green finance emphasizes the generation of environmental benefits through investment and financing activities, mainly mobilizing funds to invest in green industries and projects, improving the ecology, and supporting sustainable environmental development.[27] The theoretical proposition of developing green finance is the reduction of pollution and greenhouse gas emissions and improvement of resource efficiency by internalizing environmental externalities. It involves financial institutions and financial assets, public funds and private capital, and the financial system's effective management of environmental risks.

(4) The financing gaps of carbon-intensive industrial transition have promoted transition finance

The world has discovered that green finance ignores the financial requirements of high-stock, carbon-intensive businesses in transition, so studies on transitional finance started to be conducted from 2019. Transition finance refers to funding for the low-carbon transformation of "brown industries" and carbon-intensive sectors' low-carbon transformation.[28] Its main principles are to prevent carbon lock-in and provide mature green alternatives, and to avoid significant financing gaps and social and economic risks. By definition, transition finance is a supplement to green finance that concentrates resource allocation on green projects, and is also an important part of sustainable finance. Transition finance is still in the early stage as countries are actively formulating policy frameworks.[29]

(5) The financial concepts mentioned above are not entirely in line with what net zero requires for the current and upcoming forty years

From the historical perspective, the development of the above-mentioned concepts involves financial support to reduce environmental damage, especially the impact of climate change on sustainable development. There are not only commonalities among the concepts, but also differences in the focus of financial services and development frameworks. Against the background of carbon neutrality, the existing financial development aiming at "climate change" and "environmental protection" is far from covering the scale, duration, and risk management needs of the transition.

The financial commitment and implementation of reducing carbon emissions lag far behind

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26 UN Environment Programme (UNEP). "Definitions and Concepts: Background Note."

27 The Group of Twenty (G20), "Green Finance Synthesis Report"; International Finance Corporation (IFC) and Gesellschaft für Internationale Zusammenarbeit (GIZ), "Green Finance: A Bottom-up Approach to Track Existing Flows"; OECD, "Green Finance and Investment."

28 Organization of Economic Development and Cooperation (OECD), "Transition Finance."

29 UN Framework Convention on Climate Change (UNFCCC), "Report of the Standing Committee on Finance (SCF): Work on Definitions of Climate Finance"; The Group of Twenty (G20), "Sustainable Finance Report."

the amount required to limit the temperature increase levels of the Paris Agreement, causing a huge emissions gap and financial gap.[30] The Climate Policy Initiative (CPI) reports that global climate finance needs to increase by at least 6.9 times from the level of 2019-2020, reaching US$4.35 trillion by 2030, to meet climate goals.[31]

These enormous gaps stem from the fact that, on the one hand, since it is difficult to arrive at and implement an effective global cooperation agreement on climate change, this urgently calls for strengthening the global framework for climate governance. On the other hand, it is because the "net zero" component has not yet been included in the current financial system and structure, which limits the primary function of finance in achieving carbon neutrality.[32]

4. Zero-carbon finance: Definition and connotations

The Glasgow Climate Pact (COP26) in 2021 represents the starting point of the new financial paradigm, with a global consensus on financial support for the transition to a net-zero economy. COP26 proposed preliminary ideas on zero-carbon financial standards, private capital investment activities, the international zero-carbon bond market, the financial alliance for net zero, etc. The mission of the new financial paradigm is to strive to promote the realization of net zero emissions by the middle of the century. The inherent meanings of climate finance, sustainable finance, green finance, and transition finance all extend financial support for net zero transition.[33] In terms of breadth and depth, this has surpassed the definition of the single financial concept alone. We need to integrate the common areas of the above-mentioned concepts and greatly enrich the connotations of financial support by combining the carbon neutrality goal with climate change and sustainable development to realize a paradigm shift in finance. This new financial paradigm can be called "*zero carbon finance.*"

Zero-carbon finance is closely aligned with net-zero economic transition in terms of development logic, target scope, action framework, and implementation tools. In terms of development path, the shift in value implies that zero-carbon financing should move beyond conventional economic benefit-oriented thinking and judgments and introduce a wider range of values concerning harmony between human beings and nature and multi-dimensional human welfare, thereby driving investment, business, and individual behavior. In terms of a target scope that aims at clearly and fully guiding financial activities in line with net

30 UN Environment Programme (UNEP), "Emissions Gap Report 2022: The Closing Window—Climate Crisis Calls for Rapid Transformation of Societies"; International Monetary Fund (IMF), "Macro-Fiscal Implications of Adaptation to Climate Change," pp. 1-46; Rockefeller Foundation (RF) & Boston Consulting Group (BCG), "What Gets Measured Gets Financed: Climate Finance Funding Flows and Opportunities."

31 Climate Policy Initiative (CPI), "Global Landscape of Climate Finance 2021."

32 Nick Robins, "The Road to Net-Zero Finance: A Report Prepared by the Advisory Group on Finance for the UK's Climate Change Committee," pp. 1-42.

33 Carney Mark, "Clean and Green Finance," pp. 20-22; Climate Policy Initiative (CPI), "Framework for Sustainable Finance Integrity"; Richard Roberts and John Elkington, "Innovation and Transformation: What It Will Take to Finance Net Zero," pp. 1-40.

zero, zero-carbon finance needs to actively and scientifically integrate this idea into policy frameworks, financial markets, the real economy and social cognition while trying to bridge the financing gap between commitments and execution of decreasing emissions. In terms of action framework, zero-carbon finance requires joint action at the global and national levels, including constructing a zero-carbon financial system from the perspective of global financial governance, enhancing the compatibility of the emission goals of developed and emerging countries, and improving the binding force of international financial commitments and initiatives. In terms of implementation tools, zero-carbon finance is committed to coordinating policy formulation and market practice. Carbon prices, professional institutions, policy supervision, economic incentives, etc., will encourage market innovation and public-private financial cooperation, ensure capital flow and risk management, and support zero-carbon technology innovation, model innovation, and consumption behavior changes.

There are multiple connotations for zero-carbon finance. First, it is highly unified at the definitional level, encompassing the environmental protection component of green finance and environmental finance, the ecological resource protection and sustainable development component of sustainable finance, the climate risk impact and endogenous financial pricing components of climate finance, the risk management component of transformational finance (for transitioning carbon-intensive assets to low-carbon assets), as well as the carbon-related product transactions and market regulation components of carbon finance. Second, zero-carbon finance runs through the entire process from peaking carbon emissions, transitioning from low-carbon to zero-carbon in the timeline, supporting newly large-scale investment and financing models at different stages, integrating products with various terms, risk levels, and transaction forms, and associating multiple markets. Third, zero-carbon finance goes beyond minimizing climate risks in risk management and moves towards the "*cost-benefit + social welfare*" model. It will innovate risk management models involving various funds from the public and private sectors under market principles. Fourth, the principles and framework of zero-carbon finance will be an important direction for global financial competition and cooperation in the next forty years. Financial institutions will directly participate in the establishment of international zero-carbon financial standards and zero-carbon financial markets, contributing to the goal of carbon neutrality.

5. Zero-carbon finance implements China's New Development Concept, providing a historic opportunity for China's finance to "overtake when changing lanes"

Zero-carbon finance is consistent with China's 2060 carbon neutrality goals. It focuses on supporting the zero-carbon transformation of the real economy and sustainable growth aimed at economic wealth and social well-being. It is the comprehensive embodiment of China's New Development Concept of "*innovation, coordination, greenness, openness, and sharing*." Specifically, zero-carbon finance emphasizes the innovation of low-carbon and zero-carbon technologies and their business models, matches the zero-carbon transformation

of the industrial structure, and provides the power of green development. Starting from the imbalance in the transformation of carbon neutrality, coordinating the resource allocation and structural adjustment of industries, regions, production, and life, and solving the imbalance in green development are inherent requirements. Taking a high level of financial opening-up as the path, it supports the two-way flow of capital, talent, technology and information to promote green and low-carbon development and solve the internal and external linkage problems of green development. In terms of sharing, zero-carbon finance helps achieve a balanced transition, transforming ecological advantages into development advantages, sharing the fruits of green development globally, and resolving the social fairness and justice of green development.

China has extensive expertise in green finance, with its policy and market system of green finance already taking shape. In the shift toward global carbon neutrality and the green transition, China's financial industry is on the same starting line as the international financial industry in building zero-carbon finance. Based on its experience of existing green finance practice, market scale, and ecological foundation, China should strive to build a Chinese-style zero-carbon financial system building on its institutional advantages. It is a unique historical opportunity for China's finance to "overtake when changing lanes" and contribute to the new finance and sustainable development of the world.

III. International Exploration of the Zero-carbon Financial System

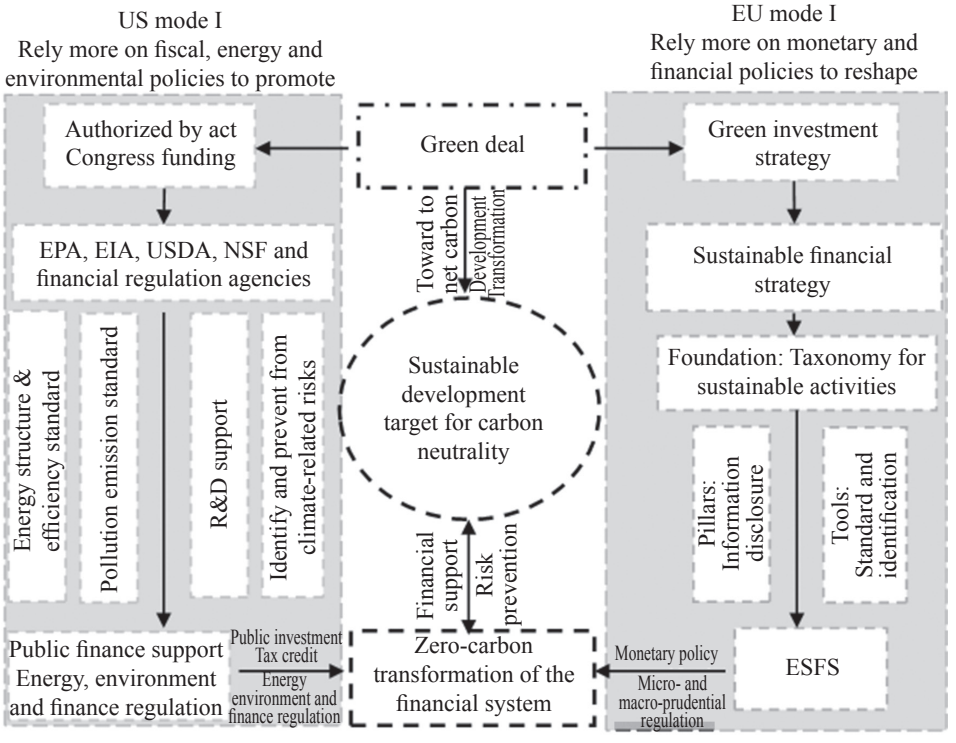
As major developed nations view carbon neutrality as a crucial strategy to obtain economic benefits and take the lead in the world, they are beginning to investigate and establish a new form of financial industry to support it. Although their existing policy frameworks have limitations due to their systems and laws, though the relevant experience and lessons of their exploration are worth learning (Figure 1).

1. EU: Top-level design, foundation building, and regulatory implementation

Based on the huge financing gap for the carbon neutrality goal and the Sustainable Development Goals (SDG), the EU was the first to recognize that mobilizing private capital to more sustainable investment requires a comprehensive change in the financial system. As of now, the EU sustainable finance policy framework, with an emphasis on net-carbon transformation, has already formed an overall strategy with one foundation and three pillars. The *Action Plan: Financing Sustainable Growth* and its updates constitute the overall strategy and objectives. Establishing a taxonomy for sustainable operations is the foundation of a sustainable financial system. Upon the foundation, the three pillars, in the form of sustainability disclosure obligations for non-financial enterprises, financial intermediaries and investor preferences have been built in as indispensable parts of the policy framework. The European System of Financial Supervision (ESFS) is the macro-management organization responsible for encouraging the zero-carbon transition of the EU financial system. The

ESFS is a multi-layered system of micro- and macro-prudential agencies, using tools like benchmarking regulation, sustainability standards and labels, and sustainable finance development strategies within its regulatory field aimed at constructing a new financial system. The European Central Bank (ECB) has incorporated climate considerations into its monetary policy framework to guide companies and financial intermediaries to innovate in sustainable finance and prevent climate risks. As a result, the EU has initially constructed a macro-management framework comprised of "*overall strategy + information disclosure and standard setting + monetary policy + micro-and macro-prudential supervision.*" (Figure 1)

Figure 1 Macro Framework for Constructing Zero-Carbon Financial System in EU and USA



2. USA: Adoption of fiscal, energy, and environmental policies aimed at promoting change

The US government's zero-carbon transition policy is rather limited in comparison to the EU's systematic deployment. US President Joe Biden only mandated that federal financial institutions should complete climate-related financial risk assessments and disclosures by signing an executive order after the US rejoined the Paris Agreement. The Federal Reserve and the Securities and Exchange Commission (SEC) have currently established expert committees and working groups, issued research reports, and put into practice many disclosure-related tasks to increase awareness and appraisal of climate-related risks. The US

financial regulatory institutions, however, confront numerous challenges in putting the carbon-neutral transformation of the financial system into practice because of the limitations imposed by the current financial regulatory and institutional structures. For instance, the Fed believes that dealing with climate change issues is not within its legal scope,[34] and the SEC's latest climate-related financial disclosure proposal is plagued by a lack of legal support under the Securities and Exchange Act that restrict its ability to regulate disclosure of specific types of information that are closely related to a company's value prospects.[35] Undoubtedly, the zero-carbon transformation policy of the US financial system lags those of many other developed countries. America relies more on the unified tax system and advanced financial market to relocate capital flows toward supporting carbon neutrality targets. The federal government's agencies, which are authorized by laws and publicly funded by Congress, issue and carry out particular climate policies, such as adjusting energy proportions, raising standards for energy efficiency and pollutant emissions, promoting climate-related research, and publishing climate risk prevention policies to direct private capital flows and indirectly reshape the financial system.

3. Main features and insights from zero-carbon financial policies of the EU and USA

Although Europe and the United States are the worldwide representatives of zero-carbon financial policies, the same limitations and fragmentation accompany their financial zero-carbon transition plans. It is more difficult for the West to change in the short term due to the obdurate impediments brought on by institutional inflexibility. The key challenges are, first, institutional limitations. The fate of the EU will surely be determined by its loose political unity, with numerous obstacles placed in the way of reaching an internal, long-lasting and sustained accord. Natural gas and nuclear energy have been introduced into the taxonomy as a basis for building sustainable finance, but these additions are likely to be uncertain variables leading to frequent foundational modifications. In the USA, the three-power structure and comparatively high levels of state government autonomy also make bringing together numerous conflicting interests a difficult, time-consuming, and repetitive task. Similarly, the development of a zero-carbon finance system will encounter numerous institutional challenges within the US's current political landscape. Second, constructing a new financial system necessitates active fiscal and monetary policies, but doing so in the EU and the US is fraught with challenges. In the divided political structure of the EU, where member countries primarily control fiscal rights, there is still a long way to go before fiscal unification is achieved. To make sustainable finance strategies practical, there is no choice but to depend even more on the integrated European System of Financial Supervision (ESFS) of the EU. Conversely, the US has a unified federal fiscal system but highly fragmented monetary and

34 Min Zhu and Daoju Peng, "New Structural Monetary Policy Mandate with Carbon Neutrality Goals," pp. 1-15.

35 Jacqueline M. Vallette and Kathryne M. Gray, "US SEC's Climate Risk Disclosure Proposal Likely to Face Legal Challenges."

financial regulatory arrangements,[36] so fiscal policy is the primary tool compared to the others. Third, it is difficult for the West to complete the task of coordinating oversight and market evolution, notwithstanding its importance. The EU has a unified financial regulatory framework, but the many domestic capital markets it regulates are all extremely isolated, while the US is the opposite, with a strong and unified market model. Strong regulation or strong market models are easily prone to the dilemma of excessive transformation and detachment from market mechanisms. Fourth, to steadily and effectively guide capital flows, manage asset replacement risks, and support the transition to carbon neutrality, zero-carbon finance evolution must simultaneously balance a number of relationships, including those between the government and the market, the environment and growth, finance and the monetary system, and transition and fairness.

IV. Building a Zero-Carbon Financial System in China

Global best practice demonstrates that initial policy development is necessary for the development of a zero-carbon finance system. China's policy coverage for developing zero-carbon finance will be broader and deeper in the light of experience and lessons learned elsewhere. China's unique institutional structure has the advantage of coordinating the efforts and assets of all parties, and the knowledge gained from the formulation and application of systematic green finance policies will help to create the conditions necessary for the financial sector to continue its transition to zero-carbon operations.

1. Creatively build China's policy framework for zero-carbon finance

China can take the lead in developing a creative zero-carbon financial macro-policy framework by sending clear signals and policy guidance to financial institutions, financial markets, investors, and enterprises to support the establishment of a zero-carbon financial system. This is based on the policy frameworks for green finance and climate finance respectively, and their integrated trend in the future.

(1) Fiscal support for the development of zero-carbon finance

Fiscal support and coordination between fiscal and monetary policy are indispensable cornerstones for building China's zero-carbon financial system. The central and local governments in China have succeeded in promoting investment and financing in energy conservation and environmental protection under the umbrella of green finance regulations, and they have contributed to the development of a Chinese green financial system. Fiscal support should continue to play a role in encouraging the allocation of financial resources, developing zero-carbon finance strategies and policy systems, stabilizing long-term market investment expectations, and forming a long-term fiscal support mechanism to accompany reorienting to carbon neutrality. The fiscal departments can utilize budget, taxes, interest-

36 Congressional Research Service (CRS), "Introduction to Financial Services: The Regulatory Framework."

discounting, and other measures to encourage zero-carbon financial innovation and support the zero-carbon related infrastructure including standard systems, digital platforms, statistical systems with carbon emissions disclosure and others. Furthermore, Chinese fiscal and tax authorities may also devote more resources to distributing the risks associated with zero-carbon finance by creating a national fund for zero-carbon development, encouraging the issuing of zero-carbon government bonds, developing novel financing guarantee methods, and so on.

(2) Building structural monetary policy that is consistent with carbon neutrality

In transferring to carbon neutrality, variables like output, consumption, investment, productivity, and trade will be affected by the structural transformation of the economy, and will also lead to uncertainties about price level and monetary policy space.[37] In order to properly direct large-scale, long-term, inexpensive, and risk-controllable financial capital to support the transition to carbon neutrality, it is necessary to take the structural impact of carbon neutrality into account when developing a structural monetary policy.[38] The central bank can build structural forecasting models that are compatible with the transition to carbon neutrality by incorporating climate change parameters, carbon neutrality transition policies and energy costs. All these elements affect the consumption and investment structure. Meanwhile, to address market failure, "zero-carbon special reloan," "carbon neutrality special loan liquidity window," "zero-carbon QE," and other structural monetary measures may be used. All of these actions will aid in directing more financial resources toward sustainability and zero-carbon emissions.

(3) Update the capital regulatory framework from Basel III to Basel-ESG

The zero-carbon transition of the financial system cannot avoid incorporating climate risk factors into the capital regulatory framework. The impact of climate risk on banks can be identified through credit, market, liquidity, operational, reputational risks, etc.[39] To reduce or avoid the impact of climate-related financial risks, China should take the lead in innovating its capital regulatory framework and drive updates from Basel III to Basel-ESG. For instance, actions include adjusting the capital and risk weights of high-carbon and low-carbon asset classes, providing counter-cyclical bank buffer capital on a carbon basis and allowing financial institutions to put carbon credits within the scope of credit collateral, and encouraging financial institutions to conduct stress tests related to climate change.

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37 Andréas Heinen, Jeetendra Khadan and Eric Strobl, "The Price Impact of Extreme Weather in Developing Countries," pp. 1327-1342; Network for Greening the Financial System (NGFS), "Climate Change and Monetary Policy Initial Takeaways"; Min Zhu and Daoju Peng, "New Structural Monetary Policy Mandate with Carbon Neutrality Goals," pp. 1-15.

38 Min Zhu and Daoju Peng, "New Structural Monetary Policy Mandate with Carbon Neutrality Goals," pp. 1-15.

39 Bank for International Settlements (BIS), "Climate-related Risk Drivers and Their Transmission Channels."

(4) Establish a climate-related financial information disclosure institution

A crucial building block for the effective operation of the zero-carbon financial market is the disclosure of financial information for the transition to carbon neutrality. In order to encourage financial institutions, investment organizations, and businesses to carry out climate-related information disclosure, governments and regulators should first offer concrete advice. Additionally, cost, benefit, and risk should be considered when designing the disclosure content, methodology, and workable implementation path that reflect China's current position. Second, we should dramatically enhance the standardization, transparency, and mainstreaming of ESG data and zero-carbon finance so that the information disclosure framework can be used more quickly and widely and feedback can be used more effectively to improve the framework. Finally, we need complementary measures to strengthen the disclosure system, including but not limited to the implementation of incentive policies for voluntary disclosure or mandatory disclosure according to the enactment of laws and regulations: formation of a set of tools and systems for the authenticity, completeness, and verifiability of the information disclosed; and giving full play to industry bodies and market forces to promote the construction of disclosure infrastructure, including industry conventions, financial standards, ratings and credit investigations, and disclosure channels.

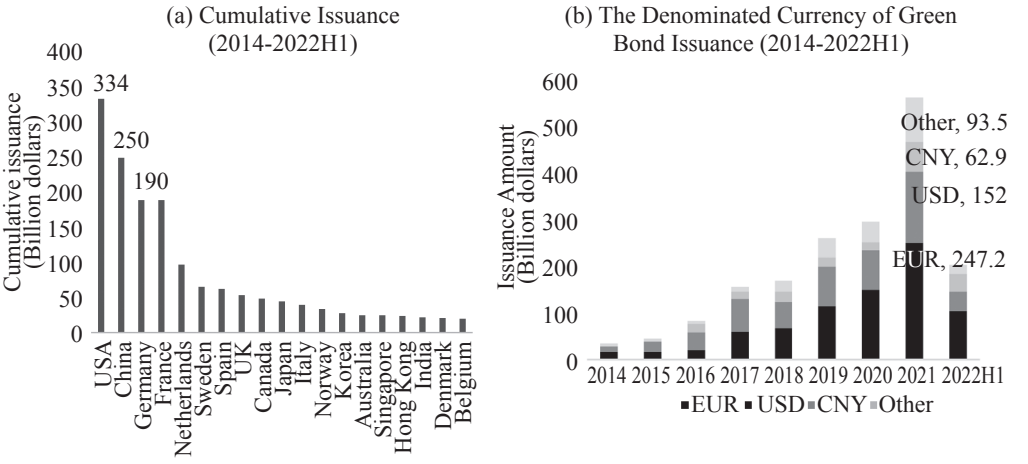
2. Shape a composite ecology for the zero-carbon financial market

Although China's green finance market has become a large-scale market that has attained international appeal, a single market structure is still unsatisfactory given the diversified and composite financial demands induced by carbon neutrality. Therefore, a comprehensive and highly prospective long-term strategy for China's zero-carbon financial system should start with the methodology of "overtaking when changing lanes" to create a composite ecosystem of a zero-carbon financial market.

(1) Advance the green finance market to a zero-carbon financial state

Over the past twenty years, China's green finance market has become a super-large market system with an outstanding scale of green assets, constant improvement of the system of standards and environmental disclosure institutions, and diversified green financial products and services. Up to September 2022, the outstanding green loans of domestic and foreign currencies in China had reached 20.9 trillion RMB and the stock of green bonds was 1.26 trillion RMB, respectively ranking first and second in the world. According to the statistics of CBI, China issued a total of US$250 billion in green bonds from 2014 to 2022 H1, and the scale of green bond issuance denominated in RMB is only behind that in Euros and US dollars (Figure 2). However, China's financing structure, constituted of more than ninety percent green loans, faces the risks of term mismatch, which make it difficult to meet the needs of flexible and long-term capital financing in the course of carbon neutrality. Furthermore, market players are not guided by an appropriate carbon price, and the signals and driving mechanisms for endogenous growth in the market are still imperfect.

Figure 2 Scale of Green Bond Issuance in China and the World



Data source: Climate Bonds Initiative (CBI)

In the future, financial support for carbon neutrality will require a more complex and diversified new zero-carbon financial market ecology. Initially, while increasing the scale of zero-carbon loans, China's banking system needs to build a new zero-carbon risk management system to deal with the huge stock of high-carbon and brown-loan assets and to develop new products of zero-carbon assets, liabilities, and intermediate business. Banks need to stimulate a range of inclusive, individualized, and customized non-standard green and low-carbon financial products and services in order to encourage greener, zero-carbon consumption and enable businesses to achieve net-zero. Secondly, we need to actively develop a zero-carbon capital market. New green loan growth is constrained by regulatory and risk factors, necessitating the development of diversified direct investments and financing tools like zero-carbon ABS/ABN and zero-carbon REITs that can accommodate a wide range of ESG investors' preferences in order to increase capital market liquidity and open up more space for zero-carbon financing. Non-financial and non-state-owned firms will make up the majority of issuers in the zero-carbon bond market in the near future as the bond cycle shifts to being more medium and long-term and fundraising becomes evenly distributed among multiple industrial sectors. The ultra-large-scale and the high-growth market will also attract greater international capital investment. Once again, zero-carbon equity is promising for multi-level and diversified investment incentives, especially risk sharing for zero-carbon technology innovation in the experimental or exploratory stage. Imaging the equity transformation of zero-carbon technology, the core assets pursued by financial institutions and ESG investors will greatly increase the market share of zero-carbon equity financing. Lastly, carbon futures will become the core of the carbon financial market, showing a wide range of market entities participating in the trading of carbon emissions and giving rise to a carbon price tool which

can be used by government and market players to guide capital flows and allocate financial resources.

(2) Build a composite ecology for the zero-carbon financial market

In order to mobilize and allocate financial resources more effectively, the Chinese government can cooperate with market players to build a transparent and efficient ecosystem for the zero-carbon financial market. First of all, it is important to understand the overall structure of the zero-carbon financial market and its complex characteristics. There should also be no confinement to a single financing structure that is predominately made up of zero-carbon loans and zero-carbon bonds, as market participants are free to innovate financial models and formats using a variety of financial tools. The final step is to create the composite ecosystem of a zero-carbon financial market with a zero-carbon credit mechanism at its center and involving "non-standardized and standardized zero-carbon investment" mechanisms.[40] Second is building a new service system integrating carbon trading, carbon measurement, carbon certification, carbon consulting, etc., and expanding the coverage of carbon trading to attract enough market entities to join the carbon financial market and get powerful and informative support for judgments on carbon policies, carbon prices, and carbon emission dynamics. Third, financial institutions should assume responsibility for facilitating the transition to carbon neutrality, promoting eco-friendly and low-carbon consumption, and integrating the use of varied financial instruments, such as credit, bonds, equity, and carbon finance, to carry out diversified zero-carbon financial service innovation while progressively reaching the net-zero goal of their asset portfolio at the same time. Fourth, a functioning system for zero-carbon financial market transactions, including trading entities, trading venues, trading products, and trading processes, should be developed using a corresponding ecosystem that broadly covers various domestic and foreign financial market segments. Finally, the expansion and extension of finance to diversified carbon neutrality scenarios will bring about accelerated integration between finance and non-finance sectors and also financial sub-industries fusion. This will inevitably further promote the adjustment and improvement of the existing seperate operation system, and also put forward more comprehensive and higher requirements for penetrating supervision.

V. Policy Suggestions

1. Formulate zero-carbon financial strategies from the height, breadth and depth of the paradigm shift

China's financial transition to zero-carbon finance requires a comprehensive, systematic combination of a top-down and bottom-up method to form its strategy and policy frameworks, and also requires standing at the deepest part of the paradigm shift to comprehensively plan

40 Min Zhu *et al*., "Embracing the New Paradigm of Green Development: China Carbon Neutrality Policy Framework Research Report," pp. 1-47.

the future of China's zero-carbon finance. First, the New Development Concept is placed at the heart of a thorough understanding of the paradigm shift of zero-carbon finance, and the definition and connotation of zero-carbon finance should catch on more broadly and deeply. Zero-carbon finance must be fully integrated into the key issues as the macro-policy development strategy and its implementation path, fiscal and monetary policy, financial system, industrial policy, innovation ecosystem and market mechanisms, macroeconomic regulation system and global cooperation. Second, using the idea of zero-carbon finance as the foundation, we should create a zero-carbon financial system to offer support for specific issues, such as the development of a zero-carbon investing and financing system, the strategy for economic and social development that follow carbon-neutral paths, the conversion of the economy to a zero-carbon structure, an increase in zero-carbon consumption, and a shift to zero-carbon society and values. It is on this basis that the transition of financial institutions to zero-carbon emissions will be achieved. Third, we need to incorporate the zero-carbon finance model into China's overall planning and policy framework for the construction of ecological civilization and socioeconomic development, and promote the reform of the corresponding systems.

2. Strengthen government planning and incentive policies

An international consensus has already been established on financial priorities in the transition to carbon neutrality, but the market cannot completely address the imbalance between financial supply and demand resulting from the transition to carbon neutrality. In order to facilitate the transition, the government must adopt a more proactive strategic planning and directing role than in the past and utilize a variety of macroeconomic and financial policy tools. With the help of regulatory incentives, China should bring complete cohesion to the market and utilize its unique institutional advantages to carry out strategic planning at the level of "top-level design."

First, we must translate the overall goal of zero-carbon finance into specific standards and indicators. For instance, to serve the goal of reaching a peak in carbon emissions before 2030, we must formulate a zero-carbon finance development strategy focusing on incremental investment and financing, including large-scale investment and financing of new energy and carbon-neutral infrastructure, and gradually build relevant disclosure policies and risk management frameworks. To serve the goal of reaching carbon neutrality before 2060, we must focus on promoting the decarburization transformation of heavy carbon industries such as coal, electricity, steel, and petrochemicals, and manage the financial risks caused by changes in asset valuation on balance sheet restructuring. Second, we must be ahead of planning for support systems comprised of fiscal and monetary policies, financial systems, and innovation ecosystems to address the positive and negative externalities involved in the transition. We must actively use fiscal and monetary policies to effectively mobilize private sector funds and expand the scale of long-term investment, share investment risks, and promote scientific and technological innovation and industrial transformation. Third, the

private financing of financial institutions and large-scale investments for carbon neutrality must at first be supported by the government. The first five years of the transition to carbon neutrality is the crucial time for large-scale investment that can lay a strong foundation for the development of low-carbon technology and business models as carbon emissions peak by 2030. On the other hand, investment encourages innovation and reaps higher late-stage returns while mitigating the rising cost of the early transition to carbon neutrality and spurring rapid economic growth. Fourth, governmental incentives must be created to promote the restructuring of financial institutions' balance sheets as well as their institutional operational, investing and financing activities to accomplish financial institutions' zero-carbon transition.

3. Deepening reform to improve the risk pricing function of the financial market

The core function of the financial market is managing financial risk and using market risk pricing mechanisms to allocate resources effectively. It is necessary for financial risk pricing to contribute to the convergence of market price to suitable price in the transition to carbon neutrality. First, we need to construct a carbon financial derivatives market to support the market mechanism for the carbon prices forming in China's Emissions Trading Scheme (ETS). In other words, explicit carbon prices should be explored and approached through financial risk pricing. Second, we should develop market information disclosure standards and systems that fit international standards, and gradually transition from conscious disclosure to mandatory disclosure. Third, financial institutions should establish an internal risk management model based on the zero-carbon target, and set up the risk factors of climate change and carbon neutrality so as to conduct stress tests and disclose them regularly.

4. Establish and improve the institutional guarantee system for the implementation of strategies

The paradigm shift of zero-carbon finance requires the initial conditions, suitable development space, and comfortable external environment provided by the economic and social system. This involves laws and regulations, measurement standards, transformation roadmaps, organizational coordination and other institutional guarantee systems. Above all, a hard constraint on carbon emissions mandated judicially is quite like the support for the development of Chinese green finance given by environmental protection legislation. It is also necessary to form a scientific, credible, fair and inclusive carbon measurement and carbon account system. Furthermore, we need to guide and coordinate the formulation of roadmaps for carbon peaking and carbon neutrality in different industries to lay the foundation for ESG investment and asset portfolios' carbon neutrality benchmarks. Lastly, we need to improve the coordination among government agencies to efficiently provide financial support for "1+N" policy system of China's carbon peak and neutrality. We further propose to establish a Central Zero-Carbon Finance Working Group to coordinate the strategy design and implementation of zero-carbon finance.

5. Expand international cooperation and sharing of zero-carbon finance

First, guided by a common and sustainable vision, China should fully participate in

global zero-carbon financial cooperation and international rule-making, and promote the development of the global zero-carbon financial market system and governance mechanism. China should assume the role of a key player and a leader, and firmly support the construction of global zero-carbon financial governance norms within a multilateral framework. Second, zero-carbon finance represents a paradigm shift from traditional finance, and calls for breakthrough innovation in both theory and practice. In order to smoothly achieve the docking of standards with developed nations, China must emphasize zero-carbon finance research, engage in in-depth discussions with international organizations, think tanks, and industry sectors, and consider building a zero-carbon financial system and standard framework that takes into account the features of various economic development phases. The PBoC should participate more actively as a main member of the G20 and the global alliances of central banks, and should play a greater role in the convergence of international standards on the basic methods of information disclosure. Third, China should actively exchange and cooperate with international organizations and Western countries to promote data connection, product exchange and capital flows. We must continuously promote the construction of China's zero-carbon bond market in the field of scale improvement, product innovation, formulation of information disclosure standards, and preferential policies and promote Shanghai as an international zero-carbon bond center. Fourth, we need to strengthen cooperation with Belt and Road countries and developing countries in zero-carbon finance; encourage financial institutions to invest in carbon neutral transformation of countries along the Belt and Road using zero-carbon finance standards; and increase investment in renewable energy projects such as hydropower, wind power, photovoltaic power generation, and smart grids. We should also increase capacity support for the development of zero-carbon finance in emerging economies and developing countries, and enhance the international influence and voice of developing countries as well as Belt and Road countries in building a global zero-carbon financial governance mechanism.

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