

Green Recovery with Resilience and High Quality Development

CCICED Annual Policy Report 2021

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PREFACE

Now, the combined forces of changes and a pandemic both unseen in a century have brought the world into a phase of fluidity and transformation. The year 2021 is a truly remarkable one for China. We achieved the First Centenary Goal of building a moderately prosperous society in all respects and have accomplished the historical feat of eradicating absolute poverty; we also embark on a new journey towards the Second Centenary Goal of fully building a modern socialist country.

In 2021, the China Council for International Cooperation on Environment and Development (CCICED) aimed to develop into an innovative platform for international cooperation on the environment and development that embraces global inclusiveness, open cooperation, and mutual benefits and development. CCICED has carried out the plan as approved by the Executive Members under the annual theme of “Green recovery and high-quality development of resilience”. The aim of this period is to provide suggestions for promoting China's environment and development undertakings, and contribute wisdom and strength to building a community with a shared future for mankind and a clean and beautiful world.

The CCICED Secretariat publishes CCICED Annual Policy Report every year, in order to better reach a consensus on green development and promote green transition and transformation. The Annual Policy Report is a flagship publication that presents research outputs, paper, report by Chinese and international CCICED teams, as well as outlining policy recommendations, the CCICED has proposed to the Chinese government. It shares the observations and thinking of the Chinese and international Members, Special Advisors and experts on hot issues in the environment and development, for the reference of decision makers at all levels, scholars, and the public.

The 2021 CCICED Annual Policy Report incorporates the policy recommendation proposed to the Chinese government “A Great Transition Toward a Green Development Epoch: Low carbon, inclusive, and harmonious with nature”;

the 2021 issues paper “The Green Development Epoch”, which is written by CCICED’s Chief Advisors; research reports from 9 Special Policy Studies, including “Global Climate Governance and China's Role”, “Post-2020 Global Biodiversity Conservation”, “Global Ocean Governance and Ecological Civilization”, “Green Urbanization Strategy and Pathways towards Regional Integrated Development”, “Green Transition and Sustainable Social Governance”, “Major Green Technology Innovation and Implementation Mechanisms”, and “Green BRI and 2030 Agenda for Sustainable Development”, “Global Green Value Chains”, “Green Finance”; Scoping study report on “Managing River Areas in Times of Climate Change”; Special Policy Report on Nature-based Solutions and Report on Gender Mainstreaming in SPS Research for the Period 2020–2021.

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Contents

Overview: The Green Development Epoch	1
Part I Global Governance and Ecological Civilization	13
1 Global Climate Governance and China's Role	15
1.1 Foreword	15
1.1.1 Green and low-carbon development has become an important direction for global economic and social development.	15
1.1.2 The carbon neutrality vision is compatible with China's climate policy	18
1.1.3 Green low-carbon development under the carbon neutrality vision represents an important connotation of high-quality development.	21
1.2 Opportunities and Challenges	22
1.2.1 Opportunities	22
1.2.2 Challenges	25
1.3 China's Mid- and Long-term Climate Goals, Roadmap and Policy Guarantee System.....	29
1.3.1 Phased goals and roadmap.....	29
1.3.2 Transition pathways towards mid- and long-term climate goals	32
1.3.3 Policy guarantee system.....	37
1.4 A Market Mechanism Centered on Carbon Pricing	42
1.4.1 About carbon pricing	42
1.4.2 Carbon pricing has been continuously practiced worldwide	44
1.4.3 Progress and problems of China's carbon pricing mechanism	48
1.4.4 Suggestions for promoting the gradual improvement of China's carbon pricing system	52

1.5	Global Climate Cooperation in the New Era and China's Role.....	53
1.5.1	State of global climate cooperation after the pandemic	53
1.5.2	Suggestions for strengthening international climate cooperation.....	56
1.6	Policy Recommendations	60
1.6.1	Gradually establish and improve an absolute carbon emission cap under the guidance of the carbon peaking and carbon neutrality goals.....	60
1.6.2	Achieve both economic recovery and low-carbon development by actively carrying out deep decarbonization efforts in key industries	60
1.6.3	Build a new power generation paradigm with low-carbon energy at its core, accelerate coal control and the large-scale deployment of renewable energy	61
1.6.4	Accelerate the development of carbon pricing, carbon market and carbon finance mechanisms and promote green finance	62
1.6.5	Strengthen international exchanges and extensively participate and lead the global climate governance and implement the Paris Agreement.....	63
	References.....	64
	Appendix: Gender Equality Analysis.....	68
2	Post-2020 Global Biodiversity Conservation	72
2.1	Background	72
2.2	Elevating Nature Agenda for an Ambitious and Transformational Post-2020 Global Biodiversity Framework (GBF).....	74
2.2.1	High Level Movement Analysis on Global Nature Agenda	75
2.2.2	Initiatives from Other Parts of the World on Translating Political Signals to National Actions.....	84
2.2.3	Progress of the Post-2020 Global Biodiversity Framework.....	86
2.2.4	Prepared for Acceleration of Immediate Implementation of the GBF after the COP15	90
2.3	Global and Regional Approaches for Post-2020 Protected Area Priorities	91
2.3.1	Countries' Differentiated Responsibilities in Fulfilling Global Conservation Area Targets.....	92
2.3.2	Cost-effective Priorities for the Expansion of Global Terrestrial Protected Areas: Setting Post-2020 Global and National Targets	94
2.3.3	Regional Scalable Priorities for National Biodiversity and Carbon Conservation Planning in Asia	96

2.4	Technical Optimization for Ecological Conservation Redline (ECR)	
	Delimitation.....	100
2.4.1	ECR is an Area with Important Special Ecological Functions that Should be Strictly Protected.....	100
2.4.2	Optimization of Methods for Identification of Important Biodiversity Conservation Areas	101
2.4.3	Identification of the ECR Areas with Important Carbon Sequestration Functions	103
2.4.4	Design and Development of an Automated Identification Platform of ECR	105
2.4.5	Suggestions on International Promotion of ECR.....	106
2.5	Cross-Cutting Nature of Biodiversity: Mainstreaming and Synergies ..	108
2.5.1	Mainstreaming Biodiversity Across Government and Society as Well as Enhancing Synergies among Environmental and Sustainable Development Agendas are Key Contributions to Realising a Broader Agenda for Societal Transformative Change	109
2.5.2	Building Meaningful Linkages Between the GBF and the LTAM to Strengthen the CBD’s Mainstreaming Agenda.....	109
2.5.3	Insights from Mainstreaming Biodiversity in Climate Policy, the Urban Sphere, the Financial Sector and Environmental Accounting.....	110
2.5.4	Seizing the Opportunity of the GBF to Enhance International Biodiversity Governance by Making Use of Synergies	113
2.5.5	Recommendations Summary on Mainstreaming and Synergies	115
2.6	Post-2020 Socio-Ecological Security, Resilience and Recovery.....	116
2.6.1	Introduction	116
2.6.2	From Emergencies to Ecological Civilization	117
2.6.3	Resilience: Why So Important?	119
2.6.4	Gender Gaps	121
2.7	Overall Recommendations on Post-2020 Biodiversity Conservation ...	125
2.7.1	Strive towards Highly Effective Implementation of the GBF 2021-2025	125
2.7.2	Based on China’s Theory of Green is Gold and the Practice of Ecological Civilization, Promote the Nature Agenda to International Platform and Translate Ambitions into Practical Actions	127
2.7.3	Share with Other Countries China’s Experiences on Implementation of Ecological Functional Zoning and Related Topics	127

2.7.4	Accelerate Work towards Social-ecological Security, Resilience, and Gender Equality for the Health and Wellbeing of All People on Our One Planet.....	128
Annex 1.	Table S1 Characteristics of Each CBD Party.....	129
Annex 2.	Additional Comments on Improvements to the Text of the Draft GBF	140
Annex 3.	Specific Recommendations to the First GBF Draft	142
References	143
3	Global Ocean Governance and Ecological Civilization.....	147
3.1	Introduction	147
3.2	Sustainable management of China's offshore capture fisheries.....	148
3.2.1	China's coastal capture fisheries	149
3.2.2	Coastal capture fishery management system	154
3.2.3	The institutional framework of China's marine ecological economy	157
3.3	China's offshore environmental pollution and its treatment	165
3.3.1	Eutrophication and mitigation actions in the China coastal sea.....	166
3.3.2	Ecological Environmental Problems and Policies of Marine Plastic Debris and Microplastics.....	171
3.3.3	Sources, distributions and trend of mercury pollution in marine environment	176
3.4	Policy recommendations	182
	Recommendation 1: Improve fisheries resource study and survey, strengthen science-based governance systems	182
	Recommendation 2: Standardize and improve management approach, strengthen the protection of fishery resources.....	184
	Recommendation 3: Establish and improve the marine environmental protection pattern, promote the formation of a joint prevention and control mechanism for ecological environmental protection in watersheds - estuaries - nearshore waters	187
	Recommendation 4: Promote the synergy between marine pollution reduction, climate change, and improve the quality of marine ecosystem.....	188
	Recommendation 5: Improve the ecological environment monitoring system, strengthen the source of control	189
	Recommendation 6: Establish and improve the joint scientific and technological research mechanism to enhance the scientific knowledge of marine pollution problems.....	189
	Recommendation 7: Enrich the development of global marine public goods and participate deeply in global marine environmental	

governance	190
3.5 Future ocean research roadmap for CCICED	191
3.5.1 Ocean in the framework of the CCICED	191
3.5.2 International framing of future CCICED ocean efforts	192
3.5.3 Identifying and prioritizing ocean issues for the future	193
3.5.4 Seamap for the Ocean Future.....	194
References.....	200

Part II Green Urbanization and Environmental Improvement203

4 Green Reshaping of China's Urbanization in the Context of Global Carbon Neutrality	205
4.1 Introduction	205
4.2 The new background of green urbanization: global carbon neutrality ..206	
4.2.1 The end of the traditional industrial era, the opening of a new era of development.....	206
4.2.2 Green urbanization under the “three new” pattern.....	207
4.2.3 The development model as the foundation of urbanization has undergone profound changes	208
4.3 Overall strategy of green urbanization in the context of global carbon neutrality.....	210
4.3.1 Strategic tasks of green urbanization	210
4.3.2 The key conditions that determine urbanization are undergoing profound changes	211
4.3.3 The meaning of green urbanization	211
4.4 Carbon peak and carbon neutrality in Cities	212
4.4.1 Current status of carbon peaks in Chinese cities.....	213
4.4.2 Urban "Dual Carbon" Goal: How to proceed in an orderly manner	214
4.4.3 How far is urban emission reduction from green transformation.....	215
4.4.4 The public's recognition of “dual carbon”: residents of some high-carbon cities are more supportive of "dual carbon"	217
4.5 Urban Renewal from the Perspective of Ecological Civilization	219
4.5.1 Urban renewal has become a central task	219
4.5.2 Outstanding problems in urban renewal	219
4.5.3 Urban Renewal: Traditional Industrialization Thinking Vs. Ecological Civilization Thinking	221
4.6 The changing trend of China's urbanization: local urbanization	223
4.6.1 China's local urbanization trend.....	223
4.6.2 City scale and economic development.....	224

4.7	Green rural revitalization under the background of urban-rural coordination.....	225
4.8	From GDP Orientation to Well-being Orientation: Urbanization in the New Development Era	227
4.9	Policy recommendations	228
4.9.1	General idea	229
4.9.2	Specific areas: four policy pillars	230
	Reference.....	235

Part III Innovation, Sustainable Production and Consumption.....237

5	Green Transition and Sustainable Social Governance.....	239
5.1	Introduction	239
5.2	Economic Contribution Analysis and Comprehensive Evaluation of China's Green Consumption	240
5.2.1	Empirical analysis of the economic contribution of green consumption	240
5.2.2	Construction and comprehensive evaluation of China's green consumption index	246
5.3	Case Studies on Green Production and Consumption Industries and Fields in China	254
5.3.1	The green tax system of China's automobile industry based on carbon neutrality	254
5.3.2	Green design policy for China's iron and steel industry.....	256
5.3.3	Eco-design policies and standards for incineration facilities in China.....	261
5.3.4	Green consumption policy for China's food.....	267
5.3.5	Green label certification policy.....	271
5.4	International Experience: Accelerating and Deepening the Green Transition	274
5.4.1	Urgency of action	274
5.4.2	Responding to the COVID-19 pandemic with green recovery plans	276
5.4.3	Supranational level: The European Union Green Deal and the Green Recovery Plan	276
5.4.4	National government strategies on Corona Recovery and Green Transitions.....	277
5.4.5	Promoting Low Carbon Transitions.....	280
5.4.6	Electric Mobility.....	284
5.4.7	Circular Economy and Eco-Design	287
5.4.8	Sustainable Food Systems	290

5.4.9	Gender	294
5.4.10	Conclusions.....	296
5.5	Policy Recommendations	297
5.5.1	China's "14 th Five-Year Plan" has entered an "in-depth" green transition period with the promotion of green production and consumption patterns moving into a substantive stage of practice, and important changes will occur. There are at least five main features:	297
5.5.2	Several specific policy issues still need to be addressed in order to launch the green production and consumption campaign in China in a bid to accomplish the relevant targets set out in the "14 th Five-Year Plan".	298
5.5.3	Conducting green taxation reform in the automobile industry ..	302
5.5.4	Introducing green design policies for the iron and steel industry	303
5.5.5	Employing the concept and methodology of eco-design to upgrade waste incineration facilities into green facilities that provide products for enhancing living environment.....	305
5.5.6	Exercising a sustainable (green) food consumption policy.....	306
5.5.7	Accelerating and Deepening the Green Consumption Transition: International Experiences.....	307
	Reference.....	309
6	Major Green Innovation Technology and Its Implementation	
	Mechanism	312
6.1	Introduction	312
6.1.1	Significance of Community Green Renewal	312
6.1.2	Vision, Criteria and Goals of Community Green Renewal	313
6.2	Global Experience and Practice: From City to Community	315
6.2.1	Decarbonization Paths for Cities/Communities from an International Perspective	315
6.2.2	Experience on Green Renovation Technologies in Domestic and Foreign Communities.....	318
6.3	Characteristics of Carbon Emission in Cities and Communities	322
6.3.1	Selection of Cities and Communities as Cases	322
6.3.2	Basic Information on the Communities and Socio-Economic Characteristics of the Population	322
6.3.3	Data Collection, Measurement, and Analysis of Carbon Emission in the Communities	325
6.3.4	Structure of Carbon Emission and Analysis of Influence Factors in These Communities.....	326

6.4	Path of carbon emission reduction in urban communities with double carbon targets.....	330
6.4.1	Outlook for Future Carbon Emissions in Urban Communities and Decarbonization Challenges.....	330
6.4.2	Recommendations on Community Green Renewal and Green Technology under the Goals of “Peaking Carbon Emissions by 2030” and “Achieving Carbon Neutrality by 2060”	341
6.4.3	Promoting a Green Lifestyle through Community Green Renewal.....	349
6.5	Mechanism guarantee of China's urban green transformation.....	352
6.5.1	Promotion of Digitized Green Transition in Chinese Cities	352
6.5.2	Creation of the Enabling Environment for Deployment of Green Technologies.....	358
6.5.3	Gender and Population-Group Perspectives: Sharing and Public Participation.....	363
6.6	Policy Suggestions	365
6.6.1	Suggestions on Promotion of Carbon Neutrality and Green Development of Cities and Communities.....	365
6.6.2	Policy Suggestions on Green Technologies in Community Renewal.....	367
	Annex I: An In-Depth Analysis On The Sharing Economy and The Climate?	373
	Annex II: Smart City Quayside In Toronto	374
	Annex III: Calculation method of carbon emissions from community energy use	375
	Annex IV: Calculation method of carbon emissions from residential travel	376

Part IV Green Energy, Investment and Trade.....377

7	Enhancing Environmental Management for BRI Projects to Boost Green BRI and 2030 Agenda for Sustainable Development.....	379
7.1.	Introduction	379
7.1.1	Promote BRI towards High-quality Development	379
7.1.2	The Green Silk Road Provides New Impetus for the Implementation of 2030 Sustainable Development Goals	382
7.1.3	BRI Investment Features the Growth of Scale and Green-Oriented Growth	382
7.1.4	Motives and the Goals of Environment Management for BRI Projects.....	385
7.2	Environmental Management system for CHINA overseas Investment.	386
7.2.1	Environmental Management Policies for China Overseas Investment.....	387

7.2.2	Features of Environmental Management Legislative Framework for China Oversea Investment.....	393
7.2.3	Summary.....	395
7.3	Experiences of Environmental management in International DFI and ODA.....	396
7.3.1	International DFI Experiences for ESRM.....	396
7.3.2	Environmental Management Mechanisms for ODA of Japan and South Korea	407
7.3.3	Summary.....	413
7.4	Policy Recommendations.....	415
7.4.1	Priority Areas for Boosting Sustainable Development in Overseas BRI Projects	415
7.4.2	Policy Recommendations for Non-Governmental Entities to Practice Environmental Management for BRI Investment and Financing.....	417
7.4.3	Five Key Pillars for Full Lifecycle Environmental Management in BRI Projects	419
	References.....	421
8	Global Green Supply Chain.....	428
8.1	Introduction	428
8.1.1	Research Background	428
8.1.2	Review of Outcomes of the Phase 1 Special Policy Study	430
8.1.3	Opportunities Related to Green Value Chains in China in the Current Economic Context.....	431
8.1.4	Challenges to Achieving Green Value Chains in China	434
8.1.5	Main Research Topics	435
8.2	Greening the Production and Sourcing of Soft Commodities in Value Chains.....	435
8.2.1	Emerging Norms for Legality, Sustainability and Traceability in Soft Commodity Value Chains	435
8.2.2	Due Diligence and Traceability Measures for Soft Commodities	445
8.3	Accelerating Circular Economy throughout the Value Chain	455
8.3.1	Why Embracing Circular Economy is Important for Greening Value Chains?	457
8.3.2	Five Enablers of Circular Economy in China's Value Chains...	475
8.4	Policy Recommendations.....	479
8.4.1	Pursue Six Priorities in the New Development Phase for China on Green Value Chains	480
8.4.2	Accelerate the Development of China's Green Value Chain	

	Promotion Mechanism	485
	Reference.....	487
9	Green Finance.....	499
	9.1 Introduction	499
	9.2 Develop Ecological Protection Finance and Advancing the Nature-Positive Principle	502
	9.2.1 Development of Finance and Nature-Positive Principle.....	502
	9.2.2 Definition and Attributes of the Nature-Positive Principle.....	505
	9.2.3 Framework for a Nature-Positive Transition of the Financial System.....	506
	9.2.4 Enabler: The Role of Fintech.....	511
	9.3 “Throttling” : Ensuring that Funds Flow to Support Conservation.....	515
	9.3.1 Practices of Chinese institutional investors in Conservation finance.....	515
	9.3.2 The Impact of Agricultural Subsidy Policy on Financial Institutions.....	520
	9.4 “Broaden sources” : Increasing Green Funding Sources.....	526
	9.4.1 The Innovation of Conservation Financial Instruments.....	526
	9.4.2 Debt and Biodiversity Conservation.....	532
	9.5 Policy Recommendations.....	539
	9.5.1 Recommendations for China’s Institutional Investors in Conservation Finance.....	539
	9.5.2 Suggestions for Financial Institutions in the Agricultural Subsidy Chain Based on the Nature-Positive Principle	542
	9.5.3 Suggestions on the Innovation of Conservation Financial Instruments	544
	9.5.4 How China Can Show Global Leadership in Developing Green Sovereign Debt Markets	545
	Reference.....	549

ANNEX 1: 2021 Policy Recommendations of the China Council for International Cooperation on Environment and Development	554
ANNEX 2: CCICED Nature-Based Solutions (NbS) Special Policy Report	565
ANNEX 3: Managing River Areas in Times of Climate Change	599
ANNEX 4: Progress on Environmental and Development Policies in China and Impact of CCICED’s Policy Recommendations (2020-2021)	603
ANNEX 5: Managing River Areas in Times of Climate Change Report on Gender Mainstreaming in SPS Research for the Period 2020 - 2021	632
ANNEX 6: CCICED Phase VI Members(as of December 2021).....	646

Overview: The Green Development Epoch

Cascading Physical Risk: The scientific case for urgent, bold climate action has never been more alarming. The 2021 IPCC report points with certainty to a warmer and more dangerous future; a future of severe flooding, prolonged drought, deadly heatwaves and other effects that have already characterized 2021: deadly flooding in China, deadly heat waves in North America and Greece, and uncontrolled forest-fires in Turkey and western North America.

Single-event anomalies have shifted to longer-term patterns. In 2020, according to the World Meteorological Organization, the global mean temperature was 1.2°C hotter than in pre-industrial times. 2020 was among the three hottest years on record and the warmest ever recorded in Europe. Even warmer average temperatures occurred at the regional level, led Eurasia—including China—with temperatures 5°C above. In 2021, the western United States recorded temperatures 10–15°F above normal. Average drought has increased by 1% per year between 1961 and 2013 ^[1]. Brazil is currently experiencing its worst drought in 91 years.

Brazilian wildfires have affected an estimated 10% of the Pantanal, the planet's largest wetland and largest flooded grasslands area ^[2]. In addition to destroying critical habitat for hundreds of species, these fires were both a net source of carbon emissions, while weakening critical carbon sequestration functions associated with wetlands and grasslands ^[3].

The Pantanal is hardly isolated. The Intergovernmental Science Policy Platform on Biodiversity and Ecosystem Services ^[4] warns that one million animal and plant species are currently threatened with extinction, with losses driven by land-use change—notably land-clearing for agriculture—climate change and other stressors.

International Cooperation: While some climate changes are irreversible, the IPCC concludes that with immediate, ambitious and bold action at scale, global warming can be constrained to 1.5°C. If ever there was a time to build genuine multilateral action, it is now. The Kunming biodiversity and Glasgow climate summits present a once-in-a-generation opportunity to advance a sustainability

transformation.

Integrated Policies: Just as science confirms that the Earth’s ecosystems are interconnected, so too does 2021 offer a precious opportunity to build an integrated, equitable, carbon-neutral, and nature-positive agenda. The 14th Five-Year Plan underscores the importance of policy integration and green development. The Plan identifies a range of green objectives, from the further expansion of renewable power, green transport, green manufacturing, the creation of national energy-saving and energy efficiency standards, agro-ecological food systems, and many other priorities.

CCICED’s work has highlighted concrete examples of policy integration. China’s Ecological Redline (ECRL) is a world-leading example of large-scale spatial planning that includes natural disaster mitigation criteria. Work continues to broaden the scope of ECRL to include carbon sequestration. The Yangtze River Economic Region’s basin-wide law and basin-wide policies are a model in overcoming jurisdictional silos to fight pollution and build green development. Nature-based solutions (NBS) are protecting biodiversity, bolstering climate adaptation and carbon sequestration. The 2021 UN Food Systems Summit has underscored the critical role of food systems in carbon neutrality and ecosystem stewardship.

Implementation: The 2060 carbon neutrality goal as well as ambitious ecological protection, pollution abatement, and circular economy goals in the 14th Five-Year Plan set out when targets will be met. Accordingly, CCICED’s work has largely focused on *how*: how clean energy and green production systems can substitute for current carbon-intensive and brown practices; how binding regulations and more flexible market-based systems can reduce greenhouse gas emissions at home; and how to advance the Green Belt and Road and green value chains practices through sustainability sourcing standards abroad, especially in soft commodities. Science leaves no doubt that bold action is needed now. Charting the macro-economic and micro-level details of implementation in ways that magnify policy coherence remains the priority of CCICED’s work.

A Green Economic Epoch

One means of framing the green transition challenge is by recalling the work of Nobel Prize economist Simon Kuznets. Recently, Chinese experts have referred to Kuznets in the context of China’s climate mitigation strategy. Kuznets’ insights into structural economic transformation—which he termed economic epochs—as opposed to shorter-term economic or business cycles, are especially relevant in thinking about green transition policy challenges. Four aspects of his work are helping to frame the following discussion: (a) the distinction between short-term economic fluctuation, mid-term business cycles, and longer-term structural

transformation; (b) the transformative role of science and technological innovation (c) the centrality of high-quality growth; and (d) the importance of addressing inequality, particularly during periods of structural change.

Short-Term and Long-Wave Cycles

Kuznets won the Nobel Prize in 1971, largely through his work in differentiating short-term economic cycles (or swings) and longer-term structural changes, adding to work by Schumpeter in innovation cycles, Minsky in financial super-cycles, and others. Given the complexity of building an Ecological Civilization and green economic epoch, identifying the short-, medium-, and longer-term sequencing of social, economic, fiscal, financial, technological, and other elements is both complex and enormously important

Immediate-Term Action: The scientific case for urgent decarbonization and the economic case made by Stern and others for a green transition have never been stronger. The United Nations Environment Programme (UNEP) Emissions Gap report concludes that unless significant carbon emission reductions happen before 2030, the Paris Agreement target will be impossible to meet. The majority of countries, together with thousands of companies, cities, universities, investors, and others have now adopted net-zero mid-century targets and sharp 2030 targets. Since the close of 2030 is less than 3,500 days away, the time to translate these plans into concrete, coherent action is now, based on the arithmetic of allowable carbon budgets.

Carbon Budget: The Global Carbon Budget 2020 report concludes that only 8% of the total carbon budget remains in order to have a 66% chance of avoiding dangerous global warming. Carbon Tracker's carbon budget, based on 2019 annual GHG emissions of 43.1 gigatons of carbon dioxide (GtCO₂), estimates the world has a 50% chance within 11.5 years of stabilizing global warming at 1.5°C warming. The United Kingdom's sixth annual carbon budget, released in June 2021, estimates a total national carbon budget of 965 million tons CO₂ equivalent for the years 2033–2037. Sectoral budgets include estimate the remaining GHG emissions for coal, oil, and gas sectors. Budgets help hold the avalanche of company-level net-zero promises to account, with claims misaligned to allowable budgets inviting claims of green-washing, as well as underscoring the financial risks of stranded assets, highlighted by the Bank for International Settlements and a growing number of central banks, supervisors, and regulators. Tools like the Pathway to Net Zero Decision Support Tool map out decarbonization pathways to net-zero for various sectors, from power and mining, to cement and transportation, within the context of national carbon budget mitigation targets and timelines.

A number of actions exist to diminish climate risk and ecosystem losses, including:

Protect Nature First, by maintaining and enhancing a system of national parks, protected wilderness areas, marine protected areas, and other systems. China's 14th Five-Year Plan includes key objectives in support of the newly established national parks system, targets to protect forests, grasslands, wetlands, nature reserves, and greenbelt areas.

Short-lived Climate Pollutants: Reducing and eliminating methane, HFCs, black carbon and pollutants can avoid as much as 0.6°C. of global warming ^[5]. Following China's adoption of the Kigali amendment to the Montreal Protocol in 2021, coupled with the inclusion of methane and other non-CO₂ emissions in the 14th Five-Year Plan, priority actions include micro-level mitigation plans supported by robust monitoring systems.

Climate Adaptation: Recent extreme weather events underscore the urgency of preparing and implementing concrete, on-the-ground, and locally tailored climate adaptation actions. Platforms like the Global Commission on Adaptation's State and Trends 2020 report and the National Adaptation Plan (NAP) Global Network share various adaptation actions at the micro and macro levels. Recent steps by the United States to include USD 3.5 billion toward climate risk reduction in the Federal Emergency Management Agency (FEMA) are a leading example of integrating adaptation with disaster response and recovery agencies.

Nature-Based Solutions (NBS): China's sponge cities program is an example of NBS intended to deliver multiple co-benefits, by investing in green infrastructure like urban lakes, ponds, wetlands, green roofs, permeable pavements to reduce the risk of urban flooding. The 2021 zero draft of the Open Ended Working Group under the Convention on Biodiversity highlight the role of NBS in carbon sequestration.

Power Sector Transition: Of the 400-some measures associated with a net-zero transition, the International Energy Agency prioritizes a clean, low-carbon electric power system as a first-order priority. Perhaps more than any other sector, having clean energy system—solar, wind, green hydrogen, bioenergy, geothermal, battery storage, smart-grids, demand-side energy efficiency standards—ready to substitute for the current system of carbon-intensive, less energy-efficient systems is a formidable challenge. However, given the fact that energy power investments today will last for up to half a century, there is a need to align China's near-term

peaking and longer-term carbon neutrality with infrastructure investments today. The IMF recently estimated that 2% of global GDP will be needed for green infrastructure investments led by shifting away from fossil fuels and toward renewable energy, with the bulk of investments from the private sector, supported by blended public–private sector finance.

Carbon Pricing and Subsidy Reform: In July 2021, the first trade under China’s national emissions trading system occurred, underscoring the critical role that market-based policies will play in carbon peaking and carbon neutrality. Anticipated next steps from its initial power sector coverage include hard-to-abate carbon-intensive sectors like cement and chemicals. A complementary carbon tax scheme is under consideration. Critical to all market-based schemes is the question of stringency: the IMF concludes the average global price needs to reach USD 75 per ton of CO₂ equivalent by 2030, while a June 2021 report by the Network of Central Banks and Supervisors for Greening the Financial System recommends a carbon pricing of USD 160/ton by 2030 to reach net-zero. An important dimension of green fiscal policy coherence is ensuring carbon pricing is not undermined by subsidies, not only to fossil fuels but also farm and other subsidies that destroy vital ecosystems or contribute to air, water, and land pollution. In 2009, the G20 committed to tackling fossil fuel subsidies. Twelve years and trillions of dollars later, the economic, fiscal, environmental and conservation finance case for identifying and sun-setting subsidies has never been stronger.

Transition Risk and Policy Coherence: The green transition presents a public policy challenge more complex than previous economy-wide challenges. However, the empirical evidence suggests that the green transition is well underway, robust, and growing daily. Work by IRENA points to the steady drop in the price of renewable energy. Estimates by the International Solar Alliance similarly track the declining overall business costs of solar energy. Both underscore the economic reality that new solar and wind power projects are now cheaper than coal in over 60% of new energy projects investments. Platforms like the Powering Past Coal Alliance underscore the importance of a systems approach to decarbonization, in which cheaper green technologies best work in coordination with carbon pricing, large-scale green power procurement, grid connectivity, long-term battery storage to form processes phase-out of coal, demand-side energy efficiency standards, and broader consumer awareness.

Green Industrial and Green Innovation Policies: More often than not, countries and companies set ambitious goals without knowing exactly today how they will meet them in the mid-term. When Apple announced that its global production chain would shift to circular economy practices, it added that it did not know how this would be achieved. When Maersk, the world's largest container ship company, committed to net-zero, it added that based on current technologies, it was uncertain how this goal would be met. As COVID-19 has reminded the world, no one can predict the future. Yet setting ambitious, bold outcomes is at the heart of successful national industrial and innovation strategies: economists like Dani Rodrik or Mariana Mazzucato have examined the key role of governments in enabling ambitious, so-called moonshot projects, through fiscal policy incentives, bold investments in science and technology, as well as framing outcomes in terms of what is being sunset, reduced, or retired, but in terms of wider societal well-being outcomes.

Carbon Neutrality Blueprints: An urgent task in backstopping carbon neutrality roadmaps is preparing, monitoring and adjusting micro-level blueprints. Detailed plans and interim targets help signal predictability to companies, investors and markets of timelines, as well as support policy coherence. China's high-level climate mitigation group, attended by Vice Premier Han Zheng and reported to include senior government members, 17 ministers and others, is an important example of coordination. Other examples of low-carbon pathways include the European Union's Green Deal updates in mid-2021, to include 12 legislative pillars, or the proposal of the U.S National Academies of Sciences to create a new National Transition Corporation.

Market-Based Pricing, Command-and-Control Regulations: A key challenge is ensuring synergies at the micro level between binding, time-bound regulatory targets and market-based approaches. Regulations are important in setting clear objectives and outcomes, while market-based mechanisms allow flexibility, particularly in rewarding early leaders in carbon neutrality. While overlap between regulations and pricing can strengthen policy redundancies, unintended duplication or overlapping of regulations and market-based systems can also trigger inefficiencies like deadweight losses or slow labour market transitions due to sticky wages. Estimating constantly dynamic cross-price elasticities, ensuring pricing avoids regressive impacts on poor households, and balancing ambitious

carbon pricing while minimizing price instability and inflation, are key challenges increasingly engaging central banks in the green transition.

International Alignment: An important focus of CCICED's work involves identifying international cooperation in the green transition. For example, since the extraction activities of soft commodities like palm oil, soy, forest products, coffee, tea, and animal products are direct drivers of deforestation, habitat loss, community dislocation, and violence against Indigenous peoples, embedding sustainable sourcing standards and tools like traceability within global supply chains continues within CCICED's work, including the role of green financing to support small-scale farmers and fishers. International cooperation is at the heart of protecting our common oceans, tackling single-use plastic pollution, and advancing common standards for sustainable fisheries. Progress continues in identifying common sustainable finance taxonomies between China and the EU, as well other converging practices like climate and biodiversity risk reporting, comparable stress testing, and other technical areas. Technical issues such as the equivalence of carbon pricing actions are likely to become more important within the context of border carbon adjustment. China's partnership in the Green Belt and Road Initiative continues to advance world-class financing standards and safeguards. Since 2021, for example, no new coal financing has proceeded within the BRI. These and other concrete examples of international cooperation will assume even greater importance in implementing the outcomes of Kunming and Glasgow.

Liability Risk: In addition to physical and transition risks, courts are becoming increasingly important in climate change issues. While environmental liability is well established in areas like contaminated sites, contaminated soils, mining tailings, and many other areas, several recent court decisions regarding climate mitigation are likely to continue and expand, underscoring the importance of science-based mitigation and conservation targets, the proactive use of environmental standards and safeguards in overseas financing like the Belt and Road, and accelerating timetables to discontinue coal and other fossil fuel financing. A recent decision by jurists in China to place more emphasis on climate change is welcomed.

Engaging People: A prerequisite for well-functioning carbon markets is both public awareness and broad acceptance. Recently, the Governor of

the People's Bank of China (PBOC) highlighted raising public awareness of climate change as an overarching priority. It is similarly important to backstop regulatory approaches: effective regulatory compliance and enforcement require high levels of awareness and understanding among the regulated community, especially as new measures are introduced.

During COVID 19, public support for climate action has continued to grow. In early 2021, UNDP and Oxford University ^[6] reported the results of the world's largest public opinion poll on the subject, in which 64% of respondents from 50 countries recognized climate change as a global emergency. Climate policies with the greatest public support were led by conservation of forests and lands, underscoring the importance of integrating nature and climate action. Similar and more granular results were found in an April 2021 poll conducted in the United Kingdom, in which 83% of respondents noted that climate change is a "concern," pointing to the public health, well-being, and economic benefits of net-zero actions, while believing that climate risk affected other countries or counties more than their own.

Science, Technology, and Innovation

Kuznets argued that the "epochal innovation that distinguishes the modern economic epoch is the extended application of science to the problems of economic production." Unlike previous economic theories and models, which regarded technological innovation as being an exogenous driver of growth, Kuznets argued that technological change was the most important determinant of economic growth.

While the private sector is the major source of green technological innovation, public policies such as primary research and development, fiscal policy incentives and tax breaks, government procurement for nascent technologies, and private-public sector partnerships to help de-risk technology innovation are examples of actions underway in different jurisdictions. The recent partnership between the European Commission and Breakthrough Technology (headed by Bill Gates) as part of the EU Green Deal to pool USD 1 billion for green hydrogen, sustainable aviation fuels, carbon capture and storage, and long-term energy. The World Economic Forum continues to highlight the broad scope and systems approach to green technology innovation, including its 2021 picks for the most promising green technologies, while the World Business Council for Sustainable Development has long championed the business case to bring green technologies to scale across different sectors.

Industry and Hard-to-Abate Sectors: The 14th Five-Year Plan commits to a green transformation of energy, steel, petrochemicals, and other industries. The Mission Possible report of the Energy Transitions Commission estimates that a shift

to low-carbon, circular economy business models can reduce 40% of carbon emissions using existing technologies like hydrogen, materials efficiency, and other steps. Investments by companies like Baowu Group, LKAB, ArcelorMittal, Thyssenkrupp, and others to develop net-zero, green steel continue, for example by making greater use of green hydrogen inputs. Similar applied research in finding net-zero cement and aluminum sectors. Progress is slow and expensive, which underscores the importance of applying existing technologies like energy efficiency.

Digitization and Sustainability: A spearhead of green technological innovation involves rapid innovation in the digital economy, from the use of fintech to spur community-based sustainability financing to the widening use of blockchain technology to support traceability in sustainable sourcing and certification. The High Level Panel on Digital Cooperation and its complementary Task Force on Digital Financing for the SDGs, established by the UN Secretary General in 2018, highlights the opportunities and challenges in ensuring accelerating digitization is open and transparent to support the 2030 Agenda.

High-Quality Development

Kuznets's early work helped set the theoretical foundation of modern national income accounts and GDP, including noting the critical importance of labour markets, the informal sector, and other aspects that contribute to current understanding of both human capital and social capital.

Progress among Chinese and international researchers and experts in implementing measurements that go beyond GDP within the context of the Sustainable Development Goals continue. The 2021 Dasgupta Review marks a significant contribution to understanding and correcting the underlying drivers of global biodiversity loss. While GDP is useful insofar as it measures recent income flows, it was never intended to assess the value and quality of underlying ecological or human capital assets, or measure externalities like the feedback effects of pollution. The Dasgupta review sets out a methodologically rigorous, statistically coherent framework to measure the broader wealth of assets or capital in an inclusive or comprehensive manner. The four pillars of this framework are human capital, natural capital, produced capital, and social capital together. Ongoing work by the Organisation for Economic Co-operation and Development (OECD) in measuring well-being has been especially important in the midst of the public health and social strains of the global pandemic, while UNEP and others have begun to link emerging green financing opportunities for ecological restoration to a country's natural capital.

China issued the Opinions on Establishing and Improving the Value Realization Mechanism of Ecological Products in April 2021, proposing that the value realization mechanism of ecological products is key to the concept that lucid waters and lush

mountains are invaluable assets. It is planned that an initial scientific system for ecological product value accounting will be initially established by 2025. Chinese experts have also carried out research on how to measure the value of different ecological capital services. For example, researchers have proposed an ecological unit accounting method. It borrows the idea of solar energy units, and uses “ecological unit” as the basic unit of accounting. The market could be used to monetize the “ecological unit.” It could provide reference to dynamic monitoring and analysis of the value of ecological services, evaluation of government performance at all levels and daily work evaluation, ecological damage assessment at the project level, formulation and implementation of green development planning, promotion of green finance development and residents’ lifestyle improvement. The Evaluation Report on Ecological Capital Service Value Accounting and Ranking of Chinese Provinces and Cities Based on the Ecological Unit, released in 2020, pointed out that GDP and ecological elements have both increased since 2015, reflecting the coordinated development of economic growth and ecological protection.

Inclusive wealth measurement has guided CCICED’s work over the past year, from estimating the broad performance outcomes of NBS beyond narrow cost–benefit analysis frameworks, to assessing inclusive wealth impacts from sustainable food systems. The September UN Food Systems Summit and October Finance in Common meetings offer opportunities to further work in sustainable food systems.

Growth, Equality, and Green Development

If there is any lesson from the global pandemic in many countries, it is the pervasiveness of systemic inequality, from poorly paid health care workers, to systemic discrimination against women, Indigenous people, black communities, and other groups, which require proactive social safety nets, legislative, and institutional reforms and other measures.

Policies to enhance equality within the context of conservation, biodiversity protection, climate action, and pollution abatement have never been more urgent. A pillar of build back better recovery objectives remains closing income and broader social inequality. As the multilateral agenda moves toward adopting 30% of protected areas by 2030, advance zero-waste cities and GHG emission cuts, it is critical that economically disadvantaged regions, sectors, or households not lose further ground through job losses, unintended regressive tax policy effects of carbon pricing, and farm-level investments in sustainable food or other systems.

The green transition has already created millions of new jobs that were barely imagined a decade ago: for example, IRENA estimated that renewable energy jobs totalled 11.5 million in 2019; the World Bank estimates an additional 200 million net new jobs could be created by 2030 through green investments; the American Council for Energy-Efficiency Economy reported that while green jobs fell in the

United States during the pandemic lockdown, clean energy remains the biggest source of job growth in the energy sector, with 2021 forecasts suggesting 400,000 new jobs created through green infrastructure investments.

Despite these and many other green job forecasts, the labour market effects of decarbonization are complex: rarely will there be a one-to-one shift from older brown to newer green jobs. For example, electric cars currently require roughly one-third fewer workers compared to workers needed to assemble internal combustion engine cars. At the same time, the International Council on Clean Transportation estimates that the United States alone will need 2.4 million electric vehicle recharging stations by 2030, up from 216,000 stations in 2020, if a target of 36% market share for electric vehicles is to be met. New jobs in decommissioning gas stations and building new green infrastructure will expand, although not necessarily in the same economic sector. A central part of the EU's Green Deal is its Just Transition Fund, in which an estimated EUR 19.3 billion is earmarked to mobilize an additional EUR 10 billion to support workers and regions—especially in the coal sector—toward carbon neutrality. The European Investment Bank has established a new loan facility to support workforce and business transition.

Kuznets's pioneered work studied the relationship between economic growth and inequality, presented by way of an inverted U-shaped curve that suggested a causal relationship between per capita growth and the eventual narrowing of inequality. Such work has proven mostly wrong. Recent data shows 71% of the world's population lives in countries where income inequality has increased, even as income has grown. Scholars like Thomas Piketty have examined the structural, governance, and other explanations for this rise in inequality, as well as policies to reduce inequality. None involve automatic outcomes of income growth.

Green Kuznets Curve: Weaknesses in the Kuznets economy–inequality hypothesis characterize subsequent work around the Environmental Kuznets curve, which has gained new attention in China and elsewhere in the context of climate mitigation. Following an initial 1995 paper by economists Grossman and Krueger—which posited that as countries reach USD 5,000 to USD 8,000 per capita GDP, environmental quality (measured narrowly by NO_x and SO_x pollution) improved. Subsequent work by economists, as well as CCICED, has shown this hypothesis to be largely wrong.^① For instance, per capita turning points for pollution abatement have been in the range of USD 2,000 for India and USD 1,500 in several sub-

^① A 2014 CCICED report, in observing that the green Kuznets curve hypothesis was generally wrong, traced the development of environmental policies in the rich countries over time has initially been reactive, triggered by accidents or single events, and was 1) compliance driven and mainly responding to command and control policies 2) following an environmental risk approach being more proactive in avoiding damage, and finally 3) a holistic and integrative approach to achieving sustainable development. Over time we see a movement from 1 to 2 to 3.

Saharan African countries, far lower than earlier estimates. For climate mitigation, the idea of a stationary turning point based on per capita GDP understates both the sharp drop in the cost of clean energy technologies coupled with growing scientific certainty and wider public support for climate action.

Summing up, we emphasize that green development must be inclusive, and should balance the relationships among economic development, social development, and environmental protection. China is marching toward its 2nd centenary goal of building China into a great modern socialist country in all respects, thus a new green economic epoch covering these dimensions is indispensable.

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Part I

Global Governance and Ecological Civilization

Chapter 1

Global Climate Governance and China's Role

1.1 Foreword

1.1.1 Green and low-carbon development has become an important direction for global economic and social development.

1.1.1.1 Climate change is an urgent global challenge in the post-epidemic era.

The United Nations Environment Programme (UNEP) has assessed the impacts of the Intended Nationally Determined Contributions (INDCs) submitted prior to October 1, 2015 (by 146 countries, approximately accounting for 90% of global emissions), and concluded that these INDCs are far from sufficient to achieve the 2 °C target^[1]. The goals of limiting global warming under the Paris Agreement require more stringent emission reduction commitments in the INDCs updated in 2020. In the remarks to the Climate Ambition Summit on December 12, 2020, the United Nations Secretary-General Guterres called on all countries to declare a State of Climate Emergency, noting that the current commitments fall far short of the Paris Agreement goals. He announced that the central objective of the United Nations for 2021 is to build a truly Global Coalition for Carbon Neutrality by the middle of the century^[2].

The emission reduction situation worldwide has been increasingly grim since the Paris Agreement pledged to limit global warming well below 2°C. Impacts from global warming of 1.5°C have already been observed, but they are smaller than those from higher magnitude of warming, according to the Intergovernmental Panel on Climate Change (IPCC) Special Report on Global Warming of 1.5°C. Studies suggested that to limit global warming to below 1.5°C, carbon emissions must drop rapidly to 25 gigatons of carbon dioxide equivalent (CO₂e) by 2030. However, the challenge is that based on the emission reduction commitments under the Paris Agreement, emissions are on track to reach 56 gigatons CO₂e by 2030, almost twice

what they should be^[3]. Contribution of Working Group I to the Sixth Assessment Report of IPCC released on August 9, 2021 emphasized again without immediate, rapid and large-scale reductions in emissions, curbing global warming to either 1.5C or even 2C above pre-industrial levels by 2100 would be beyond reach^[4].

1.1.1.2 The international community has basically reached a consensus on carbon neutrality.

To achieve the 1.5 °C target, global anthropogenic CO₂ emissions should be reduced to net zero around 2050, according to the 2018 IPCC Special Report on Global Warming of 1.5 °C . As of December 2020, totally 126 countries have prepared to commit or have committed to carbon neutrality^[5], covering 75% of global gross domestic product (GDP), 53% of global population and 63% of global emissions. Among them, Suriname and Bhutan have realized net zero greenhouse gas (GHG) emissions; 25 countries have incorporated clear carbon neutral targets into national laws (or proposed legislation) and policies, such as China, Japan, Germany, Canada, the United Kingdom and South Korea among the world's top ten emitting countries; and 99 countries have pledged carbon neutrality verbally without providing detailed information. These commitments include all GHG emissions for 28 countries and clear medium-term targets for 29 countries.

The target date is 2050 for carbon neutrality in the above-mentioned 99 countries, with the exception of Uruguay, which aims to become carbon neutral by 2030. GHG coverage and mid-term targets in roadmap towards carbon neutrality are unclear in most countries as the relevant plans are still under preparation. US President Biden has included climate change into the basic policy agenda and committed to carbon neutrality by 2050. In December 2020, the European Parliament and the Council of the European Union reached an interim agreement on the key elements of the European Climate Law, setting for the EU to further reduce its greenhouse gas emissions from 40% to at least 55% below 1990 levels, and to achieve climate neutrality by 2050, and strive to achieve negative emissions afterwards. At the Leaders' Summit on Climate held on April 22, 2021, many countries took more ambitious climate commitments. The United States pledged to reduce greenhouse gas emissions by 50-52% below 2005 by 2030 compared to the previous target of 26-28%, Japan pledged to reduce its greenhouse gas emissions by 46% by 2030 compared to the 2013 level, and Canada has committed to reduced its GHG emissions by 45% by 2030 below 2005, compared to 30% previously. Though without official announcements, Italy, Argentina, and the Netherlands have all aimed for carbon neutrality by 2050 and declared their respective mid-term targets.

1.1.1.3 China has vowed to have carbon emissions peak before 2030 and achieve carbon neutrality before 2060.

China has always been a strong supporter and powerful advocate of global climate governance and environmental protection. Among the indicators for INDCs

submitted by China in June 2015, four have met or even exceeded the 2020 targets. For example, CO₂ emissions per unit of GDP in 2018 declined by 45.8% from the 2005 level, reaching the 2020 target of 40–45% 2 years ahead of schedule. As a responsible large country, China has made strategic decisions while taking both international and domestic situations into consideration. In the statement at the General Debate of the 75th Session of United Nations General Assembly, Chinese President Xi Jinping announced that China would scale up its INDCs, with goals to peak carbon emissions before 2030 and achieve carbon neutrality before 2060. This undoubtedly embodies the determination to take responsibilities as a great power and make greater contributions to the Paris Agreement targets. The move also strongly boosts global confidence in responding to climate change. At the 9th meeting of the Central Finance and Economics Committee on March 15, 2021, in order to reinforce the implementation of the carbon peaking and carbon neutrality goals, they have been incorporated into the overall framework of the construction of the ecological civilization. On April 16, 2021, during a trilateral video summit with French and German leaders, President Xi Jinping announced that China will accept the “Kigali Amendment”. In parallel, China’s special envoy for climate change, Xie Zhenhua, and US President’s special envoy for climate issues, John Kerry, held talks in Shanghai on April 15-16, 2021, which led to the issuance of the “Sino-US Joint Statement Addressing the Climate Crisis”. On May 27, 2021, Vice-Premier Han Zheng presided over the first plenary meeting of the Carbon Peaking and Carbon Neutrality Work Leading Group, demanding that the construction of ecological civilization be solidly promoted to ensure that the carbon peaking and carbon neutrality goals are achieved on schedule. The Ministry of Ecology and Environment also issued the “Guiding Opinions on Coordinating and Strengthening the Work Related to Climate Change and Ecological and Environment Protection” on January 11, 2021, requiring unswerving implementation of the national strategy to actively respond to climate change. The third series of the second round of the central ecological and environmental protection inspectors was started in April 2021.

China's target date for carbon neutrality is about ten years later than pledged by most developed countries. Nevertheless, it should be noted that developed countries generally have a transition period of 50–70 years moving from carbon emission peaking to carbon neutrality, but China has only about 30 years. This requires China, as a large developing country, to increase the pace and intensity of efforts in the transformation of energy structure and development pattern and reduction of CO₂ and GHG emissions, compared with developed countries, which is also much more difficult.

1.1.1.4 Climate action goes hand-in-hand with sustainable development goals such as gender equality.

Climate action is not a standalone topic. It is one of the 17 Sustainable

Development Goals (SDGs) adopted by all United Nations Member States. Among the SDGs there is also SDG 5 – gender equality, and all other strategies which must go hand-in-hand for building a shared blueprint for peace and prosperity for the planet.

Climate change is not a gender neutral process. It impacts men and women differently, largely due to their gender-differentiated relative powers, roles, and responsibilities at the household and community levels. Disparities in economic opportunities and access to productive resources also render women more vulnerable to climate change because they are often poorer, receive less education, and are not involved in political, community and household decision-making processes that affect their lives ^[6].

As part of this work, we view gender equality as an important cross-cutting issue and we believe that gender equality considerations (and the rights of other vulnerable groups) should be mainstreamed into all climate change policies, strategies and programs. Given the speed and massive socio-economic impact nature of the low-carbon transformation, the inclusion of gender equality and in general considerations of the fight against inequalities needs be imbedded in policies and planning since their inception. While we recognize that more work must be done in this area, we hope that what we have provided within this paper can provide the grounds for future work.

1.1.2 The carbon neutrality vision is compatible with China's climate policy

1.1.2.1 China has gradually established a policy system for low-carbon development.

In 2012, the Report of the 18th National Congress of the Communist Party of China (CPC) proposed to build an ecological civilization by incorporating ecological progress into a five-sphere integrated plan. It also put forward for the first time the concept of "beautiful China", emphasizing that we must give high priority to making ecological progress and integrate it into all aspects and the whole process of advancing economic, political, cultural, and social progress^[7]. Since 2013, the CPC Central Committee and the State Council have issued a raft of important documents, such as the Decision of the CPC Central Committee on Several Major Issues Concerning Comprehensively Deepening the Reform, Opinions of the CPC Central Committee and the State Council on Accelerating the Construction of Ecological Civilization, and Integrated Reform Plan for Promoting Ecological Progress, and adopted more than 40 important systems with respect to ecological progress. These have formed Xi Jinping's systematic thought on ecological civilization that provide the fundamental principles for building an ecological civilization.

During the 12th Five-Year Plan (FYP) period (2011–2015), China began to tackle climate change in a systematic manner. The Outline of the 12th Five-Year Plan for National Economic and Social Development included for the first time carbon

intensity as a binding target. A system of targets in climate change has therefore taken shape, including energy intensity, carbon intensity and total energy consumption. In terms of multilateral and bilateral cooperation, China and the United States issued successive joint statements on climate change in Beijing and Washington in November 2014 and September 2015. This directly facilitated the conclusion of the Paris Agreement, making important contributions to the improvement of global climate governance system. On June 30, 2015, China submitted the Enhanced Actions on Climate Change – China's Intended Nationally Determined Contributions, which contains the INDCs targets by 2030.

During the 13th FYP period (2016–2020), China further deepened its goals and actions on climate change. The Outline of the 13th Five-Year Plan for National Economic and Social Development carried forward the multi-dimensional system of targets in energy and climate change from the previous period and stepped up the control of energy intensity and total energy consumption, referred to as dual control. With regard to the low-carbon transition of energy sector, the Energy Supply and Consumption Revolution Strategy (2016–2030) was unveiled in December 2016 with China's energy vision for 2050. In terms of market mechanisms, the Plan for Building a National Carbon Emissions Trading Market (Power Generation Industry) was released in 2017, marking the official launch of the national carbon market. At the same time, focusing on green and low-carbon development and financial policies to address climate change, China has explored the systems and practices related to climate investment and finance. The Guiding Opinions on Promoting Climate Investment and Finance was issued on October 20, 2020 as a preliminary exploration of the cap system for carbon emissions. In addition, China and the United States issued the third joint statement on climate change—China-US Joint Presidential Statement on Climate Change in March 2016, which has played a key role in the signing and entry into force of the Paris Agreement. Domestically, the Department of Climate Change was transferred to MEE in 2018 to strengthen the coordinated governance of climate change, air pollution and other ecological and environmental issues.

Peaking carbon emissions and achieving carbon neutrality is an extensive and profound systemic reform of the economy and society and should be integrated into the overall layout for building an ecological civilization, underscored the Ninth Meeting of the Central Committee for Financial and Economic Affairs on March 15, 2021. This implies that China has established the strategic direction of green development and will systematically put into practice the philosophy of green development.

China's proactive policies and actions on climate change have yielded remarkable results. As of the end of 2019, the carbon intensity was cut by 48.1% compared with 2005, while the share of non-fossil energy in primary energy consumption was

raised to 15.3%. The average annual growth of energy consumption and CO₂ emissions dropped from 6.0% and 5.4% during 2005–2013 to 2.2% and 0.8% during 2013–2018 respectively. China has not only gradually decoupled economic development from carbon emissions, but also fulfilled its international commitments for 2020 ahead of schedule.

1.1.2.2 Public health events such as the COVID-19 epidemic have urged faster actions on climate change.

The outbreak of COVID-19 epidemic in 2020 has seriously affected the world in many aspects. The COVID-19 effects can be persistent, leading to many possible scenarios and uncertainties in future development [8]. Amid the global COVID-19 spread, people have come to realize for the first time that problems in non-traditional security fields are gradually escalating. Therefore, it is necessary to pay great attention to non-traditional security issues such as ecological environment and climate change, as well as public emergencies.

China is undergoing a critical period of transition to high-quality economic and social development. Public attention to environmental health issues and public awareness of green consumption both keep growing. The Chinese government has already recognized that from the 14th FYP and mid- to long-term perspective, green low-carbon development will offer an important opportunity for high-quality economic and social development. In this context, the 2020 Government Work Report brought forward new infrastructure and new urbanization initiatives and major transportation and water conservancy projects and called for green and low-carbon deployments for economic recovery. In the meantime, green transformation of production and consumption patterns has been advanced. The Opinions on Accelerating the Establishment of a Legal and Policy System for Green Supply and Consumption adopted on March 11, 2020 clarified the legal and policy framework for green supply and consumption, providing an institutional guarantee for green transition in economic and social development.

In September 2020, on the basis of systemic trade-offs and far-reaching plans, the CPC Central Committee made the major strategic decision to peak carbon emissions before 2030 and achieve carbon neutrality before 2060. Since then, a series of policies and actions have been intensively introduced or rapidly deployed. The Special Plan on Climate Change During the 14th FYP Period (2021–2025), which is under preparation, will set out CO₂ emission targets compatible with the new target of peaking carbon emissions. The Plan of Action to Peak Carbon Emissions, which MEE is working on to cover the 14th FYP and 15th FYP (2025–2030) periods, intends to set down the roadmap, action plan and support measures for peaking carbon emissions at local level and in key industries. At the same time, MEE will promote the inclusion of such actions into the central environmental protection inspection (this SPS also put forward this policy recommendation).

1.1.3 Green low-carbon development under the carbon neutrality vision represents an important connotation of high-quality development.

China's economy has been shifting from a stage of high-speed growth to a stage of high-quality development, said the Report to the 19th CPC National Congress. High-quality development requires implementation of the principles of innovative, coordinated, green, open and shared development ^[9].

Under the vision of carbon peaking and carbon neutrality, comprehensive green transition or green low-carbon development can drive high-quality development in the following aspects: 1) Accelerate the transformation of energy structure. This will guide the orderly withdrawal of fossil energy while developing an energy supply system blending high proportion of renewable energy. China will safely develop nuclear power, actively produce and utilize green hydrogen energy and foster the hydrogen energy industry. China will also improve the electrification level of the entire economic and social process, especially end-use sectors, and strengthen the integration of digital and information technologies to realize the intelligent and digital transformation of energy system; 2) Urge the optimization and upgrading of industrial structure. Through green and low-carbon industrial development, backward production capacity will be gradually eliminated. This will accelerate the green transformation of traditional industries, as well as the withdrawal of investment-inefficient and high-carbon industries. China will support the development of green strategic emerging industries, vigorously develop high-level service industry, build a green supply chain and develop a circular economy to continuously tap the potential for high-quality growth; 3) Stimulate green and low-carbon technological transformation. Low-carbon and zero-carbon technological transformation is of vital strategic significance for China's technological innovation and high-quality economic development. It will help China enhance its global leadership in the field of new technologies and nurture core competitiveness in a new climate- and eco-friendly economy in the future, thus playing an important leading role. China has already made considerable contributions to reducing the cost of wind power and solar photovoltaic technologies. It is now a global leader in investment and application of renewable energy and production and consumption of electric vehicles. While actively exploring hydrogen production and its application in industrial and transportation sectors, China has made some deployments for a flexible, safe and stable modern smart grid system, as well as negative emission technologies such as CO₂ removal. However, this is far from enough. In a prospective pattern of competition and cooperation in low-carbon and zero-carbon fields, China needs to further scale up efforts to comprehensively deploy the research & development and commercial application of low-carbon, zero-carbon and negative emission technologies, and continue to bring down the cost of green and

low-carbon technologies by relying on its own green market and policy. As such, green and low-carbon development can inject new impetus into China's economic growth in the near future while adding more high-quality jobs to the society.

In short, carbon neutrality and carbon peaking targets do not simply put constraints on economic and social development. They provide an important opportunity of development by forcing changes in the overall patterns of economic and social development. Therefore, we must change our mindset in development, and proactively seek out endogenous growth drivers that harmonize the economy, society, energy, environment, and climate, with a view to wide-ranging green transition and high-quality sustainable development.

1.2 Opportunities and Challenges

1.2.1 Opportunities

1.2.1.1 The 14th FYP and the 2035 vision organically integrate green low-carbon development into economic transition.

The Outline of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 (hereinafter referred to as the Outline), adopted on March 12, 2021, envisaged new progress in the construction of ecological civilization. In the upcoming five years, China will optimize the development and protection of territorial space, and effectively change the modes of production and lifestyle for green transformation. Energy and resources will be more appropriately allocated and more efficiently used. Energy consumption and CO₂ emissions per unit of GDP will be cut by 13.5% and 18% respectively (respectively 15% and 18% during the 13th Five-Year Plan). The total emissions of major pollutants will be continuously reduced while the forest coverage rate will be raised to 24.1%. The ecological environment will keep improving; the ecological security shields will become stronger; and urban and rural living environment will be significantly improved. By 2035, green modes of production and lifestyle will be widely seen; carbon emissions will be steadily reduced after reaching the peak; and the ecological environment will be fundamentally improved, basically attaining the goal of building a beautiful China."

The 19th CPC National Congress formulated a two-stage strategic plan for the Two Centenary Goals. In specific, by 2035, socialist modernization will be basically realized, and by 2050, China will be built into a great modern socialist country that is prosperous, strong, democratic, culturally advanced, harmonious, and beautiful. The 5th Plenary Session of the 19th CPC Central Committee gave more systematic and comprehensive explanations on green development. It stressed that China would "advance green development and promote human-nature harmony". By doing so,

"green modes of production and lifestyle will take shape broadly; carbon emissions will decline steadily after reaching the peak; and the ecological environment will fundamentally turn better, so the goal of building a beautiful China will be basically attained." The meeting emphasized the green transformation of economic and social development on all fronts and the organic integration of development in the response to environmental and climate challenges in the new development stage and stipulated the important characteristics and nature of future development.

A series of specific tasks have been laid down in the Outline, including strengthening legal and policy guarantees for green development; developing green finance; stimulating green technological innovation; promoting clean production; boosting environmental protection industries; advancing green transformation in key industries and major fields; urging clean, low-carbon, safe and efficient use of energy; developing green buildings; carrying out green living activities; reducing carbon intensity; encouraging local areas to take the lead in peaking carbon emissions where appropriate; and formulating an action plan for peaking carbon emissions by 2030. The Outline draws up a comprehensive blueprint for economic and social development in 14th FYP period and even in the medium and long term, laying an important foundation for nurturing green and low-carbon modes of production and lifestyle and promoting the early peak and subsequent steady decline of carbon emissions with a view to carbon neutrality.

1.2.1.2 Faster green low-carbon technological transformation worldwide paves the ground for low-carbon transition.

At present, a new wave of technological revolution and energy revolution is unfolding worldwide, driving the green reconstruction of global industrial chain. Digital technology becomes deeply integrated with the economy and society, while costs continue to fall rapidly for solar energy, wind energy and energy storage technologies, paving the way to green and low-carbon growth. In the context of tough recovery and deep adjustment of global economy, all countries are trying hard to advocate and pursue a green economic recovery. With the rapid development of high-tech fields such as digital technology, information technology and artificial intelligence, the energy technology system is faced with the challenge of phasing out traditional fossil fuels and quickly switching to cleaner, safer and cheaper renewable energy sources. New technologies provide more economically feasible conditions and support for this transition. Inevitably, the economic development model that matches the above-mentioned transition will quickly turn to the path of sustainable development instead of the old path of resource-, energy- and pollution-intensive growth. Green technologies and industries themselves are conducive to improving the utilization efficiency of natural resources and creating new drivers of economic growth^[10]. They also help to fundamentally solve environmental pollution and ecological destruction associated with fixed industrial structure and energy structure

^[11], thereby improving public health ^[12]. In addition, green technologies and industries can also effectively stimulate employment. According to a 2018 report of the International Labor Organization (ILO), 24 million jobs will be created by emerging innovative industries such as electric vehicles, clean energy and green finance by 2030, while only 6 million jobs will be lost in high-carbon industries such as coal and oil exploration^[13].

1.2.1.3 Digital technology and digital economy drive forward green low-carbon transition.

Countries around the world have increasingly turned to green and digital development in their post-epidemic economic recovery plans. While lending a heavy blow to the real economy, the COVID-19 epidemic has brought new opportunities for green low-carbon development and the digital economy. Green low-carbon ways of work and life such as remote office, video conferencing and online procurement have become more popular. Especially in the process of economic recovery, the digital and intelligent transformation of industries such as low-carbon energy, low-carbon buildings, low-carbon transportation, and energy conservation and environmental protection have been significantly accelerated.

Digital technology can play an important role in improving the utilization efficiency of resources and energy, promoting the development and utilization of renewable energy, increasing the efficiency of production, sales and use of products and services in the whole society, or reducing the demand for energy and raw materials through the dematerialization of human activities and exchanges. Research showed that digital technology could already help reduce global carbon emissions by up to 15% through solutions in energy, manufacturing, agriculture and land use, buildings, services, transportation and traffic management^[14]. A study completed by the German Digital Association, the Borderstep Institute and the University of Zurich in 2020 suggested that digital technology can save up to 20% of global GHG emissions, with the greatest potential in the sectors of energy, transportation and agriculture. With the help of digital technology, it will be possible for Germany to avoid the emissions of up to 290 megatons CO₂e in 2030, corresponding to about 37% of the forecast GHG emissions ^[15]. Seizing the opportunity, the digital economy integrating green low-carbon development will help strengthen the driving force of innovation and unleash new momentum.

1.2.1.4 Unique institutional and market advantages provide effective safeguards for deep emission reduction.

Carbon emission is a typical behavior of economic externalities. The existence of externalities is generally considered as one of the defects of market price mechanisms in resource allocation. In other words, when externalities exist, market price mechanisms alone are often unable to ensure the optimal allocation of resources and the maximization of social welfare. Therefore, on the one hand, the

government should fully play the due role; on the other hand, the market should be organically combined with the government to provide new governance tools. New tools such as the Emission Trading Scheme, allowing to internalize the carbon externality, will play a significant role. Other emission capping, carbon pricing (either the ETS or a carbon tax according to the sector), carbon footprint accounting and reporting mechanisms would also contribute to measure climate risks and costs for the economy. The 2060 carbon neutrality target sends a strong positive signal for addressing climate change, but it is enormously challenging and hardly achievable by relying on a single market. China's institutional advantages can play an important role exactly in emission reduction, as proved by the outstanding performance in the fight against the COVID-19 epidemic. These advantages are mainly reflected in the coordination of all efforts to complete key national undertakings; the capability and efficiency of coping with major risks and challenges in complex situations; and the effective transmission, continuity and stability of systems and policies.

The carbon neutrality vision is a far-reaching plan made in the context of the current complex and volatile international situation and the deep domestic economic and social transformation. It not only meets the requirements of domestic high-quality development, but also conforms to the direction of future world development. However, there is still certain uncertainty in the pathways. On the one hand, we need to leverage superior resources to support industrial transformation and upgrading, technology research & development and application, and capital system guarantee. On the other hand, we need to promote consensus among all parties, and send clear and stable long-term policy and price signals by policy and market means. Only in this way will industrial transformation be clearly guided. Local governments will act seriously and the market will respond positively, to channel funds to low-carbon projects, purchase and adopt appropriate technologies, and tap the mitigation potential, thus gradually fostering a trend that the whole society advocates green low-carbon ways of production and lifestyle. At the same time, China has begun to operate the world's largest carbon market. The continuous improvement of market mechanisms will more effectively drive the progress toward carbon neutrality. Institutional advantages, huge domestic market and active shareholder engagement will provide strong support and guarantee for the carbon neutrality goal.

1.2.2 Challenges

1.2.2.1 Preparations are necessary, considering deep uncertainties in international political and economic landscape.

The COVID-19 epidemic has been impacting the global economy and society in all-around way. According to the “2021 World Economic Situation and Prospects” by te UN Department of Economic and Social Affairs, the global economy has contracted by 4.3% in 2020, which represents more than twice and a half times the

recession of the 2009 financial crisis.. The international geopolitical pattern and strategic landscape on climate change are also undergoing profound changes. All countries must intensify climate cooperation to promote the global fight against the environmental and climate crises.

After President Biden was sworn into office, his administration has brought the United States back into the Paris Agreement, has exerted climate leadership on a multilateral platform, and promoted the US-led global climate cooperation framework. It is expected that in the short term, competition will outweigh cooperation between China and the United States, even in the fields of little divergence such as climate change. Since the United States joins the Paris Agreement via presidential executive order instead of federal legislation, the US attitude to multilateral cooperation in climate change still remains uncertain.

The unstable factors of global climate governance still exist. The Covid pandemic has caused a severe and long-lasting impact on the global scale, especially in developing countries. Developing countries will make the pandemic response and the economic and social recovery their political priority, which in turn might weaken the importance given to climate action. In response to the epidemic, the G7 summit held in June 2021 committed to stop overseas public investments in unabated coal power. It proposed to eliminate inefficient fossil fuel subsidies by 2025 but lacked substantial progress on the latter. In terms of climate financing, other countries have failed to commit to increasing the supply of climate funds like Germany.

At present, there is an increasing voice of creating green barriers on the grounds of climate issues, leading to the rising protectionism that urges the use of carbon tariffs to increase trade barriers. The European Union has made it clear in 2021 to establish a carbon border adjustment mechanism. China needs to be fully prepared to deal with such uncertainties.

1.2.2.2 Emission reduction pathways are not actually smooth, given the short time frame for peaking carbon emissions and achieving carbon neutrality.

Compared with the European Union and the United States, China needs to redouble the efforts to achieve carbon neutrality. European countries such as the United Kingdom and France roughly see that carbon emission peaked in the 1980s and 1990s and declined slowly after a long plateau period. This gives 50–70 years for the European Union to move from peak carbon to carbon neutrality. As to China, since CO₂ emissions still exhibit an upward trend, strenuous efforts will be required to meet its set deadline of peaking carbon emissions. Even so, only about 30 years will be left for the transition to carbon neutrality, which necessities unusually intense pathways. More drastic structural changes would occur if the plateau period fluctuated or extended due to internal and external environmental factors. In any case, China's average annual carbon emission reduction rate will reach about 8–10% from 2030 onwards, far higher than developed countries, which poses the biggest

challenge to China. In fact, emission reduction pathways in different sectors are roughly the same for developed and developing countries, but China's shorter time frame entails higher requirements for economic restructuring, technological innovation and capital investment in a large country (Table 1-1).

Table 1-1. Comparison of transition period from carbon peaking to carbon neutrality under country commitments

No.	Country	Actual year of peaking carbon emissions ^[16]	Target year for carbon neutrality ^[17]	Transition period / years
1	United Kingdom	1973	2050	77
2	Hungary	1978	2050	72
3	Germany	1979	2050	71
4	France	1979	2050	71
5	Sweden	1976	2045	69
6	Denmark	1996	2050	54
7	Portugal	2002	2050	48
8	Ireland	2006	2050	44
9	Spain	2007	2050	43
10	Japan	2013	2050	37
11	Austria	2005	2040	35
12	Finland	2003	2035	32
13	South Korea	2018	2050	32
14	China	Before 2030	Before 2060	About 30

Note: China's target year for peaking carbon emissions is given in the table as the peak has not yet arrived.

1.2.2.3 China has weak basic research and development capabilities and faces competition in key low-carbon technologies.

Multiple major challenges hinder green low-carbon development and progress to carbon neutrality in China, including insufficient original scientific and technological outcomes, many institutional obstacles to transformation of scientific and technological achievements, inefficient allocation of innovative elements, and small number and low quality of innovative talents. In terms of low-carbon technologies, focus tends to be put on technical details, as well as the refinement and promotion of existing technologies, resulting in inadequate original innovation in and attention to disruptive technologies. China has not yet established goal-oriented mid- and long-term technological strategy and plan for emission reduction that takes into account economic, social, climate and environmental dimensions. It is still plagued by the lack of key techniques, low degree of dependence and low level of

industrialization in some key low-carbon technologies, such as hydrogen fuel cell vehicles. Regarding hydrogen energy, China is the world's largest hydrogen producer. Nevertheless, green hydrogen accounts for a low proportion because coal and natural gas support 70% of hydrogen production. There is not yet substantial technical breakthrough in hydrogen production, storage and large-scale use. While technological breakthrough offers one of the core solutions for deep emission reduction, China encounters many more obstacles in technology transfer and cooperation due to the international pattern of economic interests coupled with trade protectionism. Hence, it is imperative for China to speed up the formulation of technological innovation and support plans to facilitate carbon neutrality^[18].

1.2.2.4 Just transition is a prominent problem under carbon neutrality because of wide regional disparities.

Economic and social development is uneven in China, generally more advanced in the east and south than in the west and north. In terms of carbon emissions, carbon emissions increase slightly in relatively developed eastern regions, with peaking already close in some areas. Despite strong emission reduction capabilities, under both pressures from the economic recovery and the carbon peaking target, the instinct often falls back on using traditional economic stimulus methods based on carbon-intensive projects to stimulate the economy. In contrast, carbon emissions in central and western regions still have some room for expansion and are unlikely to peak in the short term, especially in fossil energy-rich provinces.

Under the carbon neutral vision, China has established the long-range direction and trend of withdrawal from coal production. Yet, the specific roadmap needs to be carefully designed in accordance with economic development stage and various capacity conditions, taking full account of the benefits and effects of low-carbon transition on different sectors, regions and groups. The traditional fossil fuel sector, especially upstream and downstream coal industries – including mining, transportation, coal power and coal chemicals, will be tremendously impacted in the zero-carbon transition. Such impacts will be more noticeable in areas where economic growth and employment heavily depend on coal. In addition, the coal sector transformation with the advancement of mechanization, elimination of backward production capacity and industrial upgrading has already put pressure on traditionally coal-producing provinces such as Henan and Shanxi. Jobs will be lost with the inevitable withdrawal from the coal sector. For this reason, systematic solutions are needed to explore new development models for these areas, which includes policy measures to support proper arrangement or re-employment of coal workers. These tasks should be carried out sooner rather than later.

On the whole, the COVID-19 epidemic has exerted a huge impact on the economic and social order, but there are opportunities in crisis. In the short term, the urgency of carbon emission reduction is compromised in the combat against the

epidemic; in the medium and long term, green low-carbon development remains to be one of the strategic directions. The epidemic has brought opportunities for structural adjustment while hindering economic growth. Many traditional industries fall into crisis amid the epidemic, but emerging industries such as the information industry demonstrate strong vitality. They have greatly expanded the room for green economic growth, making it possible to pursue green development. It can be said that the epidemic has created an excellent opportunity for structural upgrading. The outbreak also prompts the whole society to reflect on the development model featuring overemphasis on speed and scale. This is undoubtedly conducive to the formation of new development philosophy that places greater emphasis on green development and harmony between human and nature within the whole society, creating favorable conditions for green transition despite the impact of the epidemic. At the same time, the slowdown in energy consumption growth during economic downturn offers an opportunity for accelerating energy transition, so that new energy demand can be more met by renewable energy. China should seize the opportunity to reshape the current economic and energy system, provide support for a carbon-neutral future, and lead the creation of a greener and more resilient world.

1.3 China's Mid- and Long-term Climate Goals, Roadmap and Policy Guarantee System

1.3.1 Phased goals and roadmap

The 5th Plenary Session of the 19th CPC Central Committee set two-stage goals: By 2035, green modes of production and lifestyle will take shape broadly; carbon emissions will decline steadily after reaching the peak; and the ecological environment will fundamentally turn better, so the goal of building a beautiful China will be basically attained. By 2050, China will develop into a great modern socialist country that is prosperous, strong, democratic, culturally advanced, harmonious and beautiful. In the meantime, China will ensure ecological security, and get actively involved and take a driver seat in international cooperation in environmental protection issues such as climate change^[19].

For the purpose of accelerating green low-carbon development and deeply reducing GHG emissions, it is necessary to conduct coordinated governance of economy, society, energy, environment and climate and promote the comprehensive green transformation of economic and social development. Internally, China will step onto the path of sustainable development for the harmony between human and nature and sustained development of the Chinese nation. Externally, China will take a driver seat in global climate governance to safeguard the ecological security of the Earth and the survival and development of the mankind.

China's vision for carbon neutrality shows the world the possibility of limiting global warming to below 2°C and striving to achieve the 1.5°C target. It also further clarifies that tackling climate change is an important component of China's socialist modernization. Hence, the long-term low-carbon development strategy should be compatible with the two-stage goals and strategies for socialist modernization^[20]. Peaking carbon emissions before 2030 and scaling up INDC targets should be included as important content in the first-stage strategic plan to promote high-quality economic development. Achieving near-zero emissions before 2050 and carbon neutrality before 2060 should be taken as the leading targets and tasks in the second stage to drive the progress towards a beautiful China and foster green low-carbon modes of production and lifestyle.

1.3.1.1 Near term: Early peak of carbon emissions in certain areas and sectors

The 14th FYP period will be crucial for China to peak carbon emissions. It covers the first five years after the vision of carbon neutrality is incorporated into the economic and social development plan. Faced with difficulties and challenges unlike before, more attention should be given to strengthened alignment of energy and industrial development planning and national climate change planning. In particular, the development directions and priorities of energy and industrial transition during the 14th FYP period should be oriented to the mid- and long-term strategic goals of achieving carbon neutrality and building a beautiful China. In accordance with green and low-carbon requirements, China will speed up appropriate advanced deployment of infrastructure and industries, optimize the spatial layout of energy structure adjustment, green and low-carbon industrial transformation and resilient urban development, and promote "investment in greenness, growth, employment and future", with a view to new development pattern featuring green and low-carbon "dual circulation".

In these five years, carbon emissions should enter a plateau period. They are supposed to peak first in some of the advanced eastern provinces, southwestern provinces, and cities with sound renewable energy endowments, and high-carbon sectors such as power, steel and cement. Coal will account for 50% or so in primary energy consumption and renewable energy, more than 20%. The peak of carbon emissions will arrive through structural adjustment of coal power and strict control of coal chemical industry. In terms of policy support, coordinated plans will be formulated as soon as possible, including the special plan on climate change, action plan for peaking CO₂ emissions, integrated work program for saving energy and reducing emission, and work program for green industrial system and green living. A cap system for carbon emissions will be established, which replaces the cap on energy consumption with a more effective GHG emission target. Flexible mechanisms and pathways for carbon emission reduction targets will be explored. A mechanism that combines inter-regional indicator trading, clean development and

horizontal compensation will be adopted. Based on scenario analysis and consultation-based consensus, China's NDC will be updated in both intensity and breadth. They will contain the targets of carbon peaking and zero or net-zero emissions in the near and long term; incorporate green recovery, nature-based solutions (NBS), and non-CO₂ GHG emission reduction; and expand the scope of indicators and space of flexible adjustments. China will step up technology research & development and deployment for transition to a zero-carbon society to get well prepared for industrial transformation, lifestyle change and possible global competition in low-carbon technologies^[21]. Meanwhile, China will strengthen global cooperation in research & development and promotion of low-carbon and zero-carbon technologies.

1.3.1.2 Middle term: Early peak and steady decline of carbon emission overall

In 2025–2030, China will strive for the early peak of carbon emissions. Research suggested that given the set deadline for carbon neutrality, an earlier peak of carbon emissions will lower the total emission reduction cost of the whole society^[22]. Even so, steps to carbon neutrality need to conform to China's social and economic conditions. Action will be taken according to capability to seek outperformance and cost-effective accomplishment of phased goals. To well fulfill NDC commitments, the share of non-fossil energy in primary energy consumption will be raised to 25% or higher. At the same time, China will promote and lead climate action and international cooperation around carbon neutrality.

China's primary energy consumption is expected to enter the plateau period during 2025–2030. Through constant optimization, the overall energy mix will be comprised of coal, oil and gas, and non-fossil energy. End-use power consumption will increase significantly. Carbon emissions will have reached the peak in all provinces and cities across the country, and will peak in transportation, building and other sectors. As to measures, structural adjustment and systematic innovation will be combined to boost green transition. Reforms will be deepened in industrial, energy, transportation, and land use structures, and layouts of major infrastructure and related industries will be advanced and adjusted oriented to the zero-carbon vision. By promoting the deep integration of digital and intelligent technology into economic and social fields, green and low-carbon industrial chain, supply chain and value chain, as well as corresponding green climate finance policy system and sustainable business models will be formed and consolidated.

1.3.1.3 Long term: Construction of a carbon-neutral economic and social system

In 2035–2050, China will set up an energy supply and consumption system based on renewable energy, speed up the phase-out of fossil energy, and accelerate the deployment of carbon negative technologies including carbon capture and storage (CCS) and bioenergy with carbon capture and storage (BECCS). It will strive to achieve near-zero CO₂ emissions, further enhance adaptation capacity, continuously

improve the green, low-carbon, circular and sustainable social and economic system, and foster the pattern of sustainable consumption.

In 2050–2060, China will move towards carbon neutrality by means of carbon sequestration and carbon negative technologies and non-CO₂ emissions control, and strive for a carbon neutral world before 2070.

1.3.2 Transition pathways towards mid- and long-term climate goals

1.3.2.1 Adjustment of development model to build a green and low-carbon industrial structure

A modern industrial system serves as the biggest driving force for carbon emission reduction. Research suggested that industrial restructuring could contribute up to about 60% to China's carbon intensity target^[23]. A green, low-carbon and circular industrial system is an important component of a modern economic system. It is necessary to develop green strategic emerging industries such as energy conservation and environmental protection, clean production, and clean energy, and put in place technological and financial support systems and institutional and policy environments that are suitable for green, low-carbon, and circular industries. The construction of new infrastructure characterized by green, low-carbon and digital content should be accelerated; and the service sector should pursue green development at a higher level, creating new drivers for green, low-carbon and circular development. In the meantime, carbon emissions embodied in export trade should be reduced. In 2016, carbon emissions embodied in exports accounted for 12.5% of China's total carbon emissions^[24], which could make a difference in carbon emission reduction. China's manufacturing sector should try to climb to the high end of global value chain, while the service sector can increase the proportion of exports.

1.3.2.2 Implementation of energy revolution to develop a green and low-carbon energy system

Energy mix decarbonization offers a key way to achieve carbon neutrality and contributes to a sound energy security system in China. It can be achieved through five aspects. 1) A roadmap for orderly withdrawal from coal production should be developed. More forceful measures are necessary to control the consumption of fossil energy, especially coal; continuously optimize the structure and reduce the scale of coal utilization; and tighten the control over bulk coal. Effective measures are also needed to curb the impulse of coal-related projects in some local industries and limit the scale of high-carbon industries such as coal chemicals, in order to avoid the resulting high carbon lock-in effects and huge costs. 2) The electrification level should be significantly raised in the end-use sectors. The industrial sector should speed up the substitution of electricity for the direct use of fossil energy in the manufacturing process. The building sector should adopt distributed renewable

energy systems and expand the application of electricity in heating, while conserve building energy use and refine the energy efficiency standards. The transportation sector should vigorously develop electric vehicles, restrict and gradually eliminate fuel vehicles; and facilitate the commercial development of hydrogen fuel cell vehicles. Energy consumption in various industries should be further upgraded with the orientation of electrification, efficiency improvement and intellectualization. 3) An energy supply system blending high proportion of renewable energy should be fostered. It will encompass various suitable technologies, infrastructures and models developed through disruptive innovation, covering infrastructure, smart grid, distributed energy, energy storage, multi-energy complementation and flexible regulation, as well as smart energy. China will steadily advance the development and construction of cascade hydropower and build a group of basin-wide integrated energy bases for hydropower, wind and solar power. China will vigorously promote the coordinated development of wind power by combining centralized and decentralized development models and putting equal emphasis on local absorption and external transmission and on onshore and offshore wind power. China will move faster to expand the diversified solar power layout. For the eastern region, innovative photovoltaic plus models can be introduced to accelerate agricultural photovoltaic system and rooftop photovoltaic system and facilitate industrial and commercial distributed photovoltaic development. For Northeast China, North China, and Northwest China, photovoltaic development should be integrated with ecological governance, and solar power bases will be created. Experiences, collaborative models and NBS will be summarized and extended with respect to renewable energy in poverty alleviation, agricultural and forestry production, ecological restoration, and green hydrogen production. Biomass energy development should be adapted to local conditions while actively promoting the development and application of geothermal energy. 4) The research & development and application of technologies including energy storage, hydrogen energy, and smart grid should be accelerated to provide support for high-proportion blend of renewable energy. 5) A sound guarantee mechanism for the absorption of renewable energy power should be put into place and practice. Technological and institutional innovation is also expected to create good conditions for high-proportion blend and high-quality development of renewable energy.

1.3.2.3 Overall planning to promote diversified and coordinated regional low-carbon transformation and development

There are sharp regional differences in China with a vast territory in economic development model, economic structure, social development level, natural resource endowment, and technological level. This puts different requirements for the design of carbon emission reduction pathways in various regions. Due to the strategic layout for national economic and social development and actual local resource

endowments, the central and western regions bear considerable emission transfers from eastern provinces while producing large amounts of energy and electricity ^[25]. Preventing carbon leakage between regions is of importance not only for rational and equal decomposition of carbon emission reduction targets, but also for the realization of low-carbon development goals and just transition. Therefore, on the basis of the existing division of emission responsibilities, differentiated regional low-carbon development goals should be set, reflecting consumption-based emissions and emission transfers.

Specifically, the more developed areas along the eastern coast and some southwestern areas with abundant renewable energy resources should study and plan to take the lead in peaking CO₂ emissions during the 14th FYP period, creating favorable conditions for peaking nationwide in the next five years. The manufacturing sector will be required to accelerate the transfer to clean energy bases in the northwest and southwest for the purpose of local absorption of renewable energy. Potential issues of equity and justice in the transition process are worth special attention. Particularly, employment and economic development in coal-dependent areas and access to clean energy in poverty-stricken areas need to be properly addressed through means such as capacity building, financial transfer payment, and ecological compensation. Besides, it must be recognized that NBS will play an important supplementary role in pursuing carbon neutrality. Nature reserves will be gradually enlarged while strengthening natural restoration; and carbon storage capacity will be improved for forests, grasslands, wetlands, and agricultural land. NBS will be intentionally employed as an integrated solution to climate change, sustainable development, biodiversity conservation, disaster prevention and reduction, and poverty alleviation, thereby producing multi-field collaborative effects ^[26].

1.3.2.4 Establishment of a green modern comprehensive transportation system through both soft and hard measures

Transportation systems and services need to be transformed systematically. At present, low-carbon technology barriers have been basically cleared for the main modes of transportation in China. However, an effective low-carbon comprehensive transportation system and a corresponding low-carbon transportation service system have not yet formed to support the low-carbon transition of transportation sector. For this reason, focus should be put on adjustment of transportation structure for low-carbon transportation development. In pursuit of a modern comprehensive low-carbon transportation system, the comparative advantages and combination efficiency of various modes of transportation should be given into full play. To establish a modern comprehensive transportation system, efforts can be made in three aspects: 1) Vigorously promote the road-to-rail transition of bulk cargo transportation and accelerate the major road-to-rail projects; 2) Actively revitalize

inland waterway transportation by making smooth major river sections and transportation channels sooner, strengthening the weak links of inland waterway transportation and enhancing the truck-branch linkage capability; and 3) Actively encourage innovation in modes of transportation and accelerate the penetration of advanced methods for transportation organization. For the purpose of optimizing the passenger transportation structure, a convenient and high-quality passenger transportation service system should be constructed to provide better services. Transportation network layout also needs optimization to enhance the intensive utilization of resources, including by promoting low-carbon transportation modes for mid-long distance travels such as inter-cities travel. In terms of green travel, promoting green transportation consumption and improving green travel system are taken as a major strategic choice for low-carbon transportation development. A sound passenger transportation service system should be put in place for green travel, and publicity and education activities on green travel will be carried out for the whole people. As a measure to improve the overall energy efficiency and emission reduction efficiency of transportation, work should be quickened to advance the electrified, intelligent and shared application of new energy vehicles and improve the technology research & development capabilities and innovation mechanisms for low-carbon transportation.

1.3.2.5 Reduction of non-CO₂ GHG emissions

China's mid- and long-term emission reduction commitments towards the years 2030 and 2060 do not specify the coverage of non-CO₂ GHGs. In 2014, non-CO₂ GHGs accounted for about 16% of China's total GHG emissions. In the future, with the realization of deep emission reduction targets in the energy sector, the proportion of non-CO₂ GHG emissions will show an upward trend. This will lead to a steep increase in the marginal costs of non-CO₂ GHG emission reduction^[27]. Since there are currently few effective solutions in this regard, it is necessary to assess emission reduction indicators for source-specific non-CO₂ GHGs and short-lived climate pollutants (SLCP), develop overall GHG emission reduction targets covering all economic sectors, and timely include them into the carbon neutral vision. This will help China better respond to Article 4 of the Paris Agreement—Developing country Parties "are encouraged to move over time towards economy-wide emission reduction or limitation targets in the light of different national circumstances"^[28]. China should advance the implementation of the Kigali amendment, strengthen the research & development and application of breakthrough technologies for non-CO₂ GHG emission reduction, and accelerate financial support to combine non-CO₂ GHG (especially methane) emission reduction with CO₂ emission reduction, orderly coal phase-out, replacement of ozone depleting substances (ODS), cooling efficiency improvement and air pollution control.

1.3.2.6 Deployment of a low-carbon technology system supporting carbon neutrality

The realization of carbon neutrality vision will ultimately rest on the extensive application of low-emission, zero-emission and negative-emission technologies in production and life. To meet the needs of carbon neutrality as soon as possible, China should begin to formulate a mid- and long-term plan for low-carbon technological innovation, and accelerate the research & development and application of key carbon neutrality technologies. With a view to building a world-leading low-carbon technological innovation system, China will push for innovative research & development and commercial application of key common technologies, cutting-edge leading technologies and disruptive technologies, covering energy efficiency, large-scale grid-connected renewable energy, distributed renewable energy, advanced nuclear energy, hydrogen fuel cell, large-scale energy storage, smart grid, renewable resource recycling, carbon capture, utilization and storage (CCUS), BECCS, and direct air capture (DAC). Through a group of forward-looking, systematic and strategic projects for low-emission technology research & development and innovation, China will seek to break through technological bottlenecks in the fields of key materials, instruments and equipment, core processes, and industrial control devices, and gradually build a global innovation center of new technologies, new products, new business formats and new models for carbon neutrality.

Meanwhile, China will promote the deep integration of next-generation information technologies and advanced low-carbon technologies, and significantly enhance the overall efficiency of energy utilization. Guided and driven by the carbon neutrality vision, China will cultivate new growth drivers in high-tech, high-efficiency and low-emission fields with large development potential and strong driving force, such as digital economy, clean energy and smart city, and gradually form a number of international advanced green low-carbon manufacturing clusters. China will further strengthen carbon-neutrality-oriented international technical cooperation and technical assistance, launch China-led international scientific and technological plan on climate change and carbon neutrality, and create relevant international organizations.

1.3.2.7 Demand structure change to nurture the concept of low-carbon consumption

China will introduce consumption policies and pricing mechanisms that encourage green and low-carbon products, and expand the supply of green and low-carbon products and services. China will promote the labeling system for low-carbon and zero-carbon products and reduce certification costs for green and low-carbon products, so as to improve the recognition and market share of green and low-carbon products, creating an atmosphere of green consumption. China will scale up green procurement and build conservation-oriented institutions, low-carbon schools, low-carbon communities and low-carbon hospitals. China will make scientific plan for urban development, promote urban mixed land use to reduce

travel distance, build low-carbon public leisure & entertainment facilities and cultural consumption infrastructure, and vigorously develop urban public transportation that facilitate low-carbon travel. Guidance will be provided to the public to nurture a consumption concept of diligence and thrift and a civilized and simple way of life, which is conducive to the construction of a low-carbon society. Public opinion guidance and information dissemination will be strengthened to raise public awareness of climate change, and broad engagement and active action by the public and grassroots groups will be encouraged.

1.3.3 Policy guarantee system

1.3.3.1 Establishing a sound legal and regulatory system led by the climate change law

China will initiate the legislative process on climate change, and include the Climate Change Law or Carbon Neutrality Promotion Law in the current legislative plan and the Legislative Plan of the 14th NPC Standing Committee. The advancement of climate legislation will help China gain the initiative in international climate negotiations and enhance the image of a responsible big country. The climate change law should center on the system of capping carbon emissions or GHG emissions and lay down supporting systems such as carbon emission permit, carbon emission space allocation, carbon emissions trading, and carbon emission measurement, reporting and verification, while taking into account the legal system with flexible implementation mechanisms for clean development and green low-carbon transition, so as to promote the realization of carbon neutrality and a zero-carbon society.

On this basis, considering the comprehensiveness and complexity of the carbon neutrality goal, China will formulate and amend the relevant laws in a coordinated manner. In specific, the Energy Law, Electricity Law, Coal Law, Renewable Energy Law, and Energy Conservation Law will be enacted and amended oriented to energy mix adjustment and optimization, and the Circular Economy Promotion Law and the Cleaner Production Promotion Law will be revised to promote the efficient use and recycling of resources. For the purpose of building a nature reserve system with national parks as the mainstay for adapting to climate change, the Nature Reserve Law, National Park Law, Wetland Protection Law, and Nature Reserve Regulations will be formulated and revised to provide NBS-related legal guarantees for China's comprehensive green and low-carbon transition. Under the above-mentioned legal framework, all departments and local authorities should develop relevant administrative regulations and local regulations to provide institutional guarantees for the normal operation of the carbon market, green low-carbon transition and clean development. In addition, China will set up a progressively upgraded standard system serving the goals of high-quality development and carbon neutrality. In light of the time nodes for achieving carbon neutrality, new green and low-carbon

standards will be designed based on high-quality development requirements, product life cycles and full life-cycle impacts, in order to cost-effectively extend product service cycle and improve service quality. These standards, which cover industries, technologies, products, climate investment and finance, will provide technical specifications and guidance for achieving carbon peaking and carbon neutrality ^[28].

1.3.3.2 Improving the macro coordinated management mechanism on climate change

To fully play the due role, the National Leading Group on Climate Change, Energy Conservation and Emission Reduction will improve office settings and coordination procedures to promote work institutionalization and normalization, and strengthen overall coordination by further improving the responsibilities and working procedures of relevant departments. As such, the work of tackling climate change will be valued and implemented by various central functional departments, and a broader consensus and coordination and cooperation mechanism can be formed. At the same time, capacity building in responding to climate change and implementing low-carbon transition will be strengthened at the local level. In view of the importance of international cooperation in tackling climate change, it is necessary to improve China's leadership for foreign negotiations. China and the EU have reached consensus on climate change and circular economy, and created mechanisms for high-level environmental and climate dialogue and green partnership. Given this, considering the configuration of officials and institutions on climate change in the Biden administration, China should move faster to institutionalize the existing communication channels, establish peer-to-peer mechanisms, strengthen communication and cooperation among various departments, and formulate relevant strategies and measures in a coordinated manner for policy synergies.

1.3.3.3 Establishing a cap-based emission reduction target system and related systems

Different from the absolute reduction of carbon emissions implemented by developed countries, China needs to set up a cap-based carbon emission target system under the current administrative regime. This system will combine top-down and bottom-up approaches, and meet the needs of economic recovery and moderately advanced development. It is suggested that China establish a cap-centered carbon emission target system with dual reduction of carbon intensity and energy intensity to replace the existing energy dual-control system, and include the work into the 14th FYP Outline. This target system directly serves the goals of carbon peaking and carbon neutrality. It is also conducive to promoting economic restructuring and building a safe, efficient, clean and low-carbon modern energy system, especially an energy system blending high proportion of renewable energy, while overcoming the adverse effects on economic development brought by hard constraints on the total amount of energy consumption at this stage. Regarding specific target, China should learn from the experiences and methods of developing

and applying the existing energy and environmental constraint indicators. The cap-based carbon emission target system should reflect the overall development of economy, energy and environment, and define the range of target values through estimates based on potential economic and environmental development targets, including GDP, energy intensity reduction, and share of non-fossil energy in total energy consumption. At the same time, the statistical accounting system and related systems on carbon emission will be further improved^[26].

The central and local governments will develop and decompose carbon emission targets through consultation, and promote policy synergies between local areas and various industries. The cap-based control on carbon emissions of specific regions and industries should consider factors such as economic development stage, structural adjustment, technological upgrading, energy substitution potential, air quality, and requirements for air pollution control. Reasonable space allocation, peak and time arrangements should be made, taking into account the impact of inter-regional electricity transfer and population flow on carbon emission. In addition, in view of the current uncertainties in international and domestic economic development, progress assessment should be conducted on a regular basis during the 14th FYP period, so that targets can be appropriately adjusted according to the actual situation^[29].

1.3.3.4 Exploring policy synergies between local areas and various sectors in peaking carbon emissions

In order to ensure the effectiveness and international visibility and influence of actions taken by local areas and various departments and sectors, it is suggested that the CPC Central Committee and the State Council issue the Action Plan for Peaking CO₂ Emissions Before 2030. This plan will prompt local areas and various sectors to recognize the importance of such actions, require local areas and key sectors to formulate respective roadmaps and action plans, define the responsibilities of relevant departments in such actions, and facilitate the formation of policy synergy and sound governance system.

Local areas and key sectors will be mobilized to peak carbon emissions. MEE should, in conjunction with relevant departments, support and urge provinces (autonomous regions and municipalities) to take the following actions in light of their respective economic and social conditions and high-quality development requirements: 1) conduct in-depth research on the potential of CO₂ emission reduction; 2) where appropriate, set the target year and develop the roadmap, action plan, key projects and supporting measures for peaking carbon emissions; and 3) reflect them in local and industry development plans and earnestly put them into practice. Provinces and cities that have already pledged to peak carbon emissions need to further verify the intensity and feasibility of targets, and release the action plan in 2021. Developed eastern provinces and cities with good work foundation will be required to publish before the end of 2021 their target year and action plan. The deadline would be 2023 for

provinces and cities with relatively backward economic and social development and insufficient work foundation. Requirements specific to key industries will also be discussed and released, including target years, key technologies and major measures, with priority given to energy-intensive and high-emission industries. At the same time, China will explore the approaches and pathways for coordinating the targets and measures of local areas and sectors for peaking carbon emissions.

1.3.3.5 Accelerating the construction of market mechanisms represented by the national carbon market

To address this issue, China will make efforts in five aspects: 1) Keep improving the top-level design of national carbon market to support long-term stable market expectations. In the future, carbon prices should be maintained at a certain level through guaranteed scarcity of carbon emission allowances, market mechanisms including carbon finance, and strict market supervision. This will give rise to long-term stable expectations of carbon prices in market entities. Through effective price transmission mechanism, they will exert influence on the investment decisions of enterprises, so as to stimulate innovation of low-carbon technologies and products; 2) Reinforce the legal foundation for carbon market construction. Property rights should be clearly defined, which serves as a prerequisite for establishing a carbon emission element market^[30-31]. Clarifying the asset attributes of carbon emission allowances, including whether carbon emission allowances need to or can be recognized as property rights, will help avoid market failures in the allocation and trading of carbon emission allowances. At the same time, by providing a legal basis for strict law enforcement, this can effectively guarantee the smooth operation of carbon market; 3) Ensure appropriate policy alignment and capacity building in the process of national and local institutional reforms; 4) Draw up a roadmap for international cooperation in carbon market, and set phased targets and key tasks. On the one hand, China will continue to strengthen cooperation with the European Union, the UK and other developed countries and regions. By drawing on the experiences and lessons of foreign carbon markets, China will improve the overarching design of the domestic carbon market and predict problems that may arise in the process of market development. On the other hand, with the in-depth advancement of the Belt and Road Initiative, China will consider cooperation on carbon market interconnection with the Belt and Road countries. In this way, China can get involved in the development of relevant international rules, international cooperation roadmap and phased goals and key tasks regarding carbon market. This will facilitate the alignment with China's various measures to promote a community with shared future for mankind; and 5) Reserve a policy window for carbon tax while carrying out carbon emissions trading, and put into effect the carbon tax policy when appropriate. Due to the limitations of government's management capabilities and enterprises' trading capabilities, the carbon market can neither cover

all companies and carbon emissions nor ensure the avoidance of price failures^[32]. In addition, due to large regional disparities, it is unlikely to effectively regulate carbon emission behaviors in various places by relying solely on the carbon market. In short, the carbon emissions trading scheme alone cannot secure the realization of China's carbon emission reduction targets. In light of China's actual national conditions, it is necessary to reserve a policy window for carbon tax and when appropriate, put it into effect for coordinated implementation with the carbon emissions trading scheme.

1.3.3.6 Improving the policy system for climate investment and finance

China will gradually put in place a policy system for climate investment and finance pursuant to the Guiding Opinions on Facilitating the Investment and Financing for Responding to Climate Change. By incorporating climate factors, the green investment and finance system will fundamentally ensure the climate-friendly orientation of investment and finance, and provide the taxonomy and policy basis for guiding climate investment and financing activities of market entities and standardizing product innovation by financial institutions. Governments at local levels will scale up financial investments and tax incentives for green low-carbon transition and development, creating a favorable policy environment for climate investment and finance. The local pilot of climate investment and finance will be kicked off as soon as possible, and the innovation of climate investment and financing products and tools will be encouraged. China will develop an applicable, efficient and advanced system of climate investment and finance taxonomy, optimize the governance structure of funds from diversified sources, and guard against green debt risks. The National Green Development Fund will identify key areas of investment for boosting all-round green and low-carbon transition and innovation, or a separate green recovery and just transition fund will be created, which gives priority support to the orderly withdrawal of coal production, the transformation and upgrading of energy-intensive industries, and the just transition of backward and difficult areas. With respect to the environmental responsibility and investment performance of enterprises, China will promote a comprehensive framework of environmental, social and governance (ESG) criteria, advance corporate environmental information disclosure, long-term environmental and climate planning and comprehensive performance evaluation, and formulate corresponding investment and financing guidelines.

1.3.3.7 Strengthening the coordinated governance of climate change and air pollution

The coordinated governance of climate change and air pollution conforms to China's national conditions and governance realities. The advancement of industrialization and urbanization entails a large amount of energy consumption. As the current energy mix is still dominated by coal, the total emissions of GHG and conventional air pollutants remain high, and the reduction for better environmental quality will take a long time. For China, the world's largest developing country, it is

more urgent to control air pollution and even more necessary to effectively combine climate policies and air pollution control policies. Addressing climate change and controlling air pollution have long fallen into the responsibility of different departments. Climate authorities control GHG emissions by formulating energy plans, energy efficiency standards and industrial policies, while air pollution control authorities reduce air pollutant emissions through measures such as end-of-pipe emission control and corporate production adjustment. These two types of policies are relatively inadequately coordinated.

It is advisable to strengthen the coordinated governance of climate change and air pollution. Socio-economic development planning, energy development planning, and sector-specific plans should give full consideration to the co-benefits of climate action and air pollution control. Meanwhile, emission indicators such as regional and industry carbon emissions and carbon intensity should be aligned with air quality indicators. Climate authorities should strengthen coordination with energy, resource, environment and other authorities to jointly advance the establishment of a climate-friendly economic, social and environmental governance system. In terms of specific policy, China should adopt a climate-friendly air pollution control strategy, coordinate the measures for control over conventional air pollutants and GHG emissions, and optimize the combinations of such measures to achieve win-win results at a minimum cost.

1.4. A Market Mechanism Centered on Carbon Pricing

1.4.1 About carbon pricing

Among policies and measures for reducing GHG emissions, market mechanisms have received more and more attention and are widely used. Carbon pricing policies, especially emissions trading scheme carbon tax, has become a main economic measure for many countries worldwide to control GHG emissions.

Carbon pricing are mechanisms that gives clear pricing to the ton of carbon dioxide equivalent (tCO₂e) of GHG emissions. It mainly includes carbon tax, carbon emissions trading scheme (ETS), carbon credit mechanism, results-based climate finance (RBCF).

Carbon taxes convert the environmental costs caused by carbon dioxide emissions into production and operation costs.

ETS is a policy instrument for emission reduction. It sets emission limits for emitters and allows them to achieve compliance by trading emission allowances. There are mainly two forms of ETS: cap & trade scheme, and baseline & credit scheme. In the first form, the government sets an emission cap for a specific scope of economic sectors. The emission allowances can be auctioned or issued for free.

For every ton of carbon dioxide emitted, the entity shall turn in a unit of emission allowance. Entities can choose to use the government-issued allowances to offset their own emission reduction obligations or for trading. In the second form, the government sets an emission baseline for the bound entity. When the emissions exceed the baseline, the entity shall turn in carbon credits to offset the emissions; when the emissions fall below the baseline, the entity can obtain carbon credits and sell them to other emitters who need the credits.

Column: Advantages and Disadvantages of Carbon Tax and ETS

Carbon tax mainly has the following advantages: First, it takes effect quickly. It can directly increase the cost of GHG emissions, quickly squeeze the profit margins of emission-intensive enterprises, and force them to adopt energy-saving and emission-reduction measures or measures to limit temperature rise, hence achieving substantial emission reductions in a short period of time. Second, it has a low implementation cost. The implementation of the carbon tax mainly relies on the existing taxation system, without the need to set up new institutions or to consider issues such as supporting infrastructure. Third, the tax rate is stable. This can form a stable carbon price expectation guideline so that enterprises can make medium and long-term emission reduction plans. However, it should be noted that carbon tax does not allow direct control of the total carbon emissions. If the carbon tax rate is relatively low, high-emission and high-yield enterprises can maintain their original production and business models, with low willingness for emission reduction.

ETS has three main advantages. First, the result of emission reduction is definite. Under ETS, the government directly determines the total carbon emission allowances within a period of time, that is, the carbon dioxide emissions cap, so the emission reduction result is straightforward and clear, without the need for intermediate parameters. Second, it propels enterprises to reduce emissions through price mechanism, and has an embedded price discovery mechanism. In addition to regular trading of allowances, ETS also allows trading of derivatives such as allowance futures and options, which can further improve market efficiency. Third, it can promote the coordination of cross-border emission reduction. Different carbon markets can achieve interconnection and form a cross-border and cross-regional emissions trading market. After the interconnection, ETS can optimize emission reductions on a larger scale while improving market liquidity. However, it should be noted that an ETS is more difficult to design and costly to operate. Key parameters such as emission allocations can only be determined by estimation, and some unforeseeable situations could create unexpected challenges to the emission reduction effort and the implementation of ETS as planned. The government will need to continuously monitor and evaluate the operation of ETS and make corresponding adjustments, which requires a large amount of administrative resources.

1.4.2 Carbon pricing has been continuously practiced worldwide

1.4.2.1 Development of the carbon pricing mechanism globally

As of May 2021, 64 carbon pricing mechanisms were being implemented globally, and 3 were planned to be implemented ^[33], covering 21.5% of the global carbon emissions, in sharp increase from 15.1% in 2020. This increase was mainly due to the launch of China's national ETS. In 2020, the carbon pricing mechanism created USD 53 billion in revenue globally, an increase of about USD 8 billion over 2019, which was mainly due to the increase in the price of allowances in the EU.

1. The carbon pricing mechanism is continuing to be mainstreamed. In order to strengthen climate commitments, many countries and regions have expanded the coverage of the carbon pricing mechanism. More and more jurisdictions are considering adding new carbon pricing mechanisms beyond the scope of the existing ones to achieve emission reduction targets. For example, Europe, Germany, Austria and Luxembourg are planning to implement carbon pricing policy for sectors that are not included in the EU Emissions Trading Scheme (EU ETS). In order to achieve net zero emissions, many jurisdictions have strengthened the adoption of credit mechanisms and results-based climate finance (RBCF). As the issue of Carbon Border Adjustment Mechanism (CBAM) is put back on the agenda in Europe, countries are likely to be motivated to implement carbon pricing mechanisms more proactively.

2. Although carbon prices continue to increase in many regions, they are still far below the level required to achieve the goals of the *Paris Agreement*. According to the estimates of the High-Level Commission on Carbon Prices, to reduce carbon emissions in a cost-effective manner, the carbon price must reach at least USD 40-80/ton of carbon dioxide before 2020 and USD 50-100/ton before 2030. However, only less than 5% of the GHG emissions covered by the existing carbon pricing mechanisms have reached this price range. About half of the emissions are priced below USD 10/ton. According to IMF estimates, the current global average carbon price is only USD 2/ton.

3. In order to reduce carbon emissions, more and more enterprises have begun to adopt internal carbon pricing. In 2020, a total of 853 enterprises around the world announced that they had adopted internal carbon pricing, and 1,159 enterprises expressed their intention to do so in the next two years, including 226 of Fortune Global 500, a total increase of 20% over 2019. The total market value of enterprises involved increased from USD 7 trillion in 2017 to USD 27 trillion. This shows that the private sector has begun to incorporate climate risk into its strategy and that carbon prices have gradually become an important factor for investment decisions. However, internal carbon pricing has problems such as lack of transparency and inconsistent standards. At present, it is difficult to compare the

levels of internal carbon pricing among enterprises and evaluate its impact.

4. More and more financial institutions have begun to directly participate in carbon pricing. Currently, most carbon markets have strict restrictions on participants, but several key carbon markets are gradually opening up to financial institutions. The EU carbon market has seen the active participation of about 250 investment funds. The participation of financial institutions can help improve market liquidity, but not without risks. For example, speculative behavior of financial institutions will cause large fluctuations in the price of the allowances, which requires strengthened supervision.

5. Carbon credit trading has begun to gradually shift to projects outside the “Kyoto Mechanism”. The latest data shows that there are more than 14,500 registered carbon credit projects, with a cumulative emission reduction of nearly 4 billion tCO₂e. In the past, the Clean Development Mechanism (CDM) often dominated carbon credit activities. However, after the price collapse in the CDM market in 2012, trading in CDM projects has stabilized. Enterprises interested in valuing their emission reduction efforts remain active in the voluntary carbon market, and carbon credits under independent crediting mechanisms accounted for almost two-thirds of the total in 2019. Similarly, governments are also developing domestic carbon credit mechanisms. These projects will not only bring about benefits locally, they will also create a certain degree of flexibility for enterprises to adapt to domestic carbon pricing policies.

1.4.2.2 Development of the carbon pricing mechanism in typical countries and regions

1. The European Union

After a long time of practice and exploration, the European Union has established a carbon pricing mechanism with Emissions Trading Scheme (hereinafter referred to as EU ETS) at its core.

The EU ETS has four development stages, with the first stage being 2005-2007, the second being 2008-2012, the third being 2013-2020, and the fourth being 2021-2030. The third stage marks the maturity of the EU ETS. In addition to the transition from bottom-up to top-down determination of the total emission allowances by the EU, the allocation of the allocation of allowances has also changed from mostly free issuance to in majority auction-based. In 2013, more than 40% of the allowances were auctioned and the proportion will increase year by year (with 100% auction for the power sector). Regarding the allocation of the remaining free allowances, given the large amount of detailed data on enterprise-level emissions obtained in the first and second stages, benchmarking has replaced grandfathering and become the main method of free allocation. It covers a wider range of sectors: power generation and heating, energy-intensive industrial sectors, and intra-European commercial aviation. It also covers more types of GHGs, expanding from CO₂ to CO₂, N₂O and PCF. In

order to solve the problems of oversupply of allowances and low carbon prices in the first two stages, the European Union decided to introduce the mechanism of the Market Stability Reserve (MSR) in 2019. The core role of MSR is to reduce the total allowances circulating in the market so as to increase the scarcity of allowances. The flexibility mechanisms of EU ETS are the Clean Development Mechanism (CDM) and Joint Implementation (JI) under the framework of the *Kyoto Protocol*, allowing the relevant countries to offset their domestic emissions with the Certified Emission Reductions (CERs) and Emission Reduction Units (ERUs) generated from assisting other countries in reducing emissions, hence achieving cost-effective emission reduction. The EU ETS penalties are also becoming stricter. For emitters that fail to meet the emission reduction targets, not only will they have to make up for the unfulfilled allowances in the next year, the fine will also be increased from 40 euros per ton of carbon dioxide equivalent to 100 euros.

The remaining greenhouse gases are covered by the Effort Sharing Regulation (ESR) adopted in 2009 and revised in 2019. The sectors covered by ESR are all sectors except those covered by EU ETS, including transportation, buildings, small industrial emissions (except those covered by EU ETS), waste and agriculture, forestry, etc. The ESR targeted at all six types of GHGs (CO₂, CH₄, N₂O, HFC, PCF and SF₆) specified under the framework of the *Kyoto Protocol*. ESR allocates country-level emission budgets for sectors outside of the EU ETS with some flexibility mechanism, including some transfers between European Member States.

2. The United States

Although there is no federal-level carbon trading mechanism in the United States, local initiatives exist. Some states or enterprises have initiated carbon trading systems to limit GHG emissions, encourage innovation in energy technology and green employment. Among them, the Regional Greenhouse Gas Initiative (RGGI) and the cap-and-trade system of California are the most influential.

Since 2018, the emission targets of RGGI have been continuously strengthened. The plan is to reduce CO₂ emissions in the power sector by 50% by 2020 compared with the 2005 level, and by a further 30% by 2030 compared with the 2020 level. RGGI's reform measures also include the establishment of a cost containment reserve (CCR) to deal with the imbalance between supply and demand of allowances, that is, when the price of allowances in the secondary market reaches USD 10 per short ton of CO₂, the reserve will be triggered to release allowances to contain and stabilize carbon prices. The trigger price will be raised year by year.

At the end of 2018, California approved the reform measures for its carbon trading system after 2020. In order to help achieve California's GHG emission reduction target for 2030, the carbon trading system has been revised in terms of allowance cap, price containment measures, reduction of free allowance allocation and restrictions on the use of emission reduction offsets, and has taken effect in

April 2019.

3. Canada

Starting in 2019, Canada, under the Pan-Canada framework, requires all jurisdictions to establish carbon pricing mechanisms in the forms of carbon trading, carbon tax, or a combination of the two after 2018, or else, the Federal Backstop System shall apply. The Federal Backstop System mainly includes two parts: (1) Fossil fuel regulatory fee will be levied at 20 Canadian dollars/tCO₂e (14 US dollars/tCO₂e) starting from 2019, and will be increased by 10 Canadian dollars/tCO₂e (7 US dollars/tCO₂e) each year till it reaches 50 Canadian dollars/tCO₂e (35 US dollars/tCO₂e) by 2022; (2) An output-based pricing system (OBPS), which sets emission intensity standards for power generation and more industrial activities. OBPS is applicable to facilities that emit more than 50,000 tCO₂e per year in the jurisdictions or any facilities that meet the conditions and volunteer to participate in the system. The two parts can be implemented together or separately. OBPS entities can also offset their emissions with qualified carbon credits.

Some provinces and regions have begun to implement the Federal Backstop System. In addition, the Northwest Territories (NWT) put into force carbon tax on September 1, 2019. New Brunswick also began to impose carbon tax on April 1, 2020 at a rate of 30 Canadian dollars/tCO₂e (21 US dollars/tCO₂e), replacing the fuel fee under the federal mechanism with carbon tax. Alberta abolished carbon tax on May 30, 2019, and replaced the Carbon Competitiveness Incentive Regulation (CCIR) with the Technology Innovation and Emission Reduction (TIER) program. TIER is a baseline-and-credit emission trading system effective from January 2020. Manitoba, New Brunswick and Ontario are considering the use of supplementary carbon pricing mechanisms.

1.4.2.3 Challenges for the carbon pricing mechanism in practice

First, there is a risk of carbon leakage, which can hinder global joint actions on emission reduction. Carbon leakage refers to the phenomenon that after carbon tax or ETS is implemented, multinational enterprises can transfer high-carbon productions to areas with low emission costs, causing the carbon emissions that should have been reduced to be transferred to and emitted in other areas, greatly reducing the effect of the local carbon tax policy. The European Union is discussing the launch of a Carbon Border Adjustment Mechanism in 2021, imposing taxes on certain high-carbon products imported from countries with low carbon prices, or providing export tax rebates for exporters of countries with high carbon prices so that countries leading in emission reduction do not find themselves at a disadvantaged position in competition while avoiding the problem of carbon leakage. At present, the Carbon Border Adjustment Mechanism has not been implemented, with the main challenges being difficulties in calculating the carbon content of

imported goods and compatibility with WTO rules, etc.

Second, the low level of carbon tax rates or surplus of carbon emission allowances can hinder the carbon pricing mechanism from exerting its regulatory function. The carbon price directly reflects the cost of carbon emission cost for the company. At present, in the carbon tax system, tax rates are generally low; in the emission trading scheme, the government often overestimates the demand for allowances and even grants allowances for free and allows unused allowances to be accumulated over years, leading to excess allowances and low trading prices. For high-emission and high-profit companies, low carbon prices will weaken their motivation to reduce emissions, hence the failure to achieve the expected policy results.

Third, social inequality may be exacerbated. Carbon prices may push up the prices of some daily necessities, especially electricity prices. Since the expenditure on daily necessities accounts for a larger proportion of the total expenditure of low-income groups, carbon tax or ETS will pose greater impacts on low-income groups as compared to middle and high-income groups. Therefore, part of the revenues from carbon tax or auction of emission allowances can be recycled to help the disadvantaged groups.

1.4.3 Progress and problems of China's carbon pricing mechanism

1.4.3.1 Carbon pricing as an important policy tool for China to achieve carbon neutrality

Pricing the externalities of carbon emissions in both explicit and implicit ways, thus motivating emitters to include carbon emission factors into their production and consumption decisions, is a crucial paradigm of GHG emission control policies. For a long time, China's climate policy has relied on the synergies among energy, environmental, industrial and other policies, gradually giving rise to a "free-rider" policy structure where synergistic policies are not specially designed to control carbon emissions. As China continues to raise its ambition to tackle climate change, the lack of specific climate policies will gradually widen the remaining emission gap, failing to meet the country's medium- and long-term emission reduction needs. In this case, carbon pricing, which specially targets reducing GHG emissions, will become the dominant means for China to deepen its climate governance and achieve carbon neutrality.

Carbon pricing is an important tool to drive emission reduction. The international community is pushing for effective carbon pricing mechanisms as an important tool to address climate change. Carbon pricing can provide comprehensive incentives for transition and provide a clear value orientation for key emitting industries, while revenues generated through carbon pricing mechanisms can be used to support a just transition. Carbon pricing is also a cost minimization tool, which can generate price

signals to curb the “free-rider” effect and guide spontaneous green investment and innovation in society. Moreover, carbon pricing can increase the cost of carbon consumption and then contain unnecessary high carbon consumption activities. If major global carbon emitters have generally established carbon pricing mechanisms, these mechanisms can provide price signals for global cooperation. In particular, carbon pricing can play a critical role in specific industries such as power, cement and iron & steel, and quicken the pace of carbon reduction in key emitting industries. Looking ahead, carbon pricing of other GHGs can also contribute to earlier carbon neutrality, as IEA studies suggest that carbon pricing can include methane and other GHGs and model studies conclude that carbon prices equivalent to USD 20 could sufficiently promote methane emission reduction with more effective efforts.

1.4.3.2 Progress of carbon pricing in China

China is accelerating the establishment of a carbon pricing mechanism. On October 28, 2020, the Administrative Measures for National Carbon Emissions Trading (for Trial Implementation) (Draft for Comments) and the Administrative Measures for National Carbon Emissions Registration, Trading and Settlement (for Trial Implementation) (Draft for Comments) were open to comments. The two official documents were adopted at the MEE Ministerial Meeting on December 25, 2020 and took effect on February 1, 2021. In addition, the MEE published the 2019-2020 Implementation Plans for the Cap and Allocation of Carbon Emission Allowances (Power Generation Industry) on December 31, 2020. These policies and actions will effectively support the national carbon market to enter the substantive stage of operation. On May 14, 2021, the MEE issued the Administrative Rules Governing Carbon Emissions Registration (for Trial Implementation), the Administrative Rules Governing Carbon Emissions Trading (for Trial Implementation) and the Administrative Rules Governing Carbon Emissions Settlement (for Trial Implementation) to further regulate the registration, trading and settlement of carbon emissions nationwide. On June 22, 2021, Shanghai Environment and Energy Exchange promulgated the Announcement on Matters Related to National Carbon Emissions Trading, which makes clear trading details and other related matters. On July 16, 2021, China's national carbon market was opened, realizing the leap from a ten-year pilot program to the roll-out throughout the country.

The national carbon market is first opened to the power generation industry in consideration of the following: first, the power generation industry is a major emitter of carbon dioxide. As the 2,000-plus key emitters, including captive power plants, in the power generation industry emit 4 billion tons of CO₂ a year, opening the national carbon market to the industry can fully leverage the positive role of the carbon market in controlling GHG emissions. In fact, China's carbon emissions trading scheme has become the one covering the most GHG emissions in the world. Second,

the power generation industry boasts a relatively sound management system and a solid data foundation. Having access to accurate and effective emission data is a prerequisite to carbon market trading. The power generation industry is highly automated with a monotone line of products, complete metering facilities for emission data, normative and verifiable data management, and simple and easy allocation of allowances. Third, the power generation industry features large CO₂ emissions and high coal consumption, so incorporating the industry into the national carbon market first can create synergies between pollution mitigation and carbon reduction.

At its inception, the national carbon market is only available for spot trading of allowances between key emitters in the power generation industry, and is incorporated into the carbon intensity management system in effect in China, with the first batch of allowances approved and allocated to key emitters in the power generation industry using the baseline method and the carbon emissions accounting, reporting and verification system strictly implemented to improve data quality. At present, among the institutional design pertaining to the national carbon market, policy measures such as improving allowance allocation methods and introducing an offset mechanism should be considered to guide market expectations and then form reasonable carbon prices.

Next, China will speed up the revision of relevant the national standards for GHG emissions accounting and reporting in the principle of approving and releasing a standard after it is mature. China will then consider and develop industry-specific allowance allocation schemes and, after the carbon market for the power generation industry is on the right track, further expand the scope of industries covered by the carbon market.

Existing carbon pricing practices have paid off. First, motivated by carbon prices, enterprises begin to consider emission allowances a factor of production, which can help internalize the external costs of carbon emissions. Second, China's carbon pricing practices have facilitated low-carbon innovations in enterprises, and the more significant the carbon price signal is, the more it can induce innovation in low-carbon technologies. Third, such practices have strengthened the capacity building in response to climate change, enhanced the ability of government agencies to supervise carbon emissions and improved the ability of carbon emitters to manage their own emissions. Finally, carbon pricing practices reflect China's positive attitude towards participating in global climate governance and have increased China's voice and influence on this regard by incorporating China into the international carbon pricing system.

1.4.3.3 Problems and challenges facing China's carbon pricing mechanism

1. Carbon pricing lacks a solid rule-of-law foundation and is not adequately aligned to the overall policy objectives. At present, China has not yet identified the

status of carbon pricing in the carbon peak and carbon neutrality targets, or set or decomposed binding emission reduction targets under the carbon peak and carbon neutrality targets, disabling effective long-term restrictions on emissions, and depends heavily on the “free-rider” governance structure and campaign-style governance model. Although market mechanisms serving carbon intensity targets can indeed play a role in emission reduction, they cannot help realize the carbon peak and carbon neutrality targets. China's carbon market should match the carbon peak and carbon neutrality targets by gradually shifting from a baseline approach to a system based on absolute emission caps.

2. China's carbon pricing mechanism fails to exert the role of price discovery. While the national carbon market has clearly updated the mindset and highlighted the responsibility of enterprises for emission reduction, the legal status of carbon allowances in China's carbon market remains unclear, and administrative allocation for free of carbon allowances still dominates the distribution process of allowances. The administrative allocation of carbon allowances requires the competent authorities to be neutral, but they are easily affected by stakeholders in the policy implementation, impeding the market equilibrium and barring the carbon market from discovering the true prices of carbon.

3. The nature of property rights in China's carbon market is still unclear. Carbon allowances are allocated by the government to enterprises for free; such an arrangement does comply with the orientation of the macro policy of cutting taxes and administrative fees, but ignores the responsibilities and obligations that enterprises should have undertaken and the polluter pays principle.

4. The carbon trading market is faced with the risk of price failure. Carbon prices lie at the core of the carbon trading market system. Only under the action of the market supply and demand mechanism and the competition mechanism can reasonable carbon prices be formed in the carbon market. Then, emission reduction resources can be reasonably allocated under the guidance of the price mechanism, enabling enterprises to save energy and reduce emissions at the lowest cost. This, however, entails accurate emission data, tight allowance cap, strict laws and regulations, moderate liquidity, considerable trading volume, diversified investor structure and other important conditions. As indicated by the pilot program, it will take some time to meet the above-mentioned conditions in the environment of market economy in China. Even in the EU, where the market economy is relatively well developed, the EU carbon trading market has experienced price failures and it may be difficult to avoid such risks in the development process of China's carbon market. Therefore, China should consider using carbon taxes, apart from full free market-based means, to solve price failures in carbon trading.

1.4.4 Suggestions for promoting the gradual improvement of China's carbon pricing system

Practices show that the top-level design of carbon pricing should be law-based and market-oriented. **Being law-based** means that China should provide fundamental guarantee for climate governance by leveraging the mandatory nature of laws, form long-term signals for low-carbon transition through the stability of law-based means, and ensure efficient and equitable carbon pricing in a law-based manner. **And being market-oriented** means that China should give full play to the role of the market in allocating climate capacity resources, raise the cost-effectiveness of carbon emission reduction policies and minimize the macroeconomic impact of carbon pricing by making use of explicit carbon pricing. Compared with government regulation-based administrative means, market-based means are more efficient in reducing emissions and can avoid the controversy over “the government picking the winners” and international trade frictions caused by government subsidies.

1. China should develop a carbon emission cap system to provide an institutional basis for carbon emissions trading. China should consider and build a carbon emission cap system to provide a top-level institutional basis for the carbon market, establish the cap of allowances covered by the carbon market in a bottom-up manner and then allocate the allowances vertically to emitters in different industries. In the light of the carbon emission cap targets set by the country for different regions, a dual constraint mechanism that reflects the principles that emitters pay and that local governments undertake the overall responsibility for the environmental quality within their respective jurisdictions should be established; finally, an evaluation system that deals with the implementation of carbon emission cap targets should be formed, where administrative examination should prevail at the beginning and end of planning, law-based supervision dominate in daily operation and the role of market regulation be fully exerted.

2. China should steadily accelerate the establishment of a national carbon emissions trading system and build a hybrid carbon pricing system in due course. China should gradually increase the proportion of allowances for auction, introduce renewable energy into the national carbon emissions trading system dominated by the power industry as early as possible and incorporate other key emitting industries such as iron & steel, aluminum, cement, chemical engineering and petrochemical engineering step by step. China should develop a hybrid carbon pricing system in the principle of controlling trading costs. Enterprises with high emission concentrations should be included in the carbon trading system, and a carbon tax system that controls the cost of carbon reduction should be applied to diffuse small emission sources.

3. China should phase in carbon financial instruments to unlock market vitality and fuel low-carbon transition. Relevant financial institutions and carbon asset management companies should be encouraged to participate in market trading and innovate products and instruments, expand the capital supply for low-carbon investments, and guide the formation of stable carbon price expectations. China should appropriately relax restrictions on market access and explore the establishment of a self-discipline mechanism for the carbon finance industry. China should foster intermediaries and the intermediary market, and encourage deep integration between digital technologies and carbon finance.

4. China should enhance its basic capabilities of carbon emissions accounting, and increase the transparency of the carbon pricing mechanism. On the grounds of the existing corporate carbon emissions accounting system, China should organize the formulation of carbon emissions accounting standards for key exports. China should accelerate the development of administrative measures for GHG emissions accounting, reporting and verification for key products, and upgrade the guidelines and technical specifications on GHG accounting and reporting. An information disclosure system for carbon emissions should be established in line with international standards.

5. China should drive the negotiations on carbon market mechanisms under the Paris Agreement to produce results, avoid carbon leakage and promote fair trade. On the one hand, China should take the opportunity of the COP26 to advance the negotiations on the implementation rules for market mechanisms under Article 6 of the Paris Agreement and reach a consensus on the market mechanisms related to carbon emission reduction. China should, by means of assistance or technical assistance, facilitate the establishment of market mechanisms in other countries that have not yet established carbon emissions trading mechanisms, and push these trading mechanisms to converge. On the other hand, China should cement its partnership with the EU and promote China-EU and other joint climate actions within the framework of international multilateral climate governance. China should promote economic and trade cooperation with the EU by means of green investments under the Belt and Road Initiative, and zero- and low-carbon technology trade, and step up its efforts to address climate change through pragmatic cooperation.

1.5 Global Climate Cooperation in the New Era and China's Role

1.5.1 State of global climate cooperation after the pandemic

Green recovery after the COVID-19 epidemic has become a broad consensus of the international community. The green recovery of global economy will not only

involve the rational use of public resources, but also improve climate resilience on all fronts. Countries around the world are actively exploring pathways for low-carbon transition along with economic recovery. Although international cooperation in the fields of environment and climate encountered bottlenecks after the outbreak of the epidemic, the historical trend of win-win cooperation and development will not change by any means, so will the principles of extensive consultation, joint contribution and shared benefits. Aiming for green recovery and low-carbon transition, it is more necessary to establish an effective multilateral cooperation mechanism and strengthen international cooperation to jointly meet global challenges.

1.5.1.1 Overall situation of international cooperation in global climate governance

The global climate governance system has gone through a process of continuous development and improvement. As underpinning key documents, the United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol and Paris Agreement lay down the core principles and key institutional designs for climate governance^[34]. In essence, they play a role of coordination to maintain the efficient operation of climate governance system and provide adequate and timely support to developing countries with institutional arrangements and public funds, thereby delivering the long-term goal of tackling climate change.

1. Under the new situation of unprecedented global changes, challenges faced by the international community have become more complex and hampered the process of global climate cooperation. Faced with complex issues in various aspects of post-epidemic economic and social recovery, countries tend to compromise the priority of policies and actions on climate change because of the urgency to solve other domestic issues, resulting in weaker intensity and progress of actions on climate change. In the field of climate change, there are obvious differences in interest demands between "two camps", i.e. developing and developed countries. The United States and the European Union are the representatives of the "two forces" of the developed world, while China is the core leader of the developing country group. The game relationship among China, the United States and the European Union has a critical impact on the progress of global climate governance.

2. The COVID-19 epidemics has prompted countries to think deeply about the way to green transition and showed clearly the importance of global cooperation to meet common challenges. Reforming and improving the global climate governance system has become a common concern of the international community. Climate change is a common challenge facing human society at present, from which no country can stay aloof. The good experiences gained in the global combat against the epidemic may provide implications for post-epidemic global climate governance. Global coordination and international cooperation strengthened during the epidemic for joint research on global solutions highlight the value of the concept of a

community with shared future for mankind. In this regard, the severe challenges brought about by global climate change present a shared future for mankind in some sense. It is such shared future that has laid a deep moral and ethical foundation for cooperation between countries around the world to cope with global climate change based on consensus and rules^[35]. As Chinese President Xi Jinping emphasized in his speech at the Climate Ambition Summit 2020, "In meeting the climate challenge, no one can be aloof and unilateralism will get us nowhere. Only by upholding multilateralism, unity and cooperation can we deliver shared benefits and win-win results for all nations."^[36]

1.5.1.2 Practical demand for international cooperation on green recovery and low-carbon transition

Sustained economic recovery is an important challenge facing countries in the post-epidemic era. Green and low-carbon economic incentive measures have become the focus of attention for the international community. China, the European Union and its member states have all made funding arrangements for green development and low-carbon transition in their respective recovery plans. Since international cooperation is indispensable for pursuing green low-carbon development and tackling climate change, there are extensive demand and space for cooperation among countries in the fields of green infrastructure, green trade, green policies, low-carbon technologies, clean energy, and circular economy.

1. Under the situation of the COVID-19 epidemic superimposed on profound changes unseen in a century, the green recovery path demands a more effective cooperation mechanism at the global level. In the post-epidemic era, the top priority facing all countries is to restart the economy and restore people's livelihoods, and the path to recovery will have an extremely important impact on the direction of global climate governance. Sustained green recovery rests on a strong ecological system and a more efficient economic structure. Countries all over the world are rethinking the path to sustainable development goals (SDGs) and economic recovery and will adhere to low-carbon development path in the new economic stimulus plan to jointly promote green recovery. They also consider including green and low carbon indicators of economic stimulus plan in the updated INDCs. The green recovery and low-carbon transition in economy require in-depth cooperation between countries, including coordination and exchanges at the levels of technologies, policies, standards and systems. The original global climate governance system has already been unable to meet the realistic needs of countries in the process of economic recovery, or to effectively cope with realistic non-traditional security challenges such as climate change and public health crisis^[37]. This puts forward new requirements for the reform and improvement of global climate governance system in the new situation, the establishment of a multi-level cooperation mechanism among the government, enterprises and industry associations, and the advancement

of deeper and more effective international cooperation.

2. In light of deep uncertainty in the international political and economic landscape, removing green barriers and expanding funding channels necessities stronger green financial cooperation between countries. There is an upward tendency to create green barriers on the grounds of climate issues, as well as a growing momentum of protectionism that increases trade barriers by means of carbon tariffs. Aid funds and transfer payments are also facing the risk of substantial shrinkage due to the global economic downturn or even recession. In this context, governments and organizations at all levels should further step up pragmatic cooperation, including the formulation of international mechanisms, rules and standards, implementation of activities and formation of standardized and unified monitoring, reporting, and verification system with respect to climate investment and finance, and the establishment of robust multilateral financial institutions and platforms. They should expand cooperation and funding channels in multiple ways, and make capital allocation and use more efficient. With enhanced mutual trust and board consensus, the identification cost of green investment and finance can be reduced, and multinational investment in green and low-carbon fields will be boosted, providing financial support for green recovery of the global economy.

3. The new round of technological revolution and industrial transformation paves the ground for the development and application of green and low-carbon technologies. Realizing low-carbon transition and jointly addressing climate change requires more international cooperation in the field of technology. In the midst of a new round of technological and energy revolution worldwide, the global industrial chain is facing green reconstruction. The advancement of key low-carbon technologies represented by energy efficiency, energy storage and negative emission technologies, as well as the deep integration of digital technology with the economy and society, have smoothen the way to green low-carbon development. In the context of arduous recovery and deep adjustment of the global economy, the European Union insists on implementing the Green New Deal ^[38], and aims to reshape the global industrial chain and cultivate new green growth drivers through the development of emerging green industries, with the hope of leading the global industrial sector to the path of green development. In pursuit of a competitive and climate-neutrality world economy and the global energy and economic low-carbon transition, it is necessary not only to set up a new international cooperation mechanism on green and low-carbon technologies, but also to strengthen the alignment of standards for low-carbon technologies, equipment and products and jointly promote technological innovation in green and low-carbon industries.

1.5.2 Suggestions for strengthening international climate cooperation

The international political and economic landscape and the strategic pattern of

responding to climate change are experiencing profound changes. International relations are also undergoing long-term, fundamental and structural changes. Populism and anti-globalization trends are now prevailing. Especially after the outbreak of the COVID-19 epidemic, the agenda of international negotiations in the climate field was forced to postpone. Prolonged transition period, absence of leadership and inadequate global provision of public goods all present new challenges to global climate governance and dampen the prospects for future international cooperation and joint action. Nevertheless, climate change is one of the major and pressing global issues facing human society. Mankind is a community with a shared future that is bounded together for good or ill. Responding to climate change and promoting green low-carbon development requires the international community to boost confidence, build consensus, act actively and strengthen cooperation. China is the largest developing country and one of the major carbon emitters in the world. Despite its own arduous development tasks and challenges, China should play a more important role in international cooperation on green recovery and low-carbon transition.

1. China should actively shoulder the responsibility of a great power to promote global green low-carbon development. As a developing country, China has made unremitting efforts and positive contributions to addressing climate change, which accomplishing tremendous achievements that are obvious to all in its development process. The Proposal of the CPC Central Committee on Drawing up the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 clearly stated that "carbon emissions will be steadily reduced after reaching the peak" and "(China will) get actively involved and take a driver seat in the international environmental cooperation, including addressing climate change."^[39] China will assume the responsibility of a great power in international cooperation for global green and low-carbon development. It will actively fulfill its due international obligations and responsibilities and honor its commitments to addressing global climate change. This will help China establish the image of a responsible power in the international community and increase its voice in global governance system. This move also meets the inherent requirements of China's endeavor to accelerate the change of growth drivers and promote high-quality economic development in the new stage of development, with a view to sustainable development.

2. China should strive for a more fair and reasonable international cooperation mechanism. Global climate governance is one of the most complexes, difficult and consensus-challenging international public issues. The key factor behind is that climate change has a more direct impact on developing countries, especially poor countries dominated by agriculture. In the process of climate cooperation, the philosophy of seeking common ground while shelving differences and meeting each

other halfway should be upheld. On the basis of fully affirming the broad consensus of various countries reached through long-term efforts, practical and effective institutional arrangements should be made under the UNFCCC to further promote close cooperation between developed and developing countries and build a more fair, just and reasonable order of global climate governance. China will strive to gradually shift the focus of cooperation to the completion of short-term and medium-term emission reduction targets, and will urge developed countries to fulfill their commitments, including providing financial and technical support to developing countries and assisting developing countries in capacity building to deal with climate change.

3. China should expand international exchanges on green and low-carbon technologies. China has always been a defender of global climate governance and an active participant of multilateral climate process, and strived to fulfill its commitments on climate change. China attaches great importance to the research of technologies to deal with climate change, and scales up the input of resources to deal with environmental changes. At present, China has gradually realized parallel technology imports and exports, rather than an importer of green and low-carbon technologies. However, the global distribution of technologies to cope with climate change is scattered. Given regional differences in technology research & development standards, international standards and unified paradigms for basic research & development, systemization, and customization have not yet formed. This has greatly increased the transformation costs of related technologies, which underscores the urgency of international standardization for technologies. Under the new situation, China should actively seize the opportunity and make a strategic layout. Through multilateral and bilateral cooperation, China can build a mechanism for climate research cooperation and result sharing, and promote joint research & development plans for low-carbon technologies with developed countries such as the European Union, the United States and Japan. Climate-friendly low-carbon technologies can be identified to provide strong technical support for global response to climate change. Through breakthrough international scientific and technological cooperation in the field of climate change, China can lead the global climate governance towards new direction.

4. China should promote regional cooperation in climate change. As an all-time defender of global climate governance, China has actively upheld and participated in multilateral cooperation and spared no efforts to honor their commitments. In the face of enormous changes in the world, China should pay more attention to regional climate cooperation while actively advancing global climate governance. Building on experiences in regional cooperation and regional governance, China will continue to push forward South-South cooperation action plan on climate change and strengthen the going-global strategy for green and low-carbon technologies under

the framework of South-South cooperation by providing strategic consulting services and technology transfer services for recipient countries and summarizing and disseminating the best cases of applicable technical assistance. China will put forward an initiative of interstate cooperation on green and low-carbon technologies to spur regional cooperation on research & development of common technologies create bilateral green technology cooperation and will improve the global climate information sharing platform to scale up the sharing of scientific and technological achievements. China should strengthen the active role of multilateral organizations such as the International Climate Technology Center (UNEP IETC) and the United Nations Industrial Development Organization (UNIDO) in the diffusion of green technologies China will deepen the China-EU climate partnership and properly handle China-US climate cooperation. By reducing disputes in a divide-and-conquer approach, the overall environment can be improved based on small consensus, and major changes can be achieved based on small breakthroughs, so that China will continuously enhance its voice and influence in climate cooperation.

5. China should strengthen third-party market cooperation with key countries in Southeast Asia, Central Asia and Africa. China can push forward the reform of global climate governance system by assisting developing countries in low-carbon transition and sustainable development. On the one hand, China will create a multi-level cooperation mechanism involving the government, enterprises and industry associations, establish an enterprise-dominated and market-oriented technological innovation system in the fields of wind, solar and nuclear energy and bioenergy for joint technology and product development, and advance the transformation of research results into applications in the Belt and Road Initiative. On the other hand, China will strengthen the alignment of green standards, and develop the Belt and Road markets and international rules together with its partners. While facilitating exchanges between developed and developing countries on global environmental governance issues, China will accelerate the construction of six major economic corridors as cooperation platforms, expand the cooperation with relevant international organizations and institutions, and build a win-win global climate governance system for jointly coping with the challenges of energy security, environmental pollution and climate change.

6. China should strengthen climate cooperation between non-state actors. China, the U.S. and Europe should carry out cooperation at provincial, state, and city levels to promotes exchanges between think tanks, enterprises, universities and research institutions, thereby creating a cooperation environment along multiple tracks

1.6. Policy Recommendations

1.6.1 Gradually establish and improve an absolute carbon emission cap under the guidance of the carbon peaking and carbon neutrality goals.

First, a new dual control system based on “absolute carbon emissions” and “emission intensity” should be gradually put in place during the 14th Five-Year Plan period in key sectors and key regions, taking the lead to combine energy intensity control, absolute control and emission intensity control targets, with pilots of absolute carbon emission systems. Gradually promote it national-wide and throughout all sectors.

Second, continue to promote legislation to address climate change and provide a legal basis for carbon neutrality. further improve the monitoring, reporting and verification system of greenhouse gas emission and related infrastructures, and integrate them with energy and environment related mechanisms.

Third, further improve the carbon emission inventory and statistical accounting and reporting system, including by integrating non-CO₂ greenhouse gases. Promote the establishment of carbon accounts to market actors, and develop a carbon reporting infrastructure based on such mechanisms as the emission permit system and the energy audit systems.

Fourth, establish the regional and sectoral carbon emission target allocation methods, taking into account the characteristics of population dynamics, industrial layout, and inter-regional power transfer.

Fifth, select typical provinces, municipalities, sectors and enterprises to launch early demonstration pilots of the planning, innovation, investment and policies for early peaking and carbon neutrality.

Sixth, reinforce the functions and institutionalized role of the central working group on carbon peaking and carbon neutrality; strengthen the coordination of climate change with economics, energy, environment and other aspects. Coordinate the international and domestic climate affairs. Ensure that the fight against climate change receives recognition and is implemented in all departments of the government, and form a cooperation and consensus forming mechanism to consolidate the responsibilities of all parties. Guide government departments, local authorities, and enterprises to implement the carbon peaking and carbon neutrality.

1.6.2 Achieve both economic recovery and low-carbon development by actively carrying out deep decarbonization efforts in key industries

First, promote the in-depth development of the manufacturing industry towards decarbonization, strictly control new production capacity of the pollution-intensive and energy-intensive industries. Expand strategic emerging green industries such as energy efficiency, environmental protection, clean production, and clean energy.

Second, build a joint government-university-enterprise research and development platform to develop raw material, fossil fuel substitution and process innovation technologies. Promote the zero-carbon retrofit and innovation in high-carbon industries such as steel, non-ferrous metal, cement, chemical industry, and petrochemical industry, and actively explore technologies for carbon dioxide capture and utilization.

Third, accelerate the promotion of the integration of digital economy with the traditional economy sectors and enhance the application of big data and artificial intelligence technologies in improving energy efficiency and decarbonization.

Fourth, increase investment in low-carbon infrastructure, restrict new investments in traditional especially carbon-intensive infrastructures, and prioritize low-carbon infrastructure and the ones enabling a high share of renewables in the scope of the “New Infrastructure” as well as the 14th Five-Year-Plan.

Fifth, accelerate the restructuring of transport by developing green shipping and railways, upgrade urban cluster development driven by high-speed rail and transit networks, and set clear milestones for full electrification of vehicles and the phase-out of internal combustion engine vehicle.

Sixth, demonstrate and promote zero-carbon building technologies such as photovoltaic-energy storage-direct current-flexibility (PEDF) through leveraging low-income housing and old city renovation projects as catalyst and exploiting the structural opportunity of the development of metropolitan areas.

Seventh, protect and enhance the carbon storage capacity of forests, grasslands, wetlands, and agricultural land, and proactively implement nature-based solutions to simultaneously address climate change, sustainable development, biodiversity, disaster, poverty and unleash synergetic benefits across multiple fields and local communities.

1.6.3 Build a new power generation paradigm with low-carbon energy at its core, accelerate coal control and the large-scale deployment of renewable energy

First, boost the exploration of a new energy paradigm (especially new power system) centered on renewable energies and accelerate the establishment of relevant supporting policies, promoting utility-scale and distributed renewable energy according to local conditions, and avoid risks of curtailments under the new wind and solar capacity targets. Accelerate pilots and promotions of an energy system integrated between energy sources, grid infrastructure, load adequacy, and energy storage, which is based on renewables energies in accordance with local conditions. Systematically resolve problems of the “integration of wind power, solar power, hydro power, and energy storage” pilots, such as power imbalance, power insecurity, lack of the coordinated development of regional power grid and price transmission mechanism. Explore the cost sharing mode of energy storage, and strengthen the

demand side response mechanism to provide economic incentives for adjusting peak and valley electricity consumption. Formulate a comprehensive national development masterplan for large-scale clean energy base to strengthen the development of utility-scale wind and solar energy power and the establishment of large-scale base, propel the deployment of the distributed wind and solar power in central-eastern and southern areas; and promote the construction of off-shore wind power along the eastern areas. Formulate policies to further reduce the financing costs of renewable energy enterprises, especially in terms of land allocation, IPO queuing in advance, targeted loans and reserve ratio reduction, to support the grid parity of wind and solar power.

Second, speedily implement President Xi Jinping proposal to strictly control coal power projects and the growth of coal consumption during the "14th Five-Year Plan" period, and gradually decrease coal consumption during the "15th Five-Year Plan" period. Formulate a policy framework and roadmap to orderly phase-out coal, and strive to reduce the proportion of coal in primary energy consumption to below 50%. During the "14th Five-Year Plan", strictly control newly added thermal coal-fired power generation, phase-out scattered coal consumption and accelerate the reduction of industrial coal use. Control the development scale of carbon-intensive industries such as coal-based chemical industry. Develop fiscal and monetary policies and mechanisms conducive to phasing-out coal and avoiding stranded assets brought about by coal related projects.

Third, promote the economic and social transition of coal-dependent cities. Accelerate the development of a diversified economy, foster non-coal industries suited to local advantages, put forward solutions to social problems such as resettling compensations and employment transformation, carry out training and capacity building in the fields of emerging sectors, and set up special subsidies and funds to support local governments' coal economy transition.

Fourth, speed up electrification by promoting the deployment of electric furnace steel, building materials electric kiln and electric vehicles; applying heat pump, electric cold storage air-conditioning, thermoelectric boiler storage in culture and sports facilities, shopping malls, office buildings, hotels, airport terminal buildings; and continuously improving the proportion of electricity consumption in sectors including manufacturing, transportation, and household livelihood.

1.6.4 Accelerate the development of carbon pricing, carbon market and carbon finance mechanisms and promote green finance

First, accelerate the research and implementation of the establishment of carbon asset rights and provide supporting policies, strengthen the disclosure of climate information in financial actors.

Second, steadily accelerate the construction of the national carbon emission

trading scheme and set a clear absolute cap for the carbon market. Gradually increase the proportion of allowances allocated by auctions, and prioritize the introduction of renewables in the current national ETS (currently power generation only). Gradually incorporate other large emitting industries such as steel, electrolytic aluminum, cement, chemicals and petrochemicals.

Third, develop a hybrid carbon pricing system based on the principle of controlling transaction costs. Emission intensive companies will be included in the carbon trading system, while those with low emission intensity will be included in the carbon tax system.

Fourth, develop carbon finance to allow carbon assets can be used as a pledge and to develop carbon futures. Establish the connection between carbon market and finance market and ensure carbon market has enough capital inflows. Finance the purchase of emission quotas to keep carbon price at a certain level and form the expectation that the carbon price will rise, so that low carbon transition could be further stimulated and investment and technological innovation is promoted.

Fifth, promote green finance by bridging with the international standards on green finance and taxonomy, incorporating environmental and climate consideration into financial risk assessment. Promote mandatory disclosure of climate-related information by financial institutions, advancing the coordination and synergy of policies for green finance, industry and climate.

Sixth, promote the achievements of negotiations on the Paris Agreement rulebook on market mechanisms, preventing carbon leakage and promoting fair trade.

1.6.5 Strengthen international exchanges and extensively participate and lead the global climate governance and implement the Paris Agreement

First, overcome the barriers to personnel exchanges and information exchanges caused by the pandemic and the complex international environment. Through various online and offline methods, various platforms including the CCICED can be used to promote and strengthen the international exchanges between Chinese and other countries' government departments, and with non-state actors, keeping information flow unimpeded. At the same time, the government should actively ease conditions for international exchanges.

Second, actively carry out climate dialogues and exchanges at the expert level, and create opportunities to carry out dialogues on Track 1.5 and even Track 1. Through information exchanges, dissolve doubts, enhance mutual trust and understanding, and jointly promote multilateral processes. Enhance Sino-American and Sino-European, and China-developing countries mutual political trust. Timely manage differences, strengthen cooperation, and eliminate the negative impact of political difficulties and disturbances in non-climate issues on the global fight

against climate change.

Third, facilitate main bilateral and multilateral climate dialogues based on the governance structure of the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement. Use the Climate summits, the Major Economies Forum (MEF), the Ministerial on Climate Action (MoCA), the G20, the CBD15 and the COP26 to discuss climate cooperation mechanisms, green finance and carbon finance policies, fiscal policies for the low-carbon economic recovery from the pandemic, and low-carbon infrastructure investment cooperation.

Fourth, restrict and gradually stop public finance for overseas coal power investments. Clarify policies as soon as possible to guide policy banks and state-owned commercial banks to stop coal power investments in the “Belt and Road” region and build the green “Belt and Road Initiative” (BRI). Supports BRI countries to construct low-carbon energy infrastructures, deploy renewables and build up sustainable business model of green energy via developing better policies of green finance, strengthening technological collaboration, developing third-party cooperation.

Fifth, optimize China’s portfolio of foreign trade and investment, facilitate the integration of regional supply chain of low-carbon manufactures, and accelerate China’s green recovery and the development of low-carbon industry, by using every advantage of some regional mechanism such as the competitive position in low carbon manufacture chain that the “Regional Comprehensive Economic Partnership Agreement” (RCEP) countries have.

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Appendix: Gender Equality Analysis

Gender equality is the basic right of human. Without gender equality, half of the population loses the chance to live life at its fullest. This is particularly the case in relation to mitigation and adaptation of climate change. At the 52nd Session of the IPCC in February 2020, the Panel adopted the Gender Policy and Implementation Plan, aimed at enhancing gender equality in its processes and in order to promote a gender-inclusive environment. Gender equity is also mentioned in the Paris Agreement, as part of the issues that should be taken into consideration when taking action to address climate change. In the Nationally Determined Contributions (NDCs) submitted in 2016, 64 parties include a reference to women or gender, and when countries submit their new and updated NDCs, most of the enhanced NDCs include a reference to women or gender, demonstrating a stronger awareness and willingness to tackle gender equality in climate considerations^[1].

Gender equality is part of the basic state policy of China. To promote the status of women and gender equality, China focuses on ensuring women's equal opportunities and participation in economic activities, employment, and entrepreneurship^[2]. In the latest National Program for Women's Development 2011-2020, "women and the environment" is set as one of the seven major topics. Taking a step forward, following the UNFCCC framework and Paris Agreement, China should further recognize the importance of the link between gender equality and climate change, and include reference to women or gender when updating its NDC in order to mainstream the awareness and action towards gender equality in the implementation of its climate policies.

Specifically, it is important to ensure that women are viewed as active agents who must have equal say in the design, decision-making and implementation of relevant plans and actions, and conduct gender and vulnerability analysis at the design stage and establish sex-disaggregated baselines, indicator and targets. Collection, use and analysis of sex-, age- and disability-disaggregated data and information in the formulation of climate policies and strategies for climate mitigation and adaptation is also helpful for ensuring gender-inclusive climate solutions. We list three main areas for specific work integrating gender equality with climate actions in China.

1. Gender and climate as cross sectoral issues would rely much on multi-ministerial efforts

Gender is not a stand-alone topic. It is an issue that every sector and every region must face. In China the National Working Committee on Children and Women

under State Council is in charge of gender related work, coordinating relevant government departments to implement laws, regulations, and policies and measures for women and children. Its member departments include Ministry of Ecology and Environment, National Development and Reform Commission, Ministry of Science and Technology, and other departments responsible for climate actions and low-carbon transformation in China. It is important to make full use of the coordination power of the Committee, to mainstream gender with climate and low-carbon development. The Committee is in charge of drafting China's Outline for the Development of Women, which is a ten-year guiding document for gender equality and women's development. The latest Outline for the Development of Women (2011-2020) targeted women's equal participation in environment decision and management. For the next Outline, climate related targets could be included as a step forward, through effective coordination and communication between MEE and the Committee. Overall, it is important to strengthen cross department coordination and collaboration, to ensure coordinated efforts and co-benefit of both climate actions and low-carbon transformation, and gender equality and women's development.

2. Women's participation in the carbon-neutral job market

Carbon neutrality will need a systematic transformation of the economic structure, and will fundamentally change the job market. By phasing out carbon-intensive traditional sectors and building a new high-tech and low-carbon green economy, carbon neutrality provides a starting point for making women's contributions to society and the economy visible as well as the opportunity to revalue them. According to the ILO, taking action in the energy sector to limit global warming to 2 degrees Celsius by the end of the century can create around 24 million jobs, largely offsetting any job losses^[3]. These new job opportunities in the emerging green industries has a chance to reach men and women equally, especially those jobs that have not yet been recognized as "masculine", including a large number of technical and high-paying jobs and climate mitigation and adaptation policy and project jobs^[4]. It is important to ensure that pre-existing gender inequalities in conventional energy and industry sectors are not transferred to the emerging green economy.

Through incorporating active guidance and planning and regulation with a gender perspective into the green transformation policies, the co-benefits of green and low-carbon development as well as women's development could be achieved at the same time. In order to ensure women's equal opportunity in green jobs, it is also important to prepare education in a gender neutral way, implement capacity building programs for women and create awareness for women's participation in green job sectors, including in positions of leadership. Policy and decision makers should ensure employment and skills development policies designed for green job sectors are gender responsive, well informed, coherent and broadly supported by all relevant

stakeholders. They must ensure that green job policies harness already existing international gender frameworks and treaties. Employers should ensure that job postings are inclusive ^[5].

3. Women's safety and transportation

Women's safety in public spaces has always been an important social issue in China and around the world. It limits women from using transportation service as freely as the low-carbon modal changes would encourage. A report published in May 2021 shows that more than ten percent female passengers has encountered inappropriate behavior of drivers when they use ride-sharing services, being exposed to safety risks ^[6]. In another report which investigated violence cases towards women in public, 28.33% of the cases were reported in public transportation and another 6.67% were reported in taxis and ride-sharing services ^[7]. Concern of safety issues push women away from using public transportation and ride-sharing services. Instead of shared transportation, many women choose to drive, which leads to more carbon emissions. Improving women's safety in public – especially in public transportation – facilitates women to use transportation service in a more shared and low-carbon manner.

Improving women's safety in public requires joint efforts of stakeholders. Public security departments and media could raise awareness of gender and security, and ensure smooth reporting and complaint channels. Legislative department could improve related legislation and ensure its implementation. It would also be helpful to encourage and support civil society's participation in this area. Overall, improving women's safety in public and transportation will bring comprehensive benefits, including less carbon-intensive transportation of women.

While there would be many more, the three concrete examples above illustrate how gender equality could be promoted at the central and planning level, in the social changes that the low-carbon transition will drive, and as a multi-beneficial action that enhances gender equality and enables climate-friendly behaviors.

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Chapter 2

Post-2020 Global Biodiversity Conservation

2.1 Background

The month of September 2020 became an historic moment when Nature registered high on the political agenda of global leaders. “*We will protect our planet*” became a call of governments in their United Nations (UN) 75th Anniversary Declaration ^[1]. 124 member states participated and at least 65 heads of state and government (HoS/G) spoke at the first ever UN Summit on Biodiversity with such a level of attendance ^[2]. Together with representatives of business, international organizations, finance institutions, scientists, civil society, youth, indigenous peoples and local communities, parliamentarians and local government, political leaders have sent clear messages that immediate and stronger actions are needed to reverse biodiversity loss and put nature on a path to recovery during this decade. COVID-19 has disrupted the scheduling of major international meetings planned for late 2020, including the 15th Conference of Parties (COP) of the Convention on Biological Diversity (CBD) and the UN Framework Convention on Climate Change (UNFCCC) COP 26 by a year. The year 2021 is now *de facto* the Super Year of Environment.

Without question, we are facing the need for a critical “super decade of action” for achieving the UN Sustainable Development Goals and for addressing the climate change and biodiversity crises — plus “green recovery” from the Covid-19 pandemic. The UN General Assembly has designated 2021-2030 as the UN Decade on Ecosystem Restoration. The decade should become a stepping stone to a new green global economy that will help to build a more harmonious relationship between people and nature in all parts of the world by mid-century. We see examples emerging, such as commitments for nature-based solutions (NbS) to climate change. The Leaders Pledge for Nature ^[3] (heads of state and government

level) is calling for reversing nature loss by 2030 for sustainable development, leading towards a nature-positive future. This will require business, communities, and organizations of all types as well as governments (national and local) to take actions all together, for carbon neutral, nature positive, clean and green economic development, for substantial decoupling from today's energy and resource use levels to allow for building an equitable and sustainable future worldwide.

China sent a clear and bold signal to the world with its September 2020 UN announcement that it will strive to become carbon neutral by 2060. China has the opportunity to communicate and give signals on its ambition on nature, ahead of the rescheduled CBD COP 15 meeting that will take place in Kunming in October 2021. The theme is Ecological Civilization: Building a Shared Future for All Life on Earth, capturing the need for transformative changes and strengthened international cooperation. China's new 14th Five-Year Plan (2021-2025) includes major commitments in its drive to build a 'Beautiful China' in 2035 with realization of Ecological Civilization through green development, environmental protection and ecological improvements. This period could also be a time for China to strengthen its National Biodiversity Strategy and Action Plan (NBSAP). China is deeply engaged in ecological restoration that may well serve as an important source of knowledge and innovation for other developing countries.

This China Council for International Cooperation on Environment and Development (CCICED) Special Policy Study (SPS) has made annual recommendations since 2018 emphasizing the need for a highly ambitious agenda at the CBD COP 15, including development and acceptance of a new post-2020 global biodiversity framework (GBF), and building a solid basis for its support and accelerated early action. Also, we have highlighted some of the innovations China is undertaking, including those drawing international attention such as ecological redlining. Over this 2018-to-2021-time period we have seen international momentum build towards innovation and early commitment to action in the post-2021 period, plus better understanding of the tremendous effort required to "bend the curve" of biodiversity loss to be nature positive by 2030. The transition and implementation efforts during the years immediately following COP15 are of great significance. Furthermore, there is urgent need to address serious matters regarding gender gaps, funding gaps, and the ongoing need to build synergies among the multilateral environmental agreements and other efforts directed to sustainable development. CBD COP 15, UNFCCC and the UN Global Food Systems Summit, plus the on-going efforts to build green recovery and improve resilience against events such as epidemics and pandemics are important ways to mainstream biodiversity into national and global decision-making.

China will remain as the CBD COP President past 2021 until COP 16. During this time, China can give full play to the role of the president country, perhaps by

promoting international biodiversity governance to a new level. Rapid transitions will need to be initiated at multilateral, regional and national levels for the implementation of the GBF. Such measures will need to involve many other sectors beyond environmental institutions and ministries. Countries and the international community also must take mid-term and long-term approaches to improve relationships between people and nature. There will be important opportunities to do so in this post CBD COP 15 period.

In recent months our CCICED SPS has turned its focus towards examining some of the key planning matters still remaining before October 2021 and for the implementation of the GBF in the years immediately afterwards. The year-long postponement of the COP 15 has allowed groups to build new insights for biodiversity and ecological conservation. There is also a better sense about how a green recovery from COVID-19 might help with biodiversity and ecological improvements. Landmark studies on the economics of biodiversity have been completed, and excellent analysis is available concerning ways to link climate mitigation and adaptation to nature based and nature positive solutions in order to develop win-win situations. Originally suggested for linking climate change and biodiversity, NbS can address other societal challenges including human health, food and water security, natural disasters and biodiversity loss^[4].

The current report covers a range of matters that we believe will be of high significance during COP 15 and in the years after. There are five main topics covered (see Chapter 2), each described in a short chapter (Chapters 3-7). More detailed research reports arising from most topics are available. Since the work of this SPS is carried out in real time leading up to CBD COP 15, it is also possible that some studies will be updated as necessary in the months prior to the Kunming event. Chapter 8 presents summary recommendations of general significance.

2.2 Elevating Nature Agenda for an Ambitious and Transformational Post-2020 Global Biodiversity Framework (GBF)

Covid-19 Pandemic has made it clearer than ever that nature plays a pivotal role in our health, society, and economy. Facing planetary emergencies, expressed as intertwined climate, biodiversity, and human health crises, the challenges are daunting. But people and leaders are waking up to them.

Recent research by the Economist Intelligence Unit (EIU) found that hundreds of millions of people across 54 countries globally share a rising concern about nature^[5]. To date in 2021, 89 heads of state and government signed the Leader's Pledge for Nature committing to reverse nature loss by 2030. We also witnessed for the first time that the G7 puts nature alongside climate change at the heart of their agenda. We must now harness this 'eco-awakening' and these high-level commitments to

ensure the critical actions needed for climate and nature, and to translate these commitments and call-to-actions into national efforts and actions in global decision making. This once in a decade opportunity is to translate these commitments into an ambitious and transformational post-2020 global biodiversity framework to be agreed upon as the most important outcome of the CBD COP15.

2.2.1 High Level Movement Analysis on Global Nature Agenda

The global biodiversity agenda has accelerated rapidly since the UN Biodiversity Summit in Sept 2020 (and since we last submitted our SPS research report in Nov. 2020). More and more world leaders are putting nature high up on their agenda and commit to reverse the loss of biodiversity. The momentum is strong. While China is implementing Ecological Civilization thoughts in its national policy and actions, it is time for China to consider joining the global collective leadership. China could play a critical leadership role through either its own high level initiatives on biodiversity at global level or building on the existing global leadership initiatives. The following sections provide up-to-date observations on the biodiversity leadership at global stage.

2.2.1.1 Leaders' Pledge for Nature

1. Global leaders have made 10 Commitments^① to take urgent actions to reverse the loss of nature and to achieve sustainable development goals by 2030 in their Leader's Pledge for Nature (LPN). The LPN has by now (July 2, 2021) been endorsed by 89 world leaders, covering Heads of State and Government (HoS/G) from 88 countries and the President of the EU Commission. The LPN represents 37.45% of world gross domestic product (GDP) and over 2 billion people (a quarter of the world population) across 6 regions (Africa, LAC, Asia Pacific, Europe, Middle East, North America), and including 8 biodiversity rich countries^② (i.e., Like Minded Megadiverse Countries).

Female leaders have shown their leadership in the process as the percentage of

^① Ten commitments from the Leaders' Pledge for Nature include: Supporting an ambitious and transformational post-2020 global biodiversity framework; Integrating actions to tackle inter-linked environmental challenges; Mainstreaming biodiversity across government and sectors; Transitioning to sustainable patterns of production & consumption and sustainable food systems; Reducing pollution on land, in water and in the air; Sustainably managing our oceans; Promoting a One Health approach; Jointly putting biodiversity, climate and the environment at the heart of COVID recovery strategies and fostering a green and resilient recovery; Stepping up resource mobilisation (more support to biodiversity and nature-based solutions, including eliminating or repurposing harmful investments and subsidies and aligning financial flows to environmental commitments and SDGs); Supporting high climate ambition. https://www.leaderspledgefornature.org/Leaders_Pledge_for_Nature_27.09.20.pdf

^② Bolivia, Colombia, Costa Rica, Ethiopia, Guatemala, Kenya, Mexico, and Peru

them endorsing the Leaders' Pledge for Nature (13%) is higher than the average composition of female leaders across all countries (11%). A total 12 out of 23 female leaders (57%) endorsed the Pledge.

2.2.1.2 One Planet Summit

Leaders from 13 countries and the European Union Commission, including China's Vice Premier Han Zheng, plus 11 leaders from financial institutions, civil society organizations (CSOs) and banks joined French President Macron at the One Planet Summit (OPS)^① on January 11, 2021. These leaders reiterated the importance of nature to people and health. At the OPS,

- France and Costa Rica launched the High Ambition Coalition^[6] gaining 57 country's support to advocate for protecting at least 30% of terrestrial and marine spaces by 2030.

- A multi-stakeholder initiative "Great Green Wall Accelerator" was launched, with partners pledged \$16.85 billion in international finance from 11 countries by 2025.

- The Natural Capital Investment Alliance was announced, intended to bring together \$10 billion for nature by 2022.

- The Taskforce on Nature-related Financial Disclosure (TNFD) has gained political momentum. This initiative, promoted by public and private stakeholders, including around 50 leading financial institutions, will develop a framework for measuring the risks, impacts and benefits of economic activities with regard to biodiversity. In June 2021, major financial institutions and multinational corporates endorsed the launch of the TNFD, which will support business in assessing emerging nature-related risks and opportunities. Finance ministers from the Group of Seven (G7) of the largest economies have endorsed the launch of the new Taskforce on Nature-related Financial Disclosures (TNFD).

- UK and French committed to earmark 30% of their overseas public climate funding to nature-based solutions.

These and many other action commitments^[7] made at the OPS showed encouraging signs of concrete actions to be taken by the world leaders.

2.2.1.3 Leadership of the UN and the UN Secretary General

The UN Secretary General (UNSG) is championing the health, climate and nature agenda. In his speech on the State of the Planet in Dec. 2020, the UNSG pointed out that "humanity is waging war on nature" and called out to "make peace with nature" by not only "resetting the world economy" after COVID, "but to transform it"^[8]. Subsequently, UNEP released a report on Making Peace with Nature to tackle climate, biodiversity and pollution emergencies. These notions should and can be reflected in the GBF and inspire actions taken by countries^[9].

^① <https://www.oneplanetsummit.fr/en/news-17#node-anchor-157>

2.2.1.4 Food Systems Summit

Agriculture and food systems have a very significant environmental footprint on the world, using 34% of land, 69% of freshwater, and generating around 24-30% of greenhouse emissions. The 70% of biodiversity loss is due to the food sector. Yet around 33% of all food is wasted! How we produce and consume food is the biggest driver of biodiversity loss.

In late 2021, the UNSG will convene the first UN Food Systems Summit^① as part of the UN Decade of Action to achieve the SDGs by 2030. The Summit will gather game changing actions to deliver progress on all 17 SDGs. The summit will bring together key players from the worlds of science, business, policy, healthcare and academia, as well as farmers, indigenous people, youth organizations, consumer groups, environmental activists, and other key stakeholders. The following five actions trackers are all critical to the achievement of SGDs and building a carbon neutral, nature positive and equitable future: ensuring access to safe and nutritious food for all; shifting to sustainable consumption patterns; boosting nature-positive production at scale; advancing equitable livelihoods; and building resilience to vulnerabilities, shocks and stresses. The outcomes of the Food System Summit should provide an innovative outlook on how to address the world's food system for use at other key decision making fora.

Food systems are not only the greatest drivers of biodiversity loss globally but also the biggest drivers of biodiversity loss in China. This is also an opportunity for China to coordinate domestic efforts and actively participate in the global integrated efforts through combined decisions and initiatives in food, biodiversity, climate and health fields. China's global efforts should be built on China's great efforts and achievements on poverty alleviation, food security, as well as carbon neutrality and biodiversity conservation that China is striving to achieve. This will be an excellent opportunity for China to tell the 'China Story' to a global audience^[10].

2.2.1.5 Ocean coalitions

Two thirds of global gross marine products rely on a healthy ocean. The ocean economy's annual value is estimated to be as much as \$3 trillion by 2030^[11]. Ocean can absorb 30% of anthropogenic CO₂ emissions. 500million people depend on coastal resources for food. And 89% of fish are overfished or at maximum capacity due to resource exploitation by humans.

There is no healthy planet without healthy oceans. And yet, the global attention to oceans has not been sufficient. Amidst both opportunities and challenges, world leaders are organizing for actions.

^① <https://www.un.org/en/food-systems-summit>

- 14 world leaders^① initiated the High Level Panel for a Sustainable Ocean Economy in December 2020, to build momentum for a sustainable ocean economy in which effective protection, sustainable production and equitable prosperity go hand in hand.

- The Global Ocean Alliance^② and its current 39 members, support 30% marine protection target, which contributes to the High Ambition Coalition (HAC)'s 30% protection target for both marine and terrestrial. The chairs of the HAC, Costa Rica and France, are members of the Global Ocean Alliance.

These actions provide opportunities for the world to address the combined climate, biodiversity and pollution crisis with integrated solutions, recognizing the key role the ocean plays.

2.2.1.6 Country Leadership

The UK, host country of UNFCCC COP26, has indicated in its policy paper Global Britain in a Competitive Age: the Integrated Review of Security, Defence, Development and Foreign Policy^[12] their determination to prioritize tackling climate change and biodiversity losses in 2021 and beyond. This determination comes with political leadership, financial commitments, and national actions such as commitment to protect at least 30% of its land and sea to support nature recovery. The UK's priority actions will be, among others, to reverse biodiversity loss by 2030, delivering goals and commitments set by the Paris Agreement, the CBD COP 15 outcome, and the 2020 Leaders' Pledge for Nature. The UK also has expressed strong willingness to work with China in tackling transnational challenges. This is a wide-open opportunity for China to seek collaboration on areas of high moral ground and common interest which are in line with the interests of both China and the world, avoiding or mitigating other geopolitical disagreements.

All three Rio Conventions, UN CCD (United Nations Convention to Combat Desertification), UN CBD, UNFCCC, are critical to deliver the UN Decade of Action for sustainable development and UN Decade of Ecosystem Restoration^[13,14]. French President Macron proposes a Summit in NYC in 2021 ahead of the three COPs to give them the needed push for decisions and tangible results^[15]. He called for the mobilization of the international community at the highest level to deliver, for the first time, a message of common ambition^[15].

The UN General Assembly decided on May 20, 2021 that an International

^① The 14 Ocean Panel countries include: Australia, Canada, Chile, Fiji, Ghana, Indonesia, Jamaica, Japan, Kenya, Mexico, Namibia, Norway, Palau and Portugal

^② There are currently 39 members in the Global Ocean Alliance: Australia, Belgium, Belize, Benin, Cabo Verde, Cambodia, Canada, Chile, Costa Rica, Croatia, Denmark, Ecuador, Fiji, Finland, France, Gabon, Germany, Guatemala, Honduras, Italy, Kenya, Luxembourg, Maldives, Mauritania, Monaco, Nicaragua, Nigeria, Palau, Panama, Portugal, Senegal, Seychelles, Spain, St Kitts and Nevis, Sweden, Togo, United Arab Emirates, United Kingdom and Vanuatu.

Meeting entitled “Stockholm+50: a healthy planet for the prosperity of all – our responsibility, our opportunity” will be held in Stockholm, Sweden on June 2-3, 2022 ^[16]. This will be during the week of World Environment Day, to commemorate the 50 years since the UN Conference on the Human Environment and the establishment of UNEP. This will be a critical moment for humanity to collectively look back humanity’s half century efforts on the environment and start the strongest implementation of international agreements, such as the GBF that would be agreed before that.

2.2.1.7 China is stepping up its leadership on biodiversity at the global stage

Over the past few months, China has significantly increased its high-level global outreach with regard to global collaboration on biodiversity and CBD. China has led or jointly led the organization of several ministerial and higher-level meetings on biodiversity, CBD, and other related topics starting in May 2021.

1) On May 20, 2021, China’s Minister of Ecology and Environment (MEE) hosted the “All for One, together towards Kunming” ^[17] online Ministerial Roundtable with his counterparts from Brazil, Colombia, Costa Rica, Egypt, Ethiopia, the European Union, Germany, India, Japan, Singapore as well as Madam Amina Mohamed, Deputy Secretary-General of UN and other senior representatives from UNDP, UNEP, FAO, Secretariat of CBD, Secretariat of UNFCCC, and Secretariat of UNCCD. Both the CBD Executive Secretary Ms. Elizabeth Maruma Mrema and UNEP Executive Director Inger Andersen delivered their remarks calling for Kunming as an essential springboard towards a sustainable future and “*inspiring the deep transformations we need, with the full and active engagement of all stakeholders, to shift course and recalibrate our values and actions to attain our 2050 Vision of living in harmony with nature*”.

MEE Minister Huan Runqiu emphasized that “*adhering to systematic governance, [China] has implemented major programs for biodiversity conservation and ecological protection and restoration, and promoted the integrated protection and restoration of mountains, water, forests, fields, lakes, grasses and sands. The innovative spatial planning system and strict adherence to the ecological protection red line have effectively protected more than 25% of the terrestrial national land.*” He continued, emphasizing that: “*Firstly, we must insist on practical cooperation and share the mission. We should formulate an ambitious and practical framework, take into account the three major objectives of the Convention, draw on the experience of the Aichi Targets, and set scientific and reasonable objectives and tasks. Secondly, we must adhere to the priority of conservation and green development. Uphold the concept of respecting nature, responding to nature and protecting nature, support nature-based solutions, promote ecosystem protection and restoration as a whole, and unswervingly take the road of ecological priority and green development. Thirdly, we must insist on increasing investment and*

strengthening support. All parties are expected to uphold the concept of a community of life between human beings and nature, and from the common interests of all mankind, continue to increase investment, take the initiative to mobilize more resources for biodiversity conservation and sustainable use, and provide more financial support. Fourth, we should adhere to the cohesion and move forward together.”

2) Ahead of the International Day for Biological Diversity Day on 21 May, 2021, the Permanent Mission of the People's Republic of China to the United Nations, jointly with the Convention on Biological Diversity, and the UN's Food and Agriculture Organization (FAO) Liaison Office in New York, organized a virtual event with a theme "COP15: Road to Kunming, Building a Shared Future for All Life on Earth"^[18]. The UNSG reiterated that

“our efforts to protect biodiversity will be key” to utilize “this landmark year” to “restore balance with nature, tackle the climate emergency and get ahead of the pollution crisis”.

The President of the UNGA made remarks that with efforts *“building on last year’s Biodiversity Summit and the launch of the Leader’s Pledge for Nature, and with efforts underway on a post-2020 global biodiversity framework, we have a very real opportunity to ‘bend the curve’ on nature”.*

The Chinese Ambassador to the UN noted in his speech that *“We need to work for the adoption of a comprehensive, balanced, ambitious and implementable post-2020 framework of action at COP15”.*

The UK's permanent representative to the UN, said both President Xi Jinping and the UK's Prime Minister Boris Johnson have agreed that the two countries have a collective responsibility to tackle the issues of climate change and biodiversity loss. *"I look forward to working with all delegations toward the two COPs, and continuing the conversation with China to ensure a mutually-supported outcome,"* she said, in reference to the 26th UN Climate Change Conference of the Parties (COP26), which will be hosted by the UK.

About 200 attendees, including more than 30 ambassadors from various UN member states, including Egypt, Colombia, Antigua and Barbuda, European Union, Brazil, United Kingdom, Norway, Costa Rica, Fiji, Russia, Turkey, India and Germany, joined discussion.

3) On May 21, 2021, the Secretariat of the CBD and the Ministry of Ecology and Environment (MEE) of China, jointly organized a meeting themed *“COP15: Road to Kunming: We are part of the solutions #ForNature”.* The chief negotiator from the Foreign Ministry of China on climate change, Ambassadors of EU and Egypt to China, the Head of UNDP China joined Chinese Environmental Minister to celebrate the International Biodiversity Day on 21 May. Liu Zhenmin, deputy Secretary General of the UN and the Executive Secretary of CBD sent their videos.

The EU Ambassador Chapuis called for an ambitious and realistic GBF. He also expressed his concerns whether the NGOs participation at COP15 would be limited due to the epidemic control.

4) On May 25th, at the UN Environment Management Group's Virtual dialogue on UN system's support to the Global Biodiversity, Chinese CBD Chief Negotiator Mr. Liu Ning briefed the participants across the UN system about the progress and achievement of China's ecological conservation, China's preparation of the COP15, and calling for the need of gathering "the highest level of political wisdom" for agreeing with and implementing effectively "a comprehensive, widely-participated, transformative, ambitious and practical post-2020 GBF".

5) On June 4th, China co-hosted "The Road from Sharm El-Sheikh to Kunming – Restoration in the Post-2020 Global Biodiversity Framework", a high-level panel event^① for the United Nations Decade on Ecosystem Restoration, jointly with the Secretariat of the Convention on Biological Diversity, with the Governments of Egypt, and the Korea Forest Service.

MEE Minister Mr. Huang Runqiu shared China's willingness to "*promote (global) high-level political momentum for the post 2020 GBF and enhance the ambition of ecosystem restoration globally*". He calls for that "*facing the grim situation of global ecological and environment governance, the international community should uphold unprecedented ambition and action to explore a path of harmonious coexistence between human and nature, and protect the nature and the environment like protecting our eyes, so as to have sound ecosystems to support the sustainable development of our economy and society.*"

He proposed: First, to put ecosystem restoration at the core of policy making, increase financing for nature by public and private sectors, and drive the flow of resources to ecosystem restoration. Second, to adopt and enhance a systematic approach to ecosystem restoration, adhere to the concept that mountains, rivers, forests, lakes, grasslands, and deserts form a community of shared life and conduct overall protection, systematic restoration, comprehensive management, coordinated planning and integrated implementation. Third, to improve the quality of ecosystem restoration, give full consideration to the characteristics of different ecosystems, adhere to the principle of nature restoration as the mainstay and artificial restorative intervention as a supplement, manage and restore ecosystems according to local conditions, and constantly improve the quality and resilience of ecosystem restoration. Fourth, to establish a diversified resource mobilization mechanism.

We have observed that domestically in China, many originally planned in person parallel fora of the CBD COP15 have been executed with a combined on-line and in

^① https://www.youtube.com/watch?v=s9LC86_E0nc

person meetings to continue the communications of the biodiversity to wider audience and keep the momentum towards the COP15.

In addition to official players, there are various active non-governmental and non-state actors playing a pivotal role in elevating ambition and mobilizing resources, and effective implementation of the global agreements. It will be very helpful for China to engage with these organizations that have nature and biodiversity at the center of their agenda. These and other high level move that China is leading or jointly lead together with other official players, if can fully utilize the advice and influence of these non-state and non-governmental players, will greatly help China's communication at global stage. This can also contribute greatly to enable China to tell its stories such as "Green is Gold", Ecological Civilization, and Ecological Redlining in a global setting and in a way that can be well understood by international communities.

Ministerial discussions are also critical. Japan, when it hosted CBD COP10, organized ministerial events took place at an early stage, along with discussions involving other countries. This display of political will helped to bring about consensus for an agreement at the COP; provided a chance to hear issues from concerned countries at an early stage; and provided early nomination and sufficient guidance for ministerial facilitators during the COP.

It is encouraging to see that China has now reaching out to other parties and UN system players to explore joint agenda and share thoughts and ambitions with multiple players. The level of countries and UN agencies to participate these events are high and engaging, reflecting the expectation of international communities to China's leadership. These "green diplomacy" originated from China's central government mostly from the MEE and ministry of foreign affairs. If these efforts could be combined with outreaches of China's embassies in countries, missions to the UN and EU, negotiators at negotiation fronts, and Chinese research institutions, it would be more powerful to position China at global stage with regard to nature agenda, amidst Covid 19 pandemic and geopolitical divide.

The initiatives presented above indicate that momentums of integrating nature into the political agenda are high. However, challenges are also obvious. These mainly land in the following aspects:

- Significant gaps observed in translating leaders' commitments into national actions;
- The GBF negotiations under the auspices of the CBD have not stepped up sufficiently to translate the leaders' ambition into the GBF ambition;
- Drivers of biodiversity loss, in particular the indirect drivers, have not gained needed attention and action;
- The biodiversity agenda and other key agenda such as climate change, COVID response and economic development are still not integrated, for instance the carbon

neutral and biodiversity restoration elements have not been noticeable in green recovery packages;

- Financial flows are currently detrimental to nature, with 10 times more investment that are harmful to nature than in biodiversity conservation and sustainable use^[19].

Amidst all these, China's role has been observed but the expectation from the global community is still very high. For example, China's Vice Premier Han Zheng delivered welcome speech at OPS; Minister Huang Runqiu worked with the Egyptian government and the CBD secretariat to promote the Sharm el-Sheikh to Kunming "Nature Action Agenda"^①.

China's top leaders could consider how to build and maintain the momentum on biodiversity together with the UNGA76 in September, and with G20 and UNFCCC COP26 following immediately, as well as the Stockholm + 50 that is due to take place in June 2022. China still has time to express at global stage their determination, commitment, and willingness to work with global communities to bring the "Green is Gold" concept of development into global nature positive movement. With impact from the Covid 19 pandemic, with the delay and impediment of negotiation by information technology viability and stability, it is more imperative for China to consider one or the combinations of several of the following steps, to show leadership and build enabling conditions for the post 2020 GBF. Concretely, we suggest:

- Actively join the UNGA 76 and join the efforts with global leaders on nature, making China's own commitment and ambition for the COP15 clear and transparent in order to trigger good preparation and ambition by other governments;

- Call for or join a side HoS event at the UNGA 76 for Nature (physical or virtual), as an impulse for the COP15 and COP26 to integrate biodiversity, climate and health agenda together;

- Call for global leaders to have a (virtual) grand opening of the CBD COP15, jointly with the UNSG and inviting HoS/G and/or key ministers beyond ministry of nature/environment/natural resources, to join forces and set a strong and positive tone to provide enabling condition for a strong and transformative post 2020 GBF;

- Chinese MEE minister takes the opportunity to call the ministerial high-level

^① The Sharm El-Sheikh to Kunming Action Agenda for Nature and People is an initiative of the Chinese and Egyptian Governments with the support of the CBD Secretariat. The aim is to establish contacts with non-State actors during the current decade to inform motivate and demonstrate voluntary commitment to raise awareness of the urgency, ambition and necessary action to reduce biodiversity loss and its causes, and to achieve positive results in a transition to nature. As of 24 February 2021, there were 169 commitments in the Agenda for Action, including actions taken by Governments, the private sector, non-governmental organizations, and academic and research institutions. <https://www.cbd.int/action-agenda/newsletter.shtml>

segment, to include the ministers of finance, agriculture, infrastructure, economic, planning, and statistics from party countries;

- Make use of bilateral relations and diplomatic influence in preparation for the Kunming COP15;

- Start building bridges between developing, developed and large countries and prepare it for a facilitative role to get the maximal commitments from all groups.

2.2.2 Initiatives from Other Parts of the World on Translating Political Signals to National Actions.

2.2.2.1 A Global Goal for Nature

With climate, there is a clear goal of carbon neutrality, articulated in the target of net zero emissions by 2050, with the objective of keeping global warming below 1.5 °C. A similar time bound goal is needed for nature, to ensure that we halt and reverse biodiversity loss at the pace necessary, in support of climate action and the SDGs. A group of 14 organizations proposed a Nature Positive by 2030^[20] as a global goal for nature - in parallel to the UN Climate Convention's “net zero” carbon goal.

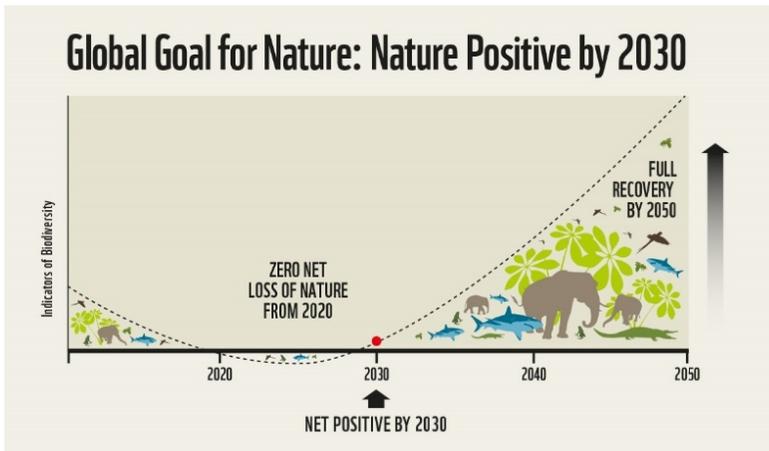


Figure 2-1 Nature Positive by 2030

Nature Positive by 2030 global goal entails that through improvement of the health, abundance, diversity and resilience of species, populations and ecosystems, the nature is restored, so that by 2030 it will be recovered beyond the baseline in 2020. The Global Goal for Nature would commit governments to taking action now to halt biodiversity loss and ensure that the world is nature-positive by the end of this decade. The “Nature Positive” concept has been taken up by many leaders in their interventions and speeches since Sept 2020. The vision of Nature Positive by 2030 for

the humanity's sustainable development should be well reflected in the post 2020 GBF.

2.2.2.2 Upsurge of Calls to Action

During the run up to the UNGA75 and the UN Biodiversity Summit, there has been an upsurge of non-state actions calling for actions to address planetary emergencies and strive to reverse the loss of nature^[21]. More than 15 environment and development organizations, more than 20 humanitarian and development organization, plus more than 100 faith and spirit groups supported Call to Actions for nature. A Youth Manifesto has been signed by more than 1000 people to say “enough” of behaviors that are harmful to nature. More than 20 local and regional governments also joined the Call to Actions on nature, people and planetary health. Business has shown unprecedented concerns on the loss of nature: 530 companies committed to reversing nature loss, 1200 companies acting now to reverse nature loss, 700 CEOs signed Business For Nature Call to Action seeking policies to reverse nature loss, and the new Science Based Targets for Nature Guidance have been launched^[22].

2.2.2.3 Inclusive Governance for Conservation

Increased attention and dialogues are on issues of inclusive conservation and recognizing the rights and conservation effectiveness of Indigenous Peoples and local communities (IPLCs). Over the last 20 years, area-based conservation has evolved from a model largely dominated by state-governed protected areas to one that is more inclusive of non-state actors and areas outside protected areas. There is more explicit recognition of and support for diverse, effective and equitable forms of governance. This is reflected in the advice and guidance provided by the Parties to the CBD in Decision 14/8 in 2018 and in the IPBES Global Assessment 2019 regarding other effective area-based conservation measures (OECMs) and guidance on the governance of protected areas and OECMs.

2.2.2.4 Ecosystem Accounting

On another front, the UN has in 2021 adopted a framework to integrate biodiversity in economic reporting: system of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA) as an international statistical standard. The SEEA EA system will enable countries to measure their natural capital and understand the immense contributions of nature to our prosperity and the importance of protecting it^[23]. China's own pilot Natural Resource Asset Audit system has already shown that valuation of natural resources dynamics can link with performance and management of the leaders to generate benefits to both nature and people. This is a great opportunity for China to collaborate with the UN Statistics Commission to accelerate rollout of such auditing to the whole world to improve understanding and management of our valuable ecosystems and biodiversity.

2.2.2.5 Essential Life Support Areas

An initiative supported by National Geographic Society, Global Environment

Facility, UNDP and many other partners provides rich spatial information through maps to facilitate decision making on area-based conservation, especially to suggest prioritized areas for the National Biodiversity Strategy and Action Plan (NBSAP) ^[24]. This can be combined with the ecological redlining initiative from China to be a hybrid approach that other countries might utilize.

2.2.3 Progress of the Post-2020 Global Biodiversity Framework

The negotiation of the GBF is at a critical stage. The co-chairs of the open-ended working group (OEWG) for the GBF have just released the first draft early July after negotiating on the updated zero-draft at SBSTTA-24 and SBI-3^①. This first draft will then be going through negotiations in a few modality steps (e.g. online discussion at the OEWG-3) before being submitted to the COP15 for final negotiation and adoption.

Analysis of the current first draft and the past updated zero-draft and their (lack of) ambition towards a nature positive future by 2030 that world leaders have agreed in their Leaders' Pledge for Nature, shows gaps that need to be filled. More efforts are much needed for parties and observers of the CBD to strive to step up the ambition and bridge the gap.

Overall, there are several issues that the current first draft and the past updated zero-draft have not sufficiently addressed, of which the future (final) draft(s) need to take into account:

- 2050 goals, 2030 milestones and 2030 targets remain insufficient for the ambition required to achieve transformative change towards halting and starting to reverse the loss of nature by 2030, which is called for by the world leaders through the Leaders Pledge for Nature.

- The voices from around the world are calling for protecting at least 30% of the planet's surface (land and ocean). It needs to be emphasized that we should protect the best (at least 30%), sustainably manage the rest and restore at least half of degraded land.

- Conservation alone cannot reverse the loss of nature; there is a strong need to have a 2050 goal or 2030 milestone on the footprint of production and consumption, which are drivers for biodiversity loss. These sectors include food and agriculture (including aquaculture), forestry and fisheries, infrastructure and their supply chains. Without seriously diverting from actions that are harmful to biodiversity conservation and sustainable use, we will not be able to reverse the loss of nature.

- A three faceted approach on financing for nature should be considered: a) reforming economic sectors to remove investments and subsidies that are harmful to

^① <https://www.cbd.int/article/zero-draft-update-august-2020>

nature, b) realign global financial flows with biodiversity conservation, sustainable use, and with nature based solutions, and c) mobilize more resources for biodiversity conservation and sustainable use.

- The GBF needs to ensure the framework is implemented through a whole of society, whole of government approach. We need to protect people through conserving nature.

- The GBF should also play a role that can enhance synergies among MEAs.

In order to halt and reverse the biodiversity loss by 2030, conservation is critical, but not sufficient. Science has told us, from land use angle, if we are to reverse the loss of nature, interventions on all levels are needed: sustainable production and consumption, and more ambitious conservation measures [25], as shown in the following graphs (Figures 2-2 and 2-3).

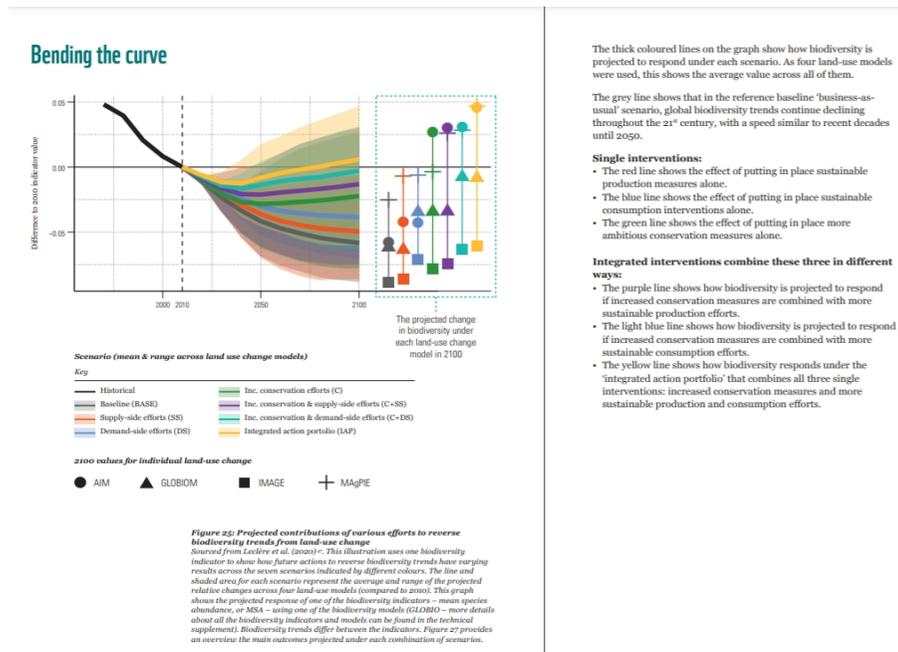
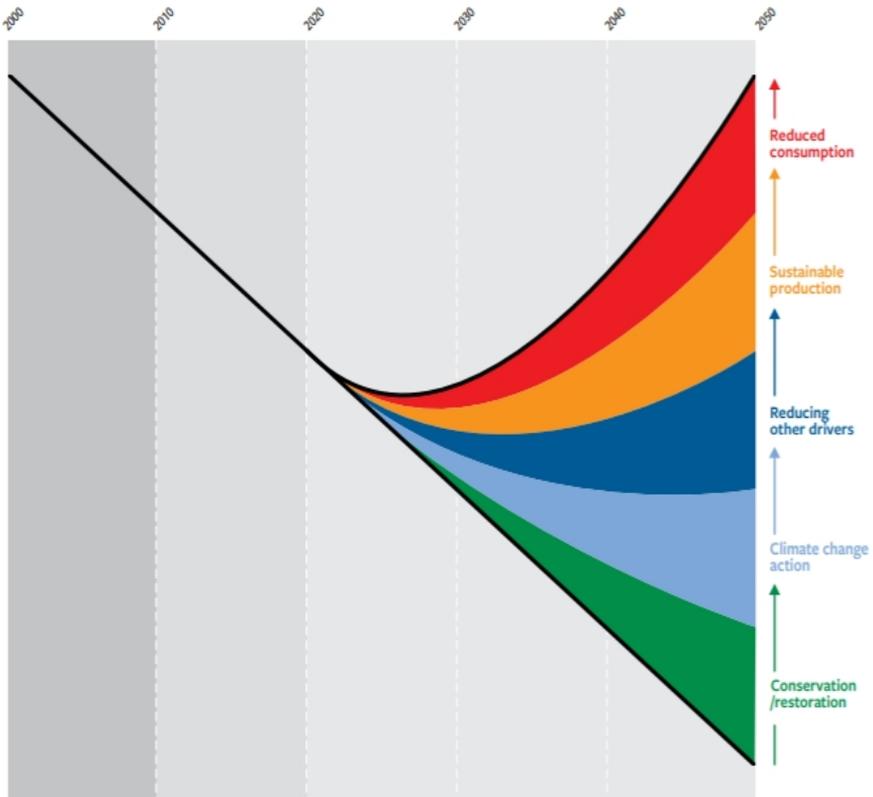


Figure 2-2 Bending the Curve. Source: WWF Living Planet Report 2020

Efforts for reducing the loss and restoring biodiversity will need to 1) increase conservation and restoration, 2) increase climate action, 3) increase sustainable production, 4) reduce consumption, and 5) reduce other drivers [26], as shown in the following graph.

A portfolio of actions to reduce loss and restore biodiversity



Trends in biodiversity (various metrics, left axis) have been declining and are projected to continue to do so under business as usual scenarios (trend line). Various areas of action could reduce the rate of biodiversity decline, and the full portfolio of actions, in combination, could halt and reverse the decline (bend the curve), potentially leading to net biodiversity gains after 2030. These are, from bottom to top: (1) Enhanced conservation and restoration of ecosystems; (2) climate change mitigation; (3) action on pollution, invasive alien species and overexploitation; (4) more sustainable production of goods and services, especially food; and (5) reduced consumption and waste. However, none of the areas of action alone, nor in partial combinations, can bend the curve of biodiversity loss. Moreover, the effectiveness of each area of action is enhanced by the other areas (see Part III of the full report for discussion).

Figure 2-3 Actions to reduce loss and restore biodiversity. Source: Global Biodiversity Outlook 5 ^[26]

Recent CBD document CBD/SBSTTA/24/3/Add.2, suggested two approaches to further define the draft mission statement. The world will need to have an approach that provides a clear path to net gain of biodiversity and nature's contributions to people by 2030 ('curve A' on page 3 in the document) ^[27]. See below.

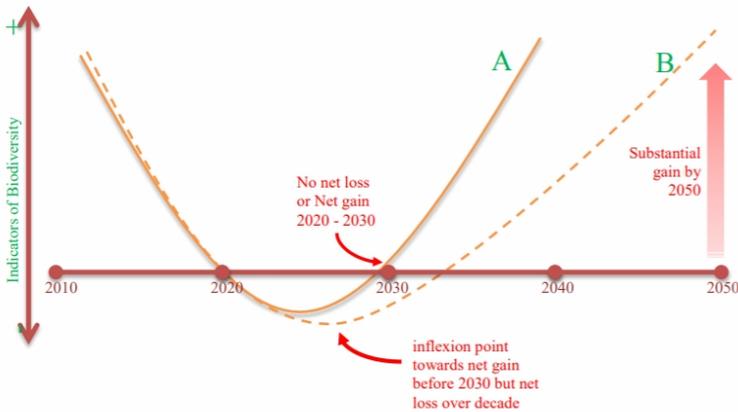


Figure 2-4 Biodiversity status during the decade 2021-2030 and towards 2050 ^[27]

With regard to the preparation of an ambitious first draft of the GBF, the following concerns should be considered:

- The theme of COP 15 “Ecological Civilization - Building a Shared Future for All Life on Earth” should be reflected in the preamble or background paragraph of the draft.

- The GBF is a framework for all, including all parts of government. The goals, targets and indicators should be set to all relevant ministries in the country;

- The GBF needs the participation of the whole of society by ensuring equitable participation of all key stakeholders including indigenous peoples and local communities, women and girls as well as youth

- With the outbreak of the COVID-19 pandemic, biosafety, biosecurity, biotechnology and newly emerged zoonotic diseases shall be adequately considered for sustainable development and human health;

- On the implementation supporting mechanisms, we propose that the attention should not only be given to mobilizing funding for biodiversity conservation and restoration, but also to reforming financial and accounting systems to remove subsidies and investment that are harmful to nature, and to realigning these financial flows to the conservation, restoration and sustainable use of biodiversity;

- Strong synergies are needed among relevant multilateral environmental agreements and other relevant international processes, especially on the interests of biodiversity and commitments or contributions to conservation efforts, including the 2030 Agenda for Sustainable Development, and instruments at the global, regional and national levels, including through the strengthening or establishment of cooperation mechanisms

- In order to track the outcomes of the implementation, more frequent reporting, review and ratcheting processes will be needed.

More specific recommendations can be found in Annex 3.

Based on China's neutral role as the host country, Chinese negotiators can still champion on some issues that are critical to the GBF and that China has accumulated good experiences and practices. These issues could include topics such as biodiversity mainstreaming and resource mobilization.

China's initiatives such as 'Green is Gold', 'Ecological Civilization', senior governmental staff resource and environmental condition departure audits (e.g., when they move to new positions, or retire), etc., are examples of mainstreaming of biodiversity practices. China should actively and openly champion this topic in the GBF discussions, drawing on China's own efforts. This will boost the positive momentum from real world experience.

Another issue that China could consider is financial resource mobilization. When talking about financing for nature, there are three aspects that need to be addressed: reduce and eventually remove the investment and incentives that are harmful to nature, realign these investment and funding to invest in nature positive actions and programs, and doubling of conservation financing and international development aids that are investing in nature. China's comprehensive practices, such as eco-compensation, transfer payment system, and South-South cooperation, can all be used to form China's comprehensive initiatives on biodiversity financing that can be tabled to the GBF and lead the dialogue for an ambitious and realistic GBF.

2.2.4 Prepared for Acceleration of Immediate Implementation of the GBF after the COP15

The GBF that is agreed at the COP15 needs to reflect the level of ambition that is needed to keep the biosphere operating in a manner that produces the goods and services on which humankind is dependent, as well as to effectively combat the interrelated biodiversity, climate, and health crises. Achieving a net gain in ecosystem health and species abundance and preventing human-induced extinctions of known threatened species by 2030, transformative changes in land and sea use, resource use efficiency, production and consumption patterns (particularly for food), resource mobilization and inclusive decision-making will be urgently needed. These changes will require the political will to agree and implement ambitious targets for 2030, the establishment of effective monitoring of results and corrective mechanisms if deviations from targets are detected.

Actions must be taken immediately building on the increasing momentum for nature conservation, sustainable use of biodiversity and access and benefit sharing. Additional immediate actions will be required in other areas, including enhancing the enabling conditions for ambitious nature positive actions.

Monitoring of progress and complementary scenario analysis may further define other critical elements of the solution.

2.3 Global and Regional Approaches for Post-2020 Protected Area Priorities

This chapter is based on scientific studies with a focus on area-based conservation. Three studies have been conducted accordingly to address three key questions for global biodiversity conservation. First, what strategies could be used for area-based conservation? Should countries adopt a uniform conservation area target (e.g., 30% and 50% targets under discussion for post-2020) or a differentiated target for different countries if taking account of the uneven distribution of biodiversity, and countries' different contribution to nature degradation and ability to pay for the cost? Study 1 aims to answer this question. Second, what strategies could be taken to achieve the ambitious conservation targets? Study 2 proposes the concept of Cost-Effective Zones – areas with high biodiversity importance but less used by people – as a solution to boost conservation areas without causing heavy impacts on the development of human society. Third, when conservation priorities vary at different spatial scales, for example, from global, regional to national scale, how should conservation actions be coordinated at different scales to most efficiently conserve biodiversity? Study 3 takes Asia as an example ^[28] to illustrate that multiscale visions are needed to optimize outcomes and to explore synergies between climate and biodiversity targets^①.

The policy recommendations are proposed based on the findings of these three systematic and comprehensive studies for post-2020 biodiversity framework. All three studies demonstrate the necessity of bold conservation targets for effective species conservation and highlight different responsibilities of individual countries in their biodiversity conservation. Ensuring high ecosystem integrity – study 2 proposes a possible approach – is also important within the priorities areas identified for global biodiversity conservation. The synergies between biodiversity and carbon are necessary and feasible. Mechanisms such as adopting National Voluntary Commitments in NBSAPs, and seeking funding for less developed countries that bear high conservation responsibilities are critical to ensure achievement of intended conservation targets 21.

^① The details of Study 2 can be found at R. Yang, Y. Cao, KP. Ma. 2020. *Cost-effective priorities for the expansion of global terrestrial protected areas: Setting post-2020 global and national targets*. Science Advances 9 Sept 2020: Vol. 6, no. 37, eabc3436 <https://advances.sciencemag.org/content/6/37/eabc3436>. The other two studies are under review currently. Important conclusions and recommendations are highlighted in bold to facilitate reading.

2.3.1 Countries' Differentiated Responsibilities in Fulfilling Global Conservation Area Targets

The efficiency of two conservation approaches for area-based conservation on land was compared: (1) **under the country scenarios**: setting a uniform conservation target (30% and 50%, respectively) for all countries and thus identifying conservation priorities within each country independently; and (2) **under the global scenarios**: setting different conservation targets for different countries based on the spatial distribution of biodiversity while the total amount of conservation areas remain the same (30% and 50%, respectively). Systematic conservation planning tools were used to identify conservation priorities that maximize the conservation of terrestrial vertebrate species and carbon with consideration of other elements (representation of ecoregion and conservation cost).

The results show that **prioritizations identified under the global scenarios would conserve far more terrestrial vertebrate species and carbon than setting uniform targets for all countries**. For example, for threatened species, the prioritizations generated with a 30% conservation target under the global scenario adequately represented 12.6% more mammals, 19.6% more birds, 17.7% more reptiles, and 15.7% more amphibians than the prioritizations generated under the country scenario. Similarly, the prioritizations generated with a 50% conservation target under the global scenario adequately represented 10.6% more mammals, 15.3% more birds, 10.6% more reptiles and 16% more amphibians compared to that under the country scenario. These results suggest that globally coordinating conservation efforts could vastly improve biodiversity outcomes as opposed to adopting a uniform conservation target for all countries.

Although prioritizations under the global scenarios were more effective in conserving species and carbon, great challenges remained for countries to fulfill their identified conservation targets. **Under the global scenarios, conservation targets identified for countries varied greatly among countries with heavier conservation burdens for economically poorer countries where biodiversity tends to be the richest (Fig. 2-5).**

We suggest cooperative and coordinated actions between countries to enhance outcomes for biodiversity under the post-2020 framework. More importantly, when countries have different conservation responsibilities, mechanisms to ensure fair sharing of conservation burdens among countries and to overcome practical obstacles to implementation are important. Much can be learned from the Paris Agreement for climate change mitigation and adaptation in this regard. We make specific recommendations below, with a focus on the implementation of different conservation targets among countries:

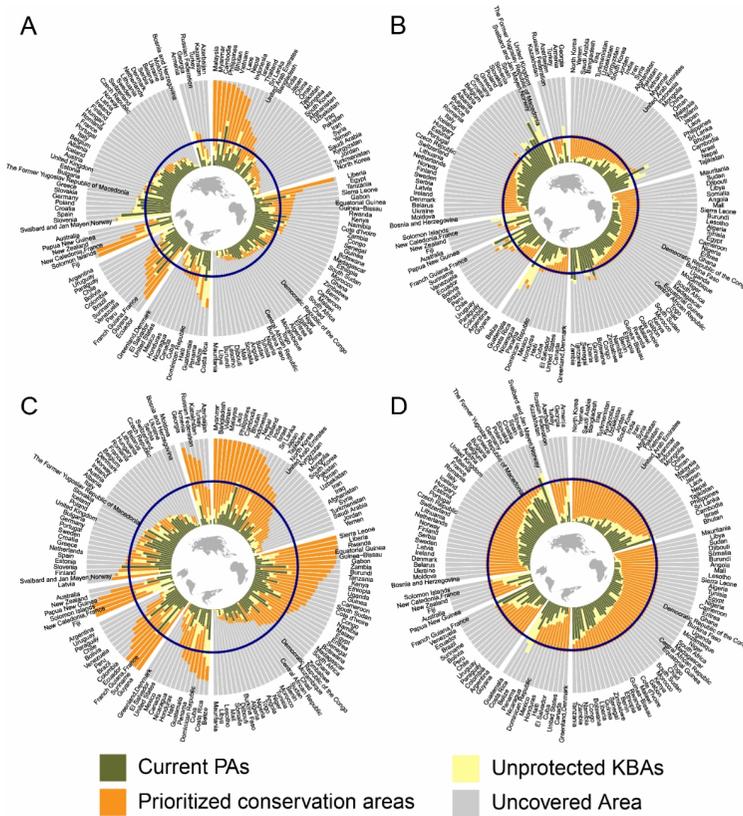


Figure 2-5 Percentage of current protected areas (PAs), unprotected Key Biodiversity Areas (KBAs), prioritized conservation areas (not including PAs and KBAs), and uncovered areas (i.e., areas not identified as conservation priorities) for each country under the global (A, C) and country (B, D) scenarios to meet the 30% and 50% conservation targets, respectively. Each bar represents 100% of the land area in a country, which is the sum of the percentages of the four types of land. PAs and KBAs are treated as top priorities for conservation. The total percentage of PAs, KBAs and prioritized conservation areas in a country is the percentage target of area-based conservation identified for the country. The blue circle in A and B represents the 30% percentage line, and that in C and D represents the 50% percentage line. Some countries are identified with very high conservation targets under the global scenarios, such as Malaysia, Myanmar and Cambodia under the 30% target (A), and Fiji and Solomon Islands under the 50% target (C). The conservation targets for few countries under the country scenarios exceeded 30% (B) or 50% (D) in order to meet other requirements (i.e., representation of ecosystems). Countries with a terrestrial area < 18,000 km² are excluded.

- We propose that the CBD adopt global conservation priorities to guide national conservation efforts and use “**the proportion of global conservation priority areas maintained or restored to a favorable condition**” as an indicator to measure progress.

- We recognize that local factors (e.g., legislation and policies, socioeconomic environments, and conservation willingness and capacity) will largely determine the feasibility of the conservation targets, and suggest that countries adjust the targets identified via global prioritizations so they are in accordance with national circumstances, and incorporate their committed targets (i.e., **National Voluntary Commitments**) in countries’ National Biodiversity Strategies and Action Plans (NBSAPs).

- Countries with high targets (e.g., Malaysia, Myanmar and Liberia) could start with a lower target and incrementally increase their target commitments over time. The progress towards the intended conservation targets of individual countries should ideally be reviewed on a regular basis (e.g., with a five-year interval) to inform successive country-level commitments to the conservation targets.

- We suggest countries with low conservation burdens (measured by prioritized conservation area divided by Gross Domestic Product) could provide financial and technical support to those with high conservation burdens (e.g., Central African Republic, Somalia and Guyana). In particular, countries with a higher ecological footprint could support conservation in other countries - ideally in those that receive the footprint, for example, in a global supply chain - to offset their ecological footprint.

- We emphasize the important role of **other effective area-based conservation measures** (OECMs) in achieving the high conservation target and in the implementation of the post-2020 biodiversity framework. Field survey and database should be set up to record existing OECMs and support them to ensure their continued effectiveness.

- We call for innovative and inclusive approaches that recognize and encourage sustainable management systems to help maintain the biodiversity of global significance in human-dominated landscapes. Designations that maintain and enhance multiple benefits (e.g., environmental and social benefits) in human-dominated landscapes would be critical to alleviate the conflicts between biodiversity conservation and social-economic development of human society for achieving high conservation targets.

2.3.2 Cost-effective Priorities for the Expansion of Global Terrestrial Protected Areas: Setting Post-2020 Global and National Targets

A spatial meta-analysis was conducted to identify global terrestrial Conservation Priority Zones (CPZs), defined as areas covered by any of the seven global

biodiversity templates (i.e., Crisis Ecoregions, Biodiversity Hotspots, Endemic Bird Areas, Key Biodiversity Areas, Centers of Plant Diversity, Global 200 Ecoregions, and Intact Forest Landscapes). CPZs were further categorized into three groups based on its significance in biodiversity: areas covered by three or more templates were defined as level 1 CPZs, those covered by two templates were defined as level 2 CPZs, and areas covered only by one template were defined as level 3 CPZs. Cost-Effective Zones (CEZs) were identified as CPZs within the Low Human Impact Areas, which were areas with biodiversity significance and less used by humans. Establishing new protected areas in these areas would alleviate the conflicts in land use and reduce the cost.

The results show that CPZs cover 77.2% of the global terrestrial land, including almost all terrestrial area near the equator. CEZs cover around 38% of global terrestrial land, of which only 24% is currently covered by existing protected areas. Three scenarios are proposed to protect CEZs corresponding to the three levels of CPZs. **The conservative target aims to conserve the level 1 CEZs, the moderate target aims to conserve both level 1 and level 2 CEZs, and the ambitious target aims to conserve CEZs of all three levels, which account for 19, 26, and 43% of global terrestrial land, respectively.**

The percentage of CEZs within a country varies widely (Fig. 2-6). Under the ambitious target, the top 10 countries (including the Russian Federation, Australia, Canada, Brazil, China, the United States of America, Congo, Kazakhstan, Indonesia, and Angola) with the largest protected area expansion potential contribute 66% to the global expansion of protected areas.

We suggest using the concept of Cost-Effective Zones to guide future conservation efforts. As only 24% of CEZs are currently under protection, there is huge potential to add CEZs to the existing protected area network. The proportion of protected areas under the four scenarios (see details in Fig. 2-6), CPZs coverage, the proportion of unprotected CPZs (unprotected CPZs/total CPZs), CEZs coverage and the proportion of unprotected CEZs (unprotected CEZs/total CEZs) for the 195 CBD country parties (excluding the European Union) was shown in Table S1 in the Annex. Especially, we emphasize four categories of countries that require special attention:

- *Mega CEZ countries.* CEZs are concentrated in a small number of countries including the Russian Federation, Australia, Canada, Brazil, China, and the United States of America, which together make up 53% of all CEZs by area. These countries are crucial to global biodiversity conservation and have great potential to increase their conservation targets.

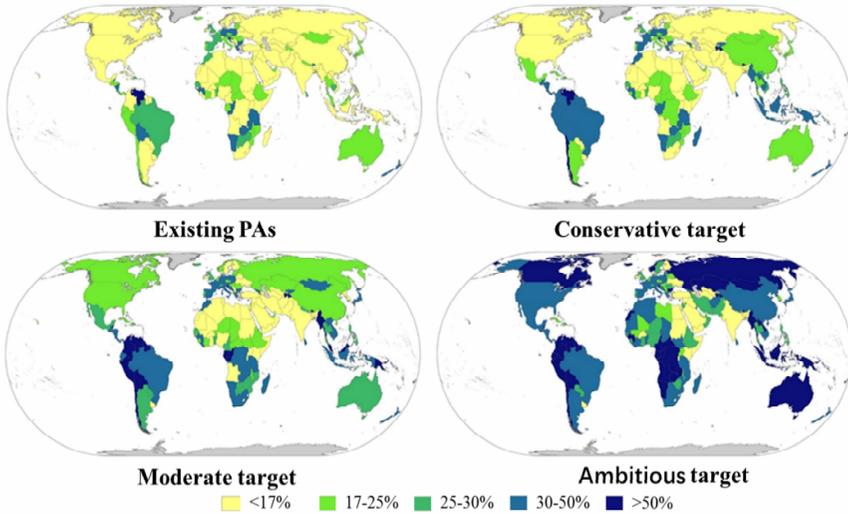


Figure 2-6 Maps of countries with different percent range protected under four scenarios. (A) existing PAs, (B) conservative target, (C) moderate target, and (D) ambitious target.

- *Countries needing to protect more CEZs.* Countries with the largest unprotected CEZs globally or those with the largest area of unprotected CEZs as a percentage of their total terrestrial land areas should take immediate action to expand their protected areas.

- *Countries with many CPZs but few CEZs, such as India.* These countries not only have important biodiversity conservation value but also have substantial human impacts. Countries in this group are likely to require more inclusive conservation actions, such as using OECMs, and ecological restoration and/or rewilding.

- *Countries with many protected areas but few CEZs.* As an example, Germany has 36.6% protected area coverage on land, while CEZs only account for 3.1%. This highlights that CEZs should not be seen as the upper limit of protected area coverage; the protected area system could be expanded outside of CEZs to protect other areas with national biodiversity importance.

2.3.3 Regional Scalable Priorities for National Biodiversity and Carbon Conservation Planning in Asia

Although Aichi Target 11 is regarded as the most successful Aichi target, the specifications aiming at representativeness are often overlooked when it comes to area-based conservation. No framework has been widely implemented or created to translate priorities into actions that are both representative regionally and implemented feasibly at the national scale. The priorities for synergy of biodiversity

and carbon storage are defined as the highest value regions contained in 30% or 50% land area (based on the potential area-based conservation for 2030 target and 2050 vision) for each zone of the three scales: regional (Asian range), biome and national scale, respectively.

Our analysis demonstrates that current protection for 8,932 terrestrial vertebrate species across Asia is neither comprehensive nor representative. Existing protected areas alone are able to effectively protect (based on the Butchart approach) ^[29] only 25% of mammals, 20% of birds and 10% of reptiles and amphibians. Targeting 30% of the land could protect over 70% of all represented species, with an increase of 59% of species additionally protected relative to current protected areas, as well as would preserve 2.3-3.6 hundred billion tonnes of stored carbon across these regions, and yet such regions are not protected at present in most cases. Diverse ecoregions frequently have the greatest protection gaps. For example, Western Asia and South China show notable gaps between existing protection areas and our proposed priorities. Taking ASEAN plus Three Cooperation countries (APT, involving the ten ASEAN countries and three Northeast Asian countries including China, Japan, and South Korea) where have the richest species and highest extinction threats for example, the majority of countries have priorities which exceed 30% of land area (Fig. 2-7A). **Most tropical countries had priorities spanning over 60% of their land area, and two countries (Brunei and Laos) had priorities spanning over 90%.**

Assessing effectiveness of the protection coverage of species within countries can enable conservation planning both at national and regional levels. The regional priority areas perform very well at covering species in most countries, but diverse countries such as Indonesia, Philippines and China often have greater conservation gaps (Fig. 2-7B). Laos has the heaviest conservation burden (defined as the ratio of the sum of conservation area weighted by human modifications contained in each country and the gross national income adjusted for purchasing power parity) for both current and future, followed by Myanmar and Cambodia with less than half of the additional burden than Laos for 2030 target and 2050 vision (Fig. 2-7C-D). Yet Southeast Asia is undergoing a biodiversity crisis, and while the analysis highlights the additional area required to effectively conserve species across the majority of tropical Southeast Asian countries, this may be especially challenging to achieve in the parts of the world that are experiencing some of the highest rates of habitat loss.

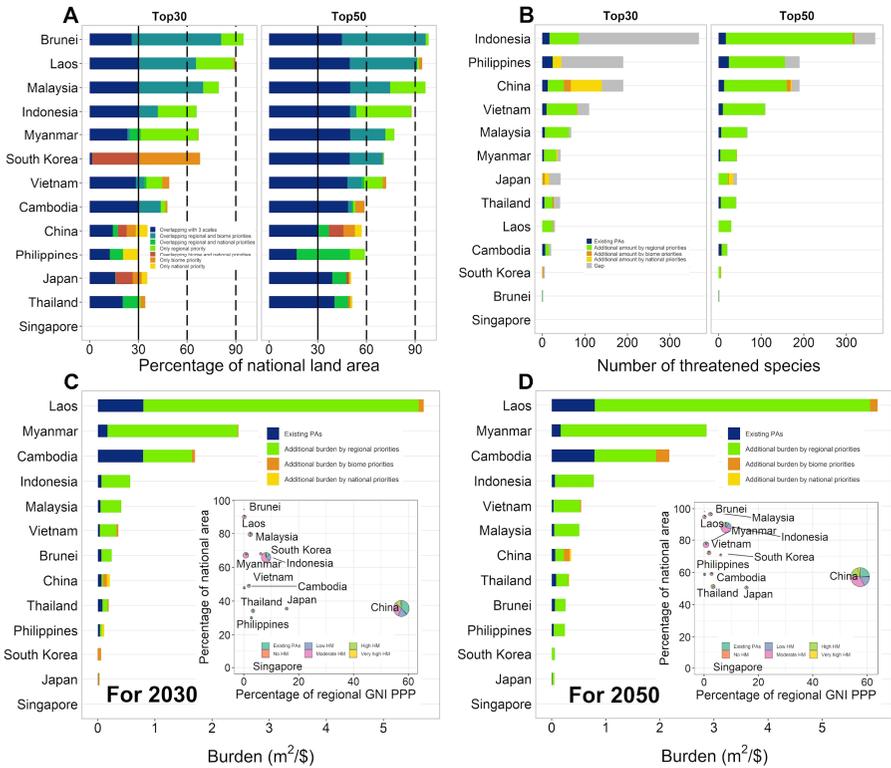


Figure 2-7 Differences in current and future conservation responsibilities (A), contribution (B) and burdens (C-D) among countries for 2030 targets and 2050 visions. (A) The percentage of multiscale priorities contained in each country. Multiscale priorities of regional and biome scales as well as overlapping host the higher priority ranks than national priorities in each country. Dark blue indicates the most congruence among three scales with the highest prioritization for conservation. (B) Variation in effective protection contribution for threatened species by existing protected areas (blue), additional amount by regional priorities combined (green), by biome priorities combined (orange) and additional amount by national priorities combined (yellow) in each country. The total number of the threatened species distributed in each country is shown in grey color. Inserted pie charts illustrate the proportion of multiscale priority area by existing protected areas and different degree of HM in each country. The radius of pie chart is proportional to the total multiscale priority area contained in each country.

Regional scalable priorities can help national biodiversity and carbon conservation planning in Asia

● **Multiscale visions** should be developed to support biodiversity and ecosystem services for nature protection in the future, thus combining a range of different scales to explore synergies between both climate and biodiversity targets can be used to optimize outcomes. To develop more ambitious and effective targets for national scales, while simultaneously taking into account complementary scalable priorities, actions could be enacted in a **stepwise manner**: regional priorities should be regarded as the highest priority (having the highest conservation efficiency), and then complemented by additional biome priorities (for ecological representativeness and diversity), and finally by national ones (as the common conservation benefits of region and country) to achieve more ambitious targets. This will maximize the representativeness and the number of species effectively covered, given the latitudinal gradients in biodiversity across the Asian region. Where regional priorities within a country exceed 30% of land, areas overlapping between regional and biome priorities should be prioritized to maximize the benefits across of species and ecosystem dimensions.

● **Additional funding or new approaches achieving transformative changes** are needed to enable conservation in larger areas in hyper-diverse regions, where 30% of land is insufficient to provide effective conservation for native species. For the CBD to effectively provide achievable goals and stem biodiversity loss, additional climate funds could be used preferentially within such regions. Moreover, mechanisms developed to ensure that complementary targets can heighten funds available to support conservation where possible and improve carbon storage ability in nature-based solutions to climate change. Yet even with this, the large conservation burdens in regions such as Laos, Myanmar and Cambodia call for further mechanisms to mainstream biodiversity and conserve diversity in complex and working landscapes. Furthermore, whilst business has started to engage with CBD initiatives, working to maintain biodiversity in regions such as China where aim to CO₂ emissions peak before 2030 and carbon neutrality before 2060 will require new approaches to agriculture and development, including green finance, certification schemes and rigorous assessments to provide viable means to support higher levels of protection needed in key regions.

2.4 Technical Optimization for Ecological Conservation Redline (ECR) Delimitation

2.4.1 ECR is an Area with Important Special Ecological Functions that Should be Strictly Protected

ECR usually includes important ecological function regions with important functions of water conservation, biodiversity maintenance, soil and water conservation, wind prevention and desertification reduction. Coastal ecological stability, as well as ecological vulnerable regions suffers from soil erosion, desertification, rocky desertification and salinization. Although carbon storage and carbon sequestration are key parts of the ecosystem services, they have not been addressed in the current ECR delimitation technical system.

According to the requirements of “Several opinions on delimiting and strictly observing the ECR” and “Guidelines for delimiting the ECR”^① issued by the Chinese government in 2017, the ECR delimitation technical system consists of indicator selection, scientific evaluation and comprehensive mapping. The indicator selection involves ecological functions and ecological fragility. The former includes water conservation, soil conservation, sand (desert) fixation and biodiversity maintenance, while the latter including soil erosion, land desertification, rocky desertification and salinization. The scientific evaluation selects appropriate models to quantitatively evaluate each indicator to identify hot spots of ecosystem services and ecological fragility. The comprehensive mapping revises the results of scientific evaluation, based on high-precision remote sensing images and land use data, in order to delineate the ECR with clear boundaries and ecological integrity.

The ECR delimitation technical system provides an effective way for provinces (autonomous regions and municipalities) in China to improve the overall ecological protection network. For example, Qinghai Province, part of the Qinghai Tibet Plateau, the ecological protection network of “one screen, one belt, three areas”^② is formed by delimiting ECR, effectively protecting the glaciers and snow mountains, river sources, forest shrub, grassland vegetation and desert vegetation in Qinghai Province plus downstream areas. In addition, the delimitation of ECR also improves the effectiveness of biodiversity conservation for some provinces with rich

^① “Several opinions on delimiting and strictly observing the ECR” was issued by the Chinese government in February 2017. They describe the scope and boundary of the ECR. “Guidelines for delimiting the ECR” was jointly prepared by the Ministry of Ecology and Environment, the National Development and Reform Commission, which was released in May 2017.

^② “one barrier, one belt, three areas” pattern of Qinghai Province: “one screen” is the ecological barrier of the meadow wetland in the Three Rivers; “One belt” is the glacier and water conservation ecological zone in the Qilian Mountain; “three areas” are the Qinghai Lake grassland wetland ecological function zone, the Qaidam desert wetland ecological function zone and the eastern hilly biodiversity function zone.

biodiversity. For example, Sichuan Province is one of the provinces with the richest biodiversity in China. Based on the ECR delimitation technology, 30.45% of the province's areas are designated as ECR to establish an ecological protection network of "four axes and nine cores"^①, including Daba Mountain, Jinsha River, Zoige wetland and other key protection areas, thus effectively protecting more than 95% of the province's species resources.

The ECR delimitation technical system is applied in each province, autonomous region and municipality in China. The ECR areas are dominated by natural ecological land, such as forest, grassland, shrubs, and water wetlands. The ecological functions of the ECR include water conservation, soil conservation, biodiversity maintenance, and desert sand dunes stabilization and reduction.

2.4.2 Optimization of Methods for Identification of Important Biodiversity Conservation Areas

According to "Guidelines for delimiting the ECR", there are two methods for biodiversity protection redline: net primary productivity (NPP) method and species distribution model method. NPP method is easy to obtain because it requires less parameter factors. The species distribution model method needs to obtain the existing species distribution data and more environmental variables, resulting in very complex calculation, thus it is less used. We suggest that the assessment method for biodiversity protection/conservation redlining should be optimized. This study discusses optimizing the identification method for such areas by comprehensively considering data of wildlife richness, ecosystem types, endemic species and threatened species. Thus, we can use important areas of biodiversity conservation as the basis for biodiversity protection redlines.

The important areas for biodiversity conservation include: (1) the areas needed for effective protection of key species. Key species include threatened species (CR, EN, VU) in the IUCN red list, threatened species (CR, EN, VU) in the national red list, national protected species (e.g., China's class-I and class-II protected species), countries' endemic species; (2) biodiversity hotspots, i.e., areas with high species diversity and high degree of threat; (3) other important areas of biodiversity protection recognized at global and national levels, including the Key Biodiversity Areas (KBA).

At present, the animal species distribution data available at the global and

^① "four axes and nine cores" pattern in Sichuan Province: the "four axes" are the Daba Mountain, the hot-dry valley of the lower reaches of the Jinsha River, the mountains in southeastern Sichuan and the hilly areas in the basin. "Nine cores" are the Ruergai Wetland, the source of the Yalong River, the source of the Dadu River, the Daxue Mountain, the Shaluli Mountain, the Min Mountain, the Qionglai Mountain, the Liangshan-Xiangling, and the Jinping Mountain.

national scales are mainly based on the distribution map of the assessed species provided by IUCN red list database, which has a comprehensive assessment of terrestrial vertebrates (mammals, birds, amphibians, reptiles), plus a small number of plant species. The data of vegetation distribution can be supplemented by the data collected at national scale. For example, in China, several scientific research institutes have established the distribution database of woody vegetation at national scale. Therefore, species distribution data from different sources may include species distribution area map, county distribution map, species distribution area grid layer and other forms, which can be used for subsequent key area delimitation. According to the suggestion of [30], the above species distribution map is superimposed with the altitude and habitat suitable for species distribution to further refine and extract the suitable habitat of species in the distribution area, namely the area of habitats (AOH), to identify the KBA.

(1) Identify areas needed for effective conservation of key species

Only when the protected area of certain species is large enough, can it survive sustainably. It is generally believed that the larger the distribution area of species, the larger protected area needed. Referring to the international standards for effective protection of species [31-32], the area standards for effective protection of species at a national scale are formulated. Overlaying the distribution map of key species and using systematic conservation planning software is a means to identify the minimum area for effective protection of key species.

(2) Identifying biodiversity hotspots

We can overlay the distribution map of animal and vegetation species and the data layer indicating the intensity of human interference (such as human footprint index, human modification and wilderness map), and assign values to different geographical units to reflect the urgency of taking action to protect them. The geographical units with high biodiversity and high degree of threat get a higher valuation. Then we determine the standard of national biodiversity hotspots (for example, select the top 20% or 30% geographical units with high valuation) as the biodiversity hotspots that need to be protected.

(3) Improve the management system of important biodiversity conservation areas.

KBA data can be obtained from public data sources, which are included in the scope of protection. Based on the above analysis, we can identify areas needed for effective conservation of key species and biodiversity hotspots. Thus important biodiversity conservation areas are identified. Then we should carefully assess the value of biodiversity protection in important biodiversity conservation areas, determine the priority management level, and identify regional and cross-sectoral institutional problems. This approach is needed in order to ascertain the level of integrity protection for the biological services and cultural value functions of the natural ecosystem—finally achieving the ultimate goal of biodiversity conservation.

2.4.3 Identification of the ECR Areas with Important Carbon Sequestration Functions

President Xi Jinping announced China's carbon summit target and carbon neutral vision at the general debate and climate summit of the seventy-fifth UN General Assembly in 2020. Terrestrial ecosystems absorb a large amount of CO₂ in the atmosphere through photosynthesis of vegetation, which is regarded as the most economical and environmentally friendly way to slow down the increase of atmospheric CO₂ concentration. The ECR, which includes forests, grasslands, wetlands and other ecosystems with important carbon sequestration functions, can help to reverse the trend of ecological degradation and enhance the carbon storage and carbon sequestration potential of ecosystems.

Carbon storage and carbon sequestration is one of the key ecosystem service functions. However, the current guideline for delimitation ECR has not considered the carbon sequestration function yet, and there is no technical method for carbon sequestration function of ECR, which therefore makes some areas with large carbon reserves not fully included in ECR zoning, resulting in the lack of protection space for carbon sequestration function. We suggest that ECRs can be delimited for carbon sequestration function. Strict protection and ecological restoration, with carbon storage and carbon sequestration recognized as a critical part of ecosystem service function, could make a substantial contribution to improve the ECR system, mitigating global climate change and realizing the vision of carbon neutrality.

Taking into account the ECR delineation method and management requirements, referring to the current status of the terrestrial ecosystems, using the latest research results and government documents related to carbon sequestration, and taking typical ecosystems such as forest, shrub and grassland as the delimited objects, an evaluation index system of carbon sequestration importance was constructed. This involved three dimensions: carbon storage, carbon sink and carbon sequestration potential (Fig. 2-8, Table 2-1) to scientifically evaluate the carbon sequestration importance of terrestrial ecosystems in China and revealed differences in importance and regional distribution of the carbon sequestration function. The terrestrial ecosystem with high carbon storage, strong carbon sequestration capacity and great carbon sequestration potential can be classified as suitable for becoming the ECR of carbon sequestration function, conducive to achieving the goal of carbon neutralization.

The index system consists of four levels: target level, criterion level, element level and index level (Table 2-1). The target level is the importance of ecosystem carbon sequestration function. The criterion level includes ecosystem carbon storage, carbon sink and carbon sequestration potential.

Carbon storage indicates the ecosystem absorption of CO₂ in the atmosphere

through photosynthesis, and fixes CO_2 in the form of organic carbon in soil and vegetation. The fixed amount is the carbon storage of terrestrial ecosystems. Ecosystem carbon storage includes vegetation carbon storage and soil carbon storage. Considering the short harvest period of crops, most of the biomass increased during the growth of crops is decomposed and released into the atmosphere shortly. Their carbon absorption and emission are thus generally balanced. Therefore, crop biomass is not considered in vegetation carbon storage analysis.

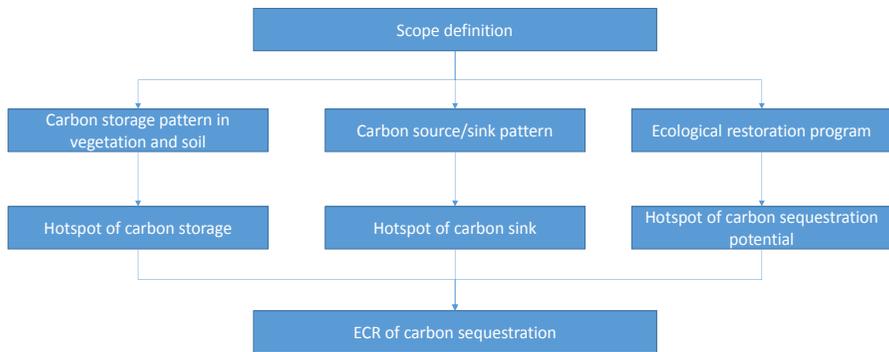


Figure 2-8 Delineation of ECR for carbon sequestration

The index system consists of four levels: target level, criterion level, element level and index level (Table 2-1). The target level is the importance of ecosystem carbon sequestration function. The criterion level includes ecosystem carbon storage, carbon sink and carbon sequestration potential.

Carbon sink refers to the function of terrestrial green plants to convert atmospheric CO_2 into organic matter for storage through photosynthesis, which mainly reflects the amount of CO_2 that can be fixed by the terrestrial ecosystem per unit area. Net Ecosystem Productivity (NEP) is usually used as the indicator. Without considering the interference of human activities, NEP greater than 0 indicates the role of carbon sink of the ecosystem. NEP is the difference between vegetation NPP and soil HR (Heterotrophic Respiration).

Carbon sequestration potential refers to the amount of carbon sequestration that may increase from the base year to the target year with the implementation of ecological restoration projects. The carbon sequestration potential of the ecosystem depends on two key factors, namely the growth intensity of NPP and the carbon turnover time. During the fixed carbon turnover period, the greater the intensity of NPP growth, the higher the carbon sequestration potential of the ecosystem.

Compared with the research results of ecosystem carbon storage and carbon sinks, the prediction of carbon sequestration potential is more uncertain and lacks a reference on its spatial distribution, which makes its contribution to the definition of

the ECR of carbon sequestration remain relatively small. Therefore, considering the situation above and with the expert consultation, the weights of indicators of the criterion level are defined with the principle of "carbon storage and carbon sequestration as the main component, and carbon sequestration potential as a supplement." The weighted values of carbon storage, carbon sequestration and carbon sequestration potential are therefore defined as 0.4, 0.4 and 0.2, respectively.

Table 2-1 Evaluation index system of carbon sequestration function

Target level	Criterion	Element	Index
Importance of carbon sequestration	Carbon storage (0.4)	Vegetation carbon storage	Forest aboveground biomass
			Grassland aboveground biomass
		Soil carbon storage	Soil organic matter content
	Carbon sink (0.4)	NEP	Vegetation NPP
			Soil HR
	Carbon sequestration potential (0.2)	Carbon increment	Vegetation distribution
			Vegetation annual NPP
			Vegetation annual NPP growth

2.4.4 Design and Development of an Automated Identification Platform of ECR

The technique for ECR delimitation can be applied automatically through GIS and computer information technology. Therefore, we propose to design an ECR software toolkit to integrate the methods and processes of ECR delimitation. On this basis, it can be used by other regions and countries.

The goal of the ECR software toolkit is to promote the concept, methods and tools of ECR in the global and regional ecological environmental protection planning, natural protection actions and natural resource management decision-making processes, and promote the scientific and simplified evaluation of ecosystem service functions. Government agencies, planning departments, regional organizations, enterprises and environmentalists could use the toolkit to carry out ecological protection planning at the regional and national levels.

The ECR software toolkit integrates the methods and processes of ECR delimitation. It has independent data models, adopted human computer interaction, which can assist in processing and producing the basic data and parameters delimited by ECR, evaluate the importance of ecosystem services, establish the ecosystem classification results, and finally generate boundary data of ECR. The ECR software kit is based on ESRI ArcGIS program running environment, and

finally runs in the form of feasibility file *.exe file or *.tbx under the support of ESRI ArcGIS environment. The toolkit's functions mainly include: basic data management function for ECR, ecosystem function evaluation function, ecosystem importance classification function, ECR boundary optimization function and ECR mapping function. The design for the operation process of an ECR software toolkit is noted in Figure 2-9.

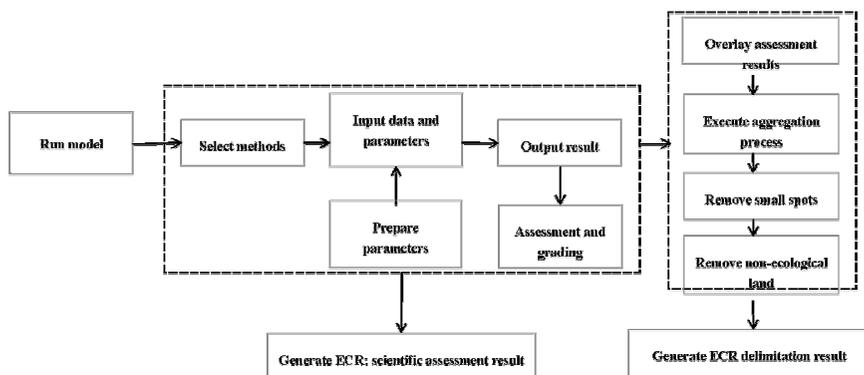


Figure 2-9 Operational process for an ECR software toolkit

2.4.5 Suggestions on International Promotion of ECR

China has made great efforts to protect, improve and restore its natural areas, biodiversity, integrity of ecosystems and their services. China also brings economic benefits to the rural people. Such efforts will be further strengthened in the Chinese 14th Five-Year Plan and future plans. In particular, China's innovative ECR has played a key role in maintaining China's ecological security and sustainable economic and social development. The delimitation of ECR is an important measure to promote the ecological civilization construction and land spatial development pattern in China, which is also an important innovation of China's ecological environment protection system. At the CBD COP 15 China's efforts will be highly valued and can be used to illustrate how to meet challenges and create new opportunities for economic and social well-being. At present, China is the only country in the world to delimit ECR. With the help of CBD, China should show the world its innovation and breakthrough for this type of ecological and environment protection, expound the function of the ECR on biodiversity protection, and possible use for delineating areas for carbon sequestration.

2.4.5.1 Integrating ECR to the Nature-based Solution to Adapt to Climate Change

Nature Based Solutions are an effective approach against climate change. Delimiting ECR is not only conducive to enhance the ecosystem stability and resilience, but also conducive to conserve and enhance the carbon sequestration

function of the ecosystem and thereby address an important aspect of climate change. During the Climate Action Summit of the 74th UN General Assembly in September 2019, the Chinese government submitted a proposal to the assembly "delimiting ECR to mitigation and adaptation of climate change—action initiative for nature based solutions". According to the proposal, the existing practice cases have proved that the purpose of "providing larger carbon sequestration services in a smaller area" can be achieved by determining the protection area with ECR.

We suggest that the Chinese government should further promote the implementation of the 2019 initiative. We could invite the parties of the UN Convention on Climate Change, the Convention on Biological Diversity, the Convention to Combat Desertification and other international organizations, non-governmental organizations and the private sector involved in biodiversity conservation. We will call on all parties to take active action to draw lessons from ECR practices and explore the provision and implementation of nature-based solutions as action initiatives for natural solutions to climate change. The above-mentioned measures can provide solutions for making a positive contribution to the global response to climate change and the realization of goals of the post-2020 Convention on Biological Diversity.

2.4.5.2 Introduce Important Carbon Sink Ecological Function Areas to Achieve Chinese Carbon Peak and Carbon Neutral Goals

According to the ECR proposed by China, the important ecological function areas, such as water conservation, soil and water conservation, wind prevention and sand fixation, and the ecological sensitive areas, such as soil erosion, land desertification and rocky desertification, are basically included as important ecological functions in ECR delimitation. However, due to the absence of taking the ecological function of carbon sequestration as a separate part in the delimitation method, some important carbon sink areas have not been identified. They could be included in the ECR. In addition, marine and coastal carbon sequestration can also be improved by delimiting marine ECR such as mudflats, mangroves and offshore marine reserves.

The carbon sink acts as an essential approach to mitigate climate change and achieve natural response to climate change, from both international and domestic perspectives. China's ECR policy will be the first of its kind to scientifically protect nature. The original purpose of this policy is to protect areas with important ecological functions and fragility, restore wildlife populations, and protect human welfare from nature. Now we are exploring the potential of the ECR in improving carbon sequestration capacity and mitigating climate change. The ECR incorporates important carbon sink ecological function areas such as forests, grasslands, peatlands and permafrost lands into the scope of protection, which also contributes to climate action. We will further improve the results of the ECR delineation in

accordance with the goals of carbon peaking and carbon neutrality proposed by China and contribute to China's effective response to climate change and the implementation of the United Nations Framework Convention on Climate Change.

2.4.5.3 Integrating ECR into a "Green BRI" to Prevent Ecological Damage Caused by Development Activities from Happening in the First Place

Most BRI countries are developing countries, which are in a critical period of balancing development and ecological protection. Pre-planning of protecting important ecosystems is an important means to avoid ecological disruption, and the delineation of ECR can solve this problem while reducing the ecological footprint of BRI countries. Therefore, we recommend promoting the experience and practice of China's ECR to BRI countries, promote BRI countries to develop ECR-based policy frameworks and submit the policy frameworks as countries' national strategies under the CBD and UNFCCC.

Although countries can and should adopt protection measures that suit their own circumstances, they can still learn a lot from China's ECR system, especially the use of scientific means for spatial planning that considers the overall ecosystem functions. We believe that China will continue the innovation and learning in the process of implementing this policy and provide experience for other countries. The "Belt and Road" initiative is a viable and ready-made way for China to share its ECR experience. China can help BRI countries to carry out ecological conservation work in a similar way as ECR delimitation.

2.5 Cross-Cutting Nature of Biodiversity: Mainstreaming and Synergies

This chapter examines how mainstreaming and synergy agendas could be further strengthened within the post-2020 global biodiversity framework (GBF) and in related preparatory documents.^① It draws lessons for biodiversity mainstreaming from case studies in climate policy, the urban context, the financial sector and national economic accounting frameworks. Regarding efforts to enhance synergies, the report analyses the different sections of the CBD Updated GBF Zero Draft and highlights entry points for realising synergies with biodiversity-related conventions.

^① A team from the German Federal Agency for Nature Conservation (BfN) led by Lennart Kümper-Schlake, a member of SPS 1-2 Post 2020 Biological Conservation, prepared two discussion reports and a Special Technical Report on *The Cross-cutting Nature of Biodiversity: on the Role of Mainstreaming and Synergies in the Context of the Global Biodiversity Framework*.

2.5.1 Mainstreaming Biodiversity Across Government and Society as Well as Enhancing Synergies among Environmental and Sustainable Development Agendas are Key Contributions to Realising a Broader Agenda for Societal Transformative Change

Both the Global Sustainable Development Report (2019) and the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) (2019) called for transformative change in order to lead us to a pathway for achieving the Sustainable Development Goals (SDGs) in 2030. The on-going development of the GBF needs to trigger the transformations identified by IPBES. While the synergies aspect touches upon the realm of biodiversity-related multilateral environmental agreements (MEAs) and organisations, the mainstreaming angle is thematic and aims at whole economic or societal sectors.

The GBF needs to lay the ground for successful mainstreaming efforts undertaken by international organisations, governments, and stakeholders. To further detail the mainstreaming agenda, the CBD COP 14 decided to establish a long-term strategic approach for mainstreaming biodiversity (LTAM). Also, an Informal Advisory Group (IAG) to advise the CBD's Executive Secretary and the Bureau on the further development of the proposal for a long-term approach, including on ways to integrate mainstreaming adequately into the GBF has been established. Both aspects, mainstreaming and synergies, need to be anchored strongly in the outcome to be negotiated at the 15th COP of the CBD.

2.5.2 Building Meaningful Linkages Between the GBF and the LTAM to Strengthen the CBD's Mainstreaming Agenda

The Updated Zero Draft released by the co-chairs of the Open-Ended Working Group on the GBF in August 2020, addresses mainstreaming under the 2050 Goal B (Contributions of Nature to People) and Goal D (Means of Implementation). Further, several targets are highly relevant for the mainstreaming agenda, including target 4 on management of wild species, target 6 on pollution, target 7 on nature-based solutions to climate change, target 9 on managed ecosystems and agriculture, target 11 on green infrastructure, target 13 on integrating biodiversity values, target 14 on sustainability of economic sectors and businesses, target 15 on sustainable consumption and lifestyles and target 17 on incentives and resource mobilization.

While the GBF is directed at a more strategic level, the LTAM will provide further operational guidance to support the implementation of the GBF's mainstreaming elements. However, the concrete integration of the LTAM in the GBF and the follow-up of its implementation still need to be discussed. Some Parties fear that duplicate structures will be created and ambitious mainstreaming goals and efforts may be outsourced from the GBF to the LTAM. The upcoming

rounds of negotiations prior to COP-15 will be crucial to clarify these points and to implement the necessary adjustments in the further development of GBF.

The LTAM and GBF intend to build upon potential synergies with other international agreements and conventions. These linkages are still under discussion and could be further elucidated in the GBF as well as in the LTAM. In the LTAM and its Action Plan, linked SDG targets are only partially included and could be emphasized more explicitly. Similar or aligned indicators for similar targets could be included in the GBF monitoring framework.

The LTAM does not explicitly single out economic sectors beyond finance, pointing to the financial sector's unique leverage for instigating change in other sectors. With its focus on GBF targets 13, 14, 15 and 17 as well as the financial sector, the LTAM focuses on the indirect drivers of biodiversity loss. The LTAM's lack of more specific guidance for other sectors and associated direct drivers has been criticised by some Parties and stakeholders. Similar concerns have been raised for the Action Plan, in which specific actions for the most relevant economic sectors should be outlined more clearly and proposed timeframes should be adjusted for more feasibility, according to some Parties.

The IAG argues that guidance on how mainstreaming in other economic sectors should take place was already provided during COP13 and COP14 as well as the IPBES global assessment (2019). However, the guidance provided during these two COPs is not coherent between sectors and therefore is likely insufficient to generate continued momentum and directionality for the respective sectors.

2.5.3 Insights from Mainstreaming Biodiversity in Climate Policy, the Urban Sphere, the Financial Sector and Environmental Accounting

While biodiversity is still insufficiently anchored in relevant policy areas and sectors, there have been promising developments in climate policy, urban planning, the financial sector and environmental accounting. In all four areas, it is a broad coalition of, among others, economic, political and civil society actors that has enabled initial mainstreaming successes. Insufficient data availability and lack of harmonised methods are currently still barriers to further mainstreaming in the areas of environmental accounting and the financial sector. In the urban sphere and climate policy, the integration of biodiversity is increasingly framed using the concept of Nature-based Solutions (NbS). In order for NbS to actually contribute to the conservation of biodiversity and its sustainable use, safeguard measures must be taken. This will ensure that biodiversity objectives are considered in the implementation process and are not inappropriately subordinated to climate and urban planning objectives. At the same time, NbS should not only be understood as measures that contribute to climate action but for all societal challenges that defined by IUCN, including health, provision of food and clean water, natural habitat

degradation and natural disaster prevention.

To further promote actions by non-state and subnational actors such as financial sector institutions, businesses or cities, their contributions to the GBF would need to be made more visible. Doing so could enhance motivation by actors to showcase what they are already doing and create more accountability to complement governmental transparency efforts.

2.5.3.1 GBF Entry Points for Strengthening Biodiversity Mainstreaming in Climate Policy

The LTAM itself does not include many references to climate change while many of its actions bear relevance to climate without explicitly mentioning them. For instance, under action area 1 (biodiversity mainstreaming across policy and planning), the LTAM includes one indicator that specifically refers to climate change (mainstreaming biodiversity in national climate action plans). Under Action 1.2.1, the LTAM Action Plan suggests governments to “align their CBD, UNFCCC and UNCCD components” with respect to SDGs and the mainstreaming agenda.

If the GBF is to function as an overarching framework that highlights the fundamental relevance of biodiversity for achieving other societal objectives, mitigation and adaptation opportunities through biodiversity action should be anchored firmly in the GBF. This way, existing climate change policy, including Nationally Determined Contributions (NDCs), could come to be subject to biodiversity policy considerations, ensuring that measures to tackle climate change do not undermine the potential for achieving biodiversity goals. Giving NbS a strong role within the GBF can also help ensure that NbS are implemented in a way that they realise climate alongside biodiversity objectives. This way, the GBF could promote NbS that do not only comply with biodiversity safeguards but also generate nature-positive outcomes. Highlighting the benefits biodiversity generates in terms of climate adaptation and mitigation also opens up the possibility of accessing climate finance for biodiversity action.

2.5.3.2 GBF Entry Points for Strengthening Biodiversity Mainstreaming in the Urban Context

The GBF directly addresses the subnational level in target 11 (health through green and blue spaces) and target 13 (values). The GBF could further strengthen biodiversity mainstreaming at subnational level by broadening the scope of the GBF’s urban biodiversity target 11. Target 11 could not only refer to green/blue spaces, but also to biodiversity-inclusive urban planning, including building and infrastructures. Cities can also contribute to achieving a number of other GBF targets and SDGs.

When strengthening the linkages to urban biodiversity across a number of GBF targets, the multiple linkages with the SDGs can be emphasised and the corresponding SDGs’ indicators could be referred to within the GBF. In particular,

SDG 11 on resilient and sustainable cities includes targets on sustainable urbanisation and land use, protection of natural and cultural heritage, access to green spaces, the protection against climate change impacts, disaster, air pollution etc.

The use of the NbS concept is still under discussion within the GBF process itself. The pros and cons of the concept have been commented on especially compared to the use of the concept of “Ecosystem-based Adaptation” during first consultations on the Zero Draft. By using a NbS concept that highlights not only climate but also ecological, social or economic benefits, the GBF could strengthen perception and effective uptake of NbS as instruments for achieving multiple benefits within the urban context and beyond.

Finally, the GBF could refer to global reference indicators and monitoring frameworks thereby contributing to more coherence and better data availability and comparability. As of now, the urban sector is not fully represented in the target system and monitoring framework of the GBF and could be strengthened if supported by recognised standards. In one of its three strategic areas, the LTAM addresses local governments and could benefit from the inclusion of specific urban elements to its Target 1.1. (on assessment, valuation, and accounting tools and methodologies) taken from newly developed NbS standards.

2.5.3.3 GBF Entry Points for Strengthening Biodiversity Mainstreaming in the Financial Sector

The role of biodiversity finance from public and private sources features prominently in the Updated Zero Draft as well as the LTAM and its Action Plan. The GBF includes a goal on green investments (D. 2030 Milestones, Goal B.2) and GBF targets 17 and 18 also directly relate to the financial sector and resource mobilisation from all sources.

The financial sector is the only sector for which the LTAM outlines a broad range of actions for all financial institutions. However, besides the goal on green investments, the GBF does not explicitly address private financial institutions at target level.

The GBF could further strengthen biodiversity mainstreaming within the financial sector by more explicitly including public-private collaboration and partnerships (cf. LTAM Action Plan 4.4) to facilitate the graduation of sustainable business models and generation of positive track records. These partnerships can provide de-risking tools for structural financial instruments pooling multiple biodiversity-related projects and bundling them into a single product with tailored risk and return profiles for investors. Further, the GBF needs to include more detailed guidance on developing a transparency framework for public and private biodiversity finance flows to enhance more consistent and comparable data on biodiversity finance.

2.5.3.4 GBF Entry Points for Strengthening Biodiversity Mainstreaming in National Accounting

National accounting is firmly anchored in the GBF, the LTAM and its Action Plan. Following the System of National Accounts (SNA) approach ensures consistency (e.g., no double counting) by linking to economic processes, and thus relevance beyond the environmental policy sphere. By specifically referring to the UN System of Economic and Environmental Accounting (SEEA) framework, the LTAM and its Action Plan contribute to integrating ecosystem services into standard approaches to national accounting. LTAM Global Goal 1 focuses on ecosystem or natural capital accounting using the SEEA framework. However, calculating market prices for goods that are not traded on markets is challenging, and will not provide a comprehensive picture of the broad range of values of biodiversity, such as intrinsic or relational values which must be assessed by additional means.

In recent years, the United Nations Statistics Division has developed an ecosystem accounting methodology to complement the SEEA framework. In order to advance GBF implementation with respect to accounting, the SEEA framework should be applied taking into account three key considerations: First, accounting results need to be fit for purpose. Not necessarily one method fits all, but all accounting efforts need a clear definition of purpose, way of use and transparent methods, to enhance comparability. Hence governments may be well advised to provide a toolbox, offering tools that are fit-for-purpose for different policy tasks, from reporting to planning, regulating, investing and prioritising. Doing so would contribute to LTAM Action Plan action 1.1.3. Second, a clear communication about the kind of Ecosystem Accounting (EA) data required is needed. This requires clarification which questions an EA is capable answering and which not. In particular, it is crucial that monetary data in the EA is not misread as representing “the value of nature”. Third, data availability needs to be improved. This includes ecological and modelling knowledge of ecosystem processes, up to date in situ monitoring data for ecosystems and biodiversity, and related analytical tools helping to translate accounting data into policy advice. For mainstreaming and generating feasible, relevant and representative indicators, it is important that SEEA EA is implemented in coordination with those responsible for national biodiversity assessments. Doing so would contribute to LTAM target 1.1.

2.5.4 Seizing the Opportunity of the GBF to Enhance International Biodiversity Governance by Making Use of Synergies

Over the last decade, countries have agreed to multiple sets of international biodiversity-related goals. For instance, the SDGs have strong biodiversity-focused elements at goal and target levels. In 2010, Parties to the CBD adopted the Aichi Biodiversity Targets, which have subsequently found endorsement and support

throughout the UN system and beyond. Many thematic and institutional connections exist between multiple strategies and sets of goals and targets. The GBF provides a further opportunity for connecting strategies and goals of different multilateral environmental agreements, including the Land Degradation Neutrality objective of the United Nations Convention to Combat Desertification (UNCCD), the Strategic Vision 2021 - 2030 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) or the natural heritage sites of the World Heritage Committee (WHC).

Coherent and mutually supportive biodiversity strategies, goals and targets at the international level will foster cooperation, coordination and synergies at regional and national levels. After the GBF is adopted, the CBD Parties will be required to revise their National Biodiversity Strategies and Action Plans (NBSAPs). This revision provides opportunities to countries or regions to strengthen implementation of biodiversity-related conventions by making use of synergies. This includes monitoring, reporting and review of biodiversity, by revising legislation or by conducting capacity development activities, e.g., on communication of biodiversity or on minimizing trade-offs, for instance by applying NbS. Furthermore, NBSAPs can take a stronger role in mainstreaming biodiversity into different productive sectors like agriculture or tourism. For that, relating NBSAPs to the SDGs is an opportunity to link biodiversity with other policy areas and to create new narratives for the importance of biodiversity.

Cooperation at the level of secretariats of biodiversity-related multilateral environmental agreements is well established, however it is only institutionalised to a limited extent and governments play a small role so far. In order to make significant progress regarding the potential for synergies, governments and the entities within governments responsible for the different multilateral environmental agreements, need to take consistent and mutually supportive decisions in all conventions to which they are a party.

The on-going process of developing the GBF presents opportunities and options for enhancing synergies, cooperation and coordination – either in the text of the GBF itself or in multiple other decisions to be taken by the CBD COP-15, such as on the long-term strategic framework for capacity development, the monitoring framework for the GBF, on resource mobilisation and on knowledge generation, management and sharing. All those decisions are related to the GBF but there is a risk that they remain under the radar of the negotiations of the GBF and governing bodies of biodiversity-related conventions other than the CBD have limited opportunities to engage.

A promising option to achieve mainstreaming and promote synergistic implementation of the GBF is the establishment of new or the revitalisation or expansion of existing joint work programmes by two or more multilateral

environmental agreements and potentially other international organisations or partners. Such work programmes could be either thematic or linked to one or more new GBF targets and constitute implementation plans for the GBF. Such thematic and/or target-based work programmes would increase ownership of all actors with the GBF, set out milestones, clarify responsibilities and help managing GBF complexity.

2.5.5 Recommendations Summary on Mainstreaming and Synergies

2.5.5.1 Mainstreaming

In addition to area-based conservation measures, integration of biodiversity into other sectors and different types of decision-making (horizontal and vertical) is a prerequisite for a nature-positive development and transformational change. The mainstreaming of biodiversity should be strengthened in the CBD, at national and subnational levels and more generally within decision-making involving economic growth and development.

The mainstreaming agenda could feature more prominently in the Global Biodiversity Framework (GBF). Sectors and non-governmental actors are addressed only indirectly, and not explicitly enough through targets and indicators in the Updated Zero Draft of GBF. Further, the relationship between the Long-term Strategic Approach for Mainstreaming Biodiversity (LTAM), its action plan and the GBF needs to be further defined in order to enable transformative action. This is important to avoid duplicate structures and outsourcing ambitious mainstreaming goals and efforts from the GBF to the LTAM.

The LTAM could be further developed in such a way that it provides the conditions for the actors in the respective sectors to organize themselves and thus ensure necessary ownership. This way, the LTAM might set out a process on how the mainstreaming agenda could be further developed rather than aiming to define every aspect itself.

2.5.5.2 NbS and Climate Change in the GBF

NbS as well as linkages with climate change could be strengthened throughout the GBF. First, the GBF could make better use of Nature-based Solutions (NbS) than currently reflected in the Updated Zero Draft. The Updated Zero Draft mostly refers to NbS in the context of climate objectives. As NbS can address a broader range of societal challenges beyond climate change, the GBF should highlight this by referring to NbS for instance in the context of urban biodiversity (target 11). Prominently including NbS in the GBF could help to (1) establish important linkages to other environmental and societal agendas and (2) ensure that NbS are understood in a nature-positive way, in line with the International Union for Conservation of Nature (IUCN) standard and other standards that go beyond “doing no harm” to biodiversity.

Second, the Updated Zero Draft refers to climate change objectives at goal and target level, with a focus on climate adaptation. If the GBF is to function as an overarching framework that highlights the fundamental relevance of biodiversity for achieving other societal objectives, mitigation and adaptation opportunities should be anchored firmly in the GBF and its monitoring framework. For instance, linkages to climate change could be included/reflected into targets related to land use, oceans and agriculture.

2.5.5.3 Synergies

The GBF provides an important opportunity for connecting strategies and goals of various multilateral environmental agreements, including the Land Degradation Neutrality objective of the United Nations Convention to Combat Desertification (UNCCD), the Strategic Vision 2021 - 2030 of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (CITES 2019) or the natural heritage sites of the World Heritage Committee (WHC). **This opportunity should be used!**

The revision of the National Biodiversity Strategies and Action Plans (NBSAPs), which will be required upon adoption of the GBF, provides opportunities for countries or regions, including China, to strengthen implementation of biodiversity-related conventions by making use of synergies. This includes monitoring, reporting and review of biodiversity, by **revising legislation** or by **conducting capacity development activities**, e.g., on communication of biodiversity or on minimising trade-offs, for instance by applying NbS. Guidelines for NBSAP revision should consider the expertise of biodiversity related **Multilateral Environmental Agreements (MEAs)** as well as UN agencies and other international organizations.

2.6 Post-2020 Socio-Ecological Security, Resilience and Recovery

2.6.1 Introduction

The crisis created by the Coronavirus (SARS-CoV-2) spreading COVID-19 disease world-wide reminds us once again that even the smallest forms of biodiversity can bring about devastating impacts for people, our globalized economies and society. COVID-19 came on suddenly, but may leave only gradually[34]. ‘Building back better’ has become a global rallying call for a more resilient planet, communities and economics. But what does that actually mean? UNEP describes a situation of triple emergency for ecology and environment: pollution, climate change and biodiversity loss (United Nations Environment Programme, 2021). To this we can add the major concern that action to address most of the 17 UN 2030 Sustainable Development Goals (UN2030SDGs) is lagging. For

all of these SD Goals, including those directly concerned with biodiversity, progress has been slowed due to various factors, including gender inequities and gaps—a major point explored at length during recent decades, but still not sufficiently resolved. A big issue is the continued challenge of treating issues individually without full consideration of potential for co-benefits and synergies. This has certainly been the case regarding mutually supportive efforts between Climate Change, Biodiversity Conventions, and Public Health. ‘One Health’^[35] is an example—a convergence of valuable knowledge regarding links of animal health, public health and health of ecosystems but still limited in mainstream applications. The need for transformative change is well recognized, with many good ideas and accords, but not yet part of the mainstream of development.

These problems should be tackled together. They share some common roots, including poverty, unsustainable patterns of resource use, overconsumption, failure to protect ecosystems, poor funding and other policy decisions by governments, limited participation by enterprises, and incomplete scientific knowledge. Almost always there is damage to biodiversity and ecosystems implicated either in terms of causality (e.g., 60 to 70% or more of epidemics and pandemics involve animals, disrupted ecosystems, invasive species), or via consequences such as destroyed economies leading to uncontrolled impacts on landscapes or species (e.g., wildfire, endangered species exploitation). COVID-19 has disrupted our whole way of life and thinking. But the precedents set in tackling this problem may also pave the way towards accelerated action and innovation for issues such as biodiversity conservation.

2.6.2 From Emergencies to Ecological Civilization^[36]

Can the massive financial efforts for stimulus and recovery from COVID-19 be truly successful unless the efforts are dovetailed with other emergencies of our time to form a common cause for the future? We are at a stage now where we can seek reasoned answers. Since mid-2020 there has been a strong call for a “green recovery from the social, economic and other impacts of COVID-19.” What should the framework be for such efforts, globally and within individual countries? Answering these questions is vital in 2021, when world attention is focused on a Summit on Food Security, COP 15 on Biodiversity, and COP 26 on Climate Change. By settling the decade’s agenda for nature’s restoration, much more can fall into place for positive sustainability outcomes from 2030 to 2050/2060. For China the transformational goal is to establish an Ecological Civilization.^[37]

2.6.2.1 The theme of the CBD COP 15 meeting is Ecological Civilization: Building a Shared Future for All Life on Earth. However, emergencies of every type still require swift action as well as eventual recovery and restoration. For the massive expenditure on COVID-19, will the cumulative effects of action be net

positive or negative on nature, climate change, and the future quality of life for people and the planet? We must take into account socio-ecological Planetary Boundaries^① within which societies can safely exist and operate, such as a 1.5 to 2.0 degree Celsius global temperature rise, excess loss of terrestrial, aquatic and marine ecosystems that provide essential ecological services, etc. These Planetary Boundaries need to be linked to the social foundations upon which societies can define their needs for a high quality existence. Together these two approaches provide a socio-ecological conceptual model called ‘doughnut economics’^[38]. They define the bounds of “safe operating space” in which humanity may function sustainably.

2.6.2.2 The criteria for a stated stimulus and recovery can be defined in economic terms but often have been difficult to fulfill in an environmental way. This was the case of the financial emergencies in parts of Asia in 1997/1998 and in the follow-up to the global financial debacle created on Wall Street during 2007/2008. A prime example is the widely expressed goal of improving resilience after such serious disruptions. To address such consequences, it is necessary to look beyond the short-term. Mark Carney, well-respected international finance expert and UN Special Envoy on Climate Change, worries about the “tragedy of the horizon”, societal and political inability to find or act on sustainability paths. Often we cannot see clearly enough, or act upon the political and social pathways of change into a better future. [39]

According to a new report^[40] by UNEP and Oxford University experts, USD14.6 trillion was committed to stimulus and recovery in 50 large economies during 2020. Most funding was spent on ‘first aid’ stimulus initiatives intended to avoid economic and public health disasters. Only USD1.9 trillion was allocated to longer term ‘recovery-type measures’. Of this smaller amount, USD341 billion supported green recovery initiatives—less than 18%. The countries providing green support were almost exclusively among the richer nations. The EU has based its recovery efforts around the 2019-2024 European Green Deal and is an exception to the general trend of some other countries and regions. The USA awaits action by the new administration. China is bundling its green efforts into relevant parts of the 14th Five-Year Plan. In general, the hope for a smooth dovetailing of COVID-19 recovery funding initiatives with the global emergencies so far has not been well realized. This should be a matter of concern at both CBD COP 15 and at the UN Climate Change COP 26. The funding gap on biodiversity matters is estimated at an average of USD711 billion per year this decade^[41]. In 2019 biodiversity conservation global financing was estimated at USD 124 to 143 billion.

Fortunately, financial sector leaders such as Mark Carney, and others from business and organizations such as the World Economic Forum, and from

^① Planetary boundaries and the socio-economic doughnut.

development banks are becoming very engaged on the subject of green finance. They are being supplied by valuable recent studies on economic analysis of ecological services, environmental risks and innovative funding models.^[42]

2.6.2.3 Some integrated solutions are available but not used as well as they should be. A prominent example is One Health.^[35] Its value is better recognized today by comparison to a half year ago. Appreciation of “nature friendly” and “nature positive” approaches to development, and the need for greater emphasis on restoring ecological services and improving their valuation in broader terms is central. Natural infrastructure and building natural capital are very much in the limelight. These and other topics are explored as the basis for longer-term green recovery.

The opportunities for working on One Health, and issues such as long-term biodiversity conservation in partnerships among countries, and with specific development relationships such as China and the Belt and Road Initiative (BRI), with ASEAN or other regional bodies such as ESCAP, and with international development banks such as the Asian Development Bank (ADB) or the AIIB need to be examined in the context of green recovery.

2.6.3 Resilience: Why So Important?

Kristalina Georgieva of IMF has noted that: “Green recovery is our bridge to a more resilient future.” OECD indicates the Path to Recovery should be “Strong, Resilient, Green, Inclusive” with a focus on “Health, Jobs and Economy, Environment.” C40 Mayors propose that: “The recovery must improve the resilience of our cities and communities.” World Bank and the GFDRR: “\$4.2 Trillion Can Be Saved by Investing in More Resilient Infrastructure.”

2.6.3.1 This idea of resilience, ever popular, is now on the lips of politicians everywhere, and all types of decision-makers. Resilience is a puzzle for scientists (ecological resilience), a tool for engineers (where the term originated), a favorite word for community leaders, and used by bankers in relation to stress tests. We can talk about ‘managing for resilience’, contrasting resilience and vulnerability in disaster-prone areas, building a sustainable and resilient future, buffering shock and stress, building resilience after crossing tipping points, resilient supply chains, global financial resilience, responsibility for maintaining resilience (e.g., New York City ‘Chief Resilience Officer’), ‘resilient multilateralism’ in regional organizations, ‘grand strategies’ of resilience as a guiding star for policymakers, water resilience, resilient societies, resilient workforces, etc. All these examples are of some potential value as we navigate our way through complex adaptive systems to “build better”, “live sustainably”, or “boost resilience by shaping economies that can withstand everything nature throws at us.”

‘Resilience’ is a word like ‘Nature’. People feel comfortable with these words. Individuals and institutions carry an image of their meanings, no matter how

different they may be compared to their neighbors' or different sectors. Engineering resilience refers to how quickly an item under examination returns to a steady state after disturbance. Ecological resilience refers to various states of an ecosystem under stresses, rather than presuming that it may return to a steady state. Trade economists worry about such matters as supply chain resilience where there is concern over the weakest link collapsing. What constitutes 'a resilient city'? Answer: a city with a capacity to survive, adapt, grow, no matter what kind of chronic stresses and acute shock. A sponge city? Tropical cities protected from storm damage by mangroves? Other cities with upstream wetlands or floodplain lakes?

When it comes to pandemics, species at risk, coral bleaching, and many other biodiversity and ecosystem concerns, environment and natural resource issues, ecological and other types of modeling have been very helpful. In some applications, such a food security, resilience may be very helpful, even in complex multivariate circumstances. But as seen with fisheries management, poly-governance initiatives, and land management there are limitations on the use of resilience as a quantitative mechanism, or in development of longer-term scenarios.

2.6.3.2 At a global level, the problems are greater still. How resilient is the earth and its biosphere? These are questions that the Stockholm Resilience Center^[43] tries to answer, and has given useful advice on the Planetary Boundaries we should not transcend. But clearly information is still inadequate. The WBCSD has taken a dashboard approach based on need for long-term recovery, and to safeguard 'earth resilience'. This approach sets out ways for investing in nature to build resilience that reduces risks of disease, extreme events, and crossing tipping points.^①

IUCN has a framework of 'resilience thinking' to understand processes of ecosystem change requiring adaptability and transformability. In this context IUCN defines resilience "as the capacity of a system to recover from stress and disturbance while retaining its essential functions, structure, feedbacks and identity". Adaptability is capacity of human/biological actors to influence resilience; transformability is capacity of actors to create a fundamentally new system when social-economic or ecological factors make the existing system untenable. Resilient thinking, according to IUCN, is consistent with the 12 Principles of the Ecosystem Approach for equitable, inclusive and holistic management laid out in the Convention on Biological Diversity. IUCN's vision of "healthy, resilient ecosystems" is a means to "bind together diverse IUCN work areas such as species conservation, ecosystem restoration, governance including equity and rights, climate change adaptation, food and water security, and disaster risk reduction." Perhaps these observations are the clearest way to express how resilience should be reflected

^① <https://www.wbcd.org/Programs/Food-and-Nature/Resources/COVID-19-a-dashboard-to-rebuild-with-nature>

from an ecological/environmental point of view.

2.6.3.3 We are left with four questions that deserve to be considered in the discussions at CBD COP 15 and even more during the design of COVID-19 green recovery initiatives, and in the design of projects for sustainable development, food security, and One Health initiatives. (1) Can resilience be defined in an integrated fashion? (2) Can resilience be measured and monitored for success? (3) How can resilience be linked meaningfully to scale, sustainability or other objectives and outcomes? (4) Should we find more precise language than this term?

2.6.4 Gender Gaps

Gender equality is essential to the discussions at CBD COP15. There remain very significant inequities in all nations regarding the full participation of women in decisions affecting their own future, their access to opportunities to shape a safe and healthy environment, and to fully contribute their skills and views. This situation is to the detriment of all, since full restoration of the planet requires full participation of all people.^[44] Clearly the road ahead between now and 2030 for will be complex with both opportunities and challenges. Gender considerations should be viewed in the most positive ways possible. Without full participation by women and girls the chance of fully achieving the biodiversity goals being proposed in the draft COP 15 GBF is likely to be small.

The Global Environmental Facility (GEF) describes the main issue as follows: “Women depend on and are direct users and stewards of natural resources and in areas such as energy and food systems, women farm and produce most of the world’s food supply. Yet they own less than 20% of the world’s land, lack equal rights to own land in more than 90 countries, and commonly face more barriers than men to access markets, capital training, and technologies, and remain unrepresented in decision-making spheres at all levels. Women’s needs, roles, and leadership have historically been unrecognized and undervalued, and persistent social and economic inequalities between men and women hold back today’s prospects for sustainable development and sound environmental management.”^①

2.6.4.1 At the High Level 25th Anniversary Commemorative Summit of the 1995 Beijing Women’s Conference, UN Secretary-General Guterres said that despite gains such as education of girls, “the ambitious vision of the Beijing Declaration remains unfulfilled.” He and several other leaders cautioned that the COVID-19 pandemic “could wipe out a generation of progress towards gender equality.” However he hoped that the COVID-19 stimulus and recovery “is also an opportunity to put women front and center of the recovery. And that “women’s full human rights and freedoms are fundamental to peace and prosperity on a healthy planet.”

^① <https://www.thegef.org/topics/gender>

2.6.4.2 In preparation for the Commemorative Summit countries were asked to prepare a national report on progress on the 1995 Platform for Action, especially over the past five years.^① China reported a number of positive items on gender and environment.^② “Promoting gender equality and environmental protection is not only a constitutional requirement but also a basic state policy. In the past five years, these two major development themes have gradually formed a normalized interaction and an institutional intersection. The gender perspective is constantly being reflected in environmental conservation, protection and projects...there are still many “blind spots” in promoting gender mainstreaming in environmental policies and practices. Environmental legislation and policies do not often touch on gender equality and women’s empowerment.”

The report from China suggested: “(1) incorporate a gender perspective in environmental legislation and policies development. In legislation and policies development, potential policy barriers to gender mainstreaming should be identified. Also, social awareness among policy/decision-makers should be enhanced. (2) further safeguard the rights of women and other beneficiaries to participate in environmental decision-making. In environmental protection and ecological progress, the assessment of impacts on gender equality should be carried out. China will improve the gender awareness and capacity building of personnel in relevant fields, including financial support. (3) further strengthen the collection, analysis and use of gender statistics in the environmental field.”

2.6.4.3 The preparations for CBD COP 15 have included extensive reviews and consultations regarding gender. In the 18 February 2021 Draft Outline of a Post-2020 Gender Plan of Action^[45] three overarching goals are proposed, with several objectives under each and numerous global biodiversity framework (GBF) links noted. Goal 1: Women and girls have equal access to, ownership and control over biodiversity and ecosystem services and associated economic resources and services. Goal 2: Women and girls benefit equally from nature and biodiversity. Goal 3: Biodiversity policy, planning and program decisions address equally the perspectives, interests and needs of women and girls.

The CBD Secretariat has produced an excellent guide that is intended to provide biodiversity professionals everywhere with “concrete ideas and actions for progress in their work towards achieving gender and biodiversity objectives, goals and targets.”^[46] The document brings the sometimes quite abstract policy thinking to ground level, while still retaining the value of maintaining a “gender lens” on biodiversity and ecological issues. It provides an important roadmap to navigate

^① <https://www.unwomen.org/en/csw/csw64-2020/preparations#national-level-reviews>

^② <https://www.unwomen.org/-/media/headquarters/attachments/sections/csw/64/national-reviews/china%20english.pdf?la=en&vs=2346>

routes in ways that can produce outcomes.

2.6.4.4 Biodiversity conservation becomes real for most people at a community and landscape (or seascape) level. This point has not been lost on the many organizations actively supporting community-based conservation. Some such as the International Union for the Conservation of Nature (IUCN) and the World Wildlife Fund (WWF) have very active programs related to gender equity and empowerment of women.

IUCN has taken a leading role in tackling violence and gender topics, since these often relating these to natural resource disputes. A seminal IUCN publication on this subject (GBV, gender based violence) was produced in 2020 ^[47]. The forms of gender based violence include, among many others, intimidation and harassment, denial of rights, physical and sexual violence, kidnappings, and murder. Some of the worst abuses that take place are against indigenous peoples. Women often take on leadership roles in asserting these rights, but may pay a heavy price for their actions. In September 2007 the UN passed an almost universally supported Declaration on the Rights of Indigenous Peoples ^[48]. Articles 21 and 22 of DRIP indicate that: “Particular attention shall be paid to the rights and special needs of indigenous elders, women, youth, children and persons with disabilities.” During the 2021 IUCN World Conservation Congress a World Summit of Indigenous Peoples and Nature will take place. ^[49] Its purpose is “to unite the voices of indigenous people from around the world to raise the awareness that enhanced measures are required to protect the rights of indigenous peoples and their roles as stewards of nature.” The outcomes document from this Summit “will articulate a defined set of high-level results for indigenous-led conservation in the post-2020 era.”

Community-based Conservation (CBC), as practiced by organizations such as WWF and also by many development organizations such as ADB and the World Bank focus directly on needs of local communities and on supporting gender-positive initiatives ^[50]. To some extent CBC represents a shift away from “fortress conservation” approaches where local people are sometimes blocked from resource use in the margins of parks, nature reserves or other protected areas. Instead there can be focus on co-management or joint management of at least some ecologically significant areas based on a combination of local knowledge and scientifically validated approaches. CBC should be based upon women’s equality, full rights and participation in opportunities linked to the UN2030SDGs including those related to health, nutrition and education.

2.6.4.5 Biodiversity conservation relies on information technology, biotechnologies, marketing and other skills that were not imagined or readily accessible a decade ago. The pace of change will likely continue and accelerate. The World Economic Forum, with a focus on both gender parity issues and the fourth industrial revolution, argues the case for preparing now by attracting young women into eight clusters of professions deemed to be of critical importance for the economy of tomorrow. Of the

eight clusters only people and culture (65%) and content production (57%) show a dominance of women. The three of greatest male dominance are data and AI (74%). Engineering (85%) and cloud computing (88%). Averaged over all clusters, males make up 61% by comparison to 39% female. WEF notes the need to narrow the gap by “hardwiring gender parity into the future of work” by creating “incentives for women and girls to enroll in science, technology, engineering and mathematics (STEM) education...[and] to create an accelerated pathway for women to be hired into the highest-growth roles of the future.”^[51]

2.6.4.6 *The case for making gender equality a leading objective for biodiversity conservation and ecosystem restoration is compelling. It is a socio-economic and ecological set of arguments including those related to climate change as well as biodiversity. Even more compelling is the human rights case for gender. It is simply wrong to deny one gender the opportunity to fully realize their potential to make a positive difference for future generations as well as for themselves. For indigenous peoples, it is hard to understand why UNDRIP, a declaration endorsed by most countries, is not being a more powerful basis for action regarding indigenous peoples and their communities. In general a much stronger effort is needed for monitoring initiatives to ensure good gender disaggregated data are available. This is essential for many reasons, but most importantly to determine whether progress on equality is accelerating, and whether adaptive planning and management changes are required.*

Women everywhere should be seen in the fullest way possible to be important agents of change. This needs to happen throughout the current decade that is so important for environment and development. It will require gender positive and nature positive investments including those being made in the COVID recovery phase and also towards the green and technologically very advanced future economy. Girls today need to have good access to education and training in order to participate and lead. It is essential that both public and private sectors take a proactive approach in attracting and welcoming this next generation of well trained and qualified women into leadership roles.

The CBD Secretariat and many groups are well aware of the urgent need for removing the barriers slowing progress on gender equality as it relates to biodiversity and ecological services. There has been an inspiring effort and inputs on this subject in the prolonged preparations for COP 15. The challenge is not so much in getting the words right in a negotiated document. It is what happens afterwards that is such a worry. There no longer is a cushion of time. Implementation goals must be met on time, and if possible exceeded. National plans must incorporate and act on gender equality needs in more effective ways. This will require greater attention to innovative incentive systems and other means. The bottom line is that gender equity must be perceived and acted upon as an outstanding opportunity to move all of humanity towards a new more valuable and harmonious relationship

with nature.

2.7 Overall Recommendations on Post-2020 Biodiversity Conservation

Momentum is building for the CBD COP 15^① in Kunming, China. That it had to be postponed due to COVID-19 was viewed as a serious concern. However, the extra time has been used to good advantage, providing a stronger base of understanding about what is needed to reverse the steady worldwide loss of biodiversity and ecological services no later than 2030. The 2050 CBD vision is for people to be ‘Living in Harmony with Nature’. Regrettably, almost none of the 20 Aichi Biodiversity Targets set at COP 11 for 2011-2020 were met. There is a strong and urgent sense that more can be done to make the strategic biodiversity conservation plan for this current decade both robust and feasible.

The Global Biodiversity Framework (GBF), the key negotiating document, has been strengthened during the past year, but more work remains. It is timely to now consider how to accelerate the pace of implementation. Mainstreaming biodiversity remains an important matter in decision-making. During 2020 more than 16 trillion dollars has been committed to stimulus and recovery from the COVID-19 emergency. Despite widespread calls for ‘building back better’, a green recovery is underway only on a very limited basis. The funding gap for biodiversity and ecological restoration remains large. Finding synergies among environmental and socio-ecological accords and initiatives is essential. Now more than ever mainstreaming biodiversity into development decisions is necessary.

Over the past three CCICED Annual General Meetings the Special Policy Study on Post-2020 Biodiversity Conservation has presented recommendations relating to COP 15 and to China’s impressive efforts for improving and restoring ecological services and restoration, and biodiversity protection. Now, as COP 15 draws near, we particularly wish to look at some ways to ensure there is effective and rapid implementation of the GBF once agreed at the Kunming meeting. China has much to contribute at this meeting and in the years after. The theme of the CBD COP 15 is Ecological Civilization: Building a Shared Future for All Life on Earth. We hope the four main recommendations below will contribute to the success of such a broad undertaking. We also include a short list of suggestions for additional improvements to the draft GBF in Annex 2.

2.7.1 Strive towards Highly Effective Implementation of the GBF 2021-2025.

The first several years of implementation are a make-or-break period to overcome the challenges identified regarding Aichi failures and also implementation

^① 15th Conference of the Parties to the UN Convention on Biological Diversity

difficulties of the Paris Climate Change Agreement, and the UN 2030 Sustainable Development Goals. Ways to do so include the following major points.

2.7.1.1 Ensure that every goal and target at global and national (NBSAP and NDC) levels is well supported by credible and operational indicators to assess progress and to make any necessary corrections quickly. Use the UN SEEA ecosystem and environmental accounting where possible to build compatibility regionally and globally. Assessment should also take into account linking biodiversity progress with selected UN SDGs.

2.7.1.2 Enrich efforts to mainstream biodiversity and build synergies, especially among multilateral environmental agreements (MEAs) including climate change, in rural vitalization and green urbanization initiatives, and major integrated and regional development programs.

2.7.1.3 Work cooperatively to explore and promote on a much larger scale the use of nature-based solutions and nature-positive economic and social development. This approach should not be limited to climate/biodiversity initiatives, and should become part of portfolios supported by governments, international development banks, local and regional commercial banks and other investment sources, private sector enterprises, and community-based organizations.

2.7.1.4 Link biodiversity and ecosystem science more strongly to public policy formulation, and to broader economic and social values such as those related to needs of indigenous people, conservation economics, circular economy, poverty reduction, removal of perverse subsidies, and alternative measures of assessing societal wellbeing. These types of transformative thinking are already demonstrating their usefulness. They fit well with the Ecological Civilization and sustainability theme of CBD COP 15. However transitions must be accelerated early on if we expect major transformations by 2030 and beyond are to be successful.

2.7.1.5 Build a stronger case for dovetailing more funding linked to a green recovery from COVID-19 including support for biodiversity-related needs. The clearest case to be made is for adoption of a One Health approach in all countries for meeting plant and animal health needs and disease prevention while also investing in ecosystem health and human health. This provides the added benefit of reducing future risks of epidemics and pandemics.

2.7.1.6 Place more emphasis both before and immediately after COP 15 on the 'Long-Term Action to Mainstream Biodiversity' within and across sectors. This is noted by IPBES to be essential. The role of enterprises, private sector finance, technological shifts, etc., will be drivers of change. There is good buy-in by some bodies such as the World Economic Forum (WEF) and The World Business Council for Sustainable Development (WBCSD) and a growing number of political leaders, groups such as C40 cities, etc., but far too many decisions still neglect/undervalue biodiversity and ecological services.

2.7.2 Based on China's Theory of Green is Gold and the Practice of Ecological Civilization, Promote the Nature Agenda to International Platform and Translate Ambitions into Practical Actions

Based on China's theory of Green is Gold and the practice of ecological civilization, China has the opportunity to show leadership at international platform. China could join other global leaders such as the UNSG or the Leader's Pledge for Nature, at an appropriate time such as UNGA76, CBD COP 15, G20, or UNFCCC COP 26 to reinforce determination and ambition at a global level to meet the goal of building a new relationship between people and nature.

China could propose to host a Head of State side event before COP 15 drawing together the themes of triple global emergencies of biodiversity, climate and pollution. Such an event could also be linked to the need for global green recovery from COVID-19. Join other leaders to set a solid foundation for the implementation of all three Rio Conventions (UNCCD, UNCBD, UNFCCC) during the Decade of Restoration. Call for nature-based solutions linking China's great efforts over several decades on food, biodiversity, ecosystem recovery, and health, and its more recent ambitions regarding carbon neutrality. China also has the opportunity to strengthen its leadership at ministerial level, leading, guiding and converging global views for a GBF that is ambitious and can bring the needed changes to be nature positive in the next decade. Bilateral engagement at HoS/G, ministerial, diplomat and negotiators levels is all critically needed.

At the CBD COP15, China as a host country, can champion critical issues such as "mainstreaming biodiversity" building on China's own experiences and practices

2.7.3 Share with Other Countries China's Experiences on Implementation of Ecological Functional Zoning and Related Topics

2.7.3.1 Introduce to other countries Ecological Conservation Redlining (ECR) as a major innovation for maintaining biodiversity and building ecological security nationally. At present it is believed that China is the only country in the world with such an integrated and systematic program for addressing green spatial planning in order to conserve most special ecological and biodiversity rich areas. ECR is the bottom line and lifeline to guarantee and maintain national ecological security. With the help of the CBD at COP 15, China could disseminate information and discuss mechanisms on how other nations might benefit from this innovative experience.

2.7.3.2 Incorporate important carbon sink ecological function areas into efforts to achieve climate change mitigation and recognize other ways to use nature-based solutions. Biodiversity and climate change initiatives potentially can have substantial synergies. Changing land use values to recognize more carbon sequestration is good for climate change action and also can secure benefits for biodiversity. If more

important carbon sequestration areas can be protected through ECR, it will assist China in meeting its carbon peaking and carbon neutral goals. The ECR methods should include carbon storage and sequestration as part of ecosystem services function when delimitating. Learning from China's efforts on carbon sequestration may also be of value to other nations. At the UNGA74, China submitted a proposal to the General Assembly to consider delimitation of ECRs for mitigation and adaptation for actions related to climate change by using nature-based solutions. It would be useful to consider following-up on this proposal, in particular through calling on a number of Global Conventions, international organizations, non-governmental bodies and the private sector draw lessons and arrange pilot initiatives.

2.7.4 Accelerate Work towards Social-ecological Security, Resilience, and Gender Equality for the Health and Wellbeing of All People on Our One Planet

The following five suggestions cover strategic matters that together will help to bend the curve from biodiversity catastrophe in 2030 to a solid road for recovery. (1) 'Building Back Better' must incorporate a strong social-ecological approach based on improvements for both people and nature at all levels from local to planetary. (2) Worthwhile concepts such as ecological and social resilience are backed by scientific reasoning, but to be fully operational require a much better basis of data collection and indicators for monitoring progress towards sustainability. (3) Spark innovation on many fronts to enhance biodiversity conservation plus ecological services and restoration. (4) Build stronger partnerships with development organizations and investors already deeply engaged in green recovery, green development and green growth. (5) Make gender equality a leading objective for biodiversity conservation and ecosystem restoration.

Annex 1. Table S1 Characteristics of Each CBD Party

The proportion of protected areas under four scenarios, CPZs coverage, the proportion of unprotected CPZs (unprotected CPZs/total CPZs), CEZs coverage and the proportion of unprotected CEZs (unprotected CEZs/total CEZs) for the 195 CBD country parties (excluding the European Union).

Countries	Existing PAs/%	Scenarios			CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
		Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
Afghanistan	0.2	0.8	8.4	31.4	99.9	99.8	31.4	99.5
Albania	17.5	22.0	27.0	27.0	99.7	82.5	20.6	46.4
Algeria	7.8	10.3	10.3	36.0	46.4	84.5	34.5	81.5
Andorra	34.2	67.3	67.3	67.3	100.0	65.8	63.3	52.3
Angola	7.0	7.0	9.3	67.2	94.2	92.6	66.7	90.2
Antigua and Barbuda	13.9	13.9	14.3	14.3	100.0	86.1	2.0	22.2
Argentina	8.4	21.5	27.7	33.4	98.0	91.6	29.6	84.4
Armenia	22.8	30.1	30.1	30.1	100.0	77.2	14.8	49.6
Australia	19.1	23.2	29.9	69.3	78.8	80.9	64.9	77.3
Austria	28.5	29.0	39.5	39.8	77.2	66.8	23.1	49.2
Azerbaijan	10.3	14.4	14.5	14.5	100.0	89.7	12.9	32.9

Countries	Scenarios				CPZs Coverage/%	Unprotected CPZs/%	CEZs Coverage/%	Unprotected CEZs/%
	Existing PAs/%	Conservative Target/%	Moderate Target/%	Ambitious Target/%				
Bahamas	33.3	42.4	69.7	69.9	100.0	66.7	57.4	63.7
Bahrain	0.9	0.9	0.9	2.1	8.6	100.0	1.2	100.0
Bangladesh	4.7	6.7	7.2	7.5	99.1	95.4	5.5	50.5
Barbados	0.0	0.0	1.1	1.1	99.8	100.0	1.1	100.0
Belarus	9.3	9.3	9.6	20.5	46.9	86.7	16.1	69.4
Belgium	24.7	24.7	24.7	25.0	18.4	30.1	3.7	9.1
Belize	37.3	38.1	57.9	74.8	100.0	62.7	71.4	52.5
Benin	28.1	28.1	28.4	34.2	100.0	71.9	17.6	34.5
Bhutan	48.0	72.2	76.5	77.1	100.0	52.0	72.5	40.2
Bolivia	30.3	40.7	55.9	62.4	99.9	69.7	55.5	57.8
Bosnia and Herzegovina	1.7	5.3	33.2	34.6	66.9	97.8	33.5	98.4
Botswana	29.2	29.2	29.2	34.3	36.8	38.8	26.6	19.2
Brazil	29.4	35.4	42.5	45.8	89.1	68.9	40.2	40.9
Brunei Darussalam	44.2	70.7	74.6	76.6	99.7	55.6	73.8	43.9
Bulgaria	40.6	41.1	49.8	52.8	98.0	59.5	30.5	40.0
Burkina Faso	15.4	15.4	15.4	15.5	100.0	84.6	11.0	1.2
Burundi	7.4	7.9	8.0	9.5	93.1	92.1	6.1	33.7
Cambodia	25.9	38.1	45.6	45.6	100.0	74.1	42.2	46.6
Cameroon	11.3	17.0	28.5	68.9	97.9	89.3	66.4	86.8

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservative Target/%	Moderate Target/%	Ambitious Target/%				
Canada	10.3	10.3	20.6	50.4	60.9	88.4	46.2	86.9
Cabo Verde	3.0	33.0	33.3	34.5	100.0	97.0	33.3	94.8
Central African Republic	18.0	18.0	20.5	80.0	100.0	82.0	79.6	77.9
Chad	17.8	17.8	19.5	36.4	68.6	74.0	28.9	64.3
Chile	19.5	51.4	66.8	70.3	95.7	81.4	63.5	80.0
China	13.6	18.8	22.7	32.5	81.4	86.1	28.0	67.7
Colombia	14.9	35.2	53.0	56.7	97.3	84.8	53.9	77.5
Comoros	10.0	39.8	39.8	39.9	100.0	90.0	35.0	85.4
Congo	37.8	39.5	55.4	90.3	100.0	62.2	86.3	60.7
Cook Islands	0.0	20.9	21.3	21.3	96.5	100.0	21.3	100.0
Costa Rica	27.5	37.2	37.8	37.9	100.0	72.5	30.9	33.7
Cote D'Ivoire	22.8	23.8	24.5	43.3	100.0	77.2	31.4	65.0
Croatia	36.8	40.3	44.8	45.3	54.5	41.8	25.4	33.6
Cuba	15.3	17.7	18.8	18.8	100.0	84.7	14.0	25.6
Cyprus	36.9	39.7	39.7	39.7	100.0	63.1	10.9	25.1
Czech Republic	21.8	21.8	21.8	22.0	10.8	8.3	5.0	4.4
Democratic People's Republic of Korea	2.2	2.2	2.8	46.2	99.1	97.9	45.0	97.8
Democratic Republic of the Congo	13.7	24.9	41.3	78.1	99.2	86.2	76.5	84.2

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
Denmark	15.7	15.7	15.7	16.1	8.8	23.4	2.6	15.4
Djibouti	1.3	1.5	24.7	28.7	99.9	98.7	27.3	100.0
Dominica	21.5	22.3	31.5	31.6	100.0	78.5	25.9	39.0
Dominican Republic	25.9	29.0	29.7	29.7	100.0	74.1	23.3	16.3
East Timor	15.5	20.7	20.7	20.7	100.0	84.5	10.1	51.6
Ecuador	21.4	40.0	47.6	50.4	100.0	78.6	46.6	62.1
Egypt	11.2	11.2	11.6	15.9	8.5	84.8	5.7	82.8
El Salvador	9.2	13.8	13.8	13.9	100.0	90.8	5.6	82.4
Equatorial Guinea	19.2	23.1	81.4	81.4	100.0	80.8	80.3	77.4
Eritrea	4.9	5.3	21.6	26.2	100.0	95.1	26.1	81.5
Estonia	18.6	18.6	20.0	55.5	99.0	81.4	50.8	72.7
Eswatini	4.1	4.6	4.7	4.7	100.0	95.9	4.2	15.6
Ethiopia	17.6	19.9	23.1	25.7	99.6	82.7	13.0	61.9
Federated States of Micronesia	0.0	39.6	39.7	39.7	99.7	100.0	39.7	100.0
Fiji	3.6	57.0	57.2	57.2	100.0	96.4	56.2	95.3
Finland	12.9	12.9	13.0	14.3	8.7	28.0	7.3	19.0
France	29.7	30.6	36.4	38.6	36.7	48.9	20.4	43.8
Gabon	23.4	39.7	74.7	93.5	100.0	76.6	91.2	77.0
Gambia	4.1	4.1	4.7	6.0	83.8	95.3	2.1	89.8

Countries	Scenarios				CPZs Coverage/%	Unprotected CPZs/%	CEZs Coverage/%	Unprotected CEZs/%
	Existing PAs/%	Conservative Target/%	Moderate Target/%	Ambitious Target/%				
Georgia	9.3	41.3	41.3	41.3	100.0	90.7	40.5	78.9
Germany	36.6	36.6	36.6	36.9	26.3	50.4	3.1	12.2
Ghana	15.1	15.8	16.4	27.7	100.0	84.9	21.6	58.4
Greece	34.6	43.1	48.9	49.2	99.1	65.2	31.2	46.6
Grenada	10.0	11.3	15.6	15.9	100.0	90.0	12.7	46.8
Guatemala	19.9	33.9	36.9	39.0	100.0	80.1	30.8	62.1
Guinea	34.4	35.4	37.8	53.5	98.8	65.3	31.5	60.5
Guinea-Bissau	16.0	16.0	19.5	26.9	80.7	82.9	15.4	70.4
Guyana	8.8	37.9	63.2	95.6	99.2	91.2	95.5	90.9
Haiti	7.0	7.3	7.3	7.3	100.0	93.0	1.2	31.0
Honduras	23.7	33.7	39.2	42.1	100.0	76.3	36.9	50.1
Hungary	22.6	22.6	22.6	23.1	15.2	19.1	5.8	9.3
Iceland	19.4	19.4	25.7	92.1	89.6	86.8	82.4	88.3
India	5.6	7.2	7.5	8.9	94.4	94.2	7.2	45.3
Indonesia	11.8	40.9	49.9	52.1	99.6	88.2	51.1	78.9
Iran	7.2	7.6	8.6	27.3	99.6	92.8	24.1	83.3
Iraq	1.5	2.0	3.0	15.5	67.2	97.8	14.7	95.3
Ireland	13.6	13.6	13.6	13.7	3.7	33.5	0.9	13.9
Israel	19.5	19.9	19.9	27.2	59.5	84.7	14.0	54.3

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservative Target/%	Moderate Target/%	Ambitious Target/%				
Italy	21.2	22.6	31.7	32.8	99.3	78.7	24.3	47.6
Jamaica	15.4	22.6	23.0	23.0	100.0	84.6	15.2	49.7
Japan	20.5	21.2	36.2	49.2	98.4	79.7	43.4	66.1
Jordan	2.3	2.6	5.9	29.4	51.6	96.3	28.8	94.0
Kazakhstan	3.3	5.6	22.9	62.3	96.3	96.7	61.1	96.6
Kenya	12.4	13.0	13.3	15.9	84.0	85.7	9.5	37.8
Kiribati	25.6	25.6	25.8	25.9	98.2	73.9	0.5	66.7
Kuwait	16.5	16.5	16.8	34.2	90.2	85.4	30.1	58.9
Kyrgyzstan	7.0	47.1	47.1	47.1	100.0	93.0	43.3	92.8
Laos	16.8	42.4	49.3	65.3	100.0	83.2	62.9	77.3
Latvia	17.9	17.9	18.4	56.7	100.0	82.1	51.4	75.4
Lebanon	2.7	6.7	6.7	6.7	100.0	97.3	4.5	89.0
Lesotho	0.6	2.3	2.4	2.4	100.0	99.4	2.3	78.8
Liberia	4.0	42.2	42.2	42.2	99.2	96.3	41.0	93.4
Libya	0.3	1.4	1.6	20.8	25.7	99.3	20.5	99.9
Liechtenstein	38.7	38.7	46.7	46.7	100.0	61.3	31.3	25.5
Lithuania	17.0	17.0	17.3	28.0	69.4	80.4	18.6	59.3
Luxembourg	51.0	51.0	51.0	52.3	17.8	17.2	11.1	11.7
Madagascar	5.5	37.4	37.4	37.4	100.0	94.5	35.4	90.0

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
Malawi	22.5	22.8	23.6	25.4	62.1	70.1	13.2	22.2
Malaysia	18.3	47.6	55.3	55.6	99.5	81.7	50.0	74.6
Maldives	0.6	0.6	0.6	1.1	38.0	98.5	0.6	100.0
Mali	8.0	8.0	8.5	22.5	58.8	86.5	18.9	76.2
Malta	22.5	22.8	29.4	29.7	71.5	79.2	12.0	60.5
Marshall Islands	3.6	3.6	3.6	4.6	88.2	96.5	1.5	66.7
Mauritania	0.6	0.6	0.9	44.2	62.4	99.1	44.2	98.8
Mauritius	3.4	12.3	13.0	13.0	98.8	96.6	12.7	75.9
Mexico	14.5	22.9	29.4	33.5	99.9	85.6	26.0	73.4
Monaco	25.0	25.0	37.5	37.5	100.0	75.0	12.5	100.0
Mongolia	17.3	17.6	35.4	55.5	83.7	85.9	48.9	78.3
Montenegro	8.0	19.9	50.5	50.9	99.7	91.9	47.3	90.7
Morocco	28.6	38.5	39.1	48.4	100.0	71.4	35.6	55.7
Mozambique	21.2	22.7	26.4	39.3	61.8	75.9	28.4	63.4
Myanmar	6.4	44.3	52.2	52.2	99.9	93.6	52.0	88.2
Namibia	37.8	38.7	43.8	57.5	55.1	46.6	42.1	46.7
Nauru	0.0	0.0	0.0	0.0	0.0	-	0.0	-
Nepal	23.5	24.2	25.2	31.4	99.7	76.5	20.8	38.3
Netherlands	21.6	21.7	21.8	22.5	10.3	31.7	5.7	14.5

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
New Zealand	32.1	35.4	37.0	37.3	99.5	67.8	29.3	17.8
Nicaragua	37.1	37.9	47.4	48.9	99.5	62.8	28.4	41.7
Niger	17.6	17.6	17.8	28.8	52.4	78.0	21.6	51.9
Nigeria	13.9	14.3	16.5	28.5	97.9	86.4	20.0	73.1
Niue	0.0	66.3	66.3	66.3	98.9	100.0	66.3	100.0
Norway	16.7	16.7	18.1	58.7	67.1	77.8	55.7	75.5
Oman	2.6	5.2	6.8	29.4	53.5	95.2	29.3	91.7
Pakistan	11.0	11.1	12.3	25.9	88.9	92.4	19.6	76.2
Palau	30.5	64.3	64.3	64.3	99.8	69.7	45.3	74.7
Panama	19.7	36.7	44.7	48.2	99.9	80.3	46.0	62.2
Papua New Guinea	3.0	41.7	74.2	79.4	99.0	96.9	78.5	97.2
Paraguay	14.2	16.1	27.7	28.7	100.0	85.8	26.0	55.8
Peru	21.5	41.9	61.3	65.8	100.0	78.5	63.2	70.1
Philippines	15.1	28.2	28.2	28.3	99.7	84.8	23.9	54.9
Poland	39.6	39.6	39.6	40.0	21.7	17.5	6.1	6.3
Portugal	22.3	22.5	29.3	29.3	84.8	75.5	11.7	59.4
Qatar	12.0	12.0	12.0	22.5	41.8	88.3	14.0	75.1
Republic of Korea	14.9	14.9	14.9	23.6	96.0	85.3	15.7	55.1
Republic of Moldova	3.6	3.6	3.6	4.5	52.6	95.2	1.1	73.6

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
Republic of North Macedonia	9.2	10.4	15.6	28.2	100.0	90.8	25.6	74.3
Romania	24.3	24.3	24.4	28.4	61.3	66.9	10.9	38.0
Russian Federation	9.0	10.8	21.9	54.5	66.2	90.2	51.4	88.6
Rwanda	9.0	9.4	9.5	9.8	100.0	91.0	8.4	9.0
Saint Kitts and Nevis	20.4	20.8	21.5	21.5	100.0	79.6	1.1	100.0
Saint Lucia	15.6	15.6	15.6	15.6	100.0	84.4	0.0	-
Saint Vincent and the Grenadines	21.9	26.5	33.4	33.4	100.0	78.1	30.2	38.2
Samoa	4.7	29.8	29.9	29.9	100.0	95.3	27.3	92.3
San Marino	0.0	0.0	1.7	1.7	100.0	100.0	1.7	100.0
Sao Tome and Principe	28.4	54.1	54.2	54.4	100.0	71.6	52.5	49.4
Saudi Arabia	4.7	8.6	8.7	10.7	13.5	86.1	7.5	80.0
Senegal	25.5	25.5	25.9	33.0	98.4	74.3	19.2	39.1
Serbia	7.6	8.5	16.0	24.8	76.2	90.5	22.0	77.9
Seychelles	36.0	41.3	41.3	41.3	100.0	64.0	8.7	61.9
Sierra Leone	10.7	17.5	17.9	26.5	91.4	89.4	20.9	75.3
Singapore	4.2	6.9	8.1	8.3	97.1	95.6	6.3	64.9
Slovakia	37.3	37.3	37.7	42.4	48.0	34.4	23.9	21.5
Slovenia	53.3	56.4	57.3	57.6	70.5	37.3	27.6	15.4

Countries	Scenarios				CPZs Coverage/%	Unprotected CPZs/%	CEZs Coverage/%	Unprotected CEZs/%
	Existing PAs/%	Conservative Target/%	Moderate Target/%	Ambitious Target/%				
Solomon Islands	0.6	69.6	71.2	72.9	97.3	99.4	72.6	99.6
Somalia	0.0	4.1	4.4	4.4	100.0	100.0	4.4	100.0
South Africa	7.7	16.0	30.9	31.1	85.3	91.4	28.1	83.2
South Sudan	16.3	16.3	17.7	32.5	100.0	83.7	27.4	59.2
Spain	27.7	30.0	33.2	33.5	90.5	70.7	14.2	40.4
Sri Lanka	29.5	31.6	36.4	36.4	100.0	70.5	32.3	21.3
State of Palestine	8.4	9.6	9.6	9.7	89.0	91.3	3.6	34.7
Sudan	2.8	2.8	2.9	12.9	61.1	96.8	10.8	93.3
Suriname	11.3	48.8	74.7	96.0	100.0	88.7	95.7	88.5
Sweden	13.8	13.8	14.2	28.6	40.8	77.8	22.3	66.2
Switzerland	6.9	10.3	28.2	28.9	100.0	93.1	26.4	83.2
Syrian Arab Republic	0.7	0.8	0.9	1.1	98.1	99.3	0.5	99.7
Tajikistan	19.0	57.8	58.2	58.3	100.0	81.0	53.7	73.1
United Republic of Tanzania	37.7	39.3	42.0	48.6	94.7	60.4	35.8	30.3
Thailand	18.7	21.0	26.2	28.2	99.8	81.3	26.9	35.4
Togo	24.5	24.5	26.9	31.8	100.0	75.5	14.9	49.1
Tonga	8.6	22.2	22.2	22.2	96.5	91.1	15.8	85.7
Trinidad and Tobago	30.1	30.1	30.1	34.5	21.5	28.8	18.7	23.6
Tunisia	7.9	11.0	11.2	44.6	97.3	92.2	40.6	90.5

Countries	Scenarios				CPZs Coverage/%	Unprotect-ed CPZs/%	CEZs Coverage/%	Unprotect-ed CEZs/%
	Existing PAs/%	Conservati-ve Target/%	Moderate Target/%	Ambitious Target/%				
Turkey	0.2	8.9	11.2	11.4	100.0	99.8	11.2	99.6
Turkmenistan	3.1	3.3	3.5	3.5	97.9	96.8	3.0	13.5
Tuvalu	0.0	0.0	0.0	0.0	90.9	100.0	0.0	-
Uganda	15.9	16.1	16.4	21.1	86.6	81.9	14.9	34.7
Ukraine	4.0	4.3	4.5	8.5	69.5	96.4	5.8	77.4
United Arab Emirates	17.7	17.7	17.7	20.1	21.1	83.8	3.5	69.7
United Kingdom	27.6	27.6	27.6	28.1	9.9	15.6	5.5	9.6
Uruguay	3.5	3.6	3.6	4.0	99.9	96.5	0.7	74.6
Uzbekistan	3.3	3.6	5.9	6.0	95.3	96.5	4.6	58.3
Vanuatu	4.2	64.0	64.5	65.5	100.0	95.8	64.2	95.5
Venezuela	53.4	61.9	71.4	73.2	84.5	45.5	58.2	34.0
Viet Nam	7.5	27.2	30.2	30.4	99.9	92.5	29.1	78.7
Yemen	0.5	11.7	13.2	13.3	56.6	99.0	13.0	98.3
Zambia	37.9	38.0	39.4	61.7	73.7	60.5	45.4	52.5
Zimbabwe	27.1	27.4	27.5	28.0	31.9	60.4	7.6	11.0

Annex 2. Additional Comments on Improvements to the Text of the Draft GBF

We recommend that the comments below plus the full text from the draft or final SPS 1-2 Summary Report 2021 might be shared informally with relevant drafters prior to the CCICED AGM. Otherwise the comments may not be received in a timely enough fashion to be useful.

Comment 1. The theme of COP 15 should be reflected in the background paragraph of the draft GBF. It could read at the end of this background paragraph: “Ecological Civilization would be a good sample for transformative change that specifies conservation strategies and action plan to implement the GBF.

Comment 2. In addition to the access and benefit sharing (ABS) protocol, biosafety protocol should be part of the 2030 milestones too. (even though a separate document on biosafety implementation has been developed.) Regarding the COVID-19 pandemic and other biosafety /biosecurity matters of biotechnology, and new emerging zoonotic diseases should be dealt within the context of sustainable development and One Health.

Comment 3. Combine Goal C (1) & (2) and replace Goal C (2) by biosafety elements.

During the twenty-fourth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA-24) discussed the updated zero draft of the post-2020 global biodiversity framework, some proposed revisions were raised as summarized below, which are however not or not fully addressed in the new released first draft:

A better logical flow is needed between the Vision, and the proposed mission, goals, milestones, targets and indicators in the post-2020 global biodiversity framework. The structure of the framework should be simplified and that overlaps between the goals, milestones and targets should be avoided or minimized. In addition, the development of a follow-up to the Global Strategy for Plant Conservation 2011-2020 shall be taken into account. No agreement is reached to use the period from 2011 to 2020 as the reference period. Three concepts were proposed to addressing baseline issues—reference reporting period, baseline condition and baseline period.

Overlapping shall be avoided. Potential overlapping exists in the framework between goals and targets, e.g. Goal C and Target 13. Overlapping exists also

between targets, e.g. target 8 & 11, targets 5 & 9.

Terms or concepts used in the updated zero draft that needed further clarity, agreed definitions or scientific information, such as healthy and resilient populations, ecological connectivity, integrity, spatial planning, other effective area-based conservation measures, priority sites, priority species, overconsumption and responsible choices.

It is inappropriate to use the term “nature’s contributions to people” in Goal B and other places, the term “ecosystem services” should be used instead. The focus on people was inappropriate.

Scientific evidences are insufficient for the percentages set in goals and targets, such as 5% (A.1) and 50% (target 6).

For target 17, Some parties suggested that the target wording should address the Nagoya-Kuala Lumpur Supplementary Protocol on Liability and Redress, thus we could consider adding this proposal to enhance the implementation of this supplementary protocol.

Most of the headline indicators have strong support from Parties according to an in-session online survey regarding of the proposed headline indicators in the draft of the monitoring framework as presented in document CBD/SBSTTA/24/3/Add.1. Some Parties suggest that the indicators and the goals and targets shall be developed together to ensure that they are measurable. Some note that the use of headline indicators shall not prevent Parties from using other indicators and that the headline indicators shall have flexibility to allow them to account for national circumstances. SBSTTA-24 proposed that the final version of monitoring framework shall be finalized by the Conference of the Parties at its fifteenth meeting (COP15) and to finish its development at COP16. An AHTEG on Indicators for the Post-2020 Global Biodiversity Framework will be established after COP15 to address related issues.

Annex 3. Specific Recommendations to the First GBF Draft

D. 2030 Milestones

1. Both biosafety protocol and access and benefit sharing (ABS) protocol shall be part of the milestones in addition to those of biodiversity conservation in the post-2020 GBF, although separate document on biosafety implementation plan has been developed. Regarding of the outbreak of COVID-19 pandemic, biosafety and or biosecurity of biotechnology and new emerged zoonotic diseases shall be adequately dealt for sustainable development and human health. We propose to combine Goal C (1) and Goal C (2), which would be also taken care of in Target 13, and to replace Goal C (2) by biosafety elements.

Goal C

C. 2 Biosafety and biosecurity are ensured;

E. 2030 Action Targets

2. Target 17. Establish, strengthen capacity for, and implement measures in all countries to prevent, manage or control potential adverse impacts of biotechnology on biodiversity and human health, reducing the risk of these impacts.

Biotechnology is developed by people to meet the request of people, thus people need have the power to control any adverse impact. Not every biotechnology application with potential benefits shall be necessarily applied and used. Those applications may add additional burdens to biodiversity conservation and human health and have to balance with their benefits. The target may not aim for reducing impacts but limit the application that having adverse impacts. The indicators for assessment and monitoring shall include, as suggested in Annex I (Proposed Headline Indicators for the Post-2020 Global Biodiversity Framework) of the document CBD/SBSTTA/24/3 and those scoring indicators in CBD/SBSTTA/24/INF/16, necessary legal, administrative, technical and other biosafety measures in place to reduce adverse impacts to biodiversity and human health by proper management for inspecting the application of biotechnology and the release of LMO that are harmful to biodiversity and human health. This can be translated into the extent of capacity-building/capacity development of the Biosafety Protocol. This target can be revised to

“Establish, strengthen capacity for, and implement measures in all countries to prevent, manage or control potential adverse impacts of biotechnology on biodiversity and human health, reducing the risk of these impacts, and to enhance

implementation of the Biosafety Protocol and the Nagoya-Kuala Lumpur Supplementary Protocol on Liability and Redress”.

3. Target 21: Ensure equitable and effective participation in decision-making related to biodiversity by indigenous peoples and local communities, and respect their rights over lands, territories and resources, as well as by women and girls, and youth. It is necessary to promote the participation of indigenous peoples and local communities, women and girls as well as youth. However, when talking equitable participation in decision-making, the role of men and the whole society cannot be absent either as reference for the equitable participation or obligated contributors to the process. We propose to revise this target to

“Through a whole-of-society approach, Ensure equitable and effective participation in decision-making related to biodiversity by indigenous peoples and local communities, and respect their rights over lands, territories and resources, as well as by women and girls, and youth, in accordance with national circumstances.”

4. In the COP14 decision (14/29), the parties recognize that parties need to strengthen their implementation and commitments to achieve the 2050 Vision. Regarding of the Parties’ calls for synergies with other multilateral environmental agreements and the COP 14 decision (14/5) that recognizes the interaction and synergy role between biodiversity and climate change and NDCs have been already set up by the UNFCCC, we propose to add one target:

“Target 22. By 2030, support all stakeholders, including government and non-government actors, to develop and present their own voluntary biodiversity commitments that are integrated into or in addition to their NBSAPs with the aim to support and increase the level of ambition needed to achieve 2050 Vision.”

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Chapter 3

Global Ocean Governance and Ecological Civilization

3.1 Introduction

The ocean is fundamentally important for humankind. The ocean is also vital for the world's economic development. A healthy ocean environment is a prerequisite for drawing on these direct and indirect benefits that the ocean provides. However, global ocean conditions are being seriously affected by large-scale environmental pressures such as global warming, increased ocean acidification under a continuously higher atmospheric carbon dioxide level, microplastics pollution, and overexploitation of natural resources.

At the same time, China, like many other coastal nations, is facing the reality of seeing its own coastal seas declining in quality, caused by both terrestrial and marine development and activities, such as increasing discharge of terrestrial pollutants into the ocean, land reclamation, overfishing, pollutants from mariculture, and so on.

Clear and directed actions are needed to limit the threats and minimize the impacts to the oceans, and thereby lay the foundation for the oceans' ability to continue to serve as the basis of human life. Dedicated efforts are required to ensure further development of current and emerging industries in a sustainable manner. **The principle of ecosystem-based integrated ocean management needs to weave through ocean management like a red thread in order to achieve these goals.**

Marine fisheries are one of the main ways for humans to develop and utilize the ocean. As a major marine fishing country in the world, China shoulders a major responsibility in conserving fishery resources and ensuring the sustainable development of fisheries industry. For this, the current management system, measures and strategies for fisheries still need improvement. Thus, CCICED

established the task team (TT1) "Establishing China's Sustainable Fisheries Policy".

With the rapid development of social economy and the urbanization process of coastal areas, more and more attention has been paid to the pollution from land and sea. Since the “reform and opening up” 40 years ago, China's marine environment quality has experienced a process from overall good to overall deterioration, and then gradual improvement, especially after the call for the “construction of ecological civilization” at the 18th National Congress of the Communist Party of China. Nevertheless, it is still a long way towards the restoration of the health of the coastal and marine environment. Thus, CCICED established the task team (TT2) "Marine Pollution" to promote the prevention and control of marine pollution, as well as the healthy development of marine ecosystem.

By drawing on both national and international experience and competence, CCICED is well placed to identify and highlight relevant policy actions that could be taken by China’s administration to ensure healthy oceans domestically and to contribute to sustainable oceans globally. To this end, CCICED established the task team (TT3) "Future ocean research roadmap" to provide a research roadmap for CCICED to embark on over the following years.

3.2 Sustainable management of China's offshore capture fisheries

Marine fisheries are one of the main ways for humans to develop and utilize the ocean, and are closely related to the production, life, and even survival and development of hundreds of millions of people around the world. As a major marine fishing country in the world, China has played an important role in promoting industrial development and maintaining world food security; on the other hand, it also shoulders a major responsibility in protecting the marine ecological environment, conserving fishery resources, and ensuring the sustainable development of fisheries industry. Due to continuous overfishing for decades, as well as environmental pollution, climate change and other factors, China's coastal fishery resources have severely declined. In recent years, China has continuously improved its fisheries policy, and it has continuously explored more effective management policies and modes in terms of fishing capacity control, attempts to promote quota fishing management, and the development of green aquaculture. These attempts have been positive and beneficial and have produced some economic and ecological benefits.

However, China’s marine fisheries have a huge catch volume and employ a large number of employees, involving complex and diversified range of fishery operations, fishing species, and fishing waters, which prove to be highly challenging to manage and regulate. The current management system and mechanisms, measures and strategies still need improvement. To this end, the China Council for International

Cooperation on Environment and Development (CCICED) established the "Global Ocean Governance and Ecological Civilization" special policy study (2020-2021), with one of the task teams (TT1) "Establishing China's Sustainable Fisheries Policy" aiming to compare and analyze the implementation of China's marine fishery policies. The outcomes of this study will provide an important reference for China to improve fisheries policy and management, better balance ecological protection and fishery development, and to enhance its ocean governance capabilities during the "14th Five-Year Plan" period.

3.2.1 China's coastal capture fisheries

China's marine fisheries have developed rapidly since 1949. Marine fishing output exceeded 10 million tons in 1995 and reached 14.775 million tons in 2000^[1], ranking at the forefront of the world's marine fishing countries (Figure 3-1). However, with the enhancement of fishing capacity and the continuous growth of fishing output, China's coastal fishery resources have experienced a serious decline; fishes with larger size and higher economic value have gradually been replaced by small pelagic fishes.

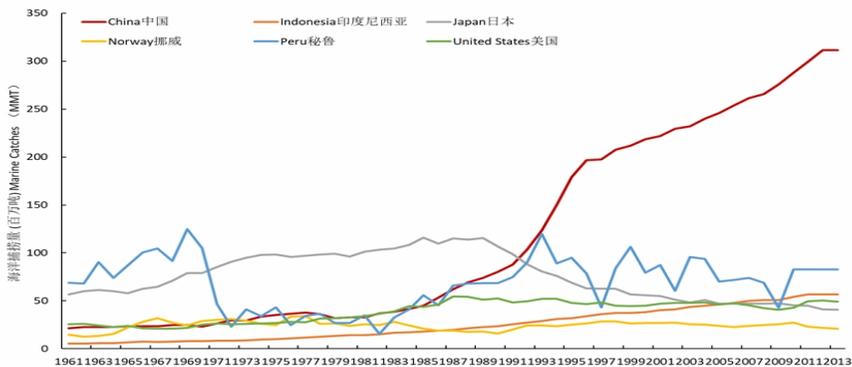


Figure 3-1 The World's Largest Marine Fishing Countries and their Catch Changes

3.2.1.1 Overview of the fishing economy

(1) Fishing boats

Fishing boats operating in China coastal oceans are classified by power. According to China's Fishery Statistical Yearbooks^[1], in 2019, there were 147,000 marine fishing vessels in China with a total power of 13.547 million kilowatts (kW). Among the vessels, fishing boats larger than 441 kW accounted for 2.1%, fishing boats between 44.1 kW and 441 kW accounted for 33.7%, and fishing boats less than 44.1 kW accounted for 64.2%.

With the advancement of marine fishing capacity control policies, the total

number and total power of marine fishing vessels in China began a downward trend after peaking in 2013 and 2015, with annual decline rates of 3.6% and 1.5%, respectively, as shown in Figure 3-2 and Figure 3-3. Among them, the number and power of fishing boats of less than 44.1 kW have dropped most significantly, from 130,000 and 2.09 million kW in 2012 to 90,000 and 1.44 million kW in 2019, with the rates of decrease at 28.5% and 31.3% respectively; The number and power of fishing boats of 44.1 to 441 kW decreased slightly. The number and power of fishing boats with power greater than 441 kW have increased, from 1,737 and 1.16 million kW in 2012 to 3,023 and 2.79 million kW in 2019, with an increase of 74.0% and 135.3% respectively. Due to the difficulty in defining artisanal fisheries and the lack of separate production statistics, coastal fisheries are represented by fishing boats with a power of less than 44.1 kW and their production.

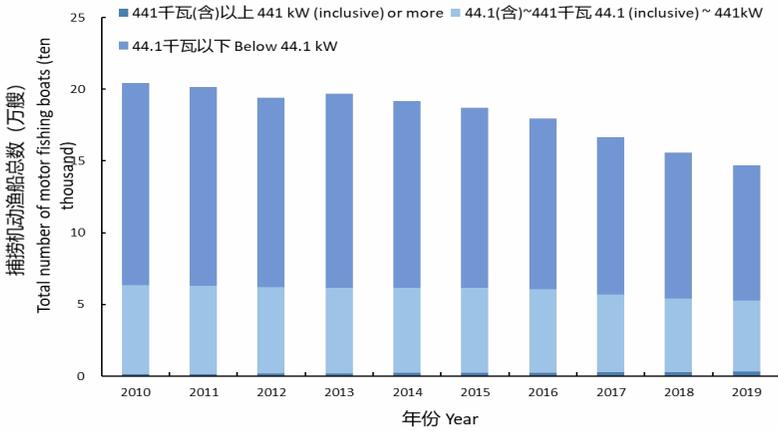


Figure 3-2 The Total Number of Motorized Fishing Vessels in China (10,000)

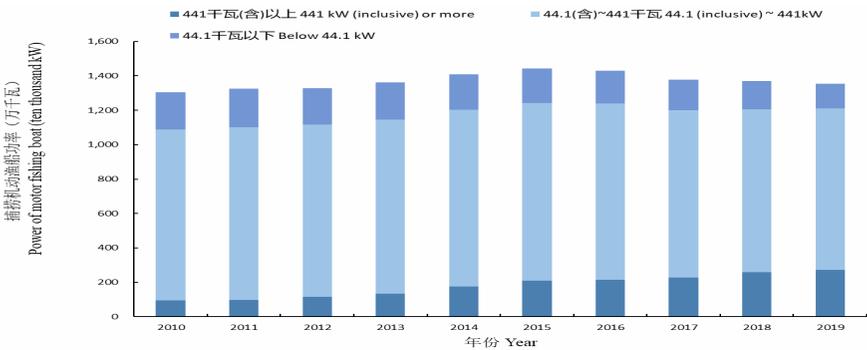


Figure 3-3 The Total Power of Fishing Vessels in China (10,000 kW)

(2) Output

In 2019, China's marine fishing output was slightly over 10 million tons, 21.1% down from 12.7 million tons in 2012. Among the marine fishing regions, fishing output in the East China Sea area is the highest, with an average output of 4.8 million tons from 2012 to 2019, accounting for 40.2% of the total coastal fishing output in China. The average output of the South China Sea and the Yellow Sea was 3.5 million tons and 2.9 million tons, accounting for 29.1% and 24.6% of the total fishing output respectively. The Bohai Sea has the lowest output of 902 thousand tons, accounting for about 7.6% of the total coastal fishing output in the country.

In terms of types of net fishing, China's marine fishing has the highest trawl output, with an average output of 5.7 million tons from 2012 to 2019, accounting for about 48.2% of the country's total coastal fishing output. The second is gillnet, with an average output of 2.7 million tons, accounting for about 22.4% of the total output. The average outputs of other fishing gear such as nets, purse nets and fishing tackles were 1.5 million tons, 98 thousand tons and 1.2 million tons, accounting for approximately 12.3%, 8.3%, and 10.3% of the country's total marine fishing output.

Fish account for the the largest catches, with an average of 8.3 million tons from 2012 to 2019, accounting for about 69.9% of the country's total marine fishing production. The second is crustaceans, with an average output of 2.211 million tons, accounting for about 18.7% of the country's total marine fishing output. The third is cephalopods, with an average output of 655 thousand tons, accounting for about 5.5% of the country's total marine fishing output. The other species totaled 879 thousand tons, accounting for about 7.4% of the country's total marine fishing output.

(3) Fishery Economic Output

According to China's Fishery Statistical Yearbook^[1], in 2019, the total output value of China's fishery economy was about 260 million yuan, of which the fishery output value was about 130 million yuan, accounting for 49.0% of the total output value. In the fishery output value, marine fishing accounted for 16.4% of the total amount of approximately 21.16 million yuan, ranking the third. The two largest production activities are freshwater aquaculture and marine aquaculture, with output values of 61.86 million and 35.75 million yuan, accounting for 47.8% and 27.6% of the fishery output value, respectively. From 2012 to 2019, China's total fishery output value continued to grow, with an average annual growth rate of 5.2%. As a general trend, the output value of freshwater aquaculture and marine aquaculture has been increasing year by year, with annual growth rates of 5.7% and 6.7%, respectively. The output value of marine fishing fluctuated greatly and declined twice after 2015 and 2018 respectively. In all provinces, regions, and cities across the country, coastal provinces such as Shandong, Guangdong, Fujian, Jiangsu, Hubei, and Zhejiang have a relatively high total fishery output value, together

accounting for 71.4% of the country's total fishery output value in 2019.

3.2.1.2 *Fishery resources*

China's coastal fishery resources are relatively rich with diverse species. China has recorded 2,028 species of marine fish, more than 1,000 species of crustaceans (more than 40 species of krill, more than 600 species of crab, and more than 300 species of shrimp), and more than 90 species of cephalopods, of which only a few species that are large in quantity have become the main fishing targets^[2,3]. According to the China's Fishery Statistical Yearbook, in the past half century, the main fishing targets in China's coastal waters have changed significantly. With the enhancement of marine fishing capacity and the expansion of fishing scale, China's fishery resources have begun to decline significantly. Small pelagic fishes have gradually begun to replace fish with larger individuals and higher economic values. For example, major fishery resources in the Bohai Sea at the end of the 1950s, such as small yellow croaker, hairtail, and prawns, all declined significantly, as shown in Table 2. The dominant species of fishery resources in the Yellow Sea have also undergone major changes. In the 1950s and 1960s, the fishery resources in the Yellow Sea were still dominated by high-quality demersal and near-demersal fish with high economic value, such as small yellow croaker, hairtail, and flounder. After entering the 1970s and 1980s, Pacific herring, blue-spotted mackerel, and mackerel became the dominant species. By the end of the 1990s, yellow anglerfish and fine-striped lionfish, which have low economic value, gradually became the dominant species in the Yellow Sea.

Studies have confirmed that overfishing is the main reason for the decline of fishery resources, changes in the composition of dominant species, and decline in species biodiversity. Four seasonal bottom trawl surveys from 1959 to 1999 showed that the fishery resources, dominant species composition, and community structure of Laizhou Bay have undergone major changes during the 40 years. Its species diversity index began to show a downward trend after reaching its peak in 1982. This shows that external disturbances such as moderately intensive fishing may increase the diversity of fish, but excessive fishing would reduce the diversity index. The fishery bottom trawl survey conducted in the waters of Laizhou Bay from August 2009 to 2013 also found that the fishery resources of Laizhou Bay are declining year by year, with obvious replacement of dominant species, significant changes in community structure, and a downward trend in species diversity.

While accelerating the decline of fishery resources, excessive fishing will also further interfere with the ecological balance and ecological health of the marine ecosystem, causing serious ecological and environmental disasters. The impacts of overfishing on the marine ecological environment and fishery economic production may be reflected by jellyfish outbursts frequently occurring in the East China Sea and the Yellow Sea in recent years.

3.2.1.3 Fisheries challenges

Firstly, although China is now a major fishing country in the world, and its volume of fishery catch and aquaculture production far exceeds that of other countries in the world, the supply gap in the domestic seafood market is still increasing.

Second, the fishery law enforcement system is not robust. In recent years, China has continuously stepped up its crackdown on illegal fishing and has introduced a series of special law enforcement action plans for the fishery administration. However, various illegal fishing behaviors still occur.

Third, the rapid development of the coastal economy has brought tremendous environmental pressures to the marine ecosystem. A large number of pollution from agricultural and industrial sources have destroyed the habitats of many wild fish species. How to manage and control the potential marine environmental impacts of large-scale aquaculture will be a major challenge in the process of China's sustainable fishery development.

Fourth, climate change is inducing rapid changes for the marine resources in China's waters. Sea surface temperatures in the Bohai Sea, Yellow Sea, and East China Sea have significantly increased over the past century, with some of the strongest warming (~ 1.96 °C) in the East China Sea^[4]. Sea level rise (SLR) rates for Chinese coastal areas are projected to be 3.1-11.5 mm/year by 2050, which is higher than the global SLR rate of 3.2-80 mm/year by 2050^[5]. Such rates imply severe coastal flooding and potential loss of remaining coastal wetlands^[6].

A growing body of literature presents clear evidence that climate change that is already underway presents many challenges for China's fisheries. Its impacts on coastal marine habitats and shifting of marine species pose risks on fishing communities in China and along its supply chains. To effectively mitigate these risks, funding and research are required to develop a scientifically informed adaptation plan.

An additional challenge is recent and potential new catastrophic events, causing serious disruptions for the entire China aquatic products supply chain. Catastrophic events are occurring more frequently, and the scope and duration of their impacts continue to exceed historical records. In particular, the novel coronavirus pneumonia (Covid-19) outbreak resulted in a global epidemic and triggered a serious public crisis, with great impacts on all links along the China and global fishery supply chain, including catch fisheries, aquaculture, processing, transportation, and wholesale and retail sales markets. While some disasters are short-term, others can last for years. Although China has actively taken countermeasures to mitigate the impact of Covid-19 and achieved good results, there is a need to strengthen the early warning system and long-term impact assessment of the disaster.

3.2.2 Coastal capture fishery management system

3.2.2.1 Top-level design of China's fishery management

The 18th National Congress of the Communist Party of China clarified the overall layout of China's coordinated promotion of economic construction, political construction, cultural construction, social construction, and ecological civilization construction. Under the guidance of the ecological civilization construction, the proposal of Marine Ecological Civilization (MEC) has further promoted the transformation of China's fishery management mode^[7]. Marine ecological civilization emphasizes the use of healthy marine ecosystems to support the prosperity and development of the blue economy. Through intensified policies, it aims at strengthening the protection and restoration of coastal and marine ecosystems and improving the utilization efficiency of fishery resources^[8]. To this end, China issued a series of policy documents during the "13th Five-Year Plan (FYP)" period, emphasizing marine environmental protection, the sustainable use of fishery resources and the establishment of eco-friendly mariculture. The 14th FYP was released in 2021. The annual plan and the 2035 long-term goal outline (draft) emphasize the creation of a sustainable marine ecological environment, the optimization of the layout of coastal green aquaculture, the construction of marine ranches, the development of sustainable coastal fisheries, and the synergy between the development of the blue economy and marine protection^[9].

3.2.2.2 Fishery management system based on the input control

In order to use fishery resources more rationally and adjust the fishing intensity, China has established specific management systems for fishing vessels, fishing gear, fishing time, and regions under the guidance of the Fisheries Law. Such systems focus on avoiding unreasonable fishing methods and excessive investment in fishing capacity, thereby protecting the sustainable prosperity of fishery resources and the benign development of the fishing economy.

(1) Fishing gear management system

To effectively reduce the adverse effects of overfishing on living marine resources, China has enacted strict regulations controlling the permitted fishing gear. To protect juvenile fish, juvenile shrimps, and juvenile crabs, China prohibits the use of fishing gear with mesh sizes smaller than the limits set by the national regulations. On the other hand, China prohibits the use of fishing methods that destroy fishery resources such as electric fishing, explosive fishing, and poison fishing, and has issued specific notices on prohibited fishing gears for marine fishing.

(2) Protection of aquatic germplasm resources

China first proposed the concept of aquatic germplasm resource protection zone in the "China Aquatic Biological Resources Conservation Action Program" in 2006. The third part of this outline requires the establishment of an aquatic germplasm

conservation zone in the main breeding areas of aquatic germplasm resources with high economic value and genetic breeding value, and to develop appropriate management practices, strengthen and standardize the management of protected areas. Up to 2021, China announced it has validated eleven groups of 535 state-level aquatic germplasm resource conservation zones in total. These protected areas can protect hundreds of national key protected fishery resources and key habitats such as spawning grounds, feeding grounds, overwintering grounds, migratory channels, etc., and initially constructed the protected area network of aquatic germplasm resources covering various sea areas and major inland rivers and lakes.

(3) Fishing season closure in summer

China's seasonal moratorium system first began in 1980. The former State Fisheries Administration in 1980 and 1981 issued the "Notice of Collective Trawlers Fishing Moratorium and the Joint Inspection of the Proportion of Young Fish in the State-run Fishing Vessel" and "Provisional Regulations on the Protection of the Aquatic Resources of the East Sea and Yellow Sea Area", which requires a two-month moratorium on collective trawlers in the Yellow Sea area from July to August each year, and a four-month moratorium on collective trawlers in the East China Sea from July to October. Since then, China has continuously adjusted the scope, period, and specific requirements of the fishing moratorium according to the endowment of fishery resources and production conditions. As of 1999, China's fishing moratorium system has covered the Bohai Sea, Yellow Sea, East China Sea, and South China Sea (not including latitude 12° south of the Sea). The fishing moratorium system implemented in 2007 is called by Chinese "the strictest regulations in history" of the fishing moratorium. The system put fishing start time advanced to May 1st and extend the moratorium period 1 month, keeping the pressure crackdown situation for fishing violations. During the annual fishing moratorium in 2017, there were a total of 7,427 cases of prosecuting illegal, 10343 people involved, of which involved 1,369 were transferred to judicial processes. More than 7,000 "Sanwu" ships and more than 400,000 extreme nets were cleaned up and banned^[10].

(4) Dual control of fishing boats

In order to control fishing intensity and conserve and rationally utilize marine resources, China has started to strengthen the total amount control of marine fishing intensity since the Eighth Five-Year Plan and the Ninth Five-Year Plan and implemented the dual control of fishing boats. Subsequently, in 1999 and 2000, the "zero growth" and "negative growth" policies were introduced for marine fisheries. The dual control of fishing vessels sets a clear control target for the number of vessels and power of marine fishing vessels nationwide. For example, the "Views on Implementing Marine Fishing Vessel Control System in 2003-2010" proposed that the number of national marine capture fisheries boats and power would be within

193,000 and 1,142.7 kW in 2010. However, affected by factors such as employment pressure in coastal areas, subsidies for conversion of fishermen, and unmatched fishing employment policies, the effect of the implementation of the dual control system for fishing vessels is not satisfactory. In 2010 there were still 205,000 coastal fishing vessels in China.

To solve this dilemma, China reiterated the goal of dual control of fishing vessels in 2010 during the 12th Five-Year Plan period and issued Several Opinions on Promoting the Sustainable and Healthy Development of Marine Fisheries in 2013, emphasizing the strict execution of marine fishing moratorium, fishing access, aquatic germplasm resources protection system at the same time, in particular, to clarify pilot of coastal fishing quotas, strict control of the coastal fishing intensity, and to improve its marine fishing vessels control system, and gradually reduce the number of fishing vessels and total power. On this basis, the former Ministry of Agriculture issued the Notice on Further Strengthening the Control of Domestic Fishing Vessels and Implementing the Total Management of Marine Fishery Resources in 2017, with a view to further improving the scientific and refined level of utilization and management of marine fishery resources. The notice requires reducing 20,000 marine fishing motorboats and 1.5 million kW power, reducing domestic marine capture production to less than 10 million tons by 2020. As mentioned above, the number of China's marine fishing vessels has been decreasing since 2013 and has dropped to 147,000 ships in 2019.

3.2.2.3 *China's fishing quota pilot*

To strengthen the total marine fishery resource control, the Ministry of Agriculture and Rural Affairs started total allowable catch (TAC) pilots in 2017 in Zhejiang and Shandong provinces and in 2018 extended the range to Liaoning, Fujian, and Guangdong provinces. Relying on the special fishing license system during the fishing moratorium period, these 9 coastal provinces (municipalities) have been carrying out the quotas experimentally.

Although the species, distribution methods, and specific requirements of these TAC pilot projects are different, they still have many similarities. First, almost all pilots use special fishing licenses to limit the total catch under TAC, while special licenses regulate the fishing time, waters, and species for fishermen. Second, most of the pilots began from single-species quotas. Although the pilots in Fujian involve four different types of *Portunus* crabs, they are not treated differently during the quota allocation and monitoring process. Third, most of the pilot projects have improved catch monitoring by implementing fishing logs, fishery observers, and fishing quota early warning systems.

These pilots not only actively accumulated significant experience in implementing TAC systems for its deployment nationwide, but also identified the potential problems and obstacles.

First China's fishery resources survey and basic evaluation have deficiencies and it is difficult to offer a clear basis catch for TAC.

Second, the pilots have not yet established a real-time, accurate, and efficient capture and monitoring system.

Third, because the majority of China's fisheries have a characteristic of multiple fish species, it is difficult for the main pilot work at this stage to focus on a single species to gain experience for the TAC across the country. In addition, with the expansion of the scope of TAC control, if the exclusiveness of fishing in the controlled waters and possible cross-regional fishery management issues are guaranteed, it will be an important challenge that will be faced in the development of the TAC system in the future.

Finally, the legal basis for the implementation of TAC in China is still not solid. Although the revised "Fisheries Law" in 2000 has put forward the implementation of the fishing quota system, the relevant supporting documents have not been published. The specified regulations on log management of fishing, boat inspection, and designated transaction mechanisms are still missing. In addition, although China has defined fishing licenses as a kind of property right, according to the "Fishing License Management Regulations", the Ministry of Agriculture still prohibits the transfer and trading of fishing licenses. This limitation will affect the further development of the Individual Transferable Quota (ITQ) system in the future in China.

3.2.3 The institutional framework of China's marine ecological economy

3.2.3.1 Marine protected areas and ecological red lines

As of 2020, 271 marine nature reserves of various types have been established in the waters under China's jurisdiction, with protected areas of about 124 thousand km² and a 4.1% coverage of the coastal ocean areas under China's jurisdiction. The protection targets include rare and endangered marine biological species including dugongs, harbor seals, and Chinese white dolphins; typical ecosystems such as mangroves, coral reefs, coastal wetlands; marine natural historical sites, etc. All the eleven coastal provinces, autonomous regions, and municipalities have marine nature reserves, and a network system of marine nature reserves has been initially formed. Since 2018, China has integrated marine protected areas into the natural reserve construction system with national parks as the main body.

However, China's current marine protected area management system still has certain limitations. First of all, despite the relatively large number of protected areas, they account for only 4.1% of China's total ocean area, which is lower than the 10% target set by the Convention On Biological Diversity and the target of "5% of the coastal ocean under China's jurisdiction being protected by 2020" set by the National Marine Major Function Zone Planning (2015)^[11,12]. Second, in the absence

of top-level coordination, the distribution of many marine protected areas is inconsistent with the priority areas identified in the National Biodiversity Strategy and Action Plan, and the protective effect is poor^[13,14]. Third, the delineation of existing protected areas has not yet fully considered the connectivity of the ocean and the differences in the utilization of different habitats by organisms. The ocean has high mobility and connectivity, which determines that many marine organisms have a relatively large range of movements, and there are many types of river-sea migration. Organisms may use different types of habitats at different stages of their life history, and their spawning grounds, nursery grounds, and feeding grounds may be distributed in different waters such as estuaries, seagrass beds, mangroves, and tidal flats. If only part of these areas are protected, it means that only part of the life history stage is protected, and the goal of comprehensive protection of marine life and ecosystems cannot be achieved. Therefore, only by setting up protected areas with appropriate and sufficient area and scope can the purpose of continuation and expansion of the protected populations be achieved.

To strengthen the protection of marine ecosystems, the former State Oceanic Administration has integrated marine protected areas and aquatic genetic resource reserves, and delineated the Red Line of Marine Ecological Protection (red-lining) under the framework of marine functional zoning. The Red-line is the bottom line of marine ecological security. By delimiting important marine ecological function areas, ecologically sensitive areas, and ecologically fragile areas as the key control areas, it strictly controls the space boundaries and management boundaries in terms of natural ecological service functions, environmental quality and safety, and natural resource utilization, in order to maintain marine ecological functions, environmental quality and safety, and the sustainable use of natural resources, and to promote the balanced development of economy, society, and the environment. Red-lining is an important institutional innovation for environmental protection in China.

The red-line protection is essential to the health of the marine ecosystems. The red line includes marine aquatic genetic resource reserves, special marine reserves, important coastal wetlands (such as mangroves, coral reefs, and seagrass beds), islands, natural landscapes, historical and cultural relics that need special protection, concentrated distribution area of rare and endangered species, and important fishery waters. In a way, the Redline is similar to marine protected areas (MPA), which includes marine natural reserve and MPA for historical and cultural conservation. Fishing is usually permitted in a MPA in China. National park is an MPA with the highest protection status, but only a small percentage of MPA can be consolidated into the national park system. The Bohai Sea is the first region in China to adopt the marine ecological red line system^[15]. In the four provinces (municipalities) adjacent to the Bohai Sea, the coverage of the marine ecological red line is about 10% (Tianjin) to 45% (Liaoning) of the sea area under its jurisdiction^[16]. Drawing on the

experience of the Bohai Sea, China will further expand the scope of the pilot red-lining and plans to achieve a Red-line coverage of more than 30%^[17].

3.2.3.2 *Nature-based coastline restoration plan*

China has nearly 3 million km² of sea area and 32,000 km of coastline, and has more than 20,000 recorded marine species. The stretch of the coastal zone is full of various high-productivity habitats, including mangroves, seagrass beds, coral reefs, seaweed forests, and tidal flat wetlands, etc., which provide various important ecological services functions. For example, mangroves can filter pollutants in the water, provide important timber and food resources for coastal communities, store large amounts of carbon sinks, and are a natural barrier against erosion and severe storms.

In recent years, China has actively promoted the restoration of coastlines such as "returning fish farms to beaches" and "returning farms to sea". In the process, nature-based solutions have received more and more attention. Nature-based solutions adhere to the restoration principle of "emphasis on nature and light on engineering", and avoids the restoration mode of artificial landscape creation through a large number of engineering measures. These solutions include protecting, restoring, and sustainably managing ecosystems, improving the resilience and adaptability of ecosystems, reducing disaster risks, and building green infrastructure, thereby simultaneously protecting biodiversity and improving human well-being. For example, by building oyster reefs to absorb wave energy, the coastline can be protected from wave erosion and storm damage, seawater can be filtered to improve water quality, and breeding habitats for economic species can be provided. In addition, some studies have shown that coral reefs are more effective than traditional breakwaters in reducing the height and energy of waves. These nature-based solutions can provide solutions for the protection of coastlines from the perspective of ecological protection.

Nature-based solutions can play an important role in the restoration of mangroves in China. In China, a large number of mangrove wetlands were converted into aquaculture ponds in the 1980s. The reduction of mangrove wetlands has severely damaged the local biodiversity, and the polluted waste generated by aquaculture has made most wetlands lose their ability to recover naturally. During the "13th Five-Year Plan" period, China began to promote the work of "returning ponds and returning wetness" and proposed to build and restore 18,800 hectares of mangrove forests by 2025 on the basis of clearing and retreating ponds in nature reserves. At present, Beihai and other places are exploring the use of nature-based solutions to restore mangroves in abandoned ponds. The local staff designed a mangrove-Wutang snakehead multi-nutrient level composite ecosystem, using natural productivity and bait to proliferate economic organisms under the mangroves and implement sustainable resource harvesting to achieve the continuous improvement

of the ecosystem and sustainable economic organisms. At the same time, it plays an extremely important role in purifying seawater, preventing wind and waves, maintaining biodiversity, and fixing carbon and storing carbon.

In addition to coastline restoration, nature-based solutions also play an important role in the process of marine ecology and environmental protection. For example, sustainable marine aquaculture based on integrated multi-trophic aquaculture (IMTA) can utilize cultured organisms of multi-trophic levels such as filter-feeding shellfish, macroalgae, and benthic animals to recycle the residual bait and biological waste in the system to reduce nutrient loss as much as possible, thereby increasing the capacity of the breeding environment and the sustainable production level of the entire system.

3.2.3.3 *Green mariculture*

Mariculture contributes to 40% of the total global marine fishery production, while China's marine aquaculture production accounts for more than 60% of the global total output. China's mariculture industry boasts its long history, large scale, and huge species variety. There are about 70 species of marine organisms listed in the official fishery statistics, including finfish, shrimps and crabs, molluscs, seaweed, sea cucumbers, and other species. A considerable part of the aquaculture species grow through photosynthesis or filter-feeding on plankton, which means no artificial feeding is needed during the aquaculture process; only about 15% of fish and crustaceans need to be fed.

Quality improvement, waste water treatment, volume reduction, and income increase are major strategies to China's fishery development and are also the general direction of green development for the industry. In 2020, Document No.1 of the Central Committee of China Communist Party made an important deployment of "promoting green and healthy aquaculture". The Ministry of Agriculture and Rural Affairs immediately issued the document, "Notice on the Implementation of the 'Five Actions' for Green and Healthy Aquaculture in 2020", making specific requirements in five aspects, including promoting ecological and healthy aquaculture modes, promoting aquaculture waste water treatment modes, reduction in application of aquaculture chemicals, replacement of trash fish with formulated feed, and enhancement of genetic resources etc. In recent years, the National Aquatic Technology Promotion Station has promoted eco-friendly aquaculture technologies such as recirculating aquaculture, integrated multitrophic aquaculture, as well as rice-fish co-cultivation to the whole country. Among them, the seawater pond (or inshore) integrated multi-trophic aquaculture technology mode is based on different physiological and ecological characteristics of fish, shrimp, and shellfish, by taking advantage of the complementary characteristics of polyculture species in the water layer, feeding habits, and living habits. The three-dimensional ecological farming mode may consist of fish in the water column, shrimp on the bottom and

molluscs in the bottom of the pond. In the process, an important issue to be solved in the development of green mariculture is how to balance the relationship between the growth of the aquaculture industry and the protection of the ecosystem.

3.2.3.4 Marine aquaculture spatial planning

As an important way of using the sea, the development of marine aquaculture needs to meet the requirements of the national, provincial, and municipal marine functional zoning. Marine functional zoning is a unique marine spatial plan in China. Marine functional zoning is revised and supplemented every ten years or so to keep the content of the plan consistent with China's marine ecological protection goals and promote the sustainable development of marine industries including mariculture. According to the Fisheries Law revised in 2013, people's governments at all levels are responsible for strengthening the overall planning and management of water areas, standardizing the use of water areas, and determining which areas can be used for mariculture. If enterprises and individual farmers decide to use waters and tidal flats for aquaculture activities, they need to apply for aquaculture license and sea area use license from or above government at the county level. Furthermore, from 2018 to 2020, coastal cities and counties across the country have comprehensively delineated the "three zones" for aquaculture (aquaculture permitted, restricted and prohibited areas), and have successively compiled regional aquaculture plans for water areas and tidal flats (2018~2030).

However, in the case of insufficient coordination of the top-level design of fishery management in China, there are serious overlaps and conflicts between mariculture zoning and marine ecological protection red lines, and the current Fisheries Law does not make provisions for the management of marine ecological protection red line. How to collectively consider the needs of fishery development and marine protection, and formulate reasonable aquaculture zoning, is an important topic of concern to the academics and the industry^[18].

3.2.3.5 Treatment of mariculture waste water

The treatment of waste water is one of the key points in the development of green mariculture. The Marine Environmental Protection Law of the People's Republic of China (revised in 2017) clearly stated that "the state establishes and implements a total pollution control system in key ocean areas, determines the total discharge control index of major pollutants, and allocates discharge control quantities to major pollution sources". At the beginning of 2019, ten ministries and commissions, including the Ministry of Agriculture and Rural Affairs, jointly issued the "Several Opinions on Accelerating the Green Development of Aquaculture Industry", further proposing to "develop ecological and healthy aquaculture modes, improve water recirculating and intake/discharge treatment facilities, support ecological upgrade and transformation of waste water treatment facilities such as water ways, ponds and subsurface wetlands; furthermore, promote the treatment of aquaculture waste water,

promote the introduction of aquaculture waste water pollutant discharge standards, and carry out the environmental impact assessment of aquaculture in accordance with the law."

In line with the promulgation and implementation of the above policies, China has organized experts since 2017 to revise the current "Freshwater Pond Aquaculture Water Discharge Requirements" (SC/T9101-2007) and "Marine Aquaculture Water Discharge Requirements" (SC/T9103-2007). Coastal provinces and cities are also actively conducting surveys of fishery pollution sources, formulating and implementing technical plans for aquaculture waste water treatment, and selecting typical aquaculture companies to carry out technology research and development, application and demonstration. Although some results have been achieved in the implementation of the work mentioned above, many problems have also been exposed. As the pollution discharge of aquaculture has characteristics of low pollutant concentration, large quantity of drainage, and non-point source discharge, it is difficult to meet the treatment requirements of aquaculture waste water by referring to the prevention and treatment of point source pollution and sewage treatment methods. In addition, the formulation of aquaculture waste water discharge standards has not taken the latest research results at home and abroad into consideration, and the regulations on aquaculture species, modes of operation, water quality, and nitrogen and phosphorus budgets are relatively outdated. The discharge characteristics and development trends of aquaculture waste water should be considered collectively in order to develop a more flexible, comprehensive, targeted, and practical discharge standard for aquaculture waste water.

3.2.3.6 The growth of recreational fisheries

China's recreational fishery started in the 1990s, slightly later than developed countries such as in Europe and the United States, but it has developed rapidly and has become a new bright spot in the development of the modern fishery economy. The "Twelfth Five-Year Plan for National Fishery Development" issued by the Ministry of Agriculture in 2011 included recreational fisheries in the fishery development plan for the first time and clearly listed it as one of the five major industries of modern fishery in China. During the "Thirteenth Five-Year Plan" period, China further proposed to form a modern fishery industry system featuring coordinated development of aquaculture, fishing, processing and circulation, enhanced fisheries, recreational fisheries, along with the integration of primary, secondary and tertiary industries. To objectively reflect the development of recreational fisheries across the country and lead the sustainable and healthy development of recreational fisheries, China launched nationwide monitoring of the development of recreational fisheries in 2017 and issued the "Report on the Development of China's Recreational Fishery Industry" in 2018. Following this, China's recreational fishery has begun to embark on a standardized development

path.

China's recreational fisheries are divided into five categories: recreational fishing and gathering industry; tourism-oriented recreational fishery; ornamental fish industry; fishing tackle, bait, ornamental fish, fishery medicine; aquarium equipment; and others. As shown in Figure 3-4, the output value of China's recreational fisheries in 2019 was mainly derived from tourism-oriented recreational fisheries, recreational fishing activities, and gathering industries, which were 44.62 billion yuan and 28.42 billion yuan, respectively, accounting for 47.30% and 30.13% of the national recreational fishery output value. In total, the two categories account for 77.43% of the national recreational fishery output value, while other categories account for relatively small proportions.

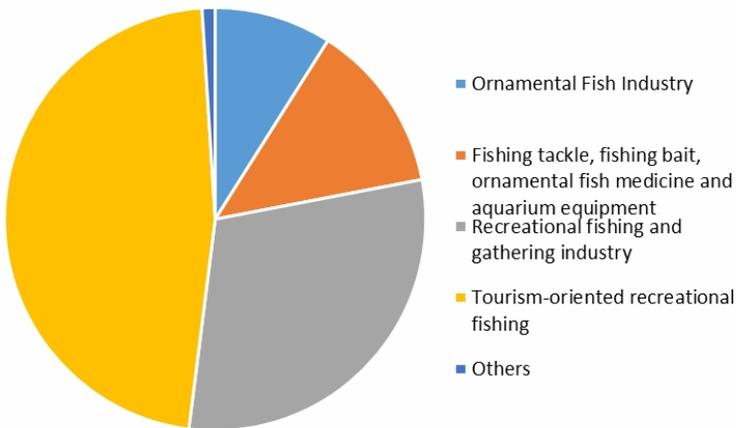


Figure 3-4 China's national recreational fishery industry structure in 2019

According to the data of China Fishery Statistical Yearbook, since the implementation of recreational fishery monitoring statistics in 2003, the output value of recreational fishery in China and its proportion in the total fishery economic output value show an overall upward trend, with an average annual growth rate of 19.6%. In 2019, the annual output value of recreational fisheries in China reached 94.32 billion yuan, accounting for 3.8% of the total output value of China's fishery economy.

3.2.3.7 Sustainable use of fishery resources

In recent years, marine fishery resources are facing increasing human and environmental pressures, and many countries, regions, and non-governmental organizations are taking action to maintain the sustainable development of marine fishery. China should give full attention to its advantages of marine environment and resources, carry out ecological farming, strengthen scientific and technological innovation, and improve the level of fishery production equipment; Implement

sustainable fishery certification, reduce the impact of aquaculture on the environment and society, ensure the healthy and sustainable development of aquaculture, and restore and develop the fishery biological population with the most ecological, economic and cultural values.

(1) Traceability System for Aquatic Products

Since 2003, China has explored the establishment of a traceability system in the aquatic field. The prevention and control of cold chain food safety during the 2020 COVID-19 pandemic has further promoted the traceability management of domestic aquatic products, including extensive coverage of traceability requirements and technological progress. The establishment of a complete traceability management system is the focus of the development of sustainable fisheries. China has a long-standing unsound and unsystematic traceability quality management status, but with the development of E-commerce and the improvement of consumer awareness, some retailers have begun to establish traceable seafood supply chains through information technology.

At present, China's aquatic product traceability hardware conditions are at a relatively advanced level, but the relevant information in the traceability system has not yet been linked to sustainable development, and it is impossible to identify whether aquatic products on the market come from overfishing areas, whether they are endangered species, and whether they are derived from illegal, unreported and unregulated fishing (IUU), etc.

(2) Sustainable Fisheries Certification

In recent years, China's aquatic product production and processing industry has developed rapidly, and the output value of foreign exchange earnings from exports has ranked first in the trade of bulk agricultural products for many years. As an operable and identifiable means, a certification is a favorable tool for leveraging the coordinated development of marine protection and industrial economy through the market. Carrying out aquatic product certification can enhance its brand competitiveness in domestic and foreign markets, improve the sustainability of fishery production and the added value of products, and effectively reduce the pressure on fishery resources. At present, the domestic aquatic product standard system mainly includes the international Best Aquaculture Practices, the Aquaculture Stewardship Council, the Marine Stewardship Council, as well as domestic organic products and green products. Among them, the strict certification standards for organic products are conducive to protecting the environment and ecological diversity, giving consumers more choices, and allowing businesses with good production conditions to obtain higher benefits. Compared with organic certification, green products are less strict, more in line with the reality of China's agriculture, and are conducive to promoting fishermen to improve their breeding environment.

3.3 China's offshore environmental pollution and its treatment

From the 1990s to 2012, the intensity of marine development has been increasing. The coastal economy has entered a development mode of resource competition, low utilization efficiency and similar main industries. The marine ecological environment quality has deteriorated comprehensively. Oil spills, pollution (including anthropogenic chemicals and microbial wastes), and eutrophication remained the major problems. However, in recent years, there has been a dramatic increase in research on macro-, micro- and nano-plastics and other forms of marine litter. By 2015, the world had produced 8.3 billion tons of new plastics and 6.3 billion tons of plastic waste. Among them, 9% of plastic waste has been recycled, 12% burned, while 79% has been piled up in landfills or abandoned in the natural environment. Based on current production and waste management trends, it has been estimated that 12 billion tons of plastic waste will enter the landfill or natural environment by 2050. It is estimated that the total amount of large and micro plastic waste floating in the open ocean is 5.25 trillion tons, and the weight is 2

69,000 tons. At the end of the 20th century, about 32600 km² of the sea area under China's jurisdiction has been significantly polluted, reaching a peak of about 67900 km² in 2012. Since the 18th National Congress of the Communist Party of China, with the continuous advancement of the start of ecological civilization, the pollution control and ecological restoration in coastal areas have been strengthened, and the marine ecological environment quality has stepped into an improvement period. The seriously polluted area of China's coastal waters has shown significant decrease. By 2020, the seriously polluted area has dropped to 30100 km².

This chapter analyzes the marine pollution status and relative governance countermeasures focuses on marine plastic pollution, coastal eutrophication and mercury pollution. The main research includes as follows.

- Compare the policies related to solid waste management and plastic pollution prevention and control in China and the European Union. Analyze the source of marine plastic debris from the whole chain of production, including product design, consumption and waste disposal. Evaluate the marine plastic pollution prevention and control effect, as well as to optimize the estimation of plastic waste flux into the sea.

- Investigate the nutrients distribution in the Bohai Sea in the context the combined effects of land-based nutrients input/reduction, climate change, water and sediment regulation of the Yellow River. Analyze coupling effect of coastal chemical elements and ecological environment in the view of the bottom layer anoxia evolution and surface seawater chlorophyll distribution. Compare regulation of human activities and climate change on nutrient cycle in the Bohai Sea and the Baltic Sea. Put forward countermeasures and suggestions on the management and

control of nutrients in coastal waters.

- Sort out the data of mercury in seawater, sediment and organism both from operational monitoring and investigation. Assess the mercury pollution in China's coastal waters. Analyze input and transfer process of mercury in the marine environment, and provide basic information to assess the effectiveness of the implementation of the Minamata Convention.

3.3.1 Eutrophication and mitigation actions in the China coastal sea

3.1.1 Overview of coastal eutrophication

As research is conducted in more habitats and using new tools and approaches, the range of effects of hypoxia driven by eutrophication that have been identified. Severe hypoxia process will lead to a large number of marine organisms to die, forming a "marine dead area". Since 1950, more than 500 sites in coastal waters have reported oxygen concentrations ≤ 2 mg liter⁻¹, a threshold often used to delineate hypoxia. This oxygen loss, or deoxygenation, is one of the most important changes occurring in an ocean increasingly modified by human activities. In estuaries and other coastal systems strongly influenced by their watershed, oxygen declines have been caused by increased loadings of nutrients (nitrogen and phosphorus) and organic matter, primarily from agriculture; sewage; and the combustion of fossil fuels. Hypoxia results a wide range of biological and ecological consequences, including not only effects on marine and estuarine fisheries and ecosystems, but also impacts on regulation of global cycles of major nutrients and carbon. In the meantime, hypoxia can enhance acidification in coastal waters.

3.1.2 Distribution patterns of nutrients and control mechanisms in coastal sea

(1) Bohai Sea

Anthropogenic activities have considerably perturbed China marginal seas, in particular the Bohai Sea. Therefore, prominent impacts on the coastal ecosystem have been observed in the Bohai Sea. Nutrient concentrations generally decreased from the coastal areas to the central part of the Bohai Sea and had significant seasonal variations. Nutrients showed stratification in summer with higher values at near-bottom layers than those in the surface and were vertically mixed well in winter. The nutrient limitation was changing from nitrogen limitation to phosphorus limitation and silicon limitation.

One of the main sources of nutrients in the Bohai Sea is riverine input. The seasonal patterns of both water discharge and sediment load have been changed by the water and sediment regulation scheme (WSRS). In particular that residence time of the Yellow River water was long in the Bohai Sea, thus the WSRS has a far-reaching influence on the ecological environment of the Bohai Sea. The composition of nutrients in the Yellow River has high ratios of N/P and Si/P, and low ratio of Si/N. Strictly controlling the amount of fertilizer and improving the application

methods, enhancing sewage treatment technology and vigorously promoting "green travel" might reduce nutrients emptied into the Yellow River based on the main source of nutrients. The second is other sources, including nutrient regeneration in summer sediments, atmospheric deposition and groundwater. Compared with river input, the contribution of nutrient regeneration in sediment to nutrient load in water in summer is nearly 2-3 times that of river input, indicating that the internal circulation of nutrients in the Bohai Sea is very important. although submarine groundwater discharge (SGD) had large uncertainties, nutrient fluxes transported via SGD to the Bohai Sea were higher than those from the riverine input and atmospheric deposition. The pollution of large-scale mariculture is widely concerned globally. Nutrients input to the Bohai Sea through marine aquaculture (including feeding and non-feeding marine culture) contributed <5% of total N and P fluxes by industrial wastewater and domestic sewage.

(2) Baltic Sea

Similar to the Bohai Sea, the Baltic Sea is a semi-closed marginal sea, which only connects with the North Sea and the Atlantic Ocean through narrow channels. The residence time of seawater in different areas of the Baltic Sea is different. The distribution characteristics of nutrients in the Baltic Sea can be traced back to the early 1990s, DIN concentrations in the sub open seas of the Baltic Sea showed increase. After that, DIN concentration in each sub open seas almost stopped increasing and maintained at a high level, with a significant decrease in most of the sub open seas. The observation of DIP in some sub open seas can be traced back to the 1960s. The DIP concentration in most sub open seas increased significantly from 1960 to 1970s, and then remained at a high level. There was no obvious trend in DIP concentration in most sub open seas. However, the DIP concentration in Aland Sea continued to increase from 1990 to 2016 and that in the Bothnian Sea, Gulf of Riga, Gdansk Basin and Northern Baltic Proper also had significant increase during 2011 to 2016. Fleming-Lehtinen showed that DS_i concentrations in northern Baltic Proper, Gulf of Finland and Bothnian Sea decreased by 30% to 50% from the beginning of 1970s to the end of 1990s, and then increased by 20% to 40%.

The total nitrogen (TN) input to the Baltic Sea included water input and atmospheric input, where the water input was a combination of river input and direct point sources input (industrial, municipal and aquaculture wastewater directly discharged into the sea in coastal areas). The total phosphorus (TP) input to the Baltic Sea mainly came from river inputs and direct point sources input. River input was mainly affected by natural and anthropogenic sources, among which anthropogenic sources included diffuse sources and point sources. In addition to natural and anthropogenic sources, some of the nutrients in the river came from non-HELCOM countries (mainly Belarus) in the upper reaches of the river, which were separately defined as trans-boundary input. Generally, the inputs of nitrogen and

phosphorus to the Baltic Sea has decreased in recent decades. River input was the main way for providing DSi to coastal water.

(3) Comparative analysis of nutrients in the Bohai Sea and Baltic Sea

The DIN concentration in the Bohai Sea was very low before the 1990s, and then began to increase significantly in recent years. Since 1978, the DSi concentration in the Bohai Sea showed a trend of decrease first followed by increase. The concentrations of DIN and DIP in most of the sub open seas of Baltic Sea increased significantly before the 1990s. After that, the DIN concentration in most sub open seas and the DIP concentration in a few sub open seas decreased due to the implementation of some management measures.

The average DIN concentration level in the Bohai Sea was higher than the peak average DIN concentration in most sub open seas of Baltic Sea. The average DIP concentration was relatively the same, while the average DSi concentration in the Bohai Sea was equivalent to the intermediate level of the sub-sea areas of the Baltic Sea. Relatively higher DIN concentrations, close DIP concentrations, and intermediate DSi concentrations in Bohai Sea resulted in higher N/P ratios and lower Si/N ratios in the Bohai Sea than that in Baltic Sea. Although relevant measures have been taken to protect the Bohai Sea in China in recent decades, previous studies have shown that the total DIN input into the Bohai Sea through rivers has not decreased significantly in recent years and maintained at a high level. In addition, the amount of agricultural fertilizer, municipal sewage discharge and aquaculture area in the Bohai Rim region have been increasing, which indirectly indicated that the total amount of nitrogen input into the Bohai Sea through these channels has not been effectively controlled. Therefore, effective control of nitrogen input in Bohai is the key to improving eutrophication in Bohai.

3.1.3 Ecological responses to coastal eutrophication

(1) Bohai Sea

The WSRS has led to that high monthly average water discharge, sediment load and nutrient transports advance to as early as 2 months earlier than before the event, such that the surface Chl-a exhibited two peaks in spring and autumn until 2002, but has exhibited only one peak in spring-summer since 2002. Along with changes in physicochemical environment, the composition pattern of the phytoplankton community changed dramatically during 1959 - 2015, in which diatoms accounted for 65.3%~99.8% of phytoplankton abundances and phytoplankton transitioned from diatom dominated communities to communities co-dominated by diatoms and dinoflagellates. Along with eutrophication caused by human activities, the diversity of benthos has been significantly decreased. During 1959-2010, there were rapid alteration in fish community structure, the abundance of dominant species changed, and the diversity of fish species and species number density decreased.

The bottom DO in the Bohai Sea has been gradually decreasing since 1978. In

terms of seasonal distribution, DO concentrations in the Bohai Sea are at a high level (~10 mg/L) in April and gradually decrease, to a minimum in summer, showing a seasonal hypoxia process. In general, the Bohai Sea hypoxia zone is still at a preliminary stage of development, and relevant studies are still scarce, especially for ecosystem impacts.

(2) Baltic Sea

The comprehensive assessment of eutrophication in the Baltic Sea from 2011 to 2016 shows that 97% of the sea areas were still affected by eutrophication in varying degrees, although the eutrophication in the Baltic Sea has improved. The nutrient level in the evaluation was the furthest from Good Environment Status (GES), meaning that it had the greatest impact on the comprehensive assessment results. Nutrient levels directly affected all aspects of the Marine ecosystem. The massive inputs of N and P promoted the algae growth. The massive growth of algae intensifies the water eutrophication, and the increase in the intensity and frequency of algal blooms usually leads to the decrease in the transparency of the water and the increase in the sinking organic matter. Long-term studies have shown that the transparency of water bodies in most sub open seas of Baltic Sea has been fluctuating or deteriorating continuously in recent decades, especially in the northeastern sub open sea areas. Only a few sub open seas have seen improvements in transparency. However, the reduction of nutrients inputs to the Baltic Sea is difficult to see the corresponding improvement of eutrophication in a short period of time. That is, the response has a lag.

The development of hypoxia processes in the Baltic Sea over the last 100 years has been unprecedented, with the hypoxia area growing rapidly from about 5000 km² to more than 80 000 km², an increase of more than 10 times, making the Baltic Sea the largest offshore hypoxia area in the world. The process of hypoxia in the Baltic Sea is influenced by multiple effects of physical processes, climate change and anthropogenic processes, in recent times, excessive nutrient input due to anthropogenic activities is the main factor contributing to hypoxia in the Baltic Sea. By the 1980s, anthropogenic inputs of nitrogen and phosphorus to the Baltic Sea had increased four fold and eight fold respectively. Overall, changes in the size of the Baltic Sea hypoxia zone lagged by 2 years compared to changes in DIN/DIP. The coupling between oxygen depletion processes and nitrogen and phosphorus biogeochemical processes in the Baltic Sea determines the above-mentioned distributional relationships. Overall, hypoxia has had a serious negative impact on the Baltic Sea ecosystem, including a reduction in fisheries resources, weakened nutrient removal and an intensification of the algal growth.

3.1.4 Mitigation actions on coastal eutrophication

(1) Baltic Sea

The governance of the Baltic Sea is a multi-level control system, including global

conventions (such as the Convention on biological diversity), regional conventions and organizations (such as the Helsinki Convention), the European Union, relevant national and local authorities, non-governmental organizations and the public society.

In 1974, the Baltic States acceded to the Convention for the Protection of the Baltic Marine Environment. In 2007, HELCOM launched the Baltic action plan (BSAP), which incorporates up-to-date scientific knowledge and innovative approaches to management into the enforcement of management policy and promotes the construction of target oriented multilateral cooperation models for Baltic coastal countries. Adaptation management is one of the important working principles of HELCOM. From 2008 to 2013, HELCOM dynamically updated and improved the nutrient emission reduction plan. The European Union attaches great importance to the issue of eutrophication in the offshore waters. Several regional seas conventions contain the contents of mitigating coastal eutrophication. Overall, the Baltic Sea reversed the growth trend in nutrient input earlier than areas such as the Black Sea and Great Barrier Reefs due to proper controls.

The Baltic Sea has gained many advanced experiences in eutrophication control, including: 1) strengthening policy formulation and effective implementation of cross-regional and cross-government policies; 2) improving the management of eutrophication. Early monitoring of long time series is very important for identifying and understanding problems, formulating and implementing management policies; 3) Solve easy-to-handle problems first, which can usually lead to significant improvement in environmental conditions, for example, reducing and controlling point source pollution first; 4) Global and regional changes increasingly threaten initial gains, requiring the revision of appropriate management measures; 5) Inclusive governance measures based on stakeholder and cross-sectoral collaboration are important to governance.

(2) Bohai Sea

In China, nutrients are usually controlled and treated as pollutants. At present, there is no special plan or treatment action for Bohai eutrophication. During the 10th Five-Year Plan period, in accordance with the overall arrangement of the state's environmental protection work, the local governments of three provinces and one city around the Bohai Sea and the relevant state departments carried out environmental protection work in the Bohai Sea in various aspects in accordance with the "Bohai blue sea action plan", "the Tenth Five-Year Plan for the prevention and control of water pollution in the Liao River Basin" and "the Tenth Five-Year Plan for the prevention and control of water pollution in the Hai River Basin" approved by the State Council, And achieved certain progress and results. However, although there is no obvious deterioration of water quality in the Bohai Sea, the situation is still not optimistic. From the perspective of pollutant indicators, although

most of the water quality indicators meet the class II sea water quality standards, inorganic nitrogen, active phosphate and petroleum are over standard in varying degrees. The plan put forward the linkage of non-point source control and prevention, and established the land pollution source control and comprehensive treatment system. Emphasize comprehensive management of secondary watershed and agricultural non-point source control to effectively solve the difficult problem of continuous increase of nitrogen and phosphorus pollutants in the Bohai Sea. The main measures to promote the reduction of nutrient emission include: 1) focus on controlling rural non-point sources in offshore land areas. 2) we have to continue to reduce the total discharge of industrial pollution sources. 3) improve the operation efficiency of urban sewage treatment facilities.

In 2018, the Ministry of Ecology, the State Development and Reform Commission and the Ministry of Natural Resources jointly issued the Bohai Sea Comprehensive Management Struggle Action Plan, aiming at ensuring that the Bohai Sea ecological environment will not deteriorate anymore and that three-year comprehensive management will be effective through scientific planning and multiple measures. One of the key tasks of the action plan is land source pollution control action, among which many measures contribute to alleviating eutrophication in the Bohai Sea, including: 1) pollution control of rivers entering the sea. 2) Rectification of pollution sources discharging directly to the sea. 3) Prevention and control of agricultural and rural pollution. 4) Prevention and control of urban domestic pollution. 5) Total control of discharge of water pollutants.

3.3.2 Ecological Environmental Problems and Policies of Marine Plastic Debris and Microplastics

3.2.1 Overview of marine plastic debris and microplastics

Marine plastic pollution has become a problem almost along with the large-scale production and application of plastics. In 2004, British scholars discovered the existence of plastics in their accumulated seawater samples for many years, and most of the plastic particles in the samples need to be observed with a microscope. Therefore, plastics of this type of size are defined as "microplastics". In 2008, international experts in related fields organized a seminar and they defined the upper size limit of microplastics as 5 mm. Since 2014, UNEP has proposed that marine plastic and microplastic pollution need urgent attention, research and response in five consecutive United Nations Environment Assembly sessions. At the G20 summit in June 2019, countries agreed on the "Blue Ocean Vision" in the "Osaka Declaration", promising to achieve zero discharge of marine plastic debris by 2050. In addition, the "United Nations Decade for Promoting the Sustainable Development of Marine Science" (2021-2030) has made marine plastic pollution one of the priority issues to be solved.

3.2.2 Distribution, source and fate of marine plastic debris and microplastic

(1) Distribution of marine plastic debris and microplastic

Plastic debris in the ocean accounts for 80% of all discarded solid waste. Eriksen^[19] and Sebille^[20] estimated based on models that there are around 15-51 trillion plastics debris floating in the ocean, weighing about 93-236 million tons. It was found that the average size of plastic debris in the ocean tends to be miniaturized, and the quantity of microplastics continues to increase. Isobe studied the long-term changes of the abundance for microplastics in the Pacific Ocean from 1957 to 2066 with a combination of numerical simulation and transoceanic surveys, and concluded that the weight of microplastics near the marine subtropical convergence zone will increase by about two times compared with the current status.

(2) Sources and pathway of marine plastic debris and microplastics

Marine plastic debris mainly comes from land sources and sea sources. Among them, the land-based source of plastic waste includes landfills, industrial sewage outlets, sewage treatment plants, coastal recreational area, agricultural plastic sheeting, shipping, and riverine input, atmospheric deposition through runoff and wind. Sea-based source input includes plastic waste discharged into the sea from activities such as fishing, aquaculture, and shipping. Marine plastic pollution from land-based sources accounts for about 80%, and the remaining 20% of plastic pollution is based on the ocean. Half of the latter comes from fishing boat operations, such as abandoned fishing nets, fishing lines, and boats. Coasts and rivers are important ways for plastic waste to enter the sea.

In terms of microplastics pollution, primary microplastic is an important source of marine microplastics. There are several ways of loss and release of primary microplastics worldwide: tires abrasion, synthetic textiles, marine coatings, road markings, personal care products, plastic microbeads, and urban dust. The release of secondary microplastics mainly comes from improper management of plastic waste. Secondary microplastics are broken into fragments due to physical and biochemical effects and enter the marine environment. With the continuous decomposition of large plastics, the content of secondary microplastics will gradually increase.

(3) Fate of marine plastic debris and microplastic

It was estimated that 8300 million metric tons (Mt) as of virgin plastics have been produced to 2015. As of 2015, approximately 6300 Mt of plastic waste had been generated, around 9% of which had been recycled, 12% was incinerated and 79% was accumulated in landfills or the natural environment. Today, the annual output of plastics has exceeded 300 million tons and is expected to exceed 1.5 billion tons by 2050. If current production and waste management trends continues, roughly 12,000 Mt of plastic waste will be in landfills or in the natural environment by 2050. The recent research shows that in the absence of any policy measures, the amount of improperly managed plastic waste will increase from 91 million tons in

2016 to 239 million tons in 2040; the amount of plastic waste generated in the next 20 years will be doubled. The amount of plastic waste leaking into the ocean will increase nearly three times and the total amount of plastic debris in the ocean will increase more than four times.

The fate of marine plastic debris and microplastic is still undergoing research. Plastic debris will be subjected to different forces in the marine environment and degrade at different rates. Marine plastic debris may float or sink in the water column, and eventually accumulate in the deep sea or tidal flat, and may occur in the food chain.

3.2.3 Current measures to reduce marine plastic debris and microplastics

(1) International actions to address marine plastic debris and microplastics

In order to reduce the generation of marine waste, we should first ensure that no solid waste enters the environment in the process of harmless treatment such as solid waste generation, collection, transfer, cleaning and transportation to incineration and sanitary landfill, put an end to improper disposal methods such as open landfill, and implement policies such as "waste classification", Let recyclable waste plastics enter the solid waste treatment system and be recycled. Building a "circular economy" of plastics is also an effective way to prevent plastic waste from entering the sea from the source.

Legal conventions related to marine waste management have been implemented as early as the 1950s. especially marine plastics debris, was highly concerned. In May 2019, Amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal was endorsed, several new categories of waste plastics are added to regulate their cross-border transportation and harmless treatment.

(2) Governance and addressing marine plastic debris in EU and China

EU

In 2015, the European Commission put forward the circular economy action plan (CEAP) and then adopted the new CEAP in 2020. The CEAP aims to promote the transition from linear economy to circular economy in Europe and realize the reuse of wastes. Plastics are listed as priority materials under the circular economy. In 2018, the EU issued the CEAP, including the plastic strategy, chemical waste management, port receiving waste management, key raw material management policies and the monitoring system of circular economy progress. The plan requires that all plastic packages on the EU market should be reused or recycled by 2030. Meanwhile, rubber tire friction dust, textile and paint are listed as plastics to be treated, which are important microplastic sources. Overall, the strategy aims to tackle plastic pollution at its sources such as avoiding leakage of plastics to the environment, reducing the emission of microplastics from products, litter from single-use plastic products, fishing activities and aquaculture. This will help to

reduce the amount of plastic waste ending up in the seas and coasts.

At the same time, the EU has adopted a series of goals: 10 million tons of recycled plastics will be used in new products by 2025, the recycling rate of plastic packaging waste will reach 55% by 2030, and plastic beverage bottles will contain at least 30% recycled plastics by 2030. Specific EU policies focus on seven aspects including 1) Plastic Bags; 2) Single-use plastics; 3) Plastic waste shipments; 4) Packaging waste; 5) Microplastics; 6) Bio-based, biodegradable and compostable plastics; and 7) Global action on plastics. On May 31, 2021, the Committee adopted the guidelines on single-use plastic products, as well as the implementation decision on reporting on fishing gear, and plans to take effect the ban on certain disposable plastic products on July 3, 2021. In 2019, European Chemical Agency (ECHA) proposed a wide-ranging restriction on microplastics in products to avoid or reduce their release to the environment. This proposal is expected to prevent the release of 500 000 tonnes of microplastics over 20 years. Plastic pollution is a global problem that needs efforts worldwide. The EU is trying for a global agreement on plastics that addresses plastic pollution throughout the entire plastics life-cycle, in order to minimise the mismanagement of plastics and prevent plastic wastes from entering the environment.

China

China is one of the earlier countries to issue "plastic ban order" (Emergency Notice on Immediately Stopping the Production of Disposable Foam Plastic Tableware, 2001) and "plastic restriction order" (Notice of the General Office of the State Council on Restricting the Production, Sales and Use of Plastic Shopping Bags, 2007).

China has been active in cleaning up the blue ocean. Specifically, in terms of laws and policies, although there is no law to directly control marine garbage in China, the state has formulated a series of regulations, policies and measures for the prevention and control of plastic garbage pollution for a long time, and constantly supplemented and revised them. In recent years, the state has also successively issued environmental protection policies such as The Action Plan for Prevention and Treatment of Water Pollution (2015), The Action Plan for Prevention and Treatment of Soil Pollution (2016), River Chief System (2016). Some coastal cities have also carried out the pilot work of "Bay Chief System" (2017) to prevent garbage from directly entering the river or randomly stacking at the edge of the water body, and strengthen the garbage treatment of the water body and its shoreline. Timely remove the garbage and floating objects in the water body and properly handle them.

In 2018, the Ministry of Ecological Environment adopted the action plan for 2018-2020 on comprehensively implementing the implementation plan for the reform of solid waste import management system by banning the entry of foreign waste, which effectively controlled an important source of marine plastic debris in

China. At the same time, since 2018, the Ministry of ecological environment has continuously carried out actions such as the Waste Removal Action of the Yangtze River Economic Belt and the Action Plan for Comprehensive Treatment of the Bohai Sea, and carried out comprehensive treatment of the garbage in the rivers and coastal waters of the Yangtze River and the Bohai Sea, so as to reduce the plastic garbage into the sea from the source.

On June 3, 2019, General Secretary Xi Jinping made important instructions on garbage sorting work, emphasizing "cultivating good habits of garbage sorting, making efforts to improve the living environment, and contributing to the sustainable development of green development". On July 1, 2019, Shanghai municipal domestic waste management regulations were formally implemented, and the compulsory domestic waste classification action was first implemented, by November 2020, the domestic waste classification system has been basically completed, and zero landfill of primary domestic waste is basically realized in 2020. The total amount of dry waste incineration and wet waste resource utilization has increased from 10250 tons per day in 2018 to 26095 tons per day in 2020. So far, the overall effect has far exceeded expectations.

On October 30, 2019, the National Development and Reform Commission officially issued Industrial Structure Adjustment Guidance Catalogue (2019 edition), it is clear that the daily chemical products containing plastic microbeads will be banned from production by December 31, 2020, and banned from sale by December 31, 2022. On January 19, 2020, the National Development and Reform Commission and Ministry of Ecology and Environment issued the Opinions on Further Strengthening Plastic Pollution Treatment, prohibited or restricted from part of the plastic products production, sale and use, application alternatives and patterns (such as plastic products, biodegradable plastic bags and biodegradable plastic sheeting, etc.), to reduce the plastic products from the source. China will strengthen the control of plastic pollution in accordance with the idea of "banning one batch, replacing one batch and standardizing one batch".

In addition to policies, China has actively participated in international intergovernmental organizations, bilateral and multilateral activities to prevent and control marine plastic debris. With the help of these policies, the recycling rate of waste plastics in China has increased in the past few years and is at peak in the global recycling and treatment of waste plastics.

(3) Challenges in prevention and control of marine plastic debris

- Internationally, there is no legally joint action to deal with and reduce marine plastic debris. And the goal of reducing the amount of marine plastic debris has not been implemented;

- Different countries have different policies on environmental protection, industrial development and international trade;

- There are still many deficiencies in the current laws and regulations;
- The recycling and classification system of plastic debris in marine fishery, water transportation, coastal and underdeveloped areas is not well-developed;
- The recycling system of waste plastics is not well-developed;
- There are widespread global conflicts in the management of plastic waste because of the misunderstandings about the nature of degradable plastics still exist, and the lack of scientific assessment of the environmental impact; and
- Part of the public is lack of scientific understanding of the pollution of marine plastics and microplastics.

3.3.3 Sources, distributions and trend of mercury pollution in marine environment

3.3.3.1 Sources of mercury in the marine environment

The mercury and mercuric compounds in the ocean come from natural and anthropogenic sources. National or continental boundaries do not restrict mercury discharge. When mercury is released into the air, it can travel thousands of miles for long-distance migration through air circulation. Most mercury will eventually enter the aquatic ecosystem in dry precipitation or rainfall and eventually merge into the ocean.

3.3.3.2 Mercury pollution in coastal waters of China

(1) Atmosphere

At present, there are two main ways to study the atmospheric mercury in near shore area: one is the long-term observation, that is, the morphological study of fixed sampling points carried out in coastal areas and islands; the other is the short-term observation, that is, the morphological study of mobile sampling points carried out with marine scientific research vessels. The concentration of GEM in China's coastal air is higher than the background value of the northern hemisphere (1.5-1.7 ng/m³), and the concentration of GEM in coastal areas was higher than that in islands and ships. Compared with the observations of other sea areas in the world, the research results in China are also significantly higher. Although the marine GEM is affected by anthropogenic emissions, the GOM and PBM in the marine atmosphere are affected by the relatively rapid speciation transformation and sedimentation rate, and there is no significant increase. Most coastal areas in China are economically developed areas, and anthropogenic emissions have a strong impact on the concentrations of GOM and PBM in the local atmosphere. Under the synergistic effect of local anthropogenic emissions and marine atmospheric background air mass, the concentrations of various forms of mercury in the coastal area are in the middle of the background values and the observations of inland cities.

(2) Seawater

Due to the low concentration of mercury in water, it is more difficult to detect various forms of mercury. Due to the limitation of many experimental conditions,

there are relatively few studies on mercury concentration and speciation analysis in seawater in China. The average concentration of THg in surface seawater in the offshore area of China's marginal sea is about 1.2-1.7 ng/L. Compared with other sea areas in the world, this value is higher than THg concentration in open sea areas and open sea waters. However, it is slightly lower than that of the Gulf and seacoast, which are greatly affected by land-based emissions. From the morphological point of view, the average DEM concentration of surface seawater in China is 27.0-63.9 pg/L, accounting for 3-6% of THg. Compared with other sea areas in the world, this value is equivalent to other open sea areas and coastal areas in the world. The DEM concentrations in the surface waters of the Yellow Sea and the South China Sea also showed a seasonal trend, with high concentrations in the warm season and low concentrations in the cold season, the trend is similar to that of other sea areas in the world. The spatial distribution trend of DEM concentration is higher in offshore area and lower in offshore area, and the DEM concentration in offshore area is similar to that in other offshore areas in the world.

(3) Sediment

The study of mercury in surface sediments and sediment cores has become an effective means to reveal the source, migration and transformation of mercury in both spatial and temporal scales. The concentration (dry weight) of THg in China's coastal sediments is mostly in the range of background concentration (20-100 $\mu\text{g}/\text{kg}$). Most of the sampling points in the Pearl River Estuary (42/54) and one sampling points in the Bohai Sea (1/29) were significantly higher than the background value ($> 100 \mu\text{g}/\text{kg}$). Compared with other sea areas in the world, THg values of marine sediments in Europe, North America, Africa and Asia are significantly lower.

From the perspective of spatial distribution, the hot spots of THg enrichment are mainly distributed in the Yellow River Estuary of the Bohai Sea, the muddy area in the middle of the Yellow Sea, the muddy area of the Yangtze River Estuary and the lower reaches of the Pearl River Estuary in the East China Sea, and the lower reaches of the Pearl River Estuary in the South China Sea, This indicates that mercury in the coastal sediments of China is mainly concentrated in the muddy areas with high organic carbon content, and mainly comes from the input of coastal human activities. From the perspective of time trend, the overall performance shows an increasing trend from the bottom to the top of the core, especially near the top of the core, which indicates that the mercury input in China's coastal waters continues to increase, especially in recent decades.

The detection data of organic mercury in coastal sediments in China are relatively few, and the existing data show that the concentration of MMHg is mostly in the range of 0.1-3.2 $\mu\text{g}/\text{kg}$, only relatively high concentrations of MMHg (15 $\mu\text{g}/\text{kg}$) was found in several estuaries. In the future, it is necessary to strengthen the study of mercury speciation in sediments.

(4) Residue in organism tissue

Seafood has become an important source of human methylmercury exposure, which poses a potential threat to human health and needs special attention. From 2007 to 2012, 11 species of mollusks (including 9 bivalves and 2 snails) were collected from the Bohai Sea. The results showed that the concentration (dry weight) of THg and MMHg ranged from 27.2 to 461.1, which were lower than the limit of MMHg in seafood in China, which is 500 $\mu\text{g}/\text{kg}$. The concentrations of THg and MMHg in molluscs did not change significantly in this period; In terms of space, there are significant regional differences; In terms of species, the percentage of MMHg in snails (57.3-65.8%) was significantly higher than that of bivalves (21.1-49.5%). MMHg in low trophic molluscs showed biomagnification effect, while inorganic mercury mainly showed growth dilution effect.

Compared with the existing data in China, the concentrations of THg and MMHg in the Bohai Sea are close to those in the other three regions, but the reports about fish in the South China Sea show relatively higher concentrations of MMHg, as high as 1811 $\mu\text{g}/\text{kg}$. Compared with other sea areas in the world, THg concentration in fish in China is relatively low.

3.3.3.3 *International (marine) mercury pollution monitoring*

(1) The Global Mercury Observation System

Global Mercury Observation System (GMOS) aims to establish a global mercury observing system to study and model global mercury emission scenarios, both regionally and globally, with support from network facilities. The system supports the operation of the Mercury Convention by measuring atmospheric mercury in ambient air and precipitation samples, providing comparable monitoring data on mercury concentrations in air and marine ecosystems in the northern and southern hemispheres. GMOS monitors through field and satellite platforms, with network facilities providing real-time or recent data from participating observatories. Adopting a global monitoring approach, this project locates monitoring stations worldwide, covering areas with different elevations, various sea levels, and a variety of climates. By employing data from those sites, researchers can test atmospheric mercury models from a regional and global perspective to improve the understandings of global mercury migration, deposition and emissions, and provide a viable foundation for international policy-making and implementation. However, due to the limited data from GMOS, it is still challenging to provide more time trend information at present. There are still rooms in improving emission inventories and monitoring data, projections of future mercury observation and the cost-benefits.

(2) EU environmental quality standards and mercury monitoring in water bodies and edible fish

The EU Water Framework Directive requires monitoring mercury and other substances following the EU Environmental Quality Standards (EQS, Directive

2008/105/EC). EU members may choose to use biota such as fish, mollusks and crustaceans as appropriate indicators for monitoring. Per monitoring mercury contents in fish and controlling human exposure to mercury through eating, is part of the EU's strategy for eliminating the impacts of mercury pollution. EC's Regulation 1881/2006 sets an upper limit of 0.5 mg/kg for fish and 1.0 mg/kg for some large fish. In addition, the European Food Safety Authority (EFSA) assesses methylmercury and inorganic mercury in 2012, setting the acceptable intake at 1.6µg/kg body weight and 4µg/kg body weight.

(3) UK monitoring of mercury emissions from water bodies

The United Kingdom (UK) occupies the major part of the British Isles archipelago, surrounded by the sea and crisscrossed internal water system. When monitoring mercury pollution in water bodies, the UK distinguishes marine water from fresh water and the estuarine and coastal water and takes different monitoring methods.

One is mercury monitoring in territorial waters, The Clean Safe Seas Environmental Monitoring Programme (CSEMP), which has been in place in the UK since 1999, collects data on mercury concentration in fish, mussels and sediments in the brine system within the territorial waters (12 nautical miles) to reflect trends in mercury emissions^[21]. However, the UK Environment Agency cautions that for monitoring data, significant effects of short-term conditions, such as storms and floods, may cause resuscitation of contaminated sediments, causing interference and over covering of data trends.

The second is mercury monitoring in freshwater, estuarine and coastal waters, Unlike mercury monitoring in territorial waters, the UK adopts the EU's EQS system for monitoring freshwater, estuarine and coastal waters.

(4) Mercury monitoring in Norway

In the Norwegian Action Plan for Reducing Mercury Releases (2010), the Climate and Pollution Agency is identified as the authority responsible for monitoring mercury concentration trends in the environment. The Agency is also responsible for revealing the causation and mechanisms of mercury runoff in the river basins and investigating the mercury concentrations in fish and food chains. Long-term mercury monitoring projects take a full ecological view of mercury, including monitoring mercury loads in marine organisms, analyzing time trends in biota, mercury inputs from rivers and industry, and data from North-South air monitoring stations. In addition, there are other periodic projects to sample and monitor mercury, such as a national lake sediment monitoring programme that includes measurements of mercury every ten years and measurements of mercury and other heavy metals in mosses every five years.

However, although a significant decline in mercury emissions is recorded in Norway, the monitoring data of mercury concentrations returned from the

monitoring stations (1990-2008) is stable and does not show a decrease. Nonetheless, the mercury content in fish does not decrease compared with the 1990s but shows a trend of significant increase. The Norwegian environmental authorities attribute this to the long-distance transport of mercury in the atmosphere. In other words, the import of mercury pollution from outside Norway into the country through the atmospheric circulation system is more important than the production of mercury from Norway itself. However, due to the significant uncertainty in Marine mercury circulation and bioaccumulation, the actual causes are still in the blank area to be explored.

3.3.3.4 International and EU mercury pollution control practices

(1) Mercury Convention and other international conventions

Later multilateral pollution controlling agreements and conventions cover some parts of mercury governance, such as the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, including a mercury waste processing, the Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade containing mercury international trade issues, and the Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention, 2001) covering the methyl mercury issues. Those international agreements and treaties expand participants' scope, trying to respond to mercury pollution as a global or regional context. Nevertheless, given the characteristics of mercury pollution, they cannot cover the entire cycle of mercury's lifespan; therefore, they cannot effectively prevent and control the pollution. Under this background, UNEP promotes a new independent mercury convention, namely the Mercury Convention.

(2) Mercury pollution control in the EU

The EU has identified mercury pollution as a global risk since 2005 and launched the Community Strategy Concerning Mercury (Mercury Strategy, COM/2005/0020) and the corresponding Directives and Action Plan to strengthen the governance of mercury pollution through law and regulation. The mercury strategy is a comprehensive plan to address mercury use and polluting issues. The core segment of the strategy is its 20 action plans, aiming at reducing mercury emissions, cutting mercury supply and demand, and protect citizens from mercury exposure. The Mercury Strategy has made international cooperation a priority, and one of the most important developments has been the active negotiation of the multilateral mercury convention (i.e., the Mercury Convention) with UNDP. The EU has played a crucial part in promoting the negotiation process. The signing of the treaty and the formation of multilateral cooperation are also important achievements of the EU in their green diplomacy.

Although existing regulations and directives relating to mercury control had generally met the requirements of the Mercury Convention, the EU introduces

further measures in 2017 to go beyond the treaty's requirements and strengthen the laws by adopting Regulation 852/2017 (replacing Regulation 1102/2008). This Regulation covers the entire life cycle of mercury, reinforcing and complementing previous environmental regulations. By implementing the Directives and Regulations mentioned above, the EU has tried to create a mercury-free economy and achieved encouraging results.

(3) Mercury pollution control in the UK

The UK has reduced mercury emissions by 88% since 1990 by putting restrictions on mercury use and discharge. This decline in emissions is linked to less use of coal and the prohibition of mercury cells in the production process in the chlorine-alkali industry. The UK has legally completed the Brexit in late 2020, but no new rules on mercury control are introduced at this reporting stage. The UK still employing those EU Directives and Regulations as their guiding rules and performs those EU provisions, keeping the same practices as the EU in manufacturing, trade, storage and reporting.

(4) Mercury pollution control in Norwegian

Although Norway is not an EU member, it shares a similar idea in mercury control and governance. Based on laws and regulations, public governance is the primary means in Norway to control and manage mercury pollution. Furthermore, Norway has set higher standards than the EU to minimize mercury use and emissions. Under the Agreement on the European Economic Area, Norway shares EU legislation on chemicals. Furthermore, in its own country, based on the Product Control Act (1976) and the Pollution Control Act (1983), Norway implements a licensing system as the primary policy instrument to deal with mercury pollution.

(5) Policy analysis of mercury pollution control

The EU and major non-EU countries, such as the UK and Norway, start the mercury control process earlier than other parts of the world. They establish a relatively perfect policy framework and achieve fairly positive results during the decade's practice, providing a valuable experience for other countries. It mainly includes the following aspects:

- European countries put emphasize combining global multilateral and domestic law and regulation-based governance;
- The mercury pollution control in Europe is based on strict policies, supplemented by market-based tools and soft policies; and
- In such a progressive policy framework, the European mercury strategy includes top-level design and emphasizes the need for collaboration among various local government authorities and the need for public participation.

It should be noted that although European countries are pioneers in mercury pollution control and leaders in international governance, there are also some lessons to be learned from the development of their governance process. It mainly includes

the following aspects:

- Although the rapid decline in mercury pollution reflects the positive effects of active policy interventions by Europe, it is more a result of the relocation of a large number of polluting industries and manufacturing industries to less developed countries due to globalization. While strengthening mercury pollution standards, European countries have not solved the problem of 'pollution flight' well;

- The performance of monitoring in European countries needs to be improved; and

- The EU's mercury policy has not yet been linked to major global issues, such as climate change, which have a very close relationship. On the one hand, reducing carbon emissions from high-carbon industries, such as coal-burning and oil, and rectifying mercury pollution have clear room for policy integration.

3.4 Policy recommendations

Recommendation 1: Improve fisheries resource study and survey, strengthen science-based governance systems

(1) Strengthening marine fishery resource assessment, natural capital accounting and management system optimization

Effective protection of China's marine ecological resources and fishery resources requires an understanding of their value and importance. First of all, China should give priority to the development of scientific research and tools related to the development of marine and fishery resources. Through marine resource surveys, the species diversity, population number and distribution of index species, breeding period, ecosystem connectivity, and habitat fragmentation should be ascertained. Furthermore, China should promote the standardization of scientific methods and technologies to provide a basis for the scientific delineation of protected areas and the design and implementation of protection management plans. China should also conduct baseline research on marine ecosystem value accounting, strengthen cooperation between provincial governments and research institutions, and identify the marine ecological hotspots with the highest natural capital to provide the strongest protection measures.

Second, China should focus on studying the nation's marine economic activities and development plans, understanding their dependence on and interrelationships with marine capital, and correctly assessing the impact of coastal development and various activities on marine natural capital. If conditions permit, it is also possible to conduct relevant research on the economic development of coastal communities to provide a scientific basis for the subsequent sustainable development of fishery and industrial transformation.

Third, in terms of marine natural capital management, China should strengthen high-level communication and cooperation between the central and provincial governments, collaboration between different administrative departments, and international exchanges and cooperation. Priorities should be given to the creation of marine national parks, build an effective ocean protected areas network system to increase marine protected areas and the protection of key species and habitats.

(2) Build and strengthen foundational research and management institutions for climate resilient fisheries

Climate change has clear impacts on the distribution and productivity of marine fisheries resources in China, as well as on the livelihoods of its fishers and coastal communities. We recommend that China strengthen its work related to climate change and fisheries in the following ways. First, policymakers should examine how marine resource management goals must adapt to changing ecosystem dynamics as climate changes. Climate change resilience should be built into marine management approaches, including funding and investment in necessary science to identify appropriate management benchmarks, monitor changes in species abundance and distributions over time, and develop forward looking policies to minimize risks under uncertainty. This should include a national climate-fisheries adaptation strategy, integrating climate adaptation to national and local fisheries planning, prioritizing fisheries and coastal communities in national climate adaptation initiatives, and developing both medium and long-term plans for fisheries to effectively respond to climate change. Second, China should strengthen the resilience of marine ecosystems by establishing effective fisheries management today, reducing cumulative stresses placed on marine ecosystems from both climate and non-climate stressors, planning for sea level rise impacts on coastal communities and habitats, and protecting and restoring diverse habitats that are critical for species likely to remain present in the region as well as those likely to move in. Third, China should seek opportunities to build and strengthen international institutions to ensure adequate authority to manage new fish stock distributions and inclusivity of affected countries. This requires collaboration and agreement on basic science concerning fish stocks, regional agreements on management goals for changing fish stock portfolios, establishing access and resource sharing agreements that adapt to changing conditions. Such collaboration will enhance China's capacity to adapt to climate change and its ability to participate in relevant international affairs.

(3) Advancing sustainable fishery development with nature-based solutions

Nature-based solutions restore the ecological environment with natural structure and strength, maintain the balance of the ecosystem, and reduce the cost of operation and maintenance. Therefore, in the process of promoting sustainable fisheries development, China can encourage nature-based solutions from many aspects,

including exploring relevant scientific foundations and technologies, designing clear indicators, standards and management mechanisms, and large-scale application of pilot results, supporting the development of long-term and profitable business models, etc. When developing and designing nature-based solutions, we should also refer to relevant principles and standards that are already available internationally, and formulate implementation plans and management systems that comply with China. For example, China's implementation plan should improve climate response capabilities and ecosystem functions (climate change adaptation or mitigation, support for ecosystem functions, etc.); set achievable and measurable goals based on science; reflect the nature and society synergies while protecting nature and balancing other social goals; design and implement with coastal communities and stakeholders to understand their most pressing challenges and establish joint responsibilities; ensure that project results can be quantified through strong monitoring, evaluation, and reporting framework, reflecting measurability and accountability.

(4) Strengthening the protection of fishery resources in coastal trawling-prohibited zone (TPZ)

Bottom trawling can create serious damage in marine ecosystems and can cause devastating effects on benthic organisms and ecological communities. It is the most unsustainable fishing method. In 1955, China issued an order on the prohibited fishing zone line of the Bohai Sea, the Yellow Sea, and the East China Sea. It stipulated that the prohibited fishing zone line should be composed of 17 base points. Since 1981, all locomotive bottom trawl nets are prohibited from entering the TPZ. However, despite being repeatedly banned, bottom trawling has yet not been eliminated in China's coastal waters (including those within the TPZ). According to "China Fishery Statistical Yearbook", nearly 50% of China's coastal fishing output comes from poorly selective trawling operations. Therefore, it is recommended that trawling operations should be prohibited in the TPZ, while the structure of coastal fishing operations should be adjusted to gradually reduce the amount of trawling, and increase the scale of angling and gillnet fishery to a reasonable level.

Recommendation 2: Standardize and improve management approach, strengthen the protection of fishery resources

(1) Continuously improving the implementation of TAC policy in China

Based on the experience of the nine pilots of quota control in coastal provinces (cities), strengthening the single species resources survey and total allowable catch assessment of major economic species in China coastal oceans^[22]. Explore ways to gradually expand the total catch control to all major economic species, such as small yellow croaker, striped bass, blue-spotted horse mackerel, mackerel, conger eel, *Collichthys lucidus*, and Pacific pleated squid. Explore a new model of TAC that is

suitable for China's coastal multi-species fisheries, and improve the feasibility of full implementation of the TAC in China. Based on the pilot experience, improve the catch monitoring system of coastal fisheries by integrating the supervisory power of fishery, maritime affairs and market affairs administrations, to guarantee the orderly implementation of TAC. Finally, the central and local legislation of the TAC should be strengthened to provide legal guarantee for the smooth implementation of the system nationwide.

(2) Enhancing the sustainable management of China's fish supply chain

China's aquatic products market is characterized by a wide range of producers, a wide variety of products, and a variety of marketing channels. In order to achieve the whole process of protection and management from source to table, it is suggested that China should develop unified recognition standards as soon as possible, such as Fishery Improvement Program (FIP), Aquaculture Improvement Program (AIP), Sustainable Fishery, and Sustainable Aquaculture Standards. On the basis of extensive industry and market research, absorbing the parts of the existing international standards that can be used as reference, developing standards for the characteristics of different fish species for domestic sales and export sales, and eventually publishing and promoting the application of the standards by authoritative institutions, and developing regulatory measures for the new standards on the basis of the existing regulatory system to effectively guarantee a high quality implementation. On the other hand, the traceability management of Chinese aquatic products should also be increased. In this process, we should not only learn from international advanced experience, but also make use of platforms such as GDST for international benchmarking to promote sustainable development of the industry with traceability management.

(3) Scientific and standardized recreational fisheries management to promote the sustainable and healthy development of recreational fisheries

In recent years, with policies to reduce China's active fishing vessels and marine catch and relocate fishermen, while higher incomes among China's urban and rural residents alike are shifting preferences for culture, tourism, and leisure, China's recreational fisheries have developed rapidly and become a new highlight in the modern fishing economy. The growth in recreational fishing takes advantage of China's rural revitalization strategy. However, it reveals several problems, such as poor understanding of the industry and necessary management responses, an unsound management system without needed laws and regulations, and potential impacts on the natural environment. There is a need to strengthen management institutions by demonstrating the feasibility of TAC and area-based management systems in recreational fishing, implementing science-based and standardized management systems, strengthening monitoring, catch and effort reporting, and stock assessments, and increasing resource and environmental protections.

Policymakers also should seek to cultivate the knowledge of recreational fishing practitioners, promote the sustainable development of recreational fisheries, and enable fishermen to obtain sustainable economic benefits while participating in protection of fishery resources.

(4) Exploring the fishery resource protection mode of community participation and joint management

In the past, the protection of fishery resources was mostly promoted through a top-down approach, which required high government resources and had limited management effectiveness. It is recommended to integrate community and social resources and explore a common management model for fishery resource protection. For example, give full play to the enthusiasm of the local community, organize training, publicity, and other activities to popularize in-depth knowledge of the ecological functions, environmental economic value, and other knowledge, obtain the recognition and support of the local residents, and guide the local residents to assist in ecological resources (such as the location of major fishing grounds, the distribution of important local natural resources, etc.) and cultural research, and carry out community-participated resource protection work through their production and life. Experience may be drawn from the river keeper model for public welfare litigation, for which citizen science helps protecting coastal areas and reporting violations. Another example is the introduction of local communities, enterprises, and fisheries organizations, in establishing protected area observer monitoring networks, encouraging local fishery practitioners to participate in monitoring and observation, gradually expanding the number of participants in protection work, improving the quality of protection personnel, and expanding protection projects from point to point, enlarge the scope of influence, strengthen the ecological environment supervision and management capabilities of marine protected areas, and achieve the goals of marine ecological environment and resource protection. On this basis, people with certain experience and willingness to support the work of protected areas and sustainable industrial transformation can be organized to form a network of leaders, enhancing the sense of belonging of local residents, and driving their support and participation in conservation work. In addition, under the premise of orderly management and environmental protection, it is necessary to cultivate the quality of recreational fisheries practitioners, promote the sustainable development of recreational fisheries, and enable fishermen to obtain sustainable economic benefits while participating in the protection of fishery resources.

(5) Promoting sustainable fishery development by green finance

At present, China has incorporated marine protection into the green financial system. For example, the Green Industry Catalog issued by the National Development and Reform Commission in 2019 has listed marine eco-friendly projects and technologies (seawater pollution control and marine ecosystem

restoration) as key support objects. In the context of the rapid development of global green finance, China's sustainable fishery development also needs to use green finance tools to innovate models to provide more financial incentives for naturally active fishery projects. For example, develop fishery financial institutions, issuing special loans without a mortgage for sustainable fishery production, or subsidizing fishery loan interest from financial institutions; establishing a fishery guarantee insurance system to solve the problem of insufficient guarantees for fishery producers' loans; strengthen financial institutions reputational risk supervision, by reminding them of potential reputational risks that may be caused by illegal fisheries and providing technical guidelines; learn from international protection experiences, using innovative mechanisms to absorb social capital into sustainable ocean projects, promote green financial tools, and expand funding sources.

Recommendation 3: Establish and improve the marine environmental protection pattern, promote the formation of a joint prevention and control mechanism for ecological environmental protection in watersheds - estuaries - nearshore waters

Establish a sound marine environmental protection pattern. To deepen the organization and implementation of the fight against pollution as an opportunity to further improve the central coordination, provincial responsibility, cities and counties to implement the marine ecological environmental protection mechanism, clearly refine the division of powers between the central and local, departments and departments, the clear implementation of the main responsibility of the coastal local party committees and governments and industry departments in charge of the permanent supervision of the responsibility, speed up the establishment of a comprehensive coordination mechanism of departmental coordination, and further improve the joint management, each responsible for the big environmental protection pattern, the full implementation of the marine ecological environmental protection target responsibility system and assessment system, and effective interface with the central ecological environmental protection inspectors.

Build a watershed-estuary-nearshore sea pollution prevention and control linkage mechanism. The Ministry of Ecology and Environment, the Bureau of watershed and marine areas, provincial ecological and environmental departments and other industries and fields in charge of the functions, in accordance with the principle of land and sea integration, to explore the establishment of coastal, watershed and marine areas in concert with the integrated management system, to promote estuaries, watersheds, nearshore marine environmental management of the integrated interface, to promote the formation of watersheds-estuaries-nearshore marine ecological environmental protection joint prevention and control mechanism. The implementation of the "14th Five-Year Plan" on the comprehensive management of key sea areas, to further focus on the key, and make great efforts to solve the

outstanding environmental problems and institutional shortcomings of key bays and estuaries.

Recommendation 4: Promote the synergy between marine pollution reduction, climate change, and improve the quality of marine ecosystem

Promote the synergy between marine pollution reduction and climate change. Strengthen the integrated management of land and sea pollution, further reduce the nitrogen and phosphorus pollutants from rivers into the sea, continuously reduce the eutrophication level of the coastal waters, alleviate the ecological deterioration under climate change, including marine acidification, hypoxia, red tide and green tide. Improve the quality and stability of marine ecosystems and their resilience in adapting to climate change.

Promote multi-sectoral linkage and integrated management of oxygen-deficient areas. The Ministry of Ecology and Environment will take the lead and set up a joint working group with the Ministry of Rural Affairs and Agriculture, the Ministry of Water Resources, the Ministry of Natural Resources, the Ministry of Science and Technology and other ministries and local governments to explore the introduction of a national action plan, gradually improve the institutional system, and combine the revision of laws and regulations to supplement the comprehensive control and management of oxygen-deficient areas to ensure that the comprehensive management of oxygen-deficient areas achieves long-term effectiveness. Integrate the reduction of pollutants and the comprehensive management of oxygen deficiency zones, and make the comprehensive management of oxygen deficiency zones one of the work objectives in the 14th Five-Year Plan to fight the battle of pollution prevention and control. Strengthen the integration of land and sea, as one to promote land-based emissions, mariculture, agricultural sources, atmospheric deposition and other ways of pollutant emissions reduction. Consider the negative feedback effect of climate change on pollutant emission reduction and oxygen deficiency zone management, strengthen the synergistic effect of pollution reduction and disaster prevention and climate resilience improvement.

Strengthen the protection and restoration of coastal ecosystems. Promote the synergy between marine and coastal zone ecological protection and restoration and adaptation to climate change, incorporate climate adaptation goals into marine ecological environmental protection planning; promote the construction of marine ecological reserves, implement a regulatory system for marine ecological protection red lines, carry out monitoring and evaluation of the effectiveness of protection and adaptation of coastal climate fragile ecosystems such as mangroves, sea grass beds, salt marshes, coral reefs, sand dunes and islands; carry out coastal ecosystem restoration and enhance the capacity of wetlands for water purification, carbon sequestration and sink, etc., improve the quality, stability and climate resilience of

marine ecosystems.

Recommendation 5: Improve the ecological environment monitoring system, strengthen the source of control

Improve the integration of land and sea ecological and environmental monitoring system. In accordance with the principle of land-sea integration and unified layout, optimize the construction of a full-coverage, refined marine ecological environment monitoring network, strengthen grid monitoring and dynamic real-time surveillance monitoring, online real-time monitoring of the main rivers into the sea, land-based sources into the sea outfalls, etc., to provide data support for the source control of marine pollution.

Strengthen the analysis and monitoring of mercury pollutants and traceability capacity building. It is recommended to accelerate the development of monitoring methods for the morphological analysis of mercury in the marine environment, promote the development and application of relevant standard substances, and build a perfect system of standards for the morphological analysis and evaluation of mercury; strengthen training on relevant analytical techniques and quality control technologies, enhance the capacity building of morphological analysis in operational monitoring institutions. Build a full-source database including the list and isotope "fingerprint spectrum" of relevant mercury emission point sources around China's offshore area, improve the ability of fine traceability, build a control system of pollution sources and their entry routes to the sea.

Strengthen the source control of marine plastic pollution and microplastics, improve waste management and disposal capacity. Strengthen technological innovation, improve the capacity of plastic waste reduction, harmless and resource disposal, accelerate the construction of waste recycling and management infrastructure; develop a comprehensive action plan for the prevention and control of marine litter and marine microplastics pollution at the national level, build a "source and sink" double interception of marine plastic litter control and prevention mechanism from the source, prevent plastic garbage from land-based sources from entering the sea. Efforts will be made to move forward with the pilot project to achieve zero plastic discharge in coastal areas, with upstream/downstream coordination, waste recycling infrastructure, and public awareness campaign; link zero plastic goals to broader carbon neutrality target.

Recommendation 6: Establish and improve the joint scientific and technological research mechanism to enhance the scientific knowledge of marine pollution problems

Establish and improve the joint science and technology research mechanism. Strengthen the major national science and technology projects on key sea areas to

fight the battle of pollution prevention and control of science and technology support role. Marine-related universities, institutes jointly carry out scientific and technological research to accelerate the solution of bottleneck technology and difficult issues. Strengthen marine pollution regulation and governance theory and applied technology research, increase investment in the arranging of talent teams and capacity building, actively promote the transfer of scientific and technological achievements and pilot demonstrations, focus on solving and tackling marine pollution management and protection of major issues and technical difficulties. Strengthen the application of scientific and technological innovation and the transformation of results to enhance the modernization of marine ecological and environmental governance capabilities.

Strengthen the scientific and technological support for marine pollutant control. Conduct research on key technologies and major issues such as pollution source analysis in near shore waters, total nitrogen reduction in watersheds, water quality evaluation in estuaries, and protection of key marine species, response to climate change, and marine ecological protection and restoration. Based on the three-dimensional monitoring data of mercury and plastics/microplastics in different environmental media, we will carry out research on the transport paths and environmental behavior of typical and new pollutants such as mercury, plastics/microplastics, assess the impact of pollutants and their transformation products on marine ecosystems, and improve the scientific knowledge of mercury and plastics/microplastics pollution.

Regularly implement special surveys of marine pollutant baselines. Through regular special surveys, identify the types, levels and distribution of pollutants in China's marine environment, identify the bottom line, assess the effectiveness of marine pollution control, prepare and regularly update the priority control list of new marine pollutants, optimize and improve the marine environmental quality monitoring network.

● *Recommendation 7: Enrich the development of global marine public goods and participate deeply in global marine environmental governance*

Promote China's governance experience and strive to provide global public goods. Benchmark the international level of marine ecological and environmental governance in the Great Bay, build the Guangdong-Hong Kong-Macao Greater Bay Area into a pioneering demonstration area for the protection and construction of "beautiful bays", show the world the successful cases of China's comprehensive marine ecological and environmental governance and green and high-quality development in the region, and take the lead in promoting China's marine ecological and environmental management experience in regions along the "Silk Road" and the Beibu Gulf region. We will make the enrichment and development of global public

goods an important strategic goal of China's marine ecological and environmental protection work in the 14th Five-Year Plan and even in the future period, and realize the profound transformation from expanding from the jurisdictional waters to the global oceans, and from concentrating on solving our own problems to deeply participating in global marine environmental governance. We will also actively explore the provision of global public goods in key areas such as marine litter and microplastic management, ocean hypoxia and acidification, polar environment and climate change.

Promote the development of the global marine environmental governance system toward a more just and reasonable direction. Under the guidance of the concept of marine community of destiny, we will deeply participate in global marine environmental governance actions and enhance our ability to comply with international conventions. Make full use of the UN General Assembly, the United Nations Environment Assembly, the Conference of Signatories to United Nations Convention on the Law of the Sea, the Informal Consultative Process on the Law of the Sea and other platforms to put forward China's proposal for win-win cooperation, lead the direction of the development of global marine environmental governance rules. It has promoted the building of the Blue Partnership, active participation in the international governance of the polar regions, and the promotion of marine cooperation with European countries. In the South China Sea, promote cooperation in the marine field to address climate change, marine plastic debris and other low-sensitive areas, form a benign pattern driven by overall cooperation and bilateral cooperation with sustained and tenacious efforts. Organize a high-end summit on marine ecological and environmental protection, actively play the role of home diplomacy, contribute China's wisdom, propose Chinese solutions, and demonstrate our image as a responsible power and show our responsibility.

3.5 Future ocean research roadmap for CCICED

3.5.1 Ocean in the framework of the CCICED

The SPS for Ocean Governance and Ecological Civilization, in its first phase (2017-2020), focused its efforts on the central theme and concept of an integrated ecosystem-based marine management. In the context of this work the SPS initiated work on a number of interlinked and relevant issues: integrated ocean management, marine living resources and biodiversity, marine pollution (plastics in particular), green maritime operations, renewable energy systems and mineral resource extraction. Climate change, technology, ocean economy, and gender issues were a common thread through the various themes.

The work of the SPS clearly demonstrated that now is the time for China and the

world at large to ensure that the ocean environment plays a critical role in the national and international efforts toward developing an ecological civilization and securing our own future. **It also identified that there is a continued need to focus on ocean governance issues and, in particular, to further explore into specific issues to provide a clear path forward.**

3.5.2 International framing of future CCICED ocean efforts

Over a period now there has been a rising societal awareness and understanding of the overarching global importance of the ocean system as basis for civilization. As a result, there have been and continues to be several key global efforts and initiatives which provides a clear framework for both global, regional and national efforts. These processes could and should provide a solid basis for policy recommendations framing national and international ocean actions and engagement by China. While there are many relevant ongoing overarching and all-encompassing ocean undertakings, three key initiatives are highlighted here, noting their relevance in guiding development of future ocean policies.

The UN **Sustainable Development Goals**^[23] are a universal call to action to end poverty, protect the planet and improve the lives and prospects of everyone, everywhere. The 17 Goals were adopted by all UN Member States in 2015, as part of the 2030 Agenda for Sustainable Development which set out a 15-year plan to achieve the Goals. SDG 14 aims to sustainably manage and protect marine and coastal ecosystems from pollution, as well as address the impacts of ocean acidification. Enhancing conservation and the sustainable use of ocean-based resources through international law is also aimed to help mitigate some of the challenges facing the global oceans.

The **High Level Panel for a Sustainable Ocean Economy**^[24], a unique group of world leaders from around the globe, delivered its report at the end of 2020, putting forth a transformative set of recommendations and actions to advance a sustainable ocean economy, prioritizing a healthy ocean alongside sustainable production to benefit people everywhere. The Panel emphasized that sound management of marine resources will allow the oceans to sustainably yield greater benefits for society, but also noted that while investments in protection of the marine environment and the development of ocean industries often have significant economic benefits; it will require incentives and a good framework. The report identifies five key areas of transformation:

- **Ocean Wealth**, stressing the need to ensure that the ocean can continue to sustainably produce food, energy, tourism, transport and others for future generations.
- **Ocean Health**, underscoring that the global community must act urgently to restore and protect coastal and marine ecosystems, reduce pollution and take a

precautionary approach to economic activity on the ocean floor.

- **Ocean Equity**, where a sustainable ocean economy puts people at its centre, facilitates the equitable distribution of ocean wealth and ensures equality of opportunity for all.

- **Ocean Knowledge**, in which it is stressed that we need to build literacy and skills, and share and apply knowledge of how ocean ecosystems work, and how they respond to stressors to inform decision-making and to guide the sustainable development of ocean industries.

- **Ocean Finance**, ensuring that access to finance is equitable and supports sustainability, recognising the needs of developing countries, and noting that public sector finance can help unlock private sector financing.

The UN **Decade of Ocean Science for Sustainable Development 2021–2030**^[25] (the Ocean Decade), fundamental for reaching the SDG 14, aims to provide an international framework for continued focus on research and innovation in ensuring better use of the oceans and ocean resources. The UN General Assembly mandated UNESCO's Intergovernmental Oceanographic Commission (IOC - UNESCO) to coordinate the preparations and implementation of the Ocean Decade, procuring the following societal benefits:

- **A clean Ocean** whereby sources of pollution are identified, quantified and reduced, and pollutants removed from the Ocean;

- **A healthy and resilient Ocean** whereby marine ecosystems are mapped and protected, multiple impacts (including climate change) are measured and reduced, and provision of ocean ecosystem services is maintained;

- **A predicted Ocean** whereby society has the capacity to understand current and future ocean conditions, forecast their change and impact on human wellbeing and livelihoods;

- **A safe Ocean** whereby human communities are protected from ocean hazards and where safety of operations at sea and on the coast is ensured;

- **A sustainably harvested and productive Ocean** ensuring the provision of food supply and alternative livelihoods;

- **A transparent and accessible Ocean** whereby all nations, stakeholders and citizens have access to Ocean data and information, technologies, and have the capacities to inform their decisions;

- **An inspiring and engaging ocean** where society understands and values the ocean.

3.5.3 Identifying and prioritizing ocean issues for the future

The SPS for Ocean Governance and Ecological Civilization, in the first phase (2019-2020?) of its work addressed several key aspects and provided a suite of policy recommendations in key areas. The SPS also emphasized that ocean studies

need to continue within the framework of CCICED to fully reflect the importance of the ocean to society, and in particular, to China’s national strategy of vitalizing blue economy and reaching carbon neutrality.

Subsequently, in the short time-span of its second phase (2021?) during the COVID-19 pandemic the Ocean SPS has focused on the two most pressing issues that have the greatest impact on the coastal marine ecosystems in China, namely Loss of Marine Living Resource and Biodiversity from Overfishing, and Marine Pollution. In addition, the Ocean SPS also developed a seamap for “ocean into the future” - in essence pointing out directions for the CCICED to focus its work in areas where China should pay special attention with regard to ocean issues in the future. As part of this effort the SPS team engaged with stake holders through a suite of scoping and dialogue meetings, where relevant experts from other CCICED SPSs and externally have been invited to discuss and suggest what and how ocean issues can and should be taken further in the next five-year period of CCICED.

3.5.4 Seamap for the Ocean Future

The Seamap for Future Ocean Work in the CCICED has been organised around the 7 societal needs identified as the motivation for the Ocean Decade, precluded by an identification of ocean actions may contribute to select key overarching policy areas in the current priorities of the Chinese government. **The list of topics included under the various policy areas is not exhaustive, but rather reflects topics that have been flagged during discussions with various stakeholders. The descriptions provided for the different topics are neither comprehensive nor detailed, but are rather provided to give an indication of potential directions for future policy relevant discussions.**

3.5.4.1 Ocean contributing to key overarching policy areas

POLICY AREA 1: Policy actions utilizing Ocean’s role as tool for carbon neutrality goal
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The ocean plays a fundamental role in mitigating climate change by serving as a major heat and carbon sink. Coastal ecosystems like mangroves, salt marshes, seagrass beds and tidal flats play a vital role in carbon storage and sequestration. Per unit of area, they sequester carbon faster and far more efficiently than terrestrial forests. These ecosystems are also vitally important to coastal and island communities around the world through the many important ecosystem services they provide. Developing active policy actions utilizing this knowledge will be an important contribution towards reaching China’s aim to have CO₂ emissions peak before 2030 and achieve carbon neutrality before 2060. To this end it will also be important to educate the public and raise awareness about the ocean’s role as a tool for the carbon neutrality goal.

The following CCICED Special Policy Studies are particularly relevant in the

context of this policy area: *SPS Climate, SPS Green Technology*.

POLICY AREA 2: Policy actions utilizing Ocean's role as climate regulator

Looking to *quantify* the effect of measures' contribution to Paris agreement, could be a useful contribution to lay the foundation for future policy actions, for example looking at the effects of specific Marine Protected Areas (MPA) as case studies. For this purpose, it could be relevant to use the approach taken by the High Level Panel for a Sustainable Ocean Economy in their report *The Ocean as a Solution to Climate Change: Five Opportunities for Action*^[26] as a starting point for similar approach in selected MPAs in China. The five opportunities in this case being ocean-based renewable energy (primarily wind); ocean-based transport ("green shipping"); coastal and marine ecosystems; fisheries, aquaculture and dietary shifts (from meat to seafood); and carbon storage in seabed.

In conducting such a case-study, it could be relevant to consider what and how the five identified opportunities above can be implemented domestically and how this can give China an opportunity to help with equity in developing countries.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Climate, SPS Green Technology, SPS Biodiversity*.

3.5.4.2 A Clean ocean

Coastal marine pollution is one of the main environmental challenges of recent decades, so its prevention and control is a key objective. Even though the oceans are vast and seemingly able to digest any amount of input, the cumulative effect of various types of pollution has tangible effects on the marine environment. The most challenging ocean pollutants include agricultural fertilizers; untreated waste water; invasive species; and micro- and macro-plastics. The relationship between upstream pressures and downstream effects highlights the importance of coordinating efforts on the management of freshwater and oceans. A "Source to Sea Approach" is crucial to addressing land-based activities and pollution.

POLICY AREA 3: Policy actions to reduce terrestrial transportation of pollutants to the sea - connecting land, river and ocean management to support a clean ocean

Over the past two centuries, with the increase of global population, human needs are also increasing, in order to meet the requirements of necessities of life, industry and agriculture are developing rapidly, and a large number of industrial, agricultural wastes and domestic garbage are discharged into the environment. Although production and emissions are largely land-based, the marine environment is the ultimate recipient of man-made pollution. In addition to the well-known problem of eutrophication caused by excessive input of terrestrial nutrients, the growing global pollution of plastics is another example of this land sea interaction.

Developing active policy actions to counter these ocean related challenges will be

important to safeguard both human health and ocean health.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS River-basin*, *SPS Green Urbanization*, *SPS Green transformation*.

POLICY AREA 4: Global control of plastic and micro-plastic pollution

Micro- and nanoplastics are persistent in the marine ecosystem and due to their micron sized particle nature, these fragments are mistaken as food and ingested by a range of marine biota and ultimately get transferred to higher trophic levels. At the same time, a large number of studies have shown that marine plastic and microplastic pollution directly or indirectly affects the safety of marine biodiversity, fisheries resources, tourism and shipping. Marine litter and microplastic pollution have become one of the world's high-level environmental issues with far-reaching impact. It involves the management of the marine ecological environment, as well as the economic behavior of terrestrial plastics and waste management. Marine litter and microplastics not only come from land-based waste management systems and riverine input, but also come from a wide range of marine sources include discarded fishing gear, mariculture, and surreptitious discharge at sea.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS River-basin*, *SPS Green Urbanization*, *SPS Green transformation*.

POLICY AREA 5: Policy actions to combat accumulation of legacy infrastructure and ghost gear

Decommissioned and abandoned oil and gas infrastructure (legacy infrastructure) can pose threats to local environment, as can other upcoming ocean infrastructures such as windfarms, seabed mining etc. Strong regulatory foundation for end-of-life handling of such infrastructure is required to minimize impacts on the ocean environment and ecosystems. Derelict fishing gear ("ghost gear") is any discarded, lost, or abandoned, fishing gear in the marine environment. This gear continues to fish and trap animals, entangle and potentially kill marine life and smother habitat. Derelict fishing gear is one of the main types of debris impacting the marine environment today. Developing active policy actions to minimize potential negative impacts of legacy activities on the ocean environment will be important.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Green Finance*, *SPS BRI*.

3.5.4.3 A healthy and resilient Ocean

For oceans, seas and marine resources to successfully contribute to human well-being, ecosystem integrity, with properly functioning biogeochemical and physical processes, is required. Marine ecosystem degradation has greatly accelerated during the last five decades due to the multitude of stressors affecting the ocean. All nations will benefit in a healthy and resilient ocean and by preserving its capacity to deliver

food, income, support transportation and many other elements of sustainable development.

POLICY AREA 6: Policy actions promoting a Blue Economy supporting a healthy ocean

Both ships and ports contribute heavily to CO₂ emissions and to the larger climate issue, while they also add on additional pollution challenges. Pollution from ships and platforms include release of oil, fuel, plastic, and human waste. Ships also cause noise pollution, disrupting the balance of life for marine animals. The fisheries have the potential to impact the marine environment in several ways in addition to pollution, including overfishing, habitat destruction and by-catch. Both shipping and the fishery industry have the potential to be pathways for the introduction of non-native species. Ports contribute to local water pollution, including widespread contamination of sediments. The emerging seabed mining industry has the potential to become a major source of pollution. Sulfide deposits created when these substances are drilled can have environmental impacts that are not fully understood. Material leaks and corrosion of equipment only exacerbate the problem.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Green Technology*, *SPS BRI*, *SPS Green Finance*.

POLICY AREA 7: Policy actions safeguarding the ocean's continued/growing role as major source of food

The ocean plays an important role in global food provision and has the potential to play a much more significant role. The potential for increased production and consumption of food from the sea will depend on physical factors, policy, technology and institutions. Ocean, climate and biodiversity are connected issues where core issue is food, - the one issue cannot be seen independent of the others. Opportunities lie in promoting policies that take these aspects into account both nationally and internationally. It seems particularly relevant to consider how one within this policy area could look at opportunities to build policies that would encourage safeguarding the ocean's food value in the context of investment initiatives in the international sphere, such as along the Ocean BRI.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Biodiversity*.

POLICY AREA 8: Policy actions to enhance and build the foundation for integrated approach to ocean management

Integrated Ocean Management (IOM) is considered an appropriate approach for ensuring protection and the sustainable use of coasts and oceans, taking sufficiently into account knowledge and the particularities of the ecosystems to be managed. A fully integrated ocean management strikes the balance between environment, economy and society, and between short-term economic gains and long-term prosperity of the ecosystem services.

The following CCICED Special Policy Studies are particularly relevant in the

context of this policy area: *SPS Biodiversity, SPS River-basin*.

POLICY AREA 9: Policy actions to contribute to a sustained and healthy global ocean system into the future

While there is general agreement in international policy that an ecosystem approach is needed to improve ocean governance, its application in practice is still limited. This is due in large part to the considerable practical difficulties of implementation, including the availability of suitable

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS BRI*.

POLICY AREA 10: Policy actions looking at how to account for the value of a healthy ocean

The ocean and coastal ecosystems are extremely important in terms of ecosystem services and economic values. Accounting for these values is one approach to tally the costs and savings associated with decisions we take that affect ocean health. There is a need to balance a number of components, such as market and non-market values, living and non-living resources and uses now and in the future.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Green Finance, SPS Green Supply Chain*.

3.5.4.4 A Predicted Ocean

Understanding the relationships between the ocean systems and human activities that take place in or impact on it, giving us a better foundation for predicting its future provide important knowledge to inform decisions and actions that shape ocean sustainability. Sustained ocean observations are vital to enable a predicted ocean. New technologies are required to enable ocean observation under various ocean environment such as the deep ocean and the ice zone. Such information is increasingly needed by nations and the ocean business community operating within or beyond national jurisdictions.

POLICY AREA 11: Policy actions to maintain/increase China's contribution to ocean knowledge supporting ocean management

The vast volume of the ocean and its complex coastlines are neither fully observed nor adequately understood. In particular, the deep sea is a frontier of ocean sciences. Sustained and systematic ocean observations are needed to document ocean change, initialize ocean system models and provide critical information for improved ocean understanding, and through this the basis for managing the ocean for the future.

3.5.4.5 A Safe Ocean

The rush for coastal recreation and economic expansion in the maritime domain has increased access to the sea to a multitude of users, producing newly built infrastructures that are increasingly vulnerable to ocean extreme events. Some of the hazards include movement of barrier islands, sea level rise, hurricanes, storms, earthquakes, flooding, erosion, pollution and human development along the coast.

They can have lasting and damaging effects on the coastal landscape, causing long-term coastal erosion, and on marine ecosystems. There is a pressing need to focus on implementing adaptation measures to strengthen the resilience of vulnerable coastal communities, their infrastructure and service-providing ecosystems.

POLICY AREA 12: Policy actions to reduce ocean hazards

Reducing the risks from tsunamis, storm surges, harmful algal blooms and other coastal hazards need to focus on implementing adaptation measures to strengthen the resilience of vulnerable coastal communities, their infrastructure and service-providing ecosystems.

3.5.4.6 A sustainably harvested and productive Ocean

The ocean is a vital source of nourishment, supporting directly the livelihood of about 500 million people. Ocean economies are among the most rapidly growing and promising in the world, providing benefits to many sectors of great economic value, such as fisheries, biotechnologies, energy production, tourism and transport, and many others. Safe and sustainable economic operations in the ocean will help policymakers and stakeholders in implementing a truly sustainable blue economy.

POLICY AREA 13: Policy actions to build sustainability in the domestic and distant water fisheries

Overfishing results in the decrease of biodiversity. Decline of top biological communities (e.g., fish) results in an ecological degradation. Healthy fishery resources will be an important indicator for the health of marine ecosystems, and the conditions supporting the healthy structure of fishery resources include moderate fishing intensity, good larval and juvenile habitats etc. In China, ecosystem-based fisheries management has appeared in a series of systems and measures, such as the summer moratorium, "dual control" of the number and power of fishing boats, enhancement release, sea ranch construction, "zero growth" in marine catch fisheries and "total output control", as well as the construction of aquatic genetic resources reserves, etc.

The following CCICED Special Policy Studies are particularly relevant in the context of this policy area: *SPS Green Finance, SPS Green Supply Chain, SPS Climate*.

3.5.4.7 A transparent and accessible Ocean

A healthy, safe, sustainable ocean very much depends on global capacity building and resource-sharing between countries. There is an enormous need for more ocean information at the scientific, governmental, private sectors, and public levels. New technologies and the digital revolution are transforming the ocean sciences.

POLICY AREA 14: Policy actions to promote data access and use

Data and information play an essential role in connecting knowledge generators and end users, but many challenges and disparities still exist in the access, sharing and use of ocean data across regions.

3.5.4.8 An inspiring and engaging ocean

Open access to ocean information and ocean literacy for all should capacitate all

citizens and stakeholders to have a more responsible and informed behaviour towards the ocean and its resources, be key in raising ocean awareness and promote better solutions.

POLICY AREA 15: Policy actions to promote the public as Ocean Ambassadors

Empowering ordinary people to understand the role of the ocean in our society and thereby themselves becoming ambassadors bringing knowledge out to others, will be important in order to raise general awareness as support for implementing actions.

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Part II

Green Urbanization and Environmental Improvement

Chapter 4

Green Reshaping of China's Urbanization in the Context of Global Carbon Neutrality

4.1 Introduction

The essence of global carbon neutrality is the most comprehensive and profound transformation of the development paradigm since the industrial revolution. The fundamental purpose of economic development is to improve people's well-being, and urbanization is the spatial manifestation of economic development. Therefore, the fundamental reason for the emergence of cities and towns is to promote economic development, thereby improving people's well-being. Different economic activities require different forms of spatial distribution. The large-scale urbanization of the population is a phenomenon of the industrial age. In the ages of agriculture, industry, and the current era of green development under Internet conditions, due to changes in development content, there are different demands for space, and the spatial form of economic activities has undergone substantial changes.

Global carbon neutrality is essentially a change in development paradigm, which has different spatial meanings. Therefore, we cannot think about urbanization in the era of green development in the perspective of traditional industrial era. The existing urbanization model, whether it is the content carried by the city or the organization of the city, is to a large extent the product of the traditional industrial era. When the development model that is the foundation of urbanization undergoes fundamental changes, the corresponding urbanization model will also undergo fundamental changes. Therefore, to think about China's future green urbanization model, we must go beyond the thinking of urbanization in the traditional industrial era.

This report studies the green reshaping of China's urbanization in the context of global carbon neutrality. The structure of the report is as follows: The first part

reveals the profound implications of carbon neutrality for the transformation of China's economic development model and urbanization. In the second part, in the new background of global carbon neutrality, further thinking about China's green urbanization strategy proposed in the previous study of this SPS. The third part focuses on the carbon peaking and carbon neutrality situation and challenges faced by Chinese cities. In the fourth to sixth parts, we discuss the "three major tasks" of China's green urbanization in turn, namely the reshaping (or urban renewal) of existing cities and towns, the green urbanization of newly-increased urban populations, and the background of rural-urban coordination. Rural revitalization. In the seventh part, we reveal how China's urbanization could shift from a GDP-oriented urbanization model to a well-being-oriented urbanization model. The eighth part is policy recommendations.

4.2 The new background of green urbanization: global carbon neutrality

4.2.1 The end of the traditional industrial era, the opening of a new era of development

On September 22, 2020, President Xi Jinping announced at the 75th United Nations General Assembly that China strives to reach the peak of carbon dioxide emissions by 2030 and strives to achieve carbon neutrality by 2060. This ambitious goal is China's strategic choice under the new development stage, new development concept, and new development pattern. It is the inevitable requirement for achieving high-quality development, deepening supply-side structural reforms, realizing modernization of "harmonious symbiosis of man and nature", and building the shared future of mankind community. If the carbon peak goal could be achieved under the traditional industrialization model, then the carbon neutral goal needs to be achieved through fundamental changes in production methods and lifestyles under the new development concept. The goal of carbon neutrality is certainly an arduous challenge, but it is also an opportunity for China to start China's next "40-year development miracle" in a new stage of development with new development concepts. If the industrial revolution started the era in which the West is leading the world, green development, marked by carbon neutrality and driven by the transformation of production and lifestyle, has provided the possibility for China to make contribution for global sustainable development.

According to incomplete statistics, more than 130 countries have pledged carbon neutrality or net zero carbon emissions in various forms. These countries account for 75% of global emissions and economy. More importantly, 70% of these are developing countries. This means that the so-called environmental inverted U-curve,

which has been regarded as the standard in the past, no longer becomes the law of economic development. A country at the low development level could achieve a low-carbon takeoff. This contrasts sharply with how countries share the burden of emission reduction in 2009. This dramatic change has occurred because of the deepening global climate change crisis. More importantly, these countries have seen the possibility of carbon neutrality and the huge opportunities behind it. From Copenhagen to the present, the cost of new energy has fallen sharply in the past 10 years, and it has become competitive energy that can compete with coal-fired power. Other green technologies are also emerging in large numbers. In the era of carbon neutrality, whoever acts early is likely to win the opportunity. Those countries that do not participate in global carbon neutrality will become losers in global competition.

As the world's largest developing country and the world's second largest economy, China's announcement of achieving carbon neutrality by 2060 has greatly encouraged global confidence in addressing climate change and has strongly promoted global consensus and actions on carbon neutrality.

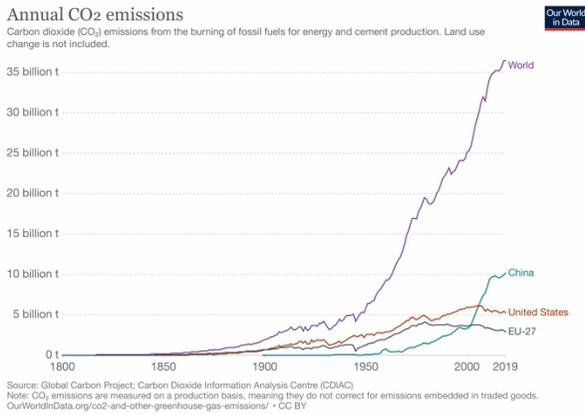


Figure 4-1 Annual CO₂ Emissions in the major economies

4.2.2 Green urbanization under the "three new" pattern

To formulate China's carbon peak and carbon neutral strategy, it is necessary to understand the background and deep meaning of China's proposed goal from the height of the new development stage, new development concept and new development pattern. If we use the traditional industrial thinking in the past to understand the goal of carbon neutrality, we may only see challenges and burdens; if we look at carbon neutrality from the perspective of new development stages, new development concepts, and new development patterns, we will see more a large number of new development opportunities.

First, it is proposed that carbon neutrality is not only due to changes in China's development stage. The development stage does not necessarily mean high emission reduction commitments. For example, the United States under Trump administration not only did not propose carbon neutrality, but also withdrew from the "Paris Agreement" or even didn't recognize the existence of climate change issues. It believed in the outdated development concepts of the traditional fossil energy era.

Second, it is not because of the so-called international pressure, but because carbon neutrality is in its own strategic interests. Emission reduction has long been a voluntary action in China, rather than the result of international pressure. Moreover, the international community generally did not expect China to proactively announce the 2060 carbon neutrality target. If China does not strategically agree that 2060 carbon neutrality is in China's national interests, no amount of international pressure will make China make such a commitment.

Third, the proposal of the carbon neutral target is basically a change in China's development philosophy. These concepts are embodied in the series of speeches by President Xi and the successful practice of China: "Green is treasure" (2013 Nazarbayev University speech), Paris Climate Conference 2015 (two "win-win"), UN General Debate (2020), Climate Ambition Summit (2020), etc. For example, in his speech at the Paris Climate Conference in 2015, President Xi Jinping put forward two "win-win" viewpoints. One is that green recovery can achieve a win-win situation between economic development and addressing climate change; the second is that addressing climate change can achieve a win-win situation among countries, and countries can share opportunities instead of zero-sum games.

Fourth, China has a clear understanding of the formidable challenge of carbon neutrality. Carbon neutrality is an inevitable choice to solve the unsustainable crisis of the traditional development model. It is not a question of whether or not it is necessary, but a question of how to achieve it. Regarding the challenge of carbon neutrality, President Xi Jinping pointed out when the United Nations announced China's 2060 carbon neutrality goal, "This epidemic has inspired us that mankind needs a self-revolution to accelerate the formation of green development methods and lifestyles, and build ecological civilization and beauty. Earth".

4.2.3 The development model as the foundation of urbanization has undergone profound changes

Carbon neutrality means a fundamental shift in the development paradigm. This means that the development model that is the foundation of urbanization is undergoing the most profound transformation since the Industrial Revolution. This green transformation is substantially different from the transformation of the development mode that we have been talking about since the 1980s. In the past, it was more about technological progress and industrial upgrading, and did not involve

changes in development concepts, values, consumption patterns, etc. However, only relying on technological progress and industrial upgrading can solve the emission reduction and problems of individual countries, but it cannot solve the problem of global emission reduction alone.

The essential difference between carbon peak and carbon neutrality has different requirements for changing production methods and lifestyles. The carbon peak is more of a response to our economic transformation in the traditional sense of the past. Carbon neutrality corresponds to a fundamental change in the mode of development, a comprehensive and profound transformation of production and lifestyles after the industrial revolution. Carbon peaking is a natural result that usually occurs in the process of economic development under the traditional industrialization model. If we want to achieve an earlier and lower carbon peak, we only need to increase emissions reduction efforts. However, achieving the 2060 carbon neutral goal means that the foundation of the existing economic operation will be fundamentally changed, and a fundamental transformation of production methods and lifestyles is required, which is a self-revolution.

As far as achieving the carbon peak goal is concerned, it does not necessarily require profound changes in production methods and lifestyles. Under the traditional industrialization model, after a normal economy has experienced economic take-off and entered a mature period, its carbon peak will usually peak in the BAU scenario and then stabilize at a high level. Therefore, mere carbon peaking does not necessarily require changes in production methods and lifestyles. In the industrialized countries that peaked in the 1980s, such as Germany, Hungary, France, and the United Kingdom, peaking carbon was a natural process, and there was no requirement to reduce emissions. After carbon emissions peak, if factors such as technological progress and overseas transfer of industries exceed the impact of domestic production expansion on carbon emissions, carbon emissions will decline to a certain extent. If a country adopts aggressive emission reduction measures, including clean energy, new technologies, etc., the decline will increase, and the peak will appear earlier and lower. However, this decline has its limits, and it is impossible to naturally decline to the level of carbon neutrality.

However, for carbon neutrality, it requires not only a change in production methods, but also a profound change in lifestyle. If the production method is changed, that is, a greener production method is used to reduce the carbon intensity of a unit product, the carbon emissions produced by producing the same GDP will be reduced. However, if the reduction in carbon intensity cannot keep up with the economic expansion, the transformation of production methods may not necessarily reduce total carbon emissions, let alone achieve net zero emissions. Therefore, the change of lifestyle, that is, the change of consumption content, becomes a must. When people's development concepts change, instead of pursuing material

consumption expansion as the goal, but turning to the satisfaction of people's overall needs, it will bring about a profound change in the content of development, and thus economic growth and carbon emissions will be largely decoupled, and finally achieve a high-level modernization under carbon neutrality.

4.3 Overall strategy of green urbanization in the context of global carbon neutrality

Global carbon neutrality is to establish a new development paradigm, and the new development paradigm will inevitably require a new urbanization model. The existing urbanization model, whether it is the economic content carried by the city or the city's own organization, is largely a product of the traditional industrial era. Jumping out of the traditional industrialization thinking framework and promoting green urbanization based on ecological civilization is the fundamental way to achieve sustainable urban development.

4.3.1 Strategic tasks of green urbanization

"Green urbanization" from the perspective of ecological civilization is not "building parks in existing cities", but "building cities in (natural) parks", which means creating without destroying the ecological environment and making full use of natural forces to create a prosperous urban economy. This means a profound change in the concept of development, the content carried by the city, the organizational logic of the city and its regional economic meaning. To reshape China's urbanization based on ecological civilization, it should be promoted around the "three major tasks" and the "two strategies".

"Three major tasks"——

The first is to reshape the existing cities in accordance with the new production and lifestyle requirements of the digital green era, including the creation of a new green economy and the green transformation of urban infrastructure; the second is to realize the urbanization of the new urban population in the future in a green way; The third is to re-understand and position the function of the countryside to realize the coordinated development of urban and rural areas.

"Two strategies"——

The first is the green transformation of urban clusters that account for more than 90%, 70%, and 30% of the national GDP, population, and land area, respectively; the second is county level urbanization. In addition to the concentration of the population in the county town, a large number of people will be urbanized on the spot in the form of characteristic towns to take advantage of the benefits of towns and villages at the same time. In addition, cities and towns should transform from a functional city to a pro-natural city model, and no longer regard nature as an

externality, but introduce the value of nature into urban planning and decision-making.

4.3.2 The key conditions that determine urbanization are undergoing profound changes

As human society enters the digital green era from the traditional industrial era, the three key factors that determine the urbanization model are all undergoing drastic changes. These changes are particularly dramatic in China. This means that China's future urbanization model will undergo profound changes.

First, the dramatic increase in transaction efficiency. With the advent of mobile Internet technology, the digital age, and the rapid transportation system, the traditional concept of time and space is undergoing major changes. Many economic activities no longer need to rely on the large-scale physical concentration of production factors and markets as in the industrial era. It can be done in a city or a fixed location.

Secondly, changes in technical conditions have enabled many public facilities and services that originally relied on the concentration of physical space to be provided in a decentralized manner. For example, heating, sewage treatment, distributed energy, garbage disposal, etc., under many conditions, can shift from centralized supply to distributed supply. This means that in some small towns and villages, a high-quality life can also be achieved at low cost. In the digital age, many government services can also be provided through digital platforms.

Third, and more importantly, changes in development content. As discussed earlier, the traditional industrialization model will inevitably lead to an unsustainable environment. One of the important contents of the green urbanization transformation is to change the content of supply. Among them, meeting people's new definition of "good life" a large number of emerging service needs is the direction of green development, and it is also the new economic foundation of green urbanization. Although urban clusters will still be very important, a lot of content no longer needs to be concentrated on a large scale like industrial production. In particular, many environments and traditional cultures are distributed in villages and small towns. Therefore, many new economic activities may appear in the countryside, and the relationship between the city and the countryside will be redefined.

4.3.3 The meaning of green urbanization

It needs to be pointed out that although the above three changes have caused many economic activities to no longer rely on the physical concentration of production factors as in the past, this does not necessarily mean "the decline of the city", nor does it mean that a large amount of economic activities will leave the city, but it means that both the traditional urban and rural concepts need to be redefined

to form a new source of growth.

—The economic activities carried by cities have undergone profound changes. People's demand for a "good life" is not just material wealth. With the escalation of people's needs, the content of economic development has expanded from traditional material wealth to more emerging services. Many economic activities that do not exist under the traditional definition of development will appear in large numbers. For example, relying on the advantages of population concentration, existing cities can develop cultural creativity and experience economy, thereby realizing the transformation of development content; the countryside is no longer just a place for the production of agricultural products, but a new type of geographic space that can accommodate many new off-farm economic activities, including experience, ecological sightseeing, education, health, etc.

—The city's own organization and geographic spatial layout will change. For example, the way of food, clothing, housing, transportation will be greatly changed; the original centralized energy supply may be partially replaced by distributed energy. Urban infrastructure will be more based on ecological principles, and so on.

The above changes have the effect of promoting the further agglomeration of economic activities and the effect of promoting the dispersion of economic activities. Whether the geographical distribution of urbanization in the future will be agglomeration or decentralization depends on which of the above three determinants dominates.

Next, we first analyze the problems of orderly urban carbon peaking and carbon neutrality in the context of carbon neutrality. Then, in this context, we will analyze the "three major tasks" proposed in the green urbanization strategy in turn, that is, the reshaping or renewal of existing cities and towns, the green urbanization of the new urban population in the future, and the rural revitalization in the context of urban-rural coordination.

4.4 Carbon peak and carbon neutrality in Cities

Carbon neutrality means a fundamental transformation of the development paradigm. Carbon neutrality becomes a global consensus and action, which can promote a city's thorough green transformation in accordance with the requirements of the development paradigm. In terms of spatial scope, cities are the centers of economic activity and the main body of greenhouse gas emissions. Cities often assume the functions of a country's political, economic, cultural, social and other activities center, and are also the main energy consumption unit of a country. Cities are responsible for 75% of a country's energy consumption and 80% of greenhouse gas emissions.

After President Xi Jinping announced at the United Nations General Assembly

on September 22, 2020 that the 2030 carbon peak and the 2060 carbon neutral target, domestic cities have accelerated their pace of reducing emissions. Since China is a vast country with uneven development, different cities have different levels of development, economic structure, and resource endowments. How to reach peaks and neutralize them in an orderly manner has become a very important issue.

4.4.1 Current status of carbon peaks in Chinese cities

Although China's new "dual carbon" was proposed in 2020, China has been unanimously adopting strong measures to reduce emissions. Since 2010, the National Development and Reform Commission of China has successively carried out three batches of national low-carbon provinces and cities in 2010, 2012, and 2017 in 6 provinces and 76 cities, aiming to explore the first to achieve low carbon emissions in different regions. Carbon development model and effective path. The national low-carbon pilot cities focus on achieving peak carbon emissions targets, forcing low-carbon development and transformation, increasing the promotion and application of low-carbon technologies and products, and promoting low-carbon development in key areas such as industry, construction, and transportation, and low-carbon development model. This work mainly preceded China's "dual carbon" target in September 2020.

Most of the cities participating in the pilot have proposed targets for the peak year of carbon dioxide emissions. According to the relevant implementation plans or plans for the control of greenhouse gas emissions issued by 9 provinces (autonomous regions and municipalities) including Beijing, Tianjin, Shanxi, Shandong, Hainan, Chongqing, Yunnan, Gansu, and Xinjiang during the "13th Five-Year Plan" period, the proposal A clear peak time for overall carbon emissions. in--
Beijing: Propose 2020 and reach the peak as soon as possible.

Tianjin: It is proposed to reach its peak around 2025.

Yunnan: It is proposed to reach its peak around 2025.

Shandong: It is proposed to reach its peak around 2027.

Shanghai: In the "Shanghai City Master Plan (2017-2035)", it is proposed that carbon emissions will peak before 2025.

Although some provinces (autonomous regions and municipalities) have not proposed the peak time for the province as a whole, they have proposed peak targets for key regions, pilot cities or key industries according to their respective provinces, and are conducting research on carbon emissions peaking, and make plan.

Jiangsu: Proposed to support Suzhou and Zhenjiang's optimized development areas to achieve the first peak of carbon emissions by 2020.

Guangdong: It is proposed that developed cities such as Guangzhou and Shenzhen strive to reach their peak in 2020.

Jiangxi: It is proposed to strive to achieve the first peak of some heavy chemical

industries around 2020.

Sichuan: It is proposed that some heavy chemical industries will achieve their peak carbon emissions at the same time as the same industries across the country around 2020.

In addition, most low-carbon pilot cities have also put forward specific peak targets in their respective pilot programs.

After the dual-carbon target, especially the Central Economic Work Conference at the end of 2020 proposed that "dual carbon" should be included in the eight key tasks of 2021, and the ninth meeting of the Central Finance and Economics Committee in March 2021 proposed that "dual carbon" work should be included in the overall layout of civilized construction, local governments have stepped up efforts to implement the central deployment, and the "dual-carbon" work has entered a new stage.

4.4.2 Urban "Dual Carbon" Goal: How to proceed in an orderly manner

The so-called "the nation acts as a whole" is that the country sets emission reduction targets, and then, in order to minimize the cost of emission reduction, various regions coordinate actions to achieve the national targets in the most efficient way according to their own conditions. If every region keeps the same pace as the whole country, it is certainly not the most efficient approach. It is necessary to formulate a national carbon neutral roadmap based on the 30-60 target and proceed in an orderly manner; it is necessary to prevent some cities from not taking effective actions to reduce emissions, but also to prevent some cities from advancing blindly.

In order to achieve the national carbon neutrality goal, every city is not required to reduce emissions to the same degree. In order to achieve the national emission reduction targets most efficiently, some places may reduce emissions more and others less, and finally achieve carbon peaks and carbon neutrality one step at a time.

City's carbon emissions:

Carbon emissions on the production end: $E_y = e_y Y$

Carbon emissions on consumption end: $E_x = e_x X$

Three possibilities: (1) $E_x > E_y$; (2) $E_x = E_y$; (3) $E_x < E_y$

Consumption X=production Y+ Net Import I

Assume that two cities form such a system of industrial division of labor:

——City A: Produce low-carbon products, then sell low-carbon products to city B, and buy high-carbon products (or electricity) from city B for consumption.

——City B: Produce high-carbon products (or provide electricity), sell high-carbon products (or electricity) to city A, and buy low-carbon products from city A.

At this time, from the perspective of production, city A's economic growth and carbon emissions have achieved a strong decoupling, and city B is a high-carbon economy.

However, from the perspective of consumption, there is no difference in carbon emissions between city A and city B. Moreover, usually because city A has higher income and higher consumption, its consumption end carbon emissions are higher than that of city B.

Obviously, the strong decoupling of city A (economic growth + decrease in absolute emissions) is at the cost of weak decoupling of city B (economic growth + carbon emission intensity declines, but total emissions still increase). The decoupling model of City A cannot solve the overall problem.

Therefore, we cannot say that the strongly decoupled city A must have made a greater contribution to the national carbon neutrality, while the weakly decoupled city B has made less contribution to the national carbon neutrality. We cannot even say that those cities that continue to increase their carbon emissions due to their industrial structure contribute less effort to the country's carbon neutrality.

4.4.3 How far is urban emission reduction from green transformation

Shan^[1] studied the economic growth and carbon emissions of 294 prefecture-level cities in China. These cities cover 55% of China's land space, 94% of the population, and most of the GDP and emissions. The study divided these cities into four types, namely, strong decoupling, weak decoupling, coupling, and negative decoupling. Strong decoupling means absolute reduction in carbon emissions and economic growth. Weak decoupling means that carbon emission intensity decreases, but total emissions continue to grow, and the economy also grows.

The results show that at present, 11% of cities have achieved strong decoupling, that is, while economic growth, carbon emissions have absolutely dropped. Although the carbon emission intensity of 65.6% of the cities has declined, their total emissions have increased. In the remaining cities, carbon intensity or total emissions are rising.

Note: Results show that 11% of the cities have negative emission growth between 2005 and 2015, whereas their economy continued to grow (i.e., strong decoupling). A total of 65.6% of cities exhibit slower growth of emissions than economic growth (i.e., weak decoupling).

Although "decoupling or not" is an important criterion for evaluating a city's emission reduction work, we cannot simply use "decoupling or not" to evaluate the quality of a city's emission reduction work. We also need to look at how these cities are decoupled and its impact. Those 11% strong decoupling cities do not necessarily mean that they have made a greater contribution to China's emission reduction endeavor, and other non-decoupling cities do not necessarily "drag" China's emission reduction endeavor. It is still needed to further examine the reasons for the absolute decrease in carbon emissions. For cities with absolute decline in carbon emissions, further investigations are needed at this time:



Figure 4-2 Decoupling of cities economic growth from their emissions (2005-2015)^[1]

First, does the decrease in emissions at the production end mean that the life-cycle emissions at the consumption end also decrease at the same time. If not, the decline in carbon emissions is largely based on high emissions in other regions, and the model cannot be extended to other places, which will greatly reduce the significance of national emission reduction and demonstration. According to Shan^[1], during the period 2010-2015, the proportion of manufacturing in those cities that are strongly decoupled has dropped, reducing their carbon emissions by 26.2%. However, industrial transfer does not necessarily mean that the proportion of manufacturing will decline. It may be more about upgrading from the low-end of the manufacturing industry to the high-end and transferring high-emission low-end industries to other places. Therefore, these need further research.

Second, if the emissions from the consumer side also decrease at the same time, has the effect on the ecological environment and resource consumption seen in the entire life cycle of the consumer side also improved? Due to data and practical

reasons, we are unable to conduct a detailed study on this yet.

Judging from macro data, most of these strongly decoupled cities are in the high-income stage, their production structure is upgraded, and their industries are at the high end of the division of labor chain, that is, at the two ends of the so-called smile curve. As a result, it is not surprising that its carbon emissions have fallen and economic growth occur at the same time.

If we examine the consumption side of these strongly decoupled cities, we can find that the consumption structure of these strongly decoupled cities is not significantly different from other cities that are at the same income level but are not strongly decoupled. In other words, they have not achieved the decoupling of economic growth and carbon emissions on the consumption side, and the strong decoupling on the production side may be achieved more due to the division of labor.

According to the research on carbon emissions from household consumption in China^[2], household consumption carbon emissions are an important part of global carbon emissions and have become a new growth point for carbon emissions, while the direct and indirect energy consumption of Chinese households and the share of carbon emissions have shown an obvious trend of gradual expansion.

According to the research of Liu Shijin's team^[3], it can be seen from Figure XX that there are obvious differences in the Gross Final Product (GFP) structure between provinces and cities in different development stages, and at the same time, it shows obvious regularity with the changes in the development stage.

This brings up a question: Although a city can achieve the decoupling of economic growth and carbon emissions, what kind of decoupling is of overall significance? What can be called a true low-carbon city? Those cities with high income levels can rely on their own advantages to upgrade their industries to low-carbon and high value-added value chains, or transfer low-end and high-polluting industries to other regions to reduce their own carbon emissions and achieve economic growth. At the same time, purchase consumer goods from other regions to maintain high emissions on the consumer side.

4.4.4 The public's recognition of "dual carbon": residents of some high-carbon cities are more supportive of "dual carbon"

Public opinion identification represents the positive identification of local netizens on related topics. Through semantic analysis of netizens' comment texts based on machine learning, emotional tendencies are identified, and calculated from the difference between the number and proportion of positive and negative emotions .

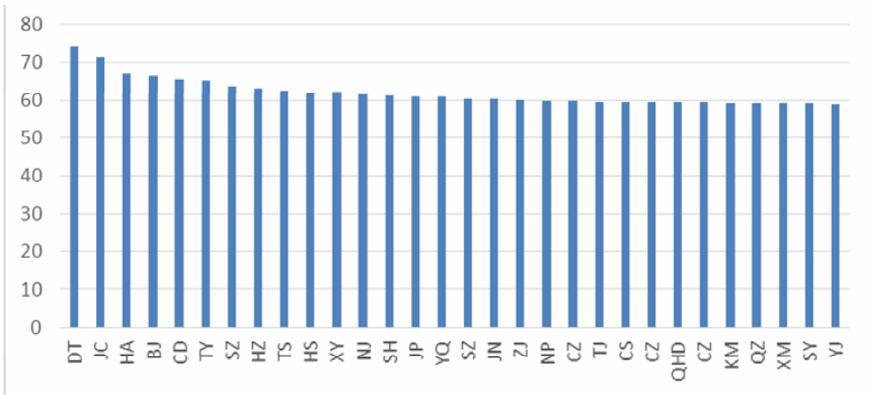


Figure 4-3 Public Recognition of “Dual Carbon” based on big data analysis in Cities

Note: This Figure shows the 30 cities with the highest degree of recognition of "dual carbon" characterized by "public opinion recognition". The purpose of this research is to reveal the reasons behind the “dual-carbon” identification and the policy implications. In order to avoid unnecessary “ranking” problems, the city names are omitted.

Data source: RIEco joint research project

Figure 4-6 shows that the national recognition of dual-carbon work is relatively high. It is generally believed that the masses in the traditional coal-based cities, due to their high dependence on coal, should have relatively low recognition of "dual carbon". However, what is inconsistent with people's intuition is that big data shows that in many cities that rely heavily on coal, their residents are ranked in the forefront of the country's recognition of the "dual carbon" goal. The reason for this may be the air pollution caused by coal, the negative image of the city, and most residents do not directly benefit from these industries. Compared with residents, the government relies more on the taxation of these industries.

In the next part, we analyze in turn the three main tasks facing China's green urbanization proposed in the previous research of our project. The first is how to reshape the urbanization formed in the traditional industrial era in accordance with the requirements of ecological civilization. This can be understood as the ongoing urban renewal. The second is how to realize urbanization in new ways for the newly added urbanized population in the future. The third is how to realize the revitalization of the countryside through redefining the countryside.

4.5 Urban Renewal from the Perspective of Ecological Civilization

4.5.1 Urban renewal has become a central task

An important part of the transformation of green urbanization is to reshape the cities formed in the traditional industrial era with new development concepts, that is, urban renewal. The new development concept means a systematic transformation of development content, resource concepts, and business models. The Central Economic Work Conference proposed the term "urban renewal" for the first time when deploying economic work in 2020. In 2020, the "Recommendations of the Central Committee of the Communist Party of China on Formulating the Fourteenth Five-Year Plan for National Economic and Social Development and the Long-term Goals for 2035" approved by the Fifth Plenary Session of the 19th Central Committee of the Communist Party of China clearly stated that "Implementing Urban Renewal Actions" ". All these indicate that China's urban renewal has received unprecedented attention and has opened a new stage of urban renewal development.

According to the central deployment, in 2020, the country plans to complete the renovation of 603 million square meters of old urban communities, the renovation of 6,891,300 households, the renovation of 251,900 buildings, and the renovation of 39,000 communities. Urban renewal at this stage focuses on the transformation of old communities, but it is not limited to the transformation of old communities. In 2020, the General Office of the State Council issued the "Guiding Opinions on Comprehensively Promoting the Reconstruction of Old Communities in Cities and Towns", which stated that "Reconstruction of old communities in cities and towns is a major livelihood project and development project. Domestic demand, the promotion of urban renewal and the transformation of development and construction methods, and the promotion of high-quality economic development are of great significance."

In 2021, the "Fourteenth Five-Year Plan for National Economic and Social Development and the Outline of Long-term Goals for 2035" adopted by the Fourth Session of the 13th National People's Congress further clearly stated that "accelerate urban renewal, transform and upgrade old communities, The functions of stock areas such as old factories, old neighborhoods and urban villages" combine urban renewal with the promotion of urban spatial structure optimization and quality improvement.

4.5.2 Outstanding problems in urban renewal

At present, China's urban renewal has made great achievements, but there are also some outstanding problems. Among them, the most important issue is that some places use the old thinking of the traditional industrial era to carry out urban renewal in the era of ecological civilization.

According to the requirements of the central government, urban renewal should conform to the law of urban development, and adopt green and low-carbon development as a path to transform urban development and construction methods. These green and low-carbon concepts are reflected in the documents.

—In 2014, the “Guiding Opinions of the General Office of the State Council on Promoting the Relocation and Reconstruction of Old Industrial Zones in Urban Areas” and the “Notice of the General Office of the State Council on Further Strengthening the Reconstruction of Shanty Areas” mentioned “green buildings”.

—In 2016, the “Guiding Opinions on Further Promoting the Redevelopment of Urban Inefficient Lands (Trial)” proposed to “firmly establish an innovative, coordinated, green, open, and shared development concept.”

—In 2020, the “Guiding Opinions on Comprehensively Promoting the Reconstruction of Old Communities in Cities and Towns” of the General Office of the State Council proposes that “combined with the rebuilding of old communities in cities and towns, simultaneously carry out the creation of green communities”.

However, due to the inertia of traditional thinking and institutional inertia, and due to that there are no definite rules on how to implement the concept of green and low-carbon in urban renewal, by which department it is supervised, and what indicators are reflected, it is often difficult to break away from traditional industrialization. Model when urban renewal is carried out in various places. These new concepts have not been well implemented in the specific work of urban renewal in various places.

The most typical reflection of traditional industrialization thinking in urban renewal is large-scale demolition and large-scale construction. To this end, the Ministry of Housing and Urban-Rural Development issued the "Notice on Preventing Major Demolition and Construction Issues in the Implementation of Urban Renewal Actions." The "Notice" pointed out: Recently, various localities have actively promoted the implementation of urban renewal actions, but some places continue to use excessive real estate development. The tendency of construction methods, large-scale demolition and large-scale construction, and eagerness for quick success, random demolishing of old buildings, relocation of residents, and felling of old trees in disguised form raise housing prices, increase living costs, and create new urban problems.

Yang Baojun conducted an in-depth analysis of urban renewal. He classified the goals and tasks of the urban renewal action as: perfecting the urban spatial structure; implementing urban ecological restoration and functional improvement projects; strengthening historical and cultural protection, shaping the urban style; building complete residential communities; advancing the construction of new urban infrastructure; strengthening urban old Reconstruction of old communities; Zhangqiang City's flood control and drainage capacity; Promotion of urbanization

with county towns as an important carrier

4.5.3 Urban Renewal: Traditional Industrialization Thinking Vs. Ecological Civilization Thinking

The traditional industrialization model is mainly based on the production and consumption of material wealth. It values tangible material resource input and material output, and ignores intangible culture, ecological environment and other resources. Therefore, if urban renewal is carried out in the traditional industrialized way of thinking, it may be habitually carried out in the form of “demolition and large-scale construction”.

We use two concrete examples to illustrate the essential difference between urban renewal under traditional industrialization thinking and urban renewal under ecological civilization thinking.

The case of Beijing 798 Art District. If the 798 factory is renovated in accordance with the traditional industrialization thinking, the first thing that may come to mind is to demolish the old factory buildings and build high-rise buildings. However, if we follow the thinking of ecological civilization. These practices did not realize that a large number of intangible cultural and ecological resources in a city can actually be transformed into a source of economic growth.

The case of "Four Seasons Market" in Dali, Yunnan. In the thinking of industrialization, the function of the old vegetable market is to sell vegetables. In the process of urban reconstruction, such places are often included as objects to be demolished. However, once you jump out of this traditional industrialization vision, you can see that in addition to the function of selling vegetables, the old vegetable market has great historical value and cultural value. These cultural values can be revitalized by entrepreneurs, designers and artists (vitalize), become new products and services, and produce good economic and social benefits.

The above two examples do not mean that all urban renewal must take the direction of cultural creativity, but use these two extreme examples to illustrate how different thinking produces different effects. The situation varies greatly from place to place, and it is necessary to adapt measures to local conditions according to their own circumstances. It can be seen that these cases are not the traditional industrialization model of traditional "demolition and construction", but fully realize the importance of intangible culture, ecological environment and other resources, and realize their value through new business models. That is, the "green" resources that "turn a blind eye" under the traditional industrialization perspective are transformed into "treasure". Among them, some are "treasure" that can be marketized, and some are not marketable, but they can greatly improve the subjective well-being of the people. For example, although the beautiful community environment has not brought the residents money income, it can significantly

improve the residents' happiness.

—Resource concept: In the traditional industrial era, economic development centered on the production and consumption of material wealth, while the resources needed by production industry are mainly material resources, such as raw materials. On the contrary, intangible culture, ecology, environment, etc., have no value in the industrial production process. Not only are they useless, but to make matters worse, they are largely destroyed by industrialized production models. For example, the traditional old Hutongs were demolished to build factories. This process of urban development is actually the destruction of the invisible social and cultural context formed by the original history by the logic of industrialization. Industrial sites and local cultural deposits are precious resources, but they are not noticed under the traditional industrialization vision, or even if noticed, their value cannot be realized commercially. These intangible resources have nonrival characteristics in economics. In other words, a city landscape can be enjoyed by many people at the same time, unlike a material commodity (such as an apple) that cannot be consumed by many people at the same time.

—The concept of well-being. The purpose of development is to pursue a better life, and a better life is not only part of market transactions, but also includes non-market transactions. For example, a beautiful ecological environment. Assume that two people have the same income, but one of them lives in an ecologically beautiful community and the other lives in an environmentally polluted community. Obviously, under the same conditions as other factors, the well-being of people living in the beautiful ecological environment is higher. In other words, for some people living in beautiful places, the same income will produce different levels of well-being or satisfaction. If you follow the concept of traditional industrialization, there should be no difference in the value of the two communities. But in fact, although the two have the same income level, they have different levels of well-being.

—Business model. Assuming an old neighborhood, if its environmental quality is improved and its culture is revitalized, it can drive many new business formats based on the environment and culture and become a driving force for economic growth. However, because intangible contents such as ecological environment and culture are difficult to be directly traded in the market, it is difficult to appear in the market. There are two basic ways: one is through government investment. However, due to the high degree of creativity in products such as culture, the government usually does not have the ability to directly provide products, but it can take the form of government purchase. This business model is that the government purchases services from the market, and these services promote new local economic formats, which in turn generate taxes and become new government revenues. The other way is a completely market-oriented way. For example, a company is responsible for the

renovation of an old neighborhood. After the renovation is completed, the property value will be increased and new business formats will be formed. The company can hold shares in these new business formats and obtain continuous returns. At the same time, companies can also hold these properties to increase their value through urban renewal and bring continuous rents.

—The implications of productivity. The green renewal of the old city seems to have a low return on investment, but in fact the return is very high, just with different form of return. One-time investment, long-term return. The form of return not only promotes the economic development of the urban area, but also improves the non-monetary well-being of residents.

—The implications of sustainable development. Since the intangible ecological environment and culture are non-material resources, unlike material that is exhaustible, and culture also accumulates over time, intangible resources become more abundant as time goes.

Of course, not all the old city reconstructions have such a good material foundation. According to the requirements of the Ministry of Housing and Urban-Rural Development, apart from some buildings that have been identified as dangerous by professional institutions and have no maintenance value, the existing buildings shall not be demolished on a large scale and in a centralized manner. In principle, the urban renewal unit (sector) or the demolished building area in the project should not be larger than the current situation. 20% of the total construction area.

4.6 The changing trend of China's urbanization: local urbanization

The second major strategic task of China's green urbanization is how to achieve urbanization in a new way for the newly added urbanized population in the future. In the past, the transfer of agricultural labor to large and medium cities was regarded as a direction. However, the current trend of local urbanization in China seems to be more obvious.

4.6.1 China's local urbanization trend

Since 2009, the National Bureau of Statistics has been tracking and monitoring the flow of migrant workers every year, and issued the "Monitoring and Investigation Report on Migrant Workers." According to its definition, local migrant workers refer to migrant workers who work within the township area where the household registration is located; migrant workers: refer to migrant workers who work outside the township area where the household registration is located. Starting from around 2010, the proportion of local migrant workers has continued to rise, while the proportion of migrant workers has begun to decline. It can be seen that if

the definition of local migrant workers is extended to the county or the surrounding distance, this trend of change will be more obvious.

From 2008 to 2019, the proportion of migrant workers in the country was about 60%, while the proportion of local migrant workers was about 40%. It can be seen that among the agricultural transfer population, the proportion of migrant workers who went out to work outside the township where their household registration was located was more than 60%. However, starting from 2010, the proportion of migrant workers in all migrant workers has gradually declined, while the proportion of local migrant workers in all migrant workers has gradually increased. The proportion of migrant workers who migrate across provinces has decreased year by year from 53.3% in 2008 to 43.1% in 2019; the proportion of migrant workers in the province has continued to rise from 46.7% in 2008 to 56.9% in 2019.

4.6.2 City scale and economic development

The concept of economies of scale is regarded by many as the driving force of urban economic development, and it played a major role in urban development. However, whether in theory or practice, urbanization is not evolving along the path of economies of scale.

In the theory of economic growth, population size is not always conducive to economic growth. For example, in Solow Growth Theory (1956), Endogenous Growth Theory, and Lewis Surplus Labor Theory, population size has a negative, positive, or neutral effect on economic growth, respectively. New economic geography represented by Krugman and Fujita^[4] emphasizes the benefits of population size to economic growth. However, as Young^[5] pointed out, the "extent of market" emphasized by Smith's theorem is not "mass production" and population size.

The research of Zhang and Zhao^[6] shows that the enterprise scale economy in the Fujita-Krugman urbanization model is not in line with reality. Some empirical studies emphasizing city size show that there is a strong correlation between city size and its per capita GDP^[7]. However, the conclusion may not be so simple. The hierarchical structure of large, medium and small cities is endogenized in the market. Due to the large market scale and high level of division of labor in large cities, their nominal GDP is usually higher than that of small and medium-sized cities. However, the GDP of large cities contains more transaction costs (commuter costs, housing prices, congestion, etc.), and the net utility is not necessarily higher. If we conduct regression analysis on urban population and GDP, we will always come to the conclusion that "the bigger the city, the higher the GDP per capita". This conclusion alone may be misleading both academically and in policy.

In reality, we can find a lot of examples of "small cities but economically developed", but also a lot of examples of "big cities but poor". In Europe, more than

half of the population lives in small and medium-sized cities with a population of 5,000-100,000. At the same time, the size of the urban population does not mean prosperity. Of the 29 megacities in the world with more than 10 million, 22 are in Africa, Asia, and Latin America. These megacities have not gained prosperity. In China, the development of many cities no longer depends on population growth. There is an inverted U-shaped relationship between population and urban economic growth. In addition, most of the industries that are the basis of urbanization are distributed in counties, not in large cities.

According to research by Li Yuhong^[8], the proportion of employees in township and village industries calculated by the Ministry of Agriculture exceeds 50%, and the proportion of employees in rural industries above designated size has increased from 40% in 2004 to 50% in 2013. According to the method of identifying urban and rural areas proposed in this paper, the proportion of rural industrial employees from 2004 to 2008 was 46%. In short, both census data and annual data show that China's rural industry has not declined since 2000, but has maintained a relatively stable growth trend.

4.7 Green rural revitalization under the background of urban-rural coordination

The city and the country are two sides of the same problem. When the content and mode of economic development change, the definition of the countryside and the relationship between urban and rural areas will also change accordingly. After achieving a well-off society in an all-round way and completing the task of poverty alleviation, the focus of rural work has shifted to rural revitalization in an all-round way. To realize rural revitalization, we must first deeply understand the causes of rural backwardness. The rural backwardness is the inevitable result of the traditional development model.

Rural rejuvenation must break away from the traditional concept of "rural", because "rural" is more a concept of traditional industrialization than a concept of ecological civilization. The 19th National Congress of the Communist Party of China put forward the concept of "Xiang Cun revitalization" rather than "Nong Cun revitalization", which has profound meaning behind it. "Nong Cun" is a very traditional industrialized concept. "Agriculture" corresponds to "industry", which means that "rural areas" can only be engaged in agriculture, which is the place where farmers work and live, which is the traditional concept of "agriculture, rural areas and farmers". In fact, the function of the village is far more than the traditional "three Nong" category. "Rural" is a spatial concept, which means that in addition to agriculture, the countryside can also have a large number of other functions, such as ecological services, culture and sports, education, leisure, health care, sightseeing

experience and other functions, which can give birth to a large number of emerging economies and non-economic activity.

The fundamental reason for the decline of the countryside in the past was the traditional industrialization model established after the industrial revolution. This model centers on the production and consumption of industrial wealth, and economic development is regarded as a process of industrialization, urbanization, and agricultural modernization. The countryside has always been in a subordinate position in the traditional development model, which is to provide industries and cities with agricultural products, labor, raw materials and markets. The process of economic development is considered to be the transfer of a large number of agricultural laborers to cities to develop industry, while traditional ecological agriculture has also been transformed into chemical agriculture using the logic of industrialization.

This development concept based on industrial material wealth and the concept of rural areas centered on cities and industry greatly restricts the development space of the countryside. The traditional industrialization model centered on industrial wealth mainly relies on the input of tangible material resources. As a result, a large number of intangible ecological and cultural resources in the countryside are difficult to play a role, and the value of "green" resources is difficult to be fully understood and even more difficult to transform into "treasure". Moreover, this traditional industrialization model will destroy the cultural and ecological resources of the countryside. For example, high-pollution industries, extractive industries, and chemical agriculture are destroying the rural ecological environment. It is this traditional industrialization development concept and development model that has led to relatively lagging rural development, destruction of the ecological environment, and a large number of social problems.

Therefore, the root of the problem in the countryside lies in the unsustainability of the traditional industrialization model. The rural problem is only one aspect of the unsustainable consequences of the traditional development model. It can be said that almost all rural problems correspond to corresponding urban problems. Solving rural problems is essentially to solve the problems of the traditional development model, not just the problems of the village itself. As Einstein said, "We can't solve the problems by using the same kind of thinking when we created them." Therefore, rural revitalization must break away from traditional industrialization thinking and transform from traditional industrial civilization to ecological civilization in order to achieve sustainable green development. This is the inherent logical relationship between rural revitalization and ecological civilization.

This is why the 19th National Congress of the Communist Party of China put forward the profound background of "Xiang Cun revitalization" instead of "Nong Cun revitalization". The current problems we are facing are actually two levels. One

is to solve the unsustainable problem of the traditional industrialization model, that is, to transform from the traditional industrialization model to green development based on ecological civilization. The second is to jump out of traditional industrial thinking and redefine the countryside under the concept of ecological civilization. The countryside is not just the concept of "three rural" in the traditional sense, but a geographical space that can carry various modern activities. In particular, in the mobile internet and digital age, the traditional concept of space has been redefined to a large extent, and rural areas can engage in many economic activities that were unimaginable in the past. In this way, the development space of the village will be greatly expanded, and the revitalization of the village will be truly realized.

4.8 From GDP Orientation to Well-being Orientation: Urbanization in the New Development Era

The fundamental purpose of economic development is to improve well-being. One of the drawbacks of the traditional industrialization model is the inversion of development goals and means. A large number of studies have shown that in many countries, including China, the economic development under the traditional industrialization model has not continuously improved the level of national happiness as people thought. This is the famous Easterlin paradox^[9], also known as the "happiness-income mystery" or "happiness paradox". Since modern economics is built on the core proposition that "increasing wealth will lead to increased welfare or happiness", this paradox raises an important question: why more wealth does not bring greater happiness^[10-13].

Smith^[14] pointed out that the high productivity of the market economy is driven by a misleading belief that material wealth brings happiness. "It is this illusion that inspired and maintained the continuous progress of human industry... and thus completely changed the face of the earth." Therefore, economic development must shift from being oriented toward GDP to orient toward people's livelihood and well-being. GDP is only a part of people's livelihood and well-being, and some parts of GDP also need to be adjusted to form new supply content to maximize well-being.

Correspondingly, urbanization formed on the basis of traditional industrialization models also requires strategic adjustments. Therefore, we must jump out of the traditional disputes over the size of cities, return to the logical starting point of why development and why there are cities, and redefine cities and villages within the framework of ecological civilization.

As Stiglitz^[15] pointed out, "GDP is a wrong tool to measure what matters". It only measures the activity of market transactions. Moreover, these activities are not all activities that fund people's well-being. Part of it is transaction cost; part is

invalid activity of "digging and filling trenches" in the Keynesian sense. If measured by the traditional concept of GDP, the larger the city, the higher the per capita GDP. It seems that the larger the city, the more efficient it is. However, once we return to the standard of the fundamental purpose of development, the optimal spatial pattern of urbanization will undergo major changes.

This industrialization perspective and urbanization under ecological civilization are similar to the geocentric theory to the heliocentric theory. Once we look at urbanization from the perspective of traditional industrialization, the concepts of cost, benefit, utility, well-being, and optimization will undergo profound changes. Many standard economic conclusions formed in the traditional industrial era may no longer be applicable.

If measured by GDP, the larger the city, the higher the per capita GDP; however, if measured by the well-being of residents, there is no substantial gap between the residents of small towns and large cities, and even small towns have higher well-being.

We use current international mainstream definitions and research methods on subject well-being (SWB) to measure the well-being of cities of different sizes. According to Easterlin^[9], the principal measure of well-being used here is self-reported feelings of satisfaction with life, one of the SWB measures recommended in the recent Stiglitz-Sen-Fitoussi report^[16]: All things considered, how satisfied are you with your life as a whole these days? Please use this card to help with your answer: 1 "dissatisfied" 2 3 4 5 6 7 8 9 10 "satisfied".

The main results are reported as follows: Due to the mobility of the population, it is difficult to accurately identify where residents live. Therefore, we use the location of the residents' first house as a proxy variable to identify the residence of the residents (the next study needs to be adjusted). It can be seen that the respondents who live in municipalities or provincial capitals or prefecture-level cities represented by the first set of properties were significantly higher than those in counties, towns, or rural areas in 2015 and 2017, but it can be seen in 2019 Respondents in the county seat had the highest life satisfaction, indicating that the happiness of buying a house in the county seat will increase with the growth of the year.

4.9 Policy recommendations

The global consensus and actions on carbon neutrality mark the end of the traditional industrial era and the opening of a new era of ecological civilization and green development. This means that the development concepts, resource concepts, development content, business models, institutional mechanisms, etc. established in the traditional industrial era are all facing the most comprehensive and profound changes since the industrial revolution. Correspondingly, the urbanization concepts

and models formed in the traditional industrial era need to be comprehensively and profoundly transformed according to the inherent requirements of the new ecological civilization.

4.9.1 General idea

First, take the "dual carbon" goal as an important strategic starting point for green urbanization, and promote cities to take the lead in achieving carbon peaks and carbon neutrality in an orderly manner; the key tasks of the first peak cities should be shifted from the production mode at the same time to promote changes in consumption patterns. The existing emission reduction model of carbon peak cities is far from a real green transformation and more of an industrial upgrade in the traditional sense. To this end, we should fully consider the differences in urban carbon peaking paths to establish a diversified and efficient policy and measure system, and encourage the first carbon peak cities to become the vanguard of green and low-carbon development.

Second, take urban renewal as a major opportunity for the transformation of green urbanization, and avoid using the old thinking of the traditional industrial era to renew the city in a new era of ecological civilization. It is not only necessary to establish urban renewal led by the improvement of ecological environment and quality of life, but also to establish a new resource concept in accordance with the new development concept, fully understand the unique cultural and historical value of the old city, and activate it in various forms to transform it into "treasure ". Strictly control large-scale demolition and large-scale construction, and strictly control the urban construction of super high-rise buildings and high-rise residential buildings; adhere to the urban construction principle of keeping, reforming, and demolition at the same time, focusing on preservation and protection. adhere to the urban construction principle of keeping, reforming, and demolition at the same time, focusing on preservation and protection. Make full use of existing buildings in urban renewal to reduce carbon emissions in the process of urban development and construction.

Third, China's urbanization strategy should go beyond the urban size debate in the traditional industrial era and redefine the city under the thinking of ecological civilization. The current urbanization has shown a clear localization trend, and green urbanization in urban agglomerations and counties should be the focus of work, and it should be closely integrated with rural revitalization.

Fourth, we must avoid using the traditional "three rural" concepts and urban perspectives to engage in "rural revitalization". The countryside is a new ground space, not just a subsidiary of cities and industries. In particular, it is necessary to promote rural revitalization in the context of urban agglomerations and county urbanization, and give full play to the unique advantages of county towns

connecting urban and rural areas.

Fifth, in the context of the new development pattern and green urbanization, use a full life cycle and multi-dimensional sustainability perspective (carbon emissions, resource consumption, biodiversity, environmental protection, etc.), as well as economy-society-environment) to rethinking the ecological environmental effects of urban infrastructure and urban buildings. Strictly control the construction of super high-rise buildings and high-rise residential buildings in cities, and reduce the high energy consumption and high resource consumption (such as the strength of building steel) caused by this. Make full use of existing buildings in urban renewal to reduce carbon emissions in the process of urban development and construction. Intensify the transformation of urban green infrastructure. Draw lessons from the devastating rainstorm disaster in Zhengzhou, increase the construction and management of the urban stormwater system, and improve urban resilience in the context of climate change.

4.9.2 Specific areas: four policy pillars

Policy Pillar One: Suggestions on urban renewal and green transformation of old urban areas

(1) Establish a transformation target system led by environmental improvement and life quality improvement

— Each city should focus on the improvement of urban economic quality, humanistic quality, ecological quality, quality of life, etc., overall design strategies and policy measures for urban renewal and green transformation of old urban areas, determine an environmental improvement indicator system, and effectively propose improvements, concrete measures for people's livelihood and well-being.

—Strengthen the protection and restoration of urban biodiversity in the transformation process, incorporate biodiversity and ecosystem services into the scope of urban planning and transformation plan design, and promote the pilot and promotion of related projects by local and municipal government agencies. The level of urbanization develops a specific plan for the optimal allocation of natural capital (ecosystem services).

(2) Design a roadmap with the goal of implementing the transformation and upgrading effects and benefits

—Build a comprehensive evaluation system based on actual results, clarify work ideas and key links, avoid blindly "promoting civil engineering" and "doing fast", focusing on key areas, and striving to use "micro-renovation" to drive "big improvement" .

— Through the establishment of a new environmental market to give value to ecosystem services, encourage social capital to invest in natural capital, improve resource and capital allocation efficiency and construction effectiveness, introduce

public and financial policies, formulate market incentives, and encourage social capital to do Renovation and upgrading provide project-based technological innovation and lowest cost solutions.

(3) Customize a systematic green transformation plan according to local conditions

— According to regional classifications such as basic, perfect, and upgrade, determine the detailed list of renovation content, standards and support policies, and specify the content and key tasks of renovation and upgrade based on the region.

— Incorporate environmental protection and promotion into the assessment scope of urban green transformation, set environmental improvement and environmental governance assessment indicators, establish an effective supervision mechanism, and comprehensively improve the long-term effects of green transformation.

— Establish a people-oriented participation mechanism for extensively soliciting public opinions, unblock online and offline information interaction channels, sink the power of suggestions to the community and the scene, deepen the community discussion and consultation mechanism, stimulate the enthusiasm of social participation, and establish a sound, open, transparent, and open participation , People's livelihood-oriented transformation work coordination mechanism.

— Explore the "government + residents + enterprise" co-construction and shared governance model, focus on the improvement of both the hard facilities and soft environment of old communities, and create a long-term mechanism for regional environmental protection and improvement.

Policy Pillar Two: Suggestions on how the cities take the lead in peaking and carbon neutral.

(1) It is necessary to fully consider the differences in the path of urban carbon peaks to establish a diversified and efficient policy and measure system

— The competent departments of provinces and cities should be encouraged to plan, design, and formulate policies and measures that suit the needs of local cities for carbon peaking in accordance with local conditions and the resource endowment, industrialization process, and socio-economic conditions of each city.

— Support all provinces and cities to adopt different low-carbon paths and measures around the common goal and orientation of national carbon peaking, taking into account overall considerations and individual development requirements at the overall level, and formulating a roadmap and timetable for urban carbon peaking to make clear the progress and steps of carbon peaks in various cities.

— Take practical measures to avoid “big pot of rice”, “one size fits al” and “release satellites”, and achieve the peak of the echelon according to the

development situation. Provide practical guidance and requirements for underdeveloped regions, determine a peak timetable based on actual conditions, provide a greater adjustment period and buffer period, and avoid a politically correct carbon neutral leap.

(2) Encourage active carbon peak cities to become the vanguard of green and low-carbon development

— Issue guidance to encourage active carbon peak cities to establish a strong peak goal, and try to achieve carbon peak and carbon neutral targets faster and deeper, so as to achieve carbon peak and carbon neutrality goals for China as a whole to create an advance amount for the target and create more room for emission reduction in underdeveloped regions.

— Introduce incentive policies to encourage qualified and proactive carbon peak cities to further strengthen the green and low-carbon transformation, and use the perspective of ecological civilization to solve the problem of inadequate balance between urban economic development and ecological environmental protection in the construction of new urbanization. Create a benchmark and demonstration for cultivating new drivers of green economic growth, and carbon provides construction experience and work guidance for other cities.

(3) Promote natural carbon peak cities to make up for short-slab corner overtaking

— Carry out special guidance to guide passive carbon peak cities to face the main reasons for the decline in carbon emissions, carefully analyze the development problems caused by the lack of traditional economic growth and insufficient kinetic energy in the process of industrialization, and encourage local and municipal authorities to focus on solving the problems faced by the promotion of emerging green technologies. Institutional and mechanism barriers and other issues, re-search for local city carbon peak carbon neutral development endowments and advantages, under the premise of building an ecological civilization, and gradually strengthen the core capabilities of green development.

— Guide the natural carbon peak cities to regard the carbon peak carbon neutral target as a new development opportunity, and take the green and low-carbon development as the guide, and gradually move from less emission, slow emission, and emission reduction to carbon neutrality, in an orderly manner Start the transformation and upgrading work led by green and low-carbon development.

— Natural carbon peak cities should adhere to the drive of technological innovation and technological innovation, attach great importance to the application and promotion of low-cost, small and fast green applicable technologies, and use green technologies with great potential and low difficulty as a breakthrough to open up the city as a whole A breakthrough point in the transformation to achieve sustainable green development.

Policy Pillar Three: Suggestions for County-level Green Urbanization Development Strategy

(1) Improve the county-level urbanization development strategy system

— Research and formulate specific and targeted development strategies, and earnestly promote the construction of policies in the fields of industry, agriculture, municipal administration, education, medical care, pension, and employment in counties and cities, and clarify effective paths to narrow the gap between urban and rural social undertakings, and promote The overall upgrading plan and planning construction will promote the construction and upgrading of new towns with intensive resources, interaction between industry and city, ecological livability, and harmony between natural and social environments.

— Focus on solving problems such as the lack of institutional mechanisms that are common in grassroots reforms, and encourage counties and cities to jointly formulate action plans to coordinate the integration and improvement of county-level urban industries, economic structures, public services, social undertakings, and the ecological environment.

— According to the national land use plan, formulate policies for local cities to utilize natural capital, create landscape economic development strategies, and encourage qualified counties and cities to build new green service industries such as agricultural tourism and ecotourism based on actual conditions, so as to achieve environmental protection and economic development The depth of integration.

(2) Promote the transformation and upgrading of core green elements

— Accelerate the reform of the rural land requisition system and land circulation system, appropriately increase farmers' rights to autonomous land transactions, and combine the vitalization of land resources with agricultural transformation and upgrading, industrial layout adjustment, farmers' employment and continuous income growth, and enable farmers Urbanization is synchronized with land urbanization and industrial urbanization.

— Customize the industrial adjustment plan in the county urbanization strategy, cluster the rural population in county towns or small towns based on industrial function classification, scientifically promote the expansion of small town industries and public service functions, and build a basic system for green development.

— Forming the effects of agricultural economies of scale, focusing on the development of mechanized agriculture, green agriculture and modern and efficient agriculture, and finally forming a new urban-rural integration pattern of urban-rural interaction, mutual benefit, mutual promotion, and mutual benefit in the coordinated development of primary, secondary, and tertiary industries in county areas.

— With county towns and central towns as the growth points of new

urbanization, establish and improve a policy system and a unified evaluation system suitable for the green development of county urbanization in the region, and give full play to the county's industries, elements, and resources between cities and townships. The cohesive functions of configuration and other aspects promote the simultaneous development of cities and villages.

Policy Pillar Four: Suggestions for the Revitalization of Green Villages

(1) Deeply carry out theoretical research and practice of agricultural green transformation and upgrading

— Analyze and study the construction achievements and challenges of "modern agriculture", sublimate the development model of "modern agriculture" characterized by industrialized agriculture and chemical agriculture, and promote the transformation and upgrading of rural areas to green ecological agriculture.

— Promote the research on the practical methods and paths of rural green development in an orderly manner, highlight the characteristics of agricultural production, rural housing, ecological environmental protection and the inheritance of agricultural civilization, and improve and enrich the research category, theory and methodology system of ecological civilization.

— Combining the research on the hollowing out of rural human resources, carry out rural talent cultivation projects, accelerate the flow of urban and rural talents, agricultural vocational training and skill training, conduct qualification certification for qualified farmers, and formulate and issue urban capital to invest in rural development. Support policies and management policies, create pilot demonstration models, open up investment channels, and promote the construction of rural technology and talent systems.

(2) Establish and improve the rural green development planning system

— Improve the systemicity, scientificity, operability, sustainability, and appraisal of the planning and design of "agriculture, rural areas and farmers" in various regions, and effectively enhance the overall planning and system solution construction capabilities of various regions.

— Break the current situation of excessive and detailed professional planning, realize the organic integration of planning, connect and link with town planning, comprehensively cover all aspects of rural green development, and create a planning system for urban and rural coordinated development.

— The county level plans to make overall plans for rural green development and implement management, scientifically demonstrate, fully refine, and strengthen planning implementation and implementation supervision and management.

(3) Promote the construction of rural integrated development model

— Redefine rural green development from a new perspective, assist cities in clarifying their own advantages in green development, new ideas, new resources,

new models, and new content, expand green development space, and help developed regions adopt green development. Leapfrog development.

— Adhere to the "one pole, multiple wings" construction model led by green development and supported by diversified development, guide the countryside to promote ecological resources and transform ecological advantages into economic resources and industrial advantages according to local conditions, promote global tourism and build beautiful pastoral and beauty The combination of rural areas, rural ecological environmental protection, rural environmental improvement, and the development of characteristic rural economy will realize the development of moderately large-scale rural industries in various forms that are guided by green agriculture.

— Intensify the "Internet +" and "Science and Technology +" services for rural green development, improve the level and quality of scientific and technological assistance to agriculture, encourage the construction and development of various new forms of business in rural areas, and promote agriculture to rely on informatization, market demand, and technical demand , The seamless docking of talent needs, deep integration of agriculture, forestry, culture, tourism, processing and other industries, to create a green agricultural industry chain, promote the transformation of agriculture into a comprehensive industry, and promote the joint development of efficient ecological agriculture and emerging rural service industries .

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Part III

**Innovation, Sustainable Production and
Consumption**

Chapter 5

Green Transition and Sustainable Social Governance

5.1 Introduction

China has currently entered a stage of high-quality development. At the 5th Plenary Session of the 19th Central Committee of the Communist Party of China (CPC), China's economic and social development goals for the 14th Five-Year Plan (FYP) period has been set up and a blueprint for 2035 drawn up. Promoting a comprehensive transition to green development of economy and society has become an inherent requirement and an inevitable option for China to achieve the ambitious goal of building a modern socialist country in an all-round way. To this end, it is extremely necessary to accurately identify the major issues with China's green production and consumption at the new development stage, and to improve key policies on promoting green production and consumption.

Generally speaking, compared with the 13th FYP period, China's economic and social development in the 14th FYP period has entered an in-depth green transition phase, and green production and consumption have entered a substantive stage of implementation. This is also a critical mark of the depth of green transition. In accordance with the current 14th FYP, to promote green production and consumption in an all-round and in-depth manner, it is necessary to put in place more specific supporting action plans and more practical policy measures, have departmental coordination and division of labor, and formulate action plans for key consumption sectors and key production industries as soon as possible, making blueprints for green production and consumption.

5.2 Economic Contribution Analysis and Comprehensive Evaluation of China’s Green Consumption

5.2.1 Empirical analysis of the economic contribution of green consumption

At present, China has undergone profound and unprecedented changes in the structure, pattern, groups and market pattern of consumption. Green consumption has become an important part and characteristic of China’s consumption revolution. It can bring about the green reconstruction of the entire industrial chain through the transmission mechanism of the upper, middle and lower reaches of the industrial chain, which will play an important and active role in promoting China’s economic reform in quality, efficiency and power, thereby stimulating green and high-quality growth.

5.2.1.1 Analysis of the status quo of residents’ income and outlook for the 14th FYP period

In 2020, China’s GDP reached RMB 101.6 trillion. Based on a population of 1.4 billion, the per capita GDP reached RMB 72,600, which was about USD 10,500. In terms of regions, the per capita GDP of Beijing, Tianjin, Shanghai, Jiangsu, Zhejiang and other provinces reached USD 15,000, while that of 20 other provinces and cities did not exceed USD 10,000. Forecasts indicate that, during the 14th FYP period, China’s regional development pattern will not have significant change, and the level of local development is expected to improve further. The number of provinces with a per capita GDP of over USD 10,000 will increase to 19, and there will be 12 provinces and cities with a per capita GDP of less than USD 10,000. But that of most provinces and cities will be close to USD 10,000.

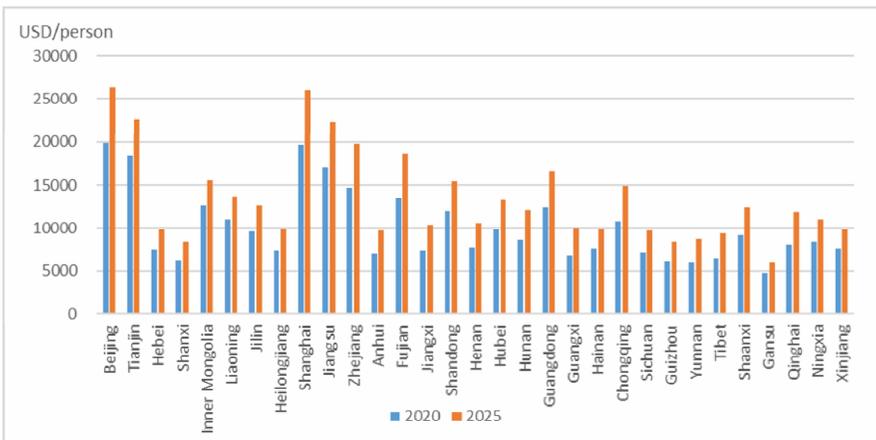


Figure 5-1 Prospects for the trend of per capita GDP by province during the 14th FYP period

It is estimated that the population with an upper-middle income is about 450 million based on the statistical analysis of urban and rural per capita disposable income data (in 2018 and 2019) of 2,851 districts and counties across the country and the corresponding urban and rural population, by selecting districts and counties with a per capita disposable income above the upper-middle-income national standard released by World Bank (USD 4,000, approximately RMB 28,000), and matching them with corresponding population. Considering that the per capita income is expected to grow up simultaneously with economic development in the 14th FYP period, it is estimated that the size of middle-income population is going to increase by more than 100 million people to 560 million. During the 14th FYP period, China's consumption rate will rise from 54.3% in 2020 to about 60% in 2025, and the investment rate will drop to about 40%. Therefore, on the whole, the continuous increase in people's income will greatly promote the consumption potential of green products. Green consumption in the 14th FYP period is expected to enter a stage of rapid development.

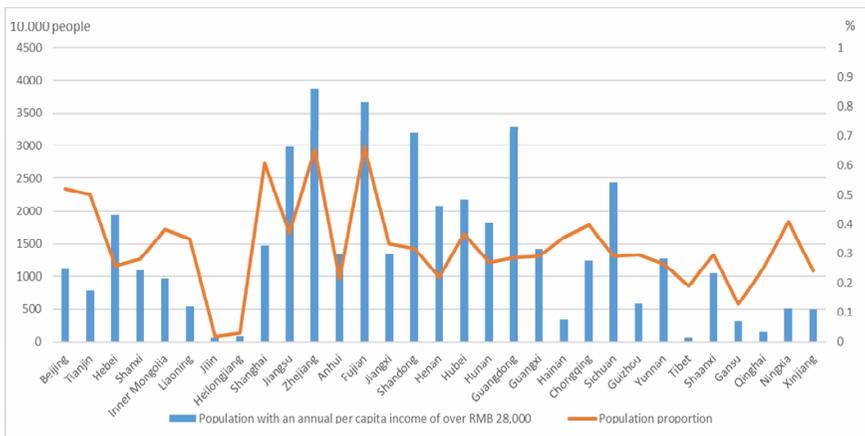


Figure 5-2 Population with an upper-middle income by province

5.2.1.2 Analysis of the consumption of green products in China

According to a research conducted by the Environmental Development Center of the Ministry of Ecology and Environment (MEE), about 8,800 domestic enterprises have obtained the Environmental Labeling Certification by 2020, and eco-labeling products are mainly distributed in 20 industries, with an output value of over RMB 5 trillion. China's green industry is beginning to take shape. Based on the availability of data, this project defines environmental protection certification mainly based on the Environmental Labeling Product Certification, Green Product Certification, Green Packaging Certification, Organic Product Certification, and China Low-Carbon Product Certification carried out by CEC and carries out related quantitative

calculations.

Based on the estimation of 2017 input-output table, the proportion of eco-labeling products used in the final demand is still not high, and they are mainly driven by exports. In general, the proportions of eco-labeling products in final consumption, investment and export in the total output of corresponding sectors are 1.6%, 1.9% and 5%, respectively. Among the final demand, eco-labeling products with the highest proportion in the total final use are audio-visual equipment, and both domestic consumption and exports accounted for 27%. As for products like electronic components, other electrical machinery and automobiles, computers, communication equipment and furniture, their proportions in consumption are far lower than those in exports. This indicates that the production of domestic green products is still mainly driven by exports, rather than domestic consumption and investment.

The CGE model has been applied to simulate the development potential of green consumption products (eco-labeling products). Based on the 2017 input-output table, this research has spined off eco-labeling products and constructed a CGE model that can analyze the economic impact of green consumption. First, the CGE model is used to carry out baseline scenario analysis. Specifically, in accordance with the BAU scenario design idea, the future market size of green consumption goods can be predicted by assuming that no additional subsidy policy is implemented. Preliminary calculations show that the scale of green consumption goods was RMB 2.2 trillion in 2020, and will expand to RMB 3.1 trillion by 2025, an increase of 40% over 2020; by 2035, it will reach RMB 5.6 trillion, which is 2.6 times that of 2020 and is slightly higher than the development rate of doubled per capita GDP.

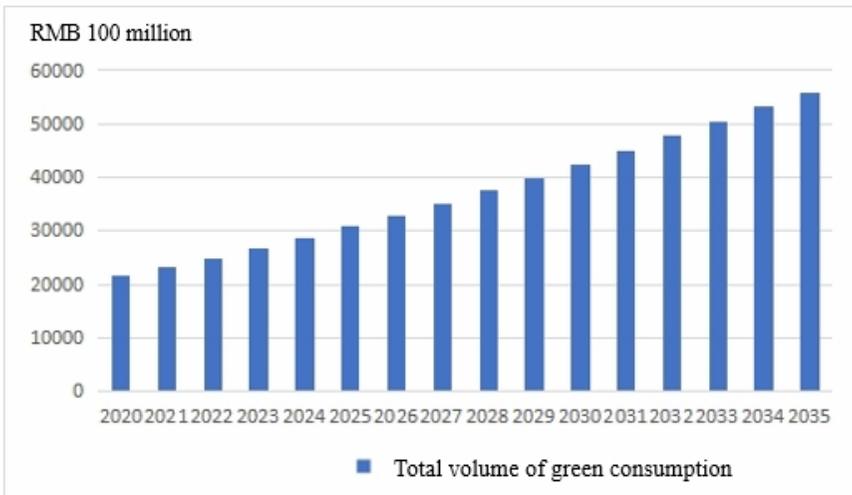


Figure 5-3 Prospects of the growth trend of green consumption in the baseline scenario

5.2.1.3 Multi-scenario analysis of the potential and impact of green consumption during the 14th FYP period

A policy scenario research is conducted based on the baseline scenario, assuming that the development of green consumption will be boosted by tax cuts for green goods during the 14th FYP period, and focusing on the analysis of the economic stimulus effect of green consumption.

5.2.1.3.1 Forecast and analysis of green consumption scale

Policy scenario: In order to promote green power consumption, price subsidies for green products used for consumption are the main feasible means. Therefore, this research initially assumes that the prices of green consumption products will be kept stable basically through consumption subsidies to support green consumption. Specifically, it is assumed that beginning from 2021, China will implement policies and measures to stimulate the development of green consumption: in the 14th FYP period, small-scale subsidies or tax cuts will be frequently provided for green products for consumption every year, so that the prices of green goods will decrease by 2 percentage per year relative to the baseline scenario, which means the prices of green products will remain stable relative to the base year to support green products consumption. The calculation results show that subsidies can effectively expand green consumption; and the scale of green consumption in 2025 and 2035 will reach RMB 3.25 trillion and RMB 5.9 trillion, respectively, an increase of RMB 170 billion and RMB 340 billion compared with the baseline scenario.

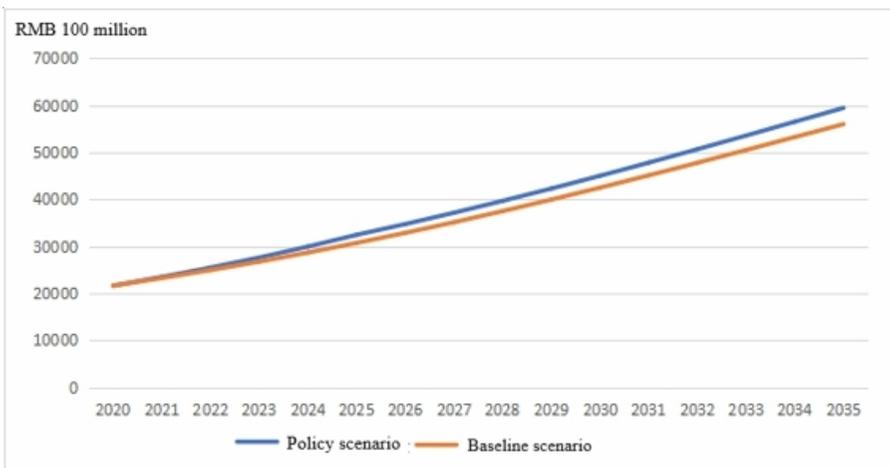


Figure 5-4 The stimulus effect of consumption tax cuts for green products on green consumption

5.2.1.3.2 The contribution of green consumption to the macro economy

The growth of green consumption has not only expanded the scale of

consumption, but also stimulated GDP growth. During the 14th FYP period, the effect of tax cuts will be manifested further, and the scale of household consumption will continue to expand on the baseline scenario, with an increase of 0.2 percentage in 2025. Meanwhile, expanded consumption will substitute export to some effect. In 2025, exports will drop by 0.24 percentage relative to the baseline scenario. Consumption-driven GDP will continue to expand relative to the baseline scenario, with an increase of 0.08 percentage in 2025. After the 14th FYP period, the scale of economic growth will continue to expand due to the technology policies spillover.

Table 5-1 The proportion of macroeconomic variables in the scenario of green consumption tax reduction relative to the baseline scenario (%)

	2021	2022	2023	2024	2025	2030	2035
GDP	0.03	0.05	0.06	0.07	0.08	0.1	0.12
Consumption	0.05	0.10	0.14	0.17	0.20	0.22	0.24
Investment	0.01	0.02	0.02	0.03	0.04	0.06	0.08
Export	0.00	-0.03	-0.08	-0.15	-0.24	-0.20	-0.19
Import	0.03	0.07	0.11	0.16	0.21	0.22	0.20

5.2.1.3.3 The impact of green consumption on energy conservation and emission reduction

The output of green products in 2025 will increase by RMB 130 billion relative to the baseline scenario, which is slightly less than the increase in consumption, reflecting a certain degree of export-substitution benefits. In 2035, the output of green products will increase by RMB 280 billion relative to the baseline scenario.

From the perspective of energy conservation, the promotion of green consumption through subsidies will affect the carbon emission in two ways. On the one hand, the expanded total scale of consumption will increase the scale of output, which will stimulate the increase of carbon emissions; on the other hand, it will promote the go-green shift of consumption structure and reduce the carbon emissions intensity of consumption goods. The combination of both determines the effect of green consumption incentive policies on China's carbon emission reduction. On the whole, the main contradiction lies in the impact of expanded consumption scale in the short term. After the policy of stimulating green consumption is introduced, energy consumption and carbon dioxide emissions will grow slightly in the short term; but in the long term, the effect of optimizing the consumption structure will be stronger, which will generate lasting effect of energy conservation and carbon reduction.

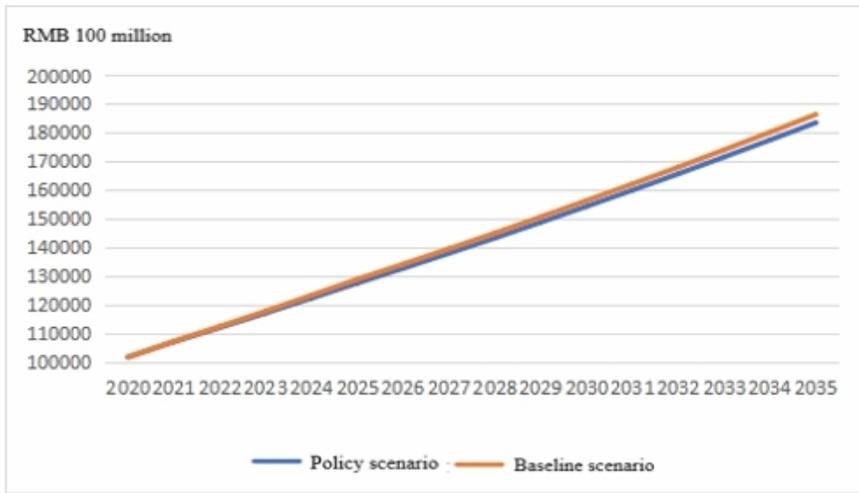


Figure 5-5 The growth trend of green product output under the policy scenario

Table 5-2 The impact of tax cut policies for green products on energy demand (%)

	2021	2022	2023	2024	2025	2030	2035
Coal	0.02	0.03	0.03	0.03	0.00	-0.04	-0.05
Oil	0.01	0.02	0.02	0.01	-0.01	-0.02	-0.04
Natural gas	0.01	0.01	0.01	0.00	-0.01	-0.07	-0.12
Electricity	0.02	0.03	0.03	0.03	0.03	-0.02	-0.05

5.2.1.4 Enhance green consumption potential

Currently, about 450 million people in China have reached the upper-middle income level. As the per capita income during the 14th FYP period is expected to increase along with economic development, it is estimated that the size of middle-income population is going to increase by more than 100 million to 560 million. The continuous increase in people's income has greatly enhanced the consumption potential of green products.

At present, the development of China's green product industry is mainly driven by exports. In the future, as the income increases, the potential of domestic green consumption will increase substantially and lay a foundation for the transition of domestic green product industry from being driven by export to being driven by both export and domestic consumption.

In order to increase the consumption of green products, subsidies in the consumption are effective. Thus, appropriate subsidy policies may be introduced during the 14th FYP period to increase the consumption of green products. In terms of specific measures, it is recommended to frequently provide continuous small-

scale subsidies to steadily cultivate the green product market.

5.2.2 Construction and comprehensive evaluation of China's green consumption index

To measure the level and extent of green consumption in different regions, identify shortcomings and deficiencies in green consumption development, and promote the overall green transition of social development, it is necessary to construct a green consumption composite index, form a systematic quantitative evaluation system, and scientifically evaluate the level of green consumption in different regions.

5.2.2.1 Construction of green consumption composite index in China

5.2.2.1.1 Construction principles

This study defines residents as the behavioral agent of green consumption, focuses on the use and disposal of products and service consumption, as well as the impact on the economy, society, resources and the environment. The basic principles of construction include:

Scientificity. The design of each indicator should have clear practical significance, and can ensure that evaluation methods are scientific, and evaluation results are authentic and objective.

Independence. The selected indicators should be independent at the same level, have no causal relations, and do not overlap with each other.

Policy-relevance. The selected indicators must not deviate from the green consumption policy, and they can trace, guide and reflect the effect of the policy.

Data availability. The acquisition of data needs to be realistic and feasible for operability, and ultimately facilitate the scientific evaluation of green consumption level in China.

5.2.2.1.2 Framework of core indicators

According to the above construction principles, the study constructed the following indicator system (see Table 5-3). The indicators selected are comprehensive and reflect the impact of consumption behavior on the environment and energy resource consumption, including four reverse indicators, i.e., domestic carbon dioxide emissions, domestic electricity consumption, domestic water consumption, and domestic waste collection, and three positive indicators, i.e., per capita park and green land area, passenger capacity of urban public transport per 10,000 population, and per capita urban investment in environmental infrastructure. The former indicators are used to reflect the resource and environmental impact of consumption, and the latter are used to reflect the efforts made to promote green consumption.

As green consumption is based on a certain standard of living, in order to eliminate the incomparability of green consumption caused by differences in the

income levels of different regions, the reverse indicators are readjusted accordingly, and they are determined as per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure, per capita daily electricity consumption per RMB 10,000 of consumption expenditure, per capita daily domestic water consumption per RMB 10,000 of consumption expenditure and per capita domestic waste collection amount per RMB 10,000 of consumption expenditure in cities and towns.

Table 5-3 Green consumption indicator system

No.	Indicators	Type of Indicator
1	Per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure (kg)	Reverse
2	Per capita daily electricity consumption per RMB 10,000 of consumption expenditure (kilowatt-hour)	Reverse
3	Per capita daily domestic water consumption per RMB 10,000 of consumption expenditure (litre)	Reverse
4	Per capita domestic waste collection volume per RMB 10,000 of consumption expenditure (kg)	Reverse
5	Per capita park and green land area (m ²)	Positive
6	Passenger capacity of urban public transport per 10,000 population (10,000 passengers/10,000 persons)	Positive
7	Per capita urban investment in environmental infrastructure (RMB)	Positive

Source: Official website of National Bureau of Statistics and statistical yearbooks of various provinces (cities, districts).

Note: Per capita urban investment in environmental infrastructure construction includes investment in gas, drainage, landscaping, city appearance and sanitation, etc., but does not include that in central heating. Due to the lack of data on the amount of waste generated, the amount of waste collection is used instead.

5.2.2.1.3 Core construction methods

The value of each statistical indicator is standardized, and the extremum method is used to calculate the individual indexes. Each statistical indicator is scored by the centesimal system. The calculation formula is:

$$\text{Positive indicator: } Y_i = \frac{[X_i - \min(X_i)]}{[\max(X_i) - \min(X_i)]} 40 + 60$$

$$\text{Reverse indicator: } Y_i = \frac{[\max(X_i) - X_i]}{[\max(X_i) - \min(X_i)]} 40 + 60$$

Specifically, Y_i is the individual index of the i^{th} indicator, X_i is the statistical value of the indicator, $\min(X_i)$ is the minimum value of the statistical indicator, and $\max(X_i)$ is the maximum value of the statistical indicator.

The objective weighting method, i.e., the entropy weight method, is used to determine the indicator weight. In accordance with the first-level indicators and their assigned weights, the synthetical index method is used to calculate the green consumption composite index of each province, which is:

$$Z = \sum_{j=1}^n W_j F_j$$

Specifically, Z is the green consumption composite index, F_j is the index value of the j^{th} first-level indicator, W_j is the weight of each first-level indicator, and n is the number of first-level indicators. **The index reflects the overall green consumption level in the region. The larger the index, the higher the level of green consumption.**

5.2.2.2 Empirical evaluation of China's green consumption index

China's provinces (cities, districts) differ greatly in the degree of economic development, urbanization rate, income level and consumption habits, and even the urban and rural areas of the same province (city, district) differ in consumption environment and lifestyle. Therefore, in order to avoid consumption differences between urban and rural areas, this study selected three municipalities directly under the central government, i.e., Beijing, Tianjin, and Shanghai for regional comparison, to initially measure the differences of different regions in the green consumption level.

The urbanization rates of the three cities have all exceeded 80%, and their economic development levels are relatively high and similar, which can avoid to a certain extent the impact of inconsistency caused by urban and rural differences in green consumption evaluation and those in the income level. Specifically, in terms of city size, Shanghai ranks first, with a relatively large amount of total consumption, as well as a high per capita disposable income and per capita consumption expenditure. In terms of consumption stage, Shanghai is leading. Beijing has the highest per capita GDP and leads in the level and extent of development, while Tianjin is relatively weak in the development level and residents' income and expenditure.

5.2.2.2.1 Green consumption composite index

Observed from changes in the green consumption composite index, the indexes of the country, Beijing, Tianjin and Shanghai all showed a rising trend in fluctuation. The growth rate began to slow down after 2014, reached a peak between 2015 and 2017 and fluctuated below this level (Figure 5-6). An analysis of relevant indicators reveals that after 2014, indicators that are "unfavorable" to green consumption, like the per capita domestic electricity consumption, have grown rapidly, while the growth rate of positive indicators such as per capita green land area and per capita investment in environmental protection infrastructure has slowed down. The two types of indicators run in parallel, and jointly bring about a slowdown or even a

decline in the growth trend of green consumption composite index.

A comparison of different cities indicates that Beijing's green consumption composite index has always been at a leading level; the index of Tianjin is basically comparable with the national average; the index of Shanghai is slightly higher than the national average and that of Tianjin, and is lower than that of Beijing. In terms of specific indicators, Beijing's per capita park and green land area and per capita investment in environmental infrastructure have contributed significantly to the level of green consumption. Tianjin's domestic carbon dioxide emissions and public transport have lagged the city's green consumption level. The three cities have showed no significant differences in other indicators.

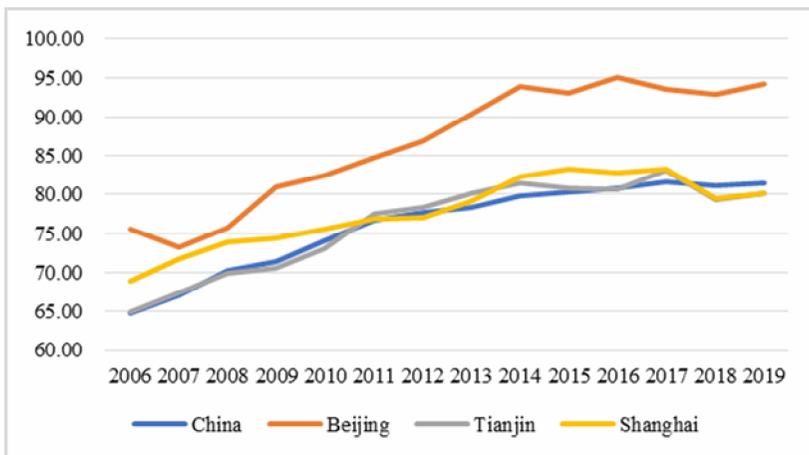


Figure 5-6 Changes in the green consumption composite index (2006-2019)

5.2.2.2.2 Analysis of green consumption indicators

(1) Per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure. On the whole, this indicator shows the impact of consumption on resources and the environment. In the ranking, Tianjin takes the lead, followed by Beijing, the country and Shanghai, and their differences are obvious. To a certain extent, carbon dioxide emissions in the domestic field are attributed partly to the intensity of energy use in life, and the difference in domestic energy use is mainly manifested in changes in the consumption structure, which indirectly reflects differences in the consumption stage. Tianjin has relatively high consumption intensity in household appliances, construction, transport and other sectors, while Beijing and Shanghai have relatively high consumption intensity in leisure, entertainment, culture and education, which causes their differences in this indicator (Figure 5-7).

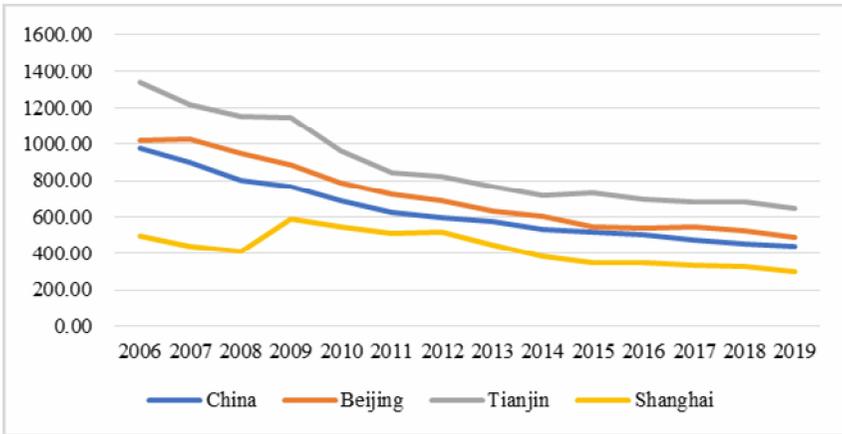


Figure 5-7 Changes in per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure (2006-2019)

(2) Per capita daily electricity consumption per RMB 10,000 of consumption expenditure. There is no significant difference among the three municipalities in terms of domestic electricity intensity, and this indicator has little impact on the ranking of the green consumption composite index. In terms of time series, in recent years, both per capita consumption expenditure and per capita daily electricity consumption have shown a trend of relatively high growth, with the per capita daily electricity consumption per unit of consumption expenditure slowing down in decline and even picking up (Figure 5-8).

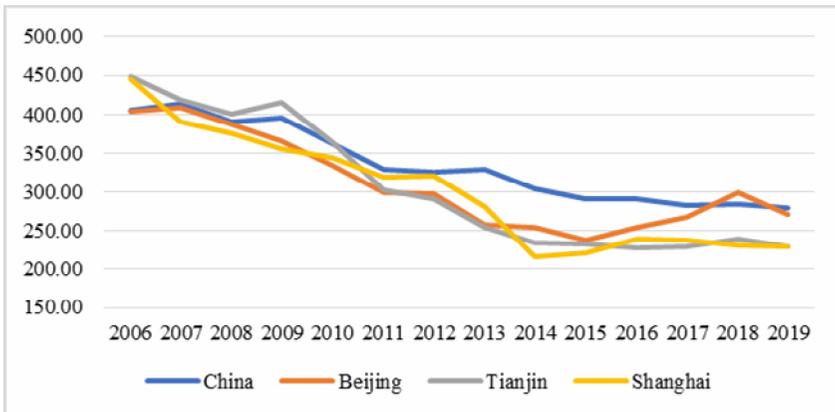


Figure 5-8 Changes in per capita daily electricity consumption per RMB 10,000 of consumption expenditure (2006-2019)

(3) Per capita daily domestic water consumption per RMB 10,000 of consumption expenditure. On the whole, the levels of Tianjin, Beijing and

Shanghai are significantly lower than the national average. In comparison, this indicator has significantly lowered the national average green consumption composite index, partly because the urbanization level of the three cities is significantly higher than that of the whole country, while the per capita daily domestic water consumption of urban areas is more intensive than that of rural areas. (Figure 5-9).

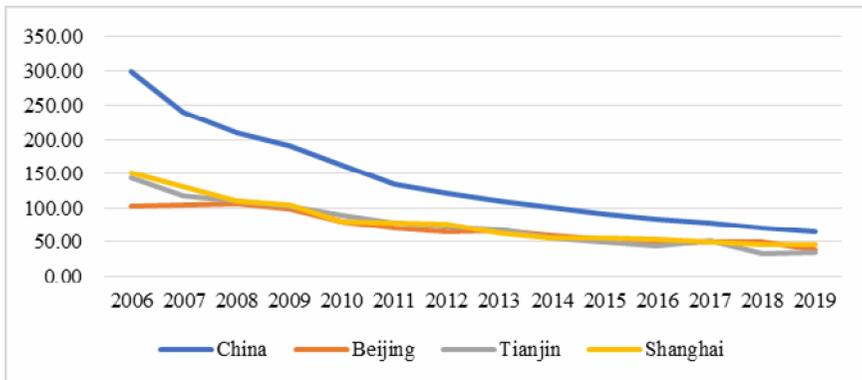


Figure 5-9 Changes in per capita daily domestic water consumption per RMB 10,000 of consumption expenditure (2006-2019)

(4) Per capita daily domestic waste collection volume per RMB 10,000 of consumption expenditure. Compared with the national average, the volume of Beijing is significantly higher, that of Tianjin is significantly lower, and that of Shanghai is basically the same with it. When the consumption level is similar to the consumption structure, this indicator usually shows differences in consumption behavior. Beijing produced more per capita domestic waste, which also indicates that its consumption behavior was more extensive and not green (Figure 5-10).

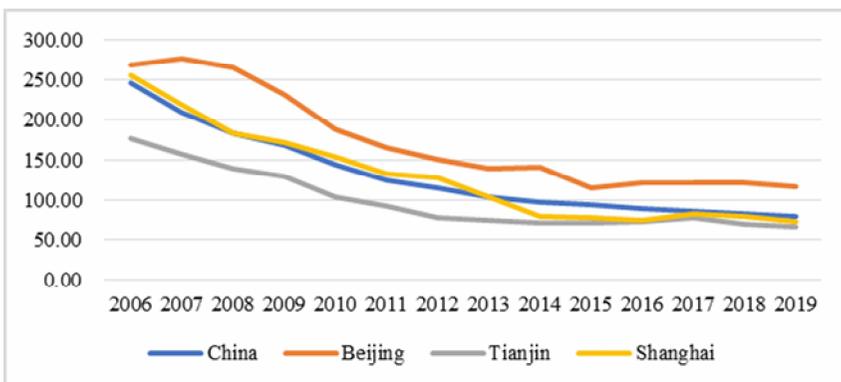


Figure 5-10 Changes in the per capita daily domestic waste collection volume per RMB 10,000 of consumption expenditure (2006-2019)

(5) Per capita park and green land area. In general, this indicator shows an upward trend. Studies show that Beijing gyrated up and is slightly higher than the national average, while Tianjin and Shanghai are significantly lower than the national average, reflecting to some extent the insufficient supply of per capita public green land in the two cities (Figure 5-11).

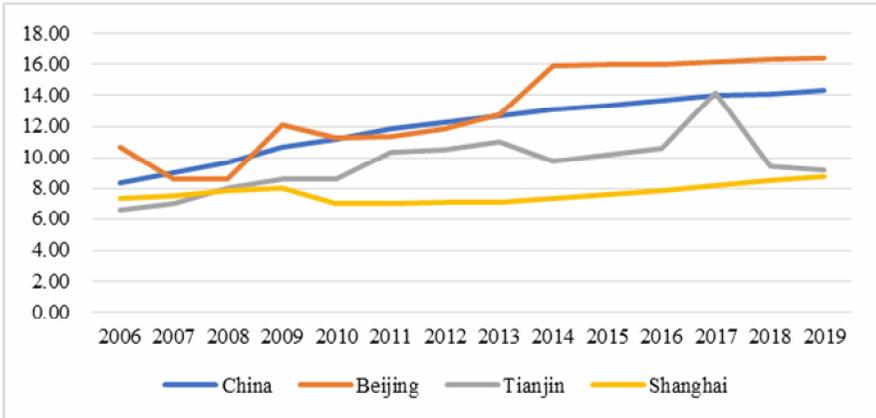


Figure 5-11 Changes in per capita park and green land area (2006-2019)

(6) Passenger capacity of urban public transport per 10,000 population. This indicator varies greatly among cities, and contributes a lot to the difference in the green consumption composite index. Statistics show that Beijing is much higher than other regions and the national average, followed by Shanghai, and Tianjin is slightly higher than the national average. This indicates the higher degree of green public transport in Beijing and Shanghai (Figure 5-12).

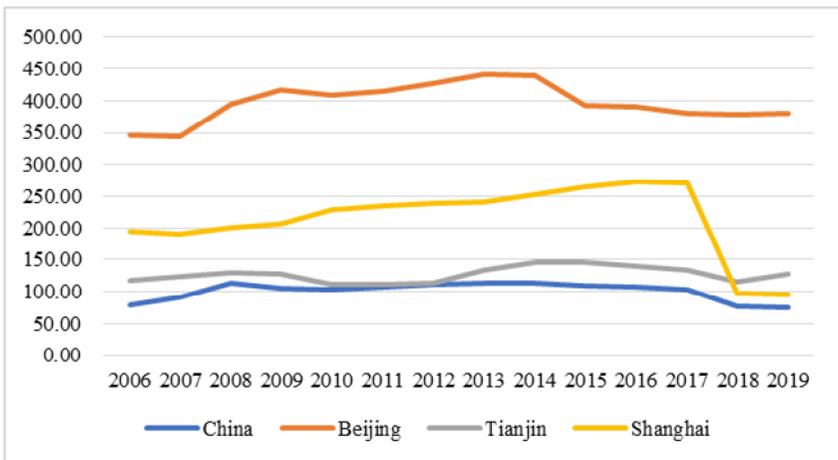


Figure 5-12 Changes in passenger capacity of rural public transport per 10,000 population (2006-2019)

(7) Per capita urban investment in environmental infrastructure construction. This indicator reflects the supply capacity of urban green infrastructure: the higher the supply capacity of green infrastructure, the more conducive to the formation of green consumption patterns, and the more conducive to mitigating the impact of consumption activities on resources and the environment. After 2010, the steep increase in investment in environmental infrastructure construction in Beijing has significantly enhanced Beijing's green consumption composite index (Figure 5-13).

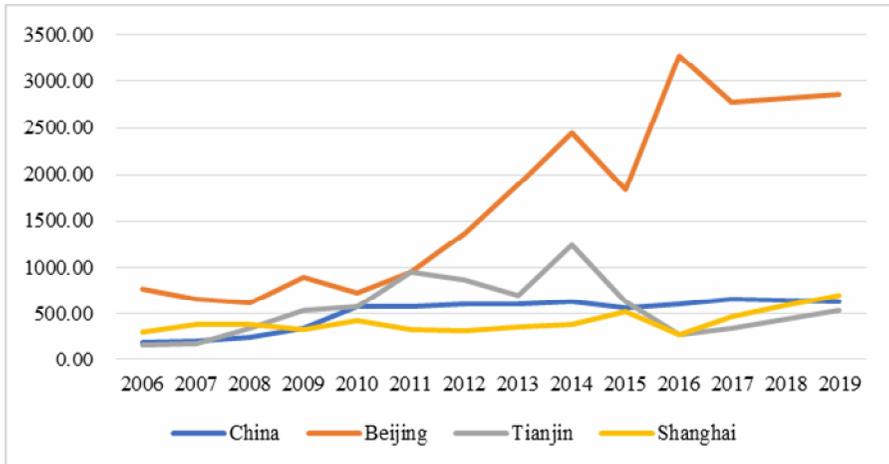


Figure 5-13 Changes in per capita urban investment in environmental infrastructure construction (2006-2019)

5.2.2.3 Analysis conclusions and policy implications

Based on the construction and analysis of the green consumption index, the main conclusions are as follows: First, the index is on the rise in general. However, with the accelerating upward trend of per capita domestic electricity consumption, per capita domestic energy consumption and other indicators since 2014, the upward trend of the comprehensive green consumption level has slowed down. Second, in comparison, Beijing showed obvious advantages in the supply of per capita park and green land, the go-green degree of urban public transport, and the supply of public environmental infrastructure, which contributed to Beijing's overall higher level of green consumption; Tianjin performed poorly in the per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure, but well in the per capita daily domestic water consumption per RMB 10,000 of consumption expenditure; Shanghai performed well in the per capita domestic carbon dioxide emissions per RMB 10,000 of consumption expenditure, but poorly in per capita park and green land area and per capita urban investment in environmental infrastructure.

For the construction and evaluation of the green consumption composite index, relevant scholars have carried out some researches, and improved the evaluation instruments and methods. However, most of these researches are restricted by the availability and relevance of data, which is related to the overall weak level in the collection, monitoring and analysis of green consumption-related statistical data. During the 14th FYP period and even a long period in the future, the green transition of China's consumption field is still facing huge challenges. The establishment of statistical and monitoring systems for relevant data is the top priority of future green consumption evaluation. The enlightenment to policy of this study is that in order to promote the green transition of social consumption at various local levels in the country, efforts need to be made in three aspects. Firstly, long-term strategic targets need to be formulated to promote green consumption and target-based indicators need to be prioritized in accordance with the current green consumption policy and practice progress and the requirements of future economy for achieving green transition and high-quality development. Secondly, it is necessary to formulate a local green development indicator system and a monitoring and evaluation system to provide a scientific basis for the decision-making of government departments, and establish a sound green consumption policy system with incentives and constraints, to accelerate the green transition of consumption. Thirdly, it is necessary to form a differentiated path to green consumption and clarify targeted key areas and tasks in accordance with the socio-economic development level and the current consumption stage of regions, to promote the transition of consumption patterns towards green and low-carbon conservation.

5.3 Case Studies on Green Production and Consumption Industries and Fields in China

5.3.1 The green tax system of China's automobile industry based on carbon neutrality

Automobiles are a pillar industry of China's national economy, and China's automobile production and sales have ranked first in the world for 12 consecutive years. Although the industry and supply chain have been shocked by COVID-19 in 2020, the growth rate of production and sales has begun to pick up gradually since March, and the annual accumulative production and sales have exceeded 25 million, due to the improved epidemic prevention and control situation, and continuous support of consumption promotion policies and measures. Moreover, the automobile industry is an important sector of energy consumption and greenhouse gas emissions: transport is a sector that consumes relatively high fossil fuels, with the consumption of gasoline and diesel accounting for 46% and 68% of the country's total consumption respectively (data of 2018 from NBS); the carbon emissions of

automobiles account for about 7.5% of the country's total (most of which come from fossil energy such as gasoline and diesel consumed in the operation and use of automobiles). Therefore, effective control of total carbon emissions in the automobile industry is particularly important for China to reach carbon emissions peak and to achieve carbon neutrality as soon as possible.

The project of last year firstly clarified the strategic position of automobiles in green consumption and production, referred to the performance evaluation methods of new energy vehicles at home and abroad, and found the ecological benefits of new energy vehicles in CO₂ emissions and energy consumption. Secondly, from top-level design, consumption and production, it analyzed the status of domestic and foreign policies and the main problems with China's policies. Finally, based on the previous research, it proposed a policy system for promoting green consumption and production in the automobile industry from the following aspects, i.e., top-level design, production, purchase, use, scrappage and recycling. The policy system includes the establishment of a green tax system for car products, the improvement of incentive policies for energy-saving and new energy vehicles, the promotion of research on the alternative technologies of HFC refrigerants in air-conditioning, the improvement of policies and regulations for the remanufacturing of auto parts, and the promotion of industry norms and sustainable development of the recycling and utilization of power batteries.

Based on the previous year's research, this year's research project organically combines the goal of carbon neutrality with the reform of vehicle tax system, focuses on the green tax system, and studies and proposes policies and measures to promote the green and low-carbon development of the automobile industry through the green tax system.

China has basically established a policy system to promote the green and low-carbon development of the automobile industry. In terms of production, China has successively promulgated the *Law on the Prevention and Control of Environmental Pollution by Solid Waste*, *Law on Promoting Clean Production*, *Circular Economy Promotion Law* and other laws to put forward requirements on reducing pollution at the source, improving resource utilization efficiency, and producer responsibility, and successively introduced a series of relevant policies and standards. In terms of consumption, China has basically established several policy systems to promote green consumption, covering tax policies, fiscal subsidies and transport policies. Among them, fiscal subsidies include vehicle purchase subsidies, urban bus operation subsidies, charging infrastructure rewards and subsidies, and relevant supporting fiscal subsidies provided by local governments. Overall, China is accelerating the development of new energy automobile industry through the joint force of central and local finance. Tax policies mainly use the tax leverage to guide automobile consumption and adjust product structure, including the formulation of

differentiated tax rates and the implementation of preferential tax policies for new energy vehicles. Transport policies are mainly local policies. They aim to enhance the convenience of energy-saving and new energy vehicles and reduce the cost of use. For purchase, they include preferential licenses and preferential insurance fees. For transport, they include preferential road and bridge tolls, high-speed tolls, and parking fee reduction and exemption discounts, road rights convenience privileges, parking convenience privileges, etc.

However, the current policies need improvement because they have failed to play a guiding role in green and low-carbon development. First, they lack systemic coordination and long-term planning. The green consumption and production policies of the automobile industry have not been planned in a unified manner, and a policy system covering laws, regulations, standards and technical specifications is still not in place. Moreover, these policies involve multi-department coordination for which various supporting policies are not systemic and coordinated. In addition, production and consumption policies have not been organically combined. Second, incentives are not in place to encourage the use of environment-friendly refrigerants. At present, automobile manufacturers in China have failed to recognize the social significance of the use of environment-friendly air-conditioning refrigerants and emission reduction, and a financial mechanism for phasing out HFCs has not been established. Third, the extended producer responsibility system has not yet been implemented. Operational difficulties in dismantling have also prevented producers from performing their responsibilities. Fourth, a green consumption policy that combines rewards and punishments has not yet been established. China's early-stage green consumption guidance policy measures focus on incentive mechanisms, including fiscal subsidies or tax reductions, which require direct or indirect input, and a long-term benign mechanism for guiding green consumption has not yet been formed.

To solve the above-mentioned four problems in the green and low-carbon development of the automobile industry of China, especially the latter three problems, the green tax system must be reformed, which has a traction effect and multiple benefits. Based on policy effects and implementation characteristics, policy design should focus on tax policies, with fiscal subsidy policies as an effective supplement for joint promotion.

5.3.2 Green design policy for China's iron and steel industry

In 2013, the Ministry of Industry and Information Technology (MIIT), the National Development and Reform Commission (NDRC), and the former Ministry of Environmental Protection (MEP) jointly issued the *Guiding Opinions on Conducting the Ecological Design of Industrial Products* (Ministry of Industry and Information Technology Lianjie [2013] No. 58), to clarify the ecological design of China's industrial products. The document points out that ecological design is an

activity that is based on the whole lifecycle concept and systemically considers at the design and development stage the resource and environmental impacts of a product during its whole lifecycle, including the selection of raw materials, production, sales, use, recycling and processing, to minimize resource consumption in the whole life cycle, minimize the use of or use no raw materials containing toxic and hazardous substances, reduce the generation and discharge of pollutants, and thus realize environmental protection. In practice, in order to integrate with the green manufacturing system, “eco design” is usually referred to as “green design”. In this report, the concepts of “eco design”, “green design” and “industrial ecological design” are not strictly distinguished. But their core connotation is consistent with the concept of “eco-design” defined above, which is based on “products” or “facilities”, and extends to production, consumption, recycling and disposal. For example, in this section, to ensure consistency, it is referred to as “green design in the iron and steel industry”; in the next section, it is referred to as “ecological design” for waste incineration facilities.

5.3.2.1 Significance of the green and low-carbon development of the iron and steel industry

In accordance with statistics, China’s crude steel output in 2019 was 996 million tons, accounting for 53.3% of the world’s steel output; the output of pig iron was 809 million tons, accounting for 64.2% of the world’s pig iron output. At present, the carbon emission contribution of China’s iron and steel industry accounts for more than 60% of the total carbon emissions of the global iron and steel industry, and about 15% of the country’s total carbon emissions, ranking first among all domestic industries. During the 14th FYP period, China’s overall crude steel output will remain at a high level, and the pressure of pollution and carbon reduction will still be huge. In addition, with the gradual removal of tariff barriers, non-tariff measures like green trade barriers are likely to become the main sanctions on China’s steel exports. Only by promoting the green design of products in the iron and steel industry and improving the green level of products from the source is it possible to deal with green trade barriers and give play to the role of the industry in reducing pollution and carbon emissions and realizing green trade.

5.3.2.2 The development status quo and overall evaluation of green design in the iron and steel industry

In order to deal with overcapacity, serious pollution, high carbon emissions in the iron and steel industry, relevant departments of the Chinese government and local governments have issued more than 30 targeted plans and industrial policies, providing important support for the green development of the industry. However, current policies overemphasize the efficient use of energy, adjustment of industrial structure and green transition of key technologies, while lacking overall consideration for green lifecycle design. Policies adopted by local governments

mainly restrict the development of iron and steel enterprises, such as relocation plans and policies. The strong government intervention in the industry may facilitate management and product quality control, but is not conducive to the differentiation of products and the formation of unique corporate advantages.

Documents such as the Notice of the General Office of the Ministry of Industry and Information Technology on Building Green Manufacturing Systems and the Guidelines for the Construction of Green Manufacturing Standard System, which were released and implemented in 2016, require accelerating the formulation and revision of standards in key areas including green design products. In accordance with statistics, more than 30 industrial standards for green design products in the iron and steel industry have been determined and are being formulated. After the above-mentioned standards are released, a standard system for the evaluation of green design products in the iron and steel industry will be gradually established.

Case: Green Design of Baogang

Baogang (Group) Co., Ltd. (hereinafter referred to as Baogang) is a 10 million-ton steel industrial base in China and the world's largest rare earth industrial base. In terms of green design, it has independently researched into and developed an online system for the lifecycle evaluation of steel products that integrates data collection, calculation, analysis, and result display. Through this system, Baogang has carried out a whole lifecycle evaluation of rare earth, rare earth steel and other products, and applied the evaluation results to product development and process improvement. For example, through evaluation, it is found that the yield rate of steel products is the most critical factor affecting the environmental load, and thus the on-site production focuses on ensuring the yield rate to minimize energy consumption and environmental emissions. On this basis, Baogang took the lead in drafting three green design product evaluation standards, for rare earth steel, iron concentrate (mined in open-pits), and sintered NdFeB permanent magnet material. Nine of its products have been included in the green design product list of the MIIT. Through green design practice, Baogang has reduced electricity consumption per ton of steel by about 4%, fresh water consumption per ton of steel by about 19%, smoke and dust emissions by about 14%, and sulfur dioxide emissions by about 74%. The sales of green products have created a direct economic benefit of over RMB 96 million, which effectively enhanced the company's green influence and product visibility, and achieved good environmental and economic benefits.

5.3.2.3 Policy issues in the green design of China's iron and steel industry

(1) Related policies are not designed in a holistic approach, and inter-departmental coordination needs to be further improved. China has not yet established an overall top-level institutional system for green design. For example,

the product certification and evaluation systems for environment-friendly, energy-saving, water-saving, recycling, low-carbon, renewable, organic, green, and eco-designed products in China overlap to a certain extent. Take sanitary wares as an example. There is an 80% overlap between *Technical Specification for Green-Design Product Assessment: Sanitary Wares (T/CAGP 0010-2016, T/CAB 0010-2016)* issued by the MIIT and *Green Product Assessment: Sanitary Wares (GB/T35603-2017)* issued by State Administration for Market Regulation (SAMR), which easily leads to unclear understanding on the concept of green products.

(2) The establishment of standards on green design products in the iron and steel industry needs to be further promoted. The MIIT proposed to issue 100 green design product evaluation standards in key industries by 2020. Of the 129 standards that have been promulgated, only 9 are in the iron and steel industry. Judging from the existing standard system of the industry, except for a few technical evaluation specifications on products, all standards are on the control of terminal emissions. In terms of source substitution, process control, resource and energy consumption, etc., technical guidance and standards are still not in place. The green design product categories issued by the MIIT include nearly 100 categories of products such as household detergents, stainless steel for kitchen utensils, and rare earth steel, covering a total of 2,176 products. However, as of now, only over 10 steel products from 5 iron and steel enterprises have been on the list of green design products. These enterprises only account for less than 1% of iron and steel companies with smelting capacity in the entire industry and these products only account for less than 1% of the total number of green design products.

(3) Guiding methods for the collaborative promotion of green design and low-carbon development have not yet been determined. Many internationally renowned iron and steel enterprises, such as Arcelor Mittal, Baowu of China, Pohang Iron and Steel Company of South Korea, JFE of Japan and HBIS Group, have released timetables and roadmaps for carbon emissions reduction. However, China has not had guiding documents, such as a policy system for the low-carbon development of the industry, carbon emissions peak and carbon neutrality programs and paths, carbon emissions control requirements and standards.

(4) The incentive mechanism for green design in the iron and steel industry needs to be improved. Enterprises that carry out lifecycle evaluation are mostly strong enterprises in the industry. The main driving force comes from the procurement and access requirements of downstream enterprises. However, the government provides insufficient guidance on the green transition of the industry, and has not yet issued clear, practical and effective incentive measures. This is not conducive to mobilizing the enterprises in terms of product design, innovation and technological breakthroughs in key green products. Thus, enterprises are insufficiently motivated to carry out relevant work.

(5) The promotion and application of the life cycle assessment (LCA) concept needs to be improved. The concept of LCA has not been sufficiently promoted in China, and has not formed social influence. Domestic iron and steel enterprises and downstream users are still unclear about or insufficiently aware of the concept of the whole life cycle, and they are not enthusiastic about participating in the LCA. Only a few enterprises with strong technical strength participate, but they often work alone. A joint force needs to be formed and communication among them needs to be enhanced.

(6) The talent training mechanism and capacity building work need to be further improved. In the context of China's high-quality development, green development, and dual-carbon goals, the green and low-carbon development of the industry featuring low energy consumption, low emissions, and low pollution has become imperative. However, the industry is facing a series of problems such as a bloated staff structure, surplus of low-end talents, lack of high-end talents, low labor productivity, low rate of capacity utilization, and an imperfect talent development system, resulting in weak innovation capabilities, insufficient scientific research output and slow green progress.

5.3.2.4 Recommendations on implementing green design policies in the iron and steel industry

(1) Strengthen the top-level design of green design policies and promote inter-departmental collaboration. MIIT, NDRC, MEE, and various industrial associations are involved in green design. They should strengthen the top-level design, establish a horizontal cooperation mechanism, and clarify their respective responsibilities and form a joint force to promote the application of green design concepts; leverage the advantage of multi-departmental collaboration, coordinate and strengthen the correlation and applicability of upstream and downstream industry standards, and simultaneously formulate new material R&D with production standards and utilization specifications to reflect the consistency of production and utilization targets.

(2) Promote green design standards and evaluation in the iron and steel industry with full-process environmental diagnosis and carbon emission reduction as the core. Standards are the basis for green design. Relevant associations and iron and steel enterprises should actively participate in the formulation of a series of green design technical specifications and standards. In addition, the iron and steel industry, with the highest carbon emissions in China, is directly related to the achievement of China's goals of carbon emission peak in 2030 and carbon neutrality in 2060. During the 14th FYP period, priority should be given to carbon emissions reduction and efforts should be made to establish a methodology that effectively integrates the life cycle and low-carbon concepts, and while building a green design system for the industry, based on the national goals of

carbon emissions peak and carbon neutrality, coordinate tasks, formulate scientific action plans and promote carbon emission peak in the industry as soon as possible.

(3) Introduce incentive measures to promote the credibility of green design and evaluation results in the iron and steel industry. Measures such as green procurement, tax reduction, strengthened price advantage for green products should be taken to encourage enterprises to explore green design paths and accelerate the promotion of green design products, technologies and services; support the establishment of a green design evaluation standard system and the release of a green design product list; and make full use of the opportunities of consumption contents and channel upgrading brought by the “new infrastructure” for vigorous industrial green design and the double upgrading of green industry and consumption. In addition, the environmental and economic policy incentive mechanism should be made full use to explore new management modes that link the results of green design evaluation with corporate environmental credit evaluation, environmental taxes, tax policies for comprehensive utilization of resources, and environmental pollution liability insurance.

(4) Actively guide the promotion and application of LCA in the iron and steel industry. Efforts should be made to promote the establishment of a sound iron and steel green product evaluation system, accelerate the improvement of the whole-life-cycle resource and environmental impact database, quantify the resource and energy consumption and environmental indicators of iron and steel products, and clarify the green degree; encourage the R&D of green improvement plans for all links of a product’s life cycle to provide a decision-making basis for iron and steel enterprises to save energy, reduce consumption and reduce pollution; and actively guide LCA promotion and application to strengthen environmental communication among upstream and downstream users and promote the construction and development of an environment-friendly and green supply chain.

(5) Establish a sound green design talent training mechanism for the iron and steel industry. Efforts should be made to enhance the awareness of enterprises in actively carrying out green design; strengthen the green design personnel team and capacity building in technical support; increase financial support for green design-related technology R&D, publicity and training; encourage enterprises to introduce senior talents from abroad, and emphasize the development of human resources.

5.3.3 Eco-design policies and standards for incineration facilities in China

5.3.3.1 The significance of ecological design for promoting the healthy and orderly development of incineration facilities

5.3.3.1.1 Characteristics of the construction and development of incineration facilities in China

Incineration has become a major way of waste treatment in China. In the next

decade, the construction of solid waste incineration facilities in China will enter a peak period, with heavy tasks and serious risks. In accordance with the *13th Five-Year Plan on the Construction of Safe Disposal Facilities for Municipal Solid Waste*, by the end of 2020, the municipal solid waste incineration capacity should account for more than 50% of the total harmless treatment capacity, and that of the eastern region should reach 60% and above. Occupying small land, having obvious reduction effect, being able to generate power, and reused for residual heat resources, incineration is vital for cities to lift their waste sieges, and has gradually replaced traditional landfills as a major harmless treatment. China's first solid waste incineration facility (Zhuhai Municipal Solid Waste Treatment Center) was put into operation as early as on July 18, 2000. Since then, the number of new solid waste incineration facilities has increased year by year, reaching a peak in 2017, when 76 new facilities were constructed and then showed a downward trend. As of the end of 2020, China had a total of 519 solid waste incineration facilities, of which 66 were constructed by Shandong Province, which had the most. Provinces with more than 50 such facilities include Zhejiang (52), Guangdong (51) and Jiangsu (51). These facilities are mostly located in the eastern coastal area. In addition, incomplete statistics show that 18 provinces and cities have issued a *Medium and Long-Term Special Plan for Solid Waste Incineration*. From 2021 to 2030, China plans to build 476 (including new projects and rebuilding and expansion projects) solid waste incineration facilities, of which 54, 49 and 35 will be built by Shandong, Guangxi and Jiangxi, respectively, which rank the top three in the number of new facilities. The number of such facilities in inland provinces has gradually increased.

5.3.3.1.2 Challenges in constructing incineration facilities in China and countermeasures

The “stigmatized” impression and the NIMBY dilemma of waste incineration facilities need to be eliminated urgently. In accordance with the public opinion monitoring data of the MEE, from 2017 to 2020, more than 330 incidents of environmental and social risks (social risks caused by environmental issues) happened in NIMBY facilities nationwide, most of which were waste incineration projects. The stigmatized impression of waste incineration facilities has become an important factor of inducing the NIMBY problem, which has seriously hindered the construction and sustainable development of public infrastructure. The main reasons for the “stigmatization” and NIMBY conflicts of waste incineration facilities are as follows: First, some old projects have problems in incineration technology and environmental protection measures, and their standards are not high. As a result, pollutants cannot be discharged continuously and stably, and odor pollution is serious. For being dissatisfied with the ecological and environmental performance of existing facilities, many people object to the construction of more such facilities. Second, some projects ignore the integration of industrial buildings and ecological landscapes in their design. As the stigmatized impression of these

projects is not changed, the disconnection and contrast between industrial buildings and ecological landscapes can easily aggravate the anxiety and rejection of the surrounding public. Third, some facilities fail to take neighborhood into account, and are deficient in the popularization of science and the design of facilities that benefit the people. Without sufficient positive publicity and public participation, it is hard to enhance public awareness of waste incineration facilities. The “stigmatization” of these facilities often leads to the opposition of surrounding residents to new projects, and such projects fall into the predicament of “causing chaos once the construction begins, and being stopped once such chaos happens”. This has not only affected the construction of important public infrastructure, but also caused adverse social impact and affected social stability.

The existing waste incineration facilities perform well in environmental protection, but fail to meet the requirements of landscape coordination and humanistic harmony. In order to promote the environmental governance and green development of waste incineration industry, China has proposed a number of standards and normative documents for waste incineration plants. These regulatory documents mostly focus on terminal management and control, having the most comprehensive requirements on environmental governance, being dominated by requirements on pollution discharge, and being close to international standards, such as the collection and treatment methods of waste gas, and the discharge compliance rate of leachate. Through analysis of the environmental performance data of all 519 facilities in operation on the national incineration plants monitoring data disclosure platform (<https://ljgk.envsc.cn/manage/index.html>), it is found that the flue gas emission concentration of almost all domestic waste incineration facilities can meet national standards, and the flue gas emission concentration of most facilities is better than existing national standards. In accordance with the *GB 18485-2014* standard on incineration, from December 2019 to December 2020, out of a total of 1,961,626 detection records of 5 flue gas pollutants, 29 over-pollution incidents occurred, and the compliance rate reached 99.99%. In accordance with the *RISN-TG022-2016 Guideline on the Incineration of Domestic Waste*, more than 90% of the emissions of sulfur dioxide, particulate matter, and carbon monoxide reached the first-level base value (the advanced international level for clean production), more than 90% of nitrogen oxides and hydrogen chloride reached the second-level base value (the advanced domestic level for clean production), and the overall environmental performance was good. However, there is still no high-level control standards and guidance for the existing facilities. In addition, the current regulatory documents are still inadequate in terms of landscape coordination and harmonious design that are of public concern. Thus, it is necessary to further strengthen regulatory constraints, and conduct case summaries and experience promotion.

Apply the concepts and methods of ecological design to upgrade waste

incineration facilities into green facilities to provide the public with a good living environment and environment-friendly products. To get rid of the NIMBY dilemma, efforts must be made to change the public impression of stigmatization, and restore the function of waste treatment facilities, i.e., disposing of waste and returning a good and qualified living environment to the people. Waste incineration facilities have dual properties: on the one hand, as industrial treatment facilities, they can dispose of waste through incineration; on the other hand, as green facilities, they can reduce the amount of waste and reduce land occupation, water pollution, soil pollution and odor pollution caused by waste, thus providing environment-friendly products and services. The application of ecological product design concepts in the design, construction and operation of waste incineration plants is of great significance to the industry's green development. They are not only an innovation in ideas, but also an innovation in the methods and tools, which will inevitably bring about a policy and institutional reform to prevent NIMBY.

5.3.3.2 Research on ecological design standards of incineration facilities

5.3.3.2.1 Establishment of standards for the ecological design of incineration facilities

Based on the existing evaluation indicators and requirements as well as the level of existing incineration facilities, this study aims to propose comprehensive evaluation indicators and requirements by establishing an ecological design evaluation model for incineration facilities that meets the needs of industrial development with comprehensive and systematic principles. The final ecological design evaluation indicator system includes 28 indicators in four aspects, i.e., environmental safety, ecological harmony, community-friendly, and economic and effective (see Table 5-4), and has basically formed an *Eco-Design Evaluation Standard for Incineration Projects*, including the standard settings and release suggestions. Specifically, Environmental Safety requires that environmental emissions meet or exceed the requirements of relevant national or local laws, regulations and standards; Ecological Harmony requires that buildings, waste incineration facilities and pollutant treatment equipment and facilities should be integrated into the natural ecological landscape and urban cultural landscape to reduce the abruptness and discomfort of the natural environment or the area where the people live; Community-Friendly requires that the access requirements should be met, and publicity, education and public facilities be put in place; Economic and Effective requires the input of energy and resources and investment and operating costs should be reasonable.

Table 5-4 Evaluation standards for the ecological design of incineration facilities

No.	First-level indicators	Second-level indicators	Third-level indicators
1	Environmental safety	Facilities	Special equipment
2			Pollutant treatment equipment and facilities
3		Flue gas emission	Flue gas emission
4			VOC emission (optional)
5		Sewage treatment	Leachate discharge
6			Whole-plant sewage discharge
7		Slag treatment	Slag reduction rate
8		Fly-ash treatment	Fly-ash disposal
9		Environmental noise	Factory boundary noise
10		Greenhouse gases	Greenhouse gas emissions (optional)
11	Ecological harmony	Location	Planning and location
12-15		Buildings	Intensive construction land
16			Harmonious architectural landscape
17	Greening	Go-green rate	
18	Community-friendly	Information disclosure	Environmental information disclosure
19		Affiliated facilities	Publicity and education facilities (optional)
20			Public facilities (optional)
21	Economic and effective	Recycling	Comprehensive utilization rate of slag
22			Waste heat utilization rate
23		Resource conservation	Electricity consumption per ton of waste entering the plant
24			Steam consumption rate of steam turbines
25			Water consumption per unit of power generation
26-27		Investment fees	Reasonable investment costs
28		Operation fees	Annual operating hours

5.3.3.2.2 Cases of ecological design evaluation of incineration facilities

The research team investigated and researched into two cases, i.e., Dynagreen Environmental Protection Group's Lanzilong Comprehensive Treatment Project in Huiyang District, Huizhou City and Everbright Environment Group's Changzhou Municipal Domestic Waste Incineration Project, and conducted ecological design evaluation from four aspects, i.e., environmental safety, ecological harmony, community-friendly, and economic and effective, to create an eco-design prototype of incineration facilities. The former project is characterized by industrial recycling,

which, through scientific planning and design, organically connects the processes applied in various projects in the circular economy industrial park to form a mutually reinforcing process chain, so that the park forms an organic whole where resources can be recycled, thus truly realizing energy conservation and emission reduction, and facilitating the green, low-carbon and sustainable development of the city. The project of Everbright Environment Group is characterized by community interaction, and has rich experience in the design of landscape, information disclosure, and public facilities and measures. The analysis results show that both domestic waste incineration projects have performed well in pollution emissions, opening to the public, and public facilities, and played a leading role in the industry, but their economic costs are slightly high, to which more attention shall be paid in the design of waste incineration projects.

5.3.3.3 Policy recommendations

(1) Give full play to the late-comer advantages of China's incineration industry, introduce ecological design concepts, protect the ecological environment and turn NIMBY into "open-arms". At present, the emission standards and design and construction capabilities of China's newly-built waste incineration facilities have reached advanced levels at home and abroad in terms of environmental safety technology, ecology, and community-friendliness. It is recommended to vigorously promote advanced concepts in the ecological design of incineration facilities, introduce ecological design methods and modes to the waste incineration industry, and generally improve the environmental performance of waste incineration facilities in China to the international advanced level, to accelerate the industry's green development, and help prevent NIMBY.

(2) Actively integrate existing green-related standards and promote ecological design in the incineration industry. Currently, green standards and normative documents on incineration facilities have different sources and the preventative mechanism from the source is not perfect. To form a joint force of promoting the application of eco-design concepts, it is recommended that the industrial authorities take the lead and unite with the MEE and other departments and industrial associations to strengthen top-level design, establish horizontal cooperation mechanisms, unify evaluation standards and technical specifications, and set up a policy framework for the ecological design of waste incineration facilities, including building an evaluation indicator system, formulating eco-design guidelines, and developing eco-design evaluation.

(3) Promote a pioneer system of incineration facilities. It is recommended to establish role models and pioneers in the ecological design of waste incineration plants, and combine them with corporate supervision. Capital investment and tax preferential policy support will be given to waste incineration plants that have obtained the eco-design environmental protection label, so that the ecological design

of waste incineration plants can be promoted in the market. In addition, a list of enterprises for eco-design of incineration facilities will be established to encourage and urge enterprises to carry out industrial eco-design and green transition.

5.3.4 Green consumption policy for China's food

The sustainable consumption of food has attracted more and more attention from the international community. The loss and waste of food not only mean the ineffective consumption of resources and other inputs and the emission of a large amount of greenhouse gases in the process of production, but also means that a large amount of greenhouse gases is generated by wasted food in various treatment methods, such as carbon dioxide, methane and carbon monoxide. If the total amount of greenhouse emission derived from the global wasted food is compared with that from a country, it will rank the third largest emitter of greenhouse gases. To reduce carbon emissions and protect biodiversity, this report analyzes the food waste problem in China and recommends relevant countermeasures.

The green consumption of food in this report refers to food consumption behavior characterized by resource conservation and environmental protection, which is mainly manifested as advocating thrift, reducing loss and waste, choosing efficient and environment-friendly food and services, and reducing resource consumption and pollution emission in the process of consumption.

5.3.4.1 The status quo of resources and environmental issues concerning food consumption in China

5.3.4.1.1 The amount of overall loss and waste in the food supply chain is large

As a large agricultural country, China feeds 22% of the world's population with only 7% of the world's arable land. Its main food, from agricultural production to consumption, is being lost and wasted at varying degrees at each stage. In China, more than 60% of grain is stored by more than 200 million farmers. The lack of professional technical guidance in post-harvest processing, processing and transportation, poor tools and equipment, rough processing, and limited market information acquisition capabilities have led to a large amount of food loss and waste in various supply links. According to the results of a sample survey conducted by the National Food and Strategic Reserves Administration (formerly the National Food Administration) in 2016, the annual food loss from field to table was about 135 billion jin, accounting for 10.9% of the year's total food output. Specifically, merely in the link of storage by farmers, the annual food loss amounted to 40 billion jin, accounting for about 8% of the stored volume, which was equivalent to 61.6 million mu of grain production. Due to the low degree of specialization, insufficient fruit and vegetable processing conversion rate, and the lagging in the development of cold chain logistics, the average loss rate of fruits in the logistics link is 20% to 30%, and that of vegetables is close to 30% to 40%. Each year, more than 100

million tons of fruits, vegetables and agricultural products are lost due to rot, causing up to RMB 100 billion of economic losses.

5.3.4.1.2 Consumers are a key contributor to food waste

It is estimated that about 35% of food loss and waste occurs in consumption^[1]. In China's entire food supply chain, the consumption end has the largest proportion of food loss^[2]. Especially in recent years, due to the improvement of living standards, people eat out more frequently, and the trend of waste and extravagance becomes obvious. An investigation report shows that from 2013 to 2015, China's annual food waste was as high as 17 to 18 million tons, which was equivalent to the annual food needs of 30 to 50 million people^[3]. In 2016, China's kitchen waste was about 97 million tons, of which more than 60 million tons came from several major cities, and accounting for about 37% to 62% in municipal domestic waste. In 2018, the country generated more than 100 million tons of kitchen waste, reaching 108 million tons, an average of nearly 300,000 tons per day.

5.3.4.1.3 Food loss and waste have caused huge economic losses

Food waste in consumption causes economic losses to consumers themselves. For example, the economic value of food wasted by Finnish households in 2010 was equivalent to 70 euros per person per year. Food waste also causes losses to society. In accordance with the food waste record of a retail store in Italy, the amount of wasted food in this store was 70.6 tons in 2015, which was mainly bread, fresh vegetables and fruits, with a total value of nearly 170,000 euros. Knowing the economic cost of wasted food may urge consumers to improve their consumption behavior, and the money saved by reduced food waste is seen as a key driving factor for preventing consumers' food waste behavior.

Globally, FAO proposed in 2015 that the economic value of food lost and wasted globally in 2012 amounted to USD 936 billion, which was equivalent to one year's gross national product in the Netherlands. Thus, reducing food loss and waste is significant for the economy. The average benefit-to-cost ratio of reducing food waste in the catering industry can reach 7 to 1. Studies in Australia have shown that in the food loss and waste reduction campaigns initiated by non-governmental organizations, every USD invested could save USD 5.71 of food from being wasted.

5.3.4.1.4 Food waste has caused certain environmental costs

The data research of China Health and Nutrition Survey (CHNS) shows that food waste from Chinese households has a negative impact on the climate, water and land resources. In 2011, food waste from Chinese households amounted to 16kg per person per year, equivalent to 40kg of carbon dioxide emissions and 18m³ of additional water loss. By analyzing the greenhouse gas emission characteristics of food and estimating the whole-life-cycle carbon emissions of food in 1996, 2000, 2005 and 2010, Wang Xiao of Tsinghua University concluded that the whole-life-cycle carbon emissions of food in China were 1.605 billion tons of carbon dioxide

equivalent per year. Even if only one-fifth of food is lost or wasted in China (rather than one-third, the global average level proposed by FAO), carbon emission will reach over 300 million tons, which is huge and cannot be ignored. In addition, the amount of kitchen waste is large in China. Domestic scholars conducted a study on 7-year household food waste in 9 provinces and cities in China in 2015 and found that 1kg of kitchen waste could produce 0.34kg of methane under fully fermented conditions, and under the standard state (0°C, 1.013×10⁶Pa), the theoretical amount of methane generated would be 0.44m³/kg. If the wasted food of the 9 provinces in 7 years is buried and fermented, 19 million tons of carbon dioxide will be emitted. In contrast, if the wasted food can be fully used as resources, 8.45 million tons of standard coal can be saved.

3.4.2 Policy recommendations on promoting green food consumption

5.3.4.2.1 For government departments

First, strengthen legislation, supervision and inspection on food waste and stop food waste in the form of legal documents by formulating local laws and regulations against food waste and putting in place rules to punish food waste in restaurants. Second, carry out diversified and multi-channel publicity and education. Efforts should be made to intensify multi-channel publicity against food waste, expose food waste phenomena, promote role models, and encourage voluntary objection against food waste in the whole society. Third, curb position-related consumption and prohibit food waste. Continued efforts need to be made to restrict position-related consumption, guide social consumption behavior by position-related dining behavior, and transform social atmosphere and dietary concepts from top to bottom. Fourth, strengthen guidance and further optimize the catering structure. Efforts need to be made to implement the *Guiding Opinions of the Ministry of Commerce on Accelerating the Development of Popular Catering* issued in 2014 to promote the rational and healthy development of the catering structure. Fifth, improve laws, regulations and application systems on the collection and recycling of kitchen waste. Legislation should be strengthened to prevent the illegal processing of kitchen waste. The existing waste recycling mechanism should be improved to encourage the disposal and recycling of kitchen waste as resources. Sixth, strengthen scientific research and platform support in the field of food consumption and waste. A basic information database on food waste should be built in typical cities and major food supply chains. A decision-making support system should be established to reduce food waste. And the advantages and experience of research institutes and universities in related fields should be actively leveraged to carry out food waste-related investigations and research.

5.3.4.2.2 For industrial associations and NGOs

First, formulate industrial standards. Functions of industrial organizations should be strengthened to expand the field of industrial supervision and promote the

standard, regulated and scientific development of food production, transportation, processing and consumption. Second, give play the role of intermediary organizations. Industrial exchanges should be organized to strengthen the communication and coordination of enterprises with the market, enterprises and consumers, consumers and the government, and promote the healthy development of the catering industry. Third, strengthen public opinion supervision and public propaganda. Scientific, moderate and green food consumption patterns should be actively called for and advocated to avoid food waste at the dining table, promote civilized dining and establish a new style of catering.

5.3.4.2.3 For catering enterprises

First, rationally position catering enterprises and improve the way of serving meals. Standardized dishes should be provided so that consumers can season their food based on needs, optional set menus can be determined, and small dishes can be offered. One ingredient for multiple dishes and one dish with multiple flavors should be advocated to make the best use of ingredients. Second, be active and responsible and encourage civilized dining among consumers. Ordering service should be improved to remind consumers of their order. Oriented dining service should be stressed to promote scientific, healthy, green and civilized consumption by recommending reasonably configured menus and offering package services. Third, strengthen the sense of responsibility and help dispose of kitchen waste. Government regulations should be abided by to dispose of or utilize kitchen waste, and prevent illegal collection and processing of kitchen waste and its circulation into the food industry.

5.3.4.2.4 For consumers

First, establish a correct concept of food consumption and follow a scientific, moderate and green consumption pattern. (1) Scientific consumption: forming healthy dietary habits and pursuing balanced taste and nutrition; (2) moderate consumption: ordering meals based on one's own economic capacity and actual needs; (3) green consumption: consumption behavior that minimizes the negative effects on the environment and maximizes the long-term environmental benefits. Second, actively participate in publicity and education activities. Actively participate in campaigns like "green consumption, healthy consumption and low-carbon consumption" to enhance the awareness of sustainable consumption and the development of healthy consumption habits; encourage consumers to monitor and report food waste behavior and hidden dangers in catering; promote thrift and voluntary objection against food waste in society. Third, actively promote the meal-sharing system. The meal-sharing system can not only prevent and reduce the chance of cross-infection of various diseases, but also reduce food waste, so that the national catering industry can save a considerable amount of food and agricultural and sideline products each year.

5.3.5 Green label certification policy

5.3.5.1 The roles of green label certification in promoting green production and consumption

Establishing a unified green product standard, certification, and labeling system can promote green, low-carbon and circular development, cultivate a green market, strengthen supply-side structural reform, improve the quality and efficiency of green product supply, guide industrial transformation and upgrading, enhance the competitiveness of manufacturing, lead green consumption and guarantee and improve people's livelihood. In the phase of achieving high-quality development and promoting green development in China, green label certification can promote green production and consumption:

First, urge enterprises to make green innovation, transformation and upgrading from the consumption end. Green label certification, for example, the environmental labeling system, adheres to the concept of whole-life-cycle process management and connects with producers with products as a carrier. Through the certification of products, it puts forward green standards and requirements in the whole life cycle, including product design, raw material use, production processes, product use and waste recycling, which provides the market with green products. Green label certification is also linked with consumers. By releasing information on green label products to consumers, the system encourages consumers' green choices, and urges the green transition of production to provide impetus for supply-side reform. Take the green label certification of China Environmental Labeling as an example. The environmental performance of certified enterprises from 2017 to 2019 is shown in the following table:

Table 5-5. Environmental performance of China Environmental Labeling products (2017-2019)

Category	Pollution factor	Emission reduction in 2017	Emission reduction in 2018	Emission reduction in 2019
Air Pollution	VOCs	472,400 tons	524,900 tons	805,500 tons
	NO _x	13,400 tons	16,400 tons	29,000 tons
	SO ₂	3,500 tons	4,300 tons	7,600 tons
	CO ₂	3.0252 million tons	3.6805 million tons	6.5375 million tons
Water pollution	Total phosphorus	3,780 tons	4,574 tons	5,297 tons
Solid and hazardous waste	Plastic waste	6,411 tons	7,566 tons	5,026.6 tons
	Heavy metal Hg	8.89 tons	11.00 tons	10.988 tons
Energy conservation	Electricity conservation	10.219 billion KWH	17.260 billion KWH	19.403 billion KWH

Category	Pollution factor	Emission reduction in 2017	Emission reduction in 2018	Emission reduction in 2019
Resources conservation	Water conservation	68.422 million tons	131.408 million tons	253.353 million tons
	Plastic conservation	9,930 tons	11,360 tons	9,520 tons
	Industrial waste	2.7487 million tons	1.9061 million tons	3.1418 million tons
	Pulp consumption reduction	1.4174 million tons	1.3229 million tons	1.4904 million tons
	Toner cartridge/Inkjet cartridge	21.6174 million	25.0001 million	2.2177 million

Second, promote the communication of environmental information among the government, enterprises in various industries, and consumers. Green label certification, especially the green label certification system, focuses on the country's ecological civilization construction and the overall goals of carbon emissions peak and carbon neutrality. As a market and economic tool, it advocates green consumption, promotes the sustainable development of social economy, improves environment quality, protects consumers' rights and interests, achieves institutional innovation that uses market mechanisms to intervene in micro-environment governance, and provides technical support for green consumption policies. More and more consumers begin to feel the environmental superiority of green products and choose to purchase green label products. Through the public consumption choices, green label products can become a link between the public and green development, thereby further promoting green consumption. Green label certification will give full play to the guiding role of standards and credibility of certification labels, and become a powerful tool to encourage enterprises to create a green, circular and low-carbon development pattern.

5.3.5.2 Problems in the development of green label certification

In recent years, the Chinese government has attached great importance to the development of certification labels and system. Various certification labels have effectively promoted the progress of green manufacturing, and played an active role in building an efficient, clean, low-carbon and recycling green manufacturing system. However, with the in-depth development of relevant practices, problems in the green label certification have gradually become prominent.

(1) The top-level design is not in place and government supervision functions are inconsistent. Green product certification labels are various and managed by multiple entities, which perform overlapping supervision functions and have inconsistent powers and responsibilities. This is not conducive to the adjustment of existing policies, laws and regulations. The certification and evaluation process of

enterprises has the problems of repeated evaluation and testing, which has increased the burden on enterprises.

(2) Continuous and effective incentives are not in place. At the current stage, a continuous financial investment mechanism for certification and labeling has not been set up, and financial investment is inconsistent and unstable. In addition, there is no clear taxation, support and preferential incentive mechanisms in the market and product evaluation, leading to inactive market adjustment.

(3) The system of laws, regulations and standards is to be improved. The existing policies and norms guiding the certification of green label products mainly include the *Opinions on Establishing a Unified Green Standard, Certification, and Labeling System* and the *General Rules for the Evaluation of Green Label Products*. As the latter has only been applied for a relatively short period of time, the level of certification is not high and management experience is insufficient. In general, laws, regulations and standards on certification labels are far from being complete, and cannot meet the needs of relevant technologies and products for scientific evaluation.

(4) The validity of certification is controversial, and the certification and evaluation system needs to be improved. China currently has a variety of green label product certification systems, and has not yet formed a unified label, standard and certification system. For a unified product range, a unified standard and conformity assessment procedure has not been formed. Enterprises are inconfident in the credibility of certification labels, consumers find it difficult to identify labels and the labels are not fully recognized in the market.

5.3.5.3 Policy suggestions

In the field of green label certification, it is necessary to gradually establish a system of green label product standards and a system of certification and labeling that is scientific, open, integrated, authoritative and consistent with advanced indicators, and improve laws, regulations and supporting policies to achieve the systemic goals for the same product, the same standard, the same list, the same certification and the same label, so as to form a joint force to significantly enhance the market recognition and international influence of green label products, increase their market share and quality benefits, reverse the current supply-demand imbalance of domestic green label products, and significantly strengthen the sense of acquisition of domestic consumers.

(1) Give play to the leading role of green label certification and promote green production and lifestyle. In the field of consumption, give full play to the leading role of green label certification/evaluation standard system to achieve the systematic and effective connection between production and consumption. In the industrial field, to promote industrial green upgrading and carbon emissions peak, focuses should be attached on the R&D of green production and the improvement of green label standard systems for green transition-related industries, such as iron and

steel, chemicals, non-ferrous metals, building materials, textiles, paper, leather, etc., with the certification of green label products as a means to lead the industry towards green and low-carbon development.

(2) Strengthen top-level design and create a unified certification system for green label products. In the field of green label certification, strengthen the collaborative management of the SAMR, the MEE, the MIIT, the NDRC and various industrial associations, and leverage the respective advantages of existing green labels, to form a joint force to strengthen top-level design and build a rational management system. A horizontal cooperation mechanism should be established to determine label management tasks from the time and space dimensions, harmonize evaluation standards and technical specifications, and form a scientific, rational, efficient and powerful management mechanism. An inter-ministerial conference system for label certification should be established to coordinate and unify different green label certifications.

(3) Improve the incentive mechanism for green label certification. Certification labels could be used to promote industrial ecological design among enterprises. In addition, environmental and economic policy incentives could be applied to incorporate industrial ecological design into the purposes and measures of corporate environmental management, which encourages enterprises to form a full-chain ecological and environmental management system. Government departments should continue to play a leading role in certification, and highlight the prominent position of label certification in promoting the green development of enterprises by purchasing green label products that have passed label certification.

(4) Improve the validity and international recognition of green label certification results. Operational and post-operational supervision should be strengthened to enhance the validity of labels and certification results, hold certification bodies accountable, form an information chain that is traceable and accountable, form a complete green label certification and evaluation system, and improve the validity of green label certification. In terms of establishing a green trade system, intergovernmental cooperation should be promoted to deepen the mutual recognition mechanism for green label certification internationally, and give play to the role of green label certification as trade passes.

5.4 International Experience: Accelerating and Deepening the Green Transition

5.4.1 Urgency of action

The ten-year anniversary of the launch of the United Nations' 10-Year Framework of Programmes on Sustainable Consumption and Production in 2022

provides a wonderful opportunity to highlight a critical message: “the major cause of environmental degradation is our current unsustainable patterns of consumption and production.”^[4] The One Planet network, a multi-stakeholder partnership formed to implement the program’s commitments, addresses six main areas: sustainable public procurement, tourism, consumer information, buildings and construction, food systems, and lifestyles and education. Many of these link to the 17 Sustainable Development Goals, including most notably SDG 12 (responsible consumption and production).

Past efforts to address sustainability problems have often failed to examine consumption and production processes in their full complexity or across their entire value chain. Unless there is a market for recycled materials, the incentive to recycle will be limited. Unless products are made using clean energy, recycled materials and sustainably derived resources, pollution problems will continue unabated. Full life-cycle approaches are needed that consider the sustainability of material and energy inputs, production processes, product design, and product use as well as the reusability of product parts and their recyclability. Innovative business models with less environmental and social impact from a system perspective are needed to mitigate the increasing demand for products and services.

Consumers must also be incentivized to consume at more sustainable levels, with less waste and more focus on product quality and the social and environmental impacts of their purchasing behavior. This also means that products must be developed that provide consumers with suitable choices and information so that they can opt for sustainable products. Results from the Swedish MISTRA Sustainable Consumption Research Programme show that it is possible to attain as much as 40% reduction of greenhouse gas emissions from consumption through switching to more sustainable products and services that are already available, e.g. switching from a meat-based diet to a vegetarian diet or from buying new furniture to buying second hand. While a transition to sustainable consumption will demand some investments in new infrastructure and more sustainable products, these results show that considerable effects can be achieved here and now also through behavioral changes.

For the past many decades, the main goal of most societies has been to foster economic growth through industrial production and consumption; too little attention has been paid to the negative environmental and societal consequences of this growth. While some progress has been made in areas, such as recycling of paper, glass, and metals; automobile emission standards; and food safety standards, the reality is that high and rising consumption volumes are leading to ever more packaging-, product-, textile-, and food waste. And even in areas where there has been progress, many challenges remain. Many products and materials are not recycled; transportation continues to be one of the largest sources of greenhouse gas emissions; and food security faces new risks from climate change, plastic pollution,

and excessive pesticide use.

The green transition will require the adoption of sustainability concepts into all realms of business, finance, government, and society. Also crucial will be sensitivity towards gender dimensions of sustainability as women and men are differently involved in and impacted by production and consumption patterns and do not always share the same preferences or have the same opportunities to be heard.

The governments of Germany, Sweden, and Japan as well as the European Union have signaled their growing concern with the sad state of the global environment by elevating the attention being paid to the green transition. They are doing this by setting green transition visions and pathways, requiring sustainability at all levels in their own operations, and introducing a broad array of new regulatory and market-based policies and measures and educational campaigns. A growing body of research and practice provides insights into how fundamental system change can be achieved.

5.4.2 Responding to the COVID-19 pandemic with green recovery plans

The importance of the green transition has been amplified by the COVID-19 pandemic. Within a few short months the pandemic spread around the world bringing economies to their knees. It has led to tragic loss of life, illness, and huge economic setbacks and losses. There are good reasons to believe that environmental degradation and the loss of natural habitats are contributing to the spread of zoonoses as humans are more frequently encountering wild animals. Climate change will certainly have even much larger economic and societal impacts. The costs of storms, floods, hurricanes, droughts, and other climate-related impacts are already enormous and will get worse as the climate continues to warm. The loss of biodiversity and wide-spread environmental degradation will have severe impacts for not only this but also future generations. A silver lining to the otherwise horrific global coronavirus pandemic is the growing recognition of the need to accelerate the sustainability transition by investing in a green recovery.

5.4.3 Supranational level: The European Union Green Deal and the Green Recovery Plan

The EU has been a frontrunner in setting ambitious plans for a green recovery. The European Union is actively moving to direct member states' economies to limit resource use and waste, develop new industries, promote green jobs, redesign urban structures, and change societal behavior through the promotion of a green transition. The European Green Deal sets a new growth strategy intended "to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use". The European Union decided to

raise its 2030 greenhouse gas emissions reduction target to 55 percent (compared to 1990 levels) and to achieve climate neutrality by 2050.

Part of the EU Corona recovery package that was spearheaded by Germany and France calls for a tax on non-recycled plastics and the introduction of carbon border taxes starting in 2023 on products being produced in countries with lower carbon emission standards than the EU. Thirty percent of the total €1.8 trillion package combining the multiannual financial framework (MFF) and Next Generation EU is to target climate-related projects.

The Recovery and Resilience Facility (RFF) is the central pillar of the recovery plan. It provides financial support to EU countries to mitigate the social and economic impact of the COVID crisis. The Next Generation EU envelope amounts to €807.1 billion including €724 billion for the RFF plan. National plans must include reforms and public investment projects that align with EU priorities, reflect country-specific challenges, support the green transition and foster digital transformation. Reforms and investments must be carried out by 2026.

5.4.4 National government strategies on Corona Recovery and Green Transitions

The following sections provide background details on case study countries - Germany, Sweden and Japan - highlighting the unique characteristics of each country's approach and presenting options which may be of interest for China as it designs its own green transition policies and social governance system.

5.4.4.1 Germany

In June 2020 Germany launched an economic stimulus package to strengthen demand and secure employment while helping the economy to emerge from the crisis in a more climate-friendly manner. In December 2020 the Federal Cabinet adopted the German Recovery and Resilience Plan (*Deutsche Aufbau- und Resilienzplan*), a follow-up to the stimulus package.

The issuance of a National Recovery and Resilience Plan is a pre-requisite to receiving funding from the EU COVID recovery plan, Next Generation EU. The German Recovery and Resilience Plan's six priority areas are: 1.) climate change (with an eye toward Germany's 2050 carbon neutral target), 2.) the digital transformation of the economy and infrastructure, 3.) digitalization in education, 4.) strengthening social participation (e.g. with a digital portal introducing retirement schemes, day-care facilities for children etc.), 5.) strengthening the health care system for pandemic-resistance, and 6.) modernization of administration and reduction of barriers to investment.

The German Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety (BMU) has developed a Corona Response Package under its International Climate Initiative (IKI). The €68 million package supports IKI's partner countries efforts to address pandemic challenges. The aim is to maintain and

strengthen existing social structures, promote and accelerate economic transformations with a focus on climate change mitigation and conservation of biodiversity to contribute to the prevention of future pandemics. The fast-track procedure has been simplified for speed and effectiveness. Priorities include: introducing emergency measures to protect nature reserves and biodiversity hotspots from a rise in poaching and deforestation linked to the loss of tourism funds; helping indigenous populations who are at acute risk; financing economic advisors in twelve partner countries so they can provide support to planning and finance ministries in designing climate-friendly economic stimulus programmes; funding ongoing IKI projects that have a special employment effect and long-term impacts on energy efficiency, renewable energies, urban development and sustainable investments; and, supporting the design and implementation of the new global framework for biological diversity and the Biodiversity Finance Initiative (BIOFIN) which aims to address knowledge gaps on the actual costs that are needed to effectively implement biodiversity strategies in partner countries.

5.4.4.2 Sweden

The government bill (2021-23) on green recovery focuses on transforming Swedish industry to lower GHG emissions, furthering the transition toward a sustainable transportation system, reducing loss in biodiversity and supporting the shift to resource effective, low-carbon, circular and non-toxic material and energy flows. The investments are expected to increase environmental quality, create new jobs and strengthen competitiveness.

One example is the introduction of governmental credit guarantees. In 2021 green credits of up to 10 billion SEK were issued to promote long term capital-investments to enable a green transformation of industry and open up future green employment opportunities. The credits are expected to increase to 15 billion SEK in 2022 and 25 billion in 2023.

The spread of the COVID-19 virus and the resulting economic crisis have had a severe impact on Swedish society. The Swedish government foresees new opportunities to intensify a transition to a circular economy through a green recovery and has recently (2020-21) introduced a national strategy and action plan for a circular economy, including sustainable consumption. Further digitalisation of both demand and supply is a key strategy. A national strategy on digitalization and sustainability was presented to the government in May 2021.

5.4.4.3 Japan

Although many events related to climate change, including COP26, were postponed due to the coronavirus pandemic, a ministerial meeting on the "online platform" was held in September 2020 with the aim of sharing measures against COVID-19 as well as concrete actions and knowledge on climate change and environmental measures in different countries, and building global momentum to

ensure that climate change measures would not be set back by the coronavirus disaster. The Chair's Summary confirmed the importance of "redesign" through the "three transitions".

In October 2020, Prime Minister Yoshihide SUGA declared that the government would make maximum efforts for the realization of a green society, focusing on the virtuous cycle of economy and the environment as a pillar of Japan's growth strategy, and set the goal of achieving a carbon-neutral, decarbonized society by 2050. In December 2020, the Growth Strategy Conference, chaired by Chief Cabinet Secretary Katsunobu KATO, decided on the Green Growth Strategy Though Achieving Carbon Neutrality in 2050 as an industrial policy to create a "virtuous cycle of economy and the environment". The strategy calls for setting high targets and initiating policies in expected growth industries (Offshore wind power; Fuel ammonia; Hydrogen; Nuclear power; Mobile and battery; Semi-conductor and ICT; Maritime; Logistics, People flow and infrastructure; Food, agriculture, forestry and fisheries; Aviation, Carbon Recycling; Housing and building; Next generation perovskite solar cell; Resource circulation; Lifestyle-related industry).

In the "With-Corona, Post-Corona Era", it has proven to be important to unleash the vitality of local communities. The Japanese government has promoted the "Circular and Ecological Economy" proposed in the Fifth Basic Environment Plan which was approved by the Cabinet in 2018. The "Circular and Ecological Economy" is a concept that aims to maximize regional vitality by forming a self-reliant and decentralized society while maximizing the use of local resources such as beautiful natural scenery, and by complementing and supporting each other's resources according to local characteristics. Japan's Ministry of the Environment is supporting organizations that are working on the creation of a Circular and Ecological Economy.

Learning from the "With-Corona Era", Japan is expected to see a shift toward new lifestyles and work styles, including the growing popularity of outdoor leisure activities with low risk of infection, increased interest in moving to provincial areas, and the prevalence of telework. In particular, the work style called "workation," in which people conduct remote work in nature and enjoy leisure time and nature activities in between work, is attracting attention. Even prior to the COVID-19 pandemic, local governments and other authorities were promoting workation as a measure to increase population in rural and smaller urban areas. In 2019, Workation Alliance Japan was established (as of July 2021, 195 organizations (23 prefectures and 172 municipalities) were members), and local governments have been working to attract people. The Ministry of the Environment of Japan supports this initiative. By May 2021, MoE has supported 269 Workation activities. Some companies have joined in on the initiative as data shows that productivity is improved when the mind and body are refreshed and a better work-life balance is achieved.

5.4.5 Promoting Low Carbon Transitions

In this section, examples of some of the innovative and impactful measures being taken to reduce greenhouse gas emissions and to shift industry and society in less carbon-intensive directions are explored.

5.4.5.1 Germany: A Federal Climate Change Act and a Coal-Phase Out Plan

The 2019 Federal Climate Change Act mandated a minimum 55 percent reduction in GHG emissions by 2030 (relative to 1990 levels); introduced annual emission budgets for the energy, industry, transport, buildings, agriculture, and waste sectors; and set climate neutrality as a goal for 2050. Government operations and investments were to be climate neutral by 2030. In May 2021, however, the German Federal Court for Constitutional Matters issued an order requiring the Federal Government to increase its GHG reduction target for the coming years in order to more evenly spread the reduction burden across generations. The court reasoned that the 55% reduction target the government had set for 2030 (compared to 1990) would mean a disproportionately large share of the remaining reduction needed to reach climate neutrality (a further 45% cut in GHGs) would have to be achieved in just 20 years (between 2030 and 2050). The court determined this was unfair to younger and future generations. In response, in June 2021 the federal government amended the Climate Change Act raising the CO₂ reduction target for 2030 to 65%, setting an 88% reduction target for 2040, moving up the date for when climate neutrality is to be reached to 2045, and aiming for negative emissions thereafter.

A wide variety of policies and programs have been introduced to convince industry, society, and energy producers to become more sustainable. Building efficiency standards have been tightened, excessive consumption and waste is being targeted, recycling and reuse is being expanded, digitalization is being promoted to enhance the efficiency of processes and the use of resources, and new transport modes are being explored. Climate policy and energy transition measures focus on innovative energy systems such as hydrogen technologies and climate-friendly infrastructure and construction. Climate-friendly construction aims at increasing the use of wood as a building material and establishing innovation clusters in the field of wood construction. Public financial investments for building renovations and the shift to renewable energies for heat generation are key measures intended to reduce greenhouse gas emissions in the building sector to 70 million tonnes of CO₂ equivalents by 2030 and to achieve both the national and the European energy and climate targets by 2030.

The Climate Change Act establishes GHG reduction expectations for various sectors (e.g. energy, buildings, agriculture, transport, and waste); these were further tightened in June 2021 when the act was amended. To support the achievement of

the climate goals a national emission trading scheme for fossil fuel burning processes in the housing and transport sectors was introduced at the beginning of 2021. The price of a certificate for one ton of GHGs was fixed at €25/t CO₂ in 2021 to rise to €30/t CO₂ in 2022, 35 Euro/t CO₂ in 2023, and €55/t CO₂ in 2025. This measure will also have a direct effect on household energy consumption.

The National Sustainability Strategy also aims to lower household per capita GHG emissions. In May 2021, the 'Green Cabinet' of the Federal Government added a target to cut in half per capita consumption-based GHG emissions by 2030 (compared to a base year of 2016) in a further advancement of the National Programme on Sustainable Consumption. The plan is to start a societal dialogue on a 'budget approach' in order to raise consumers' awareness of their 'personal consumption footprint' and stimulate their thinking about how their own GHG emissions can be reduced. The goal here is to achieve a shift in consumer mindsets. The strategy also includes targets for 2030 like halving food waste, doubling use of bicycles, and increasing the market share of certified sustainable products in e-commerce to 34%.

5.4.5.2 Sweden

Fossil Free Sweden, an initiative started by the Swedish Government in 2015, aims to mobilize society-wide involvement in climate action, and give companies, municipalities, and organizations opportunity to showcase their efforts under a common umbrella. The goal is to foster industrial competitiveness while creating more jobs and export opportunities by going fossil free.^[5]

In 2017, the Swedish parliament introduced a climate policy framework containing new climate goals, a Climate Act and plans for a climate policy council. By 2045, Sweden aims to have net zero territorial greenhouse gas emissions and to achieve thereafter negative emissions^[6].

At the request of the government, the Swedish EPA has developed five indicators to follow GHG emission performance in key consumption areas: personal transportation, air travel, food, building construction and accommodation, and textiles.^[7] This tracking of consumption-based emissions can be used as a complement to territorial emissions tracking and to promote action by inhabitants and companies. An overall indicator for consumption based GHG emissions is being used in the national follow-up process for Agenda 2030 target 12.1.

In November 2020, the Swedish Government called on the environmental parliament preparation board to develop a strategy to reduce the climate impacts of Swedish consumption with the possible introduction of national consumption objectives, policy instruments and measures.^[8] The investigation will be presented January 2022 and will contribute to the generational goal of delivering to the next generation a society that has solved the major environmental problems without exporting such problems to other parts of the world (henceforth, Generational Goal),

the Environmental Quality Objective “Limited Climate Change” and Agenda 2030.

Sweden has already more or less decarbonised its electricity and heating sectors, so the focus now is on decarbonising transport, decarbonising heavy industry, and achieving negative emissions.^[9] The industrial sector accounts for about a third of Sweden’s total territorial GHG emissions (32% in 2019). As part of initiative Fossil Free Sweden industries have produced roadmaps to show how they can enhance their competitiveness by going fossil free or climate neutral.^[10] The roadmaps identify opportunities and obstacles, industrial commitments and political proposals.^[11] The Swedish Steel Producer’ Association addressed fossil free steel production as well as a fossil free value chain from energy to mining to iron and steel production.

A system transformation will require comprehensive policies and governance approaches. The roadmap calls for: financing for long-term research and knowledge development; secured access to electricity and bio-based energy at internationally competitive costs; supporting further development of qualified life-cycle based models of climate impacts; and, supporting the creation of market demand for fossil-free steel and new business/pricing models for cost-sharing along value-chains^[12]. Innovative cost-sharing and new business models will be needed to engage both down-stream industrial sectors as well as consumers. If fossil-free steel can be produced, this would aid producers of automobiles as well as consumers in transitioning toward climate-friendly transport. By developing climate-smart technology that can contribute to more circular and fossil-free solutions, competitive advantages, employment and export opportunities can be created.

5.4.5.3 Japan

In Japan, the specifics of upgraded decarbonization measures will be revealed once the revision of the Plan for Global Warming Countermeasures is realized, but two points will be key in the new framework. The first is the maximum introduction of renewable energy as a national project and the bold use of innovative new technologies. The Green Growth Strategy of December 2020 focuses on 14 priority industry sectors for green growth, including hydrogen. This will lead to unprecedented national government investments in the green transition. The second is the creation of a framework that incentivizes individual local communities to reduce their GHG emission as much as possible, while at the same time ensuring their efforts to do so have a positive impact on their own economies. Many local governments in Japan have announced their commitment to net zero carbon emissions by 2050, and their aim to be “Zero Carbon Cities”, but many still lack comprehensive plans and specific measures to achieve carbon neutrality.

On May 26, 2021 the Diet amended the Act on Promotion of Global Warming Countermeasures without any objection. A basic principle is newly set in the revised law: all stakeholders in Japan will have to make efforts to achieve a decarbonized

society by 2050, in line with the Paris Agreement. The second pillar is to promote renewable energy also as a way of contributing to regional revitalization. The act establishes a system whereby municipalities can certify projects that contribute to the decarbonization of the region, as well as to the resolution of regional issues, by utilizing local renewable energy sources. At the same time, it introduces special measures to such projects, such as a one-stop system for related administrative procedures to facilitate smooth consensus building in the region and promote the introduction of renewable energy that contribute to the region.

In order to achieve decarbonization, in addition to national industrial policy, local governments that are engaged in activities directly related to communities need to put decarbonization policies in place. The Council for National and Local Decarbonization was established in December 2020. It is chaired by the Chief Cabinet Secretary and aims for a decarbonized society at the community level by 2050 through collaboration and cooperation between the national and local governments. The Council has studied the viewpoints of consumers, ministries, agencies, and local governments and formulated a regional decarbonization roadmap in June 2021. This includes the regional implementation of latest available technologies over a five-year intensive period to 2025 and the creation of more than 100 decarbonization leading areas by 2030, to promote bold climate actions throughout the nation.

Greenhouse gas emissions from the household and business sectors are also major sources of emissions. Japan's Ministry of the Environment is promoting a national campaign called "COOL CHOICE," which encourages people to make smart choices that are beneficial to the fight against global warming, such as purchasing products, using services, and choosing lifestyles that contribute to the creation of a decarbonized society. Specific campaigns include the "Cool Biz" and "Warm Biz" campaigns, which promote appropriate air conditioning settings and clothing in summer and winter, the "Eco-Drive" and "Smart Move" campaigns, which encourage the appropriate use of automobiles and transportation, and the "Lighting Future Plan" campaign, which advocates energy conservation and the spread of high-efficiency lighting.

In Fukushima Prefecture, which was severely damaged by the Great East Japan Earthquake and the nuclear disaster in 2011, efforts are being made to realize the "Fukushima Innovation Coast Initiative" (specified in the government's 2014 Framework Policy), a national project that aims to build a new industrial base in order to recover the lost industries in Hamadori and other areas. In 2016, the government's "Conference for the Realization of the Fukushima Plan for a New Energy Society" chaired by the Director General of the Agency for Natural Resources and Energy formulated the "Fukushima Plan for a New Energy Society" (revised in February 2021) to accelerate the efforts in the energy field of the Plan.

The government, prefectural government, and related companies are working together to expand the introduction of renewable energy and hydrogen with the aim of generating more than 100% of Fukushima Prefecture's primary energy demand from renewable energy sources by around 2040.

5.4.6 Electric Mobility

The transport sector is an important economic engine in the countries examined in this international contribution. The sector is under growing pressure to tackle its greenhouse gas emissions. Various approaches are being followed in the cases examined in this report.

5.4.6.1 Germany

The German automobile industry is Europe's largest passenger car producer and a very important contributor to Germany's economy. Despite the government's setting of voluntary targets in the past (e.g. to reach one million electric vehicles in use by 2030), German car producers have been slow in introducing electric mobility and targets have not been met. With growing concern about the sector's slow progress towards meeting GHG emission reduction targets, the industry's large environmental and climate impacts, as well as growing international competition, the Federal Government is beginning to intervene more strongly to support electric mobility. In 2011, the government introduced the National Development Plan for Electric Mobility and in 2016 issued a market incentive package with temporary purchase incentives (an environmental bonus for hybrid and non-hybrid electric cars) and introduced plans for enhancement of charging infrastructure and the purchase of electric vehicles by public officials.

In order to accelerate the shift toward direct zero-emission vehicles, new targets have been set. There are to be 7 to 10 million electric vehicles on the market and 1 million charging stations by 2030. Germany's Recovery and Resilience plan is to enhance the environmental subsidy for electric vehicles. The Federal Government has doubled the share of the state-funded buyer's premium for electric vehicles until the end of 2021, a so called "innovation bonus" that supplements the environmental bonus already in place since the market incentive program was launched in 2016 and extended until the end of 2025. Plug-in hybrid electric vehicles and hybrid and fully electric second-hand vehicles also benefit from this premium; combustion engines are excluded. The Federal Government is sending a clear message to private consumers by dedicating around €3 billion to electric car purchase subsidies. The subsidy rates for electric vehicles with a net list price of less than €40,000 are up to €9,000 for a purely electric drive (battery electric or fuel cell) vehicle and up to €6,750 for a hybrid electric vehicle that can be charged externally (plug-in hybrids). The subsidy rates for electric vehicles over €40,000 net list price are up to €7,500 for a purely electric drive (battery electric or fuel cell vehicle) and up to €5,625 for a

hybrid electric vehicle that can be charged externally (plug-in hybrids). For comparison it was previously €4,000 for a purely electric drive and €3,000 for plug-in hybrids. In addition, anyone who buys a new electric car is exempted from vehicle tax for 10 years from the date of initial registration. This tax exemption runs until the end of 2030. Parallel to the extension of the environmental bonus, the installation of an acoustic warning signal specifically for low-noise electric vehicles will be introduced. The subsidy for this is a flat rate of €100.

An additional incentive to promote e-mobility is the tax-free charging of e-cars at employers' premises. This savings on electricity costs that would otherwise be incurred, is exceptionally not taxed as a non-cash benefit unlike other taxable employer benefits, such as a company car or meal vouchers.

The Federal Government is supporting a nationwide, demand-oriented network of charging infrastructure to meet users' needs. The Federal Ministry of Transport and Digital Infrastructure intends to supplement its funding policy by commissioning the construction and operation of a nationwide fast-charging network at 1,000 locations, although the Federal Government does not intend to become an operator of charging facilities itself. In addition, the Federal Ministry of Transport and Digital Infrastructure is developing further funding programmes with the aim of extending the nationwide development of charging infrastructure to the private and commercial sector with €6 billion.

In order to promote low-emission motor oil passenger cars and take CO₂ emissions more strongly into account, the German Parliament revised the Motor Vehicle Tax Act (KraftStG) in October 2020. Similar to the case in Sweden, owners with high CO₂ emissions will be taxed more and those with low emission vehicles will receive tax breaks. The tax will depend on engine capacity and CO₂ emission levels. Cars emitting up to 95 g CO₂/km will incur no taxes. In addition, owners of cars purchased between June 2020 and December 2024 will have an annual tax bonus (International Council of Clean Transportation). There is a progressive increase of the CO₂ component and the annual tax liability for vehicle ownership based on the revised Motor Vehicle Tax Act (§ 9 Absatz 1 Nummer 2 KraftStG and § 10b KraftStG). Environmentalists warn that the tax is still too low to have much impact and point to France where taxes are higher.

Another instrument to promote use and competitiveness of clean vehicles is public procurement. Based on the revised EU Clean Vehicles Directive the Federal Government in January 2021 adopted the Law on Promotion of Clean and Energy Efficient Vehicles, requiring public authorities procure a significant share of clean vehicles. It also includes a quota for electric buses of 22.5% between 2021 and 2025) and 32.5% between 2026 and 2030.

5.4.6.2 Sweden

The transport sector is responsible for one-third of Swedish CO₂ emissions; this

level has remained stable over time. The Swedish vehicle fleet has long been dominated by large and relatively old high-fuel consuming cars. The Swedish Government set an ambitious target to reduce transport emissions by 70 per cent by 2030, compared with 2010 levels in its climate bill. ^[13] A Bonus-and-Malus System, which provides a subsidy for environmentally friendly vehicles and a tax on vehicles with combustion engines based on their emissions, was introduced on July 1, 2018. The system has several policy objectives: 1.) to shift the relative price of high-emission and low- and zero-emission vehicles so as to encourage the purchase of climate-friendly vehicles; 2.) to speed up the renewal of the vehicle fleet to meet the EU target of an average CO₂ emissions of 95g/km for new cars by 2021; and, to make support schemes for zero- and low-emission vehicles less expensive by having the “bonus” financed by a “malus” tax. In Sweden fossil fuels are subject to a VAT and fuel taxes (carbon and energy taxes). In addition, car owners pay an annual vehicle tax. The idea is that the system should pay for itself and not rely on public funding. Those who choose to buy a car with higher CO₂ emissions subsidize the purchase of those who choose a car with lower CO₂ emissions. The Bonus-Malus-system is part of a policy package with combined tools affecting vehicle purchase, usage and technology development.

To further strengthen emission reduction outcomes as well as to ensure the financing of the system, in 2020 the Government proposed a further increase in vehicle taxes on new light petrol and diesel vehicles. Stronger incentives for the purchase of zero-emission vehicles have been announced. ^[14] Electric vehicle registrations in Sweden hit a historic high of 18% in 2019, reaching a 32% share of newly sold cars that are chargeable in 2020. ^[15] Nevertheless, the current policy packages, including the Bonus-Malus system will not be sufficient for Sweden to reach EU’s average CO₂ emissions target by 2021. In terms of future policy design, the entire life cycle of the vehicle and the emissions tied to the production of electricity need to be taken account in the Bonus-Malus-system to ensure sustainability outcomes. To assure fairness, a bonus needs to be put in place to make it possible for those with lower incomes to afford more sustainable choices, such as electric vehicles.

5.4.6.3 Japan

In 2000, the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) first launched an environmental labeling system to certify automobile models that meet a certain level of emission and fuel efficiency standards. In 2009, an eco-car tax reduction program was launched for next-generation vehicles (electric vehicles, fuel cell vehicles, natural gas vehicles, plug-in hybrid vehicles, and clean diesel vehicles) and vehicles that meet certain emission and fuel efficiency standards. By imposing heavier or lighter taxes on both the acquisition and ownership of vehicles, the system encourages the acquisition and ownership of vehicles with higher

environmental performance, as well as the reduction of the use of vehicles with high environmental impact that have passed a certain age. The auto-related tax revenues that funded the FY2020 budget totaled 2,618 billion yen. The tax is equivalent to 2% of Japan's tax revenues (the initial FY2020 budget, total of national and local taxes).

5.4.7 Circular Economy and Eco-Design

5.4.7.1 The European Union

Regulations on circular economy and resource efficiency including reparability, durability, availability of spare parts, and mandatory repair instructions were initially covered by the EU Ecodesign Directive 2009/125/EG and in separate directives for single product groups.^[16] The Ecodesign Directive has been very effective in providing energy savings and reductions in GHG emissions. It has also provided other resource savings, such as water, and reduced pollutants.

Nevertheless, in 2020 the EU-commission launched consultation on a Sustainable Product Initiative to explore how further product legislation and actions could facilitate the transition towards a circular economy and contribute to reaching sustainable development goals on consumption, production, climate, air, water and biodiversity.^[17] The public has been invited to contribute ideas to the redesign of the Ecodesign Directive 2009/125/EG.

The new Circular Economy Action Plan for a Cleaner and More Competitive Europe was launched in 2020 with the aim of making sustainable products the norm, empowering consumers to make sustainable consumption choices, and ensuring less waste through a sustainable product framework and by shifting towards greater circularity in production processes. Key product value chains covered are electronics and ICT, batteries and vehicles, packaging, plastics, textiles, construction and buildings, and food, water and nutrients.^[18] In 2021, the European Commission presented a proposal for a Battery Ordinance which addresses the whole life cycle of batteries (from small household batteries to large vehicle and industrial batteries) and from the sourcing of materials and battery design to the treatment of used batteries.^[19]

Regulations targeting the textile sector are also now under consideration as part of the Circular Economy Action Plan. The textile sector causes massive global environmental and social impacts. The popular and growing embrace of fast fashion is being accompanied by a growing concern about the impacts the sector is having in terms of water and land use, toxic emissions, plastic waste, and textile waste as well as human health and working conditions in many developing countries. The EU aims at issuing a textile strategy before the end of 2021. It will follow a holistic approach and cover the whole life cycle of textiles from growing of natural fibers to separate collection of used textiles and their reuse or recycling. The aim will be to reduce negative impacts in the textile supply chain and support circularity, durability

and recyclability of textiles. The use of instruments like targets for recycled content in new textiles or sustainable public procurement are likely to be included in the strategy.^[20] From 2025 EU waste management legislation will require the separate collection of textiles.

5.4.7.2 Germany

Germany has promoted circular economy concepts for decades. The packaging ordinance of 1991 was among the first regulations worldwide to introduce Extended Producer Responsibility in a sector. The first circular economy law (Kreislaufwirtschaftsgesetz), which focused on waste management, was adopted by the Federal Government in 1996. In the meantime, a much broader understanding of the circular economy concept is being followed.

The newly revised circular economy law (2020) addresses many areas of product policy and the throw away culture that has developed. It includes an obligation for public procurement to favor sustainable products and in particular those which contribute to the circular economy. The law includes a new instrument called *Obhutspflicht*, an obligation to take care of goods. Producers, retailers and selling platforms (like Amazon) which had been treating goods returned by customers as trash (unused and often still in original packing) will now be obliged to either donate these goods or sell them. They are further obliged to report on how they dealt with returned goods.

Another piece of legislation to promote more sustainable products and ensure an enhanced circular economy is the newly revised Packaging Law (*Verpackungsgesetz*), which was adopted by the Federal Cabinet in January 2021. The revision of the law stipulates that all one-way plastic bottles and metal drink cans will have a mandatory deposit of €0.25. The aim is to give a competitive advantage to multi-use drink bottles (glass or plastic) as these are environmentally preferable. In addition PET-bottles for drinks must contain 25% recycled material starting in 2025.

The revised packaging law also contains a regulation that restaurants, take away-shops, and cafes which sell food must offer multi-use containers starting in 2023; the multi-use container option shall also not be more expensive than the single-use one. The aim is to reduce the fast rising amount of packing waste tied to “to-go” consumerism.

The German Ministry for Development Cooperation (BMZ) has set up a textile alliance as a reaction to the Ragna Plaza disaster where 2000 people died in a collapsed textile factory. The members of the alliance cover about 45% of the German textile market; they have committed to social and some environmental improvements in their textile value chain. To make these efforts visible BMZ has set up a new labelling scheme, the Green Button, which is used by companies in the alliance. Still the share of sustainable textiles in the German clothing market remains

below 5%.

The Federal Government has set a target for federal public procurement of sustainable textiles: 50% of all textiles procured shall meet recommended sustainability standards like the Global Organic Textile Standard (GOTS), Green Button or Blue Angel.

In addition to the EU regulations for reparability, durability, and availability of spare parts included in the criteria set by the Blue Angel, Germany has introduced its own even more ambitious targets. These are also to be used in public procurement decisions.

5.4.7.3 Sweden

The EU Ecodesign Directive and its product regulations are directly applicable in Sweden and secured by the Swedish Energy Agency through information campaigns and market surveillance. The Swedish Energy Agency's internal lab (Testlab) is unique in the EU. Sweden uses both negotiations and market control to bring ecodesign and energy labelling under one roof.^[21] The internal lab has helped to build expertise and is one reason the Swedish Energy Agency is often asked to contribute advice to the European Commission.

The Swedish Energy Agency informs producers, retailers and other stakeholders through the web, seminars and newsletters about EU Ecodesign policies. The Swedish Energy Agency sees good possibilities to set further resource efficiency product requirements through ecodesign, though it needs to be complemented by economic incentives, information and possibly new business models. These requirements contributing to prolonged product lifetime and increased recycling also imply increased cooperation between agencies on other issues, such as electric safety and chemical issues.

The way energy efficient product policies such as ecodesign and energy labelling are negotiated, formulated and implemented in Europe serve as an inspiration to other countries. The Swedish Energy Agency participates in a SIDA-funded UNIDO project called EELA (Efficient Lighting and Appliances), aimed to assist 21 countries in southern and eastern Africa in building product legislation for ecodesign and energy labeling. The Swedish Energy Agency helps with dialogue with the business community, building up labs and test activities as well as advanced training for various stakeholders including policy officers, lab technicians, market authorities, manufacturers, importers and public and private procurers. By supporting policy capacity building, technology transfer and business development, the overall goal is to achieve market transformation towards more energy efficient products and services outside of Europe as well.

5.4.7.4 Japan

In Japan, there is growing interest in closing the loop from design to disposal to achieve a sustainable consumption and production system. Historically, increases in

waste generation and illegal dumping led to the enactment of the Basic Act on Establishing a Sound Material-Cycle Society under the Basic Environment Law in 2000. The law prioritized the 3Rs (Reduce, Reuse and Recycle), introduced extended producer responsibility, and led to the revision of earlier laws and the establishment of new laws addressing waste and recycling in areas ranging from packaging to home appliances, food, and automobiles, as well as green purchasing requirements.

In response to these laws, industrial organizations and individual companies have promoted various initiatives. As examples, the Japan Automobile Manufacturers Association (JAMA) established the "Guidelines for Prior Evaluation at the Product Design Stage to Promote 3Rs of End-of-Life Vehicles," and Toyota is actively adopting designs for new vehicles that are easy to disassemble and sort. UNIQLO, a casual fashion retailer, reuses clothes collected from recycling boxes set up at UNIQLO stores nationwide and delivers them to people in need around the world, including those living at refugee camps and disaster-stricken areas in the form of emergency disaster relief, together with the United Nations High Commissioner for Refugees (UNHCR), NGOs and NPOs. Clothes that cannot be reused are processed and recycled as fuel or soundproofing material, and recently the company has been promoting "clothes-to-clothes recycling".

In addition to the initiatives by companies and organizations, the government also implements measures to realize a transition to circular economy. The Ministry of the Environment together with other ministries and agencies formulated the Resource Circulation Strategy for Plastics in 2019 to address issues including the marine plastic crisis. In June 2021, the Diet unanimously passed "Act on Plastic Resource Circulation" to realize plastic materials' circulation by 2050, covering all processes from product design to waste disposal.

5.4.8 Sustainable Food Systems

5.4.8.1 The European Union

The European Farm to Fork Strategy, a key element of the Green Deal, promotes sustainable food systems. This involves sustainable agriculture; a food environment that makes the healthy and sustainable choice the easy choice; and, a sustainable food-labelling framework that allows consumers to choose healthy diets as well as socially and environmentally-friendly food products. It involves ensuring food security, stimulating sustainable food processing, wholesale, retail, hospitality and food services practices, and fighting against food waste. The strategy is also considered important for achieving climate neutrality and reducing other environmental externalities.^[22]

5.4.8.2 Germany

The German Federal Ministry of Food and Agriculture (BMEL)'s Scientific

Advisory Board on Agriculture Policy, Food and Consumer Health Protection (WBAE) recommends four target dimensions to create fair food environments and more sustainability in food consumption: health, social aspects, the natural environment and animal welfare.

The food environment begins with exposure to food and food stimuli (e.g. in advertisements and on social media). Exposure calibrates our perceptual field; currently, this field is often calibrated towards products with an unfavourable nutrient profile (e.g. fast food, soft drinks) and a high climate footprint. Access to food depends on various factors, including price, availability of information, and social eating and behavioural norms. Actual food choices are shaped by socio-economic aspects, preferences, attitudes, knowledge, social norms and habits. Marketing and, to an increasing extent, social media. They are influential environmental factors that associate food with certain values and characteristics, which then influence consumer preferences. These factors play a role in determining consumption, i.e. what food is eaten, and how much and how quickly it is eaten.

The German government has started to recognize the need for an integrated policy for promoting sustainability in food consumption that significantly improves the food environment. Currently too much responsibility is placed on the individual to act. The State Secretaries' Committee for Sustainable Development is now taking up the issue. The Committee (also called 'The Green Cabinet') is in charge of the National Sustainable Development Strategy's measures and is monitoring indicators to ensure alignment with the 17 Sustainable Development Goals. In July 2020 the State Secretaries' committee published sustainable development requirements for the food system.

A simplified and extended nutritional labelling system on the front of packaging is a key element of a holistic policy for promoting healthy eating. In 2019 a representative consumer survey was made on different nutritional labelling systems. German consumers prefer the Nutri-Score, a food-labelling framework that is already available in some European countries. The Nutri-Score uses a 5-level colour scale from A to E developed by independent scientists. The scale indicates the nutritional quality of food. Energy content as well as nutritionally favorable and unfavorable nutrients are offset against each other. For example, the fibre and protein content as well as the vegetable, fruit and nut content are classified as favorable. Energy inputs and the content of saturated fatty acids, salt and sugar are rated as unfavorable. The Nutri-Score makes it possible to compare products within a product group. It only concerns food products that have a nutritional values table. Fresh products such as fruits and vegetables are excluded. It is a voluntary labelling scheme so far but an EU-wide mandatory introduction is envisaged.

A variety of different labelling schemes exist to address the environmental impacts of food. The Bio-Label based on EU legislation is the most commonly used.

Other labels based on higher standards also play a role in the market. The Eaternity Score from the Eponymous Consulting company assesses climate and water footprints quantitatively for caterers and canteen managers, and assesses animal welfare and rainforest protection qualitatively. The Ministry for Environment uses this in their cafeterias to orient customers.

The Federal Ministry for Nutrition and Agriculture (BMEL) has also launched a campaign “Too good for the bin” to handle the issue of food waste. It is estimated that there are about 75 kilos of food waste per person per year much of which is preventable. Consumers can find useful tips for everyday life (how to make better food purchasing, storage, and consumption choices) and cooking recipes on the web and via a smartphone App.

During the German presidency of the European Commission in the second half of 2020, the European Council unanimously supported a German proposal for the development of an animal welfare label and has tasked the EU Commission with elaborating a regulation for all livestock species over their entire life span.^[23]

5.4.8.3 Sweden

The Swedish government launched a long-term food strategy in 2017, with a vision that its food chain be globally competitive, innovative, sustainable and attractive to operate within by 2030.^[24] The main purpose of the strategy is to increase production, support a competitive food chain, increase employment, enhance innovation capacity and profitability and achieve relevant environmental objectives. Three strategic action areas have been identified: rules and regulations, consumers and markets (giving consumers a high degree of confidence in food and the ability to make informed and sustainable choices), and knowledge and innovation to contribute to increased productivity in the food supply chain and the sustainable production and consumption of food. The government believes that the solution is to increase environmentally efficient production, particularly production that has a low impact on the environment in global terms.

Collaboration among relevant stakeholders at the local, regional and national levels is a key factor in the implementation of the strategy. The Government has launched a series of action plans in 2017, 2019, and 2021.

Action Plan I (2017 to 2019) introduced targeting goals to have 30 percent of Swedish agricultural land certified as pursuing organic agriculture and 60 percent of public food consumption (e.g. public schools and hospitals) offering certified organic products.^[25]

The Swedish Board of Agriculture in consultation with other authorities, representatives of companies and organizations along the food chain as well as consumer and environmental organizations is drawing up an action plan and milestone targets to achieve this 2030-target. Public procurement of food and meals (such as school meals) can be used to promote even better animal protection and

environmental concerns. Another area of action is reducing food waste throughout the food chain by increased cooperation between actors along the food chain and authorities. Information targeting consumers is also important.

Action Plan II (through 2025) gave assignments to the Swedish Agency for Economic and Regional Growth to advance more effective “Rules and regulations” and to the Swedish Innovation Agency and Swedish Research Council for Sustainable Development (FORMAS) to promote innovation and research, respectively. The central part of Action Plan III (starting January 2021) is a so-called “simplification package”; concerned authorities are asked to simplify rules and regulations while making them more effective.^[26]

Some main findings from the 2020 evaluation are that Swedish companies need to increase the added value of their products and strive for increased product value rather than increased production volumes, and that knowledge and innovation are central to the long-term development of the food chain. As production becomes more high-tech and knowledge-intensive, the competitive advantage of firms and nations are more than ever dependent on a leading position in knowledge and research. If education and research in the food chain is not strengthened, Swedish food firms will fall behind in global development.

In the Swedish environmental objectives system, there are two milestone targets on reducing food waste, and both should be reached by 2025.^[27] Target one is to reduce food waste in food production, before food reaches the store and the consumer. Progress is to be monitored by the Board of Agriculture. Target two is to reduce food waste by at least 20% by weight per capita from 2020 to 2025 and is to be monitored by the Swedish EPA.

Röös et al. (2020)’s research on food policy instruments highlighted the importance of: 1) setting national goals for sustainable food consumption; 2) going beyond information provision to introducing regulations, making demands of producers and retailers, and adjusting prices; 3) recognizing that policies receive more public support if they are combined into *packages* with for instance higher taxes on red meat, coupled with lower taxes on vegetables and fruit; and, 4) using public sector meals – in schools, hospitals, kindergartens, etc. – as role models for sustainable eating.

5.4.8.4 Japan

In Japan efforts are underway to link food production to the Sustainable Development Goals (SDGs). This includes, for example, making nutritional food available to children in school (free food for poor children) (SDG 1, no poverty), international cooperation for nutritional improvement through the promotion of sustainable agriculture, forestry and fishery (SDG 2, zero hunger), the creation of welfare farms employing handicapped people (SDG 3, good health and well-being), food education (SDG 4, quality education), gender equality in farming, forestry, and

fisheries (SDG 5, gender equality), promoting sustainable use of irrigation water in developing countries (SDG 6 clean water and sanitation), renewable energy use in farming, mountain, and fishing villages (SDG 7, affordable and clean energy), creating innovation through smart agriculture, forestry, and fisheries (SDG 9), reduction of food loss and food recycling (SDG 12 responsible, consumption, and production), among other goals.

Japan's Ministry of Agriculture, Forestry and Fisheries (MAFF) is promoting efforts to spread the "Japanese-style diet" with its excellent nutritional balance. The ministry holds national conferences for the promotion of dietary education, gives awards for dietary education activities, and supports the provision of opportunities to experience agriculture, forestry, and fisheries and communal dining. Regarding the reduction and utilization of food waste and food loss, it is estimated that Japan generated 25.31 million tons of food waste of which 6 million tons was discarded despite being edible in FY2017. The Food Recycling Law was promulgated in 2000 in order to reduce the final disposal volume of food waste by controlling its generation and reducing its volume, as well as to reuse it in the form of feed and fertilizer as resources recycled from food or for heat recovery. Measures were also taken to promote recycling by food-related businesses, such as setting standards and targets for recycling, requiring periodic reporting, registering businesses, and certifying business plans. Under this law, the Ministry of the Environment of Japan is implementing efforts to match food-related businesses, recycling businesses, agriculture, forestry, and fishery businesses, etc., in order to expand the food recycling loop.

To reduce food waste, the Food Loss Reduction Promotion Act was promulgated in 2019. The goal is to reduce by half the volume of household and business food loss by FY2030 compared to the FY2000 level. As an example of efforts to encourage businesses and consumers to take action, the Ministry of the Environment is conducting the "No-Foodloss! Youth Action Project", in which students from all over Japan who wants to engage in activities/projects for food loss reduction are invited to discuss and present ideas for activities in their own neighborhoods. In addition, the Ministry of the Environment, the Consumer Affairs Agency, and the Ministry of Agriculture, Forestry and Fisheries are holding the "New Doggy Bag Idea Contest" to solicit ideas from the general public on how to popularize and establish a new style of taking home leftover food from restaurants.

5.4.9 Gender

Gender equality is a prerequisite for sustainable societal development and crucial for the ability to innovate. The entire population's experiences, skills and knowledge are needed to take full advantage of a society's innovation potential.

In Germany gender equality plays an important role in the society and in politics

for decades now. It is still an evolving issue and the process toward gender equality is still going on. Gender equality is still not reached in every part of social and work life in Germany.

In Germany, gender equality is enshrined in the Basic Law (equality article, Article 3 GG) and was recognised by a Cabinet resolution on 23 June 1999 as a universal guiding principle of the Federal Government's actions. It has also been enshrined in the Common Rules of Procedure of the Federal Ministries since 2000. At that time, it was decided to promote this task by means of Gender Mainstreaming. Gender Mainstreaming was integrated into the Federal Equality Act (BGleiG) as the legal basis for gender equality. The more consistent application of these principles and their concrete consideration in or alignment with policies and measures, remains a challenge for policy in the present day; this is equally true for climate policy, which is increasingly subject to justice requirements.

Political measures to ensure and promote gender equality are mostly found in areas like equal payment, no discrimination in work life, equal opportunities for job promotion etc. There was new legislation adopted in January 2021 which requires that companies with shares at the stock exchange have to give at least one seat in their executive board to a woman when the board has 4 or more members. For the supervisory board of these companies a law adopted in 2016 requires a share of women of 30%. For state owned companies the required share is 50%.

Environmental policies are often not addressing the issue even though there are actual differences in average attitudes on sustainability issues, different consumption habits, different eating habits etc. But usually the instruments in the area of SCP are not differentiating particular groups in the society (nor young and old, men and women, rich and not rich etc.). And it seems to be very difficult to differentiate (and by that not discriminate). Therefore gender aspects do not play a significant role in SCP policies so far but that might change.

The overall objective guiding the Swedish gender equality policy clarifies that women and men must have the same power to shape society and their own lives. With this as its starting point, the Government is working towards six sub-goals; 1. Equal distribution of power and influence, 2. Economic gender equality, 3. Gender equality in education, 4. An equal distribution of unpaid housework and provision of care work, 5. Gender equality in health, care and social services; 6. Stopping violence against women.^[28]

It is widely accepted that tax income must be used to benefit both women and men equally. The Swedish Innovation Agency's policy is that an equality perspective should be integrated into agency activities and that gender equality should be promoted in the distribution of funds for research and innovation. All activities in government should be permeated by a gender equality perspective and business should be developed so that it contributes to the gender equality policy goal

that women and men should have the same power to shape society and their own lives.^[29] It is important to integrate gender equality into the development of policy measures for a green transition, including in the realm of sustainable consumption and production. Recent research shows that with the same expenditure Swedish men give rise to 16 percent higher GHG emissions than Swedish women. Men's higher consumption of vehicles and fuels are possible reasons for this.

In 1999, the Japanese government enacted the Basic Act for Gender Equal Society. The Fifth Basic Plan for Gender Equality (approved by the Cabinet on December 25, 2020) states that in order to realize a sustainable society, the Government shall, in response to environmental issues such as climate change, expand women's participation in the policymaking process, taking into account international trends, and actively work to reflect the perspective of gender equality in specific initiatives. The Central Environment Council, which was established under the Basic Environment Law as an advisory body to the Minister of the Environment, has 14 women out of 30 expert members (as of February 2021).

The plan also calls for promoting gender mainstreaming in the implementation of Official Development Assistance (ODA) programs and projects, and encouraging gender equality and the empowerment of women and girls, thereby facilitating women's participation in all stages of development cooperation and ensuring that they receive equitable benefits from development activities. In April 2020, the Japanese government issued gender guidelines for joint crediting mechanism (JCM) Subsidy Projects in accordance with Article 6.2 of the Paris Agreement. The gender guidelines outline the actions required to achieve gender equality in the project cycle (planning, implementation, and operation stages) of JCM subsidy projects, and urge recipients of JCM subsidy projects, especially the representative entities and joint businesses in charge of project implementation, to take actions for gender equality.

5.4.10 Conclusions

The Corona pandemic has arguably led to the worst global economic crisis since the Second World War or even the Great Depression. The causes of the pandemic are many, but among them environmental degradation has certainly played a role. The pandemic moreover is a warning that future crises will certainly occur. The best way to mitigate against such future economic and social shocks is to revamp our economic and social systems in such a way that they are deeply sustainable – ecologically and socially. With growing recognition of the precarious state of the global environment and the perverse incentives that have supported polluting industries and processes, major steps are beginning to break with the past and to set European and the Japanese economies on new more sustainable paths.

With much of the low hanging fruit already picked, governments are paying more attention to how major polluting industries can be incentivized or mandated to

reduce their energy and resource footprints. Here we have considered a handful of examples of how through the post-Corona recovery plans as well as new plans and regulations big and powerful sectors are being addressed, including the energy, transportation, steel, and agricultural/food sectors. The Corona recovery plans should be as an opportunity to build more resilient and ecologically sound societies.

To meet the Paris Agreement goals, more fundamental changes may be needed, such as shifting spending from private consumption to public investments and reduction of work time.

Public acceptance is also key. The most important factor for public acceptance of a policy is that it be perceived as *fair* and effective (Matti et al, forthcoming). For environmental policy-making this means that fairness – both how it should be interpreted and how it can be achieved - needs to be given a more central role in the design of policy packages. Policies directed to companies (e.g. biofuel use and climate labelling) have more public support than policies directed towards consumers (e.g. air passenger and meat taxes).

This chapter has only been able to touch upon a few efforts, but the major lesson to take out of it is that achieving climate neutrality and a circular economy will mean that deeper structural changes and societal approaches to consumption and living will be needed. This means systems must be developed to make it possible to examine the ecological and social footprints of products at each stage of their life cycle. Consumers need options and incentives to consume more wisely and to throw away less. This can only be achieved if both industrial actors and consumers are considered at the same time and work together to find approaches to product design, recycling, and reuse that are convenient for consumers. Strengthening the interface of public engagement is critical to promoting societal movements and transitions for sustainable consumption and living.

5.5 Policy Recommendations

The 2021 SPS research results and policy recommendations are based on the latest domestic and international situation and this year's research results. Policy recommendations from 2020 remain valuable to the decision-making process.

5.5.1 China's "14th Five-Year Plan" has entered an "in-depth" green transition period with the promotion of green production and consumption patterns moving into a substantive stage of practice, and important changes will occur. There are at least five main features:

First, as China steps onto the stage as a new and modernized great power having accomplished the goal of building an all-around well-off society, new themes are on the agenda dealing with high-quality development and the associated principles of

innovation, coordination, greenness, openness and sharing. Green development is the core feature and gauging standard for high-quality development. Such strategic thought and principles will steer the direction, objectives and tasks of China during the 14th “Five-Year” Plan period and beyond.

Second, compared with its predecessors, the 14th “Five-Year” Plan for National Economic and Social Development and the Long-Range Objectives through to the Year 2035 have for the first time put green development into an individual chapter, identifying targeted requirements for green production and consumption while specifying further and higher requirements on resource and energy conservation, efficiency improvements, ecological conservation and environmental quality betterment. Specifically, they stipulate that the transition towards green production and green lifestyle shall take substantial effect in 2025; and green production and lifestyle will take shape extensively in 2035.

Third, China has incorporated the commitment of peaking carbon emissions and achieving carbon neutrality into its 14th “Five-Year” Plan as well as the overall plan for achieving an ecological civilization, and also using the task of reducing pollution and carbon emissions and its synergy effects to promote a comprehensive social and economic green transition.

Fourth, as China enters into a comprehensive well-off society marked by a per capita GDP over US \$10,000, public awareness of green lifestyles has strengthened rapidly while the Covid-19 pandemic has fueled public awareness on green development at the same time. It is predicted that the middle-income population will surge to 560 million during the 14th “Five-Year” Plan period with a corresponding increasing in the rate of consumption by up to 60%. This huge potential will gradually build-up the solid social foundation necessary for realizing green consumption.

Fifth, the Covid-19 pandemic has magnified the significance of a green and low-carbon transition and there is a new tide of interest in low-carbon transitions in the international community. These developments can greatly contribute to the advancement and replication of an in-depth green transition in China.

5.5.2. Several specific policy issues still need to be addressed in order to launch the green production and consumption campaign in China in a bid to accomplish the relevant targets set out in the 14th “Five-Year” Plan.

Although the 14th “Five-Year” Plan of China has spelt out the targets for the transition to a green production and lifestyle, the relevant tasks and measures are quite preliminary within the existing framework. Therefore, more detailed and specific actions are needed for actual implementation, including well-designed supportive laws and regulations, policy mechanism and infrastructure construction.

5.5.2.1 Incorporating steps to achieve a comprehensive green production and

consumption system into national legislation

The existing laws most closely related to green production and consumption include the Law of the People's Republic of China on Promoting Clean Production (enacted in 2002 and amended in 2012) and the Law of the People's Republic of China on Promoting Circular Economy (enacted in 2008 and amended in 2018). The building of a legal system centered on green production and consumption can be carried out along two different paths: the first is to integrate the above-mentioned two laws into one unified green production and consumption law, while the second is to amend the existing two laws, making a clear and rational identification of the legal boundary of the two by deleting the word “Promoting” and in this way making them more legally-binding so that they can serve as the basic laws for promoting green production and consumption and serve the demands for green development.

5.5.2.2 Formulating the national action plan on green consumption

The management of green production falls under the competency of government authorities for resource and energy, industry, infrastructure construction, economy and eco-environment, while implementation falls under the domain of enterprises. Green production as identified in the 14th “Five-Year” Plan can be integrated in the portfolio and policy measures of relevant governmental departments. In contrast, green consumption involves a larger number of administrative departments covering all organizations, units and individuals from various sectors, adding complexity and challenges for a unified coordination and implementation. Bearing in mind the experience of Germany and Sweden, we think it is necessary to formulate a special national action plan on green consumption under the 14th “Five-Year” Plan in an effort to draw a middle and long-term implementation plan for more comprehensive, in-depth and specific initiation of the green consumption and lifestyle campaign.

5.5.2.3 Stressing source-based measures and a systemic methodology, fully initiating eco-design tools for industrial products and vigorously constructing green supply chain.

Studies have shown that 80% of resource and energy consumption and its environmental impacts are determined at the design stage of products. Eco-design of industrial products refers to the notion that systemic consideration should be given to the environmental impacts of a product through its entire lifecycle from the selection of raw materials to the production, sale, usage, recycle and disposal at the design and development stage in a bid to maximize the reduction of resource consumption, cutting or making it free from the use of toxic and hazardous raw materials and in this way cut pollution and emissions. The EU already passed eco-design legislation as early as 2009, while China has made some meaningful exploration thereof in recent years. The Chinese government should draw up technical specifications on eco-design and initiate an eco-design methodology while at the same time launch a lifecycle management approach that expands from a

product and enterprise focus to include the entire industrial chain. The Chinese government should incorporate the concept of a green supply chain in the new development framework of the “dual circulation strategy” (in which the domestic economic cycle plays a leading role while the international economic cycle remains an extension and supplement) so as to build a green dual circulation development pattern.

5.5.2.4 Heightening efforts to certify green and low-carbon labeled products, relevant services and specialized enterprises so as to force the greening of production and services, expand green products and service provision and guide green consumption.

As green products and services are the key elements of green consumption, the expansion of green products and services provision is a natural basis for promoting green consumption. The SPS simulation showed that the provision of a consistent and appropriate subsidies for green products at the consumption stage is a viable and effective policy option for fostering a market for green products.

Certification of green and low-carbon products and services connects the consumer and the producer, which can leverage both green consumption and production which has proven to be an effective market-based mechanism, and a top-runner system. Since the EU and China have both accumulated rich experiences in this area, the Chinese government should further emphasize and give full play to the effect of this system in enhancing green production and consumption. First, top-level design should be stepped up to forge a unified certification system for green and low-carbon products and services, and this system should be integrated with related constraints and mandatory measures and incentives for achieving synergy effects; second, the certification should be expanded to the green and low-carbon performance of enterprises to exert the effect of the top-runner system; third, the Government Procurement Law should be revised to include governmental departments and institutional organizations at various levels and SOEs under the scope of green procurement requirements, and it should be explored if the scope of green products and services procurement can be widened into a compulsory green procurement system. Relevant incentive policies should be drafted to encourage other civil societies and enterprises to exercise green procurement. In addition, initial attempts could be taken to introduce a ‘carbon neutral’ requirement system for large-scale events organized by governmental departments and institutional organizations at various levels and SOEs; similar actions should also be called for other subjects.

5.5.2.5 Launching infrastructure construction and capacity building for green production and consumption

The two-year study of the SPS on the building of a green consumption assessment index system and evaluation methodology for China turned out to be

quite unsatisfactory; a dominant underlying reason for this was the lack of relevant data for key indices. To rectify this, China must make simultaneous efforts to build relevant infrastructure and strengthen capacity following the full launch of the green production and consumption campaign during the 14th “Five-Year” Plan period. This includes:

(1) Setting up a green consumption statistical system, including monitoring, data collection, accounting and an evaluation report on green consumption;

(2) Constructing a green consumption assessment index system and middle and long-term objective index system based upon it. The relevant assessment and objective indices could be set up on a regional and category specific basis accommodating the varied gap in natural conditions and development levels between urban and rural areas and different localities;

(3) Building a unified green consumption information platform, publishing information on green products and services, raising the transparency for the production and consumption of green products and encouraging various stakeholders to take credit in the certification and assessment results of green products and services;

(4) Beefing up capacity building and training on green consumption for the government, social organizations enterprises and the general public; setting up partnerships and networks among various stakeholders to boost active participation;

(5) Making full use of digital technology to support green and low-carbon lifestyles. For example, a digital green and low-carbon lifestyle platform of nationwide influence and uniform and applicable standards can be constructed to support the green and low-carbon actions of individual consumers and organizations.

5.5.2.6 Encouraging the normalization of the green and low-carbon work patterns and lifestyles that emerged during the Covid-19 pandemic, guarding against an impulsive growth of energy-intensive and heavily-polluting industries during economic recovery and supporting carbon neutrality.

Under the context of the Covid-19 pandemic, the popularization of such new working patterns and lifestyles as online-working, videoconferencing and Internet shopping have triggered the rapid growth of “no-contact” industries. These emerging industrial forms should be fully evaluated against their economic and environmental impacts so as to sift out and encourage the normalization of green and low-carbon work pattern and lifestyle. At the same time, resource and environmental management should be strengthened to gear up efforts to offer and spread training sessions on peaking carbon emissions and achieving carbon neutrality and related policies in a bid to prevent localities and enterprises from realizing economic recovery by resorting to new energy-intensive and heavily-polluting projects which would boost carbon emissions. Meanwhile, attention should also be given to new issues such as the sharp increase of packaging from online

shopping by beefing up green logistic construction.

5.5.3 Conducting green taxation reform in the automobile industry

As the leading industry in China, automobile production also stands out as a key contributor to energy consumption, pollution discharges and GHGs emissions. In 2018, the consumption volume of gasoline and diesel from the transportation sector accounted for 46% and 68% of the national total, respectively; carbon emissions from automobiles accounted for 7.5% the national total. While the automobile sector accounted for 43.6% of the national total of NO_x emissions, it contributed only to 20% of the NO_x reductions achieved nationally. Therefore, great priority should be given to promoting green consumption and production in this industry.

In 2020, the SPS put forward policy recommendations related to the green development of the automobile industry in terms of production, procurement, usage and recycling, which are regarded as the four overarching breakthrough points needed to achieve a systemic green reform and development of this industry. With this in mind and based on previous study results, the following suggestions are made on green taxation reform of the automobile industry following due consideration to the need for conservation of raw material and fuel, pollution reduction and carbon neutrality:

The first is to implement the fiscal policies stimulating the development and usage of non-HFC substitutes and substituting technologies. The spreading of refrigerant compressors for the air conditioning of green automobiles can be achieved through reward and punishment taxation policies for the industry, namely incorporating automobile air conditioning refrigerant compressors into the emission checkup index and offering preferential reductions in the consumption and vehicle purchase taxes for vehicle models meeting refrigerant compressor emission and other relevant energy-conservation and environmental protection standards. In addition, the existing practice of promoting green automobiles of/less than 1.6L should be further carried out by incorporating emission requirements for refrigerant compressors to drive the application of green technologies and products including environment-friendly refrigerant compressors.

The second is to implement a preferential taxation policy promoting the extended producer responsibility system. A simplified tax levying method is to be adopted in order to tackle the problem of limited deductible input tax for enterprises as a result of the difficulty in obtaining input VAT invoices during the process of recovery of scrapped vehicles. While for other problems such as the huge investments needed for advanced technology and facilities for the recovery and dismantling of scrapped vehicles vs. the long capital payback period, corporate income taxes should be deducted for enterprises making large investments in environmental protection and passing related checkups. In order to boost the

environmental performance of enterprises specialized in recovery and dismantling of scrapped vehicles, raise the price for recovered vehicles, reduce the number of such vehicles entering the black market and increase the overall vehicle recovery and recycling rate, R&D investments can be factored in by adding a deduction policy with 50% of the investment amount to be deductible from taxable income.

The third is to develop a reward and punishment tax policy for automobile products. Under the pretext of ensuring the overall tax balance of the automobile industry, optimization and adjustment is to be made to the existing automobile tax system to augment the regulation effect of existing taxes on energy conservation and environmental protection. The design of the policy shall combine both short-term and long-term objectives to outline different phases for implementation in line with the competitiveness and development stage of the industry. Specifically, during the 2021~2025 period, the current policy of vehicle purchase tax exemption for alternative fuel vehicles will be further exercised with a gradual phase-out; starting from 2026, new vehicle purchase taxes gauged on an energy-efficiency index coupled with a reward and punishment based consumption tax will be ushered in. Presently, China has already built up a rather comprehensive fuel consumption standard system for passenger vehicles, thus making it quite viable to integrate related indices into the automobile taxation system. The implementation of such a reward and punishment system should be carried out in a step-by-step manner with the addition of the index of fuel consumption volume/100 km for passenger vehicles to the existing tax system as a first step, to be gradually followed by a vehicle emission index, and a power consumption index for electric vehicles when the time is ripe.

As the simulation analysis pointed out, the execution of the above green taxation reform in the automobile industry shall yield substantive effects in various aspects ranging from a cut of input of raw materials in automobile production, an increase in production volume of alternative fuel vehicles to the reduction of fossil fuels, the substitution of refrigerant compressors and emission reductions of CO₂ and other regular pollutants.

5.5.4 Introducing green design policies for the iron and steel industry

In 2019, the volume of crude steel produced by China equaled 53.3% and pig iron 64.2% of world totals. The iron and steel sector not only dominates the discharge of regular pollutants in China, but also overshadows other industries in terms of carbon emissions, accounting for 15% of the national total. Therefore, the promotion of green product design in the industry and an increase in the environmental-friendliness of its products, starting from the very beginning stage of design is of great significance for its green development and future green trade.

In recent years, the Chinese government has attached great importance to the

issue of green development of this sector by resorting to measures including heightening resource and energy efficiency, industrial layout adjustment and restructuring, improvement of pollution prevention and control and improvement of key production technologies as well as the implementation of a clear-cut plan for a green manufacturing system for this industry. Currently, 30-odd industrial standards on green design for iron and steel products are under research and drafting. However, viewed holistically, the concept of green design has yet to mainstream the green development of the iron and steel industry, which is still characterized by outdated standards, lack of incentive measures and relevant capacity, directly hampering the in-depth advancement of the green development of the industry.

In this connection, the following recommendations are put forward:

5.5.4.1 Enhancing the top-level design of green policy and building a promotion mechanism involving the different departments and upper and lower reaches of the industry

The top-level design of green policy aims to draw up a roadmap and construction map for both overall and long-term implementation. The building of coordination mechanisms would require relevant governmental departments to unify their efforts and the observation of uniform standards and specifications through the industry to set up a green industrial chain.

5.5.4.2 Introducing an entire lifecycle evaluation method for the iron and steel industry

Enterprises in this sector shall be guided to make extensive application of the entire lifecycle concept, methodology, data and plans for their industrial production and service provision. To this end, a green iron and steel product evaluation system shall be construct and consolidated, a database for resource and environmental impact of products along the entire lifecycle shall be developed, and the resource and energy intensity and related environmental indices shall be quantified to specify the green level of a product; green improvement plans for products shall be developed for the various stages in the lifecycle; and a technical service system shall be set up for enterprises to translate green design into real production.

5.5.4.3 Developing green design standards, an evaluation system and certification and recognition systems for the iron and steel industry featuring synergy effects in reducing pollution and carbon emissions

As green design standards act as the basic technical baseline for conducting green design in the industry, the construction of a relevant evaluation system and certification and recognition system addressing the performance of enterprises can act as a barometer for management and the market. These systems should be drafted covering the entire lifecycle of the industry with unified consideration to resource and energy efficiency, pollution prevention and control and reduction of carbon emissions to realize synergistic effects.

5.5.4.4 Tie evaluation results and the certification and recognition of green design to the setup of relevant incentive mechanisms

Evaluation results and the certification and recognition of green design in the iron and steel industry should be pegged to relevant policies and administrative measures, such as environmental credit appraisal, environmental taxes, the tax revenue derived from the integrated utilization of resources, pollution responsibility insurance, the frequency and times of environmental surveillance, governmental green procurement, corporate tax income and fiscal subsidies, in order to forge a comprehensive incentive policy and mechanism for the practice of green design by the industry.

5.5.4.5 Supporting the iron and steel industry to carry out personnel training and capacity building on green design

By relying on various industrial associations, universities and research institutions, national and local governments can support enterprises in this sector in training of personnel specialized in green design and strengthening professional skills with capital, intelligent resources and technologies.

5.5.5 Employing the concept and methodology of eco-design to upgrade waste incineration facilities into green facilities that provide products for enhancing living environment

Power generation from waste incineration has already mainstreamed domestic refuse treatment methods in China with an ever-surging construction of related facilities. In 2020, China boasted 519 domestic refuse incineration power generation facilities. An additional 476 such facilities shall be constructed in the next decade according to plans released for 18 provinces and municipalities.

China has encountered two major obstacles in the construction and operation process of waste incineration facilities: first, with the unsound environmental performance of some facilities in operation, local residents of adjacent communities have been negatively impacted, thus causing public discontent and complaints; second, with the rapid betterment of people's living standards, the public has become quite sensitive to environmental quality and risks and may have a bias against waste disposal facilities seeing them as "dirty", and thus generating strong emotional resistance to existing waste disposal facilities or the construction of such facilities, a typical Not In My Backyard (NIMBY) situation.

Regarding the first issue, the Chinese government has made substantial improvement through heightened surveillance in recent years. As indicated by the national public platform on monitoring data from waste incineration power plants, the emission concentration of flue gas from almost all domestic refuse incineration power generation facilities meet national standards with most facilities even making better performance in flue gas emissions than prevalent national standards. Current

Chinese waste incineration power generation technologies and equipment has put China in the leading position worldwide from the perspective of technical capability.

In terms of NIMBYism, the Chinese government has taken integrated measures from various technological, management, social and informational aspects, greatly curbing NIMBY cases. However, since NIMBY is a rather complex problem comprised of multiple factors, including psychological factors and the interests of stakeholders associated with the environmental performance and risks of the facility as well as the overall social-economic development stage. Viewed from the perspective of the social-economic and environmental protection development situation of China, environmental NIMBY incidences will reoccur well into the future. Only long-term, stable and effective solutions can elevate the functioning of waste incineration power plants, and change their image with the public.

The SPS has come up with the following suggestions to further green development: the concept and methodology of eco-design should be employed to upgrade waste incineration facilities into green facilities that can enhance the surrounding living environment.

The specific method for achieving this includes the construction of a string of technical standards under the four categories of environmental safety, ecological harmony, community friendliness and economic efficacy. The waste disposal facilities constructed and operated in light of these standards shall be enabled with multiple functions: first, the problem of pollution from waste will be solved without any further environmental risks; second, the facilities will be in coordination and harmony with the local ecological landscape, the urban design layout and features as well as local customs and culture; third, the operation of the facility shall benefit local communities, thus creating a benign interaction. In addition, economic efficacy will be a key issue to consider. Presently, successful cases can be found in Chinese cities like Huizhou, Changzhou and Hangzhou.

The specific practical steps are as follows: first, existing regulations on the construction and operation of waste incineration power generation facilities should be integrated into a unified set of green standards and technical specifications; second, experience is to be accumulated from exercising the top-runner system with these green standards followed by large-scale duplication.

5.5.6 Exercising a sustainable (green) food consumption policy

The sustainable consumption of food has been gaining more and more attention from international society, since food spoilage and waste implies an ineffective consumption of resources, considering also food production and the corresponding emission of GHGs. Waste food with its varied disposal methods also generates a huge amount of GHGs emission. Should we treat all the wasted food generated worldwide as a nation, it would be the third largest emitter of GHGs globally.

The situation in China is also far from gratifying. On the one hand, there is a huge overall loss and level of waste throughout the food supply chain. As the sample survey of the State Bureau of Grain Reserve showed, the annual loss of grain from production to final consumption stood at 135 billion tons in 2016, equal to roughly 10% of the total grain yield in that year. In China, the average spoilage rate of fruits is 20%-30% during transportation, and there is a similar spoilage rate for vegetables: 30%-40%. On the other hand, more food spoilage and waste occurs at the consumption stage. As the 2018 survey report of the Institute of Geographic Sciences and Natural Resources Research of the Chinese Academy of Sciences indicated, the annual amount of food wasted from the dining table alone was 17-18 million tons from 2013-2015, enough to feed 30-50 million people for a whole year. In 2018, the amount of kitchen waste was over 100 million tons with the daily average nearing 300,000 tons. Researchers estimate that China's annual CO₂ emissions from food calculated over the entire lifecycle stands at 1.605 billion tons. The similar figure would still be as high as 300 million tons even if we assume only a one-fifth food spoilage and waste rate (in comparison the FAO estimates the world average is roughly a one-third spoilage and waste rate).

The SPS is glad to see that the Anti-food Waste Law of China was officially enacted and put into effect on April 29, 2021 as our research proposes policy recommendations on green food consumption. As a green and low-carbon consumption model underpins this law, numerous stipulations have been made for various consumption stages and subjects. The SPS regards the law as being more than a law simply opposing food waste; it is the first of its kind to enhance a green and low-carbon lifestyle in China and should be fully implemented. In specific, four major tasks are needed: first, as green consumption of food involves every household, there should be large-scale and continuous popularization of the law and public and stakeholder awareness raising about the content of the law; second, feasible and detailed rules and regulations must be drafted targeting specific stipulations in the law for its effective implementation; third, relevant government departments, industrial associations and social organizations should take the lead in working with catering enterprises and consumers should exercise self-discipline; fourth, scientific research and data collection and statistical work on sustainable consumption of food should be upgraded with a regular reporting system.

5.5.7 Accelerating and Deepening the Green Consumption Transition: International Experiences

International experiences with promoting sustainable consumption, including the United Nations' 10-Year Framework of Programmes on Sustainable Consumption and Production initiated in 2012, show that past efforts to address sustainability problems have often failed to examine consumption and production processes in

their full complexity or across their entire value chain. Innovative business models that follow a system perspective to achieve lower environmental and social impacts are needed to mitigate the increasing demand for products and services. Consumers must also be incentivized to consume at more sustainable levels, with less waste and more focus on product quality and the social and environmental impacts of their purchasing behavior. This requires sustainability considerations at all levels from the setting of green transition visions and pathways through to implementation and the introduction of a broad array of new regulatory and market-based policies and measures as well as educational campaigns.

In the current context of post-corona pandemic recovery and the transition to low carbon development, the following recommendations may be of particular interest for China as it designs its own green transition policies and social governance system.

5.5.7.1 Follow a holistic approach to support sustainable development, link sustainability to post-corona recovery

In developing approaches to support sustainable consumption, follow a holistic approach. This means a focus on the complete value chain from material and energy inputs, through to product design and production processes to product use and post-consumption management. Green transition and social sustainability are complex challenges that call for a system perspective. Furthermore, link sustainability to post-corona recovery. Corona recovery plans provide an opportunity to make some of the major infrastructural investments and policy transitions that will be needed for the green recovery. If these recovery funds are directed towards the green transition and the creation of green jobs and green infrastructure, green innovation will flourish.

5.5.7.2 Demonstrate and foster sustainable lifestyles and education, integrate new digital technologies along products' entire value chains

Launch campaigns to promote sustainable lifestyles, drawing on the Swedish and Japanese co-led program (2012-22) on sustainable lifestyles and education, which aim at fostering the uptake of sustainable lifestyles as the common norm to address global challenges such as biodiversity conservation, resource efficiency, climate change mitigation, poverty reduction and social well-being. Education for sustainable living for future generations and scenarios for 1.5 degree living in 2050 will be important to realize a green transition and increased well-being. Provide consumers with information about the sustainability of products through websites, educational campaigns, and certification systems and launch educational campaigns to promote sustainable lifestyles as is occurring in international society, including in Japan.

Integrate new digital technologies into production processes along the entire value chain of products to enhance efficiencies. Use internet platforms and social

media to disseminate information about the importance of the green transition and steps that can be taken by individuals and businesses to make a difference. A green transition requires an overall digital structural transformation that considers the goals and targets set in Agenda 2030.

5.5.7.3 Make use of green taxation and economic incentives to encourage lifestyle balancing in the post-pandemic future

Make use of green taxation and economic incentives. Tax products with high environmental externalities and provide incentives to promote the purchase of more environmentally sustainable products. Tackle fields which to date have received too little attention in sustainability discussions, such as the food supply system and textiles. These are fields with large ecological footprints. Encourage lifestyle changes that promote greater life-work balance and encourage sustainable enjoyment of nature in the post-pandemic era.

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Chaper6

Major Green Innovation Technology and Its Implementation Mechanism

6.1 Introduction

6.1.1 Significance of Community Green Renewal

Community renewal and carbon emissions. Community and block renewals will become the main method for Chinese urban renewal. Communities are the main places for city life and living. From international experience, improvements in the living quality of residents will generally lead to an increase in carbon emissions per capita. The core of community renewal and renovation, however, is to improve residents' living quality. Therefore, Chinese community/life carbon emissions may rise greatly in the future unless active interventions implementing green technologies and green lifestyles are adopted. If not, community renewal is likely to become a huge drag on achieving China's "Double Carbon" goal.

The Chinese government advocates community green renovation. Since 2020, China has defined the renovation of urban old communities as significant livelihood projects and development projects^[1], and put forward that by the end of the 14th Five-Year Plan, China will strive to complete the renovation of about 220,000 old, urban communities involving hundreds of millions of people, stimulating investment of up to one trillion RMB (\approx 154 billion USD). In July 2020, China printed and issued its *Action Plan for Establishment of Green Communities*, which advocates the idea of green development throughout the entire process of community design, construction, management, and service, and promoting environmental construction and renovation of communities by simple, moderate, green, low-carbon ways. With the gradual implementation of the Chinese urban carbon neutrality strategy, community green low-carbon renovation will gain more support from government

policies and finance.

Community green renovation is a key fulcrum of urban carbon neutrality solutions. Communities present themselves as the most practical and direct application scenario for low-carbon residential energy resources. Small-scale pilots and living laboratories on the community level have been widely applied in leading cities worldwide, and have become mature test tools and means for various green technologies at the early stages of application promotion. Experience and implementation model of community renovation are key factors for the promotion of low-carbon technologies. They can more widely mobilize public participation and drive adoption of the green living concept, as well as contribute to the formulation of relevant policies and regulations.

6.1.2 Vision, Criteria and Goals of Community Green Renewal

Vision of Community Green Renewal: Achieve people's desire for a good life by green construction, management, service modes, and green lifestyles, **build** livable communities with **green prosperity, low carbon-intensive mode, circular economy, equity and inclusiveness, safety and health**, and provide "China's samples" for sustainable, global community renewal.

Criteria of Community Green Renewal:

Criterion 1: With the goal of meeting people's demands for a good life, green community development should advocate sustainable consumption and lifestyles, fully consider the demands of women, children, and the elderly, adequately respect the development rights of vulnerable groups, improve all people's living quality, give people the opportunity to enjoy a superior green environment and facilities, and achieve sustainable development of the life sector.

Criterion 2: Green communities should adopt green, low-carbon planning, design, and operation modes, provide high-quality public goods such as affordable housing, service, facilities, mobility, energy, water, and air quality, provide residents with good space quality to meet demands, and motivate the whole society to jointly participate in a sustainable lifestyle.

Criterion 3: Green communities should adopt effective means to circularly and efficiently utilize resources, reduce ecological vulnerability, enhance resilience and adaptation to natural and human-induced disasters and reaction capacity toward natural and man-made disasters, achieve harmony between human and nature to the maximum extent, and promote climate change mitigation and adaptation.

Criterion 4: Green technologies applied in community renewal should fully consider climatic characteristics, geographical features, development levels, development patterns, and others in different regions, and the costs should be controllable, safe, and stable. A low-carbon lifestyle, promoted in community renewal, should also have social acceptability and be easily replicated and promoted.

Criterion 5: Green communities advocate all stakeholders, according to national policies and laws, to establish and strengthen partnerships, improve coordination and cooperation, and finally facilitate community residents and even social production modes, lifestyles, and values towards the low-carbon transition, so as to achieve a common green vision.

Measures on Community Green Renewal: Based on the urgency of the “Double Carbon” goal, urban communities must adopt a “green technologies + low carbon lifestyle” intensive intervention path to achieve the green community goal.

(1) Widely Adopt Green Technologies. The green technologies, used in community renewal, should be able to reduce energy consumption and promote energy utilization efficiency, as well as reduce resource consumption and promote “circular economy.”

(2) Comprehensively Promote Green Buildings and Green Construction. Greatly increase the proportion of green buildings through the reconstruction (or retrofiting) of old buildings, and drive circular economy of resources by promotion of green building materials; promote circular economy approaches to the reuse and recycling of demolished buildings.(circular economy of building materials obtained after demolition and reconstruction).

(3) Advocate Compact, Mixed Land Utilization. Form more mixed-used public spaces, and promote intensive use of overground and underground spaces; Achieve time-share efficient utilization of more buildings through management. Promote shared building modes such as public restaurants, and build public spaces adapting to the aging and living, as well as family life and working spaces.

(4) Shape Greener, Healthier, and More Flexible Open Public Spaces. Through community renewal, expand green spaces, increase carbon sinks, and improve the microclimate; Extend community shared public space, and guide healthier and more active resident communication; Construct safer and more flexible municipal infrastructures.

(5) Achieve a Low-Carbon, Green Lifestyle. Provide residents with reliable, accessible and affordable public service, and guide residents towards green mobility; Support residents to adopt lifestyles which protect the environment and reduce resource consumption; Construct community rooftop farms, vertical gardens, and so on, and create three-dimensional micro-farms; Build vertical greening using the external facade of buildings.

(6) Encourage Market Entity and Community Residents to Participate in Community Green Renewal. Formulate supportive policies, clarify rules, and establish social conventions, and guarantee benefits for various populations, especially women, children, the elderly, and vulnerable groups. Encourage residents to directly participate in reduction of community carbon emissions, and let communities become the main outlets for citizens in fulfilling their social

responsibility of reducing their carbon emission footprint.

6.2 Global Experience and Practice: From City to Community

6.2.1 Decarbonization Paths for Cities/Communities from an International Perspective

6.2.1.1 Energy

The energy transition is fundamental to getting to net-zero in China. This is not only because China's power sector accounts for around 50% of its energy-related emissions (14% of global energy-related emissions), but also because electrification will be the core of the future energy system and is vital to getting to net-zero for other sectors.

China is already the global leader in renewable energy production and has great potential in solar photovoltaic (PV) and wind power generation. If the trend of rapidly decreasing global average cost in renewable energy and energy storage continues, China could achieve 62% of electricity from non-fossil sources by 2030, higher than the 50% target set in the 14th Five-Year Plan and emissions from China's power sector could be reduced to half of 2015 levels.^[2] Green hydrogen, carbon capture utilization and storage (CCUS), sustainable bioenergy and other clean energy options will be needed in sectors where electrification is not viable. Baofeng Energy Group has operationalized the world's largest solar-powered hydrogen plant in China in April this year, powered by solar PV park. According to Baofeng, the cost for green hydrogen is competitive compared with brown hydrogen (produced from coal gasification), while reducing 320,000 tons of coal consumption annually.

6.2.1.2 Mobility

The most important for carbon neutrality in urban mobility is the increased availability and efficiency of low-carbon transportation options. This needs planning and design of city spaces for convenient mobility. Easy walking, cycling, and an optional efficient public transportation system can significantly boost green mobility and lifestyles of the general public. Bus Rapid Transit (BRT), for instance, uses dedicated lanes to make both inter- and intra-city movement by bus quick for the public. The 15-minute community life circle, which has been widely promoted in China, uses urban design to reduce mobility volume and promote a low-carbon living mode, making all basic living needs reachable within 15 minutes walking.^[3] In 'Plan Melbourne 2017-2050'^[4], Melbourne is planning a 20 minutes neighborhood covering connected and walkable places where people live, work and play. 20 minutes neighborhood is all about 'living locally', with access to safe cycling and local transport options.

Additionally, technology-enabled, demand-side strategies of Transport Demand Management (TDM), shared rides and modes of mobility, and Mobility as a Service (MaaS) all create low carbon transportation incentives and solutions for consumers. [5] Autonomous Driving (AD) will also be conducive to the extension of public transport by on-demand services. The Beijing Municipal Commission of Transport and Amap signed a strategic agreement to jointly launch the Green Transportation Integrated Service Platform. This is both the first MaaS platform in China and the first with 10 million users globally. It encourages citizens to participate in green travel through carbon inclusive methods.

Another important element is the continued mass promotion of new energy vehicles (NEV), along with the construction of NEVs charging infrastructure^[6] (However, the incentives for NEV is counterproductive to city planning that aims at reducing private car use in general). There are five million NEVs in China, and integration of solar power, energy storage with power batteries, fast charging, and battery swapping stations can improve the application of decarbonized energy in the transport system. Finally, alternative propulsion systems and alternative fuels, such as fuel cell EVs (FCEVs), green hydrogen production and ammonia fuels, as well as biofuels or synfuels, will be needed, especially in areas such as heavy-duty transport.

6.2.1.3 Building

From a full lifecycle, carbon emissions management point of view, building construction and the manufacturing of materials generate 11% of global CO₂ emissions, while building operations are responsible for 28%, around half of which is from energy consumption. [7] Consequently, decarbonizing the built environment requires new buildings to be built as net-zero energy buildings (NZEB) and retrofitting existing buildings by improving the energy efficiency and electrifying building operations, and meanwhile, using renewable energy for heating as far as possible, such as industrial waste heat for district heating in northern cities. To commercialize NZEBs, green building standards are key. There are many externalities in green buildings, such as the cost for climate risk mitigation. The transformation requires these costs to be internalized and added on top of the initial capital investment and operational cost. This procedure needs to be standardized to commercialize green buildings at scale. In buildings such as Steel Structure – Modular Internal Space (SS-MIS) buildings, the materials and construction methods can be used for reducing embodied emissions, as well as improving building lifespan. Building-integrated photovoltaics (BIPV) and other forms of distributed energy storage will realize grid flexibility by digitalization and the Internet of Things. The smart operation and maintenance of buildings - Swire Properties has installed smart meters and IoT sensors into their buildings to better understand electricity, water and waste consumption as well as indoor air quality. A cloud-based smart energy management platform and a technical cloud captures all the data from across

portfolios into a centralized cloud platform. The cloud platform is able to utilize 4IR technologies to monitor, analyze, and optimize their building systems.

6.2.1.4 Water

Water scarcity, driven by rapid urbanization and climate change, presents major challenges to industries around the world. Water management strategies and technologies can protect water resources, improve efficiency, and reduce energy and carbon emissions. Improving efficiency of Non-Revenue Water (NRW) management by reducing water leakage and promoting sewage to energy for plant self-sufficiency in wastewater treatment is an important pathway to decarbonize urban water.^[8] The sponge city is a novel concept on urban flood and stormwater management and Managed Aquifer Recharge (MAR), and has been championed in China since 2015 with 30 metropolises as a part of this project.^{[9],[10]} The objective is to have 80% of urban areas absorb and reuse at least 70% of rainwater by 2030.^[11]

6.2.1.5 Land-Use and Planning

The integration of technology deployment, land-use, and planning strategy is a key pillar to support cities' green transition. For example, the production of renewable energy resources will have huge implications on land use. The sponge city contributes to tackling urban artificial water bodies and green spaces and improving social wellbeing.^[12] Some European cities are experimenting to reduce private car ownership and increase city space. In Brussels, Belgium, local residents can receive a local one-year public transport subscription if they sell their car without buying a new one.^[13] The research in Singapore found that shared mobility could eliminate 86% of parking spaces.^[14] In a similar vein, new technologies, along with the Covid-19 pandemic, have forever changed work and shopping habits, resulting in less need for office and retail space. The "ground floor" spaces open to streets and squares can be repurposed and used for meeting, co-working spaces, urban agriculture, non-profit associations, and more.^[15] How these changes match with low-carbon lifestyles should be investigated in sustainable urban planning. The change in mindset that urban planning and development should be holistic, sustainable, and social is an example set by the sponge cities concept, which can be extended to future developments in response to the changes in urban spaces brought on by new, green technologies.

6.2.1.6 Food

Globally, the agri-food system produces a third of all GHG emissions, with China's food supply chain accounting for 11%-12%. The development of agricultural technologies, the reduction of food loss and waste, and the shift of dietary patterns are of importance to reducing GHG emissions from the agri-food system and realize carbon neutrality.^[16] Agricultural technologies may directly reduce GHG emissions, as well as indirectly through increased productivity, better supply chain linkages, and more. The majority of food-related emissions come

mainly from farmland emissions, animal enteric fermentation, rice cultivation, manure management, and agriculture residuals.^[17]

The principal factor in GHG emissions, water consumption, and land-use area pressure in the agri-food system is the growth of meat consumption in China. Reducing food waste, shifting away from meat consumption, and deploying city-relevant agricultural technologies are very important to achieve the carbon neutrality goal. Vertical farming, as an emerging technology, is characterized by high crop yield, low water utilization, and efficient utilization of natural resources. The majority of vertical farming in North America currently focuses on high-value crops, but its use in China is limited due to its relatively high cost.

6.2.2 Experience on Green Renovation Technologies in Domestic and Foreign Communities

With Sweden Hammarby Sjstad, Malmo Seashore Eco-City, and Royal Seaport City as the main cases, combined with Tokyo Boye New City, Copenhagen, Singapore, and Shanghai Meilongsan Village low-carbon demonstration community, the research focuses on experiences gained in green technology promotion, lifestyle initiatives, convention guarantees, policy support, etc.

6.2.2.1 Green Technologies

The application of green technologies has gradually evolved from a single technology to multi-dimension integration. For example, Hammarby and Royal Seaport City proposed the “SymbioCity” idea, including urban spaces, mobility, energy, water, solid waste, green buildings, intelligent management, and environmental greening, for a total of 42 green technologies in seven dimensions. In accordance with the relevance between technologies and external systems as well as local applicability, the research classified the 42 technologies into three categories:

Green technologies supported by external systems. This category of green technologies needs to be carried out on a larger scope, or needs ancillary facilities from municipal administration, including consensus of relatively mature compact blocks, mixing functions, public transport, etc., to reduce carbon emissions by nearby accessibility or low-carbon travel for the goals of employment, residence, and leisure. The other nine technologies can be summarized as two trends: The first one is municipal infrastructure towards distributed transition. The average energy utilization rate of traditional vertical electric system is about 36%, while the distributed energy systems usually use multi-variant energy supply methods such as gas turbine, solar energy, biomass energy, fuel cells, combined heat and power generation, and combined cold, heat and power (CCHP), with a comprehensive energy utilization efficacy of up to 70-90%. The second one is the transition of energy, water, and solid waste systems from independent operation to cross-net

collaboration and circular symbiosis, including waste water being made into biogas, and bio-compost, but this needs to be arranged in a larger scope. In Hammarby, for instance, 50% of energy comes from solar energy, and the other 50% is from power generation by garbage, biogas, and waste heat.

Green technologies in newly built areas. This category of green technologies usually has higher requirements for ancillary facilities and applies to newly built areas. These technologies include district cooling, underground vacuum refuse collection system, green building materials, passive buildings, and flexible power distribution. At present, there are two green technologies which have been widely used in foreign cases and gradually tried in China. The first one is district cooling technology, which uses off-peak electricity for refrigeration and accumulation of cold in the nighttime and provides regional central cooling in the daytime. It is applicable to regions with high-density demand for cooling capacity. The other one is the underground vacuum refuse collection system. There are approximately a thousand cases with successful operations at present, but no successful practical case due to insufficient garbage classification and management system problems at home and abroad.

Updated green technologies in blocks. This category of green technologies is mainly used for small facilities or intellectualized systems and applicable to renewal and renovation of block greenization. Among these technologies, photovoltaic technology, green roofs, reuse of reclaimed water, and most green building technologies have been gradually promoted in China. These technologies represent three big trends: The first one is that energy supply side, storage side, and client side have increasingly intense demands for direct current (DC), and thus the DC micro-grid gradually becomes an important development direction of the electric power system. A neighborhood with 300m*300m DC micro-grid can be established in accordance with the optimal transmission distance of DC. The DC power supply system can be built by relying on distributed generation and stored energy facilities to enable each user of the electric energy to become a provider of clean electric power. The second one is to use heat pump technology to recycle waste heat, make cascade heat (cold) supply, and enhance energy efficacy. Nordic countries such as Sweden pay much attention to recoveries of indoor waste gas, exhaust gas in traffic yards and stations, waste water, and waste heat produced in the incineration-power generation to form sewage source heat pump, air source heat pump, ground source heat pump, and so on. The heat pump technology is carried out in China now. The third one is the transition of the technological means from physical facility optimization to virtual operation optimization, and smart micro-grid and virtual power plant are the two commonly-used technologies. The smart micro-grid can form independent community self-circulation when local generating capacity is adequate; it can store electricity or sell grid-connected electricity when local

generating capacity is excessive; it can be supplemented by urban power grid when it is insufficient. The virtual power plant can organically combine distributed generator set, controllable burden and distributed stored energy facilities, and achieve integration and control by the control technology and the communication technology so as to be a special power plant to participate in the electricity market and power grid operation. Mature solutions for virtual power plants have not been formed yet due to the problems of the electricity system in China.

6.2.2.2 *Green Lifestyle*

The developed countries and green and environmental protection organizations publicize green lifestyle continuously and widely. For example, *Sustainable Living Guide*, issued by World Wide Fund For Nature, includes five aspects, i.e., clothing, food, housing, transportation, and leisure, and advocates choosing environmentally-friendly fabrics, giving used clothing to others, eating at home, not wasting when ordering food, choosing and using energy-saving appliances, garbage classification and decrement, bike sharing, low carbon cars, enjoying nature, not wasting disposable daily necessities, and other specific details of life. Through continuous decades of developed economic models, the Union of Concerned Scientists (UCS) have obtained a real carbon emissions image of the U.S., and teased out ten ideas for the lowest-carbon life, including using hybrid electric vehicles, eating 50% less meat not drinking bottled beverages, reducing 20% of shopping, and so on. *Curbed*, a US website, also issued *101 Actions to Tackle Climate Change*, which tells how to achieve low carbon life at home, on the road, and in communities.

More and more inhabitants begin to accept and practice green lifestyles in many cities and communities of Europe and North America. Particularly in zero-carbon communities and the cities that have a carbon neutrality goal, such as Hammarby and Copenhagen, green consumption and lifestyle have been widely accepted, which lays the social and public opinion foundation for them to achieve the goal of carbon neutrality.

6.2.2.3 *Convention Guarantee*

There are government or community conventions to constrain carbon emission-generating behaviors in green communities of developed countries. For example, in Hammarby, the government requires all residents to sign an environmental protection contract before residence, promise joint efforts to achieve the goals of saving electricity and water, and strictly execute garbage hierarchical classification and “pay-as-you-throw.” The government also organizes a car-sharing group, provides environmentally-friendly goods which can be obtained at any time and include organic dustbins, biodegradable garbage bags, energy-saving bulbs, and so on. Vauban Community (Germany) devotes itself to building an ideal community which shares a common fate with residents. Citizens are allowed to participate in the decision-making process and have discussed the idea of a car-free community and a

“Zero-Tolerance Parking Policy.” The community has achieved a car ownership rate at only 174 vehicles per thousand people, which is far lower than the nationwide average of 504 vehicles per thousand people in Germany.

Strengthening low-carbon consciousness of the public is an important guarantee to propel implementation of the community convention, done by providing information, consultation, training, etc. Copenhagen lists the cultivation of “Climate Citizens” as an important part of the Lighthouse Plan. The UK executes the “Green Home Plan” and provides family energy-saving consultation for London residents. In China, the creation of a national low-carbon day has become an important information window to publicize a green, low-carbon social climate.

6.2.2.4 Policy Support

Economic means are the most commonly used international means. The economic incentive policies include tax revenue, subsidy, and price policies. Hammarby stipulates that developers and contractors can obtain government subsidies if they pass the evaluation of ELP. In the initial period of construction, the government promised a subsidy of about 22 million Euros for the extra cost of autonomous environmental protection measures and technologies (the subsidy for the construction cost of the vacuum refuse collection system is up to 50%). During construction, the government constrains developers through the contract on development of urban construction, and requires the construction to meet the basic requirements and the goal of energy efficiency solutions.

Administrative means are the uppermost means in China. Through a series of policies and regulations, the government should clarify the standards and construction requirements of the energy-saving products, such as requiring building enterprises to publish energy consumption and emission standards, as well as whether equipment and materials are energy-saving, environmentally-friendly, etc. Carbon emission is listed as one of factors for government tender. Royal Seaport City put forward that the sustainable requirement should be listed in the land development conditions, included in early planning, and become an influence factor to win the bidding. The specific environmental protection conditions for developers include the energy consumption level per unit area, standards of wind or solar heat collection, water consumption, environmentally-friendly building materials, garbage collection vacuum piping system, environment management system, and so on. For the design of public areas, the construction also adds the use of light-color coatings in squares and streets, prioritization of slow-down and public traffic systems, and the setting of car-sharing spaces.

6.3 Characteristics of Carbon Emission in Cities and Communities

6.3.1 Selection of Cities and Communities as Cases

The factors for selection of communities include the following aspects: The first one is the technological level of community construction at different times. The construction times of these communities are from 1980s to 2010s, reflecting characteristics and problems of community construction in different stages. The second one is different crowds and inhabitation forms. There are middle-income communities, low-income communities, tenement communities with young people as the majority, standard communities with core families as the majority, and aging communities with urban original residents as the majority. There are different kinds of commercial housing communities, communities with private property rights, and high-density housing communities with rural collective property rights. The third one is different climatic regions and different scales of cities. These cities include: megacities, super-cities, small cities; plains, mountainous and hilly cities; hot cities in the south and hot-summer/cold-winter cities. Furthermore, factors such as community location and green technologies were also considered.

The five communities from the four cities selected as the research subjects comprise of: Shanghai Shi Bo Jia Yuan Community, Jing Jiang Yuan Community, Chongqing Hongyupo Community, Shenzhen Heyi Community, and Jiangshan Dongtang Community.

6.3.2 Basic Information on the Communities and Socio-Economic Characteristics of the Population

6.3.2.1 Basic Information on the Communities

Both Shi Bo Jia Yuan Community and Jing Jiang Yuan Community are located in Pujin Street, Minhang District, Shanghai, 15 km away from the central city (People's Square), nearby Rail Traffic Line 8 directly towards the central city. There is a AAA hospital, middle and primary schools, a hypermarket, a church, and other public service facilities within 500m. The communities have thorough community-level public service facilities and preferable greening levels, and the infrastructure, such as waterproofing for external walls, public lighting, and garbage classification, have been renovated and transformed through the “Beautiful Homeland Transformation” project. Moreover, Shi Bo Jia Yuan Community uses heat insulation walls and double-glazing green technologies.

Hongyupo Community is located in Jiulongpo District, Chongqing. Shiqiaopo region is one of the traditional centers for trade of the main urban area, with high-density population, convenient traffic, and hilly and mountainous topography. The overall quality of the buildings is poor, and roof leakage, wall cracking, stained and

damaged wall space, and other problems are present. The public environment of the community needs improvement. There are serious problems in water resources, pollution discharge, dustbin cleaning, and coordination of property management companies, and it is very difficult to maintain public facilities.

Heyi Community is located in Baoan District, Shenzhen, and almost entirely surrounded by industrial parks, including manufacturing enterprises of electronic information parts. It is a newly-built multilayer urban village with very high building density and without public space. Commerce at the bottom of the residence is the main service space and provides drinking water stations, restaurants, community shops, and internet bar services for tenants.

Dongtang Community is located in the core of the old urban area of Jiangshan. Its residents can go to the core of the old urban area only by walking. There is commerce along the street, the Jiangshan Library, the Popular Science Activity Center, and other city-level public service facilities within 500m. The land property rights of the community belongs to the residents, and are mostly either single placement dwellings with one to three floors, houses built on the funds collected by the buyers, or self-built houses. These houses are simple and crude, but heat preservation and ventilation are good. No explicit public spaces and public service facilities exist, including a lack of street lamps in the community. Some residents' water supply and fuel gas are not connected to the municipal pipe.



	Shi Bo Jia Yuan Community	Jing Jiang Yuan Community	Hongyupo Community	Heyi Community	Dongtang Community
Location	Pujiang Town, Minhang District, Shanghai	Pujiang Town, Minhang District, Shanghai	Jiulongpo District, Chongqing	Shajing Street, Baoan District, Shenzhen	Core of the old urban area of Jiangshan
Construction Age	2006	2004	1970~1980s	2010	1990s
Characteristics	New community with low carbon technology	New community without low carbon technology	Aging community	Rental houses in the urban village	Aging private property right

	Shi Bo Jia Yuan Community	Jing Jiang Yuan Community	Hongyupo Community	Heyi Community	Dongtang Community
Site Area	29ha	18ha	40ha	8.1ha	5.3ha
Plot Ratio	1.28	1.24	1.34	2.19	0.88
Building Floors	Many multistory buildings, and few medium height buildings	Multistory buildings	Many medium height buildings and few multistory buildings	Many medium height buildings	Many medium height buildings
Building Quality	Good	Good	Poor	Good	Poor
Green Area	90364	66744	132671	0	0
Renewable Building Area	0	0	107025	0	46800

Figure 6-1 General chart of basic information of the five communities

6.3.2.2 Socio-Economic Situation

Shi Bo Jia Yuan Community and Jing Jiang Yuan Community are middle-income communities with the core families as the majority. Jing Jiang Yuan Community consists of placement dwellings due to local removal and relocation. The education and income levels are lower than Shi Bo Jia Yuan Community, but the age structure is relatively young. Hongyupo Community is an aging community with stem families as the majority, and the income of residents is low. The proportion of rentals is high, and most renters are migrant workers and college graduates. The low rental price and convenient commuting options are the core advantages for attracting renters. All houses of Heyi Community are rental houses for staff working near industrial parks. Renters are mostly single, relatively young, and their education at the level of junior-senior high school. Dongtang Community is a community with small urban private property rights and with core families as the majority. It is not an aging community; both the income and the education level are the lowest among the five communities.

Table 6-1 General list of basic information of the five communities

Community Name	Shanghai-Shi Bo Jia Yuan Community	Shanghai-Jing Jiang Yuan Community	Chongqing-Hongyupo Community	Shenzhen-Heyi Community	Jiangshan-Dongtang Community
Total number of people	10119	6268	16000	11891	1734
Number of households	4195	2420	5383	8252	789
Average number per household	2.41	2.59	3.0	1.4	2.2

Community Name	Shanghai-Shi Bo Jia Yuan Community	Shanghai-Jing Jiang Yuan Community	Chongqing-Hongyupo Community	Shenzhen-Heyi Community	Jiangshan-Dongtang Community
Family structure	Core families	Core families	Stem families	Single or double lessees	Core families
Aging ratio (60 years old or above)	35%	22%	60%	1%	13%
Rental rate	20%	29%	60%	98%	0%
Income level	Upper middle	Middle	Middle	Relatively low	Relatively low

6.3.3 Data Collection, Measurement, and Analysis of Carbon Emission in the Communities

6.3.3.1 Data Collection in the Communities

To measure carbon emissions in these communities, four kinds of data were collected, i.e., domestic energy consumption data, resident mobility data, the clothing, food, and living data, and green carbon sequestration data. This research obtained the data mainly through communities and property management companies.

Household energy consumption data was collected in terms of the use of electricity, water, and fuel gas in the peak months, and the annual accounting was done in accordance with the ratio of the peak months to the whole year. It was not convenient to enter houses to collect the residents' mobility data due to the Covid-19 pandemic, so the data was calculated by mobile phone signaling and then checked through urban mobility survey reports. The clothing, food, and living data were measured in line with the amounts of garbage collection, water supply, and urban residents' food consumption. The green carbon sequestration data was obtained in accordance with the plane graphs of communities.

6.3.3.2 Metering Method of Carbon

Based on the relative research on measurement of carbon emissions, it was concluded that carbon emissions in blocks mainly involved community energy consumption, resident mobility, food, clothing, and life, and green carbon sequestration. The specific computational formula for the total carbon emissions in blocks is: $E = E_e + E_m + E_l - E_g$. E refers to the total carbon emissions in blocks; E_e means the total carbon emissions from community energy consumption; E_m refers to the total carbon emissions from resident mobility; E_l means the total carbon emissions from food, clothing, and life; E_g means the total green carbon sequestration.

6.3.4 Structure of Carbon Emission and Analysis of Influence Factors in These Communities

6.3.4.1 Structure of Carbon Emission in the Five Communities

In terms of total carbon emissions, the characteristic of high carbon emissions is obvious in the two communities of Shanghai, with the carbon emissions per capita up to 2.2~2.3t each year, about two times that of the other communities; the carbon consumption per capita is low (about 1t each year) in the two communities of Shenzhen and Jiangshan; it is moderate (1.6t each year) in the community of Chongqing.

In terms of the structure of carbon emissions, there is a large difference among different cities, and the carbon emissions from resident energy consumption and mobility accounts for the main proportion. The energy consumption of the Shanghai communities is the highest, and the carbon emission is up to 1~1.2t each year, accounting for about half of total carbon emissions; because of long-distance commuting, the carbon emissions from mobility is also high - up to 0.6t each year, accounting for 30% of total carbon emissions. The energy consumption of the Shenzhen and Jiangshan communities is only 1/3~1/4 that of the Shanghai communities, and the carbon emissions from mobility are also very low. The Chongqing community is located in a central urban area. Meanwhile, the degree of aging is relatively high; the carbon emission from energy consumption and mobility is about a half that of the Shanghai communities. There is no large difference in the total carbon emissions from life per capita, with an average of about 0.5~0.6t in each community. The contribution of carbon sequestration is slightly different due to community greening differences, but in whole, the proportion is not high (about 3%).

In terms of carbon emissions per unit area, it is the highest in Shenzhen Heyi Community, and up to 104g per square meter. The living space per capita of Heyi Community is low and the carbon emissions per capita is not high, but the carbon emission per unit area is close to two times of that in a normal community. The carbon emissions per unit area is similar and about 60kg each year in the Shanghai communities and the Chongqing community. In Jiangshan community, the living standard is low and the infrastructure not perfect, and thus the carbon emissions per unit area is the lowest and about 35kg each year.

6.3.4.2 Analysis of Factors Influencing Carbon Emissions

It can be seen from the comparison of the five communities that the main factors influencing carbon emissions in communities include residents' living standards, residential morphology, community types, mobility characteristics, energy consumption behaviors, etc.

Table 6-1 Comparison of total carbon emissions per capita and structure among the five communities (Unit: t/person·year)

Situation of carbon emissions	Shanghai-Shi Bo Jia Yuan Community		Shanghai-Jing Jiang Yuan Community		Shenzhen-Heyi Community		Jiangshan-Dongfang Community		Chongqing-Hongyupo Community		
	Per capita	Proportion	Per capita	Proportion	Per capita	Proportion	Per capita	Proportion	Per capita	Proportion	
Resident energy consumption	Water	0.02	0.80%	0.02	1.00%	0.01	0.70%	0.01	0.80%	0.04	2.20%
	Electricity	0.94	43.00%	1.01	43.40%	0.31	27.90%	0.27	28.60%	0.34	20.30%
	Gas	0.12	5.60%	0.18	7.70%	0	0.00%	0	0.00%	0.26	15.60%
	Total	1.08	49.30%	1.21	52.10%	0.32	28.60%	0.28	29.40%	0.63	38.10%
Mobility	Total	0.64	29.20%	0.64	27.60%	0.19	16.90%	0.02	2.20%	0.32	19.30%
Municipal administration	Solid waste	0.17	7.50%	0.17	7.20%	0.23	20.50%	0.28	29.30%	0.26	15.70%
	Waste water	0.04	1.80%	0.05	2.10%	0.01	1.30%	0.02	1.80%	0.19	11.20%
	Total	0.21	9.30%	0.22	9.30%	0.24	21.80%	0.3	31.10%	0.45	26.90%
Life	Breath	0.08	3.50%	0.08	3.30%	0.08	6.90%	0.08	8.10%	0.08	4.60%
	Food	0.26	11.90%	0.26	11.30%	0.28	25.80%	0.28	29.20%	0.24	14.50%
	Total	0.34	15.40%	0.34	14.60%	0.36	32.70%	0.36	37.30%	0.32	19.10%
Carbon sequestration	Plant	-0.07	-3.20%	-0.08	-3.60%	0	0.00%	0	0.00%	-0.06	-3.40%
	Total carbon emission	2.2	100%	2.32	100%	1.11	100%	0.95	100%	1.66	100%

Table 6-2 Comparison of total carbon emissions per unit area and structure among the five communities (Unit: kg/m² • year)

Situation of carbon emissions		Shanghai-Shi Bo Jia Yuan Community		Shanghai-Jing Jiang Yuan Community		Shenzhen-Heyi Community		Jiangshan-Dongtang Community		Chongqing-Hongyupo Community	
		Carbon emissions per unit area	Proportion	Carbon emissions per unit area	Proportion	Carbon emissions per unit area	Proportion	Carbon emissions per unit area	Proportion	Carbon emissions per unit area	Proportion
Resident energy consumption	Water	0.47	0.80%	0.63	1.00%	0.69	0.70%	0.3	0.80%	1.51	2.20%
	Electricity	25.21	43.00%	28.12	43.40%	29.14	27.90%	10.05	28.60%	13.72	20.30%
	Gas	3.27	5.60%	4.98	7.70%	0	0.00%	0	0.00%	10.53	15.60%
	Total	28.95	49.30%	33.73	52.10%	29.83	28.60%	10.34	29.40%	25.76	38.10%
Mobility	Total	17.13	29.20%	17.9	27.60%	17.69	16.90%	0.76	2.20%	13.03	19.30%
Municipal administration	Solid waste	4.41	7.50%	4.65	7.20%	21.39	20.50%	10.32	29.30%	10.61	15.70%
	Waste water	1.04	1.80%	1.38	2.10%	1.38	1.30%	0.65	1.80%	7.59	11.20%
	Total	5.45	9.30%	6.03	9.30%	22.77	21.80%	10.97	31.10%	18.2	26.90%
Life	Breath	2.03	3.50%	2.14	3.30%	7.24	6.90%	2.84	8.10%	3.1	4.60%
	Food	7	11.90%	7.32	11.30%	26.92	25.80%	10.25	29.20%	9.79	14.50%
	Total	9.03	15.40%	9.46	14.60%	34.16	32.70%	13.09	37.30%	12.89	19.10%
Carbon sequestration	Plant	-1.89	-3.20%	-2.35	-3.60%	0	0.00%	0	0.00%	-2.33	-3.40%
	Total carbon emission	58.68	100%	64.76	100%	104.46	100%	35.16	100%	67.55	100%

First, the higher the residents' living standards, the higher the carbon emissions. From the macro perspective, the carbon emissions of residents have a positive correlation with GDP, and the communities also follow this rule. A higher income level directly leads to an increase of carbon emissions from residents' life energy consumption and mobility^[19]. In the communities with a high income level, the living space per capita is relatively high, the residents use more kinds of domestic appliances and in higher frequencies, and the car ownership rate and motorization level are also high; all of these can cause an increase in carbon emissions. It can be seen from the cases that although Shi Bo Jia Yuan Community has used the green energy-saving technology, the carbon emissions per capita is still high.

Second, the higher the degree of mixed functions near communities, the lower the carbon emissions. A high degree of mixed functions, especially in regards to the job-housing balance, can greatly reduce the carbon emissions of residents from mobility, thereby affecting total carbon emissions. The carbon emissions from mobility are relatively low in Hongyupo Community and Dongtang Community, both of which are located in the central urban area. Heyi Community is located in an industrial agglomeration area, and the lessees are employees of the enterprises and can walk to their jobs; as a result, the carbon emissions from mobility are very low. Hongyupo Community is located in the central urban area, with the railway and public transportation being quite convenient, and private car ownership rate very low; therefore, the carbon emissions from mobility are also relatively low. On the contrary, the two communities of Shanghai are located in suburbs and there is little employment nearby, so the commute time and distance of residents are far higher than those in other communities; as a result, the carbon emissions from mobility are high and close to 30%. Therefore, better job-housing balance can greatly decrease the total carbon emissions in communities.

Third, the residential morphology decides the carbon emissions per unit area. Jing Jiang Yuan Community, Shi Bo Jia Yuan Community, and Hongyupo Community are conventional commodity housing communities with family housing as the majority. Although the intensity of energy consumption and the mobility distance are different, the carbon emissions per unit area are at the same level. On the other hand, in Dongtang Community, as privately-owned housing, the level of pipe network construction is relatively low, and residents tend to use natural water sources and natural ventilation; as a result, the carbon emissions per unit area is only a half of that in conventional communities. Of course, the influences of residential morphology on carbon emissions are comprehensive, including difference of population structures, land use mixedness, etc.

Fourth, daily behaviors have great influence on carbon emissions. In Hongyupo Community, the aging community is quite frugal in their energy

consumption, and thus carbon emissions per capita is relatively low. In Shenzhen Heyi Community with a high lease rate, residents go out early, come home late and do not cook and eat at home. Thus, the building energy consumption is also relatively low. Even within the same community, such as Shi Bo Jia Yuan Community, the families with elder population have strong energy-saving consciousness and economical living habits, and thus the domestic energy consumption is also lower than ordinary families and can be reduced by up to 15%.

Fifth, energy-saving technologies indeed reduce carbon emissions, but also increases continuous costs. Generally, the building energy consumption per capita is lower in the low- carbon communities with application of green technologies than in ordinary communities. For instance, the energy consumption per capita is lower in Shi Bo Jia Yuan Community than in Jing Jiang Yuan Community, both of which are in the same location and have similar population structures. However, it was found in the investigation that because the low-carbon technology is not yet mature, high, subsequent maintenance costs have occurred; wall space and roofs need to be repaired each year, which causes an inconvenience to the residents' lives. Therefore, the degree of maturity of green technologies and the subsequent maintenance cost should also be considered when choosing technology.

Also to consider, the influence of the material space of communities on carbon emissions may include: Building height has a certain impact on carbon emissions in communities; the physical planning elements such as residential design and building design have impact on microenvironment of communities, thereby indirectly affecting carbon emissions; larger families can have higher total carbon emissions, but help reduce carbon emissions per capita.

6.4 Path of carbon emission reduction in urban communities with double carbon targets

6.4.1 Outlook for Future Carbon Emissions in Urban Communities and Decarbonization Challenges

As urban communities in China continue to develop rapidly, their energy consumption and carbon emissions are bound to increase. Meanwhile, community renewal will result in a significant amount of extra carbon emissions. Without green technology or green renewal methods, urban renewal will prove to be a major obstacle to achieving China's goals of carbon neutrality and emissions peaking.

6.4.1.1 Future Needs and Trends of Urban Communities

The future needs of China's urban communities mainly come from four areas, namely residential energy use, mobility, utilities, and daily living.

6.4.1.1.1 Trends in Residential Energy Use

It is clear that China's residential energy consumption continues to grow, **and a large increase in demand is expected in the future.** According to the China Building Energy Consumption Research Report (2020), energy consumption of residential buildings in most cities increased more than twice in 2020, and building energy consumption in most regions grows at an average rate of six to ten percent per annum. China's per capita household energy consumption was 415.6kgce in 2017, which was slightly above the world average, or equivalent to 82% of that of Japan, 54% of the EU, and 39% of the US. Statistics show that, as per capita GDP grew from USD 17,000 to 25,000 in the United States, and from USD 10,000 to 20,000 in the EU and Japan, energy consumption jumped up. China is currently at the same stage of growth. Relevant studies reveal that, without human intervention, the total energy consumption of urban residential buildings in China will peak in 2045-2050, and is expected to increase from 361 million tce in 2017 to 510 (± 52) million tce^[18], with an incremental demand of more than 40%.

The main types of residential energy use in the case communities are electricity and natural gas. Residential electricity consumption includes lighting, hot water, home appliances, heating, and cooling. Lighting energy use is not expected to increase significantly; hot water will consume a growing amount of energy, especially in Dongtang and Heyi; energy consumption of home appliances will grow significantly, especially for kitchen appliances in the Shanghai and Chongqing communities and for smart electronic products in Shenzhen communities; communities in the hot-summer/cold-winter zone, such as Shanghai, Chongqing and Jiangshan, will have a huge growing demand for heating, and will use air-conditioning for cooling more frequently and much longer. Therefore, residential electricity demand in the case communities is on the rise and expected to peak by around 2035.

Table 6-4 Analysis of Residential Electricity Demand in Case Communities and Their Cities (t/y)

Name of community	Jingjiang yuan, Shanghai	Shibo Jiayuan, Shanghai	Hongyupo, Chongqing	Heyi, Shenzhen	Dongtang, Jiangshan
Per capita residential electricity consumption of case communities in 2020 (kWh/y)	1700	1601	590	743	525
Projected per capita residential electricity consumption in the city in 2035 (kWh/y)	1940		1352	1417	1289
Projected per capita residential electricity consumption of case communities in 2035 (kWh/y)	2300	2150	1100	1290	1300

Name of community	Jingjiang yuan, Shanghai	Shibo Jiayuan, Shanghai	Hongyupo, Chongqing	Heyi, Shenzhen	Dongtang, Jiangshan
Projected electricity consumption per unit of residential floor area of case communities in 2035 (kWh/y·m ²)	61	60	45	87	48
Key drivers of higher energy use in the future	Heating, home appliances		Heating, cooling, home appliances	Hot water, home appliances	Home appliances, heating, hot water

Natural gas is mainly used for cooking and hot water. It is expected that the demand for natural gas will remain stable in the Shibo Jiayuan, Jingjiangyuan and Hongyupo communities without external intervention. Heyi community is a rental community, and the demand for cooking gas is limited. Therefore, natural gas use is not considered in this case for the future. Dongtang community will have a certain increase in demand after connecting to the natural gas network.

After converting the forecast results of each community into energy consumption, the residential energy demand curve is formed as follows. On the whole, residential energy consumption of communities will increase significantly. Depending on the climate zone, per capita living area and development level of each community, the increase in per capita residential energy consumption and the time to peak will differ. In 2035, energy use will increase by 20% in Shibo Jiayuan and Jingjiangyuan, 37% in Hongyupo, 77% in Dongtang and 42% in Heyi.

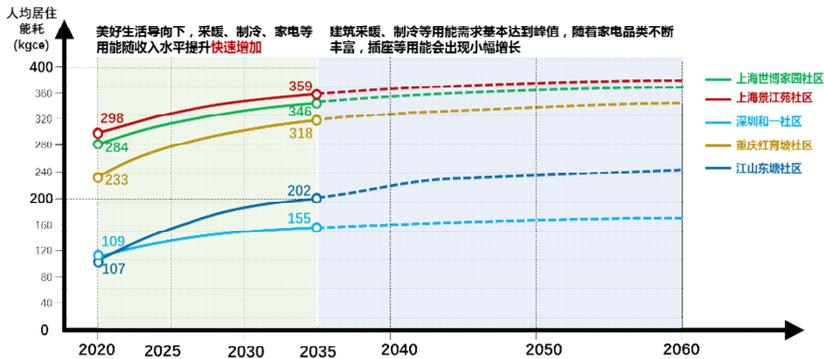


Figure 6-2 Residential Energy Consumption and Demand Curve of Case Communities (without intervention)

6.4.1.1.2 Mobility Energy Consumption Trends

In 2020, car ownership in China was 260 million, and the number of motor vehicles per 1,000 people was over 180, which was far behind that of developed

countries. As the economy continues to grow, demand for motorized private transport will increase in the future if not regulated by policies and guidance from the state, municipalities and communities.

Table 6-5 Comparison and Share of Three Typical Models of Mobility

Model	Public transport /%	Motorized private transport /%	Non-motorized transport /%
North America	<10	>50	10~20
Europe	30~40	30~40	30
Asia	>50	<20	20~30

Source: LU Ximing, Urban Transport in Asia, Tongji University Press, May 2009

Case communities had 10% to 20% of motorized private transport in 2020, with per capita annual energy consumption of at least 26kgce in Dongtang and at most 83kgce in Shibo Jiayuan. Without green intervention, the share of motorized private transport will continue to rise in the future, whereas public and non-motorized transport will decline, leading to a significant increase in energy consumption and ultimately developing into a structure similar to the European model. Due to the different population sizes, travel distances, locations, income levels, and housing patterns, energy consumption in the mobility sector will differ greatly among the communities in 2035. The two communities in Shanghai may have 45% motorized private transport, while Heyi, Hongyupo and Dongtang may only have 30%. The per capita annual traffic energy consumption is highest in Shanghai Shibo Jiayuan at 182kgce, and lowest in Jiangshan Dongtang Community at 49kgce, which is rather similar to peer communities in European countries.

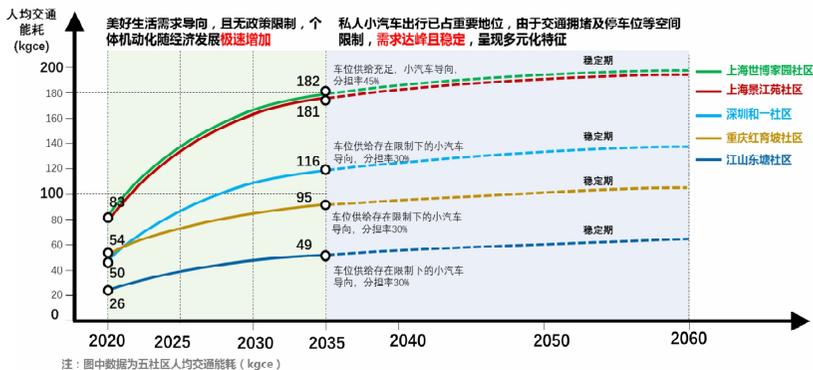


Figure 6-3 Mobility Energy Consumption and Demand Curve of Case Communities (without intervention)

6.4.1.1.3 Carbon Emissions Trends in the Municipal Sector

Water consumption and solid waste of the five case communities will be the main sources of carbon emissions in the municipal sector. With improving living standards and changing habits in the future, per capita daily domestic water consumption and waste generation in case communities will maintain an upward trend as average income and housing area grow, without considering policy regulation and green technology promotion. Community-generated municipal carbon emissions are expected to increase considerably, based on future trends in urban water use, total waste generation and corresponding carbon emissions data. There are now wide disparities between communities, which will rapidly narrow and converge. Reductions achieved through green behaviors are unlikely to fully offset the incremental carbon emissions from improved quality of life.

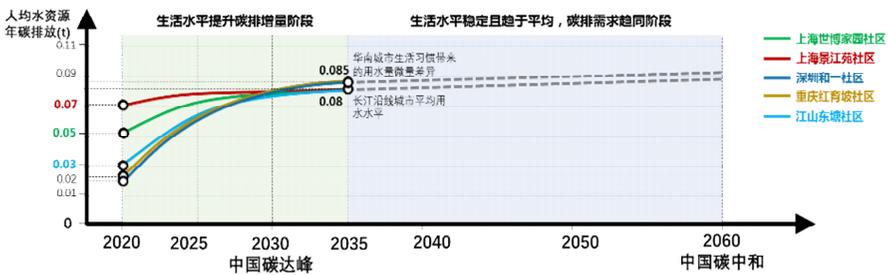


Figure 6-4 Municipal Carbon Emissions Trend Curve of Case Communities (without intervention)

6.4.1.1.4 Trends of Carbon Emissions Related to Daily Living

Carbon emissions related to daily living mainly refer to food consumption. As urban dietary patterns in China shift toward higher carbon intensity, per capita carbon emissions from food consumption will increase significantly, so will the share of emissions from food in the domestic carbon emissions of residents. In 2016, plant-based food accounted for 81.40% of total per capita food consumption in China. Vegetarian food still occupies an important place in the daily diet of Chinese residents, and emissions from this area remains relatively low^[19]. With the increasing consumption of animal proteins and fats such as dairy and meat, food consumption structure gradually shifts from plant-based to animal-based. The average per capita carbon emissions from food consumption in China grew at 1.68% per annum from 1997 to 2016^[20]. Based on this, case communities are tentatively expected to generate at least 0.31t per capita per annum by 2035.

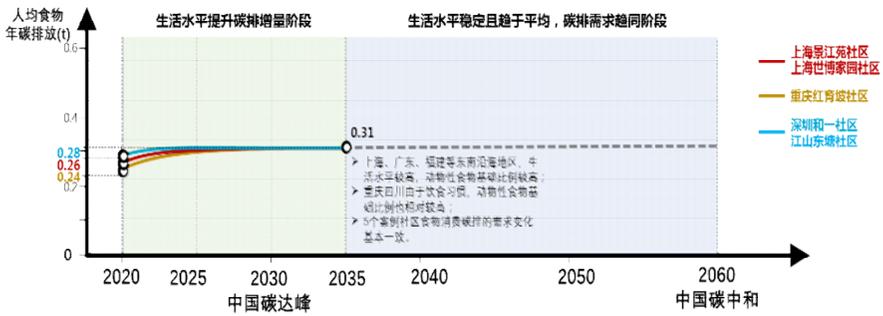


Figure 6-5 Carbon Emissions Trend Curve of Daily Living in Case Communities (without intervention)

6.4.1.2 Building Retrofitting Methods and Their Impacts on Carbon Emissions and Energy Consumption in Case Communities

Three of the five case communities will undergo building retrofits of varying scales before 2060. From the perspective of building life cycle analysis, construction and demolition of buildings can produce a high amount of carbon emissions. Therefore, it is important to analyze and assess potential carbon emissions of building retrofits for community renewal.

6.4.1.2.1 Carbon Accounting Method for Renewal and Retrofit Projects

Accounting parameters for carbon emissions of building retrofits is determined in accordance with the Standard for Building Carbon Emission Calculation GB/T51366-2019, and with consideration of the actual demand and data availability.

Carbon emissions from new construction. The calculation includes carbon emissions from production and transportation of building materials as well as construction. Based on relevant studies^{[21],[22],[23]}, carbon emissions of new residential buildings are taken to be $0.6t\ CO_2/m^2$ under the conservatism principle.

Carbon emissions from building demolition. The calculation includes emissions from demolition and waste disposal. According to relevant studies^{[24],[25]}, the value is set at $0.05t\ CO_2/m^2$.

Carbon emissions from green retrofit. The calculation includes emissions from energy efficiency retrofits of building envelopes, energy-efficient equipment replacements, indoor environment improvement and interior decoration and furnishing. It also concerns the production of building materials and transportation as well as construction. Greening retrofit can improve the quality of living environments and promote energy efficiency. According to several related studies^{[26],[27]}, the value of $0.24t\ CO_2/m^2$ is taken as the estimate of carbon emissions from green retrofit, which are 40% of the emissions from new construction.

Carbon emissions from structural reinforcement projects. The calculation

includes emissions from production and transportation of building materials as well as construction. YANG Shichun's^[28] research shows that the average age of a building designed and constructed with 50-year service life is 88.5 years, and it takes an average of 150 years before the building's load bearing capacity fails due to performance degradation. Emissions from extending building service life by 20 years is calculated at 0.145t CO₂/m², or 25% of the energy consumption for new construction. The case communities of this project were built between the 1970s and 2010s, hence no need for comprehensive reinforcement until 2060. This study assumes that 20% of the building stock will be reinforced, and estimates the schedule of such reinforcement on the basis of building conditions and the need for renewal of each community. Carbon emissions of reinforcement are accounted at 25% of that of new construction, which is at 0.15t CO₂/m².

Table 6-6 Estimated Carbon Emissions Value for Building Renewal and Retrofit

Stage of development	Carbon emissions per unit of residential building area (tCO ₂ /m ²)
New build (production and transportation of building materials + construction)	0.6
Demolition (demolition + waste disposal)	0.05
Green retrofit	0.24
Structural reinforcement	0.15

6.4.1.2.2 Timing, Method and Content of Renewal and Retrofit in Case Communities

The schedule for renewal and retrofit projects is mainly under the influence of communities' demand for quality improvement and government planning. Hongyupo is an old community compound whereas Heyi has mostly 15m² single-room apartments in high-density buildings. Both have a strong demand for quality improvement, and are included in the government's recent retrofit plan for old communities. The retrofitting work is set to start before 2025. Dongtang Community has poor building quality and a strong desire for quality improvement. However, its housing units are all privately owned, so they have not been included in the government's retrofit plan yet. Retrofitting may start after 2025. Shanghai Shibo Jiayuan and Jingjiangyuan were built relatively recently with good building quality, so there is no need for retrofitting before 2060.

The retrofit method is mainly influenced by government plans and building ownership. Hongyupo community offers commercial property, and has been included in the government's retrofit plan. It is likely that the government will organize the retrofitting work in due course, with limited amount of demolition and construction over a period of 4-5 years. Heyi community has farm houses built on

collectively owned construction land, and has been included in the government's retrofit plan. The houses may be collectively retrofitted under village organization over the course of 4-5 years. Jiangshan Dongtang community has private property houses, and is not included in the government's retrofit plan. An overall retrofit is unlikely to happen. It is assumed that residents will spontaneously make retrofit works from 2026 over a period of 10 years.

The renewal and retrofit work of each community varies greatly. Hongyupo community has relatively new high-rise buildings which do not require retrofitting. The three dilapidated buildings as well as old buildings with less than four stories will be demolished and rebuilt based on the actual situation; six-story buildings will undergo green retrofit and about 20% of them with poor quality will be structurally reinforced. Heyi community has multi-story buildings which all require retrofitting. A small number of buildings will be demolished. Dongtang community has old and poor-quality buildings, which will all be demolished and rebuilt.

Table 6-7 Timing and Content of Renewal and Retrofit in Case Communities

Name of community		Hongyupo, Chongqing	Heyi, Shenzhen	Dongtang, Jiangshan
Year of retrofit		2023-2026	2023-2026	2025-2035
Number of permanent residents after retrofit		14,200	8,822	1,734
Gross floor area (m ²)		392,152	177,274.9	46,800
Green retrofit ratio /%		27%	100%	100%
Content of retrofit (m ²)	Residential building area after green retrofit	99,668	160,557.9	0
	Demolished floor area	7,357	7,565	46,800
	Reconstructed green building area	7,357	0	46,800
	Structurally reinforced building area	19,933.6	0	0

6.4.1.2.3 Carbon Accounting for Building Retrofit in Case Communities

According to the retrofit methods, areas and schedules of the three case communities, and based on the aforementioned carbon emissions per unit area of different retrofitting stages, the total carbon emissions from retrofit in each community over the years are calculated and shown in Figure 4-8. The total carbon emissions from green retrofit and demolition in Heyi community are 38,900 tons, from demolition and reconstruction in Dongtang community are 30,400 tons, from green retrofit, structural reinforcement, demolition and reconstruction in Hongyupo community are 31,700 tons. The accounting results show that building retrofit significantly increases the total carbon emissions of communities. During the

retrofitting period, carbon emissions in relation to the retrofit in each community reach five to six times of the aggregate emissions from normal building operations (2020 baseline) per annum, and 1.5 to 2.2 times of the total annual carbon emissions of the community (2020 baseline), indicating that building retrofits are highly carbon intensive. From the perspective of energy efficiency and carbon reduction in buildings, green building technology should be used as much as possible in retrofit projects in the future to minimize the need for further energy-efficient retrofits. Meanwhile, carbon emissions from retrofit should be reduced as much as possible. In addition, efforts should be made to avoid demolition and reconstruction when buildings are still usable.

6.4.1.2.4 Comparison of Energy Consumption Curves between Renewal and Green Retrofit in Case Communities

Hongyupo community and Heyi community will **demolish a small number of buildings and retrofitted low-quality buildings using green methods**, such as improving insulation, enhancing lighting & ventilation, and using energy-efficient appliances. The energy consumption of lighting, heating, cooling and hot water is lower than the scenario without the green retrofit. The current building energy consumption in Hongyupo and Heyi communities is low. With the increase in the use of air conditioning and home appliances, per capita energy consumption still shows an upward trend. However, the green building retrofit will help significantly reduce the peak energy consumption in 2035, and substantially contribute to energy conservation. Specifically, if Hongyupo community partially replaces gas water heaters with air source heat pumps for higher energy efficiency, the total building energy consumption can be reduced by about 13%. As heating and cooling accounts for a smaller share of energy consumption in Heyi than Hongyupo, the energy savings of about 6% are less significant. Therefore, green building retrofitting methods should be promoted in the building renewal of old communities for energy conservation and emission reduction.

Dongtang community will **demolish all the existing buildings and rebuild green ones**, which will significantly improve building energy efficiency. The current per capita building energy use in Dongtang community is rather low, which will increase significantly in the future. If the renewal is to be completed by 2035, the increased energy demand for heating and cooling can be drastically reduced, according to the 65% energy-saving standard of green buildings. The total building energy consumption in Dongtang community in 2035 can be reduced by about 19% compared to the scenario without renewal, which saves a great amount of energy.

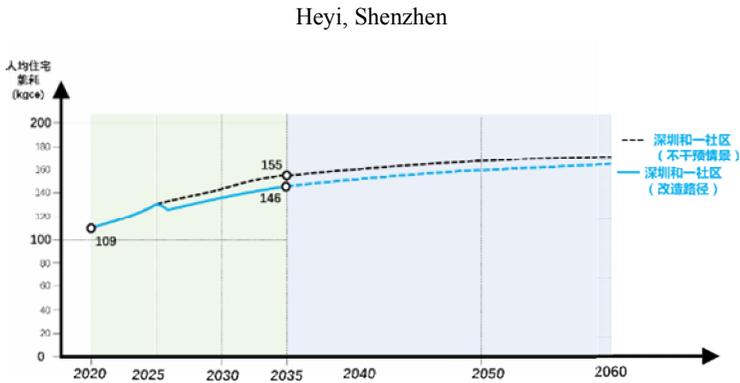
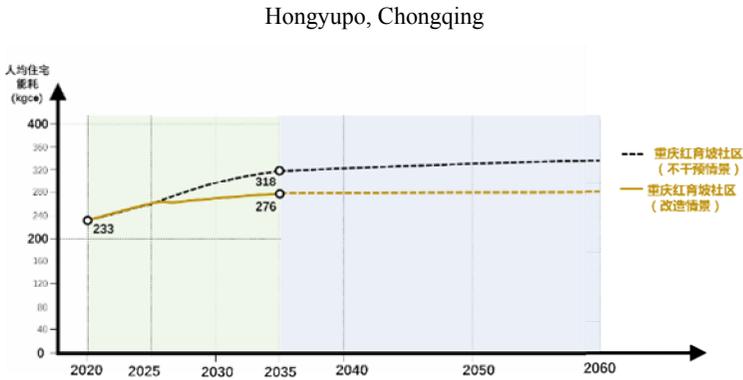


Figure 6-6 Comparison of Building Energy Consumption between Green Retrofit and Business-as-usual Scenario in Hongyupo and Heyi

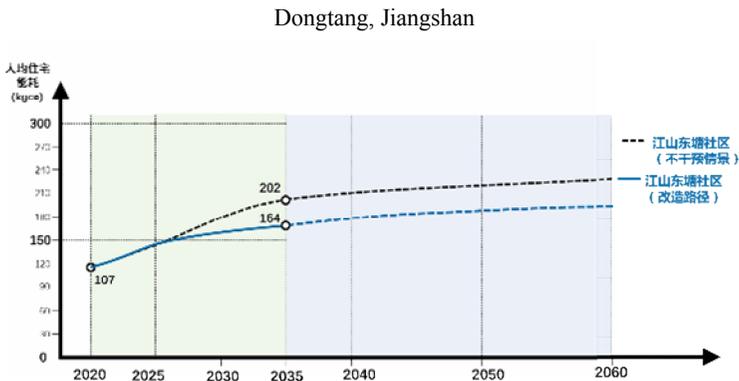


Figure 6-7 Comparison of Building Energy Consumption between Green Retrofit and Business-as-usual Scenario in Dongtang

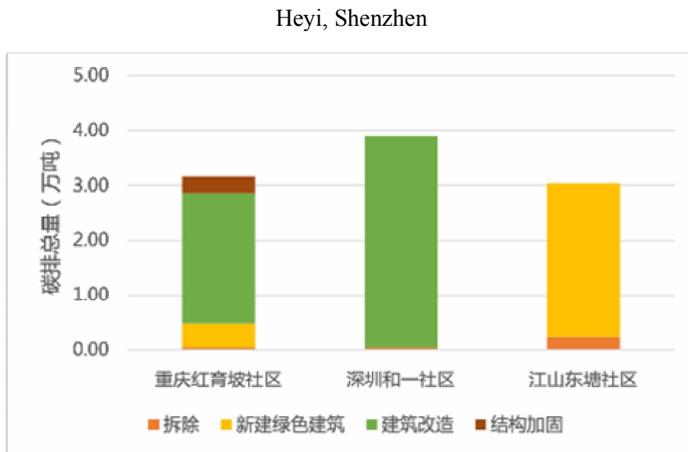


Figure 6-8 Carbon Emissions from Retrofits in the Three Communities

6.4.1.3 Difficulties and Challenges in Decarbonizing Urban Communities

6.4.1.3.1 Residential Energy Use

The case study shows that the future demand for building energy consumption (especially electricity) will grow significantly, driving up national carbon peak and making it more difficult and costly to achieve carbon neutrality. Therefore, the key tasks in the residential energy use sector by 2035 include effectively reducing building energy consumption through green technologies, implementation of green retrofit techniques in buildings through community renewal, and advocating green lifestyles, so as to control the excessive increase of residential energy consumption.

During 2035-2045, building energy consumption in case communities will reach its peak. The key tasks in the residential energy use area from 2035 to 2060 are reducing energy demand by improving equipment energy efficiency, replacing natural gas through electrification, cutting direct carbon emissions with distributed renewable energy, and eventually achieving carbon neutrality through decarbonizing the grid.

6.4.1.3.2 Mobility

Emission reduction in mobility concerns three main aspects: demand, mode and energy use. As new energy vehicles account for less than 2% of the total, they are not able to play a leading role in restructuring energy mix of the transport sector before 2035. The key to control energy demand of mobility by 2035 is to effectively transform mobility structure with green methods whilst reducing the number and distance of trips through optimizing urban functions and services.

In 2035, green mobility (public transport + non-motorized vehicles + walking) of case communities may account for over 80% of the total, which leaves limited room for reducing energy consumption through modal shift. So the key task of cutting

carbon emissions from 2035 to 2060 is to optimize the energy mix in the transport sector. As energy efficiency reaches its limit, the focus of further reduction of energy consumption and carbon emissions should be on replacing fossil fuels by clean energy for motorized transport.

6.4.1.3.3 Municipal and Daily Living

First, the promotion and practice of green lifestyles in communities should start as early as possible. As living standards improve, water consumption, domestic waste generation, and animal-based food consumption will continue to grow. At the community level, it is necessary to prioritize quality of life for residents, whilst improving their acceptance of a green lifestyle. Considering the time required to promote and popularize green lifestyles such as water conservation, waste separation and saving food, community-level carbon peaking may lag behind the set national target.

Second, investment in infrastructure and green equipment should be fully guaranteed. For water management services, efforts shall be made to renew municipal pipe networks, and apply new sewage collection and rainwater utilization technologies. For domestic waste, carbon reduction can be achieved mainly through efficient waste separation. For food consumption, rooftop farms, vertical farming, and community canteens can help cut emissions. These facilities should be implemented as a priority and require substantial financial support.

Third, extensive and concerted efforts are necessary to realize the carbon neutrality goal. Since municipal and daily living areas are the basic needs of residents, carbon emissions will go down somewhat after green retrofits, but the overall impact is rather limited. Near-zero CO₂ emissions by 2060 are not possible with community-level improvements alone.

6.4.2 Recommendations on Community Green Renewal and Green Technology under the Goals of “Peaking Carbon Emissions by 2030” and “Achieving Carbon Neutrality by 2060”

In the first phase of SPS on green technology of CCICED, Chinese and foreign experts jointly proposed six key areas of urban green technology development and offered 20 recommendations on piloting green technologies during the 14th Five-Year Plan period. Overall, these technologies focus on technological readiness, emissions-reduction benefits and financial viability.

While the second-phase study is implemented on community level, the technology application at the community level is more complex and diverse, and many differences across communities and the applicability of recommendations need to be considered for the promotion of green technologies. In particular, in the context of China’s commitment to the Goals of “Peaking Carbon Emissions by 2030” and “Achieving Carbon Neutrality by 2060” (the Goals), the contribution of

green technology recommendations to the realization of the Goals are considered.

6.4.2.1 Understanding and Responding to the Goals and Community Diversity

6.4.2.1.1 Differences of Green Development Strategies for the Two Phases under the Goals

The carbon emissions measurement and demand analysis of the communities in the case study show that while the current per-capita community carbon emissions are not high, there will be a huge increase in demand in the future. Therefore, unlike the singular focus on carbon emissions reduction seen in the developed countries of Europe and America, attention should be paid to the differences between the two phases for green renewal and green technology promotion in Chinese communities:

Phase I: Before peaking carbon emissions by 2030, priority should be given to meeting the new living needs of residents in a green way, scaling up the application of mature green technologies, promoting green lifestyles, and reducing the peak value.

Phase II: Before achieving carbon neutrality by 2060, the application of innovative green technologies in communities should be comprehensively promoted, along with the shaping of a green lifestyle and governance system to achieve net-zero emissions.

6.4.2.1.2 Three Cognitive Dimensions from the Perspective of Community Diversity

Community diversity and demographic complexity in community green renewal and green technology adoption must be fully taken into account. To understand the differences among various communities, the following three dimensions, at the minimum, must be considered:

(1) Population-group profile. There are four population types: aging, upper middle-income, lower middle-income, and young migrant tenants. The income level and willingness for long-term improvements vary among the four groups.

(2) Building features. The case communities represent four main types of Chinese communities: old communities of collective housing, old communities of private housing, sub-new communities built after 2000, and villages in city. There are significant differences among the four types of communities in terms of renewal ownership, retrofit model, green renewal requirements and pathways.

(3) Resource endowment and basic conditions. There are great differences in the richness of renewable resources in the case communities. The Heyi Community is located in an area with rich renewable energy (i.e., solar energy and wind energy); Shanghai and Jiangshan represent areas with relatively good renewable energy sources (i.e., solar energy), and Hongyupo features severe scarcity of renewable energy. Additionally, these communities have different climatic conditions (e.g., the Chongqing, Shanghai and Jiangshan areas experience cold winters and hot summers, and therefore demand heating in the winter) and different locational conditions,

which have created diverse needs in promoting green technologies.

6.4.2.2 Community-Based Green Technology Recommendations before Peaking Carbon Emissions by 2030

6.4.2.2.1 Recommended Building Technologies

Great importance must be given to green building technology. A high premium must be placed on promoting building energy-efficiency improvements and retrofit technologies, as well as adopting intelligent building-management technologies in existing buildings, so as to reduce carbon emissions in the entire building construction and operation process.

Green construction. This includes green building materials, prefabricated construction and decoration, with a focus on low-carbon, pollution-free and low energy-consumption local materials and certified green building materials. Prefabricated construction and decoration can improve quality, reduce material consumption and on-site construction energy consumption, and ease the disturbance for residents caused by construction.

Building energy efficiency improvements and retrofitting. This mainly concerns the energy-saving transformation of the enclosure structure to improve thermal performance, including using energy-saving doors and windows, adding shading facilities and thermal insulation layers, changing flat roofs to sloping roofs, adopting light color finishes, etc.

Three-dimensional greening. This refers to the greening technologies for building roofs, overhead floors, balconies, windowsills, wall surfaces or other parts involving the building structure, maintenance management system and/or plant selection. These technologies are expected to bring multiple benefits, such as improved thermal performance, improved microclimate, locally produced food, newly added carbon sinks, recovered biodiversity, etc.

Intelligent building management. Online monitoring, cloud computing, the Internet of Things (IoT) and other technologies are adopted to monitor and adjust the dynamics between energy supply and consumption in real time. Monitoring the key energy consumption equipment and analyzing the energy consumption rate can help to understand the proportion and trend of energy cost and to inform the development of energy efficiency strategies.

6.4.2.2.2 Recommended Energy Technologies

Energy conservation, electric energy alternatives and renewable energy alternatives are the main direction toward the development of low-carbon communities and the key technical direction of community green renewal.

Energy-saving appliances and equipment. Energy-saving appliances, such as high-efficiency air conditioners and water heaters using heat pump technology, can prevent the increase in energy consumption caused by more frequent use of new household appliances. Furthermore, these appliances can also contribute to the

increased efficiency of public energy consumption in the communities.

Distributed energy development and utilization. The utilization of distributed energy, including solar energy (photovoltaic, photothermal), wind energy, shallow geothermal energy, air source heat pumps and other renewable energy sources, and the adoption of natural gas combined heat, power and cooling systems are key in reducing community-based carbon emissions.

Multi-energy complementary energy supply. In communities powered by distributed energy, the combination of traditional energy systems with distributed energy systems and energy storage can ensure both the prioritized use of distributed energy and the efficient, low-cost utilization of traditional energy. For the purpose of adopting this technology, communities need to build new complementary energy stations on their idle land, or to transform and upgrade the existing heat stations and substations.

Smart energy management. The community energy supply system can be renovated in a smart way by adding load-side online monitoring, key energy-consuming equipment monitoring, and energy supply and energy storage active response facilities to keep a balance between energy supply and demand.

6.4.2.2.3 Recommended Technologies and Strategies for Mobility

Strategies for the improvement of walking and cycling conditions. The pavement can be improved and a pleasant environment can be created to control the speed of vehicles and guide the traffic flow, while enhancing the convenience and comfort of non-motorized traffic, driving a shift toward low-carbon mobility options. Non-motorized traffic can be smoothly and safely connected through urban overpasses, public buildings and open space. Depending on the local landform and climate, more diversified lanes can be added in the form of vertical traffic, covered corridors, and “wind and rain” corridors.

Bus and rail connection optimization. Efforts should be made to make public transport more attractive by designating non-motorized traffic lanes and adding community entrances, bus stops and rail transit-station entrances. During peak hours, bus services can improve the connection between communities and bus/subway stations and thus increase the penetration of public transport.

Shared mobility refined management. On-demand allocation of shared vehicles (cars, bicycles, e-bikes, etc.) has the potential to improve the utilization rate of shared mobility.

6.4.2.2.4 Recommended Technologies in Municipal Water Service

Improving the efficiency of the internal water supply and drainage units during community renewal is the main technical direction for improving the overall operational efficiency of the urban water system and reducing water-related carbon emissions.

Community sewage quality improvement and efficiency enhancement (rain

and sewage diversion). At the community level, renewal efforts should be focused on rainwater and sewage diversion and eliminating wrong connections of rainwater and sewage, so as to realize shallow drainage of rainwater and centralized treatment of sewage through pipes, and improve the efficiency of sewage collection. Community septic tanks should be gradually eliminated to reduce emissions of non-carbon greenhouse gases such as methane and nitrous oxide and increase the sewage concentration, which is conducive to energy conservation and emissions reduction of sewage treatment.

Community low impact development. Sponge communities can be built to strengthen the utilization of rainwater resources at the source and ensure the safety of waterlogging prevention. Communities should optimize the vertical design of the site and properly allocate plants by combining green and gray elements to further green the infrastructure.

Community Non-Revenue Water (NRW) Management. According to layout of water sources and topographic characteristics, communities should optimize the layout of community water supply access, the water supply pressure at the access point and the secondary water supply method; and reduce the leakage from across the pipe network. Meanwhile, they should also strengthen night flow supervision, accelerate the renewal of old and/or damaged water supply pipelines, speed up the transformation of rainwater and sewage diversion, reduce the amount of rainwater entering the sewage system, improve rainwater utilization and turn sewage into resources.

6.4.2.2.5 Recommended Technologies for the Treatment of Domestic Waste

Treatment processes have a great impact on the final carbon emissions of domestic waste. It is vital to reduce emissions from the source and optimize the treatment model.

Household kitchen waste crushing and dehydration. Special household electrical equipment should be developed to dehydrate or crush kitchen waste. Residues can be dried or discharged into the sewer to reduce the workload of sorting, collection, storage and transportation.

Smart waste sorting and recycling. Methods such as the robot arm, air separation and magnetic separation can be used to realize automatic, continuous and large-scale waste sorting and recycling, while data can be collected and uploaded to improve the proportion of recovered resources.

6.4.2.3 Recommendations on Community-Based Integration of Green Technologies

6.4.2.3.1 Suggestions on Integrating Green Technologies in Community Renewal

In renovating these communities, the biggest challenge lies in the conflict between renewal needs and limited funds. To address this issue, a gradual approach should be considered, starting from the areas requiring fewer investments and producing higher returns. The green renewal of old residential communities should be focused on such areas as utilities, public transport and buildings.

1) Municipal water service. Efforts should be taken to upgrade old and/or damaged water pipes, eliminate septic tanks and build sponge communities to reduce water consumption and resulting carbon emissions. 2) Transport. Given the inadequate parking lots in old residential communities, optimized bus/rail transit feeder systems should be combined with enhanced options for walking and cycling to increase the comfort and convenience of slow mobility and shape a greener mix of mobility options. 3) Buildings. In reducing emissions from this sector, non-technological methods should be first considered, such as reducing the vacancy rate of buildings and creating a public living space. Priority should be given to renovating existing building by adopting energy efficiency improvement technologies, such as environmentally- friendly doors and windows as well as external wall shelters, which require less investment but yield quick benefits. In the retrofit of buildings, green building technologies should be strictly adopted and in terms of public buildings, three-dimensional greening should be actively advocated.

6.4.2.3.2 Suggestions on Integrating Green Technologies for Renewal of Ageing and Middle/Low Income Households and Communities

For the ageing, mid- and low-income population groups, green renewal should fully take into account their limited resources, as well as low rates of energy consumption and mobility. Low-cost technologies are encouraged to reduce living costs, along with carbon abatement.

1) Transport. An increase in convenient, lost-cost and low-carbon transport options can increase the mobility of mid- and low-income groups. More favorable walking conditions can enhance safety and comfort for the elderly. Therefore, like that of old residential communities, it is also a top priority to build a more effective bus/rail transit feeder systems and create more enabling conditions for walking and cycling for the elderly. 2) Buildings. Building retrofits should go hand-in-hand with improvement efforts in the public environment of communities. Through measures such as changing doors and windows, adopting external wall insulation and improving ventilation and natural day lighting, carbon emissions can be reduced while also improving the comfort and cost for this population group. When it comes to community-based public buildings, high-performance energy efficiency improvement technologies are suggested to create a comfortable networking and living space outside the home.

6.4.2.3.3 Suggestions on Integrating Green Technologies for the Renewal of Communities with Abundant Renewable Resources

The communities in China's economically developed regions are and have been ready for the comprehensive use of green technologies and full use of renewable energy. For instance, Shenzhen Heyi Community, with abundant solar and wind energy resources and relatively clear rural collective property rights, has prepared itself for comprehensive green renewal and should be encouraged to build a model

area for low-carbon or even zero-carbon development.

1) Energy. Great efforts should be taken to promote the development and use of distributed energy resources and the supply of complementary energy sources and integrated applications of renewable energy technologies, including DC microgrid and energy storage. 2) Transport. New energy vehicles should be actively scaled up and associated charging stations should be proactively explored. 3) Buildings. Near-zero carbon and zero carbon buildings, which are focused on increasing energy efficiency, should be promoted while applying smart building technologies and three-dimensional greening technologies. 4) Regions with scarce renewable resources are discouraged from indiscriminately using costly green technologies in the areas of energy and buildings and from developing zero-carbon residential communities.

In addition, for Dongtang Community where the land is privately owned and the renewal efforts are undertaken by each individual household, special attention should be paid to the features of the ageing and low-income groups and to the integrated application of low-cost, distributed technologies. Green technologies should be highly integrated for building retrofits, green renewal and municipal utilities.

6.4.2.4 Suggestions on Innovating Green Technologies for the Goal of Achieving Carbon Neutrality by 2060

As part of China's effort to achieve carbon neutrality by 2060, community-based green renewal must focus on deep carbon abatement and the innovation and application of green technologies. In the first phase of SPS, CCICED has recommended 12 green technologies which should be continuously implemented in the second phase. To address the community needs and application scenarios, the second phase has added some new innovative and scalable green technologies to strengthen systemic interventions and achieve the goal of carbon neutrality.

Table 6-8 Recommended Green Technologies in Six Key Areas during the 14th Five-Year Plan Period

Key areas	Technological focus	Recommended technologies
Water	Sewage treatment and water recycling economy	Sewage treatment and plant-network-river integration
	Utilization of recycled water	Quality protection of recycled water
	Utilization of recycled water and NRW management	Smart operation of recycled water system
Energy	Integrated grid powered by green energy	Microgrid
	Near-zero carbon cooling and heating	Central heating by using industrial waste heat
		Utilization of medium-deep geothermal energy
Internet of Energy	Integrated management platform of the Internet	

Key areas	Technological focus	Recommended technologies
		of Energy
Transport	Smart mobility system	Mobility as a Service
	New energy vehicles and supportive facilities	Hydrogen vehicle Smart charging system
	Traffic demand management and cycling	Bicycle route
Buildings	Healthy buildings	Three-dimensional greening of buildings
	Green buildings	Steel structure+internal modular space
	Near-zero-energy consumption buildings	PV, BIPV, distributed energy storage and DC power supply
	Smart operations and maintenance of buildings	Networked smart building systems
Land planning and use	Green urban landscape	Technology kit for green urban landscape
	Green, livable and carbon-neutral communities	Technology kit for building green, livable and carbon-neutral communities
Food	Food tracing	Food safety information monitoring and tracking
	Urban farming	Vertical farming
	Smart agriculture	Digital food platform

6.4.2.4.1 Recommended Innovative Technologies in the Field of Energy (new)

Hydrogen utilization and fuel cells. This technology can be used in buildings after breakthroughs in technology and cost. Renewable energy for hydrogen production, large-scale hydrogen storage, natural gas pipelines for hydrogen transmission and hydrogen-powered fuel cells will come together to form a complete hydrogen production and supply ecosystem, which can ensure diversified supply of energy and urban energy security. It is noteworthy that fuel cell technology has the potential to replace natural gas-powered heating and cooling system in the communities.

Efficient air conditioning. This refers technologies with a coefficient of performance (COP) not less than 7.0. There has been a sustained growth of energy efficiency in the leading air conditioning products in recent years, which is accelerated by the adoption of heat pumps. Currently, large air conditioners, with a COP of more than 12, have appeared on the market. Looking forward may be the advent of smaller but more efficient air conditioners which are easy to be installed and used at home.

Blockchain. In trading community energy, point-to-point transactions in particular, blockchain technology will play a vital role in shaping the distributed power trading programs and policies of electricity pricing.

6.4.2.4.2 Recommended Innovative Technologies in Treating Domestic Waste (new)

Low-carbon garbage collection pipeline. Negative pressure technology can be used to pump domestic waste and transmit them to a central garbage station via dedicated pipelines before delivery to a garbage disposal plant by compressed vehicles. The fully automated process can ensure a very quick and clean collection of garbage.

Garbage incineration power generation. Domestic waste with higher calorific value are incinerated for power generation to reduce landfills, soil pollution and carbon emissions while recycling the waste to heat energy.

Anaerobic fermentation of kitchen wastes. Kitchen wastes can be treated at a large scale through anaerobic fermentation to recover crude fat, solid residues and liquids for the recycled use of biomass resources and for biogas power generation.

Distributed aerobic composting of kitchen wastes. The kitchen waste collected within a community can be treated using aerobic composting to decrease the ratio of collected, stored and transported wastes, and produce organic fertilizer. As a result of this technology, kitchen waste can be directly treated for the purpose of green conservation.

6.4.3 Promoting a Green Lifestyle through Community Green Renewal

In promoting a green lifestyle, there are three focus areas. First, low-carbon consumption can be promoted by encouraging the purchase and use of green, low-carbon products. Compared with conventional products, these low-carbon products consume less energy, emit fewer greenhouse gases and have a longer lifecycle. To shape a green lifestyle, greener mobility choices and low-carbon diets are also called upon. Second, reduction can be encouraged with an emphasis on reducing the carbon emissions from the reduced use of various household appliances and some transport options. And third, carbon chains can be shortened by reining in activities. For example, efforts can be made to change the patterns and places of working and learning (e.g., remote working/learning) to reduce the carbon emissions from daily commuting.

6.4.3.1 Low-Carbon Consumption

Buy low-carbon daily necessities. 1) Check the energy label when buying an electrical appliance and choose one with higher energy efficiency, such as energy-saving lamps, water saving toilets, inverter air conditioners and inverter refrigerators, which can translate into more than 10% savings in energy consumption and carbon emissions. 2) Buy products powered by clean energy (e.g., solar), including home electrical appliances such as solar water heaters and solar street lamps. 3) Choose durable and renewable products that produce less pollution, such as those made from degradable materials and non-disposable goods. 4) Purchase goods either without packaging or with less or recyclable packaging. 5) Avoid using products containing

micro-plastics commonly found in facial cleansers and shower gels, and use green alternatives instead.

Choose green mobility options. Rail transit is suggested for medium- and long-distance mobility while walking and cycling are more suitable for short-distance mobility. As shown in the carbon footprints of various mobility methods released by the Department for Business, Energy & Industrial Strategy in 2018, rail transit emits less carbon than automobiles. In terms of short-distance commuting, cars are ranked higher than buses, motorcycles, subways, bicycles and walking (in a high-low order of carbon emissions). The publication mentions that the smaller a vehicle is, the less carbon it emits. Another finding is that electric vehicles (EVs) and Plug-in Hybrid-Electric Vehicles (PHEVs) only produce roughly one third of the carbon emissions of gas/diesel-fuelled vehicles.

Practice a low-carbon diet. Low-carbon food such as fruits and vegetables are encouraged to reduce the carbon emissions associated with farming practices. Research shows that from the perspectives of unit weight and unit protein supply, plant-based foods, including fruit and vegetables, emit less carbon than animal-based foods (e.g., meat and dairy products), while fish, poultry and pork outperform ruminant animal-based food.

Advocate moderate consumption to reduce waste. A prudent judgement of needs, a simple lifestyle, and a moderate level of consumption can reduce the waste arising from unwanted and redundant consumption. Irrational behaviors like impulsive purchasing and giving in to merchants' promotion activities should be avoided. Food should not be wasted and a proper amount of food should be bought, including ordering moderate meals in restaurants. Research^[29] shows that on average, every Chinese person wastes 44 kilograms of food every year, ranking China 22nd in the world for most food waste. In fact, the yearly wasted food in Chinese cities is comparable to total staple food imports.

6.4.3.2 Reduced Use

Reduced and greener use of household appliances. 1) Efforts should be made to reduce reliance on electrical appliances. This can include, for instance, washing by hand instead of washing machines and dishwashers, traditional toothbrushes over electric toothbrushes, natural air drying over clothes dryers, brooms over vacuum cleaners, spring-wound alarm clocks over electronic clocks, and avoidance of elevators for lower floors; 2) Outdoor activities can be increased and indoor fitness devices should be spared to reduce the energy consumption arising from the use of lighting and air-conditioning systems associated with indoor sports; and 3) household appliances and drinking water can be used in an energy-saving and low-carbon manner. Meanwhile, energy-efficient household appliances and smart home control systems can be adopted to reduce energy consumption while satisfying the needs of daily life. For example, air conditioning and heating systems can be set at a

temperature close to outdoor temperature. Remembering to switch off the cooling or heating system when a room is vacant, shutting off the air conditioner when leaving the home, switching off the lights or taps at any possible opportunity, starting a washing machine or dishwasher only at full capacity, and cutting off the power supply when a household appliance is not being used are other actions to attempt.

Shared mobility. Ride-sharing should be encouraged to reduce the carbon emissions of each individual and diminish residents' enthusiasm for buying private cars. Network operators can join hands with residential communities and other stakeholders to build a shared mobility platform so that residents can identify common routes and time schedules for the benefits of shared mobility. This platform is particularly useful for those on the same commuting route for work or school.

Recycled use. Renewal of wasted items or trade-in can be promoted to recycle daily supplies and extend their lifecycles, while eliminating the need to dispose of, remanufacture and/or resupply those items. Recycled use, however, requires the support of communities, which can encourage and teach residents to renew used items, develop flea markets for trading used items and building online platforms for second-hand transactions.

6.4.3.3 Shortened Carbon Chains

Working and learning remotely from home. An online platform can reduce the need for commuting to work and school. Some jobs, such as IT, media and language mentoring, can be done via online platforms. Even when only a partial share of jobs are performed remotely, carbon emissions can be reduced remarkably. Research indicates that if 100 people work from home for three days a week, GHG emissions can be reduced by 70 tons throughout the year^[30]. Companies must create adequate conditions for remote work, or this would not be possible.

Growing and eating local food. Urban farming can be practiced in residential communities where residents engage in growing their own farm produce. Residents can be mobilized to grow fruits and vegetables on wasted land or on rooftops. When new farming techniques are combined, vertical farming can prosper, increasing the plantation acreage of greens and crop yields. Such community-based farming practices are expected to reduce carbon emissions from food transportation, packaging and retail sales, while also cutting down on the land use required for growing fruits and vegetables. In implementing the project, CAUPD Shanghai and Chongqing teams experimented growing vegetables and fruits on the rooftop of office buildings, gaining a rewarding and interesting experience.

6.4.3.4 Enabling Conditions for a Green Lifestyle

A green lifestyle not only depends on strong will and organization of residents, but also relies on enabling policies, governance mechanisms and facilities.

Policy support. The country or the city should exercise price controls and provide production subsidies for low-carbon products; increase the use of low-carbon product

labels; use government procurement in leading green supplies, including low carbon diets, in schools, hospitals, public ministries, state enterprises and other; strengthen the awareness of low-carbon products among communities; and support the purchase of low-carbon daily necessities. City governments and businesses should encourage and enable the practice of working remotely from home.

Governance support. Residential communities should launch dedicated campaigns to teach residents how to refabricate used items and build trade-in marketplaces, such as flea markets or second-hand transaction platforms to support the recycled use of waste products. In addition, programs should be carried out to spread knowledge on using household appliances in a low-carbon manner and promote the reduced, greener usage of these appliances. A central shared mobility platform should also be put in place to enable shared mobility.

Facility support. Cities should build a more user-friendly public transport transfer network near neighborhoods, and install shared charging stations and solar-powered charging stations for new energy vehicles to provide options for green mobility. Residential communities should optimize outdoor public spaces and facilities and build shared spaces for working, learning and catering. Also, spaces such as wasted land and rooftops can be utilized to scale up urban farming.

6.5 Mechanism guarantee of China's urban green transformation

6.5.1 Promotion of Digitized Green Transition in Chinese Cities

6.5.1.1 Analysis of Five Factors for Digitized Green Transition

Actions to make cities more livable, inclusive and sustainable have noticeably intensified over the last decades. This shift towards green and sustainable cities converges with another global megatrend which is often referred to as the digital transformation or the Fourth Industrial Revolution (4IR) ^[31]. The confluence of physical and digital infrastructures in cities bears many opportunities for the green and smart transition of Chinese cities. Table 1 provides an overview of how the key sectors of urban green development could benefit from digital technologies^[32]. The five factors, i.e., infrastructure, economy, governance, people, and environment are the key in smart and sustainable urban transitions.

Table 6-9 Examples of potential digital applications in different sectors to support green urbanization in China

Sector	Potentials application of digital technologies
1: Energy	Enabling of renewable energies, peer-to-peer energy solutions (<i>prosumer of energy</i>), increasing energy efficiency, predictive maintenance of energy systems, and improving energy planning

Sector	Potentials application of digital technologies
2: Building	Improving human-centred city planning. Improving light, heat and cooling management
3: Mobility	Enabling new forms of shared mobility, improving mobility systems to reduce carbon and noise emissions, improving public transport efficiency and reducing prices, semi-automated and automated driving
4: Land use	Supporting land use planning processes through data-analytics of resource flows and behaviours of citizens, enabling citizen participation in urban planning processes
5: Food	Enabling participatory urban agriculture and food production, enabling food sharing platforms
6: Water	Improving urban water management, monitoring water quality, enhancing residential and industrial water efficiency

Source: Based on WEF 2020, supplemented by authors.

6.5.1.1.1 Infrastructure

The smart cities alter the classical understanding of infrastructure. Infrastructure, such as roads, water, wastewater and electricity supply, waste management and public facilities, are increasingly coupled with a layer of data infrastructure (e.g., sensors and networks) and linked more closely with urban management and public services. In this way, digital technologies and the collection of data can support the efficiency, reliability, and sustainability of classical hard infrastructure on multiple levels, make infrastructure more durable, and decrease the resources used to rebuild them. Digital technologies can also manage complex systems, enhance the flexibility of urban systems (e.g. electricity supply), promote the opening of the renewable energy integration, monitor environmental conditions, and better manage infrastructure.

However, digital upgrades of infrastructure are costly and need skilled management and application abilities. Furthermore, digital technologies can also create new vulnerabilities which pose a threat to their resilience. Cyber-attacks on infrastructure, for instance, may lead to severe damages^[33]. Upgrading physical infrastructure with digitization therefore requires new and holistic concepts to strengthen the resilience of these systems. Technological solutions should be considered less as “technical fixes,” but viewed more holistically with regard to their interaction with society and the environment, as well as possible new vulnerabilities and risks.

6.5.1.1.2 Economy

Datafication of urban spaces is regarded as an important economic factor and driver for innovation. Data can be used by businesses in production and the service industries to improve the efficiency of their operations, track environmental impacts, and improve processes, thereby reducing resource consumption. In this way, businesses can reduce carbon emissions. Data provided by public institutions or generated in urban spaces can help businesses develop new products and services for

their customers that serve their needs better and are less pricy.

If urban data ecosystems and their governance systems are not carefully or effectively designed, power imbalances or data divides – and therefore imbalances in competitiveness and value-creation from data – can likely be created and eventually hamper learning, innovation and putting data to use for the common good. Therefore, cities need to carefully design their data governance schemes to support the kind of innovations they aim for to become smart and carbon-neutral.

6.5.1.1.3 Governance

The digital technologies in city spaces can contribute to changing urban governance. Data can create a better understanding of the flow of materials, vehicles, and people and help local authorities and administrations to better serve the needs of citizens and businesses. Digital systems can also allow citizens to provide direct feedback to their administrations, foster learning processes in communities and enable citizens to become an active part in city governance. Data about the habits and preferences of citizens can not only be used to increase their quality of life, but also help improve the planning of urban spaces. Environmental monitoring data can help manage the city's resources and improve the quality of living. Data can also identify accident blackspots, quickly discover environmental or natural hazards, and provide inhabitants with the safety information. The digitization of cities can therefore improve urban disaster and risk management abilities.

However, digital technologies in cities also create risks and challenges for citizens and local authorities^[34]. Digital technologies can help to manage complexity, but they themselves are also complex and create new puzzles. Cities in developing countries of the Global South struggle with building their own capacities to deal with the challenges of digitalization^[35]. Instead, they often depend on technology providers, which compromises their ability to choose the technological settings that serve their needs best. Moreover, ICT companies often deliberately position themselves in the control position of the deployment and management of smart cities in order to yield benefits from urban data flows^[36].

Furthermore, a lot of data does not necessarily lead to a lot of more valuable new insights or better decisions^[37]. Administrations need the capacities and competencies to understand and make good use of the data and know its value against the real-world problems of city dwellers. Otherwise, instead of supporting the good and participatory governance, digital tools could make the governance efficiency lower, and even overburden local authorities.

6.5.1.1.4 People

Smart green cities should put the quality of living and the needs of people in the center. Smart cities can allow residents to benefit from the quick processing of energy, transportation, public services, and administrative matters. In particular, as mentioned above, digital technologies can facilitate a direct dialogue between

citizens and their local authorities and administrations, communication between residents, and improve community consciousness and resilience in times of hardship. Furthermore, digital technologies can enable vulnerable groups to support each other and find solutions for their needs and challenges, therefore spurring social innovation. Open data can provide citizens with the information they need to pursue their aims and interests and enable them to take part in the development of their city. Please see Annex I for an in-depth analysis on the sharing economy and the climate.

However, digital technologies are no guarantee for inclusiveness – often on the contrary. There is still, even in technologically advanced societies, a large digital gap, mostly along the lines of gender, age, income, and digital skills. Digital services and tools need to be designed and implemented in a way that create benefits and are suitable also for marginalized and disadvantaged groups and avoid exclusion and disadvantages. A truly inclusive strategy for digital services could furthermore include additional offline services to enable the digitally disadvantaged to communicate with local authorities, businesses and other people. Moreover, the ubiquity of data generating technologies in smart cities have raised concerns with regard to the protection of privacy and personal rights, and the concept of smart cities has been controversially discussed. Given the potential pitfalls and risks of datafication of public spaces, cities need to carefully consider the use of data-generating technologies, enhance transparency about their application, and protect the rights of individuals. Please see the Annex II for a case study on ‘Smart City Quayside in Toronto’.

6.5.1.1.5 Environment

Digital technologies can help improve the environment and decrease the carbon footprint in cities. ICTs can manage decentralized energy systems of renewable energy and lower the energy consumption of cities. Furthermore, digital technologies can be put to use for alternative mobility, such as ride- or car-sharing. However, such solutions may not be climate friendly and entail significant downsides. Besides, digital technologies themselves have a large environmental impact. Studies vary in their estimates, but it is reasonable to assume that in 2020, ICTs were accountable for 1.8 to 3.2 percent of global carbon emissions^[38] which are expected to increase greatly in several decades. There is a big indeterminacy in the overall environmental impact of edge computing, distributed ledger technology (DLT) and 5G. Moreover, there is also a lack of data on rare earth metals and other resources in the use of raw materials; these precious resources are often exploited under conditions which are very harmful to people and the environment, and only a small proportion are recycled. The Global E-Waste Monitor estimated that worldwide 53.6 million metric tons (Mt) of electronic waste were generated in 2019, with an increase of 21 percent in five years^[39], and only 17.4 percent of it was recycled.

It is therefore challenging to assess the full environmental impact of digital systems and whether they have a positive or negative impact on improving transportation efficiency. Against the backdrop of the currently incomplete knowledge about the environmental impact of digital technologies, it is advisable to carefully consider the large-scale use of ICTs in urban settings. The ecological and social value needs to be carefully assessed before implementation, operationalized by meaningful and measurable indicators and monitored and evaluated closely during the use phase. Moreover, in order to improve life-cycle assessments of digital technologies and systems, data about resource usage in the production phase needs to be collected. A sustainable digitalization is more and more recognized as a topic for active environmental policy making. The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in Germany launched a “Digital Policy Agenda for the Environment” in 2019 that highlights key principles, goals, as well as concrete measures to align the digital transformation with sustainable development and to put it to use for climate, nature and the environment^[40].

6.5.1.2 Suggestions on the Green and Smart Urban Transition

The green and smart urban transition does not occur automatically by digitally enhancing traditional infrastructure. It is a complex task that must balance the opportunities and challenges of the use of digital technologies, driving the transition in a holistic way. It also requires an enabling environment that consists of the following elements.

6.5.1.2.1 Urban Sustainability Strategy

This urban transformation strategy needs to be anchored in a strong, long-term vision for a sustainable, carbon-neutral city. This vision should be developed in a participatory process with citizens and other stakeholders. It should also include a reflection on the role of technology in the smart and sustainable city, to make technology contribute to reaching it. Rules and principles for the procurement of smart city technologies and data centers should be included in the urban sustainability strategies. Finally, strategic aims need to be formulated in a way that is specific, measurable, achievable, relevant, time-bound (SMART) and be complemented by concrete steps on how to reach them. Strategy implementation should be monitored and regularly communicated to citizens and stakeholders to check the progress and whether the intended purpose is achieved.

6.5.1.2.2 Data Governance

Data governance must adhere to laws and regulations set on the national and international levels, especially with regard to the use of data generated on the community level. Cities should develop a data governance strategy jointly with citizens, businesses, and other stakeholders, which supports sustainability goals and serves the public good. Local data governance should carefully consider the social compatibility of digitalization and evaluate the environmental impact of using

data^[41]. Data governance frameworks should strengthen individuals' data sovereignty, increase transparency, and heighten the accountability of companies and administrations with regard to data generation and use. Data governance strategies should include a strategy for open data so that businesses, academia, society and others can benefit from data and create new business models as well as technological and social innovations. Finally, data governance needs to outline an institutional setting that implements and watches over data governance principles to create a thriving ecosystem that supports data sharing between different actors.

6.5.1.2.3 Public Participation

A smart, green, and human-centered city naturally needs to involve citizens in design and planning and improve inclusiveness and equality by particularly addressing problems for vulnerable groups. However, for citizen participation to be real, it needs to be transparent, accountable, and continuous, and requires urban administrations and institutions to continue learning. Furthermore, the participatory planning should be communicated with regard to the process, problem solving, and results. They should also be continuously monitored and evaluated in order to motivate further civic engagement.

6.5.1.2.4 Experimental and Experiential Spaces

The idea of the green and smart laboratory has gained wide attention internationally. However, in order to explore solutions that work beyond specific niches, cities need to develop new ways of engaging their citizens, businesses, and educational institutions in urban planning and innovation. One way to carry out such responsible large-scale innovation on the urban level is to actively collaborate with a city's education and academic systems. These institutions can play a major role in identifying, developing, and implementing solutions for a green and smart urban transition together with local populations. Moreover, experimental spaces should become hubs for exchange, networking and collaboration of knowledge communities that are not yet or not sufficiently interconnected, forming the communities for research on technology and sustainability.

6.5.1.2.5 Capacity Building of Local Authorities

Local authorities or communities need a brand-new skill set in order to manage the green and smart transition. On the one hand, this includes profound knowledge about digital technology trends, potential risks and benefits of ICTs as well as sound practical knowledge about how digital technologies can be put to use for urban administrations in various areas (e.g., urban planning, mobility, urban economy). On the other hand, local authorities or communities need to build up competencies that enable them to interact constructively and dialogue with citizens and local change agents (e.g., businesses and civil society), and engage them in the formulation of data governance strategies or urban planning. To fulfill these requirements, local authorities and communities do not only need competencies and skills, but also

sufficient and well-trained staff. Furthermore, in order to deal with the complexity of the smart and green urban transition, local authorities need adequate internal systems, cultures and an understanding of their own role that supports learning processes, exchange, and co-creation.

6.5.1.2.6 Finance for Transition

Finally, the creation of the aforementioned enabling environments requires sufficient financial support. One of these financial means could consist of dedicating a certain percentage of spending for local infrastructure projects to the implementation of a co-creative process involving citizens and stakeholders in the planning and implementation of digital infrastructure projects. Furthermore, two kinds of incentives need to be provided for companies: on the one hand, adequate incentives and regulations must be put in place to support and encourage private investments in sectors and projects that advance the sustainability transformation of cities; on the other hand, companies need incentives to promote the sustainability benefits of digital business models, services or other products. A “green and smart urban transformation fund” could, for example, support eco-startups in developing new digital business models and solutions that serve the smart sustainability strategy. Finally, investors could be assisted with clear guidelines on how to evaluate the social, ecological, and economic sustainability of a company to support sustainability-oriented investment decisions.

6.5.2 Creation of the Enabling Environment for Deployment of Green Technologies

6.5.2.1 Key Challenges to the Deployment of Green Technologies

From desk research and consultations with experts and inputs from over 20 large national and multi-national corporations with business operations located in China, challenges to the scaling-up of green technologies in six fields (i.e., energy, mobility, building, land-use, water and food) due to technological, regulatory, and social barriers were identified. The six fields also face financial and economic challenges which cut across the barriers.

6.5.2.1.2 Technological Barriers

Besides the issue of the technological readiness of some of the identified, emerging technologies, the bigger issue towards the scale-up of many of these technologies is the lack of infrastructure (hard and soft). The existing energy systems in China do not support the scaling-up of renewable energy. Shifting to the smart energy system will require costly, major adjustments in asset structure. Finally, for NEV charging infrastructure, siting remains an issue for its increased build-out in China. Companies have indicated many hurdles they run into during the implementation stage, including land-use approval, connectivity to the grid, safety concerns to the grid and neighborhoods, and compliance with environmental and

city planning regulations.

6.5.2.1.3 Regulatory Barriers

Carbon neutrality is a complex issue which touches upon all industries and sectors of the economy. There is a lack of cross-cutting collaboration mechanisms which gather experts from all industries and sectors. A mechanism for data sharing between companies, as well as with researchers, is currently lacking but essential for a successful net-zero transition. Food systems researchers have stressed the lack of access to the vast amounts of data generated by platform companies, which are vital to their work on sustainability in agri-food systems. In the building sector, the current business license management scheme causes a separation between building design and construction, which has caused many difficulties in full-lifecycle management.

Insufficient market mechanisms or skewed pricing prevent adoption of green technologies by the private sector. Carbon capture, utilization and storage (CCUS) technologies, for example, are not yet at the stage of commercial viability, coming across technical difficulties and cost barriers, as well as immature storage and transportation infrastructure. CCUS applied to coal fired power plants can add 14%-25% energy consumption and 20%-30% additional investment cost.^{①[44]} Businesses do not have the incentive to invest in CCUS technologies due to the lack of policy and financial support from the government, as well as the low price of carbon.

The absence of a more developed system of standards, certification, and conformity, from public or private institutions, otherwise known as *quality infrastructure*, prevent investment opportunities, cost reductions, and economies of scale for green technologies. 1) In autonomous vehicles, there is no standardization of sensor systems, as well as in communications between the intelligent grid and autonomous vehicles. Along with regulatory barriers such as lack of insurance policy and liability regulations, they are therefore prevented from developing beyond the demonstration stage. 2) The lack of standardization in EV batteries, as well as the lack of compatibility in their interfaces, is one of the main reasons for the immaturity of the battery swapping business. 3) The incompatibility among Chinese and international green building standards constrains the development of green buildings in China. 4) Finally, food labeling for alternative proteins and eco-food is essential in its promotion, but existing labeling either lacks information or is not considered trustworthy, and therefore does little to incentivize Chinese consumers.

6.5.2.1.4 Social Barriers

The energy transition faces major social challenges and the coal sector, in particular, is highly affected. In provinces such as Shanxi, the coal sector is one of the largest sources of employment, GDP and tax revenue.^[42] Without assistance

^① <http://www.tanjiaoyi.com/article-27399-1.html>

policies, there will be difficulties for coal sector employees to find new and good job opportunities. The transition will require a workforce that is both highly skilled and familiar with environmental protection. However, skills development strategies have not been currently systematically included in national climate change and green transition policies in China and inter-ministerial coordination mechanisms on training for green skills is lacking.^[43] Companies in the green building industry have concurred that there is a large talent gap for a skilled workforce on building full-lifecycle management in the industry.

Increased public awareness, knowledge, and engagement on climate issues can drive wider adoptions of green technologies by urban consumers. Fortunately, most of the Chinese public realizes the importance of adapting to a low-carbon lifestyle, although this level of understanding varies.^[44] Consumer demand and behavior changes in terms of diets, forms of mobility, and more can help to drive the scale development and net-zero transition of green technology.

6.5.2.2 Creation of the Enabling Environment for Deployment of Green Technologies

The enabling environment for green technology promotion needs joint participation of the national and local government, producers, consumers, financial institutions, and academia. The government should have robust and targeted solutions to break down the various barriers faced by the private sector in the scaling-up of green technologies. Starting with governmental strategic planning and design, as well as stakeholder, cross-sector, and international collaboration, effective policies and financing mechanisms can be implemented, along with the cultivation of a culture of innovation and public awareness.

6.5.2.2.1 Strategic Planning and Design

A successful net-zero transition by 2060 starts with a clear, long-term vision and top-level strategic design on the part of the national government to guide technology development and mobilize resources to prevent a misallocation of resources and wasteful missteps. Leaders from government and industry, as well as experts at home and abroad, need to jointly assist policymakers in implementing the right policy instruments and investment actions which support both new technology development and scaled-up deployment of existing technologies. The strategic planning and design should touch upon all sectors of carbon neutrality, especially for the massive investment required for the smart energy infrastructure that incorporates a high percentage of renewables. The build-out of transmission, NEV charging, hydrogen storage, and distribution networks are all components of the smart energy system infrastructure which require strategic design and commitment on the part of the government. Effective governance frameworks can intensify mutual support of city, provincial, and national policies. Cities have a major role to play in enhancing data collection and developing data sharing systems (e.g., for energy supply and consumption data), so they can use credible data to establish baselines for setting

targets and evaluating progress.

6.5.2.2.2 Multi-Stakeholders and Cross-Sector Collaboration

Governments need to work with each other at all levels and between different ministries, as well as with businesses, financial institutions, academia, and civil society, and the stakeholder partnerships will be helpful to formulate policies for promotion of green technologies, and investment into technological innovation and infrastructure. The future smart energy system requires the integration of technologies across sectors, so inter-ministerial cooperation mechanisms must be established. Governments must collaborate with the private sector in technology promotion and data management, and improve the system efficiency by collaboration between different fields and sectors. China has set up a high level climate inter-ministerial committee, chaired by the Vice Premier and comprised of 17 ministers/agency heads as well as the Vice Premier in charge of economic planning

6.5.2.2.3 International Collaboration

International collaboration is also needed, such as the 2021 announcement of US-China collaboration on tackling the climate crisis, which called for more sharing of international best practices, policies and market mechanisms to reduce emissions.^[45] The EU-China Climate Dialogue in February this year also provided a forum for pursuing ambitious joint commitments on climate issues. The Belt and Road Initiative International Green Development Coalition (BRIGDC), established in 2019, aims to promote international consensus, understanding, cooperation and concerted actions to realize green development on the Belt and Road Initiative (BRI) and to facilitate BRI participating countries to realize SDGs related to environment and development.^[46] These frameworks, and more, have laid solid foundations for China to pursue further international cooperation activities. Technology transfer and cooperation on some common global challenges requires global business leaders, leading scholars, governmental officials, and investors to work together to reach technical breakthrough and financial feasibility. International standards and coordination mechanisms will help the global scale-up of green technologies.

6.5.2.2.4 Preferential Policy

Subsidies, tax incentives, and price policies are important tools for the promotion of green technologies. Non-financial incentives can also stimulate promotion. In the mobility sector, for instance, priority lanes, zero-emission zones, traffic restriction based on license plates, restrictions on car purchase qualification, and so on can all encourage NEV purchasing. The best policies sync multiple solutions and maximize benefits, while at the same time avoid adverse effects. For example, promoting EVs without also scaling clean electrification and a shared economy can result in an increase in emissions from mobility.

6.5.2.2.5 Market-Based Mechanisms

The carbon market is an effective policy instrument for companies to internalize the cost of their emissions and as a price signal for companies to shift investments into green technologies. China's carbon market requires further optimization and extension into industries other than the power sector.

6.5.2.2.6 Regulation

When factors other than cost hamper accelerated deployment of green technologies, making price signals insufficient, regulations can be a more effective policy instrument. Optimization of the regulatory environment to incentivize SOEs to engage in more innovation and undertake into new business ventures towards green technology and relevant green products and services. For example, the CNOOC, a state oil giant announced the 'Green Development Action Plan' in 2019, with concrete action plans on new business ventures in renewable energy, such as offshore wind. Its first offshore wind project in Jiangsu has been commissioned in 2020.

6.5.2.2.7 Financing Mechanisms

Financing the move towards complete carbon neutrality is one of the primary challenges faced by stakeholders. The massive amounts of investment needed for infrastructure and green technology to promote innovation must be met by public and private funding. Government policies need to send market signals for the mobilization of private finance. The public finance on R&D should be prioritized towards green technologies, especially those at early technological readiness stages (e.g., CCUS and hydrogen). The private sector will need to finance most of the investment required for the promotion of green technologies,^[47] but the government can encourage the mobilization of private funds by reducing the risk for investors, and adopt suitable policy and regulatory frameworks to attract more private investment. The enhancement of Intellectual Property rights, taxation support, and other mechanisms such as dedicated industrial funds can also support a green-investment-friendly environment in China. On the other side, standardized ESG disclosure can help businesses reduce green financing costs and increase green investment. Public-Private Partnerships (PPP) can help to decrease financial risk for businesses, especially in public infrastructure works such as in the water sector.

6.5.2.2.8 Culture of Innovation

Carbon neutrality requires innovation across sectors, especially with the application of 4IR technologies. Innovations in technology, business models, policy, and visionary concepts are the key to fostering a culture of innovation, embracing innovation, and boosting the carbon neutrality agenda. Governments play a central role in creating an environment for innovation in many respects, such as ensuring IP protection, investing in fundamental research, overcoming market failures, providing standards that help market actors coordinate, and providing low cost of

capital for innovative technologies. ^[48]

6.5.2.2.9 Public Awareness

Technology scale up and deployment must be combined with human behavioral change, which is why increased public awareness, climate education, and public participation is imperative. Fifty-five percent of emissions reductions require green technology along with active involvement or engagement of citizens or consumers, and 8% from behavioral changes and materials efficiency gains. ^[49] Governments can also make it easier for consumers to make decisions and choose low-carbon alternatives through quality infrastructure which helps consumers build confidence in the product, such as with trustworthy food labeling for alternative proteins. Governments need to take into account the social and economic effects of the carbon neutralization on people and communities. Making sure of energy affordability, as well as policies that retrain workers, strategically locate new facilities, and provide aid can help to ensure a just transition.

6.5.3 Gender and Population-Group Perspectives: Sharing and Public Participation

6.5.3.1 The Role of Women in Green Community Development

6.5.3.1.1 Women Play a Dominant Role in Green Lifestyles

Women have long outnumbered men in terms of involvement in environmentally-friendly actions. Across different age groups and countries, including China, women are inclined to lead a more eco-friendly lifestyle. ^[32] Women can play more influential roles in green lifestyles. Due to the traditional division of labor, women spend more time on parenting, caring for the elderly and doing household chores. They have a greater say in making purchases and dietary choices. They place greater emphasis on health and assume important roles in communication and education on sustainability. Women are also more likely to cooperate, gather and communicate, so they find it easier to organize and participate in community improvement programs. Therefore, women are dominant in activities from shaping individual behaviors to advancing green community initiatives. In fact, women's role and leadership are indispensable in many green lifestyle initiatives, from shared laundry services to shared kitchens, elderly care, local green food, low-carbon cooking and education, and used-materials recycling.

6.5.3.1.2 Green Development Calls for Women's Engagement and Leadership

Women are more vulnerable to the negative impacts of climate change. Due to deeply entrenched social traditions and economic structures, women are more likely to encounter health, employment and family issues when exposed to a climate change event. ^[50] Therefore, climate issues must be analyzed from the women's perspective, in order to gain a complete picture of the adverse impacts of climate change and understand the potentially vicious cycle of climate and gender issues.

Female political participation can effectively improve a government's capability in responding to climate change. Countries with higher levels of female political participation are more successful in reducing carbon emissions.^① Actions taken by European leaders have proved that women are more capable crisis managers than men. Women have proven to be effective leaders in sustainable development. In cities and communities in China, there should be more women assuming leadership roles, where they can help achieve success in technology innovation, inclusion, public engagement and smart and livable city development. They can also help women raise their needs and perspectives in strategic areas of green development, so that women, as important stakeholders and innovators, can also be part of green development.

6.5.3.1.3 Women's Enormous Potential in Technology-Driven Green Transition

Science, technology, engineering and mathematics (STEM) are the foundation for innovation, social wellbeing, inclusive growth and sustainable development. The UN points out in a report that "by higher education, women represent only 35% of all students enrolled in STEM-related fields of study" and that "female students' enrolment is particularly low in ICT (3%)." Helping women learn and pursue careers in STEM-related fields will not only help develop more green technologies and improve women's economic stability, but will also strongly motivate women to be part of this technology-driven green transition. In its own right, the green transition also provides an opportunity to address gender gaps and discrimination and promote inclusion and equality.

6.5.3.2 Recommendations on Community Renewal that are Favorable for Children and the Elderly

In the debate regarding urban green development, community renewal and the promotion of green technologies, young and middle-aged people usually receive more attention, while children and the elderly are often neglected. However, more and more social issues have arisen as a result of an ageing society and the birth of fewer children. Therefore, models that are friendly to senior citizens and children should be adopted for green community renewal in light of their needs, abilities and adaptability. Studies show that enough open, highly walkable spaces, adequate leisure and service facilities and pleasantly designed environments will encourage children and the elderly to exercise outdoors, increase their social interactions, strengthen emotional bonds and foster a stronger sense of communal belonging, which in turn will also contribute to the promotion of green and low-carbon behaviors. Therefore, the following actions should be emphasized in the green

^①<https://static1.squarespace.com/static/559d276fe4b0a65ec3938057/t/55df34f2e4b08e5b72c24ede/1440691442499/Gender-and-the-climate-change-agenda-212.pdf>

renewal of communities:

1) Organize resources to provide shared elderly and child care services, which can improve community support systems and reduce carbon emissions from day-to-day activities; 2) design rooftop farms, which not only cater to elder people's preferences, but also produce vegetables for household consumption and improve resource efficiency; 3) build more public spaces with low-carbon, anti-slip and permeable materials and provide safe, accessible paths and facilities for the elderly; 4) reduce the depth of water, build gently sloping banks and create playgrounds for children in the retrofit of communities; and 5) use natural landforms and plant materials to build facilities for children to help them feel an affinity for nature and develop green lifestyles. Moreover, communities may also organize the elderly as volunteers for low-carbon and environmental protection activities.

6.5.3.3 Recommendations on Community Renewal that are Favorable for Low-Income and Vulnerable Groups

Low-income and vulnerable groups of people, including those who are financially impoverished, unemployed, migratory, informally employed and physically challenged, should also be prioritized in the green renewal of communities. Their voices should be heard to safeguard their basic rights, help them become independent and empower them to enjoy a high-quality green lifestyle at a low cost. Specific actions may include:

1) Enable more low-income and vulnerable groups to be part of community activities, with their actual needs fully factored in community renewal; 2) build more adaptive public spaces to encourage disadvantaged groups of people to spend less time indoors and assimilate into society; 3) increase the use of natural lighting and ventilation in buildings to reduce the consumption of energy such as electricity and gas; 4) renovate and renew communities in a low-cost manner to prevent expensive homes and facilities; and 5) provide job opportunities from retrofit and renewal and shared facilities to local low-income and vulnerable groups.

6.6 Policy Suggestions

6.6.1 Suggestions on Promotion of Carbon Neutrality and Green Development of Cities and Communities

Expedite the National Achievement of System Construction of The “Double Carbon” Goal

Strengthen and extend the coverage of China's carbon market, formulate the carbon price policy, and perfect the carbon trading system; Implement a quota distribution of carbon emissions in industries where it is difficult to reduce carbon emissions, and finally, cover all industries; Formulate an energy transition route map

with specific aims and schedules as quickly as possible, and provide guidance for the green transition at the whole overall system level.

Accelerate and Encourage Enterprises to Participate in Low Carbon Development of the Decarbonization Process

Through granting business permit for low carbon products and services, improve the modes such as performance assessments, and promote the leadership of state-owned enterprises in the development of decarbonization and green technologies; Guide private enterprises to participate in green technology innovation and low-carbon product manufacturing, as well as low-carbon building and infrastructure construction through broader multi-incentive policies and constraint mechanisms; Support low-carbon development of mid- and small-sized enterprises and start-up enterprises by the modes such as a “Green Fund”; clarify producers’ low-carbon responsibilities for the product life-cycle through the “Carbon Labeling” system; advocate residents to buy low carbon products.

Pay High Attention and Actively Promote Carbon Emission Reduction of Cities and Communities

Formulate an overall carbon-emissions reduction strategy plan at the city level, and propel cooperative transition of energy, building, mobility, land utilization, and infrastructure; Include climate risks into city and community planning; Accelerate the advance of the “zero-carbon cities” pilot project; Construct a batch of “zero-carbon community” demonstration projects; Apply digital technology and AI technology to green management; Design transparent, responsible, and continuous systems and mechanisms, and encourage wide participation of enterprises and the public.

Strengthen Promotion and Application of Green Technologies in Communities

Establish community-level carbon-emissions monitoring and evaluating systems, grasp the present characteristics of carbon emissions in communities, and adopt more effective green development strategies; Quicken the progress of mature green technology application in the fields of energy, building, mobility, municipal administration, etc., and expedite technological innovation and promotion; Speed up perfecting standard specifications for application of low- carbon technologies in communities.

Advocate and Practice a Green Lifestyle

Through cultivation of the mainstream values of carbon neutrality and sustainable development, motivate residents’ social responsibilities for climate risks, change their consumption patterns, and enhance green living intentions; Foster new-generation climate citizens through schools and communities; Guide and guarantee the public and social organizations to participate in community green low-carbon affairs.

Strengthen Social Impact Assessment of Decarbonization and Green Development

Fully understand and assess welfare, obtained by different social groups, and possible adverse impacts in the progress of the “Double Carbon” goal; In urban green development, community green renewal, and green technology application, pay high attention to risks and vulnerability of females, the elderly, children, low-income groups, and vulnerable groups, and formulate corresponding strategies and mechanisms in aspects such as equity and inclusiveness.

Reinforce International Cooperation of Green Development and Renewal.

Further carry out exchanges and cooperation of academic and specialized departments in green low-carbon development, actively learn the practical experience of developed countries on zero-carbon cities and communities, and impel international exchange of business enterprise sectors in green industries.

6.6.2 Policy Suggestions on Green Technologies in Community Renewal

6.6.2.1 Energy

Drive the market price mechanism of electricity demand-side response (load changes with resources). Expand the difference of electricity price at peak valley; provide subsidies for efficient energy utilization technologies and energy-efficient products, including household appliances with outstanding energy-saving effects.

Encourage the market development of stored energy, and stimulate V2G business and construction of more charging stations; encourage electricity sales through partition walls, release power of sale of renewable energy sources, activate the distributed generation market, and promote consumption of renewable energy sources.

6.6.2.2 Building

Formulate green building standards which are coincident and compatible in developed countries. Establish full life-cycle monitoring and assessment methods and governance systems for building design, construction, operation, and dismantlement, and promote full life-cycle management of green buildings.

Establish family/individual carbon-emission reduction mechanisms. Discounts of individual income tax deduction can be provided for families where energy consumption reaches an excellent standard; residents whose energy consumption greatly exceeds the standard can apply for government subsidies to make energy-saving renovations, and accept monitoring.

6.6.2.3 Mobility

Propel mobility low-carbon incentive policies. Include low-carbon mobility integral policies, subsidies for old vehicle elimination, award and discounts for low carbon vehicles and ships, etc.; Demonstration projects of mobility low carbon emission regions in pilot cities.

Optimize urban traffic structure. Develop dedicated roads for bikes, and guarantee continuity and networks of pedestrian ways; optimize rail network planning, and elevate the commuting coverage rate of rail traffic.

Improve mobility energy structure. Expedite promotion and replacement of New Energy Vehicles; Continuously reduce contamination and carbon-emissions intensity of newly-produced fuel vehicles, and establish full life-cycle carbon footprint assessments of the auto industry.

6.6.2.4 Municipal administration

Reform water price, and promote water conservation and efficient utilization through the regulatory mechanism of a ladder-like water price market; Achieve cooperative governance of water resources and water supply and discharge energy consumption in cities and communities; Achieve system efficiency promotion, energy consumption reduction, and carbon emissions reduction through cooperative smart management in terms of different qualities of multiple water resources, such as fresh water, rainwater, reused water, etc.

Optimize garbage classification supervision systems, formulate measures of reward and punishment, and enhance the quality of garbage classification; Optimize the charging system of garbage disposal, and promote decrement of garbage sources; Accelerate the establishment of recoverable material systems, introduce market mechanisms, stimulate participation of social capital, and promote increases in recoverable materials and decreases of other garbage terminal disposals.

6.6.2.5 Food

Optimize food and agricultural subsidy policies and establish a reliable food labeling system to promote sustainable food; increase public awareness of sustainable food systems and encourage food waste reduction and diet changes.

Promote urban agriculture and vertical farming to facilitate localized food production, distribution and green food demand under resource-constrained conditions and to improve the environment. Actively explore ways to reduce the economic costs of vertical farming.

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Annex I: An In-Depth Analysis On The Sharing Economy and The Climate?

Can Sharing help the climate?

With the spread of ICTs, particularly smartphones, the sharing economy has witnessed the birth of countless platforms and apps where people can share goods, such as cars or tools, skills and services, housing and accommodation or connect with each other to jointly use transportation opportunities. The question is: Does sharing help the environment and the climate? The scientific literature on this topic shows ambivalent results. On the one hand, sharing can contribute to avoiding or limiting consumption and decrease the need for the production of certain goods and therefore save resources and avoid carbon emissions. On the other hand, whether these potentials really unfold, depends on a multitude of different factors.

For example, via a sharing app someone could borrow a tool – let us say a power drill – that he or she does not frequently need from somebody else. This would make a new or initial purchase of that tool obsolete. Over its life cycle, a power drill produces approx. 28 kg of CO₂ equivalent with the usage of the tool accounting for only two percent of this amount. If it is used more often, the emissions from its energy consumption may increase – depending on the energy mix used – but the emissions that would have been generated in the production phase of a new power drill are saved. But, the calculation is not that simple, because one would also need to ask how many times the tool would need to be shared in order to significantly reduce the power drill production and therefore significantly reduce the related CO₂ emission overall. Moreover, so-called rebound effects could occur that decrease, annul or even reverse the positive environmental effects. Rebounds happen in different ways, for example when the person that borrowed the power drill invests the money she or he saved to buy another, maybe even more carbon-intensive good.

Looking at these various considerations – which hold true in similar ways for other examples of sharing – it becomes clear, that in order to become a real solution for climate and environmental challenges, more needs to be done than just sharing. Its potentials can only be lifted if embedded in an overall transition towards more sustainable lifestyles and behaviors including sufficient consumption and more sustainable production modes.

Annex II: Smart City Quayside In Toronto

In 2017, the City of Toronto announced the development of a 49.000 m² large piece of land at its waterfront into a smart city district. For that purpose, Toronto Waterfront, the agency in charge of the development of the area, partnered with the Alphabet-daughter Sidewalk Labs. What started with high expectations and much praise to create a smart and green residential and commercial area using data and latest technologies such as robots and underground waste disposal, soon turned into a problematic case and drew much criticism from the local population.

In particular, concerns around the data governance approach of the smart city project became the centerpiece of public discontent and spurred the development of an activist group called “Block Sidewalk”. Researchers analyzing the case pointed to – among other omissions – an insufficient and ineffective public consultation processes, lack of digital expertise and legitimacy on the side of Toronto Waterfront as well as non-existent or inconsequential economic, social and ecological analysis of the technologies planned to be used for the project). Moreover, they argue that due to the weakly developed Canadian data governance framework, the land-development agency Waterfront Toronto, which is not publicly accountable, would have gained unprecedented power to shape future Canadian data regulation policies. The strong presence of Sidewalk Labs in Toronto could have furthermore put pressure on Canadian policy makers to regulate data rather in the interest of Google than in the interests of Canadian tech companies, let alone Canadian citizens.

After much debate, Sidewalk withdrew from the project in May 2020, naming economic uncertainties due to the COVID-19 pandemic as reason. Researchers, however, see many lessons to be learned from the Quayside smart city project: Policy makers and urban developers need to take data issues and intellectual property rights seriously, develop data governance and policy frameworks independently and in advance to engaging with vendors and build own strong digital competencies. Furthermore, they need to rethink the role of platforms and engage citizens into the development of smart city concepts in order to avoid solutionist approaches to future city planning and to address the real needs and interests of urban residents.

Annex III: Calculation method of carbon emissions from community energy use

Carbon emissions from community energy use include carbon emissions from the three major energy sources consumed by the community: electricity, gas and water. The calculation formula is: $E_e = E_{\text{electricity}} + E_{\text{gas}} + E_{\text{water}}$. Where: $E_{\text{electricity}} = Q_{\text{electricity}} \times f_{\text{electricity}}$; $E_{\text{gas}} = Q_{\text{gas}} \times f_{\text{gas}}$; $E_{\text{water}} = Q_{\text{water}} \times f_{\text{water}}$.

Q_i represents the total amount of various types of energy use, f_i represents the carbon emission factors of various types of energy use, f_{gas} and f_{water} are taken from the 2006 National Greenhouse Gas Inventory Guide and the Chinese Ministry of Science and Technology's Citizens' Energy Conservation and Emission Reduction Manual, respectively. $f_{\text{electricity}}$ is derived from the 2019 baseline emission factors of China's regional power grid, calculated using the emission factors of the regional power grid to which each city belongs.

Annex IV: Calculation method of carbon emissions from residential travel

Transportation carbon emissions are the carbon emissions per person per trip, which are affected by the travel distance and travel mode. The calculation formula is:

$$E_m = \sum_{i=1}^{40} \sum_k A_{k,i} \cdot L_{k,i} \cdot GHG_{k_i}$$

$A_{k,i}$ refers to the traffic volume in year i of traffic mode k , and $L_{k,i}$ refers to the distance traveled in year i of traffic mode k . Both can be obtained through residential travel surveys, and the travel distance can be obtained through data signaling data. GHG_{k_i} refers to the carbon emission factor in year i of traffic mode k . This parameter can be obtained based on reported literature studies, or by using the data measured in urban scenario years, or It can be converted by considering the new energy vehicle substitution scenario.

Part IV

Green Energy, Investment and Trade

Chapter 7

Enhancing Environmental Management for BRI Projects to Boost Green BRI and 2030 Agenda for Sustainable Development

7.1. Introduction

Since the Belt and Road Initiative (BRI) was put forward eight years ago, it has achieved fruitful results and far-reaching influence. Adhering to the principle of extensive consultation, joint contribution, and shared benefits, and pursuing green, open and clean development, BRI has injected strong impetus into the process of globalization that has been challenged since the global financial crisis in 2008 by means of policy coordination, infrastructure connectivity, unimpeded trade, financial integration, and people-to-people bond. It is a well-recognized global public product provided by China to the world and creates new opportunities for BRI participating countries to develop together and share prosperity.

7.1.1 Promote BRI towards High-quality Development

In the past eight years, BRI has evolved into a mutually beneficial and win-win road that connects the development prospects of BRI participating countries, and has had a far-reaching impact on promoting the development of a community with a shared future for mankind. As of February 2020, China has signed more than 200 BRI cooperation documents with 140 countries and 31 international organizations^①. BRI and its core concepts have been incorporated into relevant documents of the

^① The list of countries that have signed BRI cooperation documents with China, Belt and Road Portal, 12 March 2021, <https://www.yidaiyilu.gov.cn/gbjg/gbgk/77073.htm>

United Nations, G20, APEC and other regional organizations^①. Focusing on the main framework of “six corridors and six channels serving multiple countries and ports”, and relying on a number of BRI landmark cooperation projects that proceed smoothly in the fields of ports, railways, highways, electric power, aviation and communications, the infrastructure in BRI participating countries has been improved substantially, and trade and investment potential has been effectively released. By the end of 2019, China had invested a total of USD 35 billion in cooperation zones built by countries along the BRI, paid more than USD 3 billion of taxes and fees to host countries, and created 320,000 jobs for the locality^②. In addition, according to the estimation of the World Bank, the decline in trade costs brought about by the BRI infrastructure development will increase global real income, and BRI-related investment can help 7.6 million people get rid of extreme poverty and lift 32 million people out of moderate poverty^③.

Although the COVID-19 once brought global development to a standstill, the BRI showed great resilience and vitality and became a bright color in the haze of the pandemic. In the first three quarters of 2020, China’s cumulative imports and exports to countries along the BRI increased by 1.5% year-on-year^④; and its non-financial direct investment in countries along the BRI increased by 29.7% year-on-year^⑤. With the tightening of pandemic prevention measures in various countries and the obstruction of shipping and air transportation, China-Europe Express gives full play to the advantages of cross-border railway freight service and helps BRI participating countries overcome the impacts of pandemic and other unfavorable factors, provides strong support to expedite the development of a green logistics network, to stabilize international supply chain, and to underpin the global war

^① Ambassador Cong Peiwu publishes a signed article on Belt and Road Initiative on CCBC's website, the official website of the Embassy of the People's Republic of China in Canada, 23 June 2021, <http://ca.china-embassy.org/eng/sgxw/t1885976.htm>

^② Ministry of Commerce of the People's Republic of China, Report on Development of China's Outward Investment and Economic Cooperation, December 2020, <http://images.mofcom.gov.cn/fec/202102/20210202162924888.pdf>.

^③ China Ushers in a New Stage of High-Quality Development in BRI Cooperation in the 14th FYP, China Pictorial, 9 December 2020, http://www.rmhb.com.cn/zt/ydy/202012/t20201209_800229530.html

^④ China's General Administration of Customs: In the First Three Quarters of 2020, China's Cumulative Import and Export to Countries Along the BRI Increased by 1.5% Year-On-Year, Ministry of Commerce of the People's Republic of China, 14 October 2020, <http://www.mofcom.gov.cn/article/i/jyj/j/202010/20201003007782.shtml>.

^⑤ Ministry of Commerce of the People's Republic of China: China's Non-Financial Direct Investment in Countries Along the BRI Increased by 29.7% Year-On-Year in the First Three Quarters, People's Network, 19 October 2020, <http://finance.people.com.cn/n1/2020/1019/c1004-31896412.html>

against the pandemic^①.

The outbreak of pandemic shows once again that humanity is a community with shared weal and woe. In the post-pandemic era, green recovery will contribute new development opportunities to the BRI. Green is the bright background of the BRI. In the process of promoting high-quality development of the BRI, building the Green Silk Road will make much more positive and promising contributions. The 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the Long-Range Objectives Through the Year 2035 (the 14th Five-Year Plan) points out that China will continue to strengthen the alignment of development strategies and policies, promote the interconnectivity and interoperability of infrastructure, deepen pragmatic economic, trade, and investment cooperation, and build a bridge for mutual learning among civilizations. The document further proposes to “strengthen exchanges and cooperation in climate change response, marine cooperation, wildlife protection, desertification prevention and control, and promote the construction of the Green Silk Road”.^② At the Boao Forum for Asia Annual Conference held in April 2021, President Xi Jinping announced that “China will continue to work with other parties in high-quality Belt and Road cooperation... in a bid to make Belt and Road cooperation high-standard, people-centered and sustainable.” Besides, China will “build a closer partnership for green development”. It will “strengthen cooperation on green infrastructure, green energy and green finance, and improve the BRI International Green Development Coalition, the Green Investment Principles for the BRI, and other multilateral cooperation platforms to make green a defining feature of Belt and Road cooperation”.^③ At the Asia and Pacific High-level Conference on Belt and Road Cooperation held in June 2021, China and other 28 countries jointly put forth the Initiative for Belt and Road Partnership on Green Development, calling for “internationally collaborative efforts to achieve green and sustainable recovery, and foster a low-carbon, resilient and inclusive post-pandemic growth”.^④

^① COVID-19 Presents Both Risks and Opportunities for BRI Development, China Today, 18 May 2020, http://www.chinatoday.com.cn/zw2018/sp/202005/t20200518_800204786.html

^② The 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the Long-Range Objectives Through the Year 2035, XinhuaNet, 13 March 2021, http://www.xinhuanet.com/2021-03/13/c_1127205564_13.htm

^③ Xi Jinping's Keynote Speech at the Opening Ceremony of Boao Forum for Asia Annual Conference 2021, XinhuaNet, 20 April 2021, http://www.xinhuanet.com/politics/leaders/2021-04/20/c_1127350811.htm

^④ The Initiative for Belt and Road Partnership on Green Development, Ministry of Foreign Affairs of the People's Republic of China, 24 June 2021, https://www.fmprc.gov.cn/web/ziliao_674904/1179_674909/t1886384.shtml

7.1.2 The Green Silk Road Provides New Impetus for the Implementation of 2030 Sustainable Development Goals

Eco-environmental cooperation is an important part of the BRI. It is the initial intention and vision of the Chinese government to build the BRI into a green road of development, and is also a key action to build a community of shared future for mankind. In the past eight years, while strengthening the construction of its own ecological civilization, China has actively worked with the BRI participating countries to build the Green Silk Road, and injected new impetus into the implementation of the 2030 Sustainable Development Goals (SDGs) based on bilateral, multilateral, regional and sub-regional ecological and environmental cooperation.

Underpinned by multilateral cooperation mechanisms such as the BRI International Green Development Coalition (BRIGC), the BRI Green Development Institute and the BRI Environmental Big Data Platform, the building of Green Silk Road has witnessed the constant improvement of the platform for policy dialogue, knowledge sharing and technology exchange, continuous deepening of cooperation on environmental governance, biodiversity conservation and climate change among BRI participating countries, and steady enhancing of international consensus on green development.

Relying on the Belt and Road South-South Cooperation Initiative on Climate Change, China helps vulnerable countries to enhance their ability to cope with climate change. It has been cooperating with Laos, Cambodia and Seychelles in the development of low-carbon demonstration zones and donated facilities for tackling climate change to Pakistan, Bangladesh, Iran, Chile, Uruguay, Cuba, Botswana, Egypt and other countries. With the implementation of the Green Silk Road Envoys Programme, China has provided training opportunities for more than 3,000 people from over 120 countries, which is therefore praised by the United Nations Environment Programme as a “Model of South-South Cooperation”.

7.1.3 BRI Investment Features the Growth of Scale and Green-Oriented Growth

The BRI is not only the road of economic prosperity, but also the road of green development. In the past eight years, the economic and trade cooperation between China and the BRI participating countries has been continuously deepened, and the investment vitality has constantly enhanced, which has facilitated the industrialization process and provided new opportunities for green development in BRI participating countries and regions along the BRI.

First, regional economic and trade cooperation is highly active, with continuous increase of total foreign direct investment. According to the statistics of the Ministry of Commerce and the State Administration of Foreign Exchange of

China, from 2013 to 2019, China’s cumulative direct investment in countries along the BRI was USD 117.31 billion, with an average annual growth rate of 6.7%, which was 2.6 percentage points higher than the China’s average in the same period. Regardless of the drop in 2016 that was affected by the significant increase in total foreign direct investment in that year, the proportion of direct investment in the BRI countries continued to grow (Figure 7-1).



Figure 7-1 China’s Outward FDI in Countries along BRI, 2013-2019

Source: Statistical Bulletin of China’s Outward Foreign Direct Investment, Report on China’s Foreign Investments and Economic Cooperation, and reports from the official website of the Ministry of Commerce of the People’s Republic of China

Second, climate change has triggered regional consensus, and the proportion of renewable energy investment has been increasing. The BRI has not only spurred the economic growth and social development of the participant countries, but also made positive efforts to cope with climate change across the globe. In September 2020, China put forward the vision of reaching its carbon emissions peak before 2030 and achieving carbon neutrality by 2060, which further enriched the connotation of green investment under BRI. In the infrastructure investment of the BRI, the proportion of renewable energy investment is also increasing. By the first half of 2020, China’s investment in renewable energy in BRI related countries surpassed investment in fossil energy for the first time^①, forming an all-round international cooperation system for clean energy covering equipment

^① Zhou Yamin. Transformation and Upgrading of China’s Industrial Chains Fueled by the Duel Goals of Carbon Emissions Peak and Carbon Neutrality. China Development Observation. 2021(Z1): 56-58.

manufacturing, joint research and development, engineering design and construction, and project investment and operation.

China's Investment in the Belt and Road Initiative (BRI) in 2020 released by the IIGF Green BRI Center also shows that the energy sector is still the focus of the BRI investment in 2020, ranking first in all industries in terms of investment amount and the number of projects, while the renewable energy investments (solar, wind, hydro) increased from 35% in 2017 to 56% in 2020 and became the majority of China's overseas energy investments.^①

Third, investment fields and subjects are becoming increasingly diversified, and the third-party market cooperation mode is gradually emerging. In the early stage, BRI investment was focused on the infrastructure such as energy, transportation, communication and water conservancy, and main investors were mostly state-owned enterprises. In recent years, the industries of direct investment in countries and regions along the BRI have become increasingly diversified, distributed in manufacturing, leasing and business services, wholesale and retail, building and construction, mining, finance, power production and heat supply, agriculture, forestry, animal husbandry and fishery, etc.^② More and more private enterprises and foreign-funded enterprises are joining the BRI investment. The model of third-party market cooperation is gaining popularity.^③ Third-party market cooperation is based on “complementary advantages”, and adopts the concept of “equal consultation”. It aims at “win-win results among three parties” through “enterprise-led” cooperation. It is highly consistent with the spirit of “extensive consultation, joint contribution, and shared benefits” advocated by the BRI. As a new mode of international economic cooperation, the third-party market cooperation has been widely concerned and welcomed by relevant enterprises in developed countries and countries and regions along the BRI. Since 2015, China has successively signed joint statements or documents on third-party market cooperation with 14 countries^④, which is characterized by diversified modes and large-scale

^① *China's Investment in the Belt and Road Initiative (BRI) in 2020*. Green BRI Center, International Institute of Green Finance (IIGF) under Central University of Finance and Economics. 2020.

^② Ministry of Commerce of P.R.C., Report on Development of China's Outward Investment and Economic Cooperation, December 2020, <http://images.mofcom.gov.cn/fec/202102/20210202162924888.pdf>.

^③ Third-party market cooperation refers to the market cooperation between Chinese enterprises and multinational enterprises in developed countries in professional fields such as foreign direct investment, infrastructure construction, financial product supply, capacity utilization, foreign aid and etc. in the third-party market with high trade complementarity for the two sides.

^④ The 14 countries are France, South Korea, Canada, Portugal, Australia, Japan, Italy, the Netherlands, Belgium, Spain, Austria, Singapore, Switzerland and the United Kingdom, which are sorted by the author according to the official websites of the Ministry of Commerce and the Ministry of Foreign Affairs of China and relevant reports from the *People's Daily*.

projects. International, bilateral and multilateral financial institutions are also strengthening financing support and constantly exploring ways to expand cooperation in third-party markets.

7.1.4 Motives and the Goals of Environment Management for BRI Projects

The Chinese government attaches great importance to the eco-environmental protection in BRI projects. With the continuous improvement of China's green finance system and the wide spread of the concept of sustainable investment worldwide, BRI investment and financing environment management has become the key in the green and high-quality development in BRI. The Chinese government has issued more than 30 policy documents focusing on areas such as foreign economic and trade cooperation, building green Silk Road, and green finance, with a series of management level requirements, guiding opinions and supporting policies on eco-environmental protection pertinent to China's "outward investment". These documents have provided clear policy guidelines for the participants of BRI projects to carry out environmental management in their investment and financing activities.

In 2013, the Ministry of Commerce and the former Ministry of Environmental Protection jointly issued the "Guidelines for Environmental Protection in Foreign Investment and Cooperation", which encourages enterprises to foster the awareness of environmental protection, fulfill environmental responsibilities according to the laws, abide by environmental protection laws and regulations of the host countries, and fulfill their duties and obligations in environmental impact assessment (EIA), emission standards, environmental emergency management and etc. In 2017, the "Guidance on Promoting Green Belt and Road" was issued jointly by the Ministry of Ecology and Environment, Ministry of Foreign Affairs, National Development and Reform Commission and the Ministry of Commerce, while the "Belt and Road Ecological and Environmental Cooperation Plan" was also released by the Ministry of Ecology and Environment. Both documents have articulated clear requirements on the environmental management of BRI investments and projects. In July 2021, the Ministry of Commerce and the Ministry of Ecology and Environment jointly issued the "Green Development Guidelines for Overseas Investment and Cooperation", which further notes to "encourage enterprises to conduct ecological and environmental risk prevention measures and improve the capacity of ecological and environmental management" and that Chinese enterprises shall "take reasonable and necessary measures to reduce or mitigate adverse environmental impacts". In addition, "Catalogue of Green Bond Support Projects (2021 Edition)" released in April 2021 also excluded high-carbon projects such as fossil energy projects, with funding skewed toward green finance to support climate change responses. It is foreseeable that the afore-mentioned new regulations will raise higher requirements for the green practice of BRI investment and financing, and underscore the

importance of environmental management for BRI investments to BRI green development, which will speed up the thorough alignment of green BRI with the 2030 Agenda for Sustainable Development.

Thus, the Special Policy Study (SPS) of 2021 places its focus on improving relevant entities' environmental management capacities for overseas investments, and puts forward targeted policy recommendations on establishing a green management system for BRI projects by a comprehensive analysis of Chinese and international environmental management policies, methods, practices, and practical experience, with the aim to secure and power green and high-quality development of BRI. Chapter 2 reviews China's environmental management system for overseas projects and the corresponding progress. Chapter 3 first examines the environment management practices of development finance institutions such as the World Bank, and then analyzes the official development assistance (ODA) practices of Japan and South Korea, the second largest economies and most important investors in East Asia, to summarize implications of environmental management in ODA to China's environmental management in overseas projects. Based on the above analysis, Chapter 4 puts forward policy recommendations on promoting the full alignment of green BRI and the 2030 Agenda for Sustainable Development, including 4 key areas for BRI investment and financing to support sustainable development at strategic level, 4 policy suggestions to guide non-governmental entities to carry out environment management from the public governance perspective; and 5 key pillars to enhance full life cycle management of the BRI's overseas projects in practice.

7.2 Environmental Management system for CHINA overseas Investment

Given the involvement of multiple stakeholders in the environmental management of overseas projects, enterprises, governments, financial institutions, professional and technical entities such as third-parties need to collaborate with each other. Among them, enterprises are the subject of decision-making, execution and responsibility in environmental management. Factors such as administrative management, policies and regulations, financial support, as well as professional and technical tools will serve as the guarantees for enterprises to practice full life cycle environmental management, providing indispensable external constraints and fundamental support. Besides, demands and feedbacks from the host countries are of equal importance for the project environmental management. This chapter will focus on China's environmental management legislative framework for overseas investments and the corresponding progress in building such framework.

7.2.1 Environmental Management Policies for China Overseas Investment

Based on the collected materials that are available through public channels, this research has identified 32 policy documents issued by Chinese governments at all levels (Tables 7-1-3), which are applicable to the environmental management of BRI overseas investment. Within the framework outlined by the above policy documents, there is no specific document on the environmental management of BRI overseas investment. However, in such policy areas as foreign trade and economic cooperation, building the Green Silk Road, eco-environmental protection, and green finance, the Chinese government has put forward a series of management requirements, guiding opinions and supporting policies on ecological and environmental protection of “outbound investment”. In particular, in July 2021, MOFCOM and the Ministry of Ecology and Environment (MEE) jointly released the “Green Development Guidelines for Overseas Investment and Cooperation”, which clearly encourages Chinese enterprises to conduct “eco-environmental management” and “eco-environmental risk prevention” in overseas investment, and comply with international requirements, including the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the 2030 Sustainable Development Goals (SDGs), Green Investment Principles for BRI (GIP), etc.

Table 7-1 Policies related to Environmental Management in BRI Investment – State Council Level

Year of Issuance	Level of Effectiveness File Name	Formulating and Publishing Units	Key Content
2017	Administrative regulations: Regulations on the Administration of Foreign Contracted Projects (Revised) (Order No.676 of the State Council of the People’s Republic of China)	the State Council	Abide by the laws of the host country/region, abide by the contract, respect local customs and tradition, and pay attention to ecological and environmental protection
2017	Normative document of the State Council: Notice on Guiding Opinions on Further Guiding and Regulating the Direction of Overseas Investment (Guo Ban Fa [2017] No.74)	NDRC/MOFCOM/PBOC/MFA (forwarded by the General Office of the State Council)	Restrict implementation of overseas investment projects that do not meet the environmental protection, energy consumption and safety standards of the host country
2016	Normative document of the State Council: Notice on Printing and Distributing the Thirteenth Five-Year Plan for Ecological Environmental Protection (Guo Fa [2016] No.65)	the State Council	Establish and improve the green investment and green trade management system, and implement the environmental protection guidelines for foreign investment cooperation

Source of information: <http://www.pkulaw.cn/>

Table 7-2 Policies related to Environmental Management in BRI Investment – Ministry Level

Year of Issuance	Level of Effectiveness File Name	Formulating and Publishing Units	Key Content
Policy Area 1-1: Management of Foreign Economic Cooperation			
2021	Departmental Regulations: Green Development Guidelines for Overseas Investment and Cooperation (No. 309 of Shang He Han, 2021)	MOFCOM, MEE	<p>7. Prevention of Ecological Environmental Risks.</p> <p>Encourage enterprises to carry out ecological and environmental risk prevention in accordance with relevant requirements for overseas investment, and improve the enterprises' ecological and environmental management.</p> <p>Encourage enterprises to follow the host countries' rules and standards and take reasonable and necessary measures to reduce or mitigate potential adverse environmental impacts caused by the investment.</p> <p>For the adverse impact on biodiversity, conservation and restoration measures shall be taken according to the international practice.</p> <p>8. Following International Green Rules.</p> <p>Encourage enterprises to comply with international requirements, including the United Nations Framework Convention on Climate Change (UNFCCC), the Convention on Biological Diversity (CBD), the 2030 Sustainable Development Goals (SDGs), and Green Investment Principles for BRI (GIP).</p>
2019	Departmental normative documents: Guiding Opinions on Promoting the High-Quality Development of Foreign Contracted Projects (Shang He Fa [2019] No.273)	MOFCOM/MFA/NDRC, etc	<p>Basic principles: Guide enterprises to adhere to the concept of green, open and clean development, and pay attention to ecological and environmental protection; Implement high-quality and sustainable infrastructure projects; Guide enterprises to establish correct values of justice and interests and earnestly fulfill their social responsibilities; Build a comprehensive risk prevention and control system to actively prevent and resolve various risks;</p> <p>Specific opinions:</p> <p>According to the internationally accepted rules and standards, the concept of sustainable development is integrated into the project selection, implementation and management of foreign contracted projects;</p> <p>Guide enterprises to strengthen communication and common interests with the government, enterprises and people in the project host country, pay attention to environmental protection and fulfill social responsibilities;</p> <p>Effectively regulate the operation of foreign contracted projects to strictly abide by the laws and regulations of China, those of the host countries, and relevant international rules and standards in key links such as environmental protection;</p> <p>Promote the development of credit system for foreign economic cooperation, and improve the provisions on the identification and information recording of dishonesty in foreign contracted projects;</p>

Year of Issuance	Level of Effectiveness File Name	Formulating and Publishing Units	Key Content
2017	Departmental regulations: Measures for the Administration of Overseas Investment of Enterprises (Order No.11 of NDRC)	NDRC	Encourage investors to protect the legitimate rights and interests of employees, respect local public order and good customs, fulfill necessary social responsibilities, and pay attention to ecological and environmental protection
2017	Departmental regulations: Measures for the Supervision and Administration of Overseas Investment by Central Enterprises (Order No.35 of SASAC of the State Council)	SASAC	Establish correct values of justice and benefit, adhere to the principle of mutual benefit and win-win cooperation, strengthen the development of public relations, and actively fulfill social responsibilities; Abide by laws and be compliant, comply with laws and regulations, business rules and cultural customs of China and the host countries (regions);
2017	Departmental normative documents: Notice on Issuing the Code of Conduct for Overseas Investment and Management of Private Enterprises (F.G.W.Z [2017] No.2050)	NDRC/MOFCOM/PBOC/MFA/NFIC	Overseas investment by private enterprises should pay attention to resource and environmental protection, including protecting resources and environment, carrying out environmental impact assessment, applying for environmental protection permit, formulating emergency plans for environmental accidents, carrying out cleaner production and paying attention to ecological restoration.
2014	Departmental regulations: Measures for the Administration of Overseas Investment (Order No.3 of the MOFCOM of the People's Republic of China, 2014)	MOFCOM	Overseas enterprises invested by them should be required to abide by the laws and regulations of investment recipient localities, respect local customs and habits, fulfill their social responsibilities, and perform duties well in environmental protection, labor protection, and corporate culture development;
2013	Departmental normative document: Guidelines for Environmental Protection in Foreign Investment and Cooperation (S.H.H [2013] No.74)	MOFCOM/Former MEP	Guide Chinese enterprises to further behave themselves in environmental protection in foreign investment cooperation; Guide enterprises to actively fulfill their social responsibility for environmental protection; Promote the sustainable development of foreign investment cooperation;
2013	Departmental normative documents: Notice on Printing and Distributing the Provisions on Regulating Competition Behavior in Foreign Investment Cooperation Field (S.H.F [2013] No.88)	MOFCOM	It shall abide by the laws and regulations of the country (region) where the project is located, respect local customs and habits, attach importance to environmental protection and fulfill necessary social responsibilities. Foreign investment cooperative business activities that constitute unfair competition in violation of regulations will be recorded, and enterprises involved shall not enjoy relevant state support policies within 3 years.

Year of Issuance	Level of Effectiveness File Name	Formulating and Publishing Units	Key Content
2008	Departmental normative document: Notice on Further Regulating Foreign Investment Cooperation of Chinese Enterprises (S.H.F [2008] No.222)	MOFCOM/MFA/SASAC	It is necessary to enhance the consciousness of “understanding the law, abiding by the law, and operating in good faith”. ... in-depth study and abide by the laws and regulations of the host countries, especially the regulations on environmental protection, labor and employment, entry and exit management, safe production, bidding and other aspects; To deal with or punish enterprises that violate laws and regulations and cause serious consequences.
2012	Inner-Party regulations: Notice on Printing and Distributing Several Opinions on the Development of Overseas Enterprise Culture in China (S.Z.F [2012] No.104)	MOFCOM/SCIO/MFA/NDR C/SASAC	Incorporate “fulfilling social responsibilities ... performing well in environmental protection, paying attention to resource conservation, and minimizing the environmental pollution and damage caused by the production and operation activities of enterprises” into corporate culture development for Chinese enterprises operating outside China
Policy Area 1-2: Information Filing and Credit System Development of Foreign Economic Cooperation			
2018	Departmental normative documents: Notice on Printing and Distributing the Interim Measures for Foreign Investment Filing (Approval) Report (S.H.F [2018] No.24)	MOFCOM/PBOC/SASAC, etc.	Investors are required to regularly submit information on key links of foreign investment according to the principle of “all filing (approval) must be reported”; Including that main problems exist in foreign investment, compliance with local laws and regulations, protection of resources and environment, protection of employees’ legitimate rights and interests, fulfillment of social responsibilities, implementation of safety protection system, etc.
2017	Departmental working document: Guiding Opinions on Strengthening the Construction of Credit System in the Field of Foreign Economic Cooperation (F.G.W.Z. [2017] No.1893)	NDRC/PBOC/MOFCOM, etc	In case of violation of domestic and cooperative countries and regions’ relevant laws and regulations, international conventions and United Nations resolutions, relevant competent departments shall record the subject, responsible person and behavior of dishonesty in credit records.
2013	Departmental normative documents: Notice on Printing and Distributing the Trial Measures for Bad Credit Records in Foreign Investment Cooperation and Foreign Trade (Shang Hefa [2013] No.248)	MOFCOM/MFA/MPS	Foreign investment behaviors that damage the local ecological environment and threaten local public safety are included in the “bad credit record of foreign investment cooperation”

Year of Issuance	Level of Effectiveness File Name	Formulating and Publishing Units	Key Content
Policy Area 2: Green Finance			
2020	Departmental normative document: Guiding Opinions on Promoting Investment and Financing in Response to Climate Change (H.Q.H. [2020] No.57)	MEE/NDRC/PBOC/CBIRC/CSRC	Encourage financial institutions to support the low-carbon development of BRI and “South-South Cooperation”, and promote climate mitigation and adaptation projects to land overseas. Regulate the overseas investment and financing activities of financial institutions and enterprises, assist them to actively fulfill their social responsibilities, and effectively prevent and resolve climate risks.
2016	Departmental normative documents: Guiding Opinions on Building a Green Finance System (Y.F. [2016] No.228)	PBOC/MOFCOM/NDRC/Former MEP, etc.	Guide financial institutions to support and promote the construction of ecological civilization and improve the green level of foreign investment
2012	Departmental normative documents: Notice on Printing and Distributing Guidelines for Green Credit (Y.J.F [2012] No.4)	Former CBRC	Financial institutions should strengthen environmental and social risk management of overseas projects
Policy Area 3: Development of Green Silk Road			
2017	Departmental working document: Guiding Opinions on Promoting the Development of a Green Belt and Road Initiative (H.G.J [2017] No.58)	Former MEP/MFA/NDRC/MOFCO	Integrate the principles of resource conservation and environmental friendliness; Encourage enterprises to comply with international rules and the laws, regulations, policies and standards of the host countries pertinent to ecological and environmental protection; Strengthen the environmental management of overseas investment;
2017	Departmental working document: Notice on Printing and Distributing the Belt and Road Ecological Environmental Protection Cooperation Plan (H.G.J [2017] No.65)	Former MEP	Comply with laws and regulations and promote the greening of international capacity cooperation and infrastructure construction; Guide and facilitate green investment decisions. Strengthen environmental risk management, improve the level of environmental information disclosure, use green financing tools such as green bonds to raise funds, and establish and use environmental pollution compulsory liability insurance and other tools to carry out environmental risk management in high-risk areas.
2015	Departmental working paper: Vision and Actions on Jointly Building the Silk Road Economic Belt and the 21st Century Maritime Silk Road	NDRC/MFA/MOFCOM (Issuance authorized by the State Council)	Highlight the concept of ecological civilization in investment and trade, strengthen cooperation in ecological environment, biodiversity and climate change, and jointly build the Green Silk Road. Encourage enterprises to operate according to the principle of localization ... Take the initiative to assume social responsibility and strictly protect biodiversity and ecological environment.

Source of information: <http://www.pkulaw.cn/>

Table 7-3 Policies related to Environmental Management in BRI Investment – -Local Government Level

Year of Issuance	File Name	Key Content
2018	Local normative documents: Notice of Shandong Provincial Development and Reform Commission on Printing and Distributing the Measures for the Administration of Overseas Investment of Enterprises in Shandong Province	<p>The investment subject shall require its invested overseas enterprises:</p> <ul style="list-style-type: none"> To comply with laws and regulations of investment recipient localities; To actively carry out the development of enterprise culture; To respect local customs and habits; To fulfill social responsibilities; To behave well in environmental and labor protection; To innovate overseas investment methods; To adhere to the principle of good faith management; To avoid unfair competition behavior; To promote communication with local communities.
2018	Local normative documents: Notice of Beijing Development and Reform Commission on Printing and Distributing the Measures for the Administration of Overseas Investment of Enterprises in Beijing	
2018	Local normative documents: Notice of Jiangxi Provincial Development and Reform Commission on Printing and Distributing the Measures for the Administration of Overseas Investment of Enterprises in Jiangxi Province	
2018	Local normative documents: Notice of Chongqing Municipal People's Government on Printing and Distributing the Measures for the Administration of Overseas Investment of Enterprises in Chongqing	
2018	Local normative documents: Notice of Sichuan Provincial Department of Commerce on Printing and Distributing the Detailed Rules for the Implementation of Administrative Measures for Overseas Investment in Sichuan Province	
2015	Local normative documents: Detailed Rules for the Implementation of Overseas Investment Management by Guangdong Provincial Department of Commerce	
2015	Local normative documents: Notice of Qingdao Municipal Bureau of Commerce on Printing and Distributing the Administrative Measures for Overseas Investment of Qingdao Municipal Bureau of Commerce	
2015	Local normative documents: Notice of the General Office of Tianjin Municipal People's Government on Forwarding the Measures for the Administration of Overseas Investment in China (Tianjin) Pilot Free Trade Zone drafted by the Municipal Commission of Commerce	
2015	Local normative documents: Notice of Hunan Provincial Department of Commerce on Printing and Distributing the Detailed Rules of Hunan Province's Measures for the Administration of Overseas Investment	
2014	Local normative documents: Notice of Gansu Provincial Department of Commerce on Doing a Good Job in Overseas Investment Management	

Source of information: <http://www.pkulaw.cn/>

7.2.2 Features of Environmental Management Legislative Framework for China Oversea Investment

7.2.2.1 Policy Coverage Areas

The above policies cover three main areas: foreign economic cooperation (overseas investment and foreign contracted projects) management, green finance, and Green Silk Road development. These areas can be further divided into the following sub-categories: (1) Specific items related to investment philosophy, behavior, risk management, direction, project selection, compliance rules of foreign investment subjects, foreign investment credit system development and punishment for dishonesty. (2) Specific items related to financial institutions' capital investment flow, investment green level, investment project environmental and social risk management. (3) Specific items related to general principles, production capacity distribution and the green behavior guidelines for enterprises in the building of Green Silk Road, as well as the environmental management and eco-environmental risk prevention for overseas investment. However, there is still no policy document especially designed as guidance and basis for the environmental management of the BRI overseas investment.

7.2.2.2 Policy Content

According to specific contents, existing policy portfolio mainly regulates and guides enterprises' environmental protection behavior in overseas investment (including the BRI overseas investment) from three aspects. First, it encourages enterprises to establish environmental protection concepts, to fulfill social responsibility for environmental protection, to respect religious beliefs and customs of the host country, to protect the legitimate rights and interests of workers, and to achieve "win-win" situation between their own profits and environmental protection. Second, enterprises are required to abide by the environmental protection laws and regulations of the host country, and investment cooperation projects are required to obtain environmental permission from local government according to law, and to fulfill legal obligations for environmental protection such as environmental impact assessment (EIA), emission compliance, and environmental emergency management. Third, enterprises are encouraged to follow international standards, and refer to environmental protection principles, standards and practices adopted by international organizations and multilateral financial institutions.

In 2015, China's National Development and Reform Commission, Ministry of Foreign Affairs and Ministry of Commerce jointly issued the first government white paper on the BRI, which is also a planning document on the BRI, *Vision and Actions on Jointly Building Silk Road Economic Belt and 21st-Century Maritime Silk Road*, for the first time setting clear environmental management requirements for the BRI overseas investment. It puts forward the concrete requirements of "highlighting the

concept of ecological civilization in investment and trade, strengthening cooperation on ecological environment, biodiversity and climate change, and building a green Silk Road together”, and encourages enterprises to take the initiative to assume social responsibility and strictly protect biodiversity and ecological environment.

7.2.2.3 The Level of Policy Effectiveness

According to the principle that “the level of effectiveness depends on the level of formulation subject” embodied in the *Legislative Law* of China, to analyze the effectiveness stages of the above policies, it is necessary to divide them into four categories from the perspective of the level of formulation subject: (1) Policy documents formulated or issued by the State Council (3 pieces): 1 piece of administrative regulation and 2 pieces of normative documents; (2) Policy documents formulated or issued by various ministries and commissions of the State Council (18 pieces): 3 pieces of departmental regulations, 10 pieces of departmental normative documents, and 4 pieces of departmental working documents; (3) Policy documents formulated and issued by local governments (10 pieces): 10 pieces of normative documents of local governments in Beijing, Tianjin, Shandong, Hunan, Sichuan, Chongqing, Jiangxi, Gansu and Guangdong; (4) Inner-party documents: 1 piece of inner-party regulation.

The ministries and commissions of the State Council are the main bodies of policy making under the current policy framework, among which the Ministry of Commerce in charge of foreign trade and investment leads the most intensive issuance (leading issuance of 9 pieces of documents). Since 2013, competent department of ecological environment has participated in the policy formulation in this field, and jointly issued the “Guidelines for Environmental Protection in Foreign Investment and Cooperation” and the “Green Development Guidelines for Overseas Investment and Cooperation” with the Ministry of Commerce, which is of symbolic significance for environmental management of China’s foreign investment. Subsequently, in the field of building a green Silk Road, it took the lead in formulating and issuing special documents such as “Guiding Opinions on Promoting the Development of a Green Belt and Road Initiative” and “Notice on Printing and Distributing the Belt and Road Environmental Protection Cooperation Plan”.

7.2.2.4 The Effectiveness of Policy Constraints

According to the binding effect of the policy content, among the above 32 documents: (1) 17 policy documents put forward specific requirements that investors should comply with laws and regulations, abide by the laws and regulations of China and the investment recipient localities, fulfill their social responsibilities, strengthen the development of public relations with all sectors of society in the country (region) where they invest, and restrict the development of overseas investment projects that do not meet the environmental protection standards of the host country, which need to be implemented, followed or referred to by investors, with corresponding

punishment mechanisms. (2) The other 15 documents encourage investors to abide by the laws and regulations of investment recipient localities, respect local customs and habits, do a good job in environmental protection, and fulfill social responsibilities. However, there is no mandatory requirement on the behavior of investors, and the policy binding force is weak.

7.2.3 Summary

The BRI overseas investment is an important part of China's foreign investment. Therefore, the environmental management of BRI overseas investment should be conducted under the existing administrative system and policy framework. The Chinese government has long been attaching great importance to the protection of ecological environment in the process of carrying out outbound investment, requiring investors to act in accordance with the laws and regulations of the recipient countries, fulfill corporate social responsibilities, and protect the environment as well as the workers. The existing foreign investment management policies are "green" in essence.

To enhance the regulation and guidance of the environmental management of BRI overseas investment, governments at all levels in China have issued 32 policy documents concerning this topic, incorporating the concept and specific requirements of green and sustainable development from the perspectives of foreign investment, green finance, and building a green Silk Road. These policies provide clear policy regulation, initiative, and guidance for overseas investors to fulfill their main responsibility of environmental management, to abide by the laws and regulations of China and host countries and to fulfill their social responsibilities.

However, with the continuous growth of BRI overseas investment, the increase in the number of host countries of the BRI overseas construction projects, and further aggravation of the impact of climate crisis on the BRI participating countries, the goal of building the BRI with high quality puts forward higher requirements for the environmental management of relevant projects. Meanwhile, since 2017, the concept and market of green finance have risen rapidly. As a feedback mechanism to force investors to pay attention to environmental impact and optimize investment decisions by adjusting capital supply, the effective and efficient operation of green financial system needs to be based on massive high-quality environmental information, and needs to promote the implementation of environmental management procedures including environmental risk assessment and environmental benefit assessment, and further improve the refined environmental management by investors.

Considering the two aspects mentioned above, the existing policies are facing with realistic challenges of relatively low legal hierarchy, weak binding force, and regulatory requirements that are not specific enough for practical implementation.

Thus, stronger policy guidance and administration measures are needed to support the existing practice.

7.3. Experiences of Environmental management in International DFI and ODA

7.3.1 International DFI Experiences for ESRM

Two reinforcing trends have dominated the development of environmental management practices among international development finance institutions (DFIs) in the last decade: internally, they have developed more robust and comprehensive oversight mechanisms, and externally, they have given greater emphasis on understanding and supporting the country systems of borrowers. While these two trends may appear to indicate movement in opposite directions, they are complementary in practice. As banks have come to better understand the environmental and reputational risks intrinsic to international development finance, they have bolstered their own project screening and oversight processes, while simultaneously working to better understand and support borrowers' own capacities to manage project portfolios.

7.3.1.1 Choice of DFIs Examined Here

This chapter attempts to examine in depth a representative sample of 8 DFIs from more than 450 DFIs that exist globally, which together manage over USD 11 trillion in assets. The DFIs studied here include as wide as possible of an array of these institutions that work internationally, with levels of activity that can be considered comparable to China's.

Firstly, they represent the three most common geographic scopes: (i) the World Bank (WB) and International Finance Corporation (IFC) are global; (ii) the Asian Development Bank (ADB), Asian Infrastructure Investment Bank (AIIB), and Development Bank of Latin America (CAF) are regional; and (iii) the Development Bank of Southern Africa (DBSA), Japan International Cooperation Agency (JICA), and Japan Bank for International Cooperation (JBIC) are bilateral in nature. Furthermore, the Multilateral Development Banks (MDBs) chosen for this study consist of MDBs with significant participation of high-income countries, including the WB, IFC, and ADB, as well as regional south-south partnership organizations, such as the AIIB and CAF. The three bilateral institutions also represent three different types of relationships: the DBSA extends South African development finance to countries within its region^①; JICA is Japan's development bank that operates overseas; and JBIC is its export credit agency (ECA).

^① It is worth mentioning that, while the Development Bank of Southern Africa lends regionally, it is owned and managed by South Africa.

Overall, DFI internal practices have become more comprehensive, incorporating a broader range of environmental concerns and incorporating them more fully into their project evaluation and oversight. As Tables 3.3 shows, the DFIs such as WB, IFC, DBSA and AIIB share a commonality of recent revisions and reforms in their environmental screening practices. The frameworks without recent revisions – at the ADB and JICA – are also the most rudimentary. Greenhouse gas emissions are evaluated in project screening by all DFIs examined here except JICA, and ecosystem services are incorporated in policy, operations, or both, by all DFIs except the ADB. This trend reflects a growing recognition of the importance of several aspects of environmental risks.

On the borrower side, DFIs have incorporated the understanding that international finance necessitates a shared oversight between lender and borrower. While lenders can protect themselves from unnecessary environmental and reputational risk through internal risk management systems, to be effective, they must also recognize and encourage the management efforts of borrowing countries. This borrower engagement begins long before projects are proposed. Each of the DFIs studied here is also active in “upstream” project strategy and preparation, assisting borrowers in developing their priorities into specific finance proposals. During project implementation, these DFIs also engage carefully with the environmental management systems of borrowing countries.

This approach often requires lenders to understand those local systems well, to know when it is appropriate to rely on them. For example, although the ADB has the oldest environmental management framework studied here, it has simultaneously developed a thorough process of not only evaluating borrower country systems for the purpose of using them where possible, but also evaluating and collaborating on strengthening borrower institutional capacity for enforcing local management policies. In addition, the World Bank, ADB, and DBSA all have provisions for evaluating country systems and using them where possible in project screening. During implementation, nearly all DFIs studied here assist with borrower transparency, facilitating the publication of borrower-produced project documentation. Finally, all but JICA and JBIC rely on third-party monitors.

In sum, the trend over the last few decades shows that DFIs have grown in their understanding that building their own environmental management systems and recognizing those of borrowing countries are complementary goals. As many scholars have noted, lenders have come to recognize that environmental management is most effective when approached as a partnership that recognizes borrower priorities, gives policy space to local authorities to carry out their own policies where possible, and strengthens local institutions so that they can better carry out their own missions alongside lenders.

Finally, as Table 7-4 shows, this selection includes DFIs that primarily lend to

sovereign governments, those that primarily lend to private-sector commercial borrowers, and one that works amply in both arenas.

Table 7-4DFIs Studied Here and their Scope

		Lending Focus (Clients)		
		Sovereign	Both	Non-Sovereign
Scope	Global	WB		IFC
	Regional	AIIB, ADB	CAF	
	Bilateral	DBSA, JICA		JBIC

Box 7-1 DFIs' Motivation for Independent Environmental Management Systems

Borrower governments face a host of conflicts of interest between project facilitation and regulation, which can leave potentially important gaps. An Inter-American Development Bank study of 200 infrastructure-related social conflicts over 40 years in Latin America found that in 86% of conflicts, national governments exacerbated the problems by underestimating risks or not sufficiently planning to mitigate those risks (Watkins et al, 2017). Unruh et al (2019) find that in East Africa, while international DFIs or donors often mandate common practices such as ESIA and resettlement plans, government capacity and political will to effectively oversee and carry out the necessary ESRM steps vary widely among host countries. Warford (2004), studying infrastructure development in East Asia and the Pacific, finds that these inconsistencies can often be linked to a lack of integration between short-term, project-specific governance measures (such as ESIA) and longer-term government goals for overall growth and development. When tensions arise between the two, it creates conflicts of interests for policy makers, which can result in a lack of follow-through on governance commitments made to international lenders or investors.

While Warford (2004) studied Asia specifically, other authors find that these phenomena are common to developing countries worldwide. For example, Ebeke and Ölçer (2017) find that low-income countries' election cycles influence their governments' appetites for spending, particularly for highly-visible infrastructure projects. Such spending peaks before elections and declines thereafter, once policy-makers are no longer under pressure to produce immediate tangible results for their constituents. Furthermore, as Ray, Gallagher, and Sanborn (2020) find in a series of infrastructure case studies in South America, these political considerations frequently result in governments' declaring of particularly visible projects as "strategic," thereby exempting them from comprehensive environmental and social risk management in order to expedite them, often resulting in highly-visible project-related failures, delays, and/or conflicts. Finally, Ballón et al (2017),

also studying Latin America, find that all of the above factors are further complicated by global commodity super-cycles. When global prices fall after a commodity boom, developing countries that depend on commodity exports for foreign exchange tend to relax the regulatory framework for new inbound international investment, in the hopes of attracting fresh infusions of hard currency. Ultimately, as Ray et al (2017) find, these lapses can leave foreign investors and lenders committed to projects that have received insufficient planning and oversight from their local governments, opening the door for reputational damage for the international partner, environmental damage to local ecosystems, and social conflict in the surrounding communities.

For all of the reasons listed above, DFIs have established corporate practices to shield their portfolios from these conflicts of interest. Such protections need not interfere in borrowers’ domestic policy, but simply protect DFIs from participation in projects that will become ensnared in technical, environmental, or social complications.

7.3.1.2 Upstream Engagement of DFIs

Before projects are proposed, each of these DFIs collaborates with borrowers to create sectoral and regional strategies and generate project proposals that are both financially and environmentally sustainable. They do so through three main avenues: strategic, technical, and financial. First, strategic cooperation produces long-term plans for project development. This can take place through cross-sector country development strategies, more specific plans for selected sectors or themes such as transportation or green energy transitions, or at the regional level through the creation of transnational, harmonized networks of projects. Second, technical cooperation shares the DFI’s knowledge base with borrowers, to assist in turning ideas into specific projects. Finally, they offer financial assistance, through grants or concessional financing, for the generation of the studies necessary to present a proposal for DFI support.

Table 7-5 DFI Upstream Engagement

	Global		Regional			Bilateral		
	WB	IFC	ADB	AIIB	CAF	DBSA	JICA	JBIC
Strategic project identification support								
Country level	B	P	B	X	X	X	P	X
Sector level	B	B	B	B	B	B	P	P
Thematic level	B	B	B	N	B	B	X	X
Regional level	B	X	B	P	P	X	X	X
Technical project preparation support								
Direct support by staff	B	P	B	B	B	B	B	P

	Global		Regional			Bilateral		
	WB	IFC	ADB	AIIB	CAF	DBSA	JICA	JBIC
Indirect support through third parties	B	B	B	B	B	B	B	X
Financial project preparation support								
Grant support, general	B	X	B	B	B	B	B	X
Grant support, thematic	B	B	B	X	X	B	X	X
Grant support, company-specific	X	B	B	X	X	X	X	X
Facility, general	B	X	B	B	B	B	X	X
Facility, thematic	B	B	B	X	X	B	X	X
Facility, company-specific	X	B	X	X	X	X	X	X

Legend:

B **Broad** availability and use of this type of assistance

P **Partial** availability in certain sectors or themes, such as public transit, infrastructure or regional integration

X **Not available** to any significant extent

Source: Adapted from Rahill (2021).

A few examples merit particular mentions. The ADB is active in all of strategic engagement approaches discussed here. Its Country Partnership Strategies lay out general directions for given borrowers, while its Energy Sector Strategy and Climate Strategy do so on the sector and thematic bases. Regionally, its Central Asia Regional Economic Cooperation Transport Strategy envisions linked networks across regional partners. A recent ADB internal evaluation found that this type of upstream engagement is an important driver of new project development.^① The AIIB, the newest of the DFIs profiled here, has developed and adopted a “Sustainable Energy for Asia” strategic approach to collaborative planning for interconnected, green energy networks.

Collaboration on project development can take technical or financial approaches. For example, the DBSA offers infrastructure planning solutions for municipalities, to assist lower-capacity local governments with project identification support. On the financial side, CAF’s Public Transport Improvement Program and Regional Logistics Development Program offer pre-investment financial support for developing new projects in specific sectors. JBIC takes a broader, trans-sectoral approach, with its Global Facility to Promote Quality Infrastructure Investment for Environmental Preservation and Sustainable Growth.

7.3.1.3 Project Screening

Table 7-6 explores DFIs approach to 13 common environmental aspects of

^① ADB. 2020. Sector-wide Evaluation: ADB Energy Policy and Program, 2009–2019.

proposed project. As the table shows, DFIs have significant agreement on covering pollution-based concerns in their operations, often with reference in high-level policy to reinforce the primacy of these considerations. Notably, most DFIs’ approach climate change mitigation in this category, through technical requirements akin to those covering pest management or hazardous materials. The only DFI without an institutional application of pollution concerns is JICA, which does not address resource efficiency or greenhouse gas emissions, either in policy or operations.

It is also noteworthy that CAF and DBSA – two purely south-south DFIs– have widespread operational incorporation of all but one of the concerns here. This finding reinforces the compatibility between developing country interests and mainstreaming environmental concerns in project evaluation.

Table 7-6 Environmental Project Evaluation Criteria

	Global		Regional			Bilateral		
	WB 2016	IFC 2012	ADB 2009	AiIB 2019	CAF 2015	DBSA 2020	JICA 2010	JBIC 2015
Pollution: mitigation hierarchy: prevention, management, control, abatement	PO	PO	PO	PO	PO	PO	O	O
Resource efficiency (particularly energy and water)	PO	PO	O	O	O	PO	X	O
Wastes, including hazardous materials	O	O	O	O	O	O	O	O
Pest management	O	O	O	O	O	O	O	O
Greenhouse gas emissions as a pollutant	O	O	O	O	O	O	X	O
Biodiversity, habitats, and forests	PO	PO	PO	PO	PO	PO	PO	PO
Living natural resources: provision for crops, livestock, fisheries	O	O	P	X	PO	O	O	O
Invasive alien species	O	O	O	O	O	O	O	O
Ecosystems and ecosystem services	P	O	X	O	O	O	P	O
Specific provisions for biodiversity offsets (beyond mitigation hierarchy)	O	O	X	P	O	O	X	O
Provisions for no net loss (biodiversity and/or habitat)	O	O	P	X	O	O	O	O
Provisions for net gain (loss of critical habitat)	O	O	X	X	O	O	X	O
Supply chains (crops, livestock, and deforestation)	O	O	X	X	X	O	X	O

	Global		Regional			Bilateral		
	WB 2016	IFC 2012	ADB 2009	AIIB 2019	CAF 2015	DBSA 2020	JICA 2010	JBIC 2015
Advisory services and/or technical assistance	X	X				X	X	
Co-financing arrangements / common approach	X		X	X	X			
Emergency lending	X		X	X			X	
Projects to be defined during implementation (framework agreements, facilities, etc)	X		X	X		X		
Financial products other than loans and grants (equity, guarantees, etc)	X	X						

Source: Adapted from Rahill (2021). Note: X indicates the use of a given process or procedure.

Another very commonly used institutional mechanism to screen out the highest-risk projects is the use of exclusion lists or divestment commitments. Almost all DFIs studied here have either a formal or informal commitment to refrain from supporting certain activities with particularly high environmental or social risks. Other, more informal divestment pledges have begun to appear, in which DFIs agree to align their lending activities with climate change mitigation goals, often by eliminating coal finance from their portfolios. For example, the World Bank does not have a formal exclusion list but eliminated nearly all financing for coal. Japan has tightened its lending rules on coal, but to such a minor extent (only extending coal financing to countries that have instituted decarbonization plans) that it does not merit inclusion here as an exclusion list.

It is also noteworthy that lender-based safeguards are not wholly incompatible with reliance on country systems. Indeed, several of the largest DFIs studied here (AIIB, ADB, and the World Bank) rely on them under specific conditions, depending on the strength of those local standards.

Box 7-2 Coal: A Special Case in Lending Exclusion

Exclusion lists are an important tool for DFI risk management, and perhaps no sector has garnered as much international attention in this regard as coal (see for example Himberg, Xu, and Gallagher 2020; Nakhoda 2011; Steffen and Schmidt 2019). DFIs have increasingly distanced themselves from coal finance, with some instituting formal commitments in this regard. Notably, this has included Japan, the top source of coal finance for newly operating plants in recent years (GEM 2021). Since 2013, no global or regional DFI studied here has directly financed coal projects, and some are actively embracing their role in supporting green energy transitions (see for example CAF 2020; Gombar 2021; World Bank 2020).

In 2013 the World Bank ushered in a new era by limiting its support for coal to “rare circumstances” (World Bank 2013). It has not directly financed any coal-fired power plants in the last decade (World Bank 2013, World Bank 2020). It has also begun to proactively support countries with long histories of coal development in their strategies for a “just transition” (shifting away from coal without harming coal-dependent communities and livelihoods) through programs such as the Platform Initiative in Support of Coal Regions in Transition (World Bank 2019).

The IFC has also not explicitly banned all coal support, but has enacted a “30 by 30” policy to increase climate-related lending to 30% of its portfolio and reduce coal support to zero or near-zero by 2030 (IFC 2020). It has also enacted restrictions on the use of its investments in financial intermediary institutions: they must “ringfence” IFC support to ensure that it does not support coal activities.

The ADB is the only one of the regional DFIs studied here to adopt a formal policy against coal-related finance (ADB 2021), though none of these regional DFIs have actively supported coal plants since 2013. Finally, while CAF does not have a formal prohibition on coal projects, recent annual reports show no record of coal finance in the last 20 years (CAF 2020).

The bilateral institutions show a variety of approaches. In March 2021, JBIC became the first of these to announce it would no longer accept applications for coal projects, although its peer JICA has not yet made any such a commitment, and is currently supporting the Matarbari coal-fired power plant in Bangladesh (JICA 2019, Proctor 2021). The DBSA recognizes the historically important role that coal has played in Southern Africa but makes no reference in recent annual reports to coal support, and has instead begun new initiatives to support just transitions. In fact, it has financed more regional renewable energy projects (33) than any other DFI (DBSA 2021; Muñoz Cabré et al 2020).

7.3.1.4 Implementation and Monitoring

Once a proposal has been approved, international DFIs continue to provide oversight and support, through monitoring, assistance in information disclosure, and independent accountability mechanisms to resolve problems that may arise in the course of project construction and operations. Where borrowing countries find themselves with unsustainable debt burdens, international DFIs have also participated in sustainability-enhancing debt renegotiations, including debt swaps for conservation or climate change mitigation or adaptation projects. Newly emerging instruments such as nature-linked bonds have open even more avenues for environmental management in development finance for the future.

Table 7-8 shows a wide variety of institutional mechanisms for oversight of projects already approved. As above, JBIC, JICA, and CAF have the sparsest coverage, having adopted only two or three of the requirements. The project management mechanisms detailed in Table 7-8 show the variety of approaches to the co-governance of projects with local governments, who oversee the day-to-day

details of project construction and operation. One of the most common approaches is to empower local communities to communicate directly with the DFI in the planning as well as implementation stages. During the planning stages, access to information and stakeholder consultation processes can expose project risks that may not have been immediately clear in feasibility studies and ESAs. Once projects are underway, complaint and grievance mechanisms can expose harm before it becomes a danger to the project itself or surrounding communities.

Table 7-8 DFI E&S Risk Management Processes and Procedures during Implementation

	Global		Regional			Bilateral		
	WB 2016	IFC 2012	ADB 2009	AiIB 2019	CAF 2015	DBSA 2020	JICA 2010	JBIC 2015
Disclosure requirements								
Disclosure of lender-produced documents - ongoing during implementation	X	X		X			X	X
Facilitation of disclosure of borrower-produced documents	X	X	X	X		X	X	
Supervision and monitoring								
Use of independent / third party monitors	X	X	X	X	X	X		
Lender determination of Broad Community Support / FPIC	X	X	X	X		X		
Project completion provisions	X		X	X	X	X		
Special provisions for highest risk / complex operations		X		X		X		
Accountability mechanisms								
Independent accountability mechanism IAM	X	X	X	X		X	X	X

Source: Adapted from Rahill (2021).

Box 7-3 Transparency Plus: Special Considerations with regard to Gender and Ethnicity

In addition to the general requirements described in Tables 3.3 and 3.4, many DFIs have come to recognize the importance of targeted outreach to heavily affected communities and segments of communities. In particular, stakeholders may be affected differently by environmental harm along their ethnic and gender divisions.

As described in detail in the 2020 CCICED Special Policy Study on the Green BRI and 2030 Agenda for Sustainable Development (Zhou, Shi, and Gallagher, 2020), many agricultural communities divide daily tasks by gender, meaning that men and women

interact differently with their natural environments. Women are often tasked with household food production while men are employed for pay, so that women's tasks are more directly impacted by damage to water or soil, for example. That gendered division of labor means that damage to biodiversity often impacts women to a greater extent than men, with a cascading impact on household food security and the community as a whole. However, societies with gendered divisions of labor often also have gendered divisions in community gatherings and discussions, so that women's concerns may not be heard in community-wide meetings. For this reason, many DFIs now recognize the importance of taking gender into account in the transparency requirements shown in Table 3.4. For example, the Convention on Biological Diversity's 2015-2020 Gender Action Plan (CDB 2017) calls for calculating project costs and benefits separately for men and women in stakeholder communities. A 2019 inter-DFI report – with participation from the ADB, AIIB and World Bank, among others – recommends incorporating gender in transparency and accountability mechanisms.

Environmental impacts are also experienced differently across ethnic lines, particularly among indigenous communities. While these communities have tremendous diversity among themselves, two common attributes are the continued use of traditional livelihoods that depend on intact ecosystems (such as hunting, fishing, and gathering) and incomplete property rights (such that the lands and waters that have traditionally supported them may not be legally recognized as theirs). For this reason, many DFIs have enacted special provisions to ensure that their needs are taken into account in project preparation and oversight. All of the global and regional DFIs profiled here have specific policies for incorporating indigenous input in project planning and accountability, minimizing or mitigating environmental harm that impacts them, and compensates them for any unavoidable loss or displacement.

7.3.1.5 Sustainability-enhancing Debt Renegotiation

In cases where borrower debt levels become unsustainable, DFIs have actively participated in sustainability-enhancing debt renegotiation. These may take several forms, but generally include collaboration between borrower and lender to convert existing debt repayment commitments into conservation or climate projects. Crucially, this type of arrangement does not involve imposing conditionality on debt restructuring or forgiveness, but requires debtor nation leadership, usually over a period of years, to plan for the structure and management of the new funds

When implemented well, debt-for-nature swaps can allow chronically indebted countries an alternative to environmentally-damaging activities to pay down debt. They can also create an institutional structure to oversee the establishment of definitions of sustainable economic activities appropriate for the newly protected areas, and the fiscal space to ensure that the new protections are well-managed, with adequate participation from local communities to ensure enforcement. However,

these swaps are not quick fixes for debt crises, nor can they bring a sudden stop to ongoing ecological disasters. Establishing the conservation areas is a process of multiple years. Thus, rather than being used as a last resort or rescue option for disaster scenarios, it is best considered as a long-term, pro-active approach to conservation. In this regard, they are well-suited to the needs of borrowers currently planning sustainable recoveries from the COVID-19 pandemic.

As countries face the challenge of rebuilding from the COVID-19 pandemic amidst debt overhangs, bilateral sustainability-enhancing debt renegotiation is likely to play an important role. In addition to traditional swap mechanisms, new instruments such as nature-linked bonds may be particularly useful in the current context. These instruments link repayment terms to borrowers' progress toward sustainability goals, but the funds are not linked to specific projects. Thus, borrowers may use them to fund immediate humanitarian efforts while their overall sustainability goals also become more affordable. They may be particularly attractive for bilateral creditors, who can easily convert existing debt to such bonds, and may even choose to denominate them in their own currencies. While these new instruments may be particularly well-suited for bilateral creditors, they are drawing attention from multilateral lenders as well. They have received attention from multilateral creditors such as the ADB and the World.

7.3.2 Environmental Management Mechanisms for ODA of Japan and South Korea

China, Japan, and South Korea are the three major economies in East Asia and the signatories to the Regional Comprehensive Economic Partnership (RCEP). Their total GDP accounts for more than one fifth of the global GDP, which enables them to play a significant role in the global economy. Among them, Japan and South Korea used to be the key components of the ancient Silk Road, and now the major participants of global outbound investment activities. In 2019, Japan and South Korea ranked the 1st and the 11th among all countries in terms of foreign investment amount, which became the 3rd and the 10th in 2020.^① Thus, this chapter focuses on Japan and South Korea to review the environmental management mechanisms in their Official Development Assistance (ODA), including the system design, policy making, specific practice, and experience gained, which can serve as useful references for BRI projects to carry out environmental management.

7.3.2.1 Environmental Management in ODA of Japan

7.3.2.1.1 Management Mechanisms

In 1988, Japan became the biggest ODA provider in the world. However, as its ODA recipient countries failed to mitigate damages to the local environment in their

^① Source: World Investment Report, <https://unctad.org/topic/investment/world-investment-report>

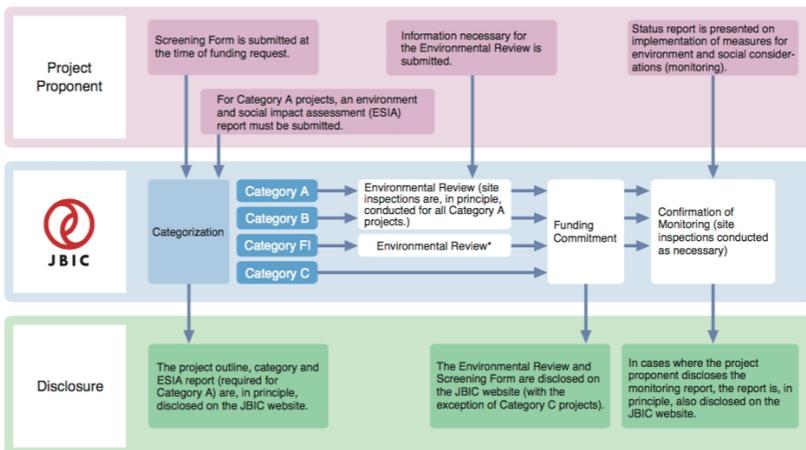
process of development, Japan's ODA received persistent criticism from the world. In response to such criticism, Japan began to explore approaches to providing ODA in a way that assist other countries to develop and at the same time urge them to consider environmental protection. In other words, Japan aimed to extend the original ODA to "green ODA". Thus, the following management mechanisms have been put into place:

Firstly, specialized agencies were set up to formulate guidelines for environmental protection. In 1986, the Japanese Ministry of Environment held a seminar on environmental conservation for ODA projects. In 1988, it established an environmental research institute under JICA. Built on the research results of the institute, environmental guidelines were formulated by JICA and Overseas Economic Cooperation Fund (OECF) and then incorporated into the Outline of Japan's ODA Activity after being approved at the cabinet members meeting in 1992, stipulating that environmental protection and economic development are equally important.

Secondly, environmental and social standards and principles for overseas investments have been developed. In order to reduce the environmental impacts of overseas investment projects, JICA and JBIC formulated environmental guidelines respectively such as Guidelines for Environmental and Social Considerations and JBIC Guidelines for Confirmation of Environmental and Social Considerations, so as to implement the projects according to environmental guidelines with full consideration of their social and environmental impact to the region.

◎ Procedure for Confirmation of Environmental and Social Considerations

Prospective projects are screened prior to funding, and classified into categories according to the degree of potential environmental impact. An Environmental Review is then conducted to verify that the environmental and social impacts have been considered in a proper manner. After funding has been approved, projects are monitored to assess the actual impact.



* For Category FI projects, JBIC confirms through the financial intermediary that the proper environmental and social considerations indicated in the Environment Guidelines have been followed for the project.

Projects are classified into one of the following four categories in relation to the degree of environmental impact, based on the information provided by the project proponent during the screening process.

Category A	Project with the potential for a serious and adverse impact on the environment.
Category B	Project with the potential for an adverse impact on the environment, but less than that of Category A projects.
Category C	Project with the potential for minimal or no adverse impact on the environment.
Category FI	Project for which JBIC provides funding to a financial intermediary, and after acceptance of JBIC funding, the financial intermediary selects and conducts screenings for specific subprojects, in cases where subprojects cannot be determined prior to acceptance of JBIC funding, and where such subprojects are anticipated to have an impact on the environment.

Source: The Role and Function of the Japan Bank for International Cooperation. JBIC. <https://www.jbic.go.jp/ja/>

Figure 7-2 “Procedure for Confirmation of Environmental Considerations” Prior to Funding Decisions in JBIC

Thirdly, multiple agents including the government and non-governmental organizations have been working together to boost environmental protection efforts in ODA. Citizen leagues and civic groups have been monitoring and criticizing environmental issues in ODA practice via media, which forced Ministry of Foreign Affairs to focus on the quality of ODA operations, and especially the formulation of related environmental policies and guidelines.

7.3.2.1.2 Good Practice

Firstly, a clear and green foreign investment strategy has been put in place. Japan has actively bid for the 8th Meeting of Conference of Parties (COP 8) to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and joined the International Environmental Technology Center (IETC) under the United Nations Environment Programme (UNEP). By so doing, Japan has put environmental issues on the government’s agenda and gradually formed a consensus on environment within the government. As a result, green measures for ODA are implemented from top to bottom. From 1986 to 1996, the proportion of ODA directed at environmental issues increased from 4% to 27%.

Secondly, special agencies have been established to formulate and implement environmental guidelines. Japan guides its domestic enterprises to participate in overseas aid and investment projects through JICA and JBIC, and reduces the project impacts on the environment of recipient countries by formulating a series of environmental planning guidelines and application procedures. In the process of implementation, JICA and JBIC are responsible for whole life cycle evaluation and monitoring of these projects. Once the implementation is confirmed to be in violation of environmental regulations, punitive measures will be adopted to rein in or even stop loans.

Thirdly, the Japanese government has accelerated the overseas layout of its green industries in the process of assisting host countries to solve environmental pollution and develop green industries with technical support. Besides enhancing the green level of environmental management for ODA and overseas investment projects,

Japan also makes active use of advanced environmental protection technologies to enhance host countries' capacity to deal with its environmental pollution, and "transfer" green industries to the host countries. On one hand, Japan creates new opportunities for the development of green industries in the host countries, and helps to satisfy local residents' needs for employment and economic development; on the other hand, it assists Japanese enterprises to cooperate with host countries in a more positive way while enhancing its national visibility and soft power, thus promoting domestic economic growth.

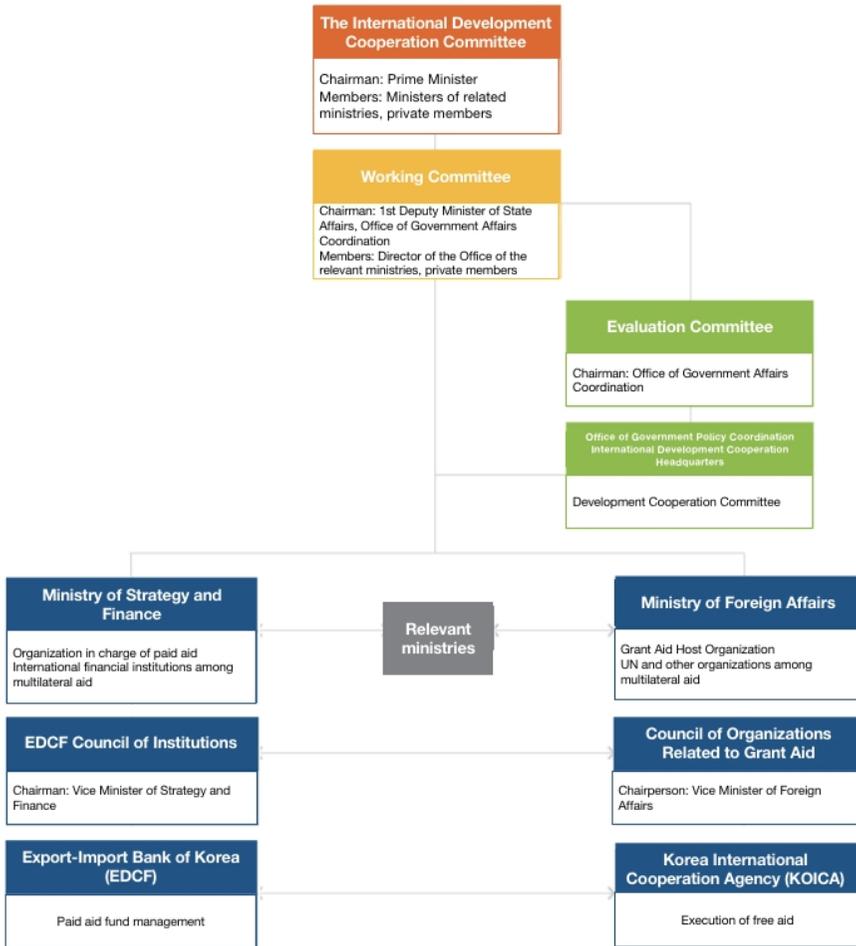
7.3.2.2 Environmental Management in ODA of South Korea

7.3.2.2.1 Management Mechanisms

South Korea's ODA history can be divided into two stages – before and after joining the OECD in 1996. After joining the OECD, especially since its entry into Development Assistance Committee (DAC) of OECD in 2009, South Korea has gradually formed a systematic and well-established ODA system.

In January 2006, South Korea set up the Committee for International Development Cooperation (CIDC) directly under the Prime Minister's jurisdiction in order to strengthen unified management of ODA policy implementation. The Committee has had two parallel organizations, Korea International Cooperation Agency (KOICA) and Economic Development Cooperation Fund (EDCF), chaired by South Korea's Ministry of Foreign Affairs (MOFA) and Ministry of Strategy and Finance (MOSF) respectively. The CIDC, as an institution under the Prime Minister's Office, is chaired by the Prime Minister of South Korea. The responsibilities of the Committee are to deliberate on the plans and reports formulated by MOSF and MOFA for concessional loans and grant aids, and to conduct evaluation.

By establishing KOICA under the Ministry of Foreign Affairs and EDCF under the Ministry of Strategy and Finance, South Korea has built a mature ODA management system which can realize unified management with two sub-organizations each responsible for one sector, thus ensuring both a clear division of labor and a unified strategy. KOICA is mainly responsible for the formulation and implementation of grant aids, covering main areas such as material supplies, emergency relief, development investigation, application for graduate students, overseas volunteer activities, cooperation with international institutions, and implementation of grant aids projects. The organization is also responsible for the formulation of basic plans and annual implementation plans in various fields as well as the evaluation of project implementation. By contrast, EDCF, operated by the Export-Import Bank of Korea, is mainly responsible for the formulation of basic plans of concessional loans and implementation plans of the current year, collection and use of foreign aid funds, as well as direct provision of funds or provision of loans through international financial institutions to recipient countries.



Source: https://www.odakorea.go.kr/ODAPage_2018/category02/L04_S01_01.jsp, 2021.03

Figure 7-3 Organizational Structure of ODA Management in South Korea

7.3.2.2.2 Good Practice

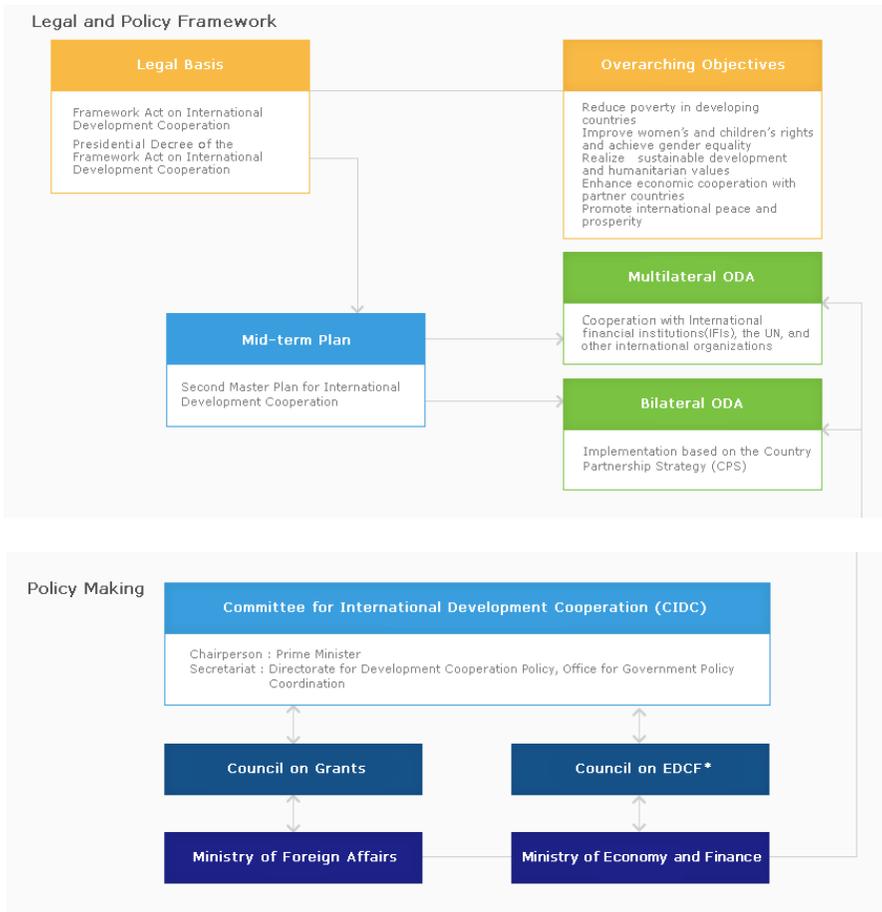
Firstly, a well-structured legal system for overseas investment has been established and due attention been paid to sustainable development. On December 26, 1986, South Korea enacted its first law on foreign investment, *Korea Economic Development Cooperation Fund Act*, which came into force on April 23, 1987. “Sustainable development and humanitarianism” is defined as one of the five major principles in the Act. The Act provides a legal basis for the establishment of EDCF, which stipulates that EDCF is under the jurisdiction of the Ministry of Strategy and Finance, and sets up a fund operation committee to operate and manage the fund. This Act, together with other relevant basic laws related to KOICA promulgated in

1991, constitutes the early regulatory system of South Korea's foreign investment policy. In order to further prioritize foreign investment from institutional level, South Korea promulgated the *Framework Act on International Development Cooperation* in January 2010, which came into effect in the same year. The law has clarified the purpose and definition of development assistance, explained the basic concepts and principles of foreign investment policy, stipulated the mechanism and mode for the implementation of the policy, and ensured the continuity of South Korea's foreign investment policy.

Secondly, a planning and implementation system to achieve UN's sustainable development goals has been finalized. Under relevant laws and regulations, South Korea plans to deploy its overseas investment based on planning. The top-level plan is the five-year *Strategic Plan for International Development Cooperation* (referred to as the Plan) which serves as a strategic document for South Korea's bilateral cooperation (grants and loans) and multilateral cooperation. The Plan points out the basic direction, scale and implementation method of policies on international development cooperation with clear planning for medium-and long-term investment plans for major countries of cooperation. With the promulgation of the Plan, South Korea's foreign investment policy is elevated to the level of national strategy.

At present, the Plan has been updated for three times, with sustainable development, environmental protection, and green development as an integral part. Safe Guards are also specified in the evaluation system of *The Third Strategic Plan for International Development Cooperation (2021-2025)* of South Korea. These Safe Guards regard minimum impact on the environment, society and human rights during the whole life cycle of project implementation as the basic obligation.

Thirdly, a full-cycle and multi-faceted evaluation mechanism is implemented. As an important part of policy implementation, the evaluation mechanism for South Korea's ODA can well serve its role in improving policy preparation, guiding policy implementation, and correcting mistakes in policy implementation. The evaluation mechanism runs through the whole life cycle of investment, including early feasibility study, mid-term evaluation and post assessment. On this basis, South Korea also evaluates the implementation of investment projects based on "self-assessment, assessment by evaluation committees, peer review among OECD countries and third-party assessment by non-governmental organizations". It adopts a set of evaluation standards that derive from OECD's evaluation standards with major principles including moderation, efficiency, effectiveness, impact, and sustainability.



Source https://www.odakorea.go.kr/ODAPage_2018/category02/L04_S01_01.jsp, 2021.03

Figure 7-4 Implementation System for ODA Management in South Korea

7.3.3 Summary

As this chapter has demonstrated, DFIs have undergone significant convergence on their management of environmental risks in their lending portfolio. DFI risk management systems with the most recent reforms also have the most comprehensive set of considerations covered by their systems, showing a growing understanding of the importance of this work. Furthermore, several components of risk management have gained near-universal adoption, indicating that these practices are essential for any DFI interested in adequately addressing environmental concerns.

First, a sound environmental risk management system begins with upstream engagement, working with borrowers to develop portfolios of projects that are both

environmentally and financially sustainable. This process puts the lender's expertise at the service of borrowing countries, to develop their priorities into specific high-quality project proposals. While DFIs' approach to this upstream engagement varies, it coalesces around three categories of work: strategic project planning, technical project preparation, and financial assistance for pre-investment studies.

Once borrower submits project proposals, high-quality environmental management systems apply screening steps to protect the reputational and financial interests of the lender. One common element of screening steps includes the use of exclusion of certain sectors or corporations that have been deemed too risky, such as coal financing or contractors with poor track records. Additional risk screening considerations include a given project's expected impact on pollution, greenhouse gas emissions, biodiversity, and ecosystem services.

During project construction and operation, the proactive DFIs shifts focus from estimating the likely risks and toward monitoring the implementation to ensure that the developers' plans and promises are met. To ensure a full understanding of project performance, DFIs prioritize and rely on independent third parties for project monitoring. They also regularly assist with the publication of project-related documents, so that any stakeholder may bring performance issues to the attention of the lender or developer. Finally, a world-class environmental risk management system is completed with an independent accountability mechanism to receive and consider grievances from the public.

As members of OECD-DAC, Japan and South Korea have similar practices in ODA environmental management with those of DFIs. At same time, their practices fully demonstrate the positive role of the "sovereign subjects" in developing policy systems and management mechanisms. Their successful experience can be further summarized as follows:

Firstly, it is important to fully consider the demands of host countries, pay close attention to the challenges faced by them in response to climate change and environmental protection, explore the full process of integrating high-quality, sustainable, risk-resisting, affordable and inclusive goals into project construction, and earnestly improve the environmental protection capacity of BRI countries. Meanwhile, efforts should be made to increase green investment into host countries, and facilitate green and low-carbon transformation and upgrading of traditional polluting industries in host countries by utilizing investors' advantages in green technologies and industrial development.

Secondly, it is necessary to set up a full-cycle, multi-faceted evaluation mechanism for investment projects. A full-cycle evaluation mechanism should be adopted for foreign investment projects. At the early stage, feasibility reports and EIA reports should be mandatory. In the process of implementation, effective monitoring and inspection are crucial to guarantee the compliance in implementation.

When the project is completed, continuous evaluation and feedback of project operation is recommended to summarize experiences which can be referred to and learnt by future investments of the same kind.

Thirdly, the role expatriate agencies should be emphasized. It is important to enhance the professional staffing for expatriate agencies in key investment industries and ecological and environmental sectors. The government needs to help enterprises gain a deeper understanding of laws, regulations, customs, and values of host countries, and adopt more effective localization strategies. Moreover, effective mitigation and reduction of environmental and social impacts on the project site and its surrounding region plays a critical role in advancing the cooperation in relevant sectors. For instance, expatriate agencies can cooperate with host countries to jointly investigate regional ecological environment. They can set up localized communication channels to guarantee adequate communication with local governments, enterprises, residents and NGOs in host countries during the whole life cycle of the project, so as to ensure smooth project implementation and effectively minimize environmental and social impacts of the project.

7.4 Policy Recommendations

Based on the above studies, this chapter puts forward targeted policy recommendations on promoting the full alignment of Green BRI with 2030 Sustainable Development Agenda, with particular focus on the environmental management for BRI investment and financing. At the strategic level, the recommendations outline 4 priority areas for BRI green investment and financing to support sustainable development. At the public governance level, there are 4 policy recommendations on guiding non-governmental entities to practice environmental management. At the level of practical implementation, 5 pillars are proposed to enhance whole life cycle environmental management for BRI investment and financing projects. These recommendations aim to establish an environmental management system for BRI investment and financing, as well as guide and support BRI green development.

7.4.1 Priority Areas for Boosting Sustainable Development in Overseas BRI Projects

7.4.1.1 Broaden the Scope of BRI Alignment to Specifically Incorporate SDGs

Global climate change has become one of the major challenges for human survival and development in the 21st century.^① The intensity and total amount of

^① IPCC AR5. Intergovernmental panel on climate change fifth assessment report (AR5) [R]. London: Cambridge University Press, 2013.

carbon dioxide emission of some BRI participating countries are not outstanding due to their economic development model and level. However, BRI has gathered many emerging economies with the most growth potential and vitality. Considering the potential of economic growth and sensitivity to climate change of BRI participating countries, incorporating the goals to deal with climate crisis and conserve biodiversity into the development of green Silk Road and cooperation with overseas BRI projects, fostering synergy among SDGs, and facilitating cooperation in areas such as green infrastructure, green energy and green finance, will be vital for BRI participating countries to achieve sustainable development and realize green and low-carbon recovery in the post-pandemic era.

7.4.1.2 Promote a Common Understanding of the Definition of Green Investment among BRI Participating Countries

With the communication and dissemination of the concepts of ecological civilization and green development, and the deepening global understanding of the importance of the 2030 Agenda for Sustainable Development, green investment has been widely accepted and welcomed by countries all over the world as a new field of sustainable investment. It is thus recommended that China develop a catalogue or taxonomy to clarify the scope and standards of green BRI investment and further engage in the formulation of green investment standards in the host countries and those at international level. This would facilitate the benchmarking and convergence of green investment standards in China, BRI participating countries, and the international ones, assist public and private sectors to identify green projects efficiently, and enhance the funding for sustainable development of the BRI.

7.4.1.3 Increase the Support and Guidance from Public Sector for BRI Green Financing

Investment and financing has a particularly important role in guiding positive actions and facilitating positive changes. Public sector participation is an indispensable supporting force for green financing development. It is suggested making coordinated use of public sector resources such as preferential policies, financial support and ODA to direct and encourage international investors, and investors from both public and private sectors in BRI participating countries to the environmental, social and governance (ESG) responsible investment with ownership. Based on the projects' demand for green investment and financing management, it is recommended to explore and establish a BRI green investment and financing evaluation system and give full play to the guiding role of investment and financing in the construction of a green Silk Road. It is necessary to develop a green performance evaluation methodology according to internationally accepted green certification standards, bring in third-party evaluation institutions in the evaluation practice, develop standardized and differentiated green assessment tools, summarize green management experience, incorporate evaluation results into foreign economic

cooperation credit records, and put in place incentive and accountability mechanisms as appropriate.

7.4.1.4 Strengthen International Cooperation, Communication, and Capacity Building

It is recommended to promote communication and regulatory cooperation in key areas such as top-level/upstream planning, pollution prevention, environmental governance, biodiversity conservation, climate change response, as well as green and low-carbon transition. It is necessary to enhance cooperation with development financial institutions as well as bilateral, multilateral and regional financial institutions in environmental management, and facilitate the green and low-carbon transformation of the economic systems in the BRI participating countries through joint efforts from relevant countries. Such programs as Belt and Road South-South Cooperation Initiative on Climate Change and the Green Silk Road Envoys Programme should be well used for capacity building to assist BRI participating countries to establish and improve their green finance system and environmental management systems for investment and financing. Make good use of existing multilateral cooperation mechanisms such as the Belt and Road Initiative International Green Development Coalition (BRIGC), the Belt and Road Ecological Big Data Service Platform, and the BRI Green Investment Principle (GIP) to strengthen information and experience sharing among BRI participating countries, and disseminate best practices in environmental and climate management by BRI projects, so as to improve the green reputation of the BRI projects, and attract the participation of global responsible investors.

7.4.2 Policy Recommendations for Non-Governmental Entities to Practice Environmental Management for BRI Investment and Financing

7.4.2.1 Financial Institutions: Facilitate the Improvement of a Hierarchical Classification and Management System for BRI Projects

It is recommended to further improve the Green Development Guidance for BRI Projects and strengthen the risk identification, risk quantification and risk exposure management of industries with prominent environmental and climate risks. Based on such eco-environmental protection and climate goals as pollution prevention, biodiversity conservation, efficient energy use, and climate change mitigation and adaptation, establish the positive/negative list of green investment, project classification standards, and technical guidelines for green projects, and practice green investment identification accordingly. Facilitate the construction of sub-platforms including the BRI green project library and the environmental risk management module for BRI investments under the Belt and Road Ecological Big Data Service Platform.

7.4.2.2 Project Sponsors and Owners: Build an Environmental and Climate Risk Screening and Impact Assessment Framework for Projects

To promote the effective practice of green management in BRI projects at the implementation level, it is necessary to set up a framework for environmental and climate risk screening and impact assessment in the whole lifecycle of the project from the project planning stage. (1) At the project selection stage, it is necessary to examine the risk management ability and practice of the project contractor, and complete the preliminary screening of project risks and impacts. (2) At the stages of project planning and scheme design, a more detailed environmental impact and climate risk assessment should be carried out, with review of management qualification of the selected contractor. (3) Policy compliance review should be carried out under the framework of the host country's foreign investment, environmental management and corporate social responsibility rules. (4) At the project implementation stage, continuous project reporting, monitoring and evaluation should be conducted. Self-monitoring by the contractor and independent monitoring and evaluation are required according to the project contract content, the agreement with the project investor and the regulatory requirements of the host country and the countries where project stakeholders are located. Corresponding information should be made public at major project milestones on the timeline.

In addition, the framework should pay special attention to gender equality elements, and identify possible impacts of the project on women's rights and interests in their communities, and the contribution of the project in improving women's employment and protecting women's development rights and interests in local communities, so as to inform subsequent projects as reference.

7.4.2.3 Market Entities: Enhance the Mainstreaming Level of Environmental and Climate Management

It is suggested that various market players involved in BRI investment and financing should formulate comprehensive sustainable development strategies, closely align enterprise development with green BRI development and UN's Sustainable Development Agenda, and regard environmental protection and climate change response as an important part of fulfilling their corporate social responsibilities. It is suggested that market entities should set up special environment and climate mainstreaming management departments or working groups in their management organizations and empower project staff with sustainable development knowledge and concepts to raise their environmental awareness. The departments or working group will also be responsible for providing management training and technical guidance related to environmental and climate risks for key position managers (risk business managers of risk management departments, etc.), project contractors and other relevant parties. In this process, it is necessary to ensure that women can equally undertake management tasks and have

equal access to training opportunities.

7.4.2.4 The Third Party Engagement: Develop Green Management Toolkit for the BRI Overseas Investment

The standard system represented by *Green Industry Guidance Catalogue* and *Catalogue of Green Bond Support Projects* provides a clear basis for investors to identify the green investment direction. Information tools, such as the Whole Process Green Assessment Framework for BRI Projects, the Environmental Risk Screening Tool (ERST), the Climate and Environment Risk Assessment Toolbox (CERAT), and the Belt and Road Ecological Big Data Service Platform, have substantially improved the accessibility of environmental and climate risk and impact assessment. The above-mentioned “tools” have expanded the applicable scope and users of green management for BRI overseas investment, and at the same time improved management efficiency and operability.

It is suggested that management tools such as information system, standardized method, evaluation index system and technical specifications should be developed around key directions of target project screening, project risk identification, risk and impact assessment, classification management, gender mainstreaming, knowledge sharing and capacity building, stakeholder communication and information disclosure, and a green management toolkit for foreign investment be formed for all stakeholders to use.

7.4.3 Five Key Pillars for Full Lifecycle Environmental Management in BRI Projects

7.4.3.1 Build a Green Investment Governance System Applicable to All Phases of BRI Projects

Expedite the greening process of foreign investment and financing by enhancing environment management for the whole lifecycle of the projects. The lifecycle of investment projects can be divided into project screening and evaluation, project monitoring and control, reporting and information disclosure, according to the Chinese practices and international norms. Engaged stakeholders should take responsibilities to enhance the green development of project throughout the lifecycle. This should be governed and administered with participation of regulatory authorities and supporting mechanisms such as the accountability mechanism.

7.4.3.2 Create Exclusionary Lists

A number of global regulators and financial institutions have developed Exclusion Lists of environmentally harmful projects that shall not be funded. Projects on the Exclusion Lists include those that have severe and irreversible negative impacts on the achievement of climate, environmental, and ecological goals without feasible solutions for mitigation. It is recommended that the *Guidelines on the Evaluation and Classification of BRI Projects* (“*Classification Guidelines*” for

short) be promulgated on the basis of the *Green Development Guidance for BRI Projects* (BRIGC, 2019). Based on the previous analysis of the policies and standards of other countries and development financial institutions, projects that may result in the deterioration of ecosystems – for example, coal mining, and coal-fired power plants – should be added in the “exclusion list” and phased out of overseas investment.

7.4.3.3 Environmental Impact Assessment

Project sponsors/owners would screen projects pertaining to environmental and social risks and impacts. For those projects deemed to have potential environmental and social impacts, the approval and management authorities for BRI projects shall determine the scope, granularity, and management requirements of subsequent Environmental Impact Assessment (EIA) for each project based on project type and features. It is recommended that low-risk projects conduct EIA at least in accordance with the local standards in the host country; and that medium- and high-risk projects shall follow more stringent standards in the EIA, e.g. in accordance with the prevailing standards of international organizations and multilateral institutions, the Chinese standards, or other best practice.

7.4.3.4 Environment and Social Management System

It is recommended that all project sponsors/owners of medium- and high-risk projects shall be required to implement an Environment and Social Management System (ESM) which includes environmental and social risk responses, management plans, and monitoring plans. These sponsors/owners shall also be obliged to report regularly to the administering authorities, regulatory bodies or other stakeholders on ESM progress.

7.4.3.5 Information Reporting and Disclosure

It is recommended that project sponsors/owners shall report and disclose information related to emissions, pollution, biodiversity targets and impact, risk management, strategy and governance in accordance with required standards or prevailing international standards, where the disclosed information shall be available in Chinese and the major languages of the host countries. It is necessary for the project sponsors/owners to provide a set of easy-to-access and transparent grievance redress mechanisms, set up liaison offices, and make contact methods (phone number and e-mail address) readily available for stakeholders to express concerns. It is suggested that all stakeholders, including project sponsors/owners, host country governments, financial institutions, etc. should further enhance collaboration to share environmental data and best practices and enhance global data repositories on climate and biodiversity. For example, the Equator Principles encourage financial institutions to share biodiversity data of their projects that are not commercially sensitive with Global Biodiversity Information Facility (BGIF) and relevant national and global data repositories.

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Chapter 8

Global Green Supply Chain

8.1 Introduction

8.1.1 Research Background

The term “Global Value Chains” refers to the processes by which value is added across different stages from production to consumption and carried out by actors located in different parts of the world ^[1]. In the global value chain, the production process is divided and distributed into different countries, with different companies undertaking their own specific tasks. Global value chains have significant advantages in many aspects, but their impacts on the environment cannot be ignored. Because they require huge volumes of raw commodities, sourced from diverse origins, global value chains can have significant negative impacts on biodiversity, climate change, ecological functions and the rights and livelihoods of communities in regions where commodities are produced. The greening of the commodity value chain is an effective strategy to deal with those challenges. Green value chains offer the dual prospect of an economy that is less harmful to nature, and production, trade and consumption that is more secure and stable^[2]. More and more global value chain participants are pursuing greener value chains through responsible production and sourcing of commodities and circular economy practices to increase longevity of products, re-use of materials and minimization of waste.

As the world's largest exporter and second largest importer, China is at the core of global value chains. Having benefited from the historical economic growth of global value chains, China may now use its influence to contribute to the greening of global value chains. To this end, in 2020, CCICED commissioned a Special Policy Study on the Greening of the Global Soft Commodity Value Chain, which analyzed the significance and action strategies of China in greening global soft commodity value chains. This 2021 study builds on that work.

China is entering a new era of development, in which it expects to progress from a well-off society to a “beautiful” and “great modern socialist country” by 2050. The

14th "Five-Year Plan" envisions a new development path that emphasizes the quality, safety and sustainability of development over the quantity of growth. In the wake of disruption to the global economy due to the COVID-19 pandemic, China is pursuing a "dual circulation" economic framework in which domestic and international value chains are mutually reinforcing with the domestic market as the mainstay. China has also pledged to strive for the peak of CO₂ emissions by 2030 and carbon neutrality by 2060. These strategic goals elevate the need for stability and green development in value chains. Greening value chains also aligns closely with China's "Six Stabilities and Six Securities" policy, which lists supply chain security as one of the "six guarantees" of stability. Building a green value chain will provide solutions and realistic paths to achieve the above goals.

Box 8-1. Definition of Key Terms

Soft commodities: Raw materials and their derivatives that are grown or produced by the agriculture (crops, livestock), seafood (aquaculture and fisheries) and forestry industries, though this study is focused more on the "big four" forest risk soft commodities – beef, palm oil, soy and timber.

Global value chains: Processes by which value is added across different stages from production to consumption and carried out by actors located in different parts of the world^[1].

Green value chains: A shorthand term for value chains with reduced environmental and social impacts due to responsible production and sourcing of commodities and circular economy measures.

Supply chains: A component of value chains that are principally the logistical linkages at a firm level^[1].

Producer countries: Countries that produce a large quantity of relevant commodities and often export those commodities.

Consumer countries: Countries that consume a significant amount of commodities and often import those commodities.

Due diligence: A risk management process implemented by a company to identify, prevent, mitigate, and account for how it addresses environmental and social risks and impacts in its operations, supply chains, and investments.

Traceability: The ability to follow a product or its components through stages of the supply chain (e.g., production, processing, manufacturing, and distribution).

Greening: A shorthand term for policies and practices that reduce the negative environmental and social impacts of economic investments, activities, and production processes.

Circular economy: A new way to design, make, and use things within planetary boundaries. It involves a holistic approach to value chains that focuses on designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

Eco-design: A principle of minimizing a product’s negative environmental impacts throughout its lifecycle in the design stage. These may include designing products for repairability, recyclability, flexibility, reuse, disassembly, energy efficiency, packaging reduction, material and chemical safety and life cycle consideration.

Reuse: Raw materials and products are reused for as long as possible.

Just transition: A concept of ensuring social inclusion, decent work for all and poverty eradication in the process of transitioning to a more sustainable economy.

Green finance: Financial instruments used to ensure environmental benefits are considered in any investment activities.

Green Procurement: Governments, businesses, citizens and non-profits use their purchasing power to incentivize environmentally friendly products and services that contributes to sustainable production and consumption.

8.1.2 Review of Outcomes of the Phase 1 Special Policy Study

The CCICED 2020 Special Policy Study on Global Green Value Chains-Greening China’s “Soft Commodity” Value Chains provided a convincing rationale and concrete policy options (Box 8-2) for Chinese leadership to green its global value chains for soft commodities— particularly those linked to tropical deforestation, such as soybeans, beef and palm oil. The recommendations in the study were favorably received both within China and by international experts and stakeholders.

Box 8-2. Key Recommendations of the 2020 CCICED SPS on Global Green Value Chains

Establish a national green value chain strategy and provide policy and institutional support

Announce a new Chinese policy initiative on greening soft commodity value chains.

Establish an Inter-Ministerial National Committee on Value Chain Security and Sustainability.

Establish a Global Green Value Chain Institute.

Adopt mandatory and voluntary measures to green soft commodity value chains

Strengthen measures to reduce the import of soft commodities from illegal sources.

Strengthen due diligence and traceability systems.

Invest in domestic capacity to rationalize food value chains and improve sustainable diets.

Build on existing Chinese policy levers and initiatives

Stakeholders in China are increasingly recognizing the importance of greening

value chains. The Foreign Environmental Cooperation Center in the Ministry of Ecology and Environment (MEE) established a green value chain institute in 2020. The Ministry of Commerce (MOFCOM) is currently developing a supply chain security index that is likely to include criteria on the sustainability of soft commodity production. The Belt and Road Initiative International Green Development Coalition commissioned a policy study in 2020 on Green Supply Chains, which proposed a “Green Commodity Supply Chain Index” for Chinese governments, companies, and financial institutions to assess the relative environmental and social risks to the long-term security and stability of commodity supply chains. The Index proposed five indicators including forest loss, water stress, yield growth, risk of illegality, and human development at the jurisdictional level to measure risk to supply chain security and stability. Internationally, China recently engaged in the Forest, Agriculture and Commodity Trade (FACT) Dialogue, which aims to foster collaboration between producer and consumer countries on sustainable soft commodity supply chains as part of the COP26 climate summit.

8.1.3 Opportunities Related to Green Value Chains in China in the Current Economic Context

The COVID-19 pandemic and international trade frictions have had huge impacts on the global economy and keep bringing uncertainties for the future. To achieve economic recovery as soon as possible, countries around the world are introducing stimulus measures to boost their economies. As the second largest economy in the world, China has made ensuring the security and stability of its supply chain one of the priorities of its economic policy. The "Six Stability and Six Guarantees" policy issued by China in 2020 lists the security of the supply chain as one of the "six guarantees" to ensure the stability of employment, financial markets, trade, domestic and foreign investment, and market expectations. Soft commodities represented by corn, soybeans, beef, coffee, wood, etc. are used as basic industrial raw materials, and their supply directly affects the safety of the industrial chain and supply chain. For soft commodities, the green value chain can help reduce environmental risks in their supply chain, ensure long-term stability of supply, and stabilize supply prices. As an example of risk associated with failure to green value chains, a recent study estimated that rising extreme heat from lost forest and savanna vegetation in the Brazilian Amazon and Cerrado regions (between 1985 and 2012) caused soy revenue losses of over USD 2000 per hectare in the 2012-13 growing season^[3] In addition, tropical forest loss can reduce rainfed agriculture revenues by delaying and shortening the rainy season^[4].

China has proposed a new “dual circulation” economic framework, in which the domestic circulation is the center of focus, with the cycles of domestic and international value chains working complementarily to reinforce each other^[5]. The

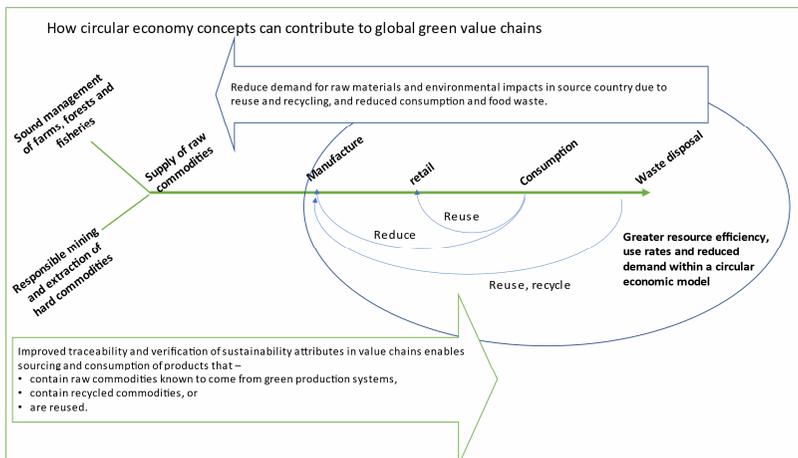
green value chain can help the "dual circulation" strategy by supporting value chain participants (farmers, manufacturers, suppliers, consumers, etc.) to focus on domestic business. Circular transformation will help promote eco-design, reuse models, and globalization of trade standards, while minimizing excessive reliance on imports of certain commodities. As China takes more proactive domestic measures to combat climate change and achieve the ecological civilization vision, greening value chains provides an opportunity to reduce the international environmental footprint of China's commodity value chains to complement its efforts domestically. In addition, China can also promote a circular economy through natural resource management, waste reduction, and promotion of a low carbon footprint in the value chain.

The green value chain is in line with the latest policy priorities and new development models of the "14th Five-Year Plan" (2021-2025). For the first time in history, the Five-Year Plan does not set a specific GDP growth target, but emphasizes the quality, safety and sustainability of development. The Plan proposes to establish a global supply chain early warning system for key resources and commodities, strengthen international cooperation in trade and supply chains, and innovate supply chain financing models. As an innovative management tool, green value chain management can become an important starting point for building a modern environmental management system and winning the battle against pollution. It meets the inherent needs of high-quality development and promotes the resilience and sustainable development of global value chains.

Green value chains are critical for China to achieve its carbon neutral commitment and ecological civilization, and actively contribute to the global agendas on climate change, biodiversity, and sustainable development. The country is stepping up efforts on climate change with President Xi Jinping's announcement that China will aim to hit peak emissions before 2030 and reach carbon neutrality by 2060. In February 2021, the State Council issued the "Guideline on Accelerating the Establishment and Improvement of a Green, Low-Carbon and Circular Economic System for Development". This policy signal calls for development with a whole of life-cycle concept, taking in raw material production, processing, manufacturing, product use and end-of-life. Green value chain management coupled with this whole of life concept, can help to achieve energy savings and emissions reductions in a systematic way along the entire value chain. In July 2021, the Ministry of Commerce and the Ministry of Ecology and Environment issued the "Green Development Guidelines for Overseas investment and Cooperation", which set out major areas of work for government agencies and companies "towards green transition" and "laying the groundwork for a new development paradigm" [6]. These areas of work include: adhering to the concept of green development; promoting green production and operations (including due diligence to identify potential

environmental risks, building green supply chains, adopting green procurement and greening the entire product life-cycle); promoting green technology innovation (including strengthening green compliance systems and “setting a standard for business practices overseas to fill in the regulatory gaps”); preventing environmental risks (including encouraging “companies to adopt international or Chinese standards in investing activities where local laws and regulations are non-existent or too lenient”).

China is also implementing circular economy policies to increase longevity of products, re-use of materials and minimization of waste. Today, China has established a legal system to regulate circular economic activities while setting circular economy concept - “reduce, recycle and reuse of resources” a priority for strategic economic growth in the country^[7]. Such policies contribute to the greening of value chains by reducing the total volume of raw materials that go into value chains and the volume of industrial waste coming out of them. Examples of China’s circular economy policies include the memorandum of understanding it signed in 2018 with the EU to exchange knowledge and develop a policy framework to accelerate the adoption of a strong circular economy across the two economies. In 2019, Shanghai introduced a mandatory waste sorting regulation to promote green development and circular economy practices. And just this year, the State Council emphasized the need for low-carbon, circular and cleaner manufacturing systems in industries such as textiles. The State Council is also calling for Chinese citizens to pursue a low-carbon lifestyle, for instance, through minimizing food waste.



Source: WRI authors

Figure 8-1. How Circular Economy Contributes to Green Value Chains

8.1.4 Challenges to Achieving Green Value Chains in China

While the current economic context offers new opportunities for greening value chains in China, some major challenges need to be addressed to realize those opportunities. First, China lacks a clear and cohesive strategy on green value chains that links to the vision of ecological civilization, its carbon neutrality commitment and other recent policy priorities. The enablers of green value chains cut across the jurisdictional and expertise boundaries of government agencies and sectors. Trade, finance, environment, agriculture, forestry, and customs are all involved in the management of value chains^[2]. While each soft commodities or circular economy practice, has a unique context, and therefore demands a tailored policy response, a cross-sectoral approach is also critical for creating an economy-wide policy framework for greening value chains that is consistent, efficient and coherent. The recommendations proposed in Section 8.4.2 of this study on developing a green value chain coordination and support system in China are a direct response to this challenge. Additionally, China could make a high-level policy commitment to green value chains to provide the impetus for government agencies, companies, financial institutions, and civil society organizations to work together to create and implement a robust green value chain strategy. As the host of CBD COP 15, China has an opportunity to announce an ambitious commitment to the greening of global value chains, while encouraging other countries to contribute.

A second major challenge is that many Chinese companies (and their suppliers) simply do not yet have the due diligence and traceability systems needed to deliver green products. Without these systems consumers cannot easily make green choices in their day to day purchasing, and companies (and the institutions providing finance to them) remain exposed to the risks associated with unsustainable practices or illegal activity in value chains. Many of the recommendations in Section 8.4.1 of this study address this challenge, including the proposal to introduce regulations related to due diligence, adoption of new technologies to support traceability, creation of new financial instruments, and the inclusion of green value chain measures in trade agreements.

A third challenge is the lack of a holistic, systemic approach to upscaling circular economy concepts and standards as drivers of green value chains. Despite the tremendous progress towards circular economy in China, many challenges remain. For instance, scaling of circular economy in the mainstream economy is impeded by a tolerance for low output efficiency of resources used in key industries, the lack of standard systems for recycling and reuse, high production intensity and low-rate usage of recycled products as raw material, fragmented approaches to standards and certification for recycled products, lack of sufficient financial incentives and business models predicated on unchecked consumption

(“14th Five-Year Plan”).

8.1.5 Main Research Topics

Building on the study in 2020, this 2021 study goes deeper into the challenges and opportunities related to greening global value chains in China. This second study –

(1) Provides more detailed analysis of regulations and technologies to encourage due diligence and traceability in soft commodity value chains, and related trade and finance measures.

(2) Explores how circular economy solutions can help make value chains greener.

(3) Makes high-level framework and policy recommendations on mechanisms to coordinate and provide technical support to the development and implementation green value chain strategies in China.

With respect to soft commodity value chains, this study build on the recommendations from the 2020 SPS (see Box 8-2 above). It explores emerging norms for legality and sustainability of soft commodity value chains (Section 8.2.1) and international and Chinese experience on due diligence and traceability measures for selected soft commodities including the role of technologies in greening soft commodity value chains (Section 8.2.2).

This study also explores how circular economy concepts can contribute to greener value chains in China. It begins with a discussion of the role and potential of circular economy in greening value chains and ties circular economy to the strategic plans and policies set forth by the Chinese government (Section 8.3.1). The study then explores five cross-cutting enablers of circular economy policies and practices (Section 8.3.2). We focus on apparel, food, timber and plastics because of their large climate impacts and the immense volumes of waste and pollution associated with these sectors. Additionally, apparel, food and timber have direct links to soft commodity value chains.

8.2 Greening the Production and Sourcing of Soft Commodities in Value Chains

8.2.1 Emerging Norms for Legality, Sustainability and Traceability in Soft Commodity Value Chains

Box 8-3. Key Takeaways – Emerging Norms for Soft Commodity Legality, Sustainability and Traceability

Major markets are developing legislation to require due diligence for legality/sustainability

in soft commodity sourcing.

Many countries that supply soft commodities have laws restricting forest conversion and degradation and tracking systems to verify commodities are produced in compliance with such laws. For commodities produced in countries with strong laws but weak governance, China can manage risks of sourcing from illegal or unsustainable sources by requiring or encouraging Chinese companies to develop and apply their own due diligence and traceability systems. In doing so, China can draw on experience gained in the timber sector through the Chinese Timber Legality Verification Scheme.

WTO rules allow China to include measures in bilateral and multilateral trade agreements to make soft commodity value chains. China can work with soft commodity producer countries entering such agreements to co-design related green standards and implementation mechanisms.

8.2.1.1 Regulations and Public Policy

Many countries that produce or consume forest-risk commodities have or are developing regulatory measures and policies that support the greening of soft commodity production within value chains. The paragraphs below provide an overview of these measures and policies and Table 8-1 lists specific country examples.

Consuming country due diligence laws - Such laws require companies to conduct due diligence to ensure the commodities they source are produced legally, and/or in compliance with critical social and environmental safeguards, in their country of origin. Greatest progress has been made in the timber sector, with the European Union, United States, Australia, Japan, and South Korea all requiring some form of due diligence to ensure wood products are not made from illegally harvested timber. These countries account for 52% of the world's forest product imports^[8]. In addition, in recent years, the UN Convention on International Trade in Endangered Species (CITES) has listed hundreds of timber species, many of which feed the Chinese furniture industry, for protection from illegal trade. Momentum is building within China, and internationally, for a similar approach to deforestation-risk agricultural commodities, with legislation under development in European Union, the UK and USA that would require companies to do due diligence on specific agricultural commodities to ensure they are not associated with illegal deforestation.

Producer country prohibitions on conversion of forests and other natural ecosystems - Most countries have laws restricting conversion of forests and other natural ecosystems to pasture, croplands or plantations. These include land-use planning processes that define “no-go” zones for agricultural development, regulations under which permits are required for land clearing or logging, and prohibitions on conversion of specified ecosystems to other land-uses. Indonesia, for

example, has a permanent moratorium on new forest clearing for plantations, or the issue of new logging permits, in primary forest or peatland. Brazil's Forest Code stipulates the maximum land area per farm that can be cleared for agriculture in each biome, e.g., 20% in the Amazon, 65-80% in the Cerrado^[9].

Producer country systems to verify legality - Producer countries are increasingly setting up government-administered or independent tracking systems and procedures to verify that commodities destined for export or domestic consumption are produced legally and/or sustainably. For example, 15 tropical countries have entered into Voluntary Partnership Agreements with the European Union to ensure that timber exported to the EU comes from legal sources. Typically, these agreements require the producer countries to set up mandatory public timber traceability systems and reporting platforms. The EU has recognized Indonesia's progress in establishing such systems by granting Indonesia a license that effectively exempts Indonesia's timber from requirements related to verifying legality under the EU Timber Regulation. Gabon has gone a step further by making it mandatory for forestry concession holders to achieve Forest Stewardship Council certification by 2022. Producer countries are beginning to apply similar approaches to deforestation risk agricultural commodities. For example, the world's two biggest palm oil producers, Indonesia and Malaysia, both require producers to secure certification under national palm oil sustainability standards.

Producer country jurisdictional approaches - In many producer countries, sub-national jurisdictions (provinces, states, districts and municipalities) are setting and enforcing no-go zones for commodity production, so they can present as "green" jurisdictions that gain preferential access to markets. A Tropical Forest Alliance (TFA) report published in 2017 documented 34 jurisdictional programs in tropical forest regions that are supporting sustainable sourcing and production strategies within value chains for palm oil, soy, coffee, cocoa, pulp, and beef.^[10] These programs typically combine public land-use planning and governance reforms with corporate activities to promote sustainable commodity production. The combination of public and private interventions means these programs are well-placed to enhance sharing of data and best practices, aggregate and provide incentives to smallholders, and have an impact at scales beyond the landholdings of individual producers^[11]. These approaches can also be implemented at national level. For example, the governments of Côte d'Ivoire and Ghana are participants in the Cocoa and Forests Initiative along with leading cocoa and chocolate companies, as a joint effort to promote sustainable smallholder cocoa production, social inclusion, and forest protection^[12].

Public procurement policies that give preference to green commodities - Through green public procurement, public authorities can set preferences or offer incentives for the procurement of green soft commodities. Globally, green

procurement is more advanced in sectors such as construction (including wood), office supplies (including paper) and energy (including bioenergy). However, some authorities have made commitments to require deforestation-free procurement for food and catering.

Table 8-1 Country Examples of Regulatory Measures and Policies that Support the Greening of Soft Commodity Value Chains

Developing Countries	
Indonesia	<ul style="list-style-type: none"> ● The <i>Timber Legality Assurance System</i> (locally known as SVLK) verifies the legal supply of timber for export of domestic consumption. Indonesia also has a log export ban. ● Under the Indonesia Sustainable Palm Oil (ISPO) regulations, palm oil plantations must secure certification that they are operating legally. ● In 2019, the Indonesian president announced a permanent moratorium on conversion of primary forests and peat lands. ● Indonesia has a <i>Voluntary Partnership Agreement</i> (VPA) with the EU and is currently the only country that can issue FLEGT licenses to ensure that timber exported to the EU is from legal sources. ● 10 provinces and 36 districts have jurisdictional initiatives to reduce deforestation.
Malaysia	<ul style="list-style-type: none"> ● Since 2020, palm oil producers must obtain certification under the Malaysian Sustainable Palm Oil standard to comply with <u>MPOB (Licensing) 2005 Regulation No. 15</u>, or face penalties and risk having their licenses suspended or revoked. ● Sabah State has a jurisdictional initiative to reduce deforestation
Brazil	<ul style="list-style-type: none"> ● The <i>Forest Code</i> stipulates the maximum land area per farm that can be cleared for agriculture per biome (e.g., 20% in the Amazon, 65-80% in the Cerrado). ● Mato Grosso state has a “<i>Produce, Conserve and Include</i>” strategy to advances a sustainable rural development agenda through implementation of the intensification of commodity production within existing degraded lands, restoration of other degraded lands to forest, and provision of improved extension services and rural credit to producers. ● The <i>Brazilian Central Bank</i> has specific regulations on sustainability due diligence for the financial sector, including requirements that prohibits/prevents loaning to illegally deforested areas, and banks can be fined if they do not comply. A public consultation is currently ongoing to impose new sustainability rules on the rural credit.
Colombia	<ul style="list-style-type: none"> ● Colombia has signed the Cocoa, Forest & Peace Initiative, which seeks to eliminate cocoa-related deforestation ● Colombia has zero-deforestation agreements with the palm oil, dairy, meat and cacao industries
Paraguay	<ul style="list-style-type: none"> ● The <i>Forestry Law</i> requires that rural properties over 20 ha in forest zones must maintain 25% as natural forest in addition to riparian forests
Liberia	<ul style="list-style-type: none"> ● Liberia has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
Côte d’Ivoire	<ul style="list-style-type: none"> ● Côte d’Ivoire has a VPA with the EU to ensure that timber exported to the EU come from legal sources. ● Côte d’Ivoire is part of the <u>Cocoa & Forests Initiative</u>, which seeks to end deforestation and restore forest areas in cocoa producing areas

Developing Countries	
Ghana	<ul style="list-style-type: none"> ● Ghana has a VPA with the EU to ensure that timber exported to the EU come from legal sources. ● Ghana is part of the <u>Cocoa & Forests Initiative</u>, which seeks to end deforestation and restore forest areas in cocoa producing areas
Cameroun	<ul style="list-style-type: none"> ● Cameroun has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
Gabon	<ul style="list-style-type: none"> ● Gabon has made it mandatory for forestry concession holders to achieve FSC certification by 2022 ● Gabon has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
CAR	<ul style="list-style-type: none"> ● The Central African Republic has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
DRC	<ul style="list-style-type: none"> ● The Democratic Republic of Congo has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
ROC	<ul style="list-style-type: none"> ● The Republic of Congo has a VPA with the EU to ensure that timber exported to the EU come from legal sources.
Developed Countries	
EU	<ul style="list-style-type: none"> ● The <u>EU Timber Regulation</u> (2010) prohibits the placing of illegally sourced wood products on the European market and requires operators and traders to exercise due diligence to minimize the risk of importing illegally harvested timber. ● The EU <u>Communication on Stepping up EU Action to Protect and Restore the World's Forests</u> (2019) highlights 5 priorities including one on reducing the footprint of EU consumption on land and encouraging the consumption of products from deforestation-free supply chains in the EU. ● The <u>EU LULUCF Regulation</u> (2018) requires EU countries to ensure that greenhouse gas emissions from land use, land use change or forestry are balanced by at least an equivalent removal of CO₂ from the atmosphere in the period 2021 to 2030.
France	<ul style="list-style-type: none"> ● France's <u>Corporate Duty of Vigilance Law (2017)</u> requires large French companies to assess and address the adverse impacts of their activities on people and the planet, by having them publish annual, public vigilance plans. ● In 2017, France adopted its National Strategy against Imported Deforestation which aims, by 2030, to put an end to deforestation caused by importing unsustainable forest and agricultural products.
UK	<ul style="list-style-type: none"> ● The UK adopted an <u>Environment Bill</u> in November 2020 to require due diligence from businesses to ensure deforestation-risk commodities have been produced in line with local laws protecting forests and other natural ecosystems.
USA	<ul style="list-style-type: none"> ● The US <u>Lacey Act Amendment</u> (2008) prohibits trade in illegally sourced wood products. ● A <u>draft bill</u> on illegal deforestation authored by Senator Brian Schatz is under discussion in the US congress. It would prohibit the import the products linked to illegal deforestation.
Japan	<ul style="list-style-type: none"> ● Japan's <u>Clean Wood Act</u> (2016) requires companies to ensure that domestic or imported timber is harvested legally.
Republic of Korea	<ul style="list-style-type: none"> ● The Republic of Korea's <u>Act on the Sustainable Use of Timbers</u> (2017) requires companies to ensure that domestic or imported timber is harvested legally.

Developing Countries	
Australia	Australia's <u>Illegal Logging Prohibition Act (2012)</u> prohibits the import of wood, pulp and paper products made from timber that is logged illegally, or the processing of raw logs of such timber.

8.2.1.2 *Voluntary Private Sector Norms and Best Practice*

In addition to government measures supporting green value chains, the portion of private sector actors with commitments to Green Value Chains is growing, and new best practice norms are emerging. The Global Canopy Forest 500 Project assesses 350 companies, and 150 financial institutions, with high influence on forest-risk supply chains. In 2021, the percentage of those companies with commitments to halt deforestation associated with soft commodities were: 71% for palm oil; 66% for timber; 48% for paper; 31% for soy; 28% for cattle; and 25% for leather. The percentage of those financial institutions with deforestation policies covering their investments in activities linked to soft commodities were: 32% for palm oil; 32% for timber; 24% for soy; and 20% for cattle ^[13].

The business reasons for companies to pursue green value chains are many, including: securing the long-term stability of supply (and therefore price) of commodities; mitigating legal and reputational risks; anticipating future markets in which consumers are more concerned with the impacts of what they buy; meeting the sustainability standards of multinational retailers and manufacturers who they supply; better management of logistics and financial discipline in the value chain; and new technologies are making traceability easier and more affordable ^[2]

At the forefront of private sector action to green soft-commodity value chains, the Forest Positive Coalition of companies is seeking to “drive collective, transformative change in order to remove deforestation, forest conversion and degradation from key commodity supply chains and support forest positive businesses” ^[14]. The coalition has two core strategies –

- transitioning from deforestation- and conversion-free supply chains to deforestation- and conversion-free businesses (i.e., they want the whole of their suppliers’ operations to be green, rather than just the specific commodities they buy) and

- taking a more integrated land use approach to encourage more transformational change in key production landscapes through stakeholder collaboration (this links strongly to jurisdictional approaches described above).

The Accountability Framework Initiative provides a consensus-based set of norms, definitions, and guidance on how to achieve green soft commodity value chains. It provides guidance on how companies can set commitments, take action, and monitor progress toward achieving value chains that are free from deforestation, conversion, and human rights violations^[15].

Growing interest in how companies account for greenhouse gas emissions in their land-based operations and soft commodity value chains has motivated the Greenhouse Gas Protocol, a multi-stakeholder global coalition that sets rules and standards on how to measure and manage greenhouse gas emissions, to develop new guidance on how companies and organizations should account for **greenhouse gas** emissions and carbon removals from **land use, land use change, bioenergy, and related topics** in their **greenhouse gas** inventories (Greenhouse Gas Protocol, 2021).

Increasingly, leading companies are calling for mandatory due diligence laws to level the playing field (see Box 8-4).

Box 8-4. Leading companies call for mandatory due diligence laws

In October 2020, a group of companies sent a letter to the UK government, encouraging the introduction of mandatory due diligence requirements to address global deforestation^[18]. The companies expressed support for the UK government's intention to "set a level playing field where sustainable commodities are the norm". They asked the government to consider the following:

- Align the definition of deforestation-free with what is necessary to achieve Net Zero, citing the Accountability Framework Initiative and Global Resources Initiative as sources of definitions that include all forms of deforestation and land conversion^[19].

- Adopt thresholds that reflect the scale influence of the company.

- Facilitate an enabling environment for our companies to act.

- Implement sector-specific requirements. Commodities should have different and pragmatic pathways in place that recognize the differences in their production and supply chain contexts.

- Protect the vulnerable, recognizing that smallholders are often the most marginalized part of the supply chain.

- Incentivize good behavior not only avoidance of problem areas.

- Allow for restoration and remediation.

- Continue to consult and collaborate with the private sector.

8.2.1.3 Finance Sector Norms and Best Practice

A study in 2017 by the G20 Green Finance Group concluded that environmental risk analysis by financial decision-makers can result in improved credit and investment policies; reduced portfolio and firm-level risk; product innovation; reallocation of capital and enhanced stakeholder engagement. However, barriers to wider adoption of environmental risk analysis practices can include: a lack of clear and consistent policy signals; limited methodologies and relevant data; capacity limitations within financial institutions; time horizons; terms of investment; and

performance incentives. The study also found that the lack of, and difficult access to, relevant use of publicly available environmental data limits the ability of financial firms and other to analyze and manage environmental risk exposures. It also hinders the reallocation of resources to financing green investment opportunities^[18].

In China, the State Council approved “Guidelines for Establishing the Green Financial System” in 2016, to incentivize and promote green loans, green bonds, green funds, green insurance, and mandatory environmental information disclosures, and other forms of green finance^[19]

As part of this growing attention to green finance many banks are developing new products and services that could support actions by clients to green their value chains. For example, banks are offering sustainability-linked loans where terms are linked to non-financial key performance indicators related to the sustainability of the borrower’s value chain. Recognition of deforestation-driven climate risks is also growing along with calls for greater disclosure of such risks. Some examples are given below.

In 2019, Marfrig, a Brazilian beef producer, issued a “sustainable transition bond” the proceeds of which would be used to ensure the cattle it purchased did not come from deforested areas, protected areas or areas that violate indigenous land rights. In 2021, Impact fund *&Green* made a \$30 million, 10-year ‘sustainability-linked loan’ to Marfrig to expand the reach of its cattle tracking and deforestation monitoring system to indirect suppliers. Potential interest rate reductions are linked to Marfrig’s ability to reach traceability on its indirect suppliers more quickly than the target dates set out in the loan agreement.

Emerging financial mechanisms such as credit lines for low-carbon agriculture, and low-cost crop finance, could help make deforestation and conversion free farming more competitive with the alternative of clearing native vegetation to create new farming land. In cases where farmers already own land with native vegetation, farmer compensation programs could be deployed to create incentives for farmers to retain native vegetation on their land^[20].

In 2019, COFCO International secured a sustainability-linked loan of US \$2.1 billion from a consortium of 20 banks, including Chinese banks, with interest savings based on its performance against environmental, social, and governance targets, including the sustainable sourcing of soy in Brazil^[21].

In issuing its communication on *Stepping up EU Action to Protect and Restore the World’s Forests* in 2019, the European Commission signaled interest in measures to improve company reporting on activities linked to deforestation and forest degradation. The Taskforce on Nature-related Financial Disclosures has begun developing a framework for nature-related reporting, which it hopes to test and refine ahead of launch and dissemination in 2023. The idea is that standardized reporting on nature-related risks will improve transparency and accountability linked

to deforestation and motivate financial institutions to deliver on zero deforestation commitments.

CDP runs a global environmental disclosure system on which over 9,600 companies have reported on climate change, water security and forests. Investors use this data to inform decision making, engage with companies, reduce risks and identify opportunities. In 2020, 687 companies reported on the steps they are taking to eliminate deforestation from their operations and supply chains.

In 2019, 230 institutional investors representing \$16.2 trillion in assets under management called on companies to take urgent action following the devastating forest fires in the Amazon ^[22]. In 2020, Ceres published *The Investor Guide to Deforestation and Climate Change*, which provides a framework to help investors understand and engage on deforestation-driven climate risks across their portfolios and proposes concrete steps investors can take to address deforestation risk ^[23].

8.2.1.4 Trade Norms

Multilateral and bilateral trade agreements can be enablers of both the upstream and downstream of green value chains, provided they comply with World Trade Organization (WTO) rules. WTO rules not only play an important role in multilateral trade discussion but also lay the foundation for bilateral free trade agreements ^[24]

Countries are increasingly using trade measures to achieve environmental objectives. In 2019, the WTO recorded 672 environmental notifications by member countries ^[25]. Around one sixth of WTO members have notified trade measures that include environmental components, and 51% of such measures notified in 2018 came from developing and least developed countries ^[27]. Most environmental-oriented trade measures do not raise any disagreement in the WTO. Only 10 disputes involving environmental measures have been decided at the WTO and in all cases the validity of environmental objectives was never questioned^[27].

WTO members can adopt trade-related measures for environmental, health, and conservation policy goals if such measures comply with the General Agreement on Tariffs and Trade (GATT) rules or fall under the exceptions to these rules ^[28]. The GATT rules require that environmental measures not violate basic trade rules such as the non-discrimination obligation (see Box 8-4) and the prohibition on quantitative restrictions; however, there are exceptions for WTO members to achieve legitimate policy objectives. Related to measures on sustainability and environment, the GATT Article XX on General Exceptions allows WTO members to adopt policy measures that are inconsistent with GATT disciplines, but necessary to protect human, animal or plant life or health, or relating to the conservation of exhaustible natural resources (see Box 8-5). WTO members' autonomy to determine their own environmental objectives has been reaffirmed by several cases ^[28].

Box 8-5. WTO's principle of non-discriminations and GATT exceptions

Under WTO, the principle of non-discrimination stipulates that a member shall not discriminate:

between “like” products from different trading partners (giving them equally “most favored-nation” or MFN status, GATT Article I); and

between its own and like foreign products (giving them “national treatment”, GATT Article III).

GATT Article XX on General Exceptions lays out a number of specific instances in which WTO members may be exempted from GATT rules. The two exceptions related to sustainability and environment are described in paragraphs (b) and (g) of Article XX.

(b) necessary to protect human, animal or plant life or health; ...

(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption. ...”

Source: WTO. “WTO | Trade and Environment.” 2021a. https://www.wto.org/english/tratop_e/envir_e/envt_rules_intro_e.htm.

Trade measures focused on preventing the degradation, fragmentation, or conversion of natural forests and other natural ecosystems, would align with the exceptions in the GATT Article XX regarding the protection of plant life and conservation of exhaustible natural resources. Thus, measures related to greening soft commodity value chain measures are allowable provided they are designed with strong scientific support and avoid arbitrary or unjustifiable discrimination ^{[24][27]}.

Countries have multiple options to design measures that support and implement green soft commodity value chains in trade agreements (see Box 8-6). For example, the EU has signed Voluntary Partnership Agreements (VPAs) with seven timber-producing countries to ensure that timber and timber products exported to the EU come from legal sources ^[28]. The VPAs are legally binding trade agreements that include measures for timber-producing countries to control, verify, and license legal timber and for the EU to only accept licensed imports from producing countries. The United States-Peru Trade Promotion Act (PTPA) is a general free trade agreement but includes a legally binding Forest Governance Annex that sets out specific policy and institutional mechanisms to reduce the risk of illegally harvested timber from Peru entering the United States^[2].

Box 8-6. Types of environmental provisions in trade agreements

General environmental provisions:

A reference in Preamble

General and specific exceptions based on GATT Article XX

A commitment to uphold environmental law, and not weaken it to attract trade

Substantive environmental provisions:

Environmental cooperation

Public participation

Dispute settlement

Coverage of specific environmental issues

Specific provisions on Multilateral Environmental Agreements (MEAs)

Implementation mechanism

Associated ex ante impact assessment

Source: OECD. "Environment and Regional Trade Agreements: Emerging Trends and Policy Drivers." 2014. <https://www.oecd-ilibrary.org/docserver/5jz0v4q45g6h-en.pdf?expires=1615917071&id=id&accname=guest&checksum=B8FB6573354CE3D6319144B9A9FF530B>.

In addition to official trade agreements, countries could also support plurilateral initiatives that promote greener value chains at regional or international trade dialogues. For example, in 2020, 50 WTO members launched an initiative to organize structured discussions at WTO on trade and environmental sustainability that include information sharing, environmental cooperation, and capacity building. Seven WTO members led by China and Fiji established an open-ended informal dialogue on plastics pollution and environmentally sustainable plastics trade ^[29].

8.2.2 Due Diligence and Traceability Measures for Soft Commodities

Box 8-7. Key takeaways on Due Diligence and Traceability

A revolution in monitoring and tracking technologies is making due diligence and traceability more feasible, practical and affordable. That same revolution makes it easier for producers (especially small/medium-size enterprises) to verify their compliance with green criteria.

By adopting these systems, Chinese companies can be ready to comply with new regulations by countries that import or export commodities.

China has already issued detailed guidance on the role of governments and companies in establishing traceability systems for certain products. Government bodies and companies can draw on this guidance and experience gained in China in sectors such as meat and vegetables, alcoholic products and drugs and herbal medicines, to strengthen traceability for other soft commodities.

8.2.2.1 International Experience - Feasibility, Practicality, Costs, and Strategy for

Developing Enhanced Legality Due Diligence and Value Chain Traceability Measures for Soft Commodities

When used in combination, due diligence and traceability can verify a commodity's origin, the chain of custody, and compliance with legality, sustainability, and/or safety standards. They often make good business sense, enabling companies to better manage logistics and ensure financial discipline throughout the value chain, as well as providing a competitive advantage to companies that can demonstrate they are procuring commodities from known and sustainable sources.

For the purposes of this study, due diligence is a process to assess and reduce the risk that commodity production within a value chain or financial portfolio is linked to illegal or unsustainable practices. It involves gathering relevant information about suppliers and where they produce, harvest or source commodities, along with information about production practices and control measures in those places. The process enables a company to assess risk of non-compliance with regulations or a sustainability standard and take measures to mitigate the risk and verify compliance.

Traceability is the ability to follow a product or its components through the production, processing, manufacturing and distribution stages of the supply chain. Achieving traceability often requires companies to identify the various actors in their supply chain and understand the relationships among them—a process known as supply chain mapping. Adequate traceability is an essential component of a green value chain. A diverse array of tools and approaches (e.g., online forest monitoring systems that provide access to satellite and related data to assess locations of ongoing deforestation; voluntary certification systems that offer third-party verification that commodities were produced in compliance with a sustainability standard and that the chain of custody is adequately controlled; supplier warranties and related supplier reporting systems; techno) are available to support due diligence and traceability.

8.2.2.2 International Examples of Company Due Diligence and Traceability Systems for Soft Commodities

Large brands and retailers

Walmart has committed to sourcing 20 commodities more sustainably and has diverse practices to achieve this. It requires its suppliers to set targets and report on key sustainability indicators on a centrally managed program called *Project Gigaton* ^[31]. Additionally, it works with its main beef suppliers in the Amazon region to fully trace their direct beef supply and has committed to guarantee 100% of the beef it sources from Brazil, Argentina and Paraguay will be deforestation-free by the end of 2021 ^[32]. Since 2018, the company has been tracing all its leafy green suppliers using blockchain technology ^[33]. Walmart works with over 3,000 suppliers in China on green sourcing. It has also completed a proof-of-concept pilot to trace pork products

back to the farm in its Chinese operations using blockchain^[34].

Mondelez has mapped and published the mill locations of 100% of their direct palm oil suppliers^[35]. The company is implanting systems to achieve full traceability of its palm oil to plantation level (i.e. pre-mill traceability) 100% of supply traced to the field by 2021^[36]. It has also mapped over 90 thousand small-holder cocoa farmers in West Africa and constantly monitor this supply for deforestation using satellite-based software^[37]

Unilever has also mapped 100% of its suppliers' palm oil mills and publishes the suppliers it has stopped doing business with because of non-compliances with its due diligence requirements^[38]. The company is using satellite data and cellphone tracking to trace the source plantations of its indirect palm oil supply^[39].

Multinational food companies

Bunge traces 100% of its direct soy purchases to the farm level in the Brazilian regions with higher risk of soy-related deforestation, publishing quarterly traceability reports^[40]. It has also launched an unprecedented program to trace 100% of its indirect soy supply to the farm level^[41].

COFCO International also announced recently that it will fully trace its direct soy supply in Brazil by 2023^[42]

JBS and **Marfrig**, the first and second biggest animal protein producers in the world, have been tracing 100% of their direct beef supply in the Amazon region for almost a decade. Together they represent more than 50% of all Chinese imports of beef from Brazil^[43]. Both companies recently committed to new systems to trace 100% of their indirect suppliers to the farm level and to zero deforestation in Brazil^[44]. Marfrig has raised a blended-finance long-term focused investment to fund these efforts and JBS will use blockchain technology^{[45][46]}. Also, these traceability efforts have enabled Marfrig to establish a producer support scheme, called Marfrig Club. Through the scheme, ranchers receive technical assistance and information to support their businesses. JBS has also announced a Together for the Amazon fund, that will fund ranchers in forest regions that meet forest protection requirements.

Local and medium-sized companies

Grupo Exito, a Colombian retailer maps its cattle suppliers using the freely available Global Forest Watch Pro system. The system allows companies of any size to manage their supply chain risk, anywhere, using satellite data. Grupo Exito has mapped more than 37,000ha of farmland in their supply chain and identified that 65% of this land complies with its no-deforestation policy. The company claims to be a leader “in the transformation of the productive livestock industry” in Colombia^[47].

Banco Sudameris, a Latin American bank, has relied on commitments to manage the sustainability risk in its investment portfolio, to secure concessional development capital from IDB Invest, the private sector arm of the InterAmerican

Development Bank. The bank uses geospatial monitoring systems to conduct due diligence on new investments, and to both verify compliance with its sustainability policies and provide support to its clients, farmers in Latin America. In a reported case, the bank received an alert from *Global Forest Watch* of a fire on a large ranch of a client and informed the client so that the fire could be contained before it destroyed the whole property and the cattle on it ^[48]. Through the *Paraguayan Roundtable of Sustainable Finance* significant number of banks in the country now use the Global Forest Watch Pro system to monitor deforestation events in or near their client's properties ^[49]. The same system is used by companies, large and small, in over 30 countries.

DSNG, a medium-sized palm oil producer in Indonesia, has committed to supplying deforestation-free palm oil and is implementing systems to provide full traceability of its suppliers. This activity has enabled the company to secure a US\$30million long-term loan from a blended-finance facility specialized in inclusive agriculture and forest protection. According to a company statement, “the long-term loan facility provides DSN Group the flexibility to diversify its sources of funding amidst a volatile global credit market backdrop impacted by the COVID-19 pandemic” ^[50]. According to the investor “8,000 smallholder farmers and 11,000 individuals are expected to benefit from jobs, services and improved incomes as the NDPE [no deforestation, no peat, no exploitation policy] is implemented” ^[51].

8.2.2.3 The Role of Technologies in Strengthening Due Diligence and Traceability Systems

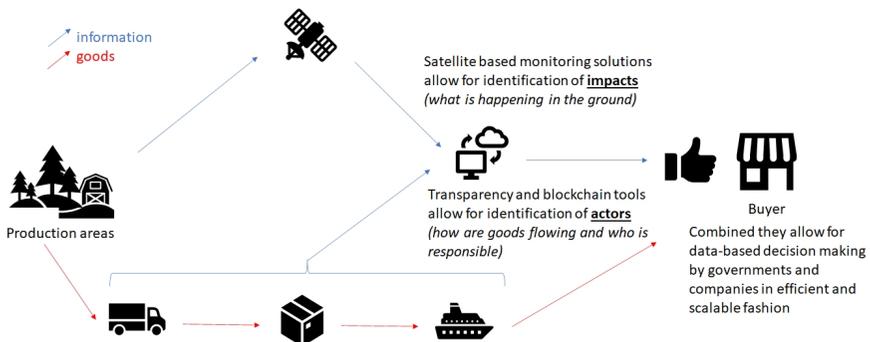


Figure 8-2. Technologies Enable Due Diligence and Traceability Across the Value Chain

The complexity of global value chains, and lack of alignment between the policies and traceability systems of different countries, poses many challenges related to the tracking and monitoring of soft commodities, and attributes related to sustainability and legality, through the entire production process. However, new science and technology is generating methods and tools to overcome these

challenges. Examples of technologies that can support due diligence and traceability are described below.

Satellite-based remote sensing: Advances in remote sensing and cloud computing have created a wide array of options for large-scale forest and land monitoring. These technologies have enabled better detection of land cover change, more frequently, over larger areas, at less cost. At the same time, geographic positioning systems, allow field staff to record more detailed coordinate points for their observations and upload those data into geographic information systems. This generates richer data and the means to ground-truth and refine automated systems for interpretation, visualization and analysis of satellite data at global, continental or national scales ^[52]. Satellite imagery spatial resolution and availability continue to improve. The European Space Agency provides open 10-meter data from the sentinel radar satellites that can see through cloud cover, smoke, and haze ^[53]. An increasing number of commercial satellite companies (e.g., *Planet*, *TerraSar*) offer high spatial resolution data (under 3 meters). While mass processing of such high-resolution imagery is often too costly for use in large-scale systematic analyses, the imagery provides a very cost-effective means of validating, calibrating, and verifying large-scale data. For example, it can be used to training algorithms that can make use of lower resolution free imagery for large scale mapping. Additionally, their costs have been significantly dropping year on year. In 2020, a partnership between Planet (an imagery provider) and the Norwegian government made near real time, high-resolution, imagery free and open for all tropical forest areas ^[54].

Online-geospatial intelligence platforms: Drawing from satellite-based remote sensing, online tools now allow for monitoring of impacts of commodity supply chains. For example, the *Global Forest Watch Pro* application combines remote sensing data and cloud computing to help companies assess, monitor and report the risk of deforestation occurring in the farms or supply sheds around the mills, silos, or slaughterhouses from which they source ^[55]. *Agroideal* is a territorial intelligence system that allows business planning for more sustainable expansion of investments and procurement in key soft commodities in South America. IBAT (Integrated Biodiversity Assessment Tool) provides authoritative geographic explicit information – like maps or reports - about global biodiversity.

Online transparency tools: The *Open Timber Portal* provides information about forest management practices and legal compliance in participating countries and companies. The portal enables geospatial data, timber producer information, legal documents, and observations by third party forest monitors to be consolidated and presented in user-friendly formats. *SPOTT* (Sustainability Policy Transparency Toolkit) tracks transparency of palm oil companies. It scores tropical timber, palm oil and natural rubber companies annually against over 100 sector-specific indicators to benchmark themselves.

GPS tracking systems: These support traceability by tracking the movement of freight and transport fleets on land or sea. Satellites detect signals from transponders mounted on ships or vehicles that identify their location, route, speed and type. This data can be processed in near-real time via cloud computing and applied to improve supply chain logistics (e.g., by enabling the reprogramming of routes to avoid delays or updating customers on expected delivery times) and to track the movement of commodities from place to place.

Blockchain: Block-chain technology to ensure the authenticity of information can be applied to increase traceability and visibility of transactions in a supply chain. Numerous recent scientific publications have explored the potential for blockchain technologies to meet consumers' needs for traceability. For example, IBM offers a traceability service called *IBM Food Trust*, which was used to create the *Beefchain* tool to trace meat origin in the US to track disease outbreaks in livestock. Other examples include projects by Walmart for eggs and Carrefour for poultry. These traceability solutions improve sustainability while also addressing health and safety and resilience in animal protein supply chains ^[56]. Starbucks is using blockchain to enable consumers to trace coffee purchased in their stores back to a source plantation in northern Kenya. The shipping company, Maersk, created *TradeLens*, a blockchain-based platform that enables everyone in a complex supply chain to track all documents related to the product and participating businesses. The Forest Stewardship Council uses blockchain to avoid fraudulent use of its certification system. The blockchain verifies the traceability of the certified products along the entire value chain, from the sourcing area, to trading partners, and final users ^[57].

Labeling and data recording technologies in chain of custody systems: These facilitate rapid collection of large amounts of data that can be electronically, time-stamped and cross-checked against records made at other checkpoints to detect and deter tampering ^[58]. Labels containing nano-molecules or imprinted with bar codes can be scanned electronically. Others, such as RIFID labels, can be accessed using radio signals. Increasingly, data logging devices support data capture in the field for immediate or subsequent transfer to online databases. These devices can be handheld devices or integrated in existing machinery such as trucks and harvesting machines. Such technologies are more efficient than manual methods because they reduce the need for error-prone manual information transfer. Validation is also supported through the metadata automatically collected with each reporting event (e.g., who reported via the user-account, when the information was collected via the time stamp, and where was the information was collected via the GPS module in the device) ^[59]

“Big data” analytical strategies: “Big data” approaches are being used at international level to identify risk of deforestation in agricultural commodity supply chains. The Transparency for Sustainable Economies (TRASE) tool draws on

publicly available production, trade, and customs data and modeling to trace commodity flows back to production landscapes while identifying the actors involved. It identifies individual companies that export, ship and import a given commodity and applies an enhanced form of material flow analysis to link them to specific production localities (“TRASE,” n.d.). Initiatives like *Chain Reaction Research* also combine multiple data types (deforestation alerts, chain-of-custody and trade data, corporate financial and governance data) to assess the exposure of individual companies to material financial risks within agricultural commodity chains^[60]. The *BVRio Institute* runs a due diligence and risk assessment system for Brazilian tropical timber trade. The systems draw from public traceability systems, registries of infractions and convictions, publicly available data on distribution and density of commercial species and spatial data from Global Forest Watch, the Brazilian Government and other NGOs use the system to identify logging permits reporting questionable or unrealistic volumes^[60].

Forensic methodologies: These are being used to query or verify claims around the origins or contents of agricultural, forest and wildlife products. For example, stable isotope analysis is used to determine origin and legality of food products and timber^{[61][62]}. DNA genetic analyses are used to bolster prosecutions for illicit trading of wildlife and timber^{[63][64]}. New wood identification tools are used by inspectors to screen suspect material in ports of entry and by scientists in the laboratory to generate prosecutorial evidence against entities accused of sourcing wood illegally. When a robust collection of physical reference samples has been gathered from the natural range of a timber species, these techniques can validate or invalidate claims about the content of a product or its source^[51].

Computational social science and natural language processing: These technologies provide systematic ways to study online interactions on media and text. By automatically translating, interpreting and geolocating text information available online (like local news and media), this technology enables understanding of social movements and creation of early warning systems for crises^[65]. For example, the *GDELT Project* monitors global broadcast, print and web news from more than 100 languages on ongoing basis every day. It can be used to automatically identify issues and tag this information, putting structure around unstructured data. These databases can then be used for several problems. For example, several researchers have used this approach to create a map of environmental conflict in India^[66]. WRI has piloted the creation of near real time for land-related conflict alerts in Brazil and Indonesia using the same approach. This information, if allied with efforts to track supply of soft commodities, can deliver important insights on potential disruptions of supply chains, further increasing their resilience.

8.2.2.4 Chinese Experience of Due Diligence and Traceability Systems for

Commodities

Policy and practice on due diligence

In the context of soft commodity value chains, “due diligence” is a risk management process implemented by a company to identify, prevent, mitigate, and account for how it addresses environmental and social risks and impacts in its operations, supply chains, and investments. In China, the term “due diligence” appears in numerous policies and standards that call for systematic identification of environmental and compliance risks for financial purposes such as acquiring or maintaining listing status on stock-exchanges, acquisitions and mergers, and refinancing proposals.

However, there are currently no regulations in China that explicitly require companies to conduct due diligence in soft commodity value chains. Article 65 of the revised Forest Law (approved by the Standing Committee of the National People’s Congress in 2019) stipulates that individuals and enterprises “shall not knowingly purchase, process or transport illegally sourced timber from illegal logging or illegal deforestation”. The revision came into effect on July 1, 2020, however, regulations for implementation have not yet been issued.

In 2009, China and the UK launched a project to develop a system with simple and low-cost procedures to promote sustainable forest management in timber producing countries. Known as the *China Timber Legality Verification Scheme* (CTLVS), this project drew on international experience in timber legality verification and China’s own forest management systems. The CTLVS framework includes the *Chinese Government-guided Timber Verification Scheme* (CGTVS) which applies to countries that have entered bilateral timber agreements with China and the *Chinese Association-guided Timber Verification Scheme* (CATVS) for application in countries without such agreements. CTLVS lays out basic principles, the content of bilateral agreements, implementation and management methods for timber legality verification, relevant institutions and functions, and supporting documents on timber legality and customs management methods. The International Trade Research Center of Forest Products of the State Forestry Administration has cooperated with the China Forest Products Industry Association to pilot the wood legality verification with enterprises in China to test the accuracy, practicability and operability of the system. The pilots private valuable learning that could be to assure compliance with Article 65 of the Forest Law or adapted for application to other commodities beyond timber.

Policy and practice on product traceability systems in China

The State Council and several ministries have released policy guidance on how to develop commodity traceability systems for key products. The *Opinions on Promoting Fair Competition in the Market and Maintaining Normal Market Order* states that “the Internet of Things should be used to build a traceability system for

important products and form an information chain with traceable sources, destinations, and responsibilities" [67]. The Opinions of the State Council on *Promoting the Legal Business Environment in the Modernization of Domestic Trade Circulation* further defined the content and tasks of building, managing, and expanding a traceability system for important products [68]. The *Opinions on Accelerating the Construction of Traceability System for Important Products* lay out the main targets for establishing traceability systems for important products^① [69]. The Opinions call for improvement in standards, laws and regulations, data sharing mechanisms, companies' awareness and implementation, and the public's recognition of traceability systems by 2020. The Opinions also highlight the different roles of companies, government agencies, industry associations, and third-party service platforms in traceability systems.

In 2017, the Ministry of Commerce and six other ministries^② jointly issued the *Guidance on Promoting the Establishment of Information Traceability System for Important Products* [70]. The Guidance, building on the Opinions issued by the General Office of the State Council, sets the main tasks for establishing traceability systems for important products, including the establishment of a national traceability management system, coordinated traceability standards, data sharing and exchange, big data analysis, general investigations and emergency management. The Guidance specifies basic tasks and sector-specific tasks. In terms of basic tasks, it proposes to establish a catalog management system for important products at both the national and local levels, improve traceability standard systems, strengthen certification and accreditation systems, promote interconnection between national, provincial, and municipal traceability platforms, promote integration with upgrades of company information systems, and strengthen supervision of traceability systems. The sector-specific tasks set priorities for different sectors mentioned in the Opinions above. For the food sector, it proposes to establish a national traceability platform compiling information about country and region of origins, production companies, brands, exporters or agents, domestic recipients, and import and export records in coordination with the necessary information for Customs as well as Inspection and Quarantine to achieve traceability from production to trade and consumption.

The Ministry of Commerce leads the development of a traceability system for important products in coordination with the Ministries of Finance, Industry and Information Technology, Agriculture and Rural Affairs, Market Supervision and

^① Important Products includes edible agricultural products, food, drugs, agricultural production materials, dangerous goods, rare earth products, etc. (General Office of the State Council, 2015).

^② Other ministries include the Ministry of Industry and Information Technology, the Ministry of Public Security, the Ministry of Agriculture, the General Administration of Quality Supervision, Inspection and Quarantine, the General Administration of Safety Supervision, and the General Administration of Food and Drug Administration

others, so as to strengthen the whole process of quality and safety management and risk control.

From 2016, the Ministry of Commerce and the Ministry of Finance began piloting traceability systems for important products in Shandong, Shanghai, Ningxia and Xiamen, and completed the evaluation of these pilots in the second half of 2018. The pilot traceability systems were then expanded nationwide for products such as meat, vegetables, alcoholic products, and Chinese herbal medicines. Up to now, 58 cities in China have implemented traceability systems for meat and vegetables. 18 provinces and cities have the system for Chinese herbal medicine supply chains, and 8 enterprises in four provinces/ cities have piloted traceability for alcoholic products.

The idea of traceability systems has expanded through the pilot programs to cover other industries. "Establishing and improving the traceability system of dairy quality and safety in the whole process of breeding, processing and circulation" was written into the Opinions of the General Office of the State Council on Promoting the Revitalization of Dairy Industry to Ensure the Quality and Safety of Dairy Products. The State Food and Drug Administration has incorporated traceability into quality management standards for drugs. The Guiding Opinions on the Construction of Drug Information Traceability System propose "establishing a whole-course traceability system for vaccines" into the Regulations on the Administration of Vaccine Circulation and Vaccination. The Administrative Measures for Organic Product Certification features the need of a traceability system for product quality and safety as well as effective anti-counterfeiting and traceability technology in the certification process. The new version of the Implementation Rules for Organic Product Certification requires a product traceability system as a component of the organic product certification process.

Under the guidance of national policies, traceability systems for food, medicines, agricultural production materials, special equipment and other important products are developed at the provincial level. In some places, traceability systems support the recognition and promotion of products from impoverished areas. For example, Nanjiang County, Sichuan Province, a poverty-stricken county, established a traceability system for Chinese herbal medicines such as *Salvia Miltiorrhiza* (red sage) in 2017. The traceability system helps to verify the authenticity of Chinese herbal medicines from a region known for the quality of its products, and also creates a long-term incentive for local producers to expand the scale, quality and efficiency of their production systems.

In the context of COVID-19, the National Health Commission issued the *Notice on Further Improving the Traceability Management of Cold Chain Food* in November 2020 to reduce the risk of spreading the virus via refrigerated food^[71]. The Notice required better tracing of cold chain foods, such as meat and seafood, from customs import inspection to storage and distribution, production and

processing, wholesale and retail, and catering services. The Beijing Cold Chain Food Traceability Platform was launched, in November 2020, and other provinces and cities soon followed. The platform requires businesses to upload data such as the source, destination, quantity and location of frozen meat and seafood products and trace their source and destination. As of June 2021, the traceability platform has stations in multiple provinces and municipalities connected and accounts for more than 90% of the country's imports. The remaining 10% of imports are traced by means of paper accounts and purchase vouchers, which are also administered by the government.

The main method to trace the source of goods is to create QR code labels or RFID tags that are affixed to the goods, scan the codes to record important information at each link in the value chain, and upload and save the information to the platform's cloud-based computing system. By scanning the code on a product, a system user can access information about products' origins and quality via the internet. The lower cost QR code label tends to be used more. However, if RFID tags are used, rich information can be written into the tags (which cannot be erased), and semi-automatic scanning can be achieved in production, packaging, warehouse, and other steps in value chains.

8.3 Accelerating Circular Economy throughout the Value Chain

Circular economy is not a new concept in China. Over the past 20 years, the country has made tremendous progresses in developing circular economy pilots, policies and national strategies. As of 2020, the last year of 13th FYP, China's circular economy development has achieved significant outcomes^[72] These include:

- The output rate of major resources^① increased by about 26% compared with that in 2015;
- The energy consumption per unit of GDP continued to drop sharply, and the water consumption per unit of GDP cumulatively decreased by 28%;
- The comprehensive crop straw utilization rate reached over 86%, and that of bulk solid waste was 56%;
- The comprehensive utilization rate of construction waste reached 50%;
- The capacity of processing and utilizing renewable resources^② has been

^① Output rate of main resources (yuan/ton) = GDP (100 million yuan, constant price) ÷ physical consumption of main resources (100 million tons). Major resources include: fossil energy (coal, oil, and natural gas), iron and steel resources, non-ferrous metal resources (copper, aluminum, lead, zinc, and nickel), non-metallic resources (limestone, phosphorus, and sulphur), and biomass resources (wood and grain).

^② In the 14th Five-Year-Plan, renewable resources refer to scrap iron and steel, scrap non-ferrous metals, waste plastics, wastepaper, waste tires, waste mobile phones and waste power batteries.

significantly enhanced;

- The utilization of waste-paper was about 54.9 million tons;
- The utilization of scrap steel was about 260 million tons, replacing about 410 million tons of 62% grade iron-concentrate;
- The output of recycled nonferrous metals was 14.5 million tons, accounting for 23.5% of the total output of ten kinds of nonferrous metals in China, among which the outputs of recycled copper, recycled aluminum and recycled lead were 3.25 million tons, 7.4 million tons and 2.4 million tons respectively.

Clearly, incorporating circular economic models in the design of green value chains can improve resource efficiency in both domestic manufacturing and consumption and reduce raw material inputs and waste volumes along the entire soft commodity value chain. China has already established and piloted the within-the-industry, multi-industry and cross-industry circular economy models in industrial parks developed for key sectors including iron, steel, coal, chemicals, nonferrous metals and building materials. Circular economy practices have greatly improved resource efficiency and recycling rates for key materials, leading to significant pollutant and emission reduction and energy conservation. The country has also implemented circular economy practices along the value chains for pilot industries, covering renewable resources, solid waste, wastewater, residual heat, etc. For instance, some "urban mineral demonstration sites" have successfully incorporated recycling, sorting, depth processing, high value utilization, and harmless treatment in their product value chain. Product parts are dismantled and recycled to become feedstocks for future production. All companies within the industrial parks are connected to allow wastewater, residual heat and solid waste generated in the production processes to be reused and recycled in a close-loop recycling manner.

The same circular economy design principles can be applied to many soft commodity manufacturers to help green their value chains and broaden the application of circular economy pilots. In turn, the implementation of green value chains can reinforce circular economy development in China. In particular, new technologies focusing on traceability and transparency in value chains can gather data that can also be used to improve the sorting of materials and identify end-users to further increase end-product reuse and recycle rates. Furthermore, global sustainability standards adopted by green value chains can be applied to verify and track internationally traded recycled materials and reused products.

As described in Section 8.1.4 and despite the achievements made, China still faces major challenges for upscaling the circular economy. Accordingly, this part of the study explores the potential to green the production and consumption parts of the value chain, where commodities are made into food and material products and used by consumers. It focuses on the concept of circular economy, defined for the purpose of this study as a new way to design, make, and use things within planetary

boundaries. It involves a holistic approach to value chains that focuses on designing out waste and pollution, keeping products and materials in use, and regenerating natural systems.

While this study is focused primarily on soft commodities, once a commodity moves into the production, consumption and recovery stages of the lifecycle, soft and hard commodities are often combined. Examples include plastic packaging of food, or metal-framed and textile covered furniture. Thus, a holistic treatment of circular economy necessarily involves issues concerning hard commodities.

8.3.1 Why Embracing Circular Economy is Important for Greening Value Chains?

Box 8-8. Key takeaways – the importance of circular economy for China and greening value chains

Circular economy practices will be needed to reduce pressure on upstream soft commodity production by cutting raw material inputs in production through reduce, reuse and recycle (the 3Rs). These practices offer the added benefit of significant emissions reduction to contribute towards China's carbon neutral commitment.

Circular economy approaches are consistent with reaching sustainable development goals within planetary boundaries and are a catalyst to innovation that presents business opportunities and competitive advantages for countries and for businesses that embrace it. Such approaches include green consumption and lifestyles, sustainable procurement, product sharing platforms, products as a service and secondary markets. Of the 3Rs, reduce is the most impactful, followed by reuse and then recycle. Reduce starts with influencing customs and habits. This aligns well with Chinese holistic approaches and with the aspiration of ecological civilization. However, innovative policy and financial instruments are needed to accelerate the social transition by influencing, regulating, and incentivizing the uptake of more sustainable practices at scale.

Circular economy practices are prevailing in major developed countries at the consumption end of global value chains. As the world largest exporter, there is a big global trade opportunity for China, but one that needs to be nurtured and supported by policy. Chinese policymakers must stay open-minded to constantly update policies to track and where relevant, lead global circular economy trends and by drawing on international experiences.

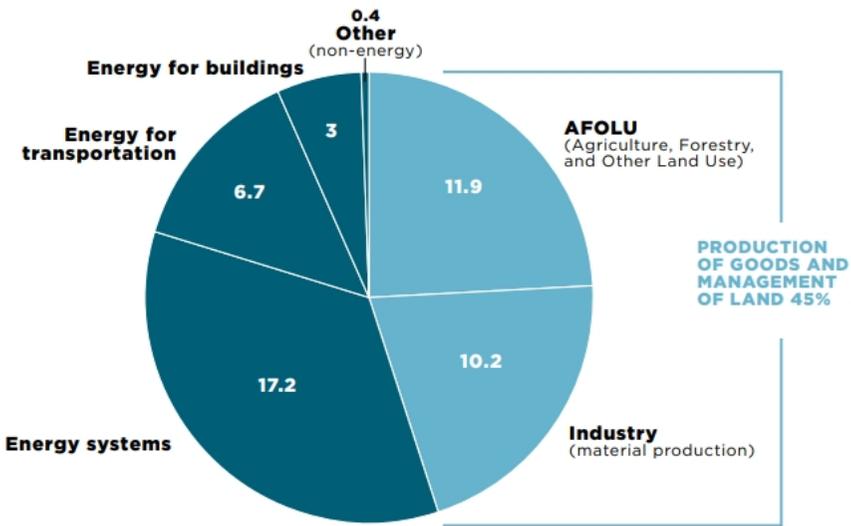
8.3.1.1 The Potential of a Circular Economy at Global Level

Global adoption of a circular economy could help reduce global greenhouse gas emissions by 39%, primary material consumption by 28% by 2030, compared to a 2011 baseline^[73], and reduce the flow of plastic waste into the ocean by 80% in 20 years^[74]. The economic benefits are also promising. Transitioning to a circular economy could close the global gap of eight billion tons between the supply and

demand of natural resources, which is equivalent to USD 4.5 trillion of economic opportunity by 2030 and US \$25 trillion by 2050^[75] add 6 million jobs by 2030 and help to retard the USD 13 billion in costs and economic losses driven by plastic pollution each year^[76].

Approximately, 45% of global GHG emissions are generated from the extraction and processing materials and from the management of land – see before.^[77] Agriculture is central to a large proportion of these emissions: the global food system (including agricultural production, processing, and distribution) emits 16 gigatons of CO₂e annually^[78]; and 23 percent of the 1.6 gigatons of CO₂e per year emitted by the textiles industry, is attributed to growing cotton^{[79][80]}.

Billion tonnes of CO₂e per year, 2010



Source: MacArthur Foundation. “Completing the Picture: How the Circular Economy Tackles Climate Change.” Ellen MacArthur Foundation, 2019a. https://www.ellenmacarthurfoundation.org/assets/downloads/Completing_The_Picture_How_The_Circular_Economy_Tackles_Climate_Change_V3_26_September.pdf.

Figure 8-3. Global GHG Emissions by Sector - 45% can be Attributed to the Production of Materials and Management of Land

The three “R” concepts of circular economy are “reduce, reuse and recycle”. REDUCE is the absolute reduction in demand due to reduced purchases by the buyer. It can be achieved in multiple ways including waste reduction at all stages in the value chain. It is important to note, however, that ‘reduce’ is explicitly linked to manufacturers and their role in the pre-market stages of the Concept and Design Life Cycle, stressing using less material per unit of production. REUSE is the repeated and optimized utilization of a product in its manufactured form, ideally for its

originally intended purpose and failing that for a lower value purpose. The process of reuse involves multiple stakeholders, from consumers, to collectors, retailers and producers. RECYCLE is the reprocessing of individual material components of a product making them available as raw materials to substitute for virgin raw materials. Recycled materials without any of the original product structure are also known as ‘secondary’ materials and can be re-applied anywhere ^[81].

Applying a circular economy approach to key materials such as cement, aluminum, steel and plastics can eliminate 3.7 billion tons of CO₂ by 2050. Additionally, circular economy strategies in food systems such as shifting to more nature-enhanced farming systems and making more effective use of the already produced food could reduce CO₂ emissions by another 5.6 billion tons by 2050. This would be equivalent to cutting all transport emissions to zero ^[82].

8.3.1.2 What is the Significance of the Circular Economy for China?

Research shows that a full embrace of the circular economy has the potential to save Chinese businesses and households roughly CNY 70 trillion (US \$11.2 trillion) by 2040 in spending on high-quality products and services, approximately 16% of China’s projected GDP. It can also improve the health and well-being of the Chinese population in cities by reducing greenhouse gas emissions by 23% and the haze-inducing fine matter particulates by 50% ^[77].

With prevailing circular economy practices in major developed countries at the consumption end of global value chains, the need for Chinese manufactures to meet the growing demand for sustainably produced products elsewhere will also reinforce China’s efforts in greening global value chains for soft commodities. Central to this shift is China’s broader relationship with the world. Already with a well-established framework for circular economy – epitomized by its 2008 Circular Economy Promotion Law – China can continue being a leader in this space by evolving its policies to keep pace with global circular economy trends and by learning from international experiences. Such trends can help to raise the ambitions of Chinese circular economy practices – moving beyond industrial strategies to ones inclusive of sustainable consumption. Already, through the 2018 China-EU Memorandum of Understanding, China has forged an alliance with the EU to exchange policy ideas to align key circular economy mechanisms, product standards and systems. Such collaborations can help to boost widespread adoption of innovative circular economy practices and support the development of a global low carbon economy ^[82]. Additionally, there is great opportunity to enhance China’s trade relationships around the world. Reframing these relationships in light of circular practices presents an opportunity for win-win collaborations with environmental, economic, and social benefits.

Bundled together, the mandates from its 14th Five-Year Plan, Six Securities and recent 2030/2060 carbon commitments can largely be tackled by fully embracing

circular economy. This will set China on the path to achieve the economic, social, ecological, and environmental targets laid down by the 14th FYP, which are crucial for the post-COVID economic recovery in the near term as well as for the realization of the Chinese dream in the medium- and long-term ^[2].

8.3.1.3 Circular Economy can Make a Significant Contribution to China's 2060 Carbon Neutrality Goal.

Clearly, reducing the use of materials can significantly contribute to carbon emission reduction. This is particularly the case for China – the world's largest manufacturer of steel (57% share of global production), plastics (25% of global production), and cement (51% of the world's production) ^{[84][85][86]}. Finally, greenhouse gases (GHGs) emissions from the Chinese agrifood systems should not be ignored, accounting for 1.09 billion tons CO₂eq or 8.2% of the total GHG emissions of the country in 2018 ^[87]. Hence, reducing food loss and waste could significantly cut emissions from the agrifood industry. Examples of how circular economy measures can reduce emissions are presented below.

Firstly, raw materials as production inputs can be reduced through improved product design and production processes that allow for minimized use of raw materials, increased use of recycled materials to replace raw materials, and increased longevity of products. In this regard, innovations are needed to improve the efficiency of the mechanical recycling of materials. For example, Apple uses its own designed AI robot Daisy to disassemble 15 different models of iPhones automatically in a speed of up to 200 devices per hour. This innovation makes it possible to recycle more materials in end-of-life iPhones with downstream recyclers. Currently, in the latest iPhone model, there are many recycled materials used in different models including 100% recycled rare earth in the magnets, 100% recycled tin in the main logic board solder and 100% recycled tungsten in the Taptic Engine etc. ^{[88][89]}.

Secondly, the use of raw materials can be reduced by preventing and reducing material loss and waste in production, processing, distribution, and retail. Currently, more than 6% of China's total food production (or 35 million tons) are lost and wasted in China ^[90]. Cutting food loss and waste per year has the potential to reduce demand for 13 million hectares of agricultural land ("liberating" marginal agricultural land to rebuild the country's carbon sink via reforestation), significantly decrease fertilizer pollution (reducing emissions of the N₂O) ^[91] and taking pressure of agricultural production off nature.

Thirdly, and equally important is reducing consumption, which can effectively reduce the total demand, leading to lower production outputs to match it. This requires a major shift in our current consumption model by reducing consumer food waste, encouraging sharing economy, and increasing the use rates of products through secondary markets and rental markets. Together, these measures

can extend the lifespan of products, lowering the demand of material input for the manufacturing of new products, which can subsequently reduce the upstreaming production pressure and emissions generated during production.

From an emission reduction perspective, reusing products can conserve the energy embedded in the resources and processes used to produce different products. Consequentially, the more a product is reused, the bigger the avoided emissions and economic savings are, by refraining from using the otherwise needed resource to produce new products. Additionally, this would avoid the emissions derived from the end-of-life processing of these new products, such as disposing them in a landfill or incinerating.

After product reuse, materials recycling is the next priority. Emissions reduction potential through recycling varies by materials. Table 8-2 below presents the GHG inventories of different materials in primary and secondary production^①, indicating clear potential for CO₂ emissions reduction through recycling. Notably, aluminium is among the materials with highest potential for emission reduction when being recovered, followed by steel, plastics, glass, paper and cardboard. This suggests that the recycling of some materials can lead to 3 times more emission reductions than others and therefore should be prioritized for climate mitigation strategies. However, evidence also suggests that not all materials can be indefinitely recycled. For instance, elements such as aluminium, glass and metal can be recycled over and over again without suffering any structural change, whereas plastics can be recyclable on average up to 3 times. During this process, plastic loses its structural property, therefore could only be used for lower value products before being disposed in landfills^[92].

Table 8-2. Comparing CO₂ Emission Reduction Potential Across Different Materials

Material	Primary production (Kg CO ₂ eq/ Kg material)	Secondary production (Kg CO ₂ eq/ Kg material)	Emission reduction potential through recycling (Kg CO ₂ eq/ Kg material)
Glass*	0.9	0.5	-0.4
Aluminium*	11	0.4	-10.6
Steel*	2.4	0.3	-2.1
Plastic*	2.1	1.3	-0.8
Paper and Cardboard*	1.1	0.7	-0.4
Cotton**	11	4.3	-6.7

Source:

^① Primary production refers to production using raw materials as input in the process, whereas secondary production refers to the usage of recycled elements as input in the process.

Hilman, Karl, Andres Damgaard, Ola Erickson, and Daniel Jhonson. "Climate Benefits of Material Recycling Inventory of Average Greenhouse Gas Emissions for Denmark, Norway and Sweden." 2015. <https://www.oecd-ilibrary.org/content/publication/tn2015-547>.

Liu, Yun, Hailong Huang, Libin Zhu, Cheng Zhang, Ren Feiyue, and Liu Zhifeng. "Could the Recycled Yarns Substitute for the Virgin Cotton Yarns: A Comparative LCA," 2020. <https://doi.org/10.1007/s11367-020-01815-8>.

8.3.1.4 Circular Economy Principles Allow Producers to Contribute to China's Dual Circulation Policy while Reducing Pressures on Nature Resources

In 2019, domestic demand accounted for 89 percent of China's economic growth, and final consumption expenditures contributed to 58 percent to GDP growth ^[2]. As we approach the natural and mineral resource boundaries of the planet, current consumption patterns will not be sustainable and will be a brake on growth unless other patterns for demand generation can be found. The growing middle class and the increased population of younger "netizens" have created just such an opportunity for the upgrading and green transition of China's consumption toward more sustainable consumption patterns and sustainably sourced and produced products. Focusing on promoting green consumption in China, circular economy practices can provide practical solutions to continue growth without coming up against resource limits.

More specially, from a production viewpoint, a new circular economic model will improve the circularity of materials by reinforcing the 3-R from the design to production, improve resource efficiency, reduce the impact of production, and subsequently improve the environmental quality and human health. For instance, with consumers becoming ever more concerned with sustainability and eco-friendly formulas, beauty brands such as *Lush* launched its first "Naked" shops in 2018 where solid soap and shampoo bars have completely eliminated the plastic packaging by redesigning the products according to eco-design principles. Other companies have started to follow suit. In 2019, Marks & Spencer started to trail over 90 lines of loose fruit and vegetables completely free of plastic packaging at its Tolworth store and expect to save 580 tons of plastic waste over two years. Moreover, trained greengrocers were introduced to offer customers advice on the selection and preservation of fruit and vegetables to avoid food waste at home ^[96]. Today, zero waste lifestyle has begun to emerge across Europe. For instance, in the UK alone, over 100 zero waste stores are offering opportunities for plastic free shopping ^[97].

Further down the value chain, circular economy can also promote green consumption and foster green lifestyle through sustainable procurement, sharing platforms, products as a service, secondary markets and the like. Reuse models extend the lifetime of products and reduce upstream pressure on production. Meanwhile, the increasing demand for quality and sustainable products in the

domestic market will also accelerate the adoption of sustainability, and/or safety standards on imported raw materials, which reinforces strategies to green global value chains. Below, we present a few concrete examples to illustrate how circular economy could support China's dual circulation policy.

Reduce the use of unsustainably sourced raw materials to meet the increasing domestic demand for green consumption in China

Purposeful design is one of the guiding pillars of the circular economy. With around 80 percent of a product's future environmental impact determined in the design phase ^[98], carefully sourcing and use of materials for quality, durability and health is key. Good design can incentivize consumer behaviors that promote repair, reuse, and recycling of products, whether it be through longer ownership, service-based models of use, or repurposing a material. Consequently, this can lead to reduced raw material usage for production. In some cases, lifting design standards as requested by legislations or certifications can also accelerate the process to green value chains, and increase resource efficiency and sustainable sourcing to reduce the overall environmental impacts.

Taking eco-design as an example, the concept is not new, but the challenge lies in incentivizing producers and manufacturers to kick start the circular value chain. Countries around the world have already developed legislation and certifications that aims to promote eco-design. In Europe, for example, the Eco-design Directive provides design guidance on products made in the EU that impact energy consumption, such as heaters, water-using devices, and insulation materials. This measure is estimated to save 167 TW hours of energy savings per year by 2030, equivalent to the annual energy consumption of Denmark ^[99]. France has taken this framework one step further with its 2020 Circular Economy Law, which proposes strict provisions on right to repair, rules around the destruction of unsold goods, and waste management. The law would, for example, require producers and importers to inform consumers of their products' environmental attributes, from recycled content to possibilities of reuse ^[100]. The EU has recently updated its Eco Design Directive to also cover the longevity aspect of the product design. It requires that spare parts of a product need to be available on the market for a longer time to allow for repairs in an easy and accessible manner ^[101].

As an early proponent of the circular economy, China has traditionally focused on end of pipe waste management, pollution prevention and cleaner production. But in the recent 14th FYP for circular economy development, Chinese government has made it clear that improving the standard system of circular economy and specifications of green designs will be a priority for the next five years. By transitioning to a more systemic model that, among other things, encourages smart eco-design, China can continue to manage these issues while aligning with the holistic approach to circularity. Similarly, the promotion of green buildings in urban

areas sets an example to reduce environmental impacts through good design. To curb greenhouse gas emissions from construction and reduce its impacts on natural capital and biodiversity throughout the value chain, the Chinese government has recently imposed more stringent regulations on real estate. This was made clear in China's 13th five-year plan, which requires that by 2020, up to 50% of the newly constructed buildings in urban areas must meet green building standards and up to 40% of construction materials must be green. Meanwhile, the number of people interested in purchasing green homes has grown three-fold in China between 2012 and 2017^[102].

New regulations together with the shift in consumer behavior has started driving the transition to green buildings that use more sustainable construction materials. It led to the creation of the "Green Supply Chain in Real Estate Industry in China" initiative in 2016, which is a business alliance of key stakeholders including real estate companies and the upstream (e.g., building construction, construction materials manufacturing) and downstream sectors (e.g., furniture manufacturing) to develop joint actions towards greening value chains^[103]. As of 2019, it has involved 100 real estate companies and 3,669 whitelisted domestic and international suppliers. The annual sales of these enterprises are valued at US\$290 billion, accounting for about 20% of the total industry in China^[103].

Since its inception, the Initiative has achieved notable success. It made significant contributions to improving legal and responsible sourcing of timber in the Chinese real estate sector by incorporating a "White List" standard into the joint procurement bidding documents endorsed by all member companies since 2018. With technical support received from the Global Forest & Trade Network, the joint procurement policies clearly state that green timber materials must not be sourced from forests with high ecological value, from tree species listed by the Convention on International Trade in Endangered Wild Animals and Plants, from forest areas without clearly established tenure rights, from areas undergoing forest and agricultural land conversion, or from genetically modified timber. This effort has led to approximately US\$28 million of wood flooring being procured (22% of China's total market) from legally logged forest land, which represents an important effort in forest conservation and eliminating the negative biodiversity effects of timber harvesting^[103]. By 2025, the initiative aims to expand this effort to shift over 50% of Chinese flooring companies to using FSC certified timber, bringing over 5 million ha of forest under sustainable management and contributing to global biodiversity conservation efforts^[104].

Focusing on high-quality design will allow Chinese companies to better address the increasing green consumption in the country while reducing the use of unsustainably sourced materials and environmental impacts. However, Chinese government must ensure a well-functioned monitoring and evaluation system in

place to support the market transition. For instance, it can develop a mechanism to certify the green value chains which could incorporate other well-established global certification schemes and sustainable standards such as the FSC certified timber. Additionally, strengthening the relevant regulations and law enforcement is also important to obtain expected outcomes.

Reuse business models powered by digital solutions can fuel China's economic growth within resource limits

Reuse of products allow for diminished resources consumption; one emerging business model is the sharing economy model which has many concrete applications including shared mobility, garments, power banks and so on. It entails the temporary use of goods and services which can be achieved through private individuals or companies owning the product and providing it as a service to consumers. Ultimately, the environmental benefit derives from an increased utilization of different goods and assets as well as their extended lifetime, which can conserve the embodied energy and other value resources and avoid GHG emissions associated with new material productions and end-of-life treatment^[105].

Taking the fashion industry as an example, the sharing economic model has seen growing popularity over the past decade, especially for designer products, including garments, shoes and accessories that are occasionally used by the middle classes in special social events. For instance, in 2009, "Rent the Runway" emerged as an e-commerce platform that allows users to rent, subscribe, or buy designer apparel and accessories. Since 2016, the business has started scaling drastically by accelerating the subscription business and became profitable. As of 2019, the company was valued over \$1 billion^[106]. Such a business model is replicable for Chinese market and could have even bigger business potential for the rapidly growing middle class, which expects to grow from 57% of the economy in 2015 to reach 75% by 2030^[107]. In fact, similar concepts have already started to emerge in China since 2014, including MsParis, Y-Closet, Yeechoo, Starluxe, Yiqidai, and Dou Baobao^[108].

Meanwhile, the luxury market is expected to expend and grow as the Chinese avidly embrace new lifestyles and new consumption habits. This rapid growing demand can be partially met through the sharing economy, whose transaction volume is expected to grow 10 percent annually from 3.38 trillion yuan (\$522.47 billion) in 2020 (Ministry of Information Industry 2021). Furthermore, e-commerce will expedite the online sales of luxury brands to reach the Gen Z from outside the first-tier cities, as 80% of Chinese prefer to buy online when it comes to luxury^[107].

Finally, reuse can also occur through secondary markets to buy a used item of apparel or furniture. Whereas rental works well in luxury markets, reselling as a form of resale currently works better in mid markets. Chinese e-commerce giant Alibaba Group runs a resale consumer marketplace called Xianyu, where users can buy and sell second-hand products and use the parent company's logistics system if

they choose.

All in all, creating new sharing economy and reuse models can increase the use rates of products. This will not only meet the increasing domestic consumptions for high-quality life, but also drive the growth of new demand without increasing production, hence less demand for raw material extraction as production input. This serves the engine to power high-quality development and green growth as noted in the 14th FYP.

Despite these important benefits, the possible rebound effects (or Jevon's paradox) of sharing economy should not be ignored. Here, rebound effect refers to the reduction in expected gains from increased efficiency of resource use through shared products, because of behavioral changes toward an increasing demand of product sharing, which may diminish the beneficial effects. Sharing economic model makes it cheaper for consumers to rent a luxury item than owning one, which collectively may increase the demand for these products. To minimize the risk of unintended rebound consequences, right policy incentives would be needed to guide the development of healthy consumption habits.

Increase recycling as an alternative solution to meeting the growing domestic consumption

While keeping products and materials in the economy through reuse that which cannot be reused can still retain value through recycling. Increased recycle rates of wood-based materials can also help China as an importer to reduce dependence on the imports of timber, which will take pressure off tropical forests. This can be done through interventions in the building construction, furniture manufacturing and paper industries.

The Chinese real estate sector is the fourth largest in the world in terms of market value (US\$540 billion) ^[109]. It is also expanding the fastest, with China adding 2 billion m² of floor area each year in its rapidly growing cities ^[110]. Additionally, China's real estate sector will expand its construction business overseas through the Belt and Road Initiative. This continuous expansion has important environmental implications both domestically and internationally.

Currently, construction and furniture manufacturing industries accounted for 51% of China's timber consumption in 2019, of which 60% was imported ^[111]. The consumption and total import volume of timber in China is expected to grow to meet increasing demand. However, a national restriction on logging makes it even harder for China to meet its needs for timber through national sources. Consequently, the market for reclaimed wood as material for flooring has been rapidly growing. While this reduces pressure on upstream production, the Chinese government must complete and strengthen the regulations on the use of reclaimed materials to minimize potential risks to human health. This is because the presence of hazardous substance during the production phase will remain in the recovered materials. Some

countries have already developed policies to regulate the recycled materials to avoid negative health impacts. For instance, the biocide regulation of the European Union (528/2012) clearly prohibits the presence of hazardous substances such as formaldehyde resins on wood-based panels.

China has been the world's largest paper since 2010, accounting for 25% of the global production ^[112]. The consumption of paper has grown massively over the past decade, largely driven by the booming of e-commerce and associated packaging. In 2017 the industry processed 40 billion orders, which implied 100 million parcels each day, and 7.9 million metric tons of packaging waste. Of it, 86% were scraps of corrugated paper, while plastics represented 3.6 %. The current demand of virgin fibers for paper production cannot be met through national sources ^[113].

A clear solution lies between sourcing timber internationally and increasing paper recycling rates. However, the former has significant local impacts in the sourcing countries. Consequently, circular practices focusing on recycling could allow China as a buyer country to reduce the pressure on countries with large deforestation fronts ^[114] Recycling has a huge potential in meeting the continuous growing demand for paper. For instance, 60% of paper packaging and almost the totality of plastics was not recycled in 2017 ^[115].

However, while increasing recycling rates is crucial, solutions on the production side alone do not address the deep-rooted problem of our current unsustainable growth model: the unsustainable expansion and growth of consumption driven by the rapid growing population and income. An alternative approach is, therefore, eliminating paper and cardboard packaging altogether and replacing it with reusable containers and a comprehensive reverse logistics system. The latter will also require the shift of existing consumption pattern. A good example of this is RePack's business model. The company operates as a provider of postal packaging products to online stores. Consumers can opt for RePack's packaging service and are offered a voucher once they send the packaging back by post. While consumers can make use of the voucher with any other online platform, retailers can align themselves with environmentally sound delivery services and create loyal customers that seek to reduce environmental impacts in their everyday life. This allows RePack's to reduce 80% in the carbon footprint as compared to disposable plastic packaging ^[116].

8.3.1.5 Circular Economy Practices Focusing on Sustainable Consumption can Set the Foundation for High-quality Development

Equally important, the 3-R concepts of circular economy can be applied to accelerating the shift of consumers' behavior toward a "reduce and reuse" model. This will cut the need for raw materials while increasing the demand for products that are made from recycled materials, which will, in turn, reduce the need for imported raw materials that are used as production inputs. Examples of such consumption-based strategies are set out below.

Shift the consumption model to reduce food loss and waste and the use of plastics

Food loss and waste (FLW) is increasingly a major challenge for China. It accounts for approximately 35 million tons of food annually, or about 6% of the country's total food production, an amount that could feed between 30 and 50 million people ^[117]. Roughly half of FLW occurs at the downstream end of the supply chain, whether it be in retail stores or at the hands of consumers. Restaurants and canteens present on average a 28% of the FLW ^[118]. In the meanwhile, China is facing shrinking arable land for growing food, largely driving by land degradation - about 40% of its soil already moderately or severely degraded ^[119]. This means China must address FLW through consumption to increase food security and reduce pressure on agricultural expansion.

Efforts are already under way in China to address the issue. In 2020, President Xi announced the Clean Plate campaign, which encourages consumers to order less at restaurants ^[120]. Furthermore, China's new food waste law will impose a fine up to 100,000 yuan to anyone who promotes overeating on popular social media channels such as binge-eating videos. Restaurants will also face fines if they induce or mislead consumers to 'order excessive meals and cause obvious waste' ^[121]. In response to the campaign against food waste, local-led efforts have been implemented across China. For instance, since April 2020, Jinling Grand Hotel in downtown Hefei started to reward diners a 10 percent discount or a 50 yuan (US\$7.19) coupon to use on their next visit if they take away their leftovers ^[122].

However, more innovations are needed to promote a change in people's customs and cultural attitudes that will reduce wasteful food consumption habit and encourage healthy diet ^[121]. For instance, policy incentives or new business models driven by technology can nudge retailers to sell food that would otherwise be wasted at a discount. For instance, to deal with an uncertain and fluctuating demand, Lunchie and ResQ created a market-place via a mobile app, which allows catering locales to sell surplus food at a discounted price to local customers who can pick up food at specific time windows. This app provides a win-win solution to consumers who can easily access to high quality food at lower price, and to local restaurants who can avoid food waste and associated revenue loss ^[123].

In addition to food waste, single use of plastics also urgently needs to be tackled. China produces around 20 million tonnes of single-use non-biodegradable material annually, including 3 million tons of shopping bags ^[124]. Policy innovations are urgently needed to nudge citizens towards lower consumption of plastic packaging. On 16 January 2020, China announced a ban, jointly issued by the National Development and Reform Commission (NDRC) and the ministry of ecology and environment, on single use plastics in restaurants, shopping plastic bags, and cosmetic products containing microplastic. The ban has come into effect on January

1st, 2021^[125], expect to reduce plastic use in takeout in the cities by 30% by 2025. The effectiveness of the policy is yet to be seen, but provinces throughout the country have since issued their plans for implementing the national policy.

Meanwhile, research in substitute products to replace plastics is also on the rise. For instance, fast-food restaurants started to offer *Bakeys* spoons, forks, and even chopsticks that are made of sorghum, rice, and wheat flour. *EnviGreen*, an Indian company invented store bags made of starch that can become food for animals after use^[126]. There already exist many inventions that have been commercialized. They provide consumers with more options to replace plastics and therefore support behavior shift toward reduced plastic usage.

Shift consumers' behavior to encourage the reuse of plastics, reducing the need for raw material inputs.

Reuse models are a clear example of how circular economy can lead to a reduced need for raw material inputs, bringing along economic and environmental benefits. For Example, at a global level, the reuse of 20% of the total plastic would generate economic benefits for USD 10 billion^[105].

Packaging reuse is of great importance to China. Its citizens generated 60 million tons of plastic waste in 2010 alone^[127]. At the same time, China is a major manufacturer of plastics as well, producing 20% of the world's plastics^[128]. During the COVID-19 pandemic, plastics production soared due to the increased demand for personal protective equipment and single use plastics like takeout containers and packaging for online purchases. By addressing the production and use of plastic, China would also be able to reduce fossil fuel consumption and imports, important raw materials for plastic production^[129].

There are four practical ways to encourage plastics reuse at the end of value chain through a B2C (business to consumer) service model. Firstly, consumers can refill plastic containers at home using refills that are delivered based on a subscription service. To bring this new business model to scale, it requires that leading companies should come together to redesign and standardize their containers. For instance, TerraCycle, a social enterprise based in the US has developed a Loop platform that aims to change the way the world shops with favorite brands in refillable packaging offered with convenience and style. Secondly, business could provide a pickup service to refill the container and return it to the customer. Thirdly, consumers could opt for refilling containers at shops and other retail locations. Finally, consumers could opt for disposing their container at specific locations from which businesses could later pick up, clean and refill; making the product ready to be sold again at retail shops. As an example, Splosh shampoo is provided within a container that allows to be reused up to 20 times. As a result, 95% of material usage is avoided as well as the energy required in the production process of the plastic container^[105].

All in all, the benefits of reuse models for plastic containers are beneficial from

an environmental and economic point of view. At the same time, they are diverse and can be implemented in different manners, being it applicable to a vast array of products. However, to upscale the reuse model, governments and businesses will need to create incentives to attract more consumers to participate.

Shift consumption to lead new fashion trends that promote the use of ecofriendly materials

The textile industry creates significant environmental impacts through the production, extraction and utilization of raw materials for natural fiber production. For example, cotton, accounting for 43% of all the fibers used within the European market, is characterized by a high-water footprint. The production of wool, another important material for fiber, generates significant GHG emissions ^[130].

As consumers become more aware of how dirty the fashion industry can be, they have taken action to demand more from the industry. Consumer demand for more sustainable consumption can drive improvement in business practices and foster new sustainable fashion trends to emerge. For instance, the iconic luxury brand Hermes teamed up with American start-up *MycoWorks* to recreate its popular *Victoria* duffel bag using *Sylvania*, a material made from mycelium or mushroom roots ^[131].

Additionally, the scarcity of raw material has forced many brands in the fashion industry to make use of recycling to meet the increasing demand for clothing. Over the past years, “Fiber to Fiber” as a sustainable alternative to raw material has already begun to emerge. However, the practice of recycling fibers to be used as input in new products is in its initial phases and hard to achieve the economy of scale. Shifting consumer demand can lead to increased investment in technological innovations that will address the transformation suffered by fibers during the recycling process, such as shortening lengths, the current use of blends of fibers for garment, and other substances involved in the production process. Moreover, a change in consumer preference can also drive the increasing use of recyclable and recycled materials in fashion design, contributing to the sustainable transition of the fashion industry. For instance, Muiccia Prada’s and Raf Simons’s collaboration collection started to produce garments made from 100% recycled nylon ^[131]. H&M, in partnership with the research institute HKRITA in Hong Kong, developed a technology that can separate cotton from recycled polyester fibers without damaging them. The recycled polyester has then been used for a children’s clothing line, contributing to the company’s emission reduction target ^[132]

As the world’s largest textile cloth manufacturer, China can be greatly affected by changes in domestic and international consumption patterns. Greener consumption style is already gaining traction, especially among the middle class. Today, consumers are becoming more aware of the environmental impacts of textile production via social media, campaigns and peer influence and are willing to pay for more sustainable lifestyles. China’s central and local governments can also support

the transition to sustainable consumption through green public procurement. In the Netherlands, for instance, the Ministry of Defense specified a preference for recycled fibers in a large contract for the supply of towels, clothes and overalls^[79]. Designers also have an important role in integrating recycled materials in fashion design, which can create fashion trends that also support the transition to green consumption and a healthier lifestyle within the planetary boundaries.

8.3.1.6 Circular Economy can Spur New Business Opportunities for Chinese Enterprises

The influence of evolving global trade dynamics and policies on Chinese enterprises

As countries continue to build their interest in the circular economy, global trade policies and practices also need to be designed with circularity in mind. This important reframing to how countries think about trade is rife with opportunity. While circular economy transitions have historically been driven through domestic policies such as those mentioned in the previous section, it is increasingly evident that trade is also important since most goods are linked in some way or another to global value chains^[133]. And as a dominant force in global trade, it is critical for China to be cognizant of the economic, environmental, and social implications of cross border flows.

Within global trade dynamics, individual countries can set policies that bring circularity into international trade. Extended Producer's Responsibility (EPR) policies, for example, require producers to take responsibility for the products they bring into the beyond the consumption stage of the products lifecycle. EPR policies are often applied to products sold domestically but can also be extended to exported products. Producers would then become responsible for the collection, sorting and after use recycling of the goods in countries to which they are exported^[134].

Industry-wide initiatives related to circular economy will also usually require supporting trade policies and practices to succeed. For example, by prioritizing eco-design, an industry can reduce waste through better product design, and make it easier to disassemble the parts of a product for reuse or recycling. Such practices, however, need "demand pull" to drive the supply. Countries can use trade regulations to generate such demand, along with harmonized standards, in multiple cross-border markets.

Global trade designed with circularity in mind provides benefits beyond the environment such as economic diversification, technological growth and innovation, and new skills development^[135]. If well-regulated, trade can move waste and materials to destinations that have better capacity to sort and process them^[133]. Open markets can be a powerful tool for good, and well-considered trade policies can reap positive commercial benefits. China can find greater security and stability in its supply chains by approaching trade and the circular economy as an interlinked system. Furthermore, as the trade in services is increasingly gaining more tractions than goods in global trade, this will create new circular economy business models in

China, especially for small or micro-sized tech firms. For instance, the most-traded services related to the circular economy include: IT services, other professional, technical, and business services (such as technical testing or environmental consulting services), leasing or rental services without an operator, R&D services, maintenance, repair, and installation (except construction) services, sewage and waste collection services and professional services related to construction services 0.

Additionally, China has a significant opportunity to assume leadership in issues of trade and circular economy, especially since the linkage between the two is still in its infancy. China can, for example, leverage the global market as feedstock for recyclable or reusable materials while simultaneously encouraging a shift in consumption habits among its 1.4 billion citizens. Additionally, plurilateral collaboration can benefit the health of intra-country relationships and extend beyond trade to other matters. China has already embraced a spirit of global cooperation, illustrated for instance, through its recent spearheading of the plastics initiative through the World Trade Organization. Today, majority of goods are linked in some way or another to global value chains ^[133] And as a dominant force in global trade, it is critical for China to be cognizant of the economic, environmental, and social implications of cross border flows.

The booming circular economy market and business innovations in China

Circular economy business models have already begun to emerge in many economic sectors in China. Many of them have generated considerable market revenues and create decent job opportunities to many.

The opportunities of the sharing economy and service provision. As previously mentioned, sharing platforms, and products as a service, bring along environmental benefits, but also economic opportunities. In China alone, the sharing economy supported US \$500 billion in transactions by 600 million people in 2019 – anticipated to represent 20% of China’s GDP by 2025 ^[137]. Of the 0.76 billion people participated in sharing economy in China in 2018, about 75 million were service providers ^[138]. In 2020, the size of the sharing economy workforce reached 84 million, of which 6.31 million were directly employed by online sale platforms (Ministry of Information Industry 2021). Expanding the sharing economic model to include the rental of designer clothing and furniture could further boost the market opportunity for shared commodities. Already, online platforms like YCloset are embracing this direction, providing a clothing rental service for consumers who pay a monthly subscription fee. YCloset has attracted high profile investors like Alibaba and brand partners like H&M, and as of 2019, had 15 million registered subscribers ^[139]. The new economic model requires businesses to transition from product providers to service providers, which can generate promising economic benefits. For example, the global maintenance and repair market was valued at \$1.3 trillion in 2019 ^[140]

The opportunities of reuse models. Globally, an estimated \$460 billion worth

of underutilized apparel is thrown away annually. If a garment is worn on average twice as long, the textile industry would potentially emit 44% less greenhouse gas^[141]. Additionally, the second-hand clothing market is expected to grow five times in the next five years to US \$64 million^[142]. Domestically, reuse models could not only reduce negative environmental effects within China, but also generate business opportunities. In China, only 10-15% of the approximately 26 million tons of textiles discarded every year is collected and reused, suggesting ample opportunity for more reuse opportunities^[143]. Additionally, second-hand market for luxury products has huge potential in China. The demand has been rising steadily since 1990 and by 2017 the total sale accounted for 8 billion Yuan, with a foreseeable increasing at a rate of 20%. In the same year, the total number of second-hand luxury product stores was roughly 2500, of which 400 stores were specialized in newly used second-hand products. The demand for second-hand luxury products has become a viable option for the growing Chinese middle class^[144].

Reuse models have also gained significant momentum in the world of packaging where a third of packaging ends up in landfill^[145]. This growing interest stems from the increasing recognition that reuse models offer not only a new range of solutions to plastic pollution, but also the potential to unlock significant business benefits. For example, Unilever has committed to reduce virgin plastic packaging by 50% by 2025, with one third coming from an absolute plastic reduction, and packaging producer Amcor's sales of reusable and refillable PET containers in markets where refill programs exist have doubled in the last two years^[146]. The Chilean startup *Algramo* aims to eliminate plastic packaging through its smart vending machines that dispense products like household cleaning products into refillable packaging^[147]. And such innovations are accompanied with high economic potential as well. In fact, converting 20 percent of the world's plastic packaging to reusable alternatives could translate into a US\$10 billion business opportunity^[148].

New recycling business model empowered by technology. China has seen a growing number of tech companies participating in recycling business. New technologies such as the internet of things and big data have been applied to transform the household recycling business. They can improve the classification and sorting of domestic wastes, dramatically increase the household recycling rates, and create different forms of incentives including gifts, credit, vouchers to reward households based on their preferences. The involvement of high-tech companies will change people's attitude toward recycling industries and create more decent jobs, especially to well-educated younger generations.

However, national-wide large-scale recycling systems in China are still in its infancy but evolving rapidly. For instance, China launched a pilot program to create "waste-free cities" in 2019 and by end of 2020, the program expected to build 100 new large-scale recycling bases to tackle solid waste^[149]. New technologies could

have an important role in scaling up the small-scale recycling models in China, by tackling particularly the final consumers. For instance, deposit-return recycling model has already existed for decades in many cities. It was implemented by bottling companies to effectively collect empty glass bottles (for beer and coca cola, for example) from end consumers via local community stores. These bottles can then be cleaned the reused by the same bottling companies, which is an important cost-saving strategy. The principle is similar to the Deposit Return Schemes (DRS) in the western world. Through it, consumers are asked to pay a fee for the price for single use metal / glass or plastic containers in which the product they buy is delivered. Being bottles for the selling of drinks the most common example. Upon return of the bottle, consumers receive their deposit back ^[150]. China could adopt the DRS to expand its existing deposit-return recycling model at the national scale and use new technologies to better classify and sort waste to improve recycling rates.

Box 8-9. Key Takeaways – Enablers of Circular Economy in China’s Value Chains

A combination of higher product standards, green finance, advanced technology, strengthened regulation and new business models are key to promote circular economy in China. The systemic change needed calls for a holistic approach that is best ensured through a coordinated green value chain mechanism.

Establishing design and product standards and certification systems based on circular economy principles can both support a national strategy for better waste management encourage transparency in cross-border trade. Setting regulations and product certifications to support secondary markets for recyclable raw materials, goods and waste indirectly supports consumer demand for higher quality, recycled products.

Innovative green finance solutions are needed to break down barriers to accessing finance for circular economy business models, particularly that sought by small and medium sized enterprises.

Advanced technologies like robotics, blockchain, and the Internet of Things can help to accelerate the transition to a circular economy through disruptive change, from improving transparency to enhancing the recyclability or reuse of products.

Appropriate regulation is needed to create incentives for circular economy throughout the value chain. Examples include Extended Producer Responsibility (EPR) and Deposit Return Schemes (DRS), two schemes that have proven to be of great use to develop reuse and recycling by both producers and consumers. Strengthened institutional capacity and law enforcement will be needed to ensure their success.

New circular business models are needed to ensure businesses thrive in a circular economy and to nudge consumers to make optimized circular decisions.

8.3.2 Five Enablers of Circular Economy in China's Value Chains

The opportunities in the circular economy are vast, and as discussed, there are myriad ways for China to apply the latest practices and trends. In this pursuit, China can leverage five cross-cutting enablers to enhance and facilitate its circular economy policies, which are the focus of this section. The cross cutting and intersecting nature of these enablers calls for a coordinated approach which could be included within the remit of the Global Green Value Chains Institute.

8.3.2.1 Circular Economy Design and Product Standards and Certification Systems

China is well-positioned to develop align its domestic circular economy polices to the highest standards, setting the pace on the international stage. China could establish itself as a recognized force in design and innovation, and counter current perceptions of Chinese manufacturing as low cost and low quality. Establishing clearer product standards and certification systems that can be implemented through China's green value chain mechanism can both support a national strategy for better waste management while also encouraging transparency in cross-border trade. Through regulation and product certification systems, China can directly support the growth of secondary markets for recyclable raw materials, goods and waste and indirectly boost consumer demand for higher quality, recycled products.

China's laws and guidelines adopted on product standards to help reduce plastic provide an existing example of such regulation and standard setting in China. The General Administration of Quality Supervision, Inspection and Quarantine, a ministerial-level department under the State Council, has elaborated two product standards for manufacturers: the 2013 Product Standard on Plastics, particularly polystyrene compounds, and the 2014 Product Standard on Paper and Plastics, including laminated films and pouches for food packaging. These standards, however, are not legally binding ^[151].

Other examples of how regulations and standards could foster the mainstreaming of circular economy include: requiring application of extended warranty periods to all electronic appliances; and standardized information on repairability and reuse of products and related incentives to encourage their repair and reuse.

There is also a need to harmonize and integrate certification systems that are tailored to different stages of the value chain. For example, standards for certification of soft commodity production, can be better integrated with the certification of recycled content within products, tools for full product life-cycle analysis, environmental product disclosures, and standards relating to product design and use, such as building certification systems. Such integration could reduce confusion for consumers and procurement offices and help them make sense of the plethora of claims and certification systems that could apply to any given product or service. Chinese agencies should maintain an inventory of established international

standards and relevant certification systems to identify opportunities for better integration, adoption or recognition of these within China's policies and guidance to companies. Close multilateral collaboration among producer and consumer countries is needed to optimize the alignment of different product standards for cross-border trade.

8.3.2.2 Tapping into Options within Green Finance to Support Circular Business Models

Companies, and in particular SMEs following long-term circular business models often generate lower short-term return on investment and therefore struggle to secure proper financing.

China's government, central bank and financial regulators can help to ease this process. The Chinese government can directly invest in circular economy activities and innovation, set direction and level the playing field through, for example, pricing externalities. Its central bank and financial regulators can integrate circular concepts in risk assessments and modelling, scale dedicated circularity measurement tools, and integrate circularity metrics in leading existing frameworks^[152].

China can tap into its existing momentum on green finance. Already, China issues more green bonds than any other country except the United States^[153] and domestically, China dedicated an estimated CNY 17 trillion (US \$2.5 trillion) to environmental protection projects during the 13th Five-year plan.

The Chinese government can design policies to ensure that SMEs have better access to financial services – perhaps by providing risk mitigation financing schemes as a guarantor on loans. They may be able to help the established waste management and recycling industry, for example, which tend to be smaller in size, through various financial vehicles to raise funding – particularly since the recycling industry is generally less attractive to investors^[154]. South Korea, for example, provides financial assistance to waste management companies. This support is critical in China's ambitions to become an ecologically sustainable nation. The EU Green Finance Taxonomy, provides a useful list of environmentally sustainable economic activities, including circular economy, that could inform the setting of priorities for green finance to mainstream the circular economy in China.

8.3.2.3 Utilizing the Advanced Technologies of the 21st Century

Already, China is among the world's leaders in disruptive technology, with city hubs like Beijing and Shanghai leading in areas like quantum computing, artificial intelligence, and big data^[155]. By leveraging its technological prowess, China can introduce new ideas and practices to enhance its circular economy policies and establish itself as a global vanguard of circularity.

Advanced information technologies like robotics, blockchain, digital markings and Internet of Things can help to accelerate the transition to a circular economy

through disruptive change. From improving the transparency of materials to enhancing the recyclability or reuse of products, such innovations enable the ease and adoption of circular practices and can help shift society towards a more circular world.

Such approaches will also encourage universal global trading standards by making it easier to track the origins of a material and generally promote greater materials traceability through embedded product information.

Companies worldwide are also putting advanced materials technologies into practice. For example, Miniwiz has developed a proprietary plastic which combines municipal plastic waste with rice husks through a manufacturing process that emits 40 percent less CO₂ as compared to conventional processes^[156] while Haier Models Co utilizes 3D printing to rapidly manufacture prototypes of home appliances, allowing for an iterative design process to improve product quality.

8.3.2.4 Strengthening Regulations and Institutions within China and Beyond

China needs to promote circular economy principles through strengthened regulations and institutional capacity. Deposit Return Schemes, Extended Producer Responsibility and bans on unwanted products (e.g., plastic shopping bags) are amongst the regulatory tools that could be applied more extensively.

Since 2015, China has established a legal framework and regulations to guide the implementation of EPR throughout the entire product life cycle, from product design, to retail, consumption, reuse, recycle, and waste management. During the 14th FYP period, the government could upscale the key EPR pilots of the 13th FYP for e-products, auto products, paper-based beverage package and lead-acid batteries. However, new institutions are needed to promote these schemes at scale to generate the expected impacts.

EPR, DPS and extended warranty periods are included in relevant Chinese laws, regulations and policy documents, including the Circular Economy Promotion Law of the People's Republic of China in 2008, the Overall Plan of Ecological Civilization System Reform in 2015, and the Plan of Extended Producer Responsibility System in 2016. However, their effective implementation requires the establishment of infrastructure such as compatible recycling systems, as well as extended policy support in other relevant areas, such as facilitating the information sharing and collaboration among production enterprises, recycling enterprises and e-commerce platforms.

EPR pilot projects have already been developed and implemented for electrical and electronic products during the 13th FYP period. The 14th FYP requires that EPR pilot projects to be also developed for automobile products. However, it is important that the DRS and EPR systems are quickly expanded to other sectors, especially for packaging materials usage in the e-commerce delivery service for both commodities and food. Chinese giant e-commerce actors, including Alibaba, Jingdong and Suning

have used various incentives (for example, price discounts and shopping coupons) to encourage consumers to choose green packaging in online orders, such as tape-free boxes and biodegradable packaging materials. However, more incentives are needed to encourage larger number of participations.

As an example, China's paper industry could be encouraged to do more recycling by means of EPR laws. For example, the responsibility of e-commerce businesses could be extended to cover other packaging materials as well, including paper and plastic packaging, accounting for roughly 40% of the used packaging ^[115]. More recently, in 2017, Chinese government made legislative push on EPR and eco-design, signaling if right products are put on market with repairability and recovery in mind, we will not only reduce the material use and impacts, but also generate more value without selling more stuff.

Furthermore, EPR schemes can be extended cross borders to nudge producers towards producing high quality products that allow for an extended product use and reducing environmental impacts beyond the country jurisdictions. The implementation of cross-border EPR schemes need to be regulated by stringent domestic policies under the international conventions, such as the Basel convention, which restricts the exports of plastic wastes that are hazardous or hard to recycle. The EU has internalized the list of restricted plastic wastes in its waste shipment regulation (EU 2020/2174), but law enforcement needs to be strengthened to ensure the effectiveness of this regulation.

Deposit return schemes can nudge consumers' behavior to support recycling of packaging. To date, about 40 countries globally have set DRS ^[157]. Well-designed and well-implemented DRS can increase the collection rate of beverage containers and improve material capture at high levels of purity and quality – Germany, Norway and the Netherlands, for example, each operate a DRS and report a 95 percent or higher collection or recycling rate of plastic beverage bottles ^[158]. There are potential emissions benefits here as well: Scotland estimates that its 2022 plan for a country-wide DRS on used bottles and cans will reduce greenhouse gas emissions by 4 million tons over a 25-year period (Zero Waste Scotland, n.d.). DRS could be implemented in China to increase its ration of domestic recycling, which is currently behind the one of other western countries.

8.3.2.5 Developing New Circular Business Models to Support the Transition to Green Consumption

A transformative introduction of circular economy calls for new business models in which business can thrive without being dependent on unchecked consumption.

Shifting from providing products to providing services is the most common approach often facilitated by advanced information technology. The company retains ownership of the asset and derives profit from selling a service to the customer thus ensuring maximum utilization and accordingly, reduced

environmental impact. As shown in Section 8.4.1.5, policy incentives and new business ideas are needed to avoid unintended rebound consequences of the sharing economy.

An example is the Dutch lighting company Philips. The company introduced ‘Circular Lighting’ or ‘pay-per-lux’ back in 2009, which allows a client to make an individual service contract with Philips for a specific level of brightness for a facility measured in lux. Rather than selling light bulbs, Philips provides a full installation, power and maintenance service and has an incentive to install the longest lasting, highest efficiency equipment, rather than the highest number of bulbs ^[159]. Integrated into the value proposition of a physical product such service components can build up high-quality branding and consumer loyalty to the brand^[160].

Companies in the apparel and furniture sector have implemented models for buying back, repairing or refurbishing and then reselling their products, thus securing the secondhand value of their brand. This maximizes longevity and supports an imperative to design for longer life and repairability.

Relevant government campaigns, such as President Xi’s “Clean Plate” campaign against food waste, that aim to accelerate the shift of consumers’ attitude and behavior toward a “reduce and reuse” consumption model, need to be continued. Opportunities should be identified to promote and mainstream green procurement by government agencies, schools, state-owned and private companies, to trigger circular economy approaches in major sectors such as construction and catering.

8.4 Policy Recommendations

The impact of COVID-19 and climate change on the economy has increased global awareness of the urgent need to transition to sustainable and circular production and consumption patterns. To help realize the new development patterns envisaged in the 14th Five-Year Plan, the “dual circulation” strategy, and the goals of peaking carbon emissions by 2030 and reaching carbon neutrality by 2060, China should seize the historical opportunity to speed up its greening of global value chains by taking actions to:

Adopt regulations requiring due diligence in soft commodity value chains, develop green finance measures, leverage technological advancement related to traceability, and utilize trade policies to support green value chains and promote the overall green transformation of economy and society.

Promote circular economy, as an integral part of green value chains, through a combination of higher product standards, green finance, advanced technology, strengthened regulation and new business models.

Accelerate the establishment of a green value chain promotion mechanism

incorporating circular economy principles, and a technical support system to facilitate these priority actions.

Table 8-3. Summary of Recommendations

Six priorities to promote green value chains in China and beyond	
Communication	Communicate China's intentions to develop a strategic framework for greening value chains in collaboration with international partners
Regulation	Develop a regulatory framework for due diligence and traceability measures for soft commodities
Technology	Develop technologies to support due diligence and traceability
Finance	Create new financial instruments that favor green value chains
Trade	Include green value chain measures in trade agreements
Circular Economy	Mainstream circular economy principles to support green consumption and sustainable sourcing
Accelerate the Development of China's Green Value Chain Promotion Mechanism	
Institution	Constitute China's Green Value Chain Promotion Mechanism
Planning	Develop plans and priorities for the Green Value Institute
Research and Policy dialogue	Foster research and policy dialogue to support the greening of the entire value chain

8.4.1 Pursue Six Priorities in the New Development Phase for China on Green Value Chains

8.4.1.1 Communicate China's Intentions to Develop a Strategic Framework for Greening Value Chains in Collaboration with International Partners

China should formally announce its intention to green value chains in relevant international fora to provide the impetus for leaders, government agencies, companies, financial institutions, civil society organizations and partners, in China and other countries, to work together to create and implement a robust global green value chain strategy in China and beyond. China could pursue the following near-term windows of opportunity to engage with international partners and communicate its ambition and commitment on greening value chains.

Specifically, China can –

- Announce an ambitious commitment to the greening of global value chains at the CBD COP 15, while encouraging other countries to contribute.
- Promote the inclusion of global green value chains as one of the topics in the

G20 Summit for global leaders to discuss, striving to reach consensus and take common actions.

- Leverage the UNFCCC COP 26, to introduce China's commitments and positions on fostering green global value chains and promoting the "dual circulation" strategy, and the goals of peaking carbon emissions by 2030 and reaching carbon neutrality by 2060, through green value chains.

- Convene green value chain discussions and sessions at the CBD COP 15 Ecological Civilization Forum and Business and Biodiversity Forum, to publicize the outcomes of this study, encourage participation and communication among key stakeholders, and facilitate the establishment of a strategic framework for the greening of soft commodity value chains in China and beyond.

8.4.1.2 Develop a Regulatory Framework for Due Diligence and Traceability Measures for Soft Commodities

Due diligence and traceability systems enable importers, financiers, the government, and consumers to distinguish those tons or shipments of soft commodities that meet legal and sustainability criteria from those that do not. By adopting regulations to require due diligence and traceability measures for ensuring legality and sustainability in soft commodity sourcing, China would be keeping up with major markets and strengthening the long-term security and resilience of its value chains.

The regulatory framework would require companies and financial institutions to exercise due diligence to ensure relevant soft commodities within their value chains or investment portfolios are produced legally in their country of origin. It would also encourage companies and financial institutions to assess the sustainability of commodities against applicable standards. The obligation to conduct due diligence would apply to all companies with such commodities in their value chains and all institutions that provide finance for the production and trade of such commodities.

Such regulations would be consistent with several proposed actions in the "Green Development Guidelines for Overseas investment and Cooperation" ^[6]. The Guidelines call for measures to:

- Promote green production and operation (and specifically due diligence to identify potential environmental risks, build green supply chains, and adopt the green procurement practices);

- Facilitate green business transition (and specifically strengthen the green compliance system and set a standard for business practices overseas to fill in the regulatory gaps);

- Prevent environmental risks (and specifically to encourage companies to take rational and necessary measures to reduce or mitigate adverse ecological impacts from investment and cooperation activities in accordance with the laws

and regulations of the host country, protect and restore the affected ecosystems in accordance with the law or international practice in case of adverse biodiversity impacts, encourage companies to adopt international or Chinese standards in investing activities where local laws and regulations are non-existent or too lenient);

- Optimize green regulatory services (and specifically strengthen the monitoring and analysis of green business development and enhance IT-based regulation).

The development of this regulatory framework should be coordinated with the work of the BRI Environment Big Data Platform and the BRI International Green Development Coalition to ensure coherence with the BRI Green Value Chain Development Index. The framework should also help inform future policy guidelines from relevant government agencies related to green procurement, supply chains, trade, and finance.

8.4.1.3 Develop Technologies to Support Due Diligence and Traceability

China can harness the revolution in monitoring and tracking technologies so due diligence and traceability become more feasible, practical, and affordable. This will make it easier for companies (especially small/medium-size enterprises) to verify their compliance with green criteria. By adopting these systems, Chinese companies can be ready to comply with new regulations by countries that import or export commodities. For circular economy purposes, block chain and digital markings can improve the transparency of materials, enhance the recyclability or reuse of products, tighten the connection between upstream producer and downstream consumer, and enable the ease and adoption of circular practices.

China has already issued detailed guidance on the role of governments and companies in establishing traceability systems for certain products. Drawing on this guidance and experience gained in sectors such as meat and vegetables, alcoholic products and drugs and herbal medicines, China can strengthen traceability systems for other soft commodities and products. In doing so, China should engage enterprises, especially small and medium sized enterprises, to ensure that due diligence and traceability systems and technologies fit well with business processes and are cost-effective when implemented.

8.4.1.4 Create New Financial Instruments that Favor Green Value Chains

China should leverage the power of financial Institutions to promote the uptake of green economy practices through innovative financing instruments. In turn, such instruments would help banks to manage risks associated with unsustainable practices (e.g., compliance, social and market risks to clients, default and reputational risks to banks). This could include innovative trade finance to producers, manufacturers, and traders that meet green performance standards. Such finance could offer low interest rates and/or fast-tracked payment of invoices as incentives for borrowers to achieve sustainability, traceability and circular economy targets.

Additionally, innovative financial instruments such as green bonds and government guaranteed loans can be used to promote circular economy practices and break down barriers to accessing finance for small and medium sized enterprises that are operating under circular economy business models.

China should explore how best to apply or extend its Guidelines for Establishing the Green Financial System to create new financial incentives for the greening of value chains and uptake of related circular economy concepts. Specifically, the China Banking and Insurance Regulatory Commission (CBIRC), in collaboration with leading banks, should pilot new financial instruments and develop specific guidelines on how to green value chains in the Chinese context. This could include:

- Revising the *Green Credits Guidelines* and *Green Credit Statistical System*
- Extending the scope of green credits to include the financing of soft commodities that meet relevant sustainability and traceability requirements, and financing linked to circular economy practices
- Updating the *Guidance on Promoting High-quality Development of the Banking and Insurance Industry* and plans to strengthen data disclosure requirements.

Such green value chain finance measures can build on the work of the BRI International Green Development Coalition and the work underway on how a “traffic light system” could evaluate the environmental performance of BRI investments. Such a system could support the greening of value chains if it applied to projects involving (a) the production and processing of soft commodities or (b) infrastructure and other projects that could indirectly encourage the expansion of soft commodity production. The system could include safeguards to limit the negative environmental and social impacts of soft commodity production while enabling the uptake of sustainable forestry and farming practices.

China should continue to engage with the G20 Sustainable Finance Working Group and its efforts to promote wider adoption of environmental risk analysis practices and improve public availability and access to environmental data to enable financial institutions to better analyze and manage environmental risk exposures and allocate resources to financing green investment opportunities.

8.4.1.5 Include Green Value Chain Measures in Trade Agreements

China can incorporate measures to green soft commodity imports in bilateral and multilateral trade agreements. This could include China’s participation in work at the WTO on creating tariff benefits for green soft commodity trade, work to coordinate sustainability standards for soft commodity production and trade at the Asia-Pacific Economic Cooperation (APEC), the Regional Comprehensive Economic Partnership (RCEP), beginning with a few pilot efforts, and the Forest, Agriculture and Commodity Trade (FACT) Dialogue, under which countries have committed to work together to protect the world’s forests while also promoting

sustainable trade.

The China International Development Cooperation Agency (CIDCA) could provide south-south development assistance to supplier countries to build capacities related to the supply of green commodities. Such assistance would include grants, interest-free loans, concessional loans, and technical assistance for practices and technologies that boost commodity yields on existing agricultural land (linked to avoided deforestation), improve traceability, and improve policy design. The purpose would be to support uptake of legal and sustainable production processes, development of verification and traceability systems, as well as measures to protect and restore forests and other ecosystems for biodiversity conservation and climate change mitigation and adaptation, while respecting the needs of farmers, local communities and indigenous peoples.

Such actions would align with the “Green Development Guidelines for Overseas investment and Cooperation”⁰, so far as they call for action to “optimize green regulatory services”. Specifically, the Guidelines call for actions to “strengthen strategic alignment and policy exchanges with countries involved and create an enabling environment for companies” and to “encourage overseas Chinese chamber of commerce or associations to study and develop guidelines for green investment and cooperation in host countries”.

As countries continue to build their interest in the circular economy, global trade policies and practices need to be designed with circularity in mind. In this way, trade agreements could simultaneously foster green consumption while encouraging transparency in cross-border trade. Ultimately, China and other countries will benefit from more secure and stable supply chains if trade and the circular economy are approached as an interlinked system.

8.4.1.6 Mainstream Circular Economy Principles to Support Green Consumption and Sustainable Sourcing

China should adopt a holistic, systemic approach to upscaling circular economy concepts as drivers of green consumption and sustainable sourcing within value chains. In doing so, China should leverage five key enablers of circular economy (described more fully in Section 8.4.2 of this study) –

- Circular economy design and product standards and certification systems
- Tapping into options within green finance to support circular business models
- Utilizing the advanced technologies of the 21st century
- Strengthening regulations and institutions within China and beyond
- Developing new circular business models to support the transition to green consumption

Due to the cross-cutting and intersecting nature of these enablers, the Green Value Chain Coordination Mechanism (described below in Section 8.4.2) should be mandated to explore how circular economy solutions can help make value chains

greener, and to coordinate and support implementation of circular economy measures, including how domestic standards and approaches can articulate with international standards and agreements.

8.4.2 Accelerate the Development of China's Green Value Chain Promotion Mechanism

As recommended in the first-phase Special Policy Study on Global Green Value Chains (CCICED 2020), China should set up a mechanism to promote green value chains with the technical support of a "Global Green Value Chain Institute". The mechanism should drive China's green value chain strategies in support China's 14th Five-Year Plan, ambitious carbon neutrality target and the "dual circulation" strategy. It would ensure coordination and technical support to greening value chains across multiple ministries and international bodies, including priority actions under Recommendation 4.1.

8.4.2.1 Constitute China's Green Value Chain Promotion Mechanism

China should fully constitute the Green Value Chain Promotion Mechanism based on the structure depicted in Figure 8-4. Subject to further deliberation, this would include setting up an inter-ministerial coordination committee, composed of relevant ministries and commissions (e.g., Ministry of Ecology and Environment, Ministry of Commerce, National Development and Reform Commission, Ministry of Industry and Information Technology, Ministry of Agriculture and Rural Affairs, National Forestry and Grassland Administration, General Administration of

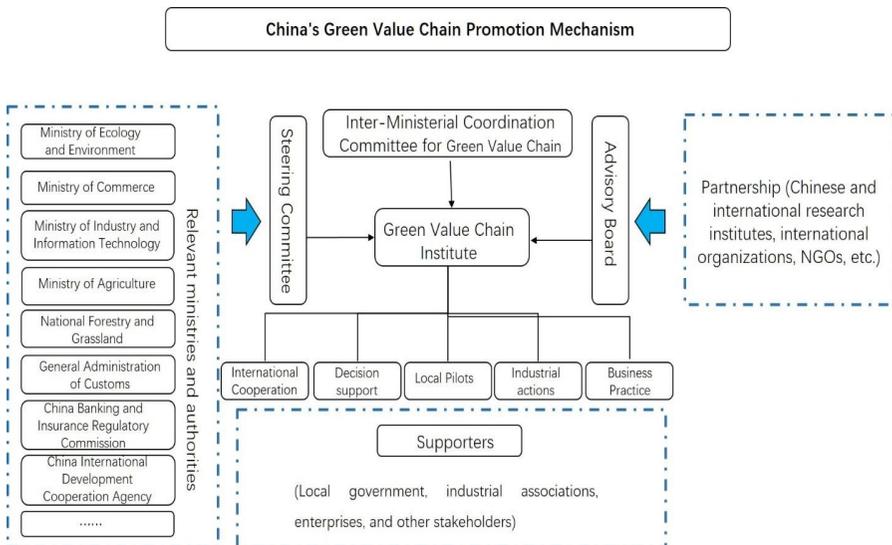


Figure 8-4. China's Green Value Chain Coordination Mechanism

Customs, China Banking and Insurance Regulatory Commission, China International Development Cooperation Agency, etc.) to review and approve China's green value chain strategy, policies, plans and roadmaps, and organize and coordinate amongst members to advance work tasks.

Each member ministry should appoint relevant departments/bureaus and responsible personnel as liaisons to form the Steering Committee to supervise the Green Value Institute and its implementation of tasks. Further, relevant industrial associations, research institutes, international organizations and NGOs will form the Advisory Board to provide intellectual, technical, financial, and project support for the Green Value Chain Institute.

8.4.2.2 Develop Plans and Priorities for the Green Value Institute

The "Global Green Value Chain Institute" was set up in FECCO of Ministry of Ecology and Environment in 2020, to serve as the core technical support body within China's Green Value Chain Promotion Mechanism. While its capacity needs to be strengthened, the Institute should expedite development of a framework for technical support for the promotion of green value chains, which can operate as a long-term cooperation mechanism with multiple stakeholder participation.

The institute should also support the development of a five-year plan and roadmap for China's green value chain development and begin fostering relevant research and policy dialogues.

The plan and roadmap should align with the focus of this report and prioritize actions related to the greening of soft commodity value chains, and circular economy measures to promote sustainable consumption and circular economy practices in a few selected sectors such as timber and food. The scope could be expanded to include actions related to hard commodities or other sectors in future years. Commodity- and sector- specific plans should be developed for what China and other major countries can do to green their global value chains, how to do it (including pilot applications), and who needs to do what. To this end, the Institute should establish a collaboration network and information exchange platform for stakeholders and reach a consensus on a national strategy that will have the greatest impact on the greening of value chains in China. The roadmap should clarify how the actions proposed relate to China's vision for ecological civilization, economic green recovery, and other major policy frameworks. The roadmap should encourage the participation of all relevant stakeholders, including those working on social and gender-related issues.

8.4.2.3 Foster Research and Policy Dialogue to Support the Greening of the Entire Value Chain

The Global Green Value Chain Institute will lead and coordinate scientific research and policy dialogue to enable development of new systems for soft commodity due diligence and traceability systems and selected circular economy

practices. The priorities and sequencing of this research and dialogue should be outlined in the five-year roadmap.

For soft commodities, the research and policy dialogue should target specific commodities and sectors to ensure that relevant commodities are legally and sustainably produced in their country of origin. For example, initial work on soft commodity due diligence and traceability systems could focus on beef and soy from Latin America, timber from the Congo Basin, and palm oil from Indonesia. Research should also focus on the benefits, cost, and limitations of different technologies and tools that could support the development of due diligence and traceability systems in China. The design of measures to ensure the legality and sustainability of commodity production should include capacity building to ensure effective participation of small and medium-sized enterprises along the entire value chain, as well as relevant producer country stakeholders – from government agencies to smallholder farmers. Such capacity building should recognize the role of large and progressive corporations in engaging their suppliers and in convening pre-competitive sector-wide platforms or jurisdictional approaches to enable uptake of aligned and consistent systems. The relevant policy paths and systems will be analyzed to determine which government departments and industries need to be involved in the formulation and implementation of due diligence and traceability system plans for those commodities.

The domestic circular economy research and policy dialogue should draw on the latest international circular economy policy and practice, learn from existing regulations and incentive policies that were successfully implemented to support secondary markets for recyclable raw materials, commodities, and waste, and guide and foster consumer demand for higher-quality, recyclable products. Greener consumption can drive market demand for greener products, which is an important incentive to foster major changes in production practices to meet this demand. After progress is made on soft commodity sourcing and production, and the circular economy priorities in the initial roadmap, the Institute could expand the focus of its research and policy dialogue to additional commodities or circularity objectives.

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Chapter 9

Green Finance

9.1 Introduction

In recent years, international practices in the field of ecological conservation finance have developed rapidly, and innovative models for mobilizing resources from the public and private sectors have continuously emerged. However, it also faces many challenges, such as a large funding gap and insufficient attention to ecological and biodiversity protection by financial institutions and institutional investors. The Tenth Conference of the Parties to the Convention on Biological Diversity (CBD CoP 10), held in Aichi Prefecture, Japan, in 2010, adopted a global Biodiversity Strategic Plan for 2011–2020, and set 20 outline goals for ecological conservation during this decade, known as the Aichi Goals. But as things stand, most of Aichi's goals will be lost. The enormous challenges of COVID-19 show that improving resilience in areas such as health, climate, biodiversity, air pollution, and food is fundamental to achieving sustainable development. While some regions have made tackling climate change part of their recovery plans, there is still little focus on biodiversity conservation and nature-based solutions. At the same time, since the outbreak of COVID-19, the world, especially developing countries, has faced economic recession and worsening public debt, which is likely to lead to deforestation in poor areas. Local governments may also pay less attention to—and reduce investment in—biodiversity protection, resulting in damage to biodiversity. In this context, maximizing the mobilization of financial resources—through the development of ecological protection finance to support ecological protection and biodiversity protection—is crucial.

On the basis of the first phase of work in the first half of 2019–2020, the Green Finance Task Group has conducted the second phase of research work since the second half of 2020. The research results include five topics: "Promoting the

Positive Principle of Nature," "Financial Practice of Ecological Protection of Chinese Institutional Investors," "Innovation of Financial Instruments for Ecological Protection," "Impact of Agricultural Subsidies on the Behavior of Financial Institutions," "Debt and Biodiversity," and an annex, "Fintech and Biodiversity," as well as a research report entitled "The Important Role of Green Finance in the Rehabilitation of Abandoned Mines Is Urgently Needed—Taking Agriculture in Huifeng, Sishui, Shandong Province as an Example." Based on the above research, the Green Finance task force has put forward policy recommendations for the development of ecological conservation finance for the 15th Conference of the Parties to the United Nations Convention on Biological Diversity (COP 15) to be held in Yunnan, China.

These studies are a joint effort by Chinese and international research teams in the Green Finance Research team, with the support of the China Council for International Cooperation on Environment and Development. The Chinese team carried out several investigations in Beijing and Shanghai on sovereign wealth funds, public and private equity funds, securities brokers, social security funds, bank finance subsidiaries, etc., and went to Shandong province to carry out a special investigation on mine restoration projects. In addition, due to travel restrictions caused by the pandemic, members of the Green finance expert group at home and abroad were unable to meet offline for the second phase of the study. For productive discussions and working sessions, GIZ organized three webinars—online study tours—on behalf of the BMU. Experts from leading international institutions and the private sector were invited to present their findings, including Simon Zadek and Ashley Gorst (F4B), Sejal Patel and Paul Steele (IIED), Rebecca Ray (Boston University), Guillaume Gruere and Silvia Sorescu (OECD), Terrence Townshend (Paulson Institute), Jeen Nijboer (Rabobank), Marianne Haahr (Green Digital Finance Alliance), Sebastian Bekker (Natural Capital Finance Union/United Nations Environment Programme WMCM) and Colette Grosscurt (ACTIAM). The results of these meetings are reflected in the reports in each section.

In addition, the report pays special attention to the role and impact of gender issues in green finance. The fifth of the UN Sustainable Development Goals—achieving gender equality and empowering all women and girls—is a cross-cutting theme that covers all the 2030 Sustainable Development Goals and is seen as an important driver of biodiversity conservation. According to the 2015–2020 Gender Action Plan under the UN CBD, considering the link between gender issues and biodiversity, it is necessary to clarify the impact and relevance of gender roles on the use, management and conservation of biodiversity. Gender roles include gender-based division of labour and responsibilities, priorities, decision-making rights, and knowledge and skills that affect how men and women use and manage ecological resources. At the same time, the formulation and implementation of various

ecological protection policies and measures will also have a crucial impact on different gender roles, thus determining the realization of gender equality goals. Centring on the topic of biodiversity finance, this study integrates the gender mainstreaming perspective into various parts of the research and tries to discover and elaborate the internal connection and mutual promotion between the two, while considering how to take into account the integration in policy recommendations as appropriate.

9.2 Develop Ecological Protection Finance and Advancing the Nature-Positive Principle

9.2.1 Development of Finance and Nature-Positive Principle

The finance system sits at the apex of—and serves and influences—the whole economy. Some argue that the application of a guiding principle within finance in relation to nature is necessary, as finance plays such a crucial role.^[1] Internationally, in respect of climate change, the role of finance has become accepted as core to the Net-Zero Transition, with policies to advance this goal infusing fiscal design, public spending, supervision and private financial institutions.^[2] If it were adopted, an equivalent nature principle could have similar far-reaching effects, affecting decision making and operations throughout the financial system: through private finance in the form of pensions, insurance, asset management and banking; and, through public finance in the form of public banks, sovereign wealth funds, sovereign debt issuance, central bank market operations, and overseas development finance.

The Dasgupta Review 2021 compiled evidence that a redirection of finance and new capital flows is needed to avoid large future economic losses from the degradation of nature and to avoid the loss of nature inheritance by future generations.^[3] The climate and biodiversity agendas are front and centre in national and international agendas in 2021, with the Conferences of the Parties for UNFCCC and the CBD. Whereas, in finance, a transition of the system to net-zero carbon has begun, a debate has begun over whether a parallel transition should follow close behind for nature and biodiversity.^[4] An international search has started within the environment advocacy community for an overarching principle to describe and for coordinating this transition, and “nature positive” has emerged as a leading option, backed by NGOs particularly in North America and Europe.^[5] This chapter describes the range of issues that would favour the complete application of the principle to the finance sector, were the principle to be adopted internationally.

Going beyond “Do No Harm,” the nature-positive principle is both proactive and ambitious. The CCICED has already examined the principle of “Do No Harm,”

making recommendations covering SDG15, ecological redlining, mainstream biodiversity screening, mitigation hierarchies and SEAs, and governance and financing structures for implementation.^[6] The “Do No Harm” principle, together with the principle of “No Net Loss,” embody ideas of protection and avoidance of loss, but the question is whether they address the large-scale restoration and recovery of depleted natural systems which would secure a thriving planet: whether they are sufficiently aspirational. A range of views has joined in an international debate, between the more inclusive language of “nature” and the narrower language of “biodiversity,” the role of offsetting, and the dimensions of metrics for measuring performance.^[7] These international views, in the NGO community in particular, have coalesced around the nature-positive principle, and this principle is beginning to attract broader political interest. This paper considers the application of this language to finance in a Chinese context.

Growing citizen awareness internationally of the state of nature has lifted this issue up the political agenda. With the G7 meeting in June expected to lay out the political framework for the climate and Biodiversity Conferences of the Parties later in 2021, there might be strong international interest in landing a guiding policy principle for nature and biodiversity. The existing institutional networks, culture, and capabilities within finance that have been built up to tackle climate change, are now at the very early stages of addressing themselves to nature. For example, the Dutch central bank has reported on macro-prudential risks arising from the depletion of nature.^[8] This system, which has been built to address climate change, could be extended to address nature. The early stages of this institutional and market program are evidenced by a large number of papers published on the subject internationally over the last 18 months.^[9]

The application of the nature-positive principle in finance creates market opportunities. When China introduced the Green Finance Principles and the Net-Zero principle, they supported a huge growth in green finance.^[10] China made a bold commitment to a low-carbon economy, achieving an emissions peak before 2030 and achieving carbon neutrality before 2060.^[11] Internationally, the CBD has suggested a milestone in 2030 and a long-term goal in 2050 to stop and reverse the loss of biodiversity.^[12] This raises a question for the international community and for China: could a nature-positive transition lend itself to a similar medium-term milestone and long-term goal? Countries around the world, including China, have already developed strategic frameworks for net-zero, consisting of milestones, targets, target allocations and road maps, transition pathways, policy instruments, and supporting institutions.^[13] A possible next step for China and countries internationally would be to take a similar approach to a transition in nature. Quite often, one sees countries develop independent pieces of policy in an area and then, when sufficient pieces are in place and political momentum has built up, the country

brings them together into a unifying strategy. The signs that this may happen soon internationally include the publication of papers, articles, and political statements; the movement forward of new policies on agricultural subsidies (such as the UK Environmental Land Management Scheme); the commencement of initiatives on financial risk and nature (such as the Task Force on Nature-Related Disclosure); activities on financial product classification (the EU taxonomy); work on trade rules and nature (EU, UK); and, preparations underway in some countries for the publication of nature strategies (e.g., UK, end 2021). These might, in due time, all be brought together in overarching nature transition policies, with a coordinating statement of mission.

The early focus of a nature transition would be likely to be on standards, data and accountability. The machinery that would allow states and markets to govern and operate a nature transition is now beginning to be developed, though still at an early stage. They involve standards (e.g., IUCN's work on standards for nature-based solutions); definitions; monitoring; data collection and access; indicators; and accountability. Fintech has a critical role to play in wiring these data flows into the financial system.^[14]

The transition could create opportunities for investment in nature—where previously there was disinvestment—and in new financial products. Internationally, the financial institutions already pursue growth in new asset classes (such as renewable energy) and new products (such as Environment Social and Governance-focused portfolios) to meet the demands of consumers.^[15] Similarly, the nature-positive transition might offer new strategic opportunities in new asset classes (such as nature-based solutions) and new products (nature-positive portfolios) as well as a host of ancillary services in fintech, which are elaborated below and in an annexe. There is a great deal of interest internationally in those aspects nearest to market (nature-based solutions and natural-climate solutions) and investment has been starting to flow into fintech in this area, particularly over the last 12 months.^[16] To date, it remains a voluntary activity, but if it becomes compliance-driven, then a very rapid market expansion could follow. Internationally, governments are working out how to channel overseas development funds at scale into this channel.

When advocating and applying the nature-positive principle, financial institutions and other key players should understand and take into account the roles, needs, and capacities of men and women, and use this understanding to inform the design, implementation, and monitoring of gender-equitable finance initiatives. The integration of gender considerations into decision making and operations not only advances gender equality (SDG 5), but can also unlock the potential of genders that might not otherwise be given opportunity, enhancing the social and environmental benefits of conservation finance projects.

Internationally, early stage discussions have recognized that a full transition

to a nature-positive financial system would involve new policies of economics and finance ministries. In its fullest version, central banks and financial services regulators could write policies equivalent to the nature-positive principle. This would mirror actions in jurisdictions such as the City of London to tackle climate change, where finance ministries and supervisors have applied the levers of governance—data analysis, disclosure and risk management machinery, investment policies and the customer engagement of the financial sector—in pursuit of a net-zero carbon outcome.^[17] The most ambitious emerging thinking internationally on nature, for example from the Finance for Biodiversity Initiative and from the Paulson Institute, is that the financial system could be harnessed for the purpose of a nature-positive transition, or a similar overarching goal.^[18]

All of the above relate both to countries’ domestic activities and their international activities. Internationally, some countries are now at an early stage of thinking about the links between nature, biodiversity, and finance in their international activities such as supply chain finance, overseas investments, sovereign debt purchasing and overseas development aid.^[19] This shows lessons learned from earlier debt-for-nature swaps.^[20]

This section describes, using international examples:

- The definition of nature positive
- The role of a nature-positive finance system
- Opportunities that will be created for China in green finance, in greening mainstream assets and in new classes of natural assets
 - The role of a nature-positive approach to finance in the greening of supply chains
 - The role of fintech
 - Application to the Belt and Road Initiative (BRI)
 - The relationship between a nature-positive approach to finance and ecological redlining.

9.2.2 Definition and Attributes of the Nature-Positive Principle

The nature-positive principle is outcome focused—those outcomes being the ecosystem services provided by nature and the assets underlying them. The principle embodies biodiversity and does not substitute its unique ecosystem services for other forms of nature. Since it is ecosystem services-based, it engages with the discipline of natural capital accounting and allows a balance sheet of assets and liabilities to be developed to manage change and to link with financial data.^[21]

It is scalable and adaptable. It allows all forms of institutions to adopt and to coordinate around a defined, policy-equivalent mission, which could be set at international, regional, national, or local level and for institutions themselves. Thus, it can mesh with the jurisdictions of existing policy, legal, market, and institutional

structures.

The nature-positive principle can be implemented consistently with other principles. The precautionary principle, the polluter-pays principle, the mitigation hierarchy and other rules which help to achieve just, efficient outcomes, all complement the nature-positive principle, because it describes only what should be achieved, not how it should be done. It can complement the rights and duties of Indigenous peoples and of consumers. Also, because it is purpose-focused, it complements more descriptive, categorical systems such as the EU taxonomy (classification and labelling) of real economy and financial assets.^[22] Although the principle would be consistent with the practice of offsetting, which some international civil society organizations have opposed, it is also consistent with legal protection of natural assets, conservation of high-value assets and emerging legal concepts such as “ecocide.”

Recommendation for China

Develop a proposal for the adoption of a nature-positive standard by banks, insurers (underwriters), asset owners, and asset managers.

Set out how the nature-positive target relates to reduction in losses, net addition, recovery, and metrics.

9.2.3 Framework for a Nature-Positive Transition of the Financial System

Finance is a system, through which a guiding principle such as “nature positive” could be applied on some or, in its fullest extent, on all elements. The Finance for Biodiversity Initiative has kick-started a debate by putting forward its ambitious view on how the fullest application of a nature-positive principle would apply to six elements. Internationally, some governments and countries have taken the first tentative steps in some of these areas, and there is now a debate about which areas to pursue first and how far and fast to take them forward. Here are the initiative’s recommendations.

9.2.3.1 Advance Citizens’ Nature Choices: Financial Institutions Take Account of Citizens’ Individual and Collective Nature-related Rights and Preferences in Their Financing Decisions.

i) Financial institutions inform and empower citizens to make biodiversity-related choices, as savers, lenders, insurers, consumers, voters, and taxpayers.

ii) Regulators require financial institutions to adopt compliance processes to respect the heritage rights of indigenous communities to biodiversity stewardship and use, and to respect their traditional livelihoods.

This would mean giving citizens the rights to choose financial products with specific nature objectives, such as “nature-positive alignment.” This would be a specific extension of ESG-aligned reporting and portfolios, which have been

growing rapidly internationally on a voluntary basis and have become much more popular with consumers in recent years. A question for governments is whether to intervene at all in the way the market is developing by itself.

In order to enable citizens' nature choices, financial institutions would take account of the nature-related rights and preferences of groups, including women, in investment and financing decision making and project implementation. Across many communities, women as caretakers, natural resource managers, and users occupy roles that are vital to their families, communities, and society. Nonetheless, evidence shows that women have limited rights and access to, benefits from, and control over resources. The principle of gender mainstreaming complements the nature-positive principle and can be implemented in accordance with the CBD Gender Action Plan.

Recommendation for China

Ensure, by 2023, that pension and other investment and savings funds offer customers a choice of products which includes nature-positive-aligned funds.

9.2.3.2 Disclose Impacts on Nature: Financial Institutions Publicly Disclose Actual and Expected Nature Impacts and Associated Risks.

i) Financial institutions make the data and assumptions underlying reported impacts and risks publicly available, to enable effective citizen and shareholder action, and to facilitate the setting of effective standards, policies and regulations.

ii) Regulators require financial institutions regularly and publicly to report the nature impact of their entire balance sheets, and to stress-test expected nature risk.”

One of the likely early areas of action is data. Data availability brings many public benefits, so governments internationally have taken an interest in this area, supporting new initiatives in standard setting, platform development, and data R&D. In particular within finance, there is already government interest and funding for institutions to develop quantitative reporting of impact and risk relating to nature in the future. The arrangements for private finance institutions are in the most advanced stage of discussion, through the Taskforce on Nature-Related Financial Disclosure (TNFD), whose mandate is to prepare some of the standardized practices that would be needed to implement this element.^[23] Stress testing methods could be adapted from climate change stress testing which are now in place in a number of international financial jurisdictions worldwide. The French government has introduced the “Loi de Vigilance” in France, which introduces new corporate duties, obliging companies to govern and report on the activities of their overseas activities in relation to human rights, fundamental freedoms, human rights, and the environment.^[24] This approach offers an example that can be used to embody the protection of nature.

Recommendations for China

Chinese and international banks should develop a quantitative approach to the use of standards, risk and impact assessment, and reporting in relation to nature and collaborate with other international institutions to work toward a convergent and harmonized set of standards as these develop worldwide.

Chinese financial institutions should support, track closely, and participate in the Task Force on Nature-Related Financial Disclosure.

9.2.3.3 Create Liability for Nature: Legal Systems Make Financial Institutions Liable for Biodiversity Impacts.

i) Legislators extend liability for nature damage caused by companies to their banks and other financing institutions.

ii) Regulators require financial institutions and corporations to establish nature protection as a public fiduciary responsibility of company directors in their corporate governance.”

Incentives are material to causing the current situation of nature depletion. Although it is true in many jurisdictions that financial incentives to avoid harm to nature are weak or absent, it might also be one of the most difficult situations to reverse politically. Internationally, the debate has focused on soft commodity supply chains, in particular timber, with the European Union introducing legislation and the UK with a draft bill progressing through its legislative chambers. So far, there have not been exclusions within investment management, in the same way that tobacco and arms are screened out of ethical investment portfolios, to remove activities that damage high-value protected areas and threaten species, though this could develop. In addition, there have been discussions among legal reform experts, which have not yet crystallized into legislation in any countries, to create a new crime of “ecocide” associated with the loss of species or significant damage to ecosystems.

Recommendations for China

China should debate and identify ways to address the role and responsibility of financiers and to extend legal liability to those who contribute to damaging nature.

China should consider the introduction of extra-territorial law to stem the use of Chinese capital and financial institutions to finance activities that damage nature beyond its frontiers.

China should articulate the concept of “ecocide” in law, to enable the courts to pursue the most serious cases of damage. It should also support and contribute to the movement seeking to develop the concept of “ecocide” in international law.

9.2.3.4 Align Public Finance with Nature: Governments and Public Agencies Transparently Align All Public Finance to Biodiversity-related Policies, Goals and Commitments.

i) Governments eliminate or reform all nature-negative subsidies and taxes and develop and scale up incentives for biodiversity restoration.

ii) This process should address public procurement, investments and financial instrument design, sovereign debt arrangements and monetary practices.

Public finance is a rich area of action for government. Fiscal reform covers agriculture and fishing subsidies, and the procurement of biodiversity restoration. The first of these is the subject of another CCICED paper.^[25] The reform of subsidies and public spending has been discussed for many years, but now the discussion is reaching wider into non-fiscal components. The non-fiscal components include governments' role as owner and funder (and policy-manager) of state-owned financial institutions (such as national banks and international development banks), and its role as lender or donor to development finance institutions. As direct owner, it can make corporate policy equivalent to its national policies on nature positive, and as a lender or donor it can make the investment and grant mandates equivalent in the same way. A government can also use its operation in sovereign debt markets to constrain the use of proceeds from its sovereign bond holdings, for example, through the arrangements becoming known as "Nature Performance Bonds," a concept now being developed internationally and which may be housed in a new international facility at the World Bank.^[26]

Recommendations for China

China should map out a nature-positive transition for public finance and subsidy practice, including overseas investment mandates and the investment mandates of its policy banks and development finance institutions.

China supports the international Global Platform on Debt, Climate and Nature currently being designed by the World Bank.

9.2.3.5 Align Private Finance with Public Policy: Financial Institutions Ensure that Their Activities are Consistent with Nature-related Public Policies, Goals, and Commitments.

i) Financial institutions align their financing with biodiversity-related public policies and international commitments—for example, through assurance of net gain of biodiversity and ecosystem services.

ii) Regulators require financial institutions to align their financial practices, including the design of financial instruments, offers, and services, with the nature-related public policies and nature-related international public policy commitments in

jurisdictions where they operate.”

Research shows that very few financial institutions internationally have policies relating to nature and biodiversity; in contrast, many more have adopted policies on climate change, including net-zero targets.^[27] Some have signed up to the Finance for Biodiversity Pledge, but all are at an early stage of understanding the meaning of a nature-positive or similar transition for finance.^[28] It seems possible, internationally, that the pattern of behaviour seen in financial institutions in the last couple of years in relation to climate, where more and more ambitious policies have been adopted, could be followed in relation to nature and biodiversity over the next 5 years. Internationally, financial supervisors and regulators have been willing to require their sectors to manage long-term risk but have not been willing to direct them in their investment policies. Those regulators have hardly begun to look at nature and biodiversity, and there is a debate whether they and the sectors they oversee have sufficient capacity to deal with nature on top of climate change. However, if and when they do decide to address nature, an overarching principle such as nature positive would provide them with a clear direction of travel.

Recommendations for China on financial corporate policy and fiscal instruments

China should define the role and expected behaviour standards of its financial institutions—along with their rights and responsibilities—and incorporate these in a plan for a nature-positive transition.

9.2.3.6 Integrate nature into financial governance

i) Governance arrangements, including mandates, instruments, and the basis on which governing bodies are held to account, should be demonstrably responsible, capable, and effective in stewarding the impacts of finance on biodiversity.

ii) Financial governance institutions, including financial regulators and monetary authorities, standards setters, and those with fiduciary responsibilities for financial assets, should publicly explain the past and likely future impacts of their decisions and actions on biodiversity.

Prior to 2014, not one central bank considered climate change to be its business. By 2020, there was not one major central bank worldwide that did not speak of its forward-looking approach to climate change. This shift was brought about in large part by exemplary leadership. Such leadership acted within their authority in addressing the risk climate change poses to financial stability. But in truth, they were as much driven by a conviction that central banks and financial regulators needed to play their part in addressing a global, existential challenge. Indeed, these leaders ensured that their progress would not be impeded by incumbent governance norms by inventing a new platform: the Network of Central Banks and Supervisors for Greening the Financial System (NGFS). The NGFS is now starting to look at

nature and biodiversity. The Dutch central bank has been an early mover, with the publication of estimates of nature dependency which makes the case for management of risk.

Those governing global finance will wish to consider the materiality of biodiversity in financing decisions. Central banks and financial regulators can advance this only by acting within their authority. Yet precedent shows that their mandates can and often are broadly interpreted. Indeed, the Group of Thirty, an international body of leading financiers, in a landmark report following the Great Financial Crisis, concluded that central banks should align with long-term public policy goals (while avoiding being responsive to shorter-term public policy measures).^[29] As financial regulators, then, there is a debate to be had about what alignment would mean. It could mean ensuring that licensed financial institutions align their behaviour and impacts with such long-term policy goals and not only with the needs of robust risk pricing and financial stability.

Recommendations for China on financial regulation

The People's Bank of China and the three leading supervisory authorities (CBRC, CIRC and CSRC) should agree on how to address biodiversity risk and impact within their respective sectors and develop policies to ensure a rapid transition to alignment with the nature-positive principle.

China's banks should then adopt policies that align with Chinese government principles, policy milestones, and targets for a nature-positive transition.

9.2.4 Enabler: The Role of Fintech

Strategies are needed to align the financial system with the broader goal of Eco-Civilization, where the flows of finance restore damaged ecosystems and favour overall balance between the natural environment and human endeavours. The implementation of a nature-positive standard would today be greatly facilitated by the judicious application of digital financial technology, i.e., fintech.

One of the common sources of resistance to greater accountability by financial sector actors for their impact on nature is that the full range of tools, namely regulations, standards, data, accounting practices, and reporting guidelines, are not in place. Under normal circumstances, the process to put this arsenal of measures in place would be long and arduous. Today, however, fintech can greatly accelerate and facilitate the uptake of new standards and practices.

While the applications of fintech to nature and ecosystems are still comparatively underdeveloped compared with other applications, for example to climate change, the gap is rapidly being filled. Developments in China and abroad suggest that there is a wide range of ways in which fintech can help speed the alignment of finance

with the requirements of nature. Key among these are the following.

Big Data: The increasing availability of and access to data relating to nature and natural resources, and the changes to them over time, is both speeding up the time between research and results and generating a base foundation of information to inform financial decisions, whether assessing risk or measuring impact. Open, accessible databases such as the Global Biodiversity Information Facility further increase availability and comparability of data, greatly reducing the obstacles to sound financial decision making.^[30]

Artificial Intelligence: The application of artificial intelligence and machine learning has accelerated enormously over the past decade, and it can now handle much of what previously required time-consuming and tedious research. By combining data sets, AI can both pinpoint the problems with more accuracy and sharpen the focus of interventions to solve these problems. Now well developed in fields like agricultural production, there remains a gap to be filled in applying AI to natural resources and the impact of human activity on them. It is a gap that must be filled urgently.

Blockchain: Distributed ledger technology, often referred to as Blockchain, can greatly improve the security and reliability of both data and the legal infrastructure that underlies accountability for damage to nature. Blockchain land registers, contracts, and other basic documentation can greatly reduce conflict and corruption around access to and use of natural resources and clarify property and access rights. Blockchain also greatly enhances the traceability and certification of products deriving from exploitation of nature, including financial instruments such as green bonds. Similarly, they can correct the power imbalances that too often lead to private over-exploitation of nature. However, the application of Blockchain technology to reduce the impact of human activity on nature remains in its infancy.^[31]

The Internet of Things (IoT): Connecting technology, instruments, and communications to the Internet and harvesting the information that is automatically generated, both vastly improves the availability of data and relieves the sometimes massive burden of sifting through and combining data sets to generate the information needed. The nature-positive standard requires a strong foundation of data, hence IoT might be an important and automated provider of much of the data needed to underpin its implementation.

The above base factors deriving from new fintech applications can, if properly applied, overcome many of the obstacles that lie in the way of the rapid adoption and application of a nature-positive standard and greatly improve the accountability of financial actors in respect of agreed standards. The application of the full range of fintech approaches would facilitate the **Digitization of Natural Assets**.

Fintech can assist by building models of economic development that respect nature by “**digitizing**” **natural assets** such as trees or water courses so as to enable trade, investment, and valuation. The construction of an open, digitized platform on

the basis of these assets would assist in boosting the transparency and traceability and might provide the foundation, for example, for a green credit system. It might also overcome the problem of data compartmentalization, enabling combination of data across enterprises and financial actors.

Disclosure of Risk and Impact: The assessment of the nature-based risks inherent in any financial transaction and the measurement of the impact on nature of these transactions, is a central challenge. Fintech applications favour and facilitate transparency and enable streamlined disclosure of risks and impacts such as these, making it possible to greatly increase the recognition of nature in governance systems and policies. It enables financial institutions to engage responsibly in the implementation of the nature-positive principle, and to apply it to those to whom they lend or in whom they invest.

Public Engagement: The implementation of the nature-positive standard is both a supply and demand challenge. Fintech facilitates both. The contribution of Fintech to the supply challenge has been outlined above. Moreover, by facilitating transparency and the accuracy of information, it can greatly support the growing demand from consumers and the public for greater responsibility toward nature. Crowd-sourced science, using mobile phone applications, is already boosting accountability as people check and communicate to public authorities and private funders what is being done with their money, correcting misinformation and building a community around a vocal demand for better outcomes. The potential of fintech to create and reinforce the demand for nature-responsible finance is only beginning to be understood.

Since the beginning of the 21st century, China has become a global frontrunner in fintech. In addition, China has demonstrated to the world its firm determination to establish a "national ecological civilization" and participate in "global climate governance." This sets the most favourable policy environment for the green application of China's fintech. However, as is the case in the Netherlands, Germany, and Spain, etc., the policy integration between fintech and green finance is still very limited, and the policy guidelines in both fields underestimate the nature-positive principle. Currently, the main challenges faced by fintech in supporting the development of biodiversity protection include:

1. **How to design and promote biodiversity conservation from the perspective of commercial feasibility:** Because technology companies generally have a low awareness of the importance and relevance of biodiversity protection with their businesses, the operability of incorporating biodiversity protection into the company's business strategy and utilizing financial technology to measure, certify, and translate it into business profit is still in a very early stage of exploration. There is still a lack of nature-positive business models, like Ant Forest, in the market for firms to learn and to borrow from.

2. **How to promote citizens' engagement in biodiversity protection:** While it

has been well accepted that fintech has a great potential to arouse citizens' green awareness and encourage engagement in personal natural positive behaviours, in the practice such importance and value have not been fully understood. Neither national nor local governments have introduced incentive mechanisms directly linked to consumers' individual green behaviours.

3. How to promote the participation of SMEs: At present, large companies are still the main players in ecological protection projects, and the participation of SMEs is still very limited. “Native” green fintechs are very rare.

4. How to promote data quality and data sharing: For the cross-border data platforms and transaction platforms, cross-border information transmission, mutual recognition and sharing face complex national and international legal issues. Moreover, the defining, pricing, and trading (i.e., liquidity) issues of data-driven biodiversity projects and assets directly affect the value of data.

Recommendations for China on Fintech

China should explicitly develop and adopt strategic guidelines to encourage fintech for biodiversity, releasing a strong policy signal to the market. It should promote the inclusion of nature-positive application of fintech into the 14th Five-Year Plan and actively seek a leading position in the field to contribute to global ecological progress.

China should identify and map out the many ways in which fintech can be enlisted in support of a nature-positive standard, pinpoint gaps in present practice and establish a program to minimize these gaps.

China should strengthen ecological protection responsibilities of the fintech industry and companies. It should establish knowledge exchanges and seminars along with regional green education centres for fintech companies, promote information sharing and green capacity building, and improve publicity and stimulate companies to innovate on nature-based sustainable business models. It might consider establishing "fintech + biodiversity protection" pilot/demonstration zones.

China should focus especially on fintech applications that enable transparency, disclosure and the accurate assessment of risk and impact related to finance and biodiversity. These should be designed with a view to their widespread use both within China and abroad, starting in key areas for biodiversity.

China should favour fintech applications that widen the opportunities for stakeholder participation in exercising accountability around a nature-positive standard.

China should favour the development of green/biodiversity infrastructure, in particular green data/biodiversity platforms, and continually support the monitoring and research of green/biodiversity data.

9.3 “Throttling”: Ensuring that Funds Flow to Support Conservation

9.3.1 Practices of Chinese institutional investors in Conservation finance

9.3.1.1 Background

In this chapter, the term “institutional investor” refers to a legal entity that is qualified to invest in financial markets, and includes sovereign wealth funds, public or private equity funds, qualified foreign investor (QFII), brokerages, insurance, social security funds, wealth management subsidiary companies of commercial banks and asset management companies etc. Most of these companies hold financial licences, but some institutions (such as private equity funds, small asset management companies, private investment companies, government investment and financing platforms) have not been included as financial institutions. In recent years, institutional investors’ activities and quota in China’s financial market are increasing gradually. The quota increased from 136.6 billion to 4718.1 billion RMB at a 30% average annual growth rate (Tong, 2018). Along with the establishment and improvement of China’s green financial policy, institutional investors, especially large institutional investors, have made great efforts in the practice of sustainable investment, and environmental, social, and corporate governance (ESG) investment. The research finds that there is rising attention and enthusiasm for green finance and ESG investment from China’s institutional investors, with the number of financial products growing. However, their practices in conservation finance are still in the initial stages, with a lot of room for improvement in the future. Large institutional investors, such as sovereign wealth funds, asset management companies, and commercial insurance companies, have not yet incorporated ecological and biodiversity conservation into their investment strategies and decision-making systems.

9.3.1.2 Practices of Chinese Institutional Investors in Developing Conservation Finance

9.3.1.2.1 Investment Funds, Securities Companies and Banks Have Launched More Ecological Protection Financial Practices

In practice, Chinese investment funds, securities brokerages, and bank wealth management companies pay more attention to ecological protection finance. Some institutions have incorporated ecological protection into their development framework from a strategic level, and actively explored products related to ecological protection in the development of green finance and ESG investment

(1) Funds

Funds are participating in conservation finance through ESG investments. In the past few years, more and more foundations of China have braced the concept of green development and ESG into their investment strategies. The tendency has

become even more distinct since June 2018, when MSCI introduced Class-A Shares in China into two of its ESG indexes, namely the MSCI Emerging Markets Index and the MSCI ACWI Index. In this mechanism, listed companies that do not meet the ESG standards will be removed. The research finds that there are a large number of publicly offered funds striving to improve their ESG frameworks by building internal ESG rating teams and cooperating with third-party rating companies or databases. According to the "China Responsible Investment Annual Report 2020" jointly released by Shandao Ronggreen and China Responsible Investment Forum (China SIF), by the end of October 2020, there were 127 pan-ESG public fund products in China, with a total scale of more than 120 billion yuan.

(2) Securities Companies

At present, many securities companies in China (including asset management companies) have begun to conduct studies on ecological protection investment. The securities companies no longer see the concept of green finance as a brand strategy like 10 years ago, but also as an innovative product that possesses both economic and social benefits. China is now developing a multi-win-win market for participants, including institutional investors, private investors, and project managers. An example is that Industrial Securities implements the concept of green development in terms of green financial evaluation criteria, business assessment criteria, and organizational structure reform and has formed a comprehensive planning of "four-in-one" system including green investment, green financing, green research, and environmental equity, and aims at being an exemplary and leading role in China's security industry.

(3) Bank Finance Companies

Commercial banks are the core of China's financial system, and ecological protection finance is an important embodiment of commercial banks' development of green finance and practice of sustainable development. In recent years, ESG and other ecological protection concepts have been applied to bank finance, and "bank department" ESG-themed finance products have become increasingly mature. In April 2019, Huaxia Bank launched the first ESG-themed financial products in China. As of December 10, 2020, there are 49 ESG and environmental protection-themed products in the market of bank financial products, and the investment targets include green bonds, green ABS, and debt assets of enterprises with good ESG performance. It covers key areas such as energy conservation, environmental protection, ecological protection, high-quality development, clean energy, rural vitalization, and people's livelihoods.

9.3.1.2.2 The Financial Progress of Sovereign Wealth Funds, Asset Management, Insurance, Investment Companies, Government Investment and Financing Platforms for Ecological Protection is Relatively Slow

At present, China's sovereign wealth funds, asset management companies and

insurance companies have made relatively slow progress in ecological protection finance. Despite the increased emphasis in recent years, no specific financial planning for ecological conservation or biodiversity has been developed at the strategic level.

The main reason is that the asset owners do not pay enough attention to ecological protection. As the performance assessment of managers by owners is still based on the return on investment, institutional investors put the return on investment in the first place when making investment choices, take the preservation and appreciation of assets as the core business objective, and give little consideration to ecological protection. In contrast, investment managers who have been entrusted by conservation-focused funders (such as those from Europe) have been faster to form ESG evaluation teams and introducing ESG criteria into their investment decisions.

9.3.1.3 The Policy Environment for China's Large-Scale Institutional Investors in Conservation Finance

Although at present the Chinese government has not issued policies specifically aimed at ecological protection, it has issued many policies in green finance that relate to ecological conservation, which has laid a good foundation for the start and promotion of conservation finance.

9.3.1.3.1 Financial Policy

There are two kinds of policies encouraging financial institutional investors to participate in developing conservation finance. One type is the policies published in 2015 and 2016 related to energy conservation and emission reduction, ecological protection, and the overall planning for green finance systems. The other one involves the measures of serving the economic entities, promoting high-quality economic development, revitalize rural areas and improve the green and low-carbon system. These policies are mainly macro-level advice and guidance, and are connected with the concepts of financial innovation, low-carbon economics, and ecological restoration under the framework of green finance (see the attachment).

9.3.1.3.2 Fiscal Policy

The fiscal policies encouraging institutional investors to participate in conservation finance are mainly embodied in China's energy conservation and environmental protection planning in the 13th Five-Year Plan period. These policies focus more on increasing government's funds for energy conservation and emission reduction projects, compensation for ecological protection, and implementing preferential tax policies on environmental protection and pollution prevention and control etc.

9.3.1.3.3 Environmental Policy (Industrial Policy)

China is encouraging institutional investors to develop conservation finance via improving various systems of ecological conservation in top-level policies, such as

the Ecological Civilization Reform Plan, the Green Industry Guidance Catalogue, and the 14th Five-Year Plan.

9.3.1.4 Challenges and Obstacles of China's Large-Scale Institutional Investors in Developing Conservation Finance

Although China has made significant progress in green finance recently, the development of conservation finance under the framework of green finance is still in its infancy. In general, institutional investors lack incentives to invest in conservation finance. They should build the concept of conservation finance into their investment strategy, take the lead in the practice, and have the courage to explore and develop the corresponding financial investment products.

9.3.1.4.1 The Less Knowledge and Attention to Conservation Finance

At present, with the support of the Chinese government, green finance has made great progress both in theory and in practice. However, regarding ecological protection finance, although there is some overlap with green finance, there are also some differences. As pointed out in Chapter 2, the nature-positive principle goes beyond the "no-harm" principle and "no-net-loss" principle in the past, and is more proactive and more effective in ecological and environmental protection. China's green economy focuses more on economic sustainability and does less to support environmental remediation and biodiversity conservation. As a result, the concept of ecological protection finance has not been widely promoted and recognized in China. Many market entities only know about green finance and ESG concepts, and do not regard ecological protection finance or even biodiversity finance as an important business goal. The research and innovation of ecological protection finance are relatively insufficient, and there is no special strategy put forward or ecological protection investment with distinct theme.

9.3.1.4.2 The Economic Returns of Conservation Projects Are not Clear

First, China's green finance mainly focuses on 1) green upgrading of traditional industries, 2) energy conservation and emission reduction, 3) important ecological resource restoration led by government financial funds, 4) construction of green towns and industrial parks, 5) new energy represented by photovoltaic and automotive lithium batteries, and 6) emerging industries represented by new materials and energy-saving equipment. Ecological protection projects have low returns, long cycles and high risks, and most of them cannot gain direct benefits in the short term or even in the long term, so there are still few conservation investment projects that can realize the economic and social benefits together. With the uncertainties of economic and investment returns combined with the absence of successful cases of conservation investment, institutional investors have fewer incentives to pilot conservation finance, and the motivation to promote conservation finance and innovate new products and services is low.

Second, the institutional investors cannot find proper matching of investment

targets. There are strict rules on the amount of assets, such as net assets required by the authorities. In the secondary market, there is a lack of listed company stocks directly related to ecological protection. Furthermore, the selection strategy is profit oriented. The environmental performance is only an auxiliary means of identifying the potential risk of enterprises, rather than the major consideration.

9.3.1.4.3 Infrastructure for Conservation Finance Is Imperfect

The major challenges of conservation finance are the long investment cycle and the uncertain investment returns without a unified evaluation system. On the one hand, the mechanisms of information disclosure are not perfect. Except for a few highly polluting industries, there is no mandatory requirement for conservation protection disclosure. It is difficult for investment institutions to accurately judge the risk and return of ecological protection investment. On the other hand, the standard for ecological protection is not clear. It is hard to price ecological assets, which makes it difficult for investment institutions to carry out post-investment management

9.3.1.4.4 Relatively Lack of Policy Incentives

From the perspective of projects, the anticipated cash flow for the project is uncertain. There are two types of benefits from conservation projects that have no positive incentive for investors, namely incomes from tourism projects and the carbon sink benefits from the protected areas (e.g., forests, wetlands). As for tourism projects with conservation goals, they are more like the spillover effect brought by environmental improvement after the remediation. It cannot be directly distributed to the investors as the income of restoration project. As for the carbon sink benefits, due to the relatively loose quota allocation in China's pilot carbon market, the carbon price was too low to generate enough benefits of the carbon sink for conservation projects. Therefore, it is necessary to stimulate ecological protection finance from the policy level. However, the research found that the current policy incentives are relatively insufficient, making it difficult for institutional investors to develop and promote related products.

From the perspective of management, as the entrusting and supervising parties of large state-owned institutional investors, the government bodies have not yet incorporated ecological and biodiversity conservation into the performance evaluation system. Under the condition that the current evaluation system focuses on financial returns and has clear assessment criteria for financial returns, the motivation of state-owned institutional investors to invest in natural ecological assets is obviously insufficient.

9.3.2 The Impact of Agricultural Subsidy Policy on Financial Institutions

9.3.2.1 The Main Forms of Agricultural Subsidies in China and Their Impact on the Financial System

For a long time, China has built a complete agricultural support policy system oriented to increasing production and income. This system has played an important role in ensuring China's grain supply and promoting the increase of farmers' income, but it has also caused serious damage to the agricultural ecological environment. China has gradually changed the policy orientation of one-sided pursuit of increasing production and started to implement a new agricultural subsidy policy system that combines the dual objectives of increasing production with ecological protection.

9.3.2.1.1 The Main Form of Agricultural Subsidies in China

China's agricultural subsidies are mainly for grain production. In 2016, based on the experience gained from pilot projects, China rolled out the reform of the agricultural subsidies, combining “subsidies for superior crop varieties,” “direct subsidies for grain,” and “general subsidies for agricultural means of production” into “subsidies for agricultural support and protection.” The policy objectives were to protect the fertility of cultivated land and appropriately scale grain operations. At the same time, China also has carried on the reserve policy reform, establishing the “soybean target price subsidies” and “corn producer subsidies.” After the 2016 reform, China's main agricultural subsidies can be divided into four categories: Direct Subsidies, Producer Subsidies, the Policy of Minimum Grain Purchase Prices (MGPP) and Agricultural Insurance Premium Subsidies (AIPS).

Table 9-1 China's main agricultural subsidy policies

Types of agricultural subsidies	WTO policy attributes	Amount of subsidy (billion CNY)
1. Direct subsidies		
1) Agricultural support and protection subsidies (ASPS)		163.35
Land fertility protection subsidies (LFPS)	Green box policy	141.66
Moderate-scale operation of grain subsidies (MSOGS)	Amber box policy	21.69
2) Purchase subsidies for agricultural machinery (PSAM)	Amber box policy	25.66
2. Producer subsidies		
1) Corn producer subsidy (CPS)	Blue box policy	39.03
2) Soybean producer subsidy (SPS)	Blue box policy	7.34
3. The policy of minimum grain purchase prices (MGPP)		
1) The policy of minimum rice purchase prices (MRPP)	Amber box policy	/

Types of agricultural subsidies	WTO policy attributes	Amount of subsidy (billion CNY)
2) The policy of minimum wheat purchase prices (MWPP)	Amber box policy	/
4. Agricultural insurance premium subsidies (AIPS)	Green box policy	28.8

Data source: WTO domestic support notification documents.

9.3.2.1.2 The Influence of China's Agricultural Subsidy Policy on the Behaviour of Financial Institutions

The main purpose of agricultural subsidy policy is to adjust the behaviour of agricultural producers. However, different forms of subsidies will have different effects on the behaviour of financial institutions, but generally speaking, financial institutions' responses to agricultural subsidy policies are mainly divided into two categories: adjustment of lending scale and adjustment of premium prices.

(1) Green Box Policy

Green box policy refers to the policy that has only a slight distorting effect on agricultural trade and agricultural production. China's green box policy mainly consists of LFPS and AIPS.

LFPS is provided to the actual cultivators according to the area of the land, but in practice, the subsidies are often directly issued to the farmers who have the right to contract the land. Therefore, LFPS does not easily affect the production behaviour of farmers, but is more like a transfer payment to improve their income. In the process of subsidies, farmers' incomes are raised, and financial constraints are eased, and demand for credit is reduced, which may lead financial institutions to scale back lending.

AIPS makes the government bear part of the insurance cost for farmers, so it will promote farmers' demand for agricultural insurance. AIPS have greatly increased the number of farmers purchasing insurance and significantly expanded the scale of the agricultural insurance market, which will inevitably prompt major financial institutions to increase the supply of agricultural insurance products and increase the premium prices.

(2) Amber Box Policy

Amber box policies are direct price interventions and subsidies for agricultural products that distort agricultural trade. China's amber box policy mainly includes MSOGS, PSAM, and MGPP.

MSOGS is a subsidy given to farmers who grow grain to a certain extent, which can effectively promote farmers' moderate-scale operation. Stimulated by subsidies, farmers' enthusiasm for food production will increase, and the transferring of land to expand the scale of operation will increase. The scale expansion will lead to an increase in the demand for agricultural machinery, which is generally manifested as

a substantial increase in the demand for credit. In China's institutional context, where rural land rights can be mortgaged, financial institutions are likely to expand lending accordingly.

PSAM can reduce the capital cost of farmers' purchasing agricultural machinery and effectively stimulate farmers' demand for agricultural machinery. However, even with subsidies, most farmers cannot afford to buy farm machinery at full cost, so a rise in the demand for farm machinery will inevitably lead to an increase in the demand for credit. In addition, improved agricultural machinery will encourage farmers to expand production, which in turn will lead to higher levels of credit demand growth. Under such circumstances, financial institutions will lend more.

MGPP is to guarantee the income of rice and wheat farmers and help them avoid being excessively affected by the fluctuation of agricultural prices, which will undoubtedly increase the enthusiasm of farmers to plant rice and wheat. Such an increase in enthusiasm will, on the one hand, put more land into agricultural production; on the other hand, it will also increase the use of pesticides and fertilizers by farmers. All these behaviours will increase farmers' demand for funds. Under such circumstances, financial institutions will raise the threshold of lending and moderately expand the scale of lending. In addition, since MGPP has a certain degree of substitution relationship with AIPS, the subsidy will also reduce the insurance demand of farmers and make financial institutions lower the price of insurance products.

(3) Blue Box Policy

The blue box policy is the special amber box policy of direct payment in connection with the production restriction program. China's blue box policy is mainly producer subsidies for corn and soybeans.

Producer subsidies are aimed at farmers who plant corn and soybeans. This subsidy is an adjustment of agricultural structure and will encourage farmers to plant more corn and soybeans. China's soybean and corn production areas are mainly in the north, and increasing the planting area of corn and soybean will mainly reduce the size of the area growing wheat. However, since the production cost of wheat differs little from that of corn and soybeans, it will not have a big impact on farmers' demand for credit. On the other hand, due to the adjustment of varieties, the demand for corn and soybean insurance products will increase, financial institutions will launch more corn and soybean insurance products and increase the insurance premium price.

Table 9-2 Behavioural responses of farmers and financial institutions under the stimulus of agricultural subsidy policy

Type	Agricultural subsidy policy	Behavioural responses of agricultural producers	Behavioural responses of financial institutions
Green box policy	LFPS	Falling demand for credit	Scale back lending
	AIPS	Increased demand for insurance	Increase the price of insurance premiums
Amber box policy	MSOGS	Enlarge the scale of agriculture; Increased demand for credit	Expand lending
	PSAM	Demand for agricultural machinery increased; Increased demand for credit	Expand lending
	MGPP	The enthusiasm for agricultural production was increased; Increased demand for credit; Falling demand for insurance	Raise the loan threshold; Expand lending; Reduce insurance premium prices
Blue box policy	Producer subsidies	The proportion of corn and soybean increased	Raise the premium prices of corn and soybeans

9.3.2.2 The Impacts of China's Agricultural Subsidies on the Environment and Ecosystem

9.3.2.2.1 The Possible Impacts of China's Traditional Agricultural Subsidies on Nature and Ecosystems

Most of subsidies mentioned above were not designed with an eye to environmental protection, causing some negative environmental externalities.

1) The income effect of the general subsidies for purchasing agricultural supplies may lead to excessive use of chemical fertilizers, pesticides, and mulching film by farmers, which may cause agricultural non-point source pollution.

The widespread use of chemical fertilizers and pesticides has played a vital role in promoting grain production and ensuring China's food security. At the same time, planting is also a dominant source of water and soil pollution. Subsidy policies for specific fertilizers and pesticides help encourage farmers to choose high-yielding crop varieties, but they have long-term adverse effects on soil and water resources. According to China's national pollution survey data, the total nitrogen loss from the planting industry in 2007 was 1.5978 million tons, and total phosphorus loss of 108,700 tons, accounting for 33.8% and 25.7% of the country's total nitrogen and total phosphorus emissions respectively. Residual pesticides and fertilizers have also directly destroyed the agricultural ecosystem and biodiversity in some areas, posing a greater threat to the survival of fish, amphibians, waterfowl, and beasts. Mulch

film has been largely used and lightly recycled, and the problem of residual pollution and land erosion of mulch in some areas has become increasingly serious.

2) Multiple subsidy policies have led to more land that is unsuitable for farming being put into agricultural production, which may disrupt the ecological balance.

In order to obtain a number of agricultural subsidies, there may be a phenomenon of excessive land reclamation and land wasting. Excessive development has caused vegetation destruction and soil erosion to increase, some rivers have reduced or even cut off flow during dry seasons, rivers have increased sand content, and pollution of drinking water sources still occurs from time to time, which were influenced by long-distance transportation of inland pollutants and unfavourable meteorological conditions such as local pollution source emissions.

3) The direct subsidies to grain growers encourage farmers to grow the same grain crops annually, resulting in a single planting structure and a decline in soil fertility.

The traditional model of diversified planting is extremely important to maintain the balance of the farmland ecosystem, while the specialized single crop production model guided by subsidies breaks the original farmland ecological balance. At the same time, with an increasing number of migrant workers, farmers are more inclined to plant food crops with high-yield, low-input, easy management, and relatively stable prices in the agricultural production of main grain production areas. This reduces the buffering performance of the farmland ecosystem. Farming techniques of ridge and plowing may aggravate the decomposition of soil organic matter and structural damage, and also aggravate the threat of disease and insect pests to food production, becoming a potential factor that seriously affects the country's food security.

4) The economic incentives of agricultural insurance may lead to the separation of planting and breeding industries, and the discharge of livestock and poultry wastes has become an important source of water pollution.

Traditionally, farmers operated diversified planting and breeding, and used human and animal manure as fertilizer to fertilize crops. At the same time, the waste generated in the process of crop production can also be used to feed animals, which is green and environment friendly. The ecological circular development model can minimize the adverse effects of external materials on the rural environment.

The emergence of agricultural insurance has formed an alternative to the traditional agricultural risk dispersion model of diversified planting; that is, farmers can also provide risk protection for their agricultural production by purchasing agricultural insurance services. If farmers choose to engage in specialized planting or breeding under the economic incentives of agricultural insurance, the original circular economy development model will be challenged. To increase the output of

agricultural products, farmers must continue to increase the input of pesticides and fertilizers, causing soil structure to suffer. Environmental destruction and the untreated discharge of livestock manure caused by large-scale breeding will also become a serious environmental problem.

9.3.2.2.2 Characteristics of the Transformation of Agricultural Subsidies in China in Recent Years

1) The orientation of general subsidies for purchasing agricultural supplies is transferred to green and sustainable objects.

In response to the high price of chemical fertilizers at the beginning of this century—and the widespread fertilization in rural areas combined with the serious problem of excessive fertilization in some areas—the central government established and implemented a soil testing and formula fertilization subsidy program in 2005. As of 2019, China has invested 10.4 billion yuan in subsidies for soil testing and formula fertilization. During the 13th Five-Year Plan period, with the adjustment of agricultural policies and green development policies, the use of chemical fertilizers nationwide has experienced decline for four consecutive years from 2016 to 2019, and the intensity of fertilizer use has also maintained a downward trend. In the planting industry, the main driving force for emission reduction comes from the decline in the total amount of fertilizer application, the continuous optimization of the fertilizer input structure and the further improvement of fertilizer utilization.

2) General subsidies for purchasing agricultural supplies have mainly shifted from the promotion and use to the end of recycling.

In 2017, the Ministry of Agriculture issued the "Agricultural Film Recycling Action Plan." The plan encourages 100 counties in Gansu, Xinjiang, and Inner Mongolia to promote the transformation of subsidy funds from supplementary use to supplementary recovery while farming corn, cotton, and potato. Vigorously promote the mechanical picking of mulch film, open subsidies for mulch film recycling machines, and make up for them. In 2019, The central government will continue to support local governments in recycling waste mulch film to promote the construction of agricultural film recycling demonstration counties.

3) An ecological compensation mechanism should be established to promote the balance between nature and the ecosystem.

For example, in view of the serious soil erosion in the middle reaches of the Yellow River, the central government has increased its subsidies. In 2019, the National Development and Reform Commission issued the Pilot Plan for Comprehensive Ecological Compensation, taking the lead in pilot projects for comprehensive ecological compensation in five counties (county-level cities and districts) in each of 10 provinces.

9.4 “Broaden sources”: Increasing Green Funding Sources

9.4.1 *The Innovation of Conservation Financial Instruments*

9.4.1.1 *Developing REITs of Ecological Environment Infrastructure in China*

9.4.1.1.1 China's Ecological Environment Infrastructure Urgently Needs to Broaden Financing Channels

(1) The Investment Demand of Ecological Environment Infrastructure Is Very High

The traditional ecological environment infrastructure is mainly about all kinds of pollution control, involving air pollution control, solid waste pollution control, noise pollution control, and other aspects. The specific projects include domestic sewage treatment plants, sewage treatment pipe networks, industrial solid waste disposal facilities, etc. In March 2020, China proposed to speed up the construction of new infrastructure. The new infrastructure of ecological environment includes the green transformation of traditional infrastructure (such as charging stations (piles) of new energy vehicles), intelligent and digital transformation (such as domestic waste transfer system based on Internet of Things), etc. Both traditional and new eco-environmental infrastructures need huge capital investment. Taking the upgrading of urban sewage in China as an example, according to the calculation of China Merchants Securities, the investment scale of this project alone is more than 800 billion yuan.

(2) The Sources of Funds for Eco-Environmental Infrastructure Are Insufficient

Due to the characteristics of strong public welfare and low commercial return rate, the sources of investment funds for eco-environmental infrastructure mainly focus on two ways. One is government financial funds or bank credit funds relying on government credit, including financing through PPP projects supported by the government. The COVID-19 pandemic has brought about slower economic growth and increased government investment since 2020, which has led to a more tense fiscal situation in China. At the same time, defusing the hidden debt of local government led to decreasing financial support of this channel. Second, enterprises raise funds from the financial market. Affected by the economic environment, China's power, water, gas and heat, garbage, and hazardous waste industries have a high level of asset liability ratio and their financing ability is limited. Many enterprises engaged in ecological environment infrastructure investment are private small and medium-sized enterprises, so it is difficult to obtain green bond issuing qualifications in the bond market or green credit funds from banks. Moreover, their own operations are facing difficulties, and the investment of free cash flow in ecological environment infrastructure is declining.

China has begun to introduce REITs in the infrastructure sector. In June 2021, China's first batch of nine infrastructure REITS was listed, of which two were

ecological and environmental infrastructure projects.

9.4.1.1.2 Problems in REITs of Ecological Environment Infrastructure

(1) Lack of Tax Incentives

China's environmental protection projects involve many taxes from construction, transfer, and disposal, such as land value-added tax, transfer income tax, business tax, deed tax, and stamp tax; in the operation stage, they face double taxation of enterprise income tax and individual income tax which directly affect the enthusiasm of all parties involved in Chinese REITs. The international mature REITs usually enjoy various preferential tax policies. For example, the American REITs stipulate that if the company meets certain requirements, it can be exempted from corporate income tax and only levy individual income tax on investors. Tax policy has a direct impact on the enthusiasm of China's REIT participants.

(2) Lack of Liquidity and Low Yield

The real estate ownership and franchise of eco-environmental infrastructure have a fixed term, which affects the valuation and pricing of assets. Compared with real estate REITs, the valuation of environmental protection facilities REITs under the income method has decreased year by year, and, due to the relatively poor liquidity, the return rate of environmental protection facilities REITs has been further reduced.

(3) Franchise and Ownership Transfer Channels Are not Smooth

Infrastructure funds should penetrate through vehicles such as asset-backed securities and project companies to acquire full ownership or concession rights of projects. However, some projects currently have problems with restrictions on land or equity transfer and the need to obtain the consent of the competent authorities for the transfer of concessions. In the transfer of state capital, there is also a need to fulfill the procedure of state capital entry transaction, but the relevant supporting policies are not perfect. These original institutional regulations are contradictory to the characteristics of REITs, and supporting policies to solve the above problems are not yet in place

9.4.1.2 Practice of Government Guidance Funds Based on Ecological Protection

Recently, in order to promote ecological protection and support sustainable economic development, the central and local governments and state-owned enterprises have launched certain explorations and practices in setting up government guidance funds based on green development. However, compared with other fields, the scale is relatively limited, and there is still a lot of room for development in the future.^①

^① The government guidance fund in this article is a broad concept, including not only the guidance fund established by government finances, but also the guidance fund established at the level of central enterprises and state-owned enterprises.

9.4.1.2.1 Development Status

Government guidance funds based on green development mainly include the National Green Development Fund, the Yangtze River Green Development Fund, and the green industry investment funds initiated and established by local governments. The National Green Development Fund was initiated and established by the Ministry of Finance, the Ministry of Ecological Resources, and the Shanghai Municipal Government in July 2020. The operating entity is the National Green Development Fund Co., Ltd. (located in Shanghai), and the initial scale is 88.5 billion yuan. The Yangtze River Green Development Fund was established in November 2019. It is jointly funded by Three Gorges Group, Three Gorges Capital Holdings Co., Ltd. under Beijing Enterprises Water Group, and Beijing Enterprises Financial Services (Beijing) Investment Holdings Co., Ltd. The initial scale is 20 billion yuan.

In recent years, the local government level has also begun to establish guidance funds related to green industries and sustainable development. More than 10 provinces have set up nearly 20 green development guidance funds at the provincial level, with a target scale of nearly 500 billion yuan.

Table 9-3 Guiding funds related to ecological protection in recent years

	Provinces and cities of the fund	Fund name and year of establishment	Fund size (100 million yuan)	Establishment and main investment direction
1	Shandong Province	Green Development Fund, 2017	10 billion yuan	Comprehensive use of sovereign loan funds from Asian Development Bank, French Development Agency and other countries to attract social capital to participate together. It is the first green fund set up at the provincial level with loans from international financial organizations. Focus on energy conservation and emission reduction, environmental protection and governance, clean energy, circular economy, green manufacturing, climate change, etc.
2	Shandong Province	Three Gorges Green Industry (Shandong) Equity Investment Fund, 2020	5 billion yuan	It is jointly invested and established by Three Gorges Capital Holdings, Qingdao West Coast New Area Ocean Holding Group and provincial, municipal and district-level guiding funds. Focus on clean energy, eco-environmental protection and other green industrial chain areas, and boost the conversion strategy of new and old kinetic energy in Shandong Province.
3	Hebei Province	Green Economy Development Fund, 2019	2 billion yuan for the first phase	Hebei Xintou Group and International Green Economy Association invested and established, focusing on supporting a number of energy-saving and environmental protection enterprises to build a green manufacturing industry with Hebei characteristics.

	Provinces and cities of the fund	Fund name and year of establishment	Fund size (100 million yuan)	Establishment and main investment direction
4	Shanxi Province	SDIC Green Energy Development Fund, 2018	1 billion yuan	Shanxi State Investment Corporation, Shanxi Securities, Zhangze Power and other provincial state-owned enterprises jointly launched, focusing on green power generation projects.
5	Liaoning Province	Low-Carbon Green Industry Investment Fund, 2020	3 billion yuan, 500 million yuan for the first phase	Invest in the equity of outstanding enterprises in the field of environmental protection industry, key projects in the field of environmental protection, advanced environmental protection equipment manufacturing, smart environmental protection, and carbon sink trading.
6	Liaoning Province	New Energy and Low-Carbon Industry Investment Fund, 2011	5 billion yuan	Liaoning Energy Investment (Group) Co., Ltd. was jointly established with Haitong Securities Co., Ltd., focusing on new energy and low-carbon industries.
7	Jiangsu Province	Ecological Environment Development Fund, 2017	80 billion yuan, 6 billion yuan for the first phase	Huarong Tianze Investment Co., Ltd., a subsidiary of China Huarong, was jointly established with the Jiangsu Provincial Government Investment Fund, with Jiangsu Eco-environmental Protection Investment Fund and Jiangsu Eco-environmental Protection Facility Upgrading Fund, etc., focusing on the projects in the library of "263" special action project.
8	Zhejiang Province	"Two Mountains" Rural Revitalization Green Development Investment Fund, 2020	1 billion yuan	Anji County People's Government, Zhejiang Jinkong and China Land Reclamation Industry Development Fund jointly set up 9 investment projects, covering many industries such as ecological agriculture and tourism in Anji County.
9	Henan Province	Green Development Fund, 2019	16 billion yuan, 3.5 billion yuan in the first phase	The provincial finance, Henan Agricultural Comprehensive Development Corporation and relevant provincial cities jointly funded projects in areas such as clean energy, ecological environment protection and restoration, garbage and sewage treatment, soil remediation and treatment, and green forestry in Henan Province.
10	Guangdong Province	Green Industry Investment Fund, 2016	5 billion yuan	It is composed of 50 million yuan of government guidance funds and 4.95 billion yuan of social funds. The early investment direction is to promote the urban green lighting demonstration city project and promote the development of green lighting industry.
11	Sichuan Province	Urban and Rural Green Development Industry Guidance Fund, 2016	40 billion yuan	Sichuan Provincial Department of Housing and Urban-Rural Development, Provincial Development and Reform Commission, Provincial Key Office and related enterprises participated in the establishment, and focused on supporting innovative enterprises in the initial stage.

	Provinces and cities of the fund	Fund name and year of establishment	Fund size (100 million yuan)	Establishment and main investment direction
14	Guangxi Province	Green Emerging Industry Fund, 2020	5 billion yuan, 1 billion yuan for the first phase	CICC Capital Operation Co., Ltd., Guangxi Forestry Group Co., Ltd. and Nanning Industrial Investment Group Co., Ltd. are jointly established, which will focus on serving the development of green emerging industries, building the development pattern of high-end green home industry chain, and supporting the transformation and upgrading of high-end manufacturing, electronic information and big health industries.
15	Ningxia Province	Green Industry Development Fund, 2017	2 billion yuan	Rundongfang is jointly established with Ningxia Agricultural Investment Group, which mainly invests in green industry projects.
16	Ningxia Province	Environmental Protection Industry Fund, 2017	1 billion yuan, 500 million yuan for the first phase	The government's guiding fund is 100 million yuan, and 900 million yuan is raised from social investors and financial institutions.
17	Guizhou Province	Industrial and Provincial State-owned Enterprise Green Development Fund, 2019	30 billion yuan	It consists of three parts: Guizhou provincial financial industry special funds, provincial state-owned enterprise funds integrated investment and social capital directional collection, and invests in high-quality industries and state-owned enterprises with good development prospects and good growth.
18	Guizhou Province	Green Industry Poverty Alleviation Investment Fund, 2017	90 billion yuan in 2020	Focus on providing financial support around the rural industrial revolution and twelve major agricultural characteristic industries.

Note: The author organizes based on public information.

Note: The author organizes based on public information.

9.4.1.2.2 Problems and Obstacles

(1) Little Input Into Green Projects

Because the establishment of the Green Development Fund has been relatively short, it is still in the stage of organizational structure establishment, preliminary market research, and expansion of strategic cooperation. There is a lack of specific ecological protection investment projects. From the local government level, the fund establishment time that can be found in public information is after 2016, and about half of the funds were established after 2019. Many of them are still in the fundraising stage and have not yet been actually operated.

(2) Unclear Positioning and Development Goals

First, some provinces equate ecological protection guidance funds with emerging

industry investment funds and agricultural funds. Although marked "green" in the name, these funds did not invest strictly in ecological protection projects. Most of the investments flow to high-tech enterprises or other agricultural enterprises.

Second, some local governments have a strong arbitrariness in determining the amount of funds and the target amount. Some provinces did not consider the local economy, financial environment and green industry project conditions; therefore, the determination of the number of funds and the target amount was relatively arbitrary. Under this circumstance, the scale of the fund is too large, and the proportion of amplifying social capital through fiscal funds is too high. Not only may it cause greater difficulties in social fundraising, but it will also make the government have a weaker voice in the follow-up fund investment, which is not conducive to the long-term development of the fund.

(3) Imperfect Management Mechanism

First, there are too many institutional constraints and lengthy decision-making procedures. Some local governments still stick to the traditional financial special fund management thinking for fund management. They use administrative means to intervene or replace supervision, resulting in low fund efficiency. In addition, relatively few projects receiving investment from green funds have been disclosed.

Second, supervision and performance evaluation of government guide funds are imperfect. In terms of supervision, it is supervised jointly by the Ministry of Finance, the National Development and Reform Commission, and the industrial sector. In terms of performance evaluation, a nationwide system has not yet been established, and some documents have only a principled discussion. As a result, the evaluation systems of local governments also mainly focus on the investment, progress, and withdrawal of capital, which is unable to comprehensively and effectively supervise and evaluate the daily management and operation of the fund.

In addition, most of the guidance funds have strict regulations on investment income and periods and are subject to strict restrictions on the preservation and appreciation of state-owned assets. However, ecological protection-related projects generally have a long investment period, and the annual cash flow cannot be guaranteed. This does not match the investment preferences of the guidance fund, which easily leads to the difficulty of landing the ecological protection guidance fund.

(4) Lack of Investment Standards

At present, the environmental information disclosure mechanism, especially the information disclosure of non-listed companies, is incomplete. The standards for ecological projects and green projects have not yet been fully established. As a result, the ecological protection guidance fund, like other ecological protection finance, lacks investment instruments, and advances relatively slowly.

9.4.2 Debt and Biodiversity Conservation

China is increasingly prioritizing nature as a central component of its policy making. The target to reach net-zero emissions by 2060 and the hosting of the 15th Convention on Biological Diversity this year on a post-2020 Global Biodiversity Framework underline China's global leadership on the environment.

Across emerging markets there is a growing debt and nature crisis. Half of low-income countries are either at high risk of or in debt distress, creating the need for immediate fiscal space and resources to drive economic growth. Many of these nations are dependent on nature to drive productivity and service debt payments, fuelling international discussions about potential solutions to address debt and nature issues together. The G20 is advancing discussions on the range of solutions to address both crises, with China's role as a creditor putting it in a position to engage in discussions on how to support debtors through the crisis.

Sustainable debt issuance has grown rapidly across international and Chinese financial markets. Global sustainability-aligned debt now exceeds USD 1.5 trillion and is expected to make up 10% of global issuance in 2021. China is a global leader in green bonds, with the domestic bond market worth USD 120 billion, the second largest market in the world. The sophisticated architecture and implementation capacity that China has developed to rapidly advance this market puts it at the forefront of emerging developments in global debt markets.

A new generation of sovereign debt instruments captures the financial risks and opportunities posed by nature and climate. Nature performance bonds are instruments that link debt terms to nature outcomes, providing ways for issuers and investors to build green considerations into financial markets. These range from sustainability-linked instruments that link debt terms with performance outcomes to more established green bonds focused on financing nature-positive investments. The growth of these products in sovereign and corporate bond markets offers China global opportunities to deploy these instruments in the current crisis and to integrate nature more broadly into financial markets.

China is uniquely positioned to seize the opportunity to rapidly develop a program to support the uptake of sovereign and domestic nature performance bonds. To advance this, China can undertake practical steps to consolidate emerging international best practice and build on its strong domestic experience in green bond markets. The following paper sets out three key recommendations that China could carry out to advance this agenda:

1. A technical analysis of international experience of instruments and their short- and longer-term potential for improving biodiversity outcomes.
2. Engagement with international processes and discussions about instruments and architecture around greening sovereign debt markets.

3. Launching a nature-linked set of sovereign, sub-sovereign or domestic debt deals using nature performance bonds.

9.4.2.1 *China's Opportunity for Global Leadership on Nature and Biodiversity*

China has put nature at the forefront of its domestic and international policy making. Ever since China embedded a policy of *shentai wenming* (“ecological civilization”) into its constitution in 2018, the concept of prioritizing the environment has taken greater hold, particularly under President Xi Jinping. This has been one of the ways China has demonstrated its ambition to ensure nature is not simply consumed, but that its environmental and social dimensions in economic activity are placed at the centre of decision making.

China's leadership in 2021 is likely to shape international commitments to climate and biodiversity. China's strong domestic commitments on climate include reaching net-zero emissions by 2060. The hosting of the Convention on Biological Diversity (COP-15) in Kunming this year will set global post-2020 ambition for maintaining biodiversity for the coming decades. In the run up to this event, China has elevated the importance of the creating strong implementation and enabling conditions to ensure greater support for developing countries in terms of resource mobilization, technology and capacity building.

That principle of ecological civilization is aligned with a growing global consensus that nature plays a critical role in economic growth and resilience. Nature, and the biodiversity that supports it, determines the quality of the air, the availability of fresh water and soils, pollination and pest control, and mitigates the impact of natural hazards. The World Economic Forum (WEF) estimates that 40% of global GDP depends on nature, with this share higher in many developing countries.^[32] The recent Dasgupta Review in the UK on the economics of biodiversity highlights the increasing importance of nature's role in supporting resilience and economic productivity.^[33] Research by WWF, the Global Trade Analysis Project (GTAP) and the Natural Capital Project has shown that there is a clear correlation between the decline in services nature is able to provide and GDP growth.^[34]

The link between nature and the drivers of economic growth is increasingly understood and measurable, and of immediate relevance to policy-makers and investors. Nature is central to mitigating climate and other physical risks, and creates a growing number of economic opportunities, including carbon credits and sustainable tourism. For instance, the United Nations Food and Agriculture Organization estimates that 95% of agriculture relies on the productivity of soils,^[35] while nature-based tourism contributes between 10%–20% of GDP to Kenya and Namibia.^[36] The Food and Land Use Coalition estimates a global commercial opportunity of USD 200 billion from protecting and restoring nature by increased conservation and the restoration of 300 million hectares of tropical forests by 2030.^[37]

However, nature conservation efforts have to date fallen far short of what is needed to sustain its vital contribution to economies and broader well-being. Nature's health and the impacts of climate change pose both immediate and long-term risks to investors, particularly those in sovereign debt markets that depend on "natural capital" to drive economic productivity and resilience of national economies. While there is growing recognition that nature and biodiversity have a critical role to play in the health of economies, sovereign debt markets lag behind in allowing investors ways to integrate nature into the attractiveness and risk of a country's sovereign debt. Currently, 80% of financial resources available for conservation are from public sources, illustrating the large gap and opportunity to align private finance with nature.^[38]

9.4.2.2 The Growing Pressure on Global Sovereign Debt Markets

These considerations have great relevance at a time when many developing countries are saddled with large accumulated debt. The COVID-19 pandemic has reduced the growth prospects of most emerging market countries, while global recession and containment measures to stop the spread of coronavirus have led the International Monetary Fund (IMF) to estimate that economic growth in emerging markets will contract by 5.7% in 2020.^[39]

The combined effect of increased public spending and reduced government income has put a large fiscal strain on many economies, leading to an urgent need to secure liquidity. The fiscal impacts of COVID-19 have increased already large debt burdens, pushing many countries toward the risk of default. The cost of debt service in 2020 and 2021 will be over USD 3 trillion across emerging economies, raising concerns in financial markets about debt sustainability in some of the poorest countries. In 19 sub-Saharan African countries, the debt-to-GDP ratio reached 71% in 2020 compared with 26% in 2012.^[40] Debt restructurings in Ecuador, Argentina, Belize, Suriname, Zambia, and Angola are examples of the pressure on developing and emerging markets, with the IMF warning that over half of low-income countries are either at high risk of or in debt distress.^[41]

The global debt crisis has been particularly severe in countries with greater economic dependence on nature, and high levels of biodiversity. Work by the International Institute for Environment and Development highlights the countries where a deterioration in debt terms intersects with areas of critical global biodiversity and climate vulnerability.^[42] These include low-income sub-Saharan African countries such as Kenya, Madagascar, Mozambique, Uganda, Angola, and Cameroon and middle-income Asian countries such as Vietnam, Laos, and Bhutan. To date, the response to the twin crises of sovereign debt and climate and natural change has been insufficient to restore strong economic growth, while deteriorating natural capital raises longer-term risks to growth and resilience.

9.4.2.3 Addressing Debt and Biodiversity Through New Financial Tools

Sovereign debt instruments today offer little or no opportunity for borrowers to capitalize on improvements in their natural capital or for investors to seek better nature performance. There are growing calls to facilitate a transition toward incorporating nature and climate into emerging and global debt markets, providing issuers and investors with the tools to respond to better aligning the cost of capital with natural capital. The recent growth of sustainability-aligned debt now exceeds USD 1.5 trillion, and is expected to make up 10% of global issuance in 2021, illustrating growing global demand for these investments. ^[43] Initiatives such as the Task Force on Nature-related Financial Disclosures (TNFD) and related policy and regulatory developments have exemplified and accelerated greater investor awareness and accountability. ^[44]

Investments in nature can also provide greater assurance of debt sustainability and management of nature-related risks. According to the IMF, better management of natural capital can reduce expected productivity and resilience to future risks, hence improving the credit conditions of the debt issuing country even as it issues greater volumes of debt. ^{[45],[46]} Investments in nature also offer an economically efficient way to achieve countries' commitments to increase biodiversity and meet other environmental goals, especially emissions reductions. Achieving these goals will become increasingly expensive if countries delay action. ^[47]

There is both a short- and long-term imperative to better integrate nature into sovereign debt markets. In the short term, there is the opportunity to use a new set of debt instruments to repurpose existing unsustainable debt or issue new debt in ways that drive a nature-positive economic recovery. In the long-term, there is hope to begin a transition toward embedding nature risks and opportunities into sovereign debt arrangements. As noted by Hank Paulson in September 2020, "As governments rebuild... policymakers must learn to value nature, providing the right conditions and incentives to drive change. One important step would be to create a new asset class comprised of things such as productive soils, crop pollination, and watersheds." ^[48]

There are now mature policy and market initiatives to green sovereign debt markets. Several national governments, including members of the G20, are discussing green sovereign debt options for emerging markets. The World Bank and other international organizations—including the IMF, the OCED and the UN—are working to develop a facility to catalyze a set of new debt instruments that respond to short-term emerging market needs, as well as facilitating a transition to integrating nature more broadly into sovereign debt markets. ^[49] These developments are backed up by proposals from international organizations, including the United Nations Economic Commission on Africa, which aims to provide African nations

with the tools to meet immediate liquidity needs and develop medium-term green stimulus investments supported by nature and climate financing instruments.^[50]

9.4.2.4 Nature Performance Bonds

An emerging set of debt instruments, nature performance bonds (NPBs), offers a solution for linking debt payments with nature and climate outcomes. These instruments possess the potential to fund immediate liquidity needs and form a structural solution that enables better long-term and sustainable growth.^[51] NPBs would be structured in various ways to provide sovereign and corporate issuers and their investors with options to build nature into their financing decisions. These instruments range from:

- **KPI-linked or sustainability-linked bonds**, which allow a general use of proceeds but incentivize performance toward nature outcomes by providing a deduction on the principal of the bond value or a reduction in the interest in exchange for meeting nature-based outcomes.

- **Use of proceeds bonds**, such as green bonds, that link the funds raised through bond issuance to specific nature-based projects.

These instruments could build on existing green bond models and support a range of nature-based outcomes, such as restoring wetlands, protecting forests from encroachment, and reducing threats to wildlife and plant species. The central features of these instruments are:

a. Provision of liquidity to direct resources to economic recovery measures.

- In the case of a sustainability-linked bond, this would generate funds for general purpose use to fund immediate economic and social priorities. On issuance of the bond, the debtors would receive the full amount of funds released, which could be used by debtors to fund immediate fiscal needs or capital spending. The debtor's performance against the agreed performance indicators would then determine how much debt is repaid to creditors annually and at maturity of the bond. Pakistan is amongst the first sovereign issuers to pledge to use this instrument to fund a recovery package.^[52]

- In the case of a use of proceeds bond, this would generate funds to support strategic investments in nature-based investments, which could be linked to short- and long-term economic productivity drivers. Up to November 2020, 22 governments have issued use of proceeds bonds in the last four years,^[53] including in the developed countries of France, Germany, and South Korea, as well as in middle-income countries including Indonesia, Nigeria, and the Seychelles.^[54]

b. NPBs can be structured around a set of standardized nature outcomes that can be regularly and consistently monitored and used across the market.

- Reporting and verification of performance outcomes would be designed to be transparent and robust, and linked to emerging natural capital, biodiversity, and climate standards and protocols to allow sovereigns and investors to benchmark

performance indicators against internationally recognized metrics.

- Central to building a scalable asset class is a structure that aligns with emerging nature and climate performance measurement standards. This would enable the bonds to have the potential to be used across countries with different biodiversity and climate opportunities, allowing for maximum investor potential.

c. NPBs provide the debt issuer with flexibility over how most effectively to achieve nature and biodiversity outcomes suited to their circumstances.

- In contrast to use of proceeds models, sustainability-linked bonds would provide issuers the incentive to meet performance outcomes at least cost, which would give creditors the added incentive to fund nature and biodiversity outcomes that represent better value for money.

An overview of the structure of a sustainability-linked bond is summarized in Figure 9-1.

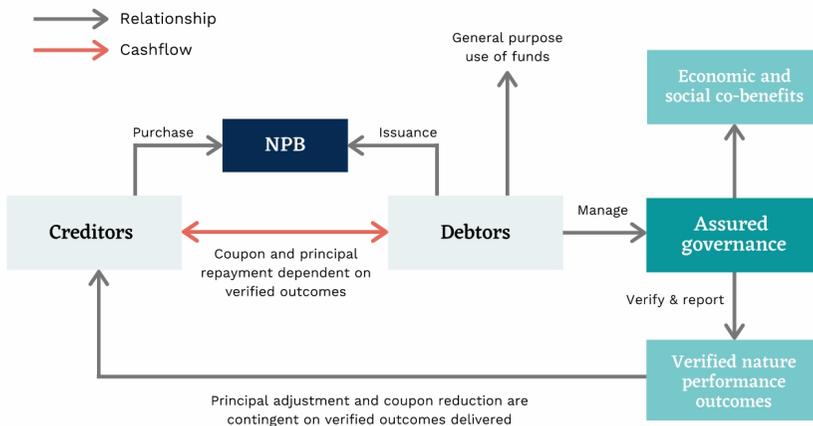


Figure 9-1 How sustainability-linked bonds connect nature and climate outcomes to sovereign debt repayment terms

d. NPBs can be supported by blended public–private finance in some circumstances:

- Public creditors may wish to use the instruments to repurpose unsustainable debt to generate immediate liquidity for debtors, or may be willing to forgo some financial returns in exchange for assured nature performance.

- Initial involvement of private sector investors could be supported by blended or concessional finance, where the public investor is willing to pay for a nature performance outcome.

- The involvement of the private sector in the market for NPBs will evolve as the bonds become increasingly standardized and liquid. Private creditors would be

increasingly interested in these assets if they are convinced that nature performance outcomes materially affect solvency risks.

Box 9-1 The parallel development of sustainability-linked bonds in corporate debt markets

A number of similar instruments are emerging in parallel with the opportunity to develop NPBs, which helps demonstrate the feasibility of NPBs and potential range of applications. These are chiefly sustainability-linked bonds, which have been issued by a range of international corporate firms:

- A recent survey by Environmental Finance shows that since 2019, 49 “sustainability-linked bonds” have been issued worldwide, worth USD 27 billion. These feature a range of green, sustainability, and social outcomes (as well as payment structures, should performance outcomes be achieved).
- In January 2021, Hong Kong property developer New World Development Co issued the first sustainability-linked bond in Asia, worth USD 200m over 10 years.
- In 2019, the Italian energy group Enel issued a USD 1.5 billion 5-year, sustainability-linked bond. The bond rate is subject to it having achieved a target of at least 55% of its installed capacity in renewable energy by 2021. If the 55% goal is not reached by end 2021, the coupon will be increased by 25 bps until the bond matures.
- This initial activity has been followed by other firms issuing these bonds, including LafargeHolcim (November 2020), Suzano (September 2020), and Novartis (September 2020).

9.4.2.5 China’s Unique Role and Potential to Develop a New Asset Class of Nature Performance Bonds

China now has an opportunity to consolidate emerging international best practice and build on existing green financial market experience. Specifically, China can use expertise from developing green debt markets, coupled with its global environmental leadership to explore the potential of this new asset class, with the potential to become the standard in sovereign debt markets.

China can do this spearheading the design and application of new financial instruments, nature performance bonds. There are at least four reasons why China is in a unique position to lead a shift to nature-positive sovereign debt markets in this way, thus driving a positive shift out of the current debt and nature crises.

a. **China is already leading global ambitions for biodiversity conservation.** China’s domestic policies have demonstrated how quickly a country can move toward building back nature, and its hosting of the Convention on Biological Diversity (COP 15) in Kunming this year could set global ambition for maintaining

biodiversity for the coming decades. This is further reinforced by China's strong recent commitments on climate change, including reaching net-zero emissions by 2060 as set out in the 14th Five-Year Plan.

b. **China plays a central role in the sovereign debt markets.** It is by far the largest single official creditor to emerging economies. Since the beginning of this year, China has actively participated in and implemented the G20 Debt Service Suspension Initiative (DSSI) to suspend debt repayments of the poorest countries and has announced a moratorium on debt repayments for 77 developing countries and regions.

c. **China has already demonstrated its ability to accelerate the development of green sovereign debt instruments, starting with large green bond issuances in 2015.** It is now a global leader, with Chinese domestic bond market currently worth USD 120 billion, making it the second largest in the world, according to the Climate Policy Initiative report *The State and Effectiveness of the Green Bond Market in China*.^[55] China also has a unique scheme of green finance pilot zones, incorporating six provinces and nine regions. The program is being used to test green finance options locally prior to being used nationally.

d. **China has established the capacity and institutional infrastructure to design, rate and structure green debt instruments through a regulatory framework and supporting institutional infrastructure that allow markets to rapidly scale.** Key institutions include the People's Bank of China (PBOC), the Green Finance Committee, and the National Association of Financial Market Institutional Investors. These bodies play a central role in setting standards on the design, structure and certification of green bonds, opening the way for these institutions to play a central role in leveraging existing capacity to develop similar architecture for nature performance bonds.

9.5 Policy Recommendations

9.5.1 Recommendations for China's Institutional Investors in Conservation Finance

9.5.1.1 Highlighting the Importance of Conservation Finance in Green Finance at the Policy Level

1) From the strategic height of top-level design, highlight the important position of conservation finance, and regard ecological protection finance as an important field of sustainable development investment

2) Even if we cannot implement special policy or measures aimed at conservation finance in the short term, it is suggested to revise the original green finance policy by adding conservation finance content.

3) In the green finance system, the assessment of the ecological and biodiversity conservation effects of institutional investors should be further highlighted. In terms of supporting policies, it is also more about "outcomes" than "processes."

9.5.1.2 Improving the Infrastructure Needed for the Institutional Investors in Conservation Finance

1) We should establish and improve the conservation disclosure framework of enterprises. Compulsively require enterprises to disclose relative information by different stages and levels, which could provide information for the investors when making decisions.

2) We should regard ecological protection finance as a subdivision of green finance and establish an indicator evaluation system and evaluation standard system to provide authoritative and unified theoretical support and indicator system standard support for the next innovation of financial products and services.

3) We can advocate and gradually require large institutional investors to issue social responsibility reports, responsible investment reports, and conservation investment reports. Preferential policies and investment promotions could be given to institutions that actively carry out conservation investment and information disclosure.

4) Accelerate the establishment of a natural resource asset accounting system to provide a fair evaluation system for the asset accounting of ecological protection-related enterprises. In terms of securities market access, special listing standards (such as profit standards) for ecological protection-related enterprises, which are different from traditional for-profit enterprises, should be formulated to increase financing channels for ecological protection-related projects.

9.5.1.3 Highlight the Ecological Protection Responsibility of Asset Owners

1) For sovereign wealth funds, government industrial investment funds, and large state-owned investment institutions, it will be important to add ecological protection requirements in addition to assessment of investment returns. In the supervision of products, it is necessary to check whether the content of the products is consistent with its name. For example, if the theme fund is named after ecology, its portfolio should be targeted at enterprises related to ecological protection industry as defined in the existing Green Industry catalog.

2) For institutional investors, regular unified training should be conducted for personnel related to the development of ecological protection investment products and risk management, so as to improve their professional knowledge of ecological protection industry needed in the investment process.

9.5.1.4 Encouraging Institutional Investors to Participate in International Cooperation in Specific Sectors

Under the framework of ecological protection finance, research and practice in subdivided fields should be further strengthened, especially in some international

frontier fields. China's ecological protection finance practice can be accelerated by strengthening international cooperation. For example, in the marine sector, the EU issued the "Sustainable Blue Economy Financing Principles Initiative" in 2018. In 2021, the United Nations Environment Programme Finance Initiative (UNEP FI) released "The Tide is On: Drawing a Blueprint for Marine Finance in the New Decade" and "Turning the Tide: How to Finance sustainable Marine Recovery—A Guide for Financial Institutions" and a companion list of Recommended Exclusions. At present, three small and medium-sized Chinese banks have joined UNEP FI. It is suggested that government departments set up special task forces to construct financing principles, standards, and guidelines for the blue economy in line with China's national conditions. We will encourage institutional investors to participate in international cooperation and strengthen exchanges and communication with international organizations.

9.5.1.5 Encouraging Institutional Investors to Focus on Women's Rights When Developing Eco-Protective Finance

Gender mainstreaming is critical to institutional investors in two ways. First, ESG concepts, in which the social responsibility issues represented by the "S" (i.e., "social") include many factors and scenarios of gender equality (e.g., gender inclusion in internal operations and corporate governance, gender risk identification and management mechanisms of investment and financing projects, etc.), which is itself an important embodiment of the implementation of ESG strategies; second, the development of gender equality principles based on Secondly, stakeholder communication and exchange based on the principle of gender equality can help institutional investors to better examine and understand the needs, interests, roles and impacts of different genders (with particular attention to the impact of biodiversity loss), thus making financial solutions more compatible with social and environmental aspirations and contributing to the achievement of multiple sustainable development goals.

Currently, large domestic financial institutions focus more on internal operations and corporate governance, such as the protection of women's rights and interests (see CSR report) and the proportion of female board members or executives. Institutional investors need to consider and implement whether investment and financing projects can bring more employment opportunities, economic income, and economic autonomy to women. More attention should be paid to how to avoid harming women and girls in investment and financing activities, and how to encourage women and representatives of women's groups to participate in discussions and decisions on biodiversity investment and financing, and to develop corresponding policy mechanisms and action plans.

9.5.2 Suggestions for Financial Institutions in the Agricultural Subsidy Chain Based on the Nature-Positive Principle

Agricultural subsidy policies based on the principle of nature positive are conducive to encouraging multi-sectoral cooperation including agricultural authorities, financial regulators, financial institutions, and local governments to promote financial services to pay more attention to the protection of ecological environment and biodiversity. In the future, efforts should be focused on the following aspects.

9.5.2.1 Adjust the Structure of Agricultural Subsidies

The current design of agricultural subsidies in China has already taken into account the objective of ecological protection, and not all subsidies will cause damage to biodiversity. The arable land fertility protection subsidy and agricultural insurance premium subsidy are inclusive subsidies, which will not change farmers' production behaviour and will not affect biodiversity. Subsidies for the appropriately scaled grain operations and the purchase of agricultural machinery and tools have promoted large-scale and specialized agriculture, improved the utilization efficiency of chemicals, and helped protect the ecological environment. In the future, the reform of agricultural subsidies should have clear objectives and focus on adjusting the minimum purchase price policy and producer subsidy policy to change farmers' production behaviour. Such policies, which encourage farmers to plant a single crop in large tracts, risk upsetting the ecological balance by creating an area with too little species diversity.

To be specific, we should appropriately reduce subsidies to corn and soybean producers, lower the minimum purchase price standards for rice and wheat, and increase subsidies of a universal nature so as to reduce the damage of subsidies to biodiversity while ensuring that farmers' income and agricultural output do not decline. In addition, China can set an upper limit on producer subsidies in a certain region, so that only the most efficient corn and soybean producers can receive subsidies. In this way, on the one hand, agricultural production efficiency can be improved, and on the other hand, biodiversity can be prevented from being affected by single crop planting in the region.

9.5.2.2 Strengthen Supervision on the Implementation of Policies

Although many of China's current subsidy policies are designed with environmental factors in mind, they are distorted in the implementation process and fail to achieve the expected policy objectives, such as LFPS. In principle, this subsidy only subsidizes the landowners who have made great achievements in protecting the cultivated land. However, in the actual operation process, the grassroots government, in order to reduce the cost of policy implementation, turns it into a kind of universal subsidy, which only increases the income of farmers, but

fails to achieve the goal of protecting cultivated land. Therefore, China should strengthen the supervision of policy implementation in the future, formulate convenient and quantifiable eligibility criteria for subsidies according to regional characteristics, and strictly urge the grassroots levels of government to implement policies according to the standards and requirements, so as to strengthen the pertinence of subsidy policies and reduce the damage of agricultural subsidies to the environment.

9.5.2.3 Shift From Direct Subsidies to Indirect Subsidies

In order to achieve biodiversity goals, China should reduce direct subsidies to agriculture and convert them into indirect subsidies. That will reduce the amount of subsidies directly distributed to agricultural producers. It will also increase the input in agricultural science, technology innovation, and technology promotion, in order to reduce the price of technology, improve the modernization level of agricultural production, and change the current situation that agricultural subsidies harm biodiversity.

9.5.2.4 Take Environmental Targets Into the Criteria for Determining Subsidies

China should include environmental targets in the criteria for the recipients of subsidies; that is, only agricultural producers who take ecological protection into account in their production can receive agricultural subsidies. At present, the design of agricultural subsidies in China has shown a tendency to develop in this direction. For example, LFPS requires farmers to pay attention to the protection of land in the production process, but the expected goal has not been achieved in the implementation process. In the future, environmental targets should be included in the identification criteria of more subsidy policies, and stricter identification criteria should be formulated for the recipients. More requirements on ecological protection should be put forward for the recipients, such as testing water quality, air, soil, etc., and the inspection results should be taken as a standard to determine whether farmers can get agricultural subsidies.

9.5.2.5 Focus on Supporting Women Farmers

In view of the current situation that women account for the majority of the rural labour force, special knowledge popularization and ability training should be provided for female farmers.

Due to the low level of education among the rural population and the poorer rights and opportunities for women (including women and children) to access educational resources than men, the habits, needs and capabilities of rural women should be fully taken into account in carrying out knowledge and skills training on biodiversity and ecological conservation. International studies have shown that, women show more friendly behaviours toward the environment than men, in line with the UN Convention on Biological Diversity's emphasis on gender mainstreaming and its gender action plan. Reasonable agricultural subsidy policies

would not only promote ecological protection but also provide support to improve the economic situation of rural women, thus contributing to the realization of the goal of gender equality in the economic empowerment of women.

9.5.3 Suggestions on the Innovation of Conservation Financial Instruments

9.5.3.1 Further Promoting REITs of Ecological Environment Infrastructure

9.5.3.1.1 Introduce REITs Tax Incentives and Other Supporting Policies

Based on the characteristics and complex architecture design of infrastructure REITs products, it is essential to clarify the tax policy of each link and give appropriate preferential treatment. It is suggested that the tax burden should be reduced in the process of establishment in combination with international tax experience, such as the exemption of deed tax that the project company needs to pay when the issuer transfers the target assets to the project company. In order to avoid double taxation, it is suggested that the income used for dividends in REITs should be subject to enterprise income tax or individual income tax only once at the level of the project company or investor, and the stamp tax should be reduced or exempted at the holding and establishment stage.

9.5.3.1.2 Relax Restrictions on Franchise and Ownership Transfer

It is suggested to clarify the approval process of franchise transfer in REITs and deregulate the process. Relevant supporting policies should be issued to lay the foundation for the long-term development of REIT products.

9.5.3.1.3 Expand the Source of Underlying Assets

Since 2014, the mainstream operation mode of eco-environmental projects is the PPP mode, but the proportion of this mode in the total amount of franchise projects is not high, and the proportion of PPP projects that can meet the requirements of pilot projects with an operation period of not less than 3 years is lower. In addition, there are still conflicts between the PPP mode and REITs. It is suggested that a transition period should be set for the selection of REITs projects, and it is allowable to select from the existing BOT projects before 2014.

9.5.3.1.4 Strengthen Information Disclosure and Investor Education

Regulatory authorities and financial institutions should help public investors understand the product characteristics and risks of REITs in a rich and easy-to-understand way so as to match the risk preference of investors. Regulatory authorities should strengthen the supervision of information disclosure, ensure the healthy and orderly development of the market with strict routine supervision, and protect the legitimate rights and interests of investors. As for the information that is clearly stipulated by law and has a significant impact on investors' decision making, REITs issuers should fully disclose all the information that should be disclosed.

9.5.3.2 Government Guidance Funds Based on Ecological Protection

9.5.3.2.1 Innovate Mechanisms for Cooperation Between State Capital and Private Capital

The operation mode of the existing industrial investment fund is basically government-initiated, attracting social capital according to a ratio of 1:1 or sometimes higher. The decision-making mechanism is basically in the hands of the government-authorized state-owned investment institutions, which is not very attractive to social capital in terms of decision-making rights and benefit distribution. It can be considered to draw on international experience that government funds do not aim to make profits, but to share risks with social capital and promote ecological protection investment. To this end, it is recommended, first, to limit the right to unequal returns: government capital exits with a zero return rate for successful investment projects during the investment period; government capital shares the losses with social capital for failed investments; Second, to establish a more market-oriented investment decision-making mechanism and decide the investment direction through the scientific formation of an investment decision-making committee.

9.5.3.2.2 Perfect the Appraisal System

It is recommended that the state or relevant functional departments issue a special performance evaluation approach for ecological protection guidance funds based on a unified guidance framework for guidance fund performance evaluation, taking into account the policy benefits and green economic benefits of the funds, etc. For state-owned ecological protection investment funds, the investment period of the fund should be appropriately relaxed to focus on the long-term performance of the fund and avoid excessive pursuit of economic returns in the short term.

9.5.4 How China Can Show Global Leadership in Developing Green Sovereign Debt Markets

To address the current debt and nature crisis, and garner the long-term debt and nature sustainability benefits of NPBs, China can act quickly to develop this new asset class. This new market segment could quickly rival the size of its growing green bond market and lead a global movement to fully integrate nature and climate into sovereign debt markets. The key recommendations for capitalizing on this opportunity are:

9.5.4.1 Conduct A Technical Analysis of International Experience of Instruments and Their Short- and Longer-Term Potential for Improving Biodiversity Outcomes.

China could commission and oversee work to gather existing and emerging international best practice on the set of nature-linked debt instruments. By doing this, China could quickly assess the short and long-term market size and potential of these instruments by:

1) Engaging with key international initiatives and stakeholders involved in the design of the new generation of nature-linked debt instruments. China could rapidly engage with leading initiatives and networks at the intersection of finance and biodiversity to collate international best practice. To do this effectively, it could link with key knowledge partners, including the Finance for Biodiversity Initiative, who play a role in convening key international stakeholders.

2) Conducting a technical analysis of the short- and long-term potential of existing and emerging nature-linked debt instruments. Following engagement with international initiatives and financial institutions, China could synthesize international best practice and understand the size of the opportunity for developing a market for new nature-linked debt instruments. This would involve a detailed examination of:

a. The set of instruments that link debt-to-nature and climate performance indicators, including sustainability-linked bonds, nature performance bonds, green, and blue bonds.

b. International examples and case studies of where instruments have been used, incorporating the experiences of sovereign, sub-sovereign and corporate debt markets.

c. Types of nature and climate indicators that could be used in a new generation of performance instruments, including the metrics and frameworks to monitor and verify nature performance outcomes and work to align these with corporate sustainability-linked bond issuances worldwide to increase investor appeal.

d. A review of the market infrastructure, regulatory frameworks, and stakeholders likely to be involved in the development of instruments in China and internationally, building on work on the *Guidelines for Establishing the Green Financial System* jointly conducted across seven ministries.

This would enable China to quickly draw together international experience to plan prior to the emergence of these nature-linked debt markets internationally. This could enable China to benefit from its existing experience in green financial markets by assessing the potential for these instruments to play a role in discussions about resource mobilization in post-2020 biodiversity framework discussions at COP 15 and to capitalize on market developments.

9.5.4.2 Engage with International Processes and Discussions about Instruments and Architecture around Greening Sovereign Debt Markets

1) China can engage with the G20 on the design of international policy to address the emerging market sovereign debt crisis. China can use its leadership position to facilitate discussions about the potential to integrate debt with nature and climate by engaging with other G20 members, debtor countries and financial institutions. China's role as the Co-Chair of the Sustainable Finance Study Group (SFSG), means it could work with like-minded nations to build leadership and share

learning. Specifically, it can work with members of the G20 to assess the role that scalable nature-linked debt can play in the development of the Common Framework for Debt Treatments.

2) China can play a central role in the design of an initiative by the World Bank to develop a new facility to support the issuance of nature- and climate-linked sovereign bonds. The facility would establish the conditions and coordinate stakeholders to scale the integration of nature into sovereign debt markets, in both the immediate context of the debt crisis for the longer term. This could catalyze a global market for nature performance bonds in which China could play a central role. China could play a key international leadership role as G20 SFSG Co-Chair by engaging with the World Bank to ensure alignment with G20 policy. It can also ensure that the facility is developed to meet the needs of the post-2020 biodiversity framework by ensuring the facility supports the mobilization of public and private finance for biodiversity outcomes.

3) China can also engage with leading nature practitioners to further assess the short- and long-term potential to support these instruments. Several initiatives bring together leading experts and draw on the combined expertise of international stakeholders about how to design and implement these debt instruments. This includes the Learning Group on Debt and Nature convened by Finance for Biodiversity, which aims to discuss the market and technical barriers and opportunities for deploying nature performance debt instruments across many different contexts worldwide. China could act as an observer in these groups to understand challenges and opportunities and monitor emerging international best practice.

9.5.4.3 Launch Nature-linked Set of Sovereign, Sub-sovereign, or Domestic Debt Deals Using NPBs

1) China could engage in a one-year program of work to launch a pilot scheme for NPBs internationally. We could pilot these instruments internationally in the context of debt restructuring or issuance of new debt in which nature and biodiversity outcomes are greatly improved, and countries' ability to sustain their debt is enhanced. China is already engaging with many emerging economies considering the current global debt situation, opening up the opportunity for China to negotiate debt terms that are mutually advantageous. The scheme could also support the issuance of NPBs to finance domestic companies, building on China's developed market infrastructure around green bonds.

2) Rapidly identifying countries where China has mutual interests in supporting fiscal and nature outcomes could pave the way for significant discussions about how NPBs could support Chinese debtors. This could support highly vulnerable debtors in need of liquidity, while driving nature improvements linked to China's existing or planned BRI investments. China has already begun a

strategic shift to support sustainable, green growth, recognizing the long-term benefits to those countries. As shown in Box 2, several Chinese debtor countries that are at risk of defaulting also have an identified set of biodiversity projects or initiatives in the pipeline that could be undertaken rapidly.

3) Green the Belt and Road Initiative (BRI). In April 2019, the BRI International Green Development Coalition (BRIGC) was set up. It includes initiatives and partnerships to foster objectives such as: biodiversity and ecosystem management, green finance and investments, and environmental legislation and standards. By identifying countries where China has mutual interests in supporting biodiversity or climate outcomes, China could pave the way for significant discussions about the use of NPBs to support highly vulnerable debtors, while driving nature improvements linked to China's existing or planned BRI investments.

Box 9-2 Countries with high levels of Chinese debt that are high in biodiversity.

A large portion of China's current official debt holdings is relevant for NPBs. According to research by the International Institute for Green Finance, China holds USD 102 billion across 52 BRI countries that also qualify for DSSI support, which means these countries face significant debt burden risks alongside significant nature and biodiversity loss risks.

The five countries with the most outstanding debt owed to China were: Pakistan (USD 20 billion), Angola (USD 15 billion), Kenya (USD 7.5 billion), Ethiopia (USD 6.5 billion) and Laos (USD 5 billion).

Additional work by the Global Development Policy Center has identified 41 countries that have the highest potential for Chinese debt relief linked to biodiversity and climate potential. This work identifies Angola, Cambodia, Laos, Myanmar, Uganda, and the Solomon Islands as having the highest potential for mutually advantageous biodiversity or climate outcomes and high dependency on China for lending.

4) Launch domestic nature performance bond pilots. China's unique Green Finance Pilot Zones Programme, incorporating six provinces and nine regions, creates the opportunity to trial nature performance bonds to support domestic municipalities or firms in achieving nature-based performance objectives. The first municipal green bond issuance by Ganjiang New Area in Jiangxi Province to finance smart utility pipelines was 12 times oversubscribed, highlighting strong investor demand. Widening this pilot program to finance China's nature priorities could further broaden the domestic green debt market.

5) Through effort, the first instrument issuance could take place by the end of the year in partnership with key debtor countries or domestic firms. This would align with broader international discussions about debt relief, highlighting China's commitment to international efforts to addressing debt and biodiversity, and

advancing ecological civilization on a global basis. Chinese leadership could be highly catalytic in encouraging other creditor nations to examine the potential for linking improvements on debt terms to biodiversity outcomes.

6) Plan new market and regulatory infrastructure that can be applied to support scaling up of new debt markets. This would encourage companies and investors rapidly to develop and issue nature- and climate-linked performance debt instruments and to quickly become a leading market for these instruments. China can play a significant role in the strengthening of a green and sustainability bond market that delivers on climate and biodiversity outcomes through application of standards aligned with the 1.5°C ambition of the Paris Agreement on Climate and the targets of the CBD. As the green bond market grows internationally, investors are increasingly interested in credible delivery of outcomes. International standards are improving, and alongside science-based approaches on climate, they will increasingly incorporate science-based targets for other environmental matters. China has a role to play in strengthening those standards and increasing their application.

7) Engage and coordinate key domestic regulators to plan and develop capacity to issue these new instruments. This could include the People's Bank of China, China Banking Regulatory Commission China Securities Regulatory Commission for exchange-traded corporate green bonds, National Development and Reform Commission for public-sector issuers, and the National Association of Financial Market Institutional Investors, and China Securities Regulatory Commission. By enabling these institutions to quickly develop capacity to issue this new asset class, China could broaden both a domestic and international market for this potentially large RMB-dominated global debt market segment.

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ANNEX1:

2021 Policy Recommendations of the China Council for International Cooperation on Environment and Development

A Great Transition Toward a Green Development Epoch: Low carbon, inclusive, and harmonious with nature

A once-in-a-generation transition is underway. The world faces multiple crises, including COVID-19 and its economic consequences, climate change, the destruction of nature, and pollution. The 2021 Intergovernmental Panel on Climate Change report warns that climate change is widespread, rapid, and intensifying, with some changes, such as the rise in sea level, being irreversible. The fifth *Global Biodiversity Outlook* concludes that the rate of biodiversity loss is unprecedented in human history. The ongoing economic recovery must place a strategic priority on integrating low-carbon solutions, nature stewardship, and pollution protection.

Global action against COVID-19 has shown us again that global ecosystems are interconnected. No country or region can face these crises alone. Therefore, global solidarity and international cooperation in reducing wildlife trade and the destruction of natural habitats are urgently needed to reduce the risks of future pandemics caused by zoonotic diseases. Commitments are deepening across countries and all levels of society to reach carbon neutrality, protect nature, minimize waste and pollution, fund integrated approaches like One Health, and support greater equity. The Convention on Biological Diversity's 15th Conference of the Parties, in Kunming, and the 26th United Nations Climate Change Conference of the Parties (UNFCCC COP 26), in Glasgow, present historic opportunities to advance an inclusive, carbon-neutral, and nature-positive agenda. Efforts to strengthen environmental governance and enhance synergies among multilateral environmental agreements are especially significant to support integrated policies.

The members of the China Council for International Cooperation on Environment and Development (CCICED) greatly appreciate President Xi's commitment to building an ecologically sustainable world and to the harmonious co-existence of humanity and nature. This commitment includes targets and measures mainstreaming high-quality, green development as detailed in the 14th Five-Year Plan and 2035 Long Range Objectives.

CCICED members believe that President Xi's announcement of the nation's plan for carbon peaking and carbon neutrality sets a clear direction for China's post-pandemic recovery and green prosperity. The world is looking to China for experience and inspiration. To implement its commitments in an efficient, stable, and predictable manner, China needs to pay attention to policy coherence across economic sectors, the interplay between regulatory binding targets and market-based pricing mechanisms, and the dynamic role of demand-side consumption.

Accordingly, based on the research outcomes of ongoing Special Policy Studies and discussions during the Annual General Meeting, CCICED members recommend that China grasp and capitalize upon the dynamic opportunities offered by technological innovation and the green industrial revolution; pay special attention to targets, timelines, and pathways for structural transformation; formulate actions at both the macro and micro levels; and set out clear, robust, integrated, and systemic green policies that advance and implement a comprehensive socio-economic green transition. CCICED highlights the following broad areas for action:

- **Value the integrity of global ecosystems.** Mainstream actions for addressing climate change, protecting biodiversity and ecosystems, and controlling pollution, and enhance policy coordination across regions. Examine steps to establish green responsibility mechanisms through ecological and natural capital accounting in ways that strengthen the micro-level foundation for green, low-carbon development and that ensure a comprehensive, stable, and inclusive transition.
- **Develop a new model for green urbanization,** taking it as a strategic starting point for commitments on carbon peaking and carbon neutrality. With urban renewal, county development, and green rural revitalization as the three pillars, innovate spatial planning with low-carbon roadmaps.
- **Jointly promote sustainable production and consumption,** with an emphasis on the utility of digital technology innovation for sustainability. Integrate low-carbon and ecosystem protection standards into green supply chains, including upstream product design to expand materials and product reuse and recycling, to bolster circular economy practices. Establish a green “dual circulation” model to provide new impetus for high-quality development.
- **Align domestic green targets and measures with multilateral and international cooperation:** Develop closer green development partnerships, promote an equitable and inclusive green transition, and share development achievements, including through the adoption of green investment and green financing, green supply chains and sustainable trade, and jointly building the green Belt and Road Initiative.

Specific suggestions are as follows:

1.1 Enhance global ecosystem integrity, prioritize nature agendas, and promote a new development pattern of harmony between nature and humanity.

1.1.1 Coordinate and implement the carbon-peaking and carbon-neutrality targets

1. Institutionalize China's high-level central working group on carbon peaking and carbon neutrality to advance inter-agency and inter-sectoral coordination in the development of carbon-neutral interim targets, timetables, and action roadmaps. Encourage those provinces and cities that have rich endowments in renewable energy, as well as the sectors that produce power, steel, and cement, and other high-carbon industries to reach peak CO₂ emissions ahead of schedule. By 2050, build a carbon-neutral economic and social system, striving to reach near-zero CO₂ emissions.
2. Update the nationally determined contributions plan prior to the Glasgow UNFCCC COP 26, with a view to closing the gap between collective global ambitions and the Paris Agreement targets. Establish an absolute carbon-emission cap control system. Replace the total energy consumption control target with a binding target for total greenhouse gas (GHG) emissions control. Pay full attention to reducing non-CO₂ GHG emissions, such as methane emissions. Step up measures to drive energy efficiency and demand-side management. Bring all high emissions sectors into the carbon market as soon as possible. Provide long-term, clear, stringent, and stable market expectations and an effective price transmission mechanism to support the national emissions trading system. Take account of differences in carbon-peaking timetables within and between sectors and regions, and enable market-based approaches to provide price, investment, and other incentives for early action. Clarify the asset attributes of carbon emission rights, promote the establishment of carbon accounts for market players, and improve the disclosure of carbon emissions. Reserve a policy window for introducing a carbon tax for key sectors not covered under the emissions trading system, supported by a hybrid carbon pricing system at an opportune time. Implement climate-friendly air pollution prevention and control strategies.
3. Strengthen the legal basis for the climate transition. Encourage ongoing public awareness and education regarding the "dual carbon" objectives. Encourage all actors in society to play their part. Undertake climate risk assessments associated with extreme weather events like flooding, heat

waves, coastal storms, droughts, and other climate stressors, and increase climate adaptation, including in the wider river basin areas of the Yangtze and Yellow Rivers.

4. Accelerate the decarbonization of the manufacturing sector, including by strictly controlling the increase of production capacity of industries with high energy consumption and high emissions. Promote net-zero technological innovation and applied scientific research in hard-to-address industries like steel, non-ferrous metals, cement, and the chemical and petrochemical sector. Integrate low-carbon, climate-resilient, and nature-positive infrastructure planning and project design, paying special attention to achieving high rates of renewable energy penetration with minimal biodiversity impacts. Develop and deploy low-carbon roadmaps for other key areas, including transportation, construction, and so on.
5. Set out clear targets, timetables and detailed green investment roadmaps to achieve carbon peaking before 2030 and carbon neutrality before 2060. Conduct cost-benefit analyses of proposed carbon-intensive infrastructure, including the analysis of economic and financial risks such as stranded assets. Fully implement climate risk disclosure and climate risk reporting. Encourage innovation in climate investment and in financing products and instruments, initiate local pilot projects, and develop an applicable, efficient, and advanced classification standard system for climate investment and financing. Actively phase out fossil fuel subsidies.
6. Address equity and justice issues that may arise from the green transition prudently, especially employment and economic development in coal-reliant areas. Advance gender equity in this context. Develop coal phase-out mechanisms. Consider solutions such as resettlement compensation and employment transition. Establish dedicated funds for a just transition and the orderly phase-out of coal, for the upgrading of high energy-consuming industries and for the inclusive transformation of underdeveloped areas.

1.1.2 Mainstream biodiversity conservation

7. Mainstream biodiversity conservation within key economic sectors; integrate nature and nature-based solutions into financial planning for public and private sectors. Develop science-based, quantifiable, ambitious, and pragmatic biodiversity objectives and associated indicators to track progress, covering the pressures on biodiversity, the state of biodiversity, and the impacts and outcomes of response measures.
8. Strengthen the system of national parks and protected areas by identifying low-cost and high-efficiency priority conservation areas; improve the effectiveness of protection based on respective capabilities; and ensure high

- levels of ecological integrity within each national park, as well as marine and wilderness protected areas. Pay special attention to maintaining green connectivity in cross-provincial and cross-border biodiversity hotspots. Assess the overall carbon-sequestration potential of the Ecological Conservation Redline areas, and identify areas with a high carbon-sequestration function.
9. Take actions to promote the full implementation of the *Post-2020 Global Biodiversity Framework*, and share innovative implementation mechanisms such as the ecological redlines, eco-compensation, and other actions. Support these actions with reliable and operable indicators capable of assessing progress in ways that take full account of natural capital and ecosystem services, treating nature and its systems as valuable assets. Actively contribute to meeting the goals of the UN Decade of Ecological Restoration.
 10. Scale up biodiversity-relevant conservation financing and investments. Highlight ecological protection, conservation, restoration, and regeneration as key focuses of green finance. Further identify the steps needed to ensure public and private finance flows are consistent with biodiversity objectives, supported by conservation finance pilots, risk disclosure, reporting, stress-testing, and wider public accountability for private sector investments. Apply financial technology in biodiversity conservation, including establishing “fintech and biodiversity” pilot demonstration areas. Ensure that the benefits derived through conservation accrue to local communities. Evaluate emerging international conservation finance goals such as green debt arrangements.
 11. Actively identify and subsequently reform environmentally harmful incentives, regulations, spatial planning, subsidies, and other measures. For example, replace environmentally harmful agricultural subsidies with low-carbon, regenerative agricultural practices. Introduce convenient and quantifiable subsidy identification standards according to local conditions. Increase investment in agricultural science innovation and technological application. Provide stronger support for female farmers and provide much-needed knowledge and skills training.
 12. Jointly promote livestock, wildlife, and plant health; ecosystem integrity; disease prevention; and early warning systems within the One Health framework that gives full play to “whole-of-society” approaches.

1.1.3 Strengthen integrated management of land and sea, and promote integrated ocean management based on ecosystems

13. Strengthen the protection of key marine species and the conservation and

restoration of their habitats to improve the quality and stability of marine ecosystems. Conduct baseline studies of marine ecosystem values. Assess the impact of coastal development and other activities on marine natural capital. Monitor and assess the effectiveness of the conservation and adaptation of vulnerable and carbon-rich coastal ecosystems such as mangroves, seagrass beds, salt marshes, coral reefs, dunes, and islands. Enhance the protection and restoration of coastal ecosystems, and build stronger climate resilience, including through coastal nature-based solutions.

14. Establish and improve joint scientific and technological research mechanisms to improve science-based marine and oceans management, including tackling marine pollution from point and non-point sources. Strengthen pollution prevention and control with integrated land and sea management. Bolster the monitoring and traceability of mercury pollutants, tackle marine plastic and micro-plastic pollution at the source, reduce plastic waste, and enhance the capacity of waste management and disposal.
15. Set out targets and plans for the sustainable management of the seafood supply chain. Implement advanced traceability and monitoring systems, regulatory targets, and broader public awareness campaigns regarding sustainable fishery benefits. Formulate and deploy science-based indicators, standards, and management mechanisms to track the progress of sustainable fisheries. Develop long-term and profitable business models. Identify the green financial instruments and market opportunities for the sustainable sourcing of fisheries. Integrate community and social resources to explore the joint management model of fishery resources protection.
16. Enrich global marine public goods, and deeply engage in global marine environmental governance. Drawing on international experiences, set up blue economy financing principles, standards, and guidelines in line with China's conditions; pioneer the development of the Bohai Bay and Guangdong-Hong Kong-Macau Greater Bay Area as "Beautiful Bay" demonstration areas.

1.2 With urban renewal, county development, and green rural revitalization as the three pillars, create a new model of green urbanization and a low-carbon spatial pattern.

17. Ensure that carbon peaking and carbon neutrality form the strategic foundation of green urbanization and spatial planning. Fully consider the leading role of urban clusters in economic development and environmental protection, and promote rural revitalization and urban green transformation.

Redefine urban-rural functions and the division of labour with a new supply of ecological products. Support local governments to formulate an urban sustainable development vision and strategy based on a multi-stakeholder participation process.

18. Optimize urban renewal actions as a major opportunity for green urban transformation. Establish green urban renewal targets, design and construction standards, and best practices that enhance multiple benefits such as ecological protection, public health, and enhanced human capital and quality of life. Fully recognize the unique cultural and historical value of old towns, and revitalize them in various ways to transform them into economic benefits. Strictly control large-scale demolition and construction, and restore brownfield sites. Increase the green revitalization of older neighbourhoods and older buildings, including through circular and green building materials and through retrofitting plans to increase energy efficiency. Assess impacts on green landscapes and urban spaces, and on GHG emissions as part of the approval reviews of new construction and development projects.
19. Intensify the transformation to green, low-carbon urban infrastructure. Increase the construction and management of urban stormwater systems, including through nature-based solutions such as sponge cities. Given warming average temperatures, pay special attention to the mitigation of urban heat island effects. Increase investments and financing in green urban infrastructure projects. Explore and pilot neighbourhoods powered by renewable energy; realize the role of digital smart towns in supporting carbon neutrality.
20. Improve rural and county green development, including reform of the rural land acquisition system and land transfer system. Moderately increase farmers' rights to engage in independent land transactions, and combine the revitalization of land resources with modern green agricultural transformation, industrial layout adjustment, and farmers' employment and sustained income increase. Give full play to counties as the bridge to link urban and rural areas in terms of industries and resource allocation to synchronize rural revitalization and urban green transformation.
21. Adhere to the "one pole and multiple wings" rural integrated development model dominated by green development and supported by diversified development. Assist local cities in clarifying their green transition roadmaps and advantages; greatly expand the space for green development; and help underdeveloped areas in deploying green technologies and practices capable of leapfrogging older development patterns. Promote ecological and climate-friendly tourism, and guide villages in planning

green development in the context of their local conditions, promoting the transformation of ecological resources and advantages into economic resources and industrial advantages. Provide capacity-building funds and set qualifications for a green, smart, and participatory urban transition. Promote integration among rural ecological environment protection, rural environment governance, and the development of a rural economy suitable to the region. Realize the diversified rural industrial operation at an appropriate scale, guided by green and ecological agriculture.

1.3 Empower digital technology innovation for sustainability, jointly promote sustainable production and consumption, and build domestic and global green value chains.

1.3.1 Build a green supply chain incorporating a circular economy

22. Incorporate green, biodiversity-positive, and low-carbon elements into the upstream product design and production as well as downstream consumption of the value chain both within China and in international trade. Follow the principles of a circular economy, and encourage the sustainable transformation of global production and consumption through improved product standards, green finance, advanced technologies, and strengthening the supervision and innovation of business models.
23. Strengthen the establishment of relevant laws and regulations, and clarify the responsibilities and obligations of participants in the global value chains. Accelerate the development of a green value chain support system, including through due diligence systems, to ensure the sustainability of production at source, with a special focus on the deforestation risk posed by soft commodities (soy, palm, beef, pulp and paper, timber, etc.). Reinforce this system by using traceability technologies like blockchain, digital tags, and other technologies and practices needed to support credible, robust, transparent, independent third-party certification. Support the system by using labels and other mechanisms to increase the market share of green, regenerative consumer products and services. Formulate a comprehensive, national Five-Year Plan and roadmap to green China's supply chains, supported by the Green Supply Chain Institute.
24. Identify opportunities for preferential tariffs for sustainable soft commodities, and examine means to tackle trade in single-use plastics through the World Trade Organization and other forums. Under the Asia-Pacific Economic Cooperation and the Regional Comprehensive Economic Partnership, pilot alignments of sustainable standards for the production

and trade of soft commodities.

1.3.2 Promote sustainable production and consumption

25. Integrate green consumption into in-depth, supply-side structural reform to green the “dual circulation” and high-quality development patterns. Incorporate green production and consumption into the national legislative process. Build a statistical system for green consumption with a green consumption evaluation index and medium- and long-term target indicators. Establish a nationwide green consumption information platform to release information on green products and services. Strengthen public awareness about low-carbon and biodiversity-friendly consumption through activities such as enhancing capacity building and training on green consumption and building networks to engage stakeholders.
26. Promote a digital, green, and smart industrial transition. Adopt eco-design tools for industrial products to improve efficiency. Strengthen the top-level policy framework for green consumption and related design requirements. Build strong links between digitalization and sustainability. Shift the innovation visions and patterns of digital pioneers toward sustainability. Modernize digital capabilities as a precondition for governing digital change. Build strong networks between digital and sustainability research communities, and create dialogue structures between civil society, the state, private business, and science to ensure sustainability is deeply anchored in the digital economy.
27. Develop a mechanism to allow stronger inter-agency governance and coordination between upstream and downstream entities to advance green consumption. Put in place voluntary or regulatory documents such as guidelines and regulations on eco-design and a low-carbon circular economy. Advance a consistent consumer labelling scheme for green, biodiversity-friendly, and low-carbon products, services, and companies in one universal certificate system to expand the supplies of green products and services. Encourage the normalization of the green and low-carbon work and lifestyle behaviours adopted during the pandemic. Strengthen the development of green logistics. Adopt instruments for the circular economy such as extended producer responsibility and deposit-refund schemes to address problems at the source. Level up waste reuse and recyclability by improving the market potential for product recycling and reuse. Develop the second-hand product market and the shared economy as important pillars of the low-carbon, circular economy
28. Adopt an assessment system covering the entire life cycle of products in the steel industry, including developing standards, assessment measures, and

- certification schemes for eco-design in the steel industry to encourage synergies in carbon emission reduction and pollution control. Advance green taxation reform in the automobile industry, and implement tax policies to encourage the use of HFC-free technologies. Apply eco-design concepts and methodologies, as well as stronger disclosure and public participation mechanisms, to ensure the minimal environmental footprints of waste incineration facilities, creating livable habitats for people.
29. Develop guidelines for public entities to integrate sustainability criteria for public procurement. Develop a central registry for green procurement practices and case studies in order to share the business argument for green procurement, as well as to register performance outcomes including carbon emission reduction, nature protection, and other benefits. Develop and implement a comprehensive green labelling scheme as the basis of green public procurement practices.
 30. Support the implementation of the Law Against Food Waste with awareness-raising campaigns to promote healthy eating habits and reduce food waste; introduce implementation rules and plans according to specific regulations. Establish a mechanism that allows for collaboration in the efforts of the government, industry associations and non-governmental organizations, catering businesses, and consumers to tackle food waste.

1.4 Actively participate in international environmental governance, and build closer partnerships for green development; emphasize extensive consultation and joint contributions to international green principles and the sharing of development achievements.

31. Broaden the “green” concept of Belt and Road Initiative (BRI) development. Deeply align BRI partnerships and investments with the United Nations 2030 Agenda for Sustainable Development, incorporating the implementation of the Sustainable Development Goals, such as climate mitigation; climate adaptation; clean, accessible, and affordable energy; and biodiversity conservation, into the development of the green BRI, and strengthen the synergy between the goals. Enrich the forms of, and pool of participants in, green investment and financing, and broaden and mainstream the sources of green investment funds for BRI. Scale up financing in sectors such as renewable energy, sustainable storage and power grids, and conservation financing. Establish mechanisms to ensure that future BRI financing and investment will exclude coal projects. Promote cooperation in green energy, green infrastructure, and green

- finance. Support sustainable development and post-pandemic green and low-carbon recovery in BRI countries.
32. Build a green management system for all BRI projects. Based on the management needs of the project's full life cycle, conduct environmental, biodiversity, and climate risk screening and impact assessment for all projects. In line with project-based green investment and financing management needs, advance a BRI green investment and financing evaluation system based on standards, safeguards, and best Chinese and international practices on environmental and social governance. Strengthen the communication, cooperation, and information-sharing among overseas investment and financing authorities, ecological environmental authorities, and financial regulatory authorities, and improve the classification management system of BRI investment and financing projects. Work with key ministries to incorporate "green and sustainable" as core risk evaluation criteria into the performance evaluations of financial institutions and project developers.
 33. Rely on professional platforms to strengthen dialogue, exchanges, and capacity-building. Strengthen multilateral cooperation platforms such as the BRI International Green Development Coalition, the BRI Environmental Big Data Platform, and the Green Investment Principles. Promote information-sharing, experience exchange, and dialogue on policy among participating countries regarding key topics, such as the definition of green and low-carbon projects, environmental and climate management in investment and financing, and mutual recognition of green standards. Collaborate with the Belt and Road South-South Cooperation Initiative on Climate Change and the Green Silk Road Envoy Program. Further implement capacity-building projects, forge closer partnerships for green and sustainable development, and actively communicate the benefits of green solutions to partner countries. Organize the Belt and Road Green Development Expo to present green products, strengthen green industry technology matchmaking, and share emerging practices around emerging green and sustainable trade.

CCICED Nature-Based Solutions (NbS) Special Policy Report

2.1 Introduction

On March 15, 2021, in an address to the Ninth Meeting of the Central Committee for Financial and Economic Affairs, President XI Jinping reiterated China’s goal of peaking carbon emissions and reaching carbon neutrality were part of the transition towards an ecological civilization that would “give full play to the ecological environment, including forests, wetlands and grasslands, in increasing carbon sinks.”

In January 2021, the Ministry of Ecology and Environment (MEE) released *Guiding Opinions on Integrating and Strengthening Efforts in Climate Actions and Ecological and Environmental Protection*, which prioritizes holistic governance approaches to “integrating, coordinating and strengthening” climate and ecological and environmental conservation.” Nature-based solutions (NbS) are identified in the guidance as a priority, as a means to

Mitigate and adapt to climate change, coordinating efforts to promote biodiversity protection and ecosystem restoration, taking the holistic approach to conserving mountains, rivers, forests, lakes and grasslands, enhancing the capability to adapt to climate change, and improving the quality and stability of ecosystems. In addition, urban-based solutions/urban green and blue infrastructure deliver multiple benefits for human health.

Interest in NbS at the international, national, and sub-national levels of government—among the business community and across conservation, climate mitigation, adaptation, freshwater management, agro-ecological regenerative food systems, and other communities—has increased in recent years. NbS are widely seen as supporting nature-positive and carbon-neutral pathways and as means to bridge the Kunming and Glasgow multilateral agendas. Accordingly, during the third quarter of 2020, CCICED convened a sub-committee on NbS to identify promising and urgent areas of forthcoming work. The sub-committee held meetings with Chinese and international experts, as well as two joint meetings (see Annex Two).

This report has benefited from these CCICED exchanges, as well as comments on various drafts. This final scoping report is organized thus: *Part One* examines

some key concepts, scientific evidence, challenges, and research trends. *Part Two* provides examples of NbS at the economic sector or other levels. *Part Three* provides NbS case studies. *Part Four* examines ways to measure NbS. *Part Five* provides examples of NbS governance approaches. The report concludes with the following recommendations:

1. NbS should be a topic of future CCICED work, including through the creation of a new Special Policy Study. Such work should be coordinated with CCICED's ongoing work related to biodiversity, climate mitigation, climate adaptation, and integrated water resource, as well as international work including the green Belt and Road Initiative (BRI), green supply chains, and green/conservation finance.
2. Additional CCICED recommendations include:
 - a. Identify key sectors, regions, and objectives to advance NbS, as well as adopting a clear, coherent definition of NbS that includes appropriate safeguards. The 2021 Food Systems Summit is an opportunity for CCICED to identify eco-agriculture, regenerative and other approaches;
 - b. Identify opportunities for international NbS cooperation, including through South–South cooperation, innovative green BRI financing and other opportunities;
 - c. Establish a database and portal of NbS case studies, with clear criteria;
 - d. Apply innovative measurement of NbS outcomes, including through the use of inclusive wealth;
 - e. Identify policies and partnerships needed to implement NbS.

2.2 Background and Definitions

NbS at the project level have existed for decades, under different categories and definitions, such as the Ecosystem Approach and ecosystem-based approaches for climate change mitigation and adaptation and disaster risk reduction (endorsed by Parties to the UN Convention on Biological Diversity [CBD], in relation to different project features of integrated water resource management [IWRM]), to support natural disaster risk reduction measures and to support various aspects of agro-forestry, sustainable agriculture, urban green and blue infrastructure, and sustainable livelihoods.

As the 2021 MEE Guideline underscores, NbS play an important role in forest and other ecosystem conservation linked to climate mitigation. An important platform launched in 1997 in support of the UN Kyoto Protocol were project financing, related assessment tools, and methods intended to *reduce emissions for*

deforestation and degradation (REDD). In 2008, at the United Nations Framework Convention on Climate Change (UNFCCC) 14th Conference of the Parties (COP 14), REDD was modified to REDD+ in order to support measures to enhance carbon stocks in forests. Since the inclusion of REDD+ in the 2015 Paris Climate Agreement, examples of project finance similarly related to carbon sinks include the World Bank Forest Carbon Partnership Facility, the African Forest Landscape Initiative, the Bonn Challenge, and the Architecture for REDD+ Transactions.

While carbon sequestration is one important reason for the increased attention to NbS, a critical assumption is a need for NbS to support multiple concurrent natural and human capital benefits and outcomes. The breadth of definitions linked with NbS underscores this key point. Examples include ecosystem-based adaptation, natural climate solutions, ecosystem-based disaster risk reduction, natural water retention measures, and other terms associated with climate adaptation; climate nature solutions, biological-based carbon capture and storage, biological engineering and others associated with climate mitigation; climate-smart agriculture, conservation agriculture, sustainable ecological restoration, regenerative food systems, nature-positive food production systems associated with sustainable food systems; and engineering with nature, green infrastructure, and others linked with green infrastructure. Many NbS concepts have strong links to ongoing work related to conserving, measuring, monitoring, and monetizing ecosystem services. For example, recent work by the World Economic Forum (WEF) identifies actions to advance a nature-positive food, land and oceans system, with multiple actions linked to NbS measures.

WWF defines NbS for climate as “Ecosystem conservation, management and/or restoration interventions intentionally planned to deliver measurable positive climate adaptation and/or mitigation benefits that have human development and biodiversity co-benefits managing anticipated climate risks to nature that can undermine their long-term effectiveness.”

Recent work by the Food and Agriculture Organization of the United Nations (FAO) and The Nature Conservancy (TNC) on NbS (January 2021) refers to the International Union for Conservation of Nature’s (IUCN’s) 2016 definition. This IUCN definition and the more recent publication of its gold standard for NbS now serve as an important common definition of NbS:

Actions to protect, sustainably manage, and restore natural or modified ecosystems, that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.

In addition to global definitions, several governmental bodies have advanced their own NbS definitions. For example, the European Union defines NbS as:

Solutions that are inspired and supported by nature, which are cost-

effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.

Protect First: The IUCN definition establishes a useful sequence of NbS priorities, beginning with protecting existing ecosystems. Protecting forests, habitat, and ecosystems, as well as species, is of pressing importance in light of scientific reports of worsening trends in global ecosystem losses, including the accelerating loss of tropical forests. The loss of forests has a double or dual-materiality negative climate effect, by reducing and degrading carbon sinks while contributing to net greenhouse gas (GHG) emissions arising from forest burning for land clearing as well as forest fires. The loss of tropical forests is among the most urgent global ecological and climate challenges due to their dual role in terrestrial biodiversity and carbon sequestration (see Table 2 below).

The IUCN definition further underscores the importance of ensuring human well-being in NbS. Since landscape-based NbS entail localized efforts like avoided fuelwood harvesting, agroforestry management, cropland nutrient management, avoided grassland conversion, improved rice and legume cultivation, or animal husbandry practices, people-centred NbS projects and policies are central to their success. Finally, IUCN underscores the importance of ecosystem restoration, either by allowing landscapes to be left undisturbed and recover ^[1] or via policy interventions like the Trillion Trees reforestation or similar initiatives.

Safeguards: While NbS can support multiple benefits, win-win outcomes are neither automatic nor easy. Problems with NbS projects that focus only on one outcome—for example, scaling up or expanding carbon sinks—risk detrimental ecosystem impacts. For example, introducing non-native monoculture species in large-scale afforestation or reforestation projects could yield carbon mitigation outcomes to the detriment of ecosystem integrity, biodiversity, and local communities. Similarly, NbS projects that support climate adaptation through the restoration of coastal mangroves have been shown to have significant benefits in reducing flood risk and helping local communities (see Part Three examples). However, without due diligence, planning, consultation, and safeguards, mangroves could risk upstream and downstream freshwater availability.

The IUCN *Global Standard for Nature-Based Solutions* sets out the principles and higher-level guidance on NbS safeguards. Eight criteria that elaborate these safeguards include governance and community-level engagement principles, the importance of NbS transparency and measurement, and quantitative safeguard criteria such as ensuring all NbS projects move beyond “do no harm” principles to

achieve durable net positive outcomes.

Recommendation: CCICED should support work by China in aligning its definition of NbS with IUCN and other international definitions while taking into account its own theories, practices, governance models, and international partnerships.

2.3 Emerging Sectors, Systems and Places

NbS are being implemented in different economic sectors (such as agriculture), at different scales (for example, within urban clusters and wider freshwater basins), in different ecosystems (for example, forests or grasslands). Below are illustrative examples of how NbS are being applied. Future CCICED projects will align key sectors, systems, and places with criteria that will also guide case study selection.

2.3.1 Sustainable Food Systems

Many current agricultural production systems and related farm policies are unsustainable, including contributing to ecosystem, habitat, and biodiversity loss through land-use change, to freshwater scarcity, nonpoint pollution, and the depletion of aquifers for irrigation and on-farm uses, to organic soil degradation, as well as to climate change. Agriculture is also increasingly vulnerable to climate-related extreme events like prolonged drought, flooding, wildlife, and changing insect vectors.

A 2020 review by the European Commission concluded that current soil management practices associated with intensive agricultural practices led to significant losses of soil organic content, whereby most of Europe's agricultural soils were likely to be "net contributors to rather than sinks of atmospheric carbon"^[2]. Agriculture is also a major net source of GHGs, notably carbon dioxide, nitrous oxide, and methane. The Intergovernmental Panel on Climate Change (IPCC) recently concluded that the combined effects of agriculture, deforestation, and other land uses were responsible for approximately one third of GHGs, including 40 percent of methane emissions. The 2020 European Commission analysis concludes that the sustainable management of agricultural landscapes offered greater carbon benefits compared to forestry/afforestation, urban sequestration, or blue NbS projects, including protecting and restoring seagrass and salt marshes.^[2]

An extensive literature review showcases conservation/sustainable agriculture, including low-tillage or no-tillage practices, to reduce emissions and practices to increase physical organic soil properties leading to enhanced carbon storage (AgEvidence). Rewilding landscapes can help restore ecosystems, increase biodiversity, and support climate mitigation, including replacing ruminant livestock with native species to reduce methane emissions^[3].

Following decades of work ^[4], reducing and eliminating environmentally harmful agricultural subsidies has gained new policy traction because of accelerating global threats to nature as well as the gap in conservation finance. The 2020 *Financing Nature* report recommends that an early step needed to close the global biodiversity conservation funding gap is to identify, reduce, eliminate, and reform the approximately US\$540 billion governments spend annually on agricultural, forestry and fishery subsidies. Other recent examples of work to reform agricultural subsidies include *The Little Book of Investing in Nature* of the French development agency and ongoing work by the International Monetary Fund in the context of fiscal policy reform.

At the policy level, the European Union announced steps to align its Common Agricultural Policy with the EU Green Deal, including through its *Farm to Fork* program and other actions. China's Clean Plate initiative is an important national plan to reduce food waste; the FAO estimates that, globally, one third of all food is wasted annually, increasing to 45 percent for all fruit and vegetables (FAO Food Loss Index).

The 2021 UN Food Systems Summit, to be held in September 2021, will be an important opportunity to advance sustainable food systems, including via NbS. The Summit offers an opportunity to better align separate tracks of the multilateral system, including linking to the UN CBD agenda with sustainable food systems. Of the five Action Tracks of the Summit, WWF International is the co-lead of Action Track Three: Boosting Nature-positive production.

Table 1 N Food Systems Summit: Action Track Three

<p>Action Track Three aspires to</p> <ul style="list-style-type: none"> (a) Protect natural ecosystems against new conversions for food and feed production; (b) Sustainably manage existing food production systems to benefit both nature and people; and (c) restore and rehabilitate degraded ecosystems and soil functions for sustainable food production (<i>UN Food Systems Summit</i>).

Recommendation Two: The 2021 UN Global Food Summit provides an opportunity to advance agriculture-related NbS. CCICED should convene an informal meeting to examine opportunities for NbS to support the UN Food Systems Summit.

2.3.2 Terrestrial Ecosystems

Scientific estimates suggest between 33 to as much as 37 percent ^[5] of the global climate mitigation needed to meet the Paris Climate Agreement can be

achieved through NbS in a cost-effective way. The IPCC concludes that NbS are “indispensable” to achieving carbon neutrality.

Annual deforestation accounts for approximately 10 percent of global GHG emissions, the second-largest single source after emissions from fossil fuels.

Table 2 Two functions of forest to absorb carbon

Carbon storage	Carbon sequestration
The absolute quantity of carbon held within a reservoir is referred to as a carbon stock. This reservoir is a component of the climate system, other than the atmosphere, which has the capacity to store, accumulate, or release carbon. Oceans, soils and forests are examples of reservoirs of carbon.	The process of increasing the carbon content of a carbon reservoir other than the atmosphere. Biological approaches to sequestration include the direct removal of carbon dioxide from the atmosphere. Vegetation removes carbon dioxide from the atmosphere through photosynthesis.

Source^[2]

A widely cited *Science* (2019) article noted that planting trees on a massive scale and sustained period of time “is one of the most effective solutions at our disposal to mitigate climate change”^[6]. For example, planting trees has the potential to sequester up to 20 percent of U.S. GHG emissions annually by fully stocking currently under-stocked productive forests.

Other research suggests leaving nature unperturbed to restore itself can contribute more in terms of carbon sequestration than previously estimated, underscoring the importance of ecosystem protection prior to reforestation or afforestation. The most extensive empirical evaluations of forest sequestration rates (based on some 13,000 geo-referenced studies) conclude that allowing natural regeneration may be preferable to afforestation. A *Nature* 2020 article concludes that the IPCC estimates of the carbon sequestration potential of standing forests may underestimate above-ground carbon accumulation by 32 percent, significant variance among different eco-regions, and overestimated natural forest regrowth by 11 percent.

The table below provides a higher-order comparative estimate of global carbon stocks by major ecosystems. The estimates are based on the geographic extent and average carbon content per hectare of different ecosystems, measuring above-ground, below-ground, and soil organic carbon up to 30 cm depths.

Table 3 Estimate of global carbon stocks by major ecosystems

Ecosystem	Typical carbon density (tonnes of carbon per ha)	Estimated global carbon content (Gt C)
Mangroves	502	7.3
Seagrass	111	5.0
Marshes	265	5.6

Ecosystem	Typical carbon density (tonnes of carbon per ha)	Estimated global carbon content (Gt C)
Boreal forests	264	283
Temperate broadleaf forests	268	133
Temperate conifer forests	272	66
Tropical dry forests	166	14
Tropical moist forests	252	295
Boreal peatlands	500	181
Temperate peatlands	500	9.3
Tropical peatlands	504	30
Temperate grasslands	77	39
Tropical grasslands	43	30
Montane grasslands	104	27

Source^[7]

The table below provides a snapshot of the different time frames for carbon sequestration by ecosystem, underscoring the sequence of the IUCN and other definitions to protect and sustainably manage first, and then look to restoration and remediation to realize climate benefits.

Table 4 Different time frames for carbon sequestration by ecosystems

Ecosystem	Average time to recover vulnerable carbon, if lost (years)
Tropical grasslands	19
Temperate grasslands	35
Montane grasslands	205
Tropical moist forests	60
Tropical dry forests	77
Temperate broadleaf forests	78
Temperate conifer forests	78
Boreal forests	101
Marshes	64
Seagrass	93
Mangroves	153
Boreal/temperate peatlands	More than 100
Tropical peatlands	More than 200

Source^[7]

Recommendation: CCICED should identify best-in-class sequestration

verification systems, including third-party certification, fit-for-purpose accounting systems, and other safeguards.

2.3.3 Water Management

Protecting and restoring ecological processes in a landscape can have important impacts on hydrology. Evidence also suggests that NbS closely associated with ecosystem services contribute to water quality. Examples include enabling wetlands to help purify wastewater, improving nutrient management to reduce nutrient runoff, and other nonpoint sources of water pollution. China is a world leader in using NbS to reduce flood risk through some 30 Sponge City initiatives.

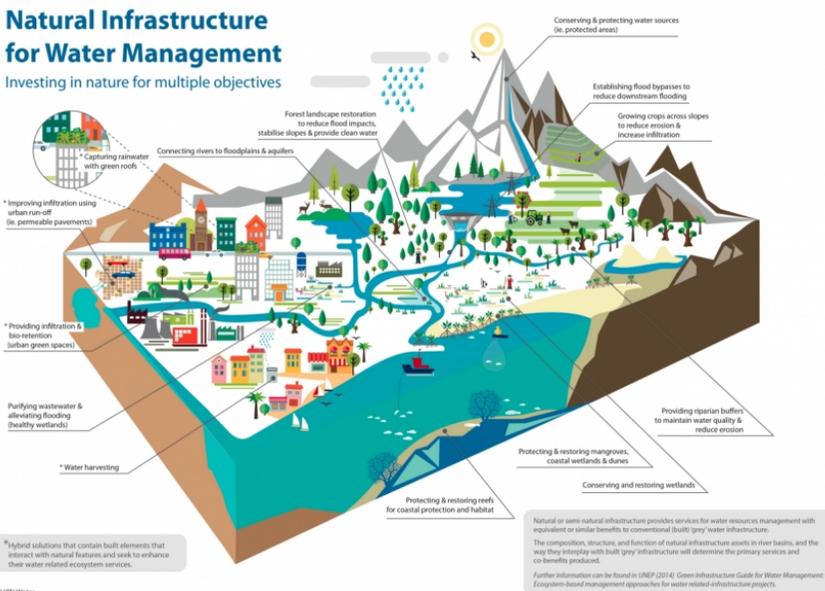


Figure1 Examples of NbS contributions to freshwater management include:

Source: IUCN 2020

Sponge Cities: An important source of NbS innovation is China's advancement of sponge cities. In 2014, China launched its Sponge City strategy to mitigate urban water risks in urban areas. The objective of the strategy is to ensure that that urban areas are capable of absorbing and reusing a large proportion of stormwater linked to typhoons, coastal flooding and other events. Since different cities have different flood risk exposure, depending on location, hydrological and other characteristics, sponge city targets and indicators have been tailored based on science-based targets [8]. A number of pilot initiatives involving some 30 cities—including Beijing, Shanghai and Shenzhen—together comprise an estimated US\$300 billion in green-blue infrastructure investments, including urban wetlands,

rain gardens and artificial ponds as catchment areas, and permeable pavements designed to decrease flooding risk ^[4]. China has also been partnering with TNC in piloting buildings that contribute to sponge city objectives, as well as exploring the role of innovative green finance (for example, in the issuance of environmental impact bonds).

Recommendation Three: NbS should be one area of focus in CCICED’s forthcoming work in the Yangtze and Yellow River basins, with proposed pilot projects to deploy NbS-related flood control grey infrastructure. Preliminary work should include project-level cost-benefit analysis.

2.3.4 Sustainable Cities

Many examples of urban NbS projects reduce climate-related hazards such as heat island effects, flooding, or landslide risk from deforested hillsides. Urban NbS projects vary from enhanced vegetation cover, expanding or creating new green spaces, building green roofs or vertical gardens, and using hybrid green and grey infrastructures like stormwater ponds, bioswales, or the restoration of riparian zones to restore natural hydrologic functions. The European Union’s Urban Nature Atlas classifies 12 categories of co-benefits from over 1,100 urban NbS projects, several of which are cross-referenced with the Sustainable Development Goals (SDGs).

Table 5 Urban NbS benefits linked to the SDGs:

Benefit	SDG
Climate adaptation, resilience, and mitigation	SDG 13
Coastal resilience and marine protection	SDG 14
Economic development and decent employment	SDG 8
Environmental quality, including air quality and waste management	
Green space, biodiversity, and habitats	SDG 15
Health and well-being	SDG 3
Inclusive and effective governance	SDG 16
Regeneration, land use, and urban development	
Social justice, cohesion, and equity	SDG 10
Sustainable production and consumption	SDG 12
Water management	SDG 6

Source: [Naturvation](#)

2.3.5 Oceans

Oceans play a role in mitigation and adaptation (WRI, 2021). Evidence, for example, suggests that marine benthic soft-sediment ecosystems provide important habitat, thereby playing an important role in regulating biogeochemical cycling,

climate-active gases, ocean chemistry, and the removal of carbon from the ocean-atmosphere system. One example is the role of marine megafauna in enhancing vertical nutrient transfer through cetacean deep-feeding, surface defecation, and physical mixing, which in turn is estimated to affect carbon sequestration on a large scale ^[10].

Recommendation: In follow-up CCICED research, an analysis should identify a comprehensive list of eligible economic sectors, ecosystem services, and geographic regions with promising NbS opportunities, including agriculture, infrastructure, and resource extraction.

2.4 Tools and Case Studies

2.4.1 Maps and Spatial Planning

The UN CBD's Subsidiary Body on Scientific, Technical and Technological Advice notes the importance of comprehensive spatial planning to integrate climate and biodiversity. Land use represents 13 percent of global carbon dioxide emissions, 44 percent of methane emissions, and 81 percent of nitrous oxide emissions. Land is also a net source of emissions, driven largely by deforestation and partially offset by afforestation and reforestation ^[11].

Tools to understand the characteristics of different landscapes have long been deployed for conservation and protected area planning. By contrast, they have been used far less in planning for carbon sinks. However, this is changing with China as a global leader: the Ecological Redline is being used to delineate both areas for nature protection and carbon benefits. Other examples of maps and landscape-level planning tools linking biodiversity and carbon sequestration include:

- Nature Map provides beta data on terrestrial biodiversity, biomass carbon density, threatened species, human impacts on forests, and other indicators.
- The Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) tool identifies the location and estimated value of ecosystem services that sustain human capital.
- The United Nations Development Programme Essential Life Storage (ELS) Areas Map provides geospatial information on areas that conserve biodiversity and provide food, water, and carbon storage services. Two pilot maps under the ELS platform for Costa Rica and Uganda triangulate the location of opportunities to advance the SDGs, the UNFCCC, and the UN CBD.
- Other examples include the AgEvidence data portal, supported by TNC and agro-environmental integrated opportunities in the U.S. Midwest.

Experts recommend that maps are included in both Nationally Determined

Contributions as well as the National Biodiversity Strategies and Actions Plans of the UN CBD (NBSAPs) to realize at the implementation-level synergies and integrated implementation.

Recommendation: CCICED should identify how China can effectively exchange experiences with international partners in the use of large-scale spatial planning and the Ecological Redline, including regions within countries with important biodiversity, carbon sequestration, human capital and other endowments. The 2021 China-Africa Summit, the green BRI, South–South cooperation, and other platforms provide opportunities to share such experiences.

2.4.2 Case Studies

There are thousands of NbS case studies. Several useful and accessible online NbS portals exist to share experiences about NbS features; examples include the United Nations Environment Programme (UNEP) NbS Contribution Platform, which lists almost 200 initiatives (including roughly 40 from China); the Compendium of Contributions of NbS prepared by New Zealand and China in support of the 2019 UN Climate Action Summit; the Urban Nature Atlas; the Panorama Solutions for a Healthy Planet portal; the Science for Nature and People Partnership; the U.S. Army Corps of Engineers Engineering With Nature atlas; EcoShape; and others.

The Urban Nature Atlas is accompanied by an interactive scenario planning tool to estimate individual and simultaneous NbS policy pathways, expected outcomes and budgets (<https://www.urbannatureexplorer.com/#/ExploreSite>).

Below are some examples of NbS case studies. Preliminary criteria guiding case study illustration focus on their primary objective (flood protection, urban heat islands, forestry conservation, watershed management, etc.). Experts of the sub-committee emphasized the need for criteria to highlight multiple non-linear ecosystem linkages, including co-benefits measured over long time periods (see Annex Two).

2.4.2.1 Coastal Flood Protection

Coastal Protection, Tanzania: In order to reduce the risk of coastal flooding from sea-level rise, more extreme storms, and higher average wave height, a coastal defence system based on ecosystem-based adaptation combining grey and green infrastructure was implemented in Tanzania with the support of the Global Environment Facility. The coastal defence comprises 2,400 m of seawalls and dikes, the restoration of approximately 1,000 ha of mangroves, and 3,000 m² of coral reefs. In addition, 2,300 m of drainage systems were created to reduce waterborne insect breeding spaces and lower public health risks; no-take zones were established in nearby forests; and enhanced rainwater collection services were created through boreholes and other collection devices. The project evolved from bottom-up

community and household engagement. The project goal is to benefit 500,000 people ^[12].

Coastal Flood Protection: Salt Marshes in Flood Protection, Wadden Region Delta Program, the Netherlands. The Netherlands is particularly vulnerable to climate-related coastal flooding from heightened sea levels, extreme surge levels, extreme wave heights, and more powerful wind conditions. The project focused on maintaining and enhancing coastal flood protection using green infrastructure by increasing barrier islands, salt marshes, and inter-tidal areas with a steady resupply of sediments. By bolstering natural barriers across approximately 9,000 ha, wave impacts were reduced while enlarged salt marshes provide valuable new habitats to several plant and bird species. They also have new green spaces for tourism through walking paths, bird-watching, bicycle paths, mudflat hiking, and other activities. An interpretation centre to support education about the functions of the marsh opened in 2016 ^[13].

Mangrove Forest Restoration, Costa Rica: Since the 1980s, Costa Rica has lost an estimated 25,000 ha of mangroves, more than 40 percent of the country's total. This local trend mirrors a grim global picture, in which 30 to 50 percent of the world's mangroves have been destroyed or depleted, making mangroves one of the world's most threatened tropical species. As mangroves cleared, they were replaced by aggressively growing ferns (*Acrostichum aureum*), which grow up to 3 metres and block the regrowth of new mangroves.

The goal of the NbS project is to clear 2,000 ha of invasive ferns, thereby allowing mangrove regrowth. The first phase of the project has led to the clearing of 30 ha and the planting of 28,000 mangrove saplings. The benefits of this project include local employment; community receiving payments of \$1,500 per ha to restore mangroves, with the potential of 100 ha per year; harvesting of local mussels that grow in mangrove forests; and multiple climate benefits related to carbon storage in mangroves and increased coastal resilience ^[14].

2.4.2.2 Urban Green Infrastructure

Sponge City, Shenzhen: In 2016, Shenzhen became an early pilot city of China's Sponge City initiative by deploying green infrastructure to reduce the risk of urban flooding. Shenzhen has been prone to flooding, exacerbated by the widespread use of paved surfaces and storm pipes designed to remove as much water as quickly as possible, resulting in both capacity limits during extreme events and land-based pollution during runoff into the bay. Examples of green infrastructure to capture rainfall include green roofs, planted areas for catchment services, restoring urban forests and green spaces, and building water retention ponds and urban wetlands, which together help mimic the natural functions of catching and slowing filtering and releasing water. Green roofs in Shenzhen have also shown promising impacts in reduced urban heat islands ^[15].

Green Infrastructure, Tara River, Kenya: The Tara River is the source of 80 percent of Nairobi's drinking water supply, 70 percent of the region's hydroelectricity, and the source of 645 km² of farmland irrigation. Decades of conversion of riverbeds and hillsides to farmland have increased soil erosion and sedimentation, decreased the integrity of the basin's reservoir, and increased water treatment costs. The NbS includes improving the river's riparian management, creating hillside terracing, and restoring degraded lands, including adding grass strips on farms adjacent to the river. The Nairobi City Water Supply and Sewage Co., a partner in the project with local conservation and other groups, has reported source water benefits that include avoided filtration and lower energy costs for treatment. The 10-year US\$10 million project is projected to deliver \$21.5 million in benefits over 30 years.

Greater Cape Town Water Fund, Cape Town, South Africa: Confronting an acute water supply crisis, in 2018 Cape Town, developed a new business plan informed by consultations, modelling, and other steps. The plan focused on investing US\$25 million in the restoration of the city's upper watershed catchment area. By protecting the upper catchment area's natural systems, the project estimated that 100 billion litres of fresh water would be supplied within 30 years, of which half would be available within five years. The study concluded that, at one tenth of the cost of alternative options, catchment restoration was significantly more cost effective than other water supply augmentation solutions, including grey infrastructure solutions (Panorama).

Grey to Green Project, Sheffield, U.K.: Under the project's first phase, an old redundant concrete highway was replaced with a 1.2-km urban green space of wildflowers, trees, and shrubs that includes trails and benches. In addition to providing the local population with access to green spaces (and a local art installation), the greenbelt also functions as an urban drainage system, thereby reducing flood risk, including by creating natural rain gardens. The project won a number of awards in 2016, including the Eric Hughes Award for Outstanding Contribution to Improving Sustainability.

Green Infrastructure Plan, New York City, United States: Grey and green infrastructure are being used to capture urban stormwater runoff, including by using bioswales and green roofs to capture 90 percent of excess water during wet weather events while enhancing biodiversity and reducing daytime urban air temperatures. A 2.7 ha. green roof on the city's main convention centre retains more than half of storm event precipitation, thereby reducing storm runoff pollution and flooding.

Urban Tree Cover Reduces Extreme Heat: Upper Midwest, United States: Increasing urban tree cover helps regulate extremely hot temperatures. A pilot project in Madison, Wisconsin, was comprised of planting trees along roads and intersections and then measuring changes in average heat levels throughout the day,

then comparing day and night. The results showed that air temperature decreased with increased tree cover: an increase in average tree cover by up to 100 percent led to a decrease in average daytime temperatures of 0.7°C over a 10-km range and up to 1.3°C over a 30-km range ^[16].

2.4.2.3 Wetlands

Wetland Protection and Restoration, Bow River and South Saskatchewan River, Alberta, Canada: Following extreme flooding in 2013, interest in NbS to reduce flooding hazards focused on protecting existing wetlands and restoring others. The region had lost over 60 percent of its natural wetlands, which had been drained for farming, grazing, or construction. Project analysis, modelling, and consultations concluded that it was more cost effective to invest in wetland restoration than build additional grey infrastructure. NbS saved an estimated USD 257 million—saving \$10,000 per ha in rural areas from averted flood damages and doubling that savings closer to the urban centre of Calgary.

Peat Land Restoration, Belarus: Belarus is leading European efforts in peatland restoration. In the past decade, an estimated 50,000 ha of degraded peatlands have been restored—primarily in the Białowieża Forest, one of Europe’s last remaining primary forests. The forest, which is a UNESCO World Heritage Site and an Important Bird and Biodiversity Area, houses some 250 bird species. The government announced plans to preserve 29 percent of its total peatland by 2030. The benefits include enhanced carbon sequestration, improved water quality, and improved biodiversity protection.

Flood Management in China's Yangtze River Basin through River and Lake Connectivity: After the 1998 Flood, the WWF began to think about the protection of the Yangtze River at the basin level, especially in the areas of wetland protection, river and lake connectivity, ecological dispatch, and integrated watershed management policy advocacy. WWF hopes to work with the government, enterprises, and the public to reshape the Yangtze River as a "river of life". Since 2002, WWF has helped the Chinese government develop a river and lake connectivity plan to manage floods through economically viable nature-based solutions. By 2010, there were more than 30 lakes in the Yangtze River basin, about 2000 square kilometers of seasonal river and lake connectivity. Plus Poyang Lake and Dongting Lake as two natural lakes connected to the river, there are nearly 6000 square kilometers of lakes connected to the Yangtze River. There is flood control capacity of 1.5 billion square meters added. Among them, Dongting Lake and Poyang Lake Wetlands have the same flood control capacity as the \$45 billion Three Gorges Dam. At the same time, the number of 39 threatened species has increased, and 30 million people has access to cleaner water resources.

Ecological Aquaculture Management of Ramsar Wetland in The Back Bay of Mai Po Nai, Hong Kong: Located in the Inner Back Bay at the mouth of the

Pearl River, the Ramsar Wetland in Mai Po Nai are composed of tidal beaches, mangroves, marshes, traditional shrimp ponds (*metapenaeus ensis*) and fish ponds, providing wintering and transit habitats for more than 80,000 water birds each year. The area has recorded more than 400 species of birds, including 24 globally endangered birds that depend on wetlands. Their survival depends on the quality of the wetland. Mi po's aquaculture operation is a good example of how semi-artificial habitats can support high biodiversity with proper management. In the 1950s, most of Mipo's coastal mangroves were converted into tidal culture ponds, which also retained mangroves that feed shrimp, oysters and fish. After rotating drainage, the ponds attract water birds to prey on the remaining small fish or invertebrates. Currently, most shrimp ponds are managed as habitats and foraging habitats for migratory birds. In addition, there are innovative methods on Mai Po, such as grazing Buffalos in the freshwater wetland, which is more effective to attract water birds than artificial methods. Except for bird watching and environmental education participants, human activities in the Ramsar Wetland are severely restricted, while in commercial fish ponds next to nature reserves, farmers are involved in the implementation of ecological farming methods appropriate to wetland conservation. As a result, this well-managed wetland area supports important carbon sinks and biodiversity hotspots.

2.4.2.4 Forests

China's Sloping Land Conversion Programme (or Grain for Green Programme) is one of the world's largest tree-planting projects. Established over two decades years ago, covering 25 provinces, and involving some 124 million people, the project has converted some 28 million ha of croplands on steep slopes to forests and grasslands. Farmers are supported through direct payments or grain supplies in exchange for conversions. The program's multiple objectives include reversing deforestation and land degradation, addressing climate change, supporting biodiversity, and alleviating rural poverty. A 2016 analysis suggested that soil erosion decreased, forest cover increased by 10 percent, and carbon storage increased. At the same time, progress can be made in tree mix away from monoculture species to support wider biodiversity outcomes ^[17].

Forest Conservation, Gabon: In 2019, Gabon and Norway finalized a USD 150 million agreement over 10 years by which payments would be made to leave standing forest intact as a means to finance habitat protection, avoid deforestation, maintain important forest carbon sinks, and avoid GHG emissions from deforestation and land degradation. The agreement is coordinated through the Central African Forest Initiative (CAFI). The agreement supports Gabon's ongoing efforts, including the creation of 13 national parks since 2000—of which one is a UNESCO Natural Heritage site—and support for sustainable forest management outside of parks. Through these measures, large tracts of Gabon's forests are intact

and home to 60 percent of the threatened African forest elephants. The Norway-Gabon forest agreement is viewed as a model for other agreements in the West African and Central African forests in mitigating climate change.

Ranch Systems and Viability Planning Network, U.S. Northern Great Plains: Led by the World Bank, this project provides support to ranchers in Montana, Nebraska, and South Dakota to improve cattle grazing practices over 1 million ha of land. Benefits include improved grasslands, increased carbon sequestration, and improved ecosystem protection. Support to ranchers includes individual knowledge sharing, training, financial support, and tools for monitoring to measure conservation and climate outcomes. The region supports 1,595 species of plants, 300 bird species, 95 mammal species, 28 reptile species, and many important pollinators. Launched in 2020, partners of the project that support sustainable sourcing include McDonald's, the Walmart Foundation, Cargill and WWF.

Integrated Farming, Forestry and Livestock Approach, Guatemala: Guatemala has taken ambitious actions to mainstream ecosystem-based adaptation measures into its national development plan, *Plan K'atun 2032*. The country continues to advance innovative governance systems, including enabling legislation, community-level consultations, financing, the development of a roadmap to upscale projects, and other measures. Today, the country has the largest number of climate adaptation projects of any Central American country. The project supports a shift from intensive, single-crop production to extensive inter-cropping that blends primary crops—maize and potatoes—with the addition of secondary crops like beans and vegetables, as well as sheep grazing. In the past decade, there has been a significant increase in overall crop yields; communities have been involved in forest conservation and agroforestry practices that have built community resilience to climate-related crop failures, disease, and pests (International Climate Initiative/PAGE).

Mountain Ecosystem Restoration, Nor Yauyos, Peru: Changes in average temperatures coupled with extreme weather events like hailstorms adversely affect livestock and farm livelihoods. The project has involved restoring water channels and reservoirs to increase freshwater supply security; protecting grasslands to enhance pastoral livelihoods and increase resilience to drought and frost; enhancing the protection of a local species, the *vicuña*, used to produce animal fibre; and enlarging communal livestock management in natural grasslands. The benefits of the project include enhanced carbon storage in grasslands; a six-fold increase in the capacity per hectare of grasslands to support sheep grazing; reduced overall pressure on pastures, wetlands, and alpine ecosystems; improved indicators of biodiversity; and enhanced local governance and engagement.

Recommendation: CCICED should develop criteria to share international case studies, including (a) case studies that demonstrate climate adaptation, climate

mitigation, and nature-positive outcomes in a quantitative way; (b) that provide information on how safeguards were designed and implemented; and (c) quantitative analysis of costs and benefits. In order to support South–South cooperation, CCICED should synthesize data, maps, and other information from leading countries with high-value ecosystems, carbon sinks, and human capital estimates. Finally, CCICED should prepare and update an online portal of case studies.

2.5 Measuring NbS Outcomes and Benefits

Measuring and quantifying NbS benefits is complex. Different NbS projects use different baselines, scales and time frames. Comparing NbS benefits with comparable engineering-based approaches is one way of estimating the relative NbS costs and benefits compared to grey infrastructure projects. Several case studies noted above compare these kinds of comparative savings. However, drawing wider measurement conclusions of NbS performance in its own right remains challenging.

2.5.1 Estimating Carbon Stocks

Methods to calculate carbon sequestration of land use, land-use change, and forestry (LULUCF) have been elaborated for 25 years; the IPCC’s 2006 *Revised Guidelines for National Greenhouse Gas Inventories* set out good practices for national- and project-level GHG accounting, including accounting of LULUCF inventories. The [2019 IPCC refinement of those 2006 guidelines](#) has standardized GHG inventory methodologies, including updated methods (Volume 4) regarding agriculture, forestry, and other land uses.

Table 6 The definition of carbon budget

Carbon budget: The balance of the exchanges of carbon between carbon pools or within one specific loop (e.g., atmosphere – biosphere) of the carbon cycle. This is a generic definition of “carbon budget” in the context of national GHG inventories. This term may be defined with other specific meanings in other contexts (IPCC, 2019).

The 2019 IPCC guidance marks an important step in standardizing GHG inventory methods. At the same time, methodological challenges remain. For example, many GHG inventories are based on statistical extrapolation drawn from limited field samples. Any extrapolation poses accuracy challenges at the micro level—for example, landscapes and ecosystems differ while inventories are less adept at estimating carbon fluxes such as annual changes in carbon stocks (for example, from wildfires). Given the growing interest in sequestration among private sector actors, there are many third-party carbon sequestration certification bodies,

including Verified Carbon Standard, Carbon Trust, Climate, Community and Biodiversity Alliance and others.

The California Air Resource Board 2018 GHG inventory technical update provides a highly useful example of state-level GHG inventory methods based on the 2016 IPCC guidance, including the use of maps; the rationale for using the atmospheric flow approach to account for carbon fluxes to/from the atmosphere for lands and wood product pools, including from imported products; the use of land-fire data; and options to augment field-based monitoring with the application of remote-sensing tools to provide up-to-date estimates of changes in carbon stocks.

Examples of national-level GHG inventory systems and tools based on IPCC guidance related to LULUCF carbon sequestration include the Natural and Working Lands (NWL), in partnership with TNC, WRI and other groups under the US Climate Alliance and the US Environmental Protection Agency State Inventory and Projection Tool. The scope of NWL inventories comprises forests, wetlands, grasslands and shrubs, croplands and rangelands, wetlands, and urban areas, underscoring differences in carbon sink and sequestration characteristics between different biomass systems. As a further illustration, inventories differentiate the carbon attributes of wetlands into tidal wetland restoration, peatland restoration, avoided seagrass loss, and seagrass restoration.

2.5.2 Estimating Costs and Benefits

There are various estimates of global NbS benefits. The estimated global value of coastal flood protection provided by coral reefs is US\$270 billion^[18]. A review of 52 coastal NbS flood mitigation and storm surge protection projects concluded that, on average, these were 2–5 times more cost effective than grey infrastructure and related engineering solutions. A 2020 WEF report concludes that investing in a nature-positive economy would generate an additional US\$10 trillion in annual business revenues and cost savings by 2030 and an additional 395 million jobs.

Such aggregated global estimates are helpful in providing orders of magnitude of wider returns on NbS investments. Analysis at the project level similarly suggests that NbS investments have the potential for lower capital and operating costs compared to grey/engineering solutions and higher multi-year returns on investment. For example, green roofs, green spaces, and tree canopy urban projects have recorded localized temperature cooling effects of between 0.5 and 7°C, within a cost range of US\$10–US\$100 per GHG cost/tonne equivalent of avoided emissions. In turn, reduced exposure to extreme heat has been measured in reduced public health hazards and lower energy demand from air conditioning and industrial cooling.

Since well-designed NbS projects deliver multiple benefits simultaneously, valuation techniques used for ecosystem services are also used to quantify NbS outcomes. These services can include less climate-related flooding, increased carbon

storage and sequestration, improved water management and drainage, stronger ecological protection, and human and social capital benefits ^[19]. NbS work has included estimating the value of a hectare of the urban forest at US\$1,500 ^[20]; an estimated value related to green tourism and recreational values per hectare of coastal ecosystems at US\$4,700 ^[21]; and an estimated value of one m² of green roofs at US\$290 and US\$700 ^[22].

A long-standing challenge in ecosystem valuation is linking the bottom-up valuation of localized actions with top-down or highly aggregated observations. *The Economics of Biodiversity: The Dasgupta Report* (February 2021) is an important contribution: it sets out a robust methodological framework for valuation to inform both micro and macro-level estimates. Drawing on ongoing work over several decades with more robust data and new methods, Dasgupta's work in inclusive wealth estimates based on valuing natural capital, human capital, social capital, and produced capital have influenced ongoing work by the World Bank, and, more recently, aspects of the UN System of Environmental-Ecological Accounting.

However, aggregating or scaling up project-level benefit valuation to wider observations remains a key challenge. For example, a recent study estimates the global values of wetlands contribute US\$7,000/ha per annum in flood control, US\$3,400/ha in freshwater supplies, and US\$5,800/ha in water quality services ^[23], with an estimated global aggregate in wetlands services of \$26.5 billion per year. However, given the uncertainties in aggregating local service values, the study cautions that such estimates have a variance of as much as US\$20.2 billion per year. This margin of error of 80 percent underscores continued challenges to the economic valuation of ecosystem services in general, including NbS outcomes.

A central conclusion of a 2020 review of NbS projects by the Global Environment Facility underscores the ongoing challenges in NbS outcome measurement and calls for

much more attention on the costs and benefits of interventions, assessed comprehensively across outcomes for both society and nature; and the need to consolidate some sort of evidence base in this regard that is linked to monitoring and evaluation that might give investors (whether public or private) more confidence of ... more 'bankable' returns on investment. (GEF STAP 2020)

Fit for Purpose: Annex One examines how inclusive or comprehensive wealth is fit for the purpose of NbS measurement. Standard economic measurement tools like cost-benefit analysis, cost-effectiveness analysis recommended in the IUCN Global NbS Standard, and economic impact analysis face shortcomings and limitations in assessing the full value of NbS performance outcomes. Since these standard economic frameworks do not serve NbS well, a more holistic approach is needed. Both the Dasgupta report and updated UN System of Environmental

Economic Accounting are welcome in measuring how natural capital assets contribute to overall national wealth. At the same time, more work will be needed to bridge these national or economy-wide systems with measuring the inclusive wealth of NbS at the project level, particularly in measuring long-term effects on ecosystems as well as families, farmers, foresters, and communities from human and social capital perspectives.

Recommendation: CCICED should apply pilot new approaches to NbS measurement based on more holistic ecological or natural capital accenting within a broader inclusive wealth framework at the micro or project levels.

2.6 Policies, Pathways, and Practices

An important challenge for China and others that are on a carbon-neutral pathway is moving from individual NbS projects to systems to implement them in an ecologically and equitable way that is at scale. Options for further elaboration include:

Green Financing: 2020 saw a significant increase in climate ambition, both in countries, of which, China's September 2020 carbon neutrality pledge was the most important, as well as in some 1,500 leading companies. For example, Transform to Net Zero (launched in mid-2020) includes companies like Danone, Microsoft, Mercedes-Benz, Maersk, Nike, and Starbucks, supported by the Environmental Defense Fund, sharing lessons in decarbonization. The UNFCCC's Race to Zero initiative comprises over 2,000 businesses, 127 of the world's largest investors, and over 500 universities, to achieve net-zero carbon emissions by 2050 or earlier.

Reflecting this growing decarbonization push, private markets are poised to expand investments in carbon sequestration to help meet targets. For example, the first 2021 report of the Task Force on Scaling Voluntary Carbon Markets estimates that investments in NbS-related carbon sinks could expand to between US\$50 billion and US\$100 billion in the future. This compares with total spending on forest conservation of US\$2.8 billion, of which only US\$159 million comes from voluntary carbon markets. The scale with which forest-related carbon sequestration investments are expected to increase has led to an increased debate about the ecological integrity of forest carbon sinks.

In anticipation of a significant expansion in private sector financing, it will be critical to ensure the integrity and transparency of project design, adoption of comparable accounting systems, and the implementation of safeguards that protect and enhance ecosystem integrity while providing benefits to local communities, farmers, foresters and others. Existing financing models, including water fund models and conservation trust funds, provide existing governance models to leverage increased financing.

One opportunity to make use of existing financing initiatives is the Conservation Reserve Program, administered to remove ecologically important lands from agricultural production; restore native trees, grasslands and shrubs to protect water quality; decrease soil erosion; and increase habitat. Approximately US\$2 billion has been provided to landowners under this voluntary program, which has led to over 100,000 km² in land designated, with a contract duration of 10–15 years. Aggregate results include a reduction of nitrogen and phosphorus runoff by more than 80–90 percent in set-aside lands, increased topsoil protection from erosion, and the protection of 20 million ha.

A second example of using existing governance models to leverage NbS financing is China's eco-compensation to support the conservation of forests, grasslands, and wetlands. In 2014, the *Environmental Protection Law* proposed that “the state will establish and improve an eco-compensation system, and strengthen the fiscal transfer payment for ecological protection region; the relevant local government shall implement eco-compensation funds and ensure it is used for eco-compensation; the state will guide relevant governments of the beneficiary areas and ecological protection areas to implement eco-compensation in accordance with the market rules through consultation”. Further elaboration of China's eco-compensation laws and practices related to public transfers include the February 2018 *Guiding Opinion on Establishing Eco-Compensation and Long-Term Protection Mechanisms in the Yangtze River Economic Basin*. In 2019, NDRC announced it would advance a national-level eco-compensation plan with pilot projects in some 50 counties, with a focus on forests and rivers.

Yangtze River Basin: The Yangtze River Economic Basin is an example of a large-scale region comprised of multiple jurisdictions. While most of the case studies discussed in this report involve projects within regimes, ecosystems cut across different jurisdictions. A basin-wide approach to piloting and scaling NbS offers an opportunity to coordinate solutions. Given the importance of the Yangtze and Yellow River basins in the 14th Five-Year Plan, NbS projects can expand current work in sustainable ecological restoration and regenerative agricultural practices linked to rice, wheat, and other crops, as well as pilot projects for hydropower restoration. For example, with support from the TNC Center for Sustainable Hydropower linking NbS freshwater projects with underlying integrated water resource management approaches, including focusing NbS on both surface and groundwater issues and linking ecosystem restoration with organic soil carbon sink recovery.

National Laws and Regulations: An emerging approach to NbS governance involves laws and regulations. Peru is among the first countries with a national NbS law, consisting of provisions for green infrastructure investments to protect the sourcing of drinking water supplies and the elaboration of principles of a

remuneration or compensation system. An Executive Order by the State of California sets out guiding principles in support of NBS.

NBS is still a relatively new concept in many jurisdictions, hence it doesn't yet appear in many legal systems. Attempts to integrate it are under way in some countries, such as the US and China. In some countries, NGOs, prosecutors and judges have attempted to bring the principles of NBS into court cases. After examining existing laws, policies, and cases, several recommendations for CCICED are made.

Recommendation: 1) CCICED should emphasize the importance of integrating nature-based solutions in China's climate and biodiversity strategies, and strengthening China's legal framework, which include integrating NBS into the new EIA Law, establishing a strong legal framework for ECRL, and enhancing preventive public interest litigation.

2) CCICED should continue to help mitigate risks to nature from overseas investments and trade, highlight the significance of implementing the traffic light system and green investment principles for BRI projects.

Annex 1: **Evaluating Nature-based Solutions (Executive Summary)**

In 2020, the IUCN released a global standard for nature-based solutions with eight criteria for “the verification, design and scaling up” of nature-based solutions (NbS). Criterion 4 states that NbS should be “economically viable” and that this viability should be evaluated by comparing the costs and benefits of implementing NbS with those of traditional solutions. In principle, such a comparison is valid for choosing between NbS and traditional solutions. In practice, however, the approach is fraught with shortcomings, many of which emanate from biases built into the standard cost-benefit analysis (CBA) frameworks. These biases pose particular problems for the evaluation of NbS.

CBA emerges out of people’s innate ability to compare short-term costs and benefits. Most of us are remarkably adept at assessing the costs and benefits of alternative pathways in our daily lives. This kind of simple CBA, which is largely informal and even unconscious, suits when the consequences of decisions are small. This is not the case with all decisions, however. Many of us are required to make decisions with consequences reaching far beyond the personal. As a result, a formal decision-making discipline has arisen, employing frameworks with carefully structured methods and data requirements. Unsurprisingly, given how instinctual the comparison of costs and benefits is for humans, the central framework for formalized decision-making has evolved around this very approach.

The rise of formalized CBA occurred largely in western countries during the middle of the 20th century. This was a time when continuous economic growth—as measured by GDP—was the unquestioned doctrine of governments and businesses alike. It was also a time when national statistical agencies were rapidly expanding and improving their collections of economic statistics, using the newly minted System of National Accounts as their guide. The combination of growth doctrine and increasingly robust data describing the market economy was a potent force. Those developing CBA as a discipline were inevitably drawn to focus their concepts, methods and data on the market economy. Costs and benefits not part of the market economy—including those related to the environment—were considered of secondary relevance, if at all. Clearly, this market bias disadvantages NBS when evaluated via CBA.

CBA in its purest form requires a comparison of costs and benefits in monetary terms. Any cost/benefit not already monetized must be converted into money for the purpose of the analysis. Of course, this is not always possible. Some costs/benefits

are best (or only) expressed in “natural” units; for example, the benefit of building a hospital might best be expressed in terms of the number of lives saved rather than the purported “economic value” of those lives. For this reason, variants of pure CBA have been developed that allow benefits to be recorded in natural units. Cost-effectiveness analysis (CEA)—the framework recommended for NbS evaluation by the IUCN—is one such variant. In CEA, costs are expressed in monetary terms, but benefits remain in natural units. The choice between two projects depends on which of them offers its benefits at the lowest cost.

Comparing NbS and traditional solutions on the basis of CEA is problematic in a number of ways. First, it may be difficult to find an NbS that offers the same suite of benefits as a traditional solution. When benefits differ, how are the projects to be compared? Is, for example, the expansion of a mangrove forest that protects 200 ha of land, a school, and 100 homes from flooding better or worse than protecting 150 ha of land, 80 homes, and a hospital by building an artificial breakwater? There is no obvious answer to this question. Timing of benefits can also pose problems. Breakwaters can be built relatively quickly and begin offering full protection immediately. Mangroves take time to grow and offer only limited protection until fully grown. How are benefits today to be compared with benefits in the future?

Challenges exist on the cost side of CEA as well. For one, as already noted, not all costs may be easily expressed in monetary terms. For another, projected costs related to NbS are treated asymmetrically to costs for traditional solutions in corporate and government balance sheets. No balance sheet acknowledges mangrove forests as assets, whereas every balance sheet would admit an artificial breakwater as an asset. Thus, a government choosing to expand mangrove forests for flood protection would have to forego adding an asset to its balance sheet, something it may be reluctant to do. Governments—and the bond rating agencies that assess their credit-worthiness—like to see assets on balance sheets as evidence that public spending is “going somewhere.” Artificial breakwaters have a clear advantage over mangrove forests due to this overly narrow definition of assets.

For the reasons above, CEA will often not provide clear guidance for choosing between NbS and traditional solutions. This is all the more so when NbS are proposed in the form of policies rather than projects. While projects may have reasonably well-defined costs and benefits, this is not always true for policies. Policies may cost practically nothing to implement but have major impacts on society and the economy. Reflecting this, another framework—economic impact analysis (EIA)—has emerged to support decision-making around policies. In it, complex and data-intensive models are used to measure policy outcomes (say, the change in spending on automobiles induced by an electric-vehicle subsidy policy) into impacts on GDP and other core macroeconomic variables. Policies are then judged by the size of their economic impacts.

For many of the same reasons that CBA and CEA are problematic when applied to NbS, so too is EIA. The models used in EIA focus on market impacts, and the fact is that many NbS have limited market impacts. Conserving a forest for its carbon sequestration function does little to stimulate the economy (indeed, it may stifle economic activity), so EIA is unlikely to recommend it over a traditional solution.

Overall, formalized decision-making frameworks cannot be expected to serve NbS well. The frameworks are excessively market-centred, tailored to the kinds of costs and benefits that traditional solutions offer and difficult to adapt to non-traditional solutions.

The last two decades have seen an emergence of an alternative framework for measuring economic progress that holds considerable promise for NbS evaluation. The central thesis of the framework—which is known by the name “comprehensive” or “inclusive” wealth—is that sustainability depends on wealth passing from one generation to another. Unlike traditional conceptions of wealth, however, comprehensive wealth is defined—as the name would imply—to include more than just buildings, machinery, stocks, and bonds. Comprehensive wealth adds natural capital (ecosystems and natural resources), human capital (skills and knowledge), and social capital (trust and norms) to the overall wealth portfolio.

Among many insights, comprehensive wealth offers a new way of thinking about economic evaluation. In a recent and thorough presentation of the framework titled *The Economics of Biodiversity*, Cambridge economist Sir Partha Dasgupta outlines why comprehensive wealth is, in fact, the proper basis for deciding among project options. More specifically, Dasgupta shows that the change in the size of a country’s (or a company’s) comprehensive wealth portfolio is the yardstick by which investment options should be compared. Choosing between flood protection using mangrove forests versus artificial breakwaters, for example, becomes a matter of assessing the contribution each makes to stocks of produced, human and natural capital. The project with the greatest contribution to wealth, other things equal, is that one that should be pursued.

There is much to recommend comprehensive wealth as the framework for evaluating economic viability. Many of the shortcomings of standard evaluation approaches would fall away if comprehensive wealth were routinely used for this purpose. Importantly, the asymmetry in the treatment of NbS and traditional solutions on balance sheets would disappear since comprehensive wealth explicitly recognizes nature as a form of capital. The excessive market focus of the standard approaches would also be dealt with since comprehensive wealth is built around the notion that “accounting” prices and not market prices should be the basis for valuation. Accounting prices are defined as those that reflect the social, rather than private, worth of a good or service. Concern over the timing of costs and benefits

would also disappear since the asset values required to measure the change in comprehensive wealth are current-period measures.

Of course, no framework is perfect and comprehensive wealth, which remains relatively new as an area of inquiry, is not without challenges. Notably, the accounting prices it calls for cannot be observed. They may sometimes be proxied by market prices, but, especially in the case of natural capital, markets are often badly distorted from their social equilibria. Methods exist to model accounting prices, though these can be complex, data intensive, and not without controversy.

Standard economic evaluation frameworks do not serve NbS well. Comprehensive wealth, as Dasgupta and others show, offers an improved basis for assessing economic viability. Given this, it would be appropriate for researchers and institutions promoting NbS to engage in the effort to refine and apply comprehensive wealth thinking. A useful step in this direction would be to revise Criterion 4 in the IUCN global standard to call for comprehensive wealth, rather than cost-effectiveness analysis, as the basis for evaluating economic viability. Beyond this, support for research on, among other things, accounting prices would be helpful. Finally, and perhaps most importantly, governments must be persuaded to begin compiling and using measures of comprehensive wealth to drive decision-making. So long as governments remain fixated on growth in GDP, standard evaluation frameworks will remain their primary analytical tools, and NBS will remain disadvantaged in decision-making.

Evaluating Nature-based Solutions FULL REPORT

Annex 2: CCICED Sub-Working Group Nature-Based Solutions Meeting Summary April 6, 2021

Opening Remarks

Professor LIU Shijin, CCICED Chinese Chief Advisor, kicked off the meeting by providing an overview of recent policy updates in China. He noted the growing interest in applying nature-based solutions (NbS) to climate actions, adding that NbS could also bring synergistic effects on solving many other challenges facing China today, namely biodiversity, ecological recovery, pollution prevention, and economic growth. He underscored the Chinese philosophy on following nature's laws and called for incorporating such traditional wisdom in the research, implementation, and communication about NbS. He also highlighted the importance of cultivating consensus, introducing international experiences, and identifying domestic case studies.

Mr. Scott Vaughan, CCICED International Chief Advisor, expressed gratitude to all participants' contribution to the sub-working group's scoping work, which set to identify future work priorities and solid solutions for China. He outlined four major aspects of the sub-working group's work to guide the discussion: 1) identifying the science foundation of NbS; 2) presenting and organising case studies; 3) measuring the cost and return; 4) policy pathways, focusing on scalability, bankability, and private sector engagement.

Session 1: Science, Definitions, Safeguards

Mr. Thomas Lovejoy, Senior Fellow, Biodiversity and Environmental Science, UN Foundation, shared the larger picture of NbS in linking the biological and physical system by reviewing the role the biological and geological process in bringing down the CO₂ level twice in historical periods during which the CO₂ level was higher than today. He also pointed out the CO₂ in the atmosphere from destroyed terrestrial ecosystems is equivalent to what stays to an extent terrestrial ecosystem, which reflects the atmospheric consequences of climate change, as well as the opportunity for restoration (Woodwell Climate: [Soil Carbon Debt](#)). At last, he highlighted the dual benefits of ecosystem restoration on carbon sequestration and the

ecosystem (The [Dasgupta Report](#)).

Ms. LI Lin, Director of Global Policy and Advocacy at WWF International, recommended considering positioning NbS as a preferred solution to climate change, as well as to societal challenges. She highlighted the importance of coordinating different layers of land in spatial planning and pointed out that carbon sequestration, as one of the biggest ecological services, has not been considered in the ecological redlining and zoning at this moment. She also shared a few other remarks: 1) NbS provides an opportunity to mainstream nature and biodiversity; 2) financing NbS needs not only generating new funding but also removing harmful subsidies and realigning the financial flow to conservation; 3) China has carried out some experimental work on natural resource asset accounting. She suggested setting up a task force under the sub-working group to explore the synergies between NbS and other Special Policy Studies (SPS).

Dr. ZHANG Xiaoqun, Chief Scientific Officer, The Nature Conservancy, acknowledges the challenges in reaching a common definition for NbS. He suggested focusing on deepening the understanding on the key features and the science foundation of NbS. He provided insights on identifying the pathways, categorisation and the connotations. Dr. ZHANG recognised the necessity of raising awareness on NbS, while warning the risk of generalisation and misuse of the concept for greenwashing purposes. He concluded that NbS set to restore, conserve, and imitate nature under the inspiration of nature.

Session 2: Case Studies Comparable Criteria

Mr. Laszlo Pinter, Senior Fellow, IISD; Professor and Head of Department of Environmental Sciences and Policy, Central European, shared the progress of “Naturvation”, an EU project aiming to understand the potential of NbS in the urban context. The project finds NbS as a new paradigm, standardizes the language and terminologies, and develops an [Urban Nature Atlas](#). The project concludes that NBS addresses multiple SDGs and has the potential to contribute more, including green recovery. He outlined the challenge of identifying integrated business cases addressing societal challenges and the importance of tools (i.e. [Nature Navigator](#) and [Urban Nature Explorer](#)).

Dr. ZHU Chunqun, China Head, Tropical Forest Alliance, World Economic Forum Beijing, commented that the criteria should be based on the contribution of natural assets and ecosystem services to the economy and society. He emphasized three bottom lines: 1) preserving and adding value to natural and ecological assets; 2) enabling continuous ecological services to the wellbeing of human being; and 3) causing no harm to ecological assets nor to the self-restoration and resilience of ecosystems. He pointed out that any analysis on NbS should be made 1) within a

limited time unit and spatial scale, taking into consideration the mutual diminishment and/or add-on effect among different ecological services; 2) based on the openness and fairness in the allocation of resources among different stakeholders; 3) at a moderate spatial and time scale in comparison to the short-/mid-/long-term impacts of engineer-based solutions.

Mr. SHI Lei, Researcher, International Centre for Bamboo and Rattan, addressed the importance of respecting the non-linear, complex ecological system; not following the internal rules of the natural system could lead to systemic collapse (Biosphere 2). Regarding criteria, he suggested considering the multi-outputs of NbS, respecting the differentiated rules under different scales, limiting the project assessment to a certain spatial and temporal, and promoting the integration of local species, community, culture, and policy, as well as existing projects. He stressed that NbS is multi-sectoral, multi-space, multi-stakeholder by nature, which requires comprehensive consideration in project design and implementation.

Session 3: Measurement, Cost-Benefit Analysis and Business Case

Mr. Robert Smith, Principal, Midsummer Analytics, Former Director of Environment Accounts and Statistics, argued the prevailing analytical frameworks such as cost-benefit analysis (CBA), cost-effectiveness analysis (CEA) and economic impact analysis (EIA) do not serve for NbS, for the following reasons: excessive market-orientation, tailored to the traditional solutions, and difficulties to adapt to NbS. He recommended exploring emerging alternatives such as the “inclusive wealth” model proposed in the Dasgupta Report, which measures the contribution to national wealth rather than contribution to GDP, income, and employment as a proper basis for evaluating investment options, as the framework for evaluating the economic viability of NBS.

Mr. REN Wenwei, Director for China Surface Water Program, World Wildlife Fund, pointed out WWF's many experiences on Yangtze River conservation can be now categorised as NbS. He shared two case studies carried out by WWF: 1) Since 2002, the initiative of re-establishing seasonal linkage of 60+ rivers and lakes increased the resilience of natural watershed and resulted in multiple outputs (i.e. restoration of threatened species, increasing access to clean drinking water, increased capacity on flood control); and 2) A bankable and scalable NbS case in Rhine estuary in Netherland where the ecological service resulted from wetland restoration is purchased by the government and paid off through public-private partnership (PPP) on affordable housing development. Dr. Ren added that two potential bankable NbS cases were already identified in the Yangtze River economic zone.

Session 4: Policy Pathways

Mr. Dimitri de Boer, Chief Representative of the China Office, ClientEarth, pointed out the inadequacy of regulations on NbS worldwide because of the difficulties for lawmakers to grapple with the complex concepts of NbS and to materialize the cross-cutting multi-benefits. He shared two exceptional cases: an executive order in California (Expanding nature-based solutions), and the MEE's Guiding opinions (2021). He recommended integrating NbS in China's legal system, policy frameworks and spatial planning, prioritising Yangtze River protection, climate adaptation, and disaster protection and prevention. He also suggested focusing on regulating supply chains as a first legislative pathway, in addition to prioritizing mitigating risks in the BRI and addressing harmful subsidies.

Professor LI Yu'E, Chinese Academy of Agricultural Sciences, provided a brief introduction on China's policy initiatives on promoting sustainable and green agriculture, grassland eco-compensation and the fishing ban in key areas of the Yangtze River Basin. She acknowledged the increasing notion in China on using carbon sequestration as a solution to climate mitigation. Prof. LI also shared the recent progress of the of the upcoming UN Food Summit: 1) 3 approaches are identified to "Boost nature-positive production" (namely, protection of the ecological system, sustainable management, and recovery and restoration); and 2), a list of 22 NbS are identified through questionnaires and submission, and it will be further narrowed down to a shorter list prior to the Summit.

Mr. QIU Jie, Research Center for Ecological Protection and Restoration, Nanjing Institute of Environmental Sciences, MEE, shared about China's policy initiative "Ecological Redline" which was first introduced in 2017 and matured in 2019. He highlighted the Ecological Redlines not only cover all areas of great ecological importance and fragility but also areas that cannot be identified now but are potential of ecological value. He addressed three bottom lines for the Ecological Redlines: 1) no arbitrary change of use; 2) no decrease but increase; and 3) prohibition in the principle of human activities in core protected zones, and strict prohibition of exploiting and productive construction activities in other areas within the Redlines.

Mr. Bob Tansey, Senior Advisor, The Nature Conservancy, shared how NbS can be used in solving the challenges in agriculture reform and nonpoint source pollution reduction: regenerative agriculture, urban environmental markets, and water fund for eco-compensation. He added that altogether, the three NbS approaches could achieve a great reduction in nonpoint source pollution while producing added benefits in line with the goals of the Yangtze River Protection Law.

Session 5: Recommendations on Next Steps

Professor WANG Yi, Team Lead, CCICED SPS Climate; Member of the Standing Committee of the 13th National People's Congress; Vice President, Science and Technology Strategy Consulting Institute, the Chinese Academy of Sciences, pointed out the crucial importance of finding an accurate and effective position of the NbS in China that is problem- and goal-oriented. He also outlined a few priorities for future work: 1) carrying out quantitative analysis on the cost and benefits; 2) enhancing the coordination across ministries; 3) strengthening international cooperation; 4) identifying comparable case studies of traditional projects; and 5) increasing the influence and acceptance of NbS in CBD COP15.

Concluding Comments

Professor LIU Shijin, CCICED Chinese Chief Advisor, noted that many past initiatives in China could be categorised as NbS. He addressed the people-centered principle in furthering NbS practices in China. Echoing the participants' speech, Professor Liu proposed three future work priorities: 1) exploring the application of "inclusive wealth" accounting in the Chinese context; 2) strengthening the recognition on the conviction of NbS to guide conscious implementation; 3) integrating good practices on NbS in China's upcoming provincial and sectoral specific 14th Five-Year Plans.

Mr. Scott Vaughan, CCICED International Chief Advisor, thanked all participants for sharing their insights and welcomed their continuous inputs to the sub-working group's draft report. He proposed two actions for the next step: 1) setting up a portal of case studies on both international and Chinese examples (i.e., sponge cities); 2) identifying 2-3 specific themes (i.e., sustainable agriculture, bridging COP15/COP26) for future collaboration.

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Managing River Areas in Times of Climate Change

Scoping Study for a CCICED Special Policy Study

3.1 Summary

3.1.1 Purpose

This scoping study reports on the scope and viability of a future special policy study concerning the management of river areas in times of climate change, both worldwide and with a focus on China.

3.1.2 Main Findings

The study group investigated fourteen stress categories, meaning pressures driven by human activities in river areas or the outside world. Around the world and in China, river systems face multiple stresses, and combinations of these stresses introduce different dynamics. Climate change affects many of them and combines with many other stress factors. The latter include, for example, altered water and sediment flows; abstraction of surface water, and in particular ground water; pollution, including legacy pollution; and land use that influences sediment and water flows.

Promising governance approaches to various aspects of river management are emerging, although a truly integrated river basin management system remains elusive. Although some notable successes are being achieved, for example on improving water quality and managing flood risks, they often result from sector-wise approaches and will therefore not lead to a high-quality river system. This will require more ambitious approaches, across sectors and involving a larger array of actors.

Overall, the reality of climate change is seriously changing the whole arena for policy, governance, and research on river basin management. Most people, including politicians and business leaders, are now aware of the disrupting effects of climate change. Yet, at this point in time, the direct and cascading effects of climate change, and those of other stressors that may be more influential on some river systems over a shorter timescale, are barely considered in most countries' policy strategies. This hampers not only adequate adaptation to climate change, but also progress towards ecological civilization and Sustainable Development Goals.

However, by the same token, river basins present a key opportunity for innovation and new governance. While implementing an ecological civilization is complex, river systems lend themselves well to this and to the implementation of green, low-carbon goals. A river basin is well defined: it is clear what belongs to the river basin and what does not. It is a concrete system that presents opportunities for

sustainable management while providing several ecosystem services to society. It is complicated, but not too complicated. Challenges and possible solutions are known and can be addressed in a practical way. In addition, it is often clear what went wrong in the past, and thus building a better future should be possible. Technical innovations, new approaches, and innovative governance will be required in order to bend the trend.

Current challenges and gaps, which are useful topics for the envisaged SPS, include vision building and broad engagement, unified law, spatial planning and procedures to handle conflicts of interest, finance and long-term adaptive budgeting that integrates uncertainties and engages the private sector, quantitative assessment of stressors or risks, and consistent monitoring across jurisdictions and across agencies. While a truly integrated approach is work in progress, there are good cases of interest for an SPS.

Addressing the multiple stressors on river systems demands a systems approach. River systems have to be managed as a natural unit, including the landscape that they are part of and across any boundaries in jurisdictions.

3.1.3 Guiding Principles

The results of our analysis of stress factors across global river systems and of interesting cases in the management of river areas can be summarized in five high-level principles. These principles will play out differently in each individual river area. The present scoping study proposes these principles as a framework to select cases for in-depth analysis by an eventual SPS.

In addition, conceivably, these principles could serve as a frame to structure Chinese or CCICED input for the 2023 UN Water Decade Conference. The conference presents a unique opportunity for China to lead on global solutions to river-related challenges, if so desired.

1. Make good on your responsibility stretching from the headwaters to the coastal seas. Never shift problems—not from upstream to downstream, and not in time. Be aware that the river area is a natural unit in which the interests of both people and nature must be considered.

2. Adopt a 100-year perspective and plan your steps. Uncertainties are important. Make them central to your strategy, planning, and adaptations.

3. Engage everybody who can contribute and develop a shared vision. Engage interest groups and the private sector in the policy development process and in the implementation.

4. Adapt to climate change and other principal river stressors in every aspect of the management of river areas, including planning, management, and governance. Apply nature-based solutions where possible. Make spatial planning comprehensive, not sectoral.

5. Continue to strengthen and innovate management methods, knowledge programs, policy instruments, and forward-looking financing mechanisms. Keep exchanging experiences within China and worldwide.

3.2 Recommendations to CCICED

1. Given the governance and knowledge challenges and the innovative opportunities that river areas offer to bridge short and long-term policies towards climate resilience and an ecological civilization, the study group recommends that the CCICED consider a **next-stage SPS on river areas**. Details are in Chapter 5. In summary, it is proposed to focus on the following six elements:

Element 1. Select **interesting and important cases, within and outside China**, that demonstrate climate-resilient development; promising approaches for truly coherent, integrated policy development; and stakeholder engagement in joint fact-finding and policy development processes.

Element 2. In an international setting, scrutinize and draw lessons from cases featuring innovative **methods and metrics in order to monitor, assess, and evaluate developments over time of river areas in China and globally**. This includes indicators for monitoring and evaluation that enable the periodic assessment of how pressures affect river areas, including climate change, and how the use of the river and its water as well as the functions and values of river areas change in the context of sustainable development.

Element 3. In an international setting, scrutinize and draw lessons from **conventional and especially new methods to assess the success of plans and investments to guide decisions to a more climate-resilient and sustainable path**, based on shared values represented by the SDGs and the concept of an ecological civilization.

Element 4. Explore **promising strategies and policy regulations on the interface between rivers and oceans**, in an international setting, focussing on aligning the requirements for high-quality river areas, coastal seas, and the oceans, and supporting a long-term safe development of deltas in the face of sea-level rise, land subsidence, further urbanization and economic development, and changing freshwater and sediment flows.

Element 5. **Assess the status, strengths, and weaknesses of the available model systems** within China to support the **understanding of each individual river basin system** and enable problem analyses and future explorations as the basis for wise, fair, and fact-based policies that incorporate the unavoidable challenges of climate change. To provide important background, this need to upgrade our understanding is summarized in Box 1.

Element 6: Take advantage of experiences within China, specifically for transitions in the **Yangtze River Economic Belt** and the **Yellow River**, the economic axes of China, in which integrated approaches and options have been explored in the face of climate change, decarbonization and the operationalization of the ecological civilization concept. If and when development of the **Yarlung**

Tsangpo high-altitude dam goes ahead at the time of the SPS, this would be an interesting option for studying the experiences of a third, even younger project.

2. The CCICED should use an upcoming Rivers SPS as a unique opportunity to provide input to the **2023 UN Water Decade Conference** along the lines of the five principles listed above, based on the early findings of the proposed SPS. This means that the SPS should start soon, preferably in 2021.

3. Setting up and conducting an SPS focused on managing river areas in times of climate change will require a broad and systematic approach that does not focus only on hydraulics, hydrology, sediments, and water quality, but that also includes land use planning, ecology, socio-economic aspects, and more. Nevertheless, the study group recommends adhering to **adaptation to climate change** as the point of entry. The study group also underlines the value of interaction with other relevant SPSs, especially through joint field research. Of particular relevance would be interaction with any studies during 2022–2027 on oceans, urban development, and nature-based solutions, as well as on agricultural renewal and on decarbonization.

ANNEX 4:

Progress on Environmental and Development Policies in China and Impact of CCICED's Policy Recommendations (2020-2021)

4.1 Forward

2021 sees the international community stumbling through “a resurgence of the COVID-19 pandemic”. Countries in the world are actively engaged in the prevention and control of the pandemic, and are working to achieve economic and social recovery and development through cooperation in the international industrial chain. China has claimed a small victory in containing the spread of the virus, with its efforts to resume work and production paying off, and economic development and social activities gradually getting back on track and gaining momentum.

In 2021, China has ushered in a new stage of high-quality development and embarked on a new journey to fully build a modern country. Chinese President Xi Jinping proposed at the general debate of the 75th session of the UN General Assembly on September 22, 2020 to have CO₂ emissions peak before 2030 and achieve carbon neutrality before 2060, setting off several rounds of active international response to climate change, with scores of countries announcing more ambitious emission reduction commitments. The “30-60 target” has been incorporated into the 14th FYP and the Long-Range Objectives Through the Year 2035, and included in the new round of ecological and environmental protection as an important part of the development of an ecological civilization.

Over the past year, China has met the three-year goal of “the battle against pollution” in an excellent manner and promoting the 13th FYP a complete success by maintaining strategic focus on the development of an ecological civilization, continuing to drive business and social transformation through environmental protection and pushing the national economy toward a new stage of high-quality development. For example, Beijing has made significant progress in pollutant control, with the average PM_{2.5} concentration falling to 38 µg/m³ in 2020 for the first time.

Over the past year, the institutional framework for promoting ecological progress oriented towards “continuous improvements in the environmental quality and the ecological environment” continues to be upgraded. The central environmental protection inspection system has become a powerful weapon to promote local environmental protection actions given its strong deterrence against

environmental violations, laying a solid foundation for the goal of basically building a beautiful China in 2035.

Over the past year, the Xi Jinping Thought on Ecological Civilization has been carried forward, with a series of new assertions put forward, including that “endeavors to protect green hills will definitely pay off”, and ecological and environmental protection enhanced in all respects. The rule-of-law system for ecological and environmental protection has been improved. China has carried out inspections of the enforcement of the Law on the Prevention and Control of Soil Pollution, the Law on the Protection of Wildlife and relevant law enforcement inspection, enacted the Yangtze River Protection Law and the Biosecurity Law, completed the revision to the *Law on the Prevention and Control of Environmental Pollution Caused by Solid Wastes*, and pushed forward the legislation for the protection of the Yellow River, among others. By strengthening inspection and enforcement of ecological and environmental protection, launching a campaign to prevent and control pollution by focusing on the strategic goal of “winning the battle against pollution”, advancing the optimization and adjustment of the industrial, energy, transportation and land use structures, and intensifying regional joint prevention and control, China continues to see positive results yielded in the blue-sky battle again. Also, China has been actively responding to climate change by launching the formulation of an action plan for peaking CO₂ emissions before 2030, introducing the *Measures for the Administration of Carbon Emissions Trading (for Trial Implementation)* and getting the national carbon emission trading market in gear.

Through its efforts, China has successfully fulfilled the nine binding targets for ecological and environmental protection as set forth in the 13th FYP and the phased targets and tasks of the battle against pollution, giving its natural ecology and social environment a new look and enabling its people to have an obvious sense of contentment and happiness.

As a direct channel to the Chinese government policies and a link, bridge and window for China's environmental cooperation with the international community, the CCICED upholds Bringing In strategy, has conducted research on topics with a significant impact on the environment and development at home and abroad, developed policy recommendations for promoting the ecological civilization in China by giving full play to the role of overseas and domestic top experts and scholars as top-level advisors; in the meantime, upholding the Going Global strategy, the CCICED works in an innovative way during the pandemic, continues to engage in think-tank exchanges and advisory activities, contributing wisdom and strengthen to the sustainable development across the world.

4.2 Environmental and Development Planning

During the 13th FYP period, authorities of ecology and environment collaborated with departments concerned and local governments in launching a campaign to prevent and control pollution by focusing on the strategic goal of “winning the battle against pollution” and successfully beaten the nine ecological and environmental binding targets. While consolidating the current outcomes that have achieved, the 14th FYP will continue to address the pollution problem by constantly promoting economic restructuring and green development and improving the quality of the ecological environment, thereby laying a sound environmental foundation for China’s new journey toward the full construction of a modern socialist country.

In 2019, the CCICED recommended that the 14th FYP should embody and back up the vision of a beautiful China by 2035, efforts to tackle climate change and the global vision 2050 for biodiversity conservation. The 2020 CCICED Policy Recommendations systematically stated that the 14th FYP should further push forward a comprehensive framework for green development, including ideas, policy goals, priorities, systems and mechanisms of development, and set an example of sustainable development worldwide. Efforts should be made to unwaveringly advance the development of an ecological civilization, put into practice the conviction that “lucid waters and lush mountains are invaluable assets” and facilitate green economic and social transformation in all aspects, in a bid to pursue people-oriented green high-quality development. In key areas, the formation of green production and lifestyles should be promoted driven by green technology innovation, aided by sustainable production and consumption and based on green development of cities. In terms of implementation mechanisms, comprehensive measures should be adopted to align short-term targets with mid- and long-term goals and ensure coordinated systems and mechanisms. All these recommendations epitomize the CCICED’s systematic thinking and holistic approach, and are of strategic importance to the national 14th Five-Year Plan for ecological and environmental protection, especially the alignment and integration of the green development targets in the 14th FYP with the UN 2030 Agenda for Sustainable Development and addressing climate change.

4.2.1 The Outline of the 14th FYP and the Long-Range Objectives Through the Year 2035

The core of the Outline of the 14th FYP and the Long-Range Objectives Through the Year 2035 is to “realize harmony between man and nature”, and general guiding principles have been put forward: adhering to the concept that “lucid waters and lush mountains are invaluable assets” and that of respecting, conforming

to and protecting the nature, prioritizing conservation, protection and natural restoration, implementing the sustainable development strategy, improving coordination mechanisms that promote ecological progress, establishing an ecological civilization system, fueling green economic and social transformation across the board and building a beautiful China.

The Outline of the 14th FYP and the Long-Range Objectives Through the Year 2035 lay down the directions and targets mainly in three aspects, namely “ecosystem quality and stability”, “continuous improvement of eco-environmental quality” and “acceleration of green transition of the development model”, mapping out a clear blueprint and priorities for the next five years and through 2035:

(1) In terms of “ecosystem quality and stability”, the Outline proposes to adopt a holistic approach to conserving maintains, rivers, forests, farmlands, lakes, and grasslands, with emphasis on enhancing the self-restoration capability and stability of ecosystems, hold the natural ecological security bottom line and ultimately promote the overall quality improvement of natural ecosystems, thus providing strong and continued support for the full construction of a modern socialist country. Specific measures include improving the ecological security barrier system, establishing a nature reserve system and perfecting the ecological protection compensation mechanism.

(2) In terms of “continuous improvement of eco-environmental quality”, the Outline proposes to “step up the fight against pollution, establish a sound environmental governance system, advance accurate, scientific, law-based and systematic pollution control, promote pollution and carbon reduction in a coordinated manner, continue to improve the quality of air and water environment, and effectively control the risk of soil pollution”. Through “continuous improvement of eco-environmental quality”, people will enjoy a more fresh and beautiful production and living environment, cleaner air, clearer water and healthier soil, and have a stronger sense of contentment. Specific measures include intensifying the prevention and control of pollution, comprehensively improving environmental infrastructure, strictly preventing and controlling environmental risks, actively responding to climate change and upgrading the modern eco-environmental governance system.

(3) In terms of “acceleration of green transition of the development model”, the Outline proposes to “uphold ecology first and green development, promote overall management, scientific allocation, comprehensive conservation and recycling of resources, and coordinate efforts to promote high-quality economic development and high-level environmental protection”. The key to achieving “harmony between man and nature” lies in ecologicalization of industries, which means promoting green transformation of modes of production and high-quality development, and minimizing resource consumption and environmental load. Specific measures

include improving the resource efficiency across the board, establishing a resource recycling system, vigorously developing green economy and building a policy system for green development.

In the Outline of the 14th FYP and the Long-Range Objectives Through the Year 2035, deepening VOCs emissions control and replacement of high-VOCs products and promoting co-control of pollutants and greenhouse gas (GHG) emissions are particularly emphasized. Local versions of the Outline of the 14th FYP will also be rolled out over time. For example, proposals of provinces and municipalities such as Hubei, Jiangxi, Hunan, Guizhou, Sichuan, Hainan, Liaoning, Jilin and Shanghai for their respective 14th five-year plans state establishing sound eco-environmental governance systems that coordinate the conservation of ground and underground, land and water ecosystems; fully implementing pollution discharge permit systems and advancing market-oriented trading of pollution discharge permits, energy use rights, water use rights and carbon emission permits; supporting eligible areas in launching pilot projects and accelerating the establishment of value realization mechanisms for ecological products; pushing forward the construction of regulations, policies and standards for green development, and encouraging innovation in financial policies such as green funds, green credit, green bonds and green insurance.

Following the release of the Outline and the Long-Range Objectives Through the Year 2035, the 14th Five-Year Plan for ecological and environmental protection is being pushed ahead.

4.2.2. Eco-environmental protection planning and high-quality development of the Yellow River basin

The 2020 CCICED Policy Recommendations proposed to perfect the value accounting methods and realization mechanisms for ecological capital services, and promote high-quality development of the Yellow River basin; seek development within the bearing capacity of the environment and resources, intensify the application of natural capital value accounting in spatial planning and safeguard the integrity and healthy, sustainable development of ecosystems in the basin; innovate the ecological compensation mechanism and expedite the transverse ecological compensation process in the basin from the perspective of water resources, water environment and water ecology.

In August 2020, the Political Bureau of the CPC Central Committee deliberated the *Outline of the Plan for Ecological Protection and High-quality Development of the Yellow River Basin* and required improving the ecological environment in the Yellow River basin by adjusting measures to local conditions and conforming to the laws of nature. Intensive and economical use of water resources in the Yellow River should be energetically promoted, and water resources

should be considered the biggest rigid constraints to save water and expand the space for development. A long-term perspective should be taken, the disaster prevention and reduction system be perfected, and the capability of dealing with various disasters be enhanced. Effective measures should be taken to promote high-quality development of the Yellow River basin, quicken the replacement of old growth drivers with new ones, build a modern industry system with distinctive advantages, optimize the urban development pattern and push forward rural revitalization. The Yellow River culture should be protected and carried forward to continue the historical context there. Coordination should be strengthened to have competent authorities in provinces and autonomous regions along the Yellow River fulfill their responsibilities and develop specific planning, implementation plans and policy systems as early as possible, with a view to making significant progress during the 14th FYP period.

The Supreme People's Court promulgated the *Opinions on Providing Judicial Services and Guarantees for Ecological Protection and High-quality Development of the Yellow River Basin* (the *Opinions*) on June 5, 2020. The *Opinions* contains specific requirements for people's courts to hear various cases in a law-based, fair and efficient manner and fully play to the judicial role in seven aspects, such as enforcing strict liability, promoting water and sediment regulation, advocating green water use and supporting an innovation-driven approach, and adheres to the strictest rule of law, a new concept of development and differentiated measures, so as to facilitate the overall improvement of the eco-environmental quality in the Yellow River basin. At present, courts in the nine provinces and autonomous regions in the Yellow River basin have set up 117 tribunals regarding the environment and resources, and 246 collegiate panels or judgment panels. Last year, Gansu Province, located in the upper Yellow River, set up a specialized court for the environment and resources to coordinate the judicial work on important environmental and resource cases across the province.

During his visit to Shandong in July 2021, Mr. Han Zheng, Vice Premier of the State Council, pointed out that we should implement the new concept of development completely, accurately and comprehensively, strengthen ecological protection and governance of the Yellow River basin, intensify scientific and technological innovation, and facilitate new progress in high-quality development. We should respect the nature and science, step up wetland and bird protection in the Yellow River Delta, reduce the impact of human activities on birds, and improve the quality of bird habitats. We should deeply study and demonstrate the evolution trend of the relationship between water and sediment in the Yellow River and reasonably regulate the water-sediment relationship to ensure safety along the Yellow River.

In May 2021, the Ministry of Water Resources (MWR) unveiled the Draft of the Yellow River Protection Law (Exposure Draft) to solicit opinions from the

public. The Standing Committee of the National People's Congress has included the legislation on the protection of the Yellow River in its legislative work plan for 2021.

4.3 Ecosystem and Biodiversity Conservation

4.3.1 The 15th Conference of the Parties to the Convention on Biological Diversity (CBD COP15) and biodiversity conservation

The 2020 CCICED Policy Recommendations proposed to motivate ambitious multilateral cooperation and strengthen national actions by taking the opportunity of successfully holding the CBD COP15, in a bid to protect the nature and people's wellbeing.

The Chinese government, as the host of the CBD COP15, will discuss global biodiversity conservation issues, develop a "post-2020 global biodiversity framework", set global biodiversity targets for the next decade and strengthen the enforcement mechanisms together with other countries.

The Chinese government has done a great deal of work around biodiversity. As of May 2021, China was home to 11,800 various nature reserves at all levels, accounting for 18% of the land area and 4.1% of the sea area. Due to enhanced protection, populations of many endangered wild animals and plants have steadily increased, with continuous improvements in their living conditions. To be specific, wild pandas were downgraded from endangered to vulnerable as a result of an increase in the population from 1,114 in the 1970s and 1980s to 1,864. Meanwhile, China has accelerated the establishment of a nature reserve system led by natural parks and the National Forestry and Grassland Administration (NFGA) has successively launched ten pilot national parks, including those for giant pandas, northeast China tigers and leopards, and Sanjiangyuan (the sources of three rivers, namely the Yangtze, Yellow and Lancang Rivers). In August 2021, wild Asian elephants in Yunnan province returned safely southward after migrating north for more than 110 days, reflecting the progress of China's biodiversity conservation efforts.

Local biodiversity conservation has produced fruitful results. Tibet has adopted the strictest ever ecological protection policy to enclose around 50% of its territory within ecological red lines, giving rise to an obvious recovery in the quantity of rare wild animals endemic to the plateau. For example, the number of wild yaks in Tibet has reached over 40,000, an increase of about 25,000 from 2003; the number of *Pantholops hodgsonii* has grown to over 200,000 from 80,000, that of *Equus kiang* has climbed from 50,000 to approximately 90,000, five rare wild animals have been newly discovered, and the number of *Cervus elaphus wallichii*, which was thought to be extinct, has exceeded 10,000. Jiangsu Province has maintained strict ecological

space control and built 31 nature reserves, which cover 5.5% of the provincial total area, with a natural wetland conservation rate of 46.2%, and protect nearly 60% of the species within the province, resulting in increasing populations of rare and endangered species such as *Elaphurus davidianus* and *Grus japonensis*. Henan Province has further improved its monitoring-based prevention and control system. As at the end of 2020, 95% of key wild animals were brought under protection, indicating significantly enhanced protection efforts.

4.3.2 Continuous advancement of the “Green Shield” special action

2021 marks the fourth year of the “Green Shield” special action on nature reserve supervision. Based on the “Green Shield 2020” special action, the “Green Shield 2021” mission furthers nature reserve supervision and inspection in the light of the progress in the rectification of key problems identified.

In 2020, the Ministry of Ecology and Environment (MEE), in conjunction with departments and units concerned, carried out the “Green Shield 2020” enhanced supervision of nature reserves. As at the end of 2020, of the 5,503 key problems with national nature reserves, 5,038 had been rectified, indicating that 92% were rectified; of the 1,388 key problems with national nature reserves in the 11 provinces (municipalities) along the Yangtze River Economic Belt (YREB), 1,217 had been rectified, implying a rectification rate of 87%.

At the local level, Shandong Province continues to deepen the “Green Shield 2020” mission, and has completed the rectification of four types of 1,099 key problems with seven national parks and 4,107 violations of laws and regulations in nature reserves at or above the provincial level. Ningxia Hui Autonomous Region has inspected 2,646 sites of human activities in nature reserves, with 2,632 ones retained and rectified, indicating a rectification rate of 99.47%. Of the 2,983 clues of human activities, Henan Province has rectified 91.9% of the key problems in nature reserves, such as stone or sand quarrying, land for mining and industry, tourism and hydropower facilities in core areas and buffer zones, through shutdown within a definite time, demolition, vegetation recovery and other measures.

4.3.3 New progress in ecological red line delineation and ecological protection

The 2020 CCICED Policy Recommendations proposed to set the target of building ecological corridors based on ecological red lines and ecological protected areas, build an efficient and stable ecological security network and protect the integrity of ecosystems.

In November 2020, the MEE approved and released seven standards, including the *Technical Specification for Supervision of Ecological Conservation Redline – Baseline Investigation (on Trial)*, as national environmental protection standards. In December 2020, the MEE issued the *Opinions on Strengthening the Supervision of*

Ecological Protection (the Opinions). According to the *Opinions*, a system of laws and standards for supervising ecological protection and a national ecological monitoring network will be preliminarily established by 2025 to improve government regulation of nature reserves and ecological red lines and raise the level of biodiversity conservation, so that the quality and stability of ecosystems will be further enhanced. By 2035, a modern regulatory system for ecological protection and regulatory capacity that match the goal of a beautiful China will be built to promote harmony between man and nature.

In May 2021, the MEE published the *Opinions on Strengthening the Supervision of Ecological Protection* and the *Interim Measures for Ecological and Environmental Supervision in Nature Reserves*, developed indicators and criteria concerning the supervision of ecological red lines, and advanced the construction of an ecological red line supervision platform. The MEE also guided 12 provinces (municipalities), including those along the YREB and Qinghai, to release and implement “three lines and one list” (namely red line for environmental protection, bottom line for environmental quality, and upper-limit line for resource utilization, as well environmental access list), completed the technical review of the “three lines and one list” submitted by each province (autonomous region or municipality) and Xinjiang Production and Construction Corps, and quickened the establishment of an ecological and environmental zoning management system.

The implementation of “three lines and one list” has been pushed forward in different localities. As of December 2020, people’s governments of the 12 provinces (municipalities) in the first echelon had all published their respective “three lines and one list” and entered the stage of implementation and application; and the “three lines and one list” of the 19 provinces (autonomous regions and municipalities) and Xinjiang Production and Construction Corps in the second echelon had passed the technical review.

4.3.4 Exploration on ecological compensation mechanisms and value realization mechanisms for ecological products

The 2019 CCICED Policy Recommendations proposed to promote green development in the Yangtze River Economic Belt, accelerate the establishment of a basin-wide ecological compensation mechanism involving a vertical compensation option and multiple horizontal compensation options, which features the dominance of local finance, incentives from the central finance and active social engagement. The CCICED policy recommendations also have implications for the establishment of the basin-wide ecological compensation mechanism in the Yellow River basin.

In May 2020, the Ministry of Finance (MOF), the MEE, the MWR and the NFGA jointly issued the *Implementation Plan for Supporting and Guiding the Establishment of a Pilot Horizontal Ecological Compensation Mechanism*

throughout the Yellow River Basin (the *Implementation Plan*), which requires Shanxi, Inner Mongolia, Shandong, Henan, Sichuan, Shaanxi, Gansu and other provinces to further improve the eco-environmental governance system and capacity in the Yellow River basin by gradually setting up a basin-wide ecological compensation mechanism and establishing a sound value realization mechanism for ecological products. Local authorities have developed specific measures in accordance with the document. For example, Shandong Province published the *Guiding Opinions on Establishing a Horizontal Ecological Compensation Mechanism in the Yellow River Basin*, which sets the basis, including criteria, forms and amount of compensation, for the implementation of the *Implementation Plan* by different cities and prefectures in the province.

In April 2021, the General Office of the CPC Central Committee and the General Office of the State Council issued the *Opinions on Establishing a Sound Value Realization Mechanism for Ecological Products* (the *Opinions*). The *Opinions* points out that establishing a sound value realization mechanism for ecological products is the key path to practicing the concept that lucid waters and lush mountains are invaluable assets. It also states that by 2025, an institutional framework for value realization of ecological products should be preliminarily established, a science-based value system for ecological products be initially set up, policies and systems for compensation for ecological conservation and for damage to ecology and environment be gradually improved, a government assessment mechanism for value realization of ecological products take shape, problems such as “difficulty in measuring, mortgaging, trading or liquidating ecological products” be effectively settled, a benefit-oriented mechanism for ecological and environmental protection be basically formed, and the capability of turning ecological advantages into economic ones be remarkably enhanced. By 2035, a sound value realization mechanism for ecological products should be established, a new model of ecological civilization construction with Chinese characteristics be completed, and green production and lifestyles be formed extensively, thus providing strong support for basically realizing the goal of building a beautiful China.

Relevant work has been carried out at the local level in line with the *Opinions*. In June 2021, for example, the Party Committee and Government of Jiangxi Province held the conference on commending advanced collectives and individuals in ecological civilization construction and establishing a sound value realization mechanism for ecological products, where they proposed to establish the concept of ecology first and green development, deeply practice the conviction that “lucid waters and lush mountains are invaluable assets”, ensure effective transformation of ecological value with institutional reform and innovation at its core and emphasis on industrialized utilization, value-based compensation and market-oriented trading, and lead in the construction of a value realization mechanism for ecological products.

4.4 Energy and Climate

The 2020 CCICED Policy Recommendations proposed to actively tackle climate change and build a low-carbon society with energy transformation and upgrading at the core; establish a clean, low-carbon, safe and efficient energy system; and set more ambitious binding targets for GHG emission reduction.

On September 22, 2020, Chinese President Xi Jinping declared that “China will scale up its Intended Nationally Determined Contributions (INDCs) by adopting more vigorous policies and measures. We aim to have CO₂ emissions peak before 2030 and achieve carbon neutrality before 2060”. During the subsequent nine meetings, including the Climate Ambition Summit and the Leaders Summit on Climate, President Xi repeatedly emphasized China’s 30·60 target, endeavoring to promote the building of a fair and reasonable global environmental governance system with win-win cooperation.

On March 15, 2021, President Xi stressed at the 9th Meeting of the Central Finance and Economics Committee that achieving the peaking of CO₂ emissions and carbon neutrality is a broad, profound systematic socioeconomic reform, and we should include achieving the peaking of CO₂ emissions and carbon neutrality in the overall layout of ecological civilization construction, and take solid steps to achieve the target of peaking CO₂ emissions before 2030 and achieving carbon neutrality before 2060 as scheduled.

In his remarks titled “For Man and Nature: Building a Community of Life Together” at the Leaders Summit on Climate on April 22, 2021, Chinese President Xi Jinping especially mentioned that China will strictly control coal-fired power generation projects, and strictly limit the increase in coal consumption over the 14th FYP period and phase it down in the 15th FYP period. China has committed to move from carbon peak to carbon neutrality in a much shorter time span than what might take many developed countries, and that requires extraordinarily hard efforts from China.

On May 26, 2021, the first plenary meeting of the leading group for peaking carbon dioxide emissions and achieving carbon neutrality was held in Beijing. Han Zheng, Member of the Standing Committee of CPC Central Committee Political Bureau and Vice Premier of the State Council, noted that feasible targeted policy initiatives should be put forward to promote the optimization of the industrial structure, advance the adjustment of the energy structure, support the R&D and promotion of green and low-carbon technologies, improve the green and low-carbon policy system, and perfect the system of laws, regulations and standards.

Under the unified deployment of the leading group for peaking carbon dioxide emissions and achieving carbon neutrality, the National Development and Reform Commission (NDRC) and other departments concerned are developing a top-level

design document for peaking of CO₂ emissions and carbon neutrality, compiling the action plan for peaking CO₂ emissions before 2030 and sector-specific implementation plans, deliberating support plans covering financial, pricing, fiscal and tax, government procurement, standards and other policies, and accelerating the establishment of a “1+N” policy system for the peaking of CO₂ emissions and carbon neutrality.

4.4.1 Building new power systems dominated by new energy

The 2020 CCICED Policy Recommendations proposed that China should increase the investment in infrastructure for power generation from renewable energy, including developing large-scale offshore wind power, smart grid and energy storage technologies, and advance the green electricity market reform; formulate hydrogen economic policies at the national level, popularize fuel cells in transportation and combined heat and power generation, and increase the share of sustainable biomass gas production in the energy structure.

On March 15, 2021, Chinese President Xi Jinping presided over the 9th Meeting of the Central Finance and Economics Committee and explicitly pointed out that we should establish a clean, low-carbon, safe and efficient energy system, control the total amount of fossil energy, improve the energy efficiency, implement the replacement of fossil energy with renewable energy, deepen the electricity system reform and build new power systems dominated by new energy. Earlier, the National Energy Administration (NEA) proposed to “build new power systems that suit the development of a high proportion of renewable energy”.

On May 15, 2021, China Southern Power Grid (CSG) issued the *White Paper on the Action Plan for Building a New Power System (2021-2030)* in Guangzhou to speed up the construction of a new power system dominated by new energy and build a safe, reliable, green, efficient and intelligent modern power grid. The new power system is expected to be basically completed by 2030. On May 19, 2021, State Grid Corporation of China (SGCC) held a workshop on building a new power system with new energy at the core to promote the establishment of a new power system dominated by new energy, thus contributing to the target of achieving the peaking of CO₂ emissions and carbon neutrality.

According to the NEA, as at the end of 2020, the installed capacity generated by renewable energy reached 930 million KW nationwide, accounting for 42.4% of the total. To break it down, the installed capacity in hydropower, wind power, PV power and biomass power registered 370 million KW, 280 million KW, 250 million KW and 29.52 million KW respectively. The NEA will enact more proactive new energy development policies, and build a clean, low-carbon, safe and efficient energy system to meet the target of increasing the proportion of non-fossil energy consumption to 25% and installed wind and PV power capacity to 1.2 billion KW by 2030.

4.4.2 Strengthening energy conservation and energy efficiency improvement

In 2020, all localities and departments earnestly made arrangements for controlling both total energy consumption and energy intensity, pushed ahead with energy conservation in key sectors such as industry, construction, transportation and public institutions, strengthened the management of energy conservation in key energy consumption units, reinforced the constraints of energy conservation rules and standards, and intensified energy conservation publicity, giving rise to a continued drop in energy intensity, an obvious fall in energy consumption growth and a drastic increase in energy efficiency.

In December 2020, the NEA proposed at the national energy working conference to strive to raise the level of energy supply, accelerate the development of wind and PV power generation, steadily advance hydropower and nuclear power construction, vigorously enhance new energy absorption and storage capabilities, deeply promote clean and efficient exploitation and utilization of coal, and further optimize grid construction.

In December 2020, the Ministry of Industry and Information Technology (MIIT) proposed at the national industry and information technology working conference to encourage and guide industrial enterprises to improve the quality of electric energy, step up electric equipment transformation and IT application, and comprehensively improve energy efficiency and demand response capability. A number of demonstration enterprises and industrial parks should be set up and promoted in key regions and sectors on the basis of guidance for power demand side management. Industrial low-carbon initiatives and green manufacturing projects should be implemented, and industrial power demand side management be intensified to guide the transformation of energy consumption patterns and better facilitate energy conservation and emission reduction among industrial enterprises.

On May 30, 2021, the MEE released the *Guidelines on Strengthening the Prevention and Control of Environmental Pollution at the Source for Energy-Intensive and High-Emission Projects* (the *Guidelines*). According to the *Guidelines*, departments of ecology and environment at all levels should expedite the application of the results of “three lines and one list” in the industrial layout and restructuring of energy-intensive and high-emission industries and site selection of key projects. Localities to which iron & steel, electrolytic aluminum and other industries are transferred should strictly enforce the ecological and environmental zoning management requirements and regard the bottom line for environmental quality as a hard constraint. The environmental impacts of energy-intensive and high emission projects should be assessed strictly before approval. Construction projects should be strictly inspected for environmental access. The construction, reconstruction and expansion of energy-intensive and high emission projects must comply with laws

and regulations on ecological and environmental protection and relevant statutory planning, and meet the requirements for controlling the total emissions of key pollutants, the target of peaking CO₂ emissions, environmental access lists, relevant planning environmental impact assessment (EIA) and environmental access conditions for construction projects in specific industries, and the principles and requirements of examination and approval of EIA documents. Coordinated control of pollution and carbon should be promoted in energy-intensive and high-emission industries, and impact assessment of carbon emissions should be included in the EIA system.

In June 2021, the NDRC General Office issued the *Notice on Further Strengthening the Supervision of Energy Conservation* to push for the peaking of CO₂ emissions and carbon neutrality by enforcing energy conservation laws, regulations and standards, and securing the control of total energy consumption and energy intensity.

4.4.3 Actively promoting co-control of GHG emissions and atmospheric pollutants

The 2020 CCICED Policy Recommendations stated that China should actively respond to climate change by setting more ambitious binding targets for GHG emission reduction and covering non-CO₂ GHGs such as methane and hydrofluorocarbons (HFCs), with emphasis placed on energy transformation and upgrading. Climate indicators should be included in the scope of central inspection on ecological and environmental protection.

Authorities of ecology and environment attach great importance to co-control of atmospheric pollutants and GHG emissions. Since the implementation of the *Air Pollution Prevention and Control Action Plan*, emissions of atmospheric pollutants have been significantly reduced through measures such as structural adjustment and end-of-pipe treatment, playing an important role in promoting GHG control. The *Three-Year Action Plan for Keeping Skies Blue* explicitly requires significantly cutting the total emissions of major air pollutants and at the same time reducing GHG emissions.

In late June 2020, the MEE promulgated the *Plan for Controlling Volatile Organic Compounds (VOCs) in 2020*, which mentions that China is facing the dual pressure of a grim situation of PM_{2.5} pollution and increasing ozone pollution, especially in summer, when ozone has become the primary factor of excessive air pollutants in some cities. This is particularly the case with the Beijing-Tianjin-Hebei region and its surrounding areas, the Yangtze River Delta, the Fenhe-Weihe River Plain and the intersections of Jiangsu, Anhui, Shandong and Henan provinces. Mainly originating from the combustion of fossil fuels, local atmospheric pollutants and GHG emissions present the physical basis of homologous emission reduction. Coordinated reduction of non-CO₂ GHG emissions has a great positive impact on

the improvement of local environmental quality and the protection of human health, while contributing significantly to mitigating global warming and its adverse impacts.

In January 2021, the MEE unveiled the *Guidelines on Coordinating and Strengthening the Work on Climate Change and Ecological and Environmental Protection* to accelerate the coordination of functions, work and mechanisms pertaining to addressing climate change and ecological and environmental protection, strengthen pollution control at the source, systematically and holistically, with a view to further advancing climate change response, creating synergies between pollution abatement and carbon reduction, providing support for realizing the peaking of CO₂ emissions and carbon neutrality, and fueling the building of a beautiful China.

4.4.4 Launching the national carbon market

The 2020 CCICED Policy Recommendations proposed to expand the coverage of China's national carbon emission trading market and further promote the internalization of external costs.

After China set the "30-60" target in September 2020, the national carbon emission trading market has been rolled out at a quicker pace. On December 30, 2020, the MEE officially published the *2019-2020 National Total Carbon Emission Allowance Setting and Allocation Implementation Plan (for the Power Generation Industry)* and the *List of Key Emitting Units Included in the 2019-2020 National Carbon Emission Permit Trading Allowance Management*. On February 1, 2021, the *Measures for the Administration of Carbon Emissions Trading (for Trial Implementation)* came into force. The publication of these documents marks the official launch of the national carbon market.

On May 27, 2021, the national carbon emission trading market was officially launched, with the trading center located in Shanghai and the registration system in Wuhan, Hubei Province. On June 22, 2021, Shanghai Environment and Energy Exchange released the *Announcement on the Matters Related to National Carbon Emission Trading*, which specifies the matters pertaining to the national carbon emission trading, including venue, form, period and account of trading, among others.

On July 16, 2021, the national carbon trading market completed the first online transaction. The first transaction involved 2,162 power enterprises, with 4.5 billion tons of CO₂ placed under control. In the future, iron & steel, cement and other key carbon-emitting industries will be included. In addition, the national carbon market will phase in Chinese Certified Emission Reductions (CCERs), carbon sink and other products into its trading system, establish a trading mechanism for carbon financial derivatives, and actively guide social investment.

4.4.5 Driving low-carbon development through green urbanization and sustainable consumption

The 2020 CCICED Policy Recommendations proposed to push ahead with green transformation of cities with the goal of green prosperity, low carbon and intensiveness, recycling, fairness and inclusiveness, safety and health. Meanwhile, the CCICED also recommended that the green consumption revolution be leveraged to improve society-wide awareness of green consumption and significantly increase the supply of green consumer goods and services.

The Outline of the 14th Five-Year Plan (2021-2025) for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 contain special requirements for green urbanization and green consumption. To be specific, Chapter 8 “Improving the New Urbanization Strategy and Enhancing the Urbanization Quality” proposes to “advance coordinated layout of infrastructure, division of labor and cooperation, sharing of public services and joint environmental governance”. Chapter 14 “Comprehensively Promoting Consumption” proposes to “follow the trend of household consumption upgrading, combine expanding consumption with improving the quality of people’s lives, promote greener, safer and healthier development of consumption and steadily increase the household consumption level”.

In February 2021, the State Council published the *Guidelines on Accelerating the Establishment of a Sound Economic System for Green, Low-carbon and Circular Development* (the *Guidelines*). The *Guidelines* proposes to “establish a sound consumption system for green, low-carbon and circular development”, including “step up green government procurement, expand the scope of green procurement and gradually extend the green procurement system to cover state-owned enterprises (SOEs). Increase the guidance for enterprises and residents in purchasing green products and encourage localities to promote green consumption by means of subsidies, rewards, etc. Strengthen the management of certification of green products and services, and upgrade the credit supervision mechanisms of certification bodies”.

On April 29, 2021, the 28th Meeting of the 13th National People's Congress (NPC) Standing Committee adopted an anti-food-waste law, which aims to promote sustainable economic and social development by preventing food waste, safeguarding national food security, advocating a civilized, healthy, resource-saving and environmentally friendly consumption style, and promoting a simple and moderate, green and low-carbon lifestyle.

4.5 Pollution Prevention and Control and Marine Governance

4.5.1 Air pollution prevention and control

The 2020 CCICED Policy Recommendations proposed to strengthen economic evaluation of coal-fired power and develop a roadmap for phasing out and finally eliminating coal-fired power; increase the investment in infrastructure for power generation from renewable energy, including developing large-scale offshore wind power, smart grid and energy storage technologies, and advance the green electricity market reform. The 2019 CCICED Policy Recommendations also suggested further controlling coal use and secure a victory in the blue-sky battle; developing a national long-term strategy for zero emissions and phasing out coal; increasing subsidies and other financial support for renewable energy and gradually eliminating fossil fuel subsidies; striving to completely ban bulk coal in the Beijing-Tianjin-Hebei region and the Fenhe-Weihe Plain region around 2020; and prioritizing absorption of electricity generated from non-fossil energy into power grids.

In September 2020, the MEE released the *Action Plan for Comprehensive Atmospheric Pollution Control in the Beijing-Tianjin-Hebei Region and Its Surrounding Areas, and Fenhe-Weihe Plain in Autumn and Winter during 2020-2021*, which states that during October through December 2020, the average number of days with heavy pollution and above should be controlled within five.

On June 3, 2020, the CPC Central Committee and the State Council the *Guidelines on Coordinating Epidemic Prevention and Control with Ecological and Environmental Protection for Economic and Social Development (the Guidelines)*. The *Guidelines* points out that we should focus on co-control of fine particulate matters and ozone within key periods of time and emphasize VOCs and NO_x control in key industries; comprehensively advance comprehensive control of VOCs in petrochemical, chemical, industrial coating, packaging and printing and other key industries as well as in oil storage, transportation and marketing, industrial parks and enterprise clusters.

On June 29, 2020, the MEE issued the *Technical Guidelines for the Formulation of Emergency Emission Reduction Measures by Key Industries for Heavy Pollution Weather (2020 Revision)* to implement differentiated control of 39 enterprises in key industries by management performance by dividing these enterprises into three grades A, B and C according to the achievement of differentiated indicators such as production process, pollution control technology, pollutant emission limits, management of unorganized emissions, monitoring level, environmental management level, mode of transportation, and transportation monitoring.

In 2021, the MEE continues to advance the air quality improvement campaign. It continues to promote clean heating in winter in North China, ultra-low-emission

transformation of the iron & steel industry and comprehensive pollution control of boilers and furnaces, and advance in-depth management of cement, coking, glass, ceramic and other industries; strengthen the regulation over emissions from new vehicles, speed up the phase-out of old vehicles, and intensify the law enforcement and supervision over motor vehicles and non-road mobile machinery; actively facilitate the construction of special railway lines and increase the proportion of rail freight; enhance regional collaboration on air pollution prevention and control; and ensure good air quality for Beijing 2022 Olympic and Paralympic Winter Games.

4.5.2 Water pollution prevention and control

On June 3, 2020, the MEE released the *Opinions on Ensuring the Security in the Six Areas under the premise of the regular epidemic prevention and control, and Waging a Determined Battle to Prevent and Control Pollution* (the *Opinions*). The *Opinions* proposes to promote the control of black and odorous water bodies in cities, with equal emphasis on improving weak links and preventing resurgence; accelerate the pollution control in agriculture and rural areas; guide and complete the formulation of county-level special plans for rural domestic sewage treatment to advance rural sewage treatment in an orderly manner and launch a pilot program for controlling black and odorous water bodies in rural areas.

On November 3, 2020, the MEE adopted the *National Surface Water Monitoring and Evaluation Program during the 14th Five-Year Plan Period (for Trial Implementation)* and the *Discharge Standard of Water Pollutants for Electronic Industry*, which propose to further improve the methods of monitoring and evaluation, and optimize the allocation of monitoring resources to better support accurate, science-based and law-based pollution control. The two documents also suggest further optimizing surface water monitoring indicators and evaluation methods, and gradually exploring the implementation of monitoring and assessment of new pollutants in eligible river basins and regions; constantly strengthening the quality management of monitoring data, and ensuring that the data is “true, accurate and complete” and can objectively and genuinely reflect the quality of water environment; maintaining the disclosure of information on surface water environmental quality, consciously accepting social supervision and holding local governments accountable for water pollution prevention and control.

Furthermore, the 14th FYP suggests that we should continue to improve environmental quality; work to extend the sewage pipe network to all urban areas and basically eliminate black and odorous water bodies in urban areas; comprehensively implement the pollution discharge permit system and push forward market-oriented trading of pollution discharge permits, energy use rights, water use rights and carbon emission permits.

4.5.3 Soil pollution prevention and control

On June 3, 2020, the MEE released the *Opinions on Ensuring the Security in the Six Areas under the premise of the regular epidemic prevention and control, and Waging a Determined Battle to Prevent and Control Pollution* (the *Opinions*). The *Opinions* proposes to reinforce soil pollution control and remediation by category and actively cooperate with inspection of the enforcement of the law on soil pollution prevention and control; strengthen solid waste pollution prevention and control by category, put into effect the *Implementation Plan for Banning the Entry of Foreign Garbage and Promoting the Reform of the Administrative System for Solid Waste Import*, continue to slash solid waste imports and basically achieve zero solid waste imports by the end of 2020. It also requires deepening the pilot construction of no-waste cities; enhancing the environmental monitoring and risk control of “hazardous wastes, tailings and chemicals”; constantly advancing normative environmental management of hazardous wastes, speeding up the improvement of weak links in facilities collecting and treating medical and hazardous wastes, and launching a special campaign to identify and manage hazardous wastes.

On July 17, 2020, nine ministries, including the NDRC, the MEE, the MIIT, the Ministry of Housing and Urban-Rural Development (MOHURD), the Ministry of Agriculture and Rural Affairs (MARA), the Ministry of Commerce (MOFCOM), the Ministry of Culture and Tourism (MCT), the State Administration for Market Regulation (SAMR) and the All China Federation of Supply and Marketing Cooperatives, jointly issued the *Notice on Solidly Promoting the Work on Plastic Pollution Control*, which requires implementing specific measures in key areas of plastic reduction, standardizing the use of banned or restricted ultra-thin plastic shopping bags, ultra-thin agricultural plastic films, disposable foam plastic tableware and disposable plastic swabs, regulate the use of plastic shopping bags in retail & catering, and intensifying the classification, collection and disposal of plastic waste.

On September 1, 2020, the newly revised *Law on the Prevention and Control of Environmental Pollution Caused by Solid Wastes* was put into effect to promote the settlement of prominent problems according to law, implement the household waste classification system, tighten the management of hazardous waste treatment and create a good living environment. On September 9, 2020, the MEE held the national working conference on environmental management of hazardous wastes and the meeting for promoting the three-year action on hazardous waste control to enforce the newly revised *Law on the Prevention and Control of Environmental Pollution Caused by Solid Wastes*, strengthen environmental supervision over hazardous wastes, and push forward the three-year action on hazardous waste

control and special action on law enforcement. In November 2020, the MEE, the NDRC, the Ministry of Public Security (MPS), the Ministry of Transport (MOT) and the National Health Commission (NHC) revised and published the *Directory of National Hazardous Wastes (Version 2021)*.

In 2020, soil environmental risks were basically controlled nationwide. Initial estimates show that about 90% of the polluted cultivated land was utilized safely, while over 93% of the polluted land parcels were utilized safely, indicating that the worsening soil pollution was preliminarily contained. The soil environment of agricultural land was generally stable across China.

4.5.4 Marine ecological protection

The 2020 CCICED Policy Recommendations proposed to strengthen comprehensive ocean management, enhance the resilience of marine ecosystems and support the sustainable growth of a blue economy. We should tighten the control over sea reclamation, step up its efforts to protect and restore coastal wetland, and rebuild critical habitats; delineate marine ecological red lines and marine protected areas to assist marine biodiversity conservation and fishery development; strengthen scientific research and monitoring, reinforce law enforcement, push ahead with protection and restoration of marine ecosystems and high-quality development of the marine economy, and develop ecosystem-based comprehensive marine management policies by giving better play to the role of inter-ministerial coordination mechanisms and national marine advisory bodies. We should build green fishing boats and green fishing ports, develop green mariculture, establish a traceability system for marine aquatic products, and promote green shipping.

On July 30, 2020, the MEE convened the conference for promoting the formulation of the 14th Five-Year Plan for national marine ecosystem conservation. The conference pointed out that efforts should be made to push forward the construction of “beautiful bays” and solidly promote water quality improvement and ecological protection and restoration of bays in coastal cities; carefully plan a system of targets and indicators, with emphasis on ecological elements, and form a reasonable indicator system that is effectively aligned to the important indicators in the 13th FYP.

On September 17, 2020, the MEE held the video conference for coordinating the comprehensive environmental governance of the Bohai Sea in the first three quarters of 2020. The conference required consolidating and improving the marine environmental quality, keeping a close watch on key indicators such as the proportion of offshore areas with excellent or good water quality and water quality of state-controlled sections of rivers emptying into the sea, and taking harsh measures to promote steady improvements in offshore water quality; accelerating ecological restoration, and combining ecological restoration with the coordination of

protection and construction of “beautiful bays”.

In 2020, the quality of waters under China’s jurisdiction was steadily improved and 96.8% of the waters met the Class I quality standard in summer. The proportion of the offshore areas with excellent or good water quality (Class I and II) was 77.4%, up 0.8% year on year; while the proportion of the offshore areas with water quality inferior to Class IV was 9.4%, down 2.3% year on year. To be specific, the proportion of the offshore areas of the Bohai Sea with excellent or good water quality rose by 4.4% year on year, and that of the offshore areas with water quality inferior to Class IV fell by 3.6%.

4.6 Environmental Governance and Rule of Law

4.6.1 Enactment and enforcement of new laws

In December 2020, the 24th Standing Committee session of the 13th National People’s Congress voted to pass the *Yangtze River Protection Law*, which would come into force on March 1, 2021. As China’s first basin-specific law, the *Yangtze River Protection Law* is of great significance to strengthen ecological restoration and environmental protection, promote reasonable and efficient utilization of resources and ensure ecological security in the Yangtze River basin, as well as maintain the harmony between man and nature and sustain the development of the Chinese nation. With respect to the legislation on the protection of the Yangtze River, the CCICED recommended early in 2004 accelerating the development of the *Regulations on the Administration of the Protection of Water Resources and Water Environment of the Yangtze River*, and proposed in 2018 to formulate the *Yangtze River Protection Law*.

On January 22, 2021, the 25th Standing Committee session of the 13th National People’s Congress adopted the revision to the *Law of the People’s Republic of China on Administrative Penalty*, which would take effect on July 15, 2021. The revised *Administrative Penalty Law* provides for the implementation of comprehensive administrative law enforcement in urban management, market supervision, ecological environment, cultural market, transportation, emergency management, agriculture and other fields, including ecological environmental protection in the scope of comprehensive administrative law enforcement. Accordingly, there is a clear legal basis for comprehensive administrative law enforcement in the field of ecology and environment. After the revision comes into effect, the comprehensive administrative law enforcement team for ecological environmental protection can relatively concentrate the power of administrative penalty.

On May 28, 2020, the 3rd Standing Committee of the 13th National People’s Congress voted to adopt the *Civil Code of the People’s Republic of China*. The *Civil*

Code lays down a punitive compensation system for ecological and environmental damage and clear rules on restoring and compensating for such damage, thus contributing to the establishment of a sound law-based environmental and ecological protection system.

On January 24, 2021, the State Council published the *Regulation on the Administration of Permitting of Pollutant Discharges* (the *Regulation*), which would enter into force on March 1, 2021. The *Regulation* is made to strengthen the administration of pollutant discharge permits, regulate pollutant discharge by enterprises, public institutions and other production operators, and can help control pollutant discharges and protect and improve the ecological environment.

4.6.2 Advancement of reforms to streamline administration and delegate power, improve regulation and upgrade services

On January 7, 2021, the MEE issued the *Guidelines on Optimizing the Ways of Law Enforcement for Ecological and Environmental Protection and Improving the Efficiency of Law Enforcement* (the *Guidelines*), which require local authorities of ecology and environment to tighten law enforcement responsibilities, optimize the ways of law enforcement, improve law enforcement mechanisms and standardize law enforcement, thereby improving the efficiency of ecological and environmental law enforcement across the board. Ideas such as differentiated, intelligent and standardized supervision and increased support for law enforcement embodied in the *Guidelines* will help win support from enterprises and industries concerned and foster a good atmosphere of law enforcement in society at large.

In June 2021, the MEE issued the *Guidelines for Further Strengthening Oversight over the Ecological Environment in the Model of "Random Inspection and Public Release"* to align systems and mechanisms such as the positive list for environmental supervision and law enforcement, credit supervision, management of pollutant emission/discharge permits, response to heavy pollution weather and joint inspection, coordinate the work on supervision and law enforcement between environmental authorities at different levels and between environmental authorities and other authorities, so as to achieve information communication and mutual recognition of inspection results during a random inspection and prevent overlapping in administration.

4.6.3 Regular supervision of ecological and environmental protection

Effective supervision over ecological protection is a key part of ecological civilization construction, an important task in the battle against pollution, and a crucial step towards the reform of the ecological and environmental supervision system.

According to the decision of the CPC Central Committee and the State Council,

a new round of inspections should be launched against the entities to be inspected from 2019 to 2021; and a “look-back” supervision will be launched against some localities and departments in 2022, when the second round of inspections will cover all provinces in China. Under this timeframe, the second batch of inspections in the second round of central environmental protection inspections was launched in August 2020, targeting three provinces (municipalities) including Beijing, Tianjin and Zhejiang, and two central enterprises, namely Aluminum Corporation of China (CHINALCO) and China National Building Material Group Co., Ltd. (CNBM), and a pilot supervision was carried out on the NEA and the NFGA.

On January 29, 2021, the fifth central environmental protection inspection team pointed out the problems that existed and suggestions for rectification in its feedbacks to Beijing, Tianjin, Zhejiang and CNBM. On January 29, 2021, the sixth central environmental protection inspection team gave feedbacks to the NEA. The inspection results indicated that the NEA failed to give due attention to ecological and environmental protection, and its policy system lacked adequate environmental protection requirements. Measures such as the *Air Pollution Prevention and Control Action Plan* and the *Three-Year Action Plan for Keeping Skies Blue* had not been fully implemented. The NEA was required to establish a sound energy policy system for green development, fulfill the responsibility of supervising environmental protection when managing industries; continue to promote clean heating in northern areas, accelerate the adjustment of the energy structure, pursue the high-quality development of renewable energy, optimize the layout and structure of the coal-fired power development industry, and guide and supervise the settlement of universal environmental problems in different industries.

In April 2021, the third batch of inspections in the second round of central environmental protection inspections was launched across the board, and eight inspection teams carried out inspection of eight provinces (autonomous regions) including Shanxi, Liaoning, Anhui, Jiangxi, Henan, Hunan, Guangxi and Yunnan. On April 16, the MEE released a circular, which said that the field inspection identified and verified a number of outstanding ecological and environmental problems. As of May 9, the inspection teams received 29,133 cases reported by the general public (excluding repeated ones), of which 12,732 ones were concluded and 6,393 ones were temporarily settled; 2,575 entities were fined a total of RMB 191,282,100; 160 cases were investigated, with 95 people detained; 1,708 Party and government leaders and cadres were grilled and 844 of them were held accountable.

It should be noted that curbing energy-intensive and high-emission projects has been included in the scope of the central environmental protection inspection. During its inspection in Shanxi Province, the first central environmental protection inspection team found that counties in Jinzhong City, including Jiexiu, Pingyao and Lingshi, blindly launched a number of water- and energy-intensive and high-

emission coking projects regardless of water resource endowment and the carrying capacity of the environment, bringing about serious ecological and environmental problems.

4.6.4 Improvement of ecological and environmental governance efficiency

The modernization of the system and capacity for environmental governance should be accelerated. A sound environmental problems system that matches the new development pattern should be established, and on the basis of the overall completion of the top-level design for the reform of the ecological civilization system, the systematicness, integrity and synergies of reform measures should be fully leveraged to mobilize the endogenous momentum of relevant entities. The 2019 CCICED Policy Recommendations proposed to enhance information disclosure and public engagement. To arouse the enthusiasm of individuals and non-governmental organizations (NGOs) for participation, the environmental information disclosure and public engagement system should be implemented on a full scale.

On April 22, 2020, the MEE introduced the *Guidelines on Implementing a Reward System for Reporting Ecological and Environmental Violations*. Encouraging public participation in ecological and environmental protection by implementing a reward system for reporting environmental violations is an important step in building an environmental protection pattern led by the government, dominated by enterprises and extensively participated by social organizations and the public.

On May 24, 2021, the 17th meeting of the central committee for deepening overall reform deliberated and adopted the *Reform Plan for the Law-based Environmental Information Disclosure System* (the *Reform Plan*). The *Reform Plan* fully strengthens the corporate disclosure responsibility and urges the fulfillment of the corporate disclosure obligation to effectively protect the public's right to know. Meanwhile, by focusing on key entities and key information, the document ensures that environmental information is timely, true, accurate and complete by strengthening departmental collaboration, guiding public scrutiny and improving the efficiency of law-based supervision and social supervision.

On June 3, 2021, the MEE and the General Office of the Central Commission for Guiding Cultural and Ethical Progress jointly issued the *Guidelines on Promoting the Development of Voluntary Services for the Ecological Environment* (the *Guidelines*). The *Guidelines* is the first national program of action on voluntary services for the ecological environment, which provides guidance for promoting the development of such voluntary services in six aspects including the guiding ideology, basic principles, enriching the contents and forms, enhancing team building, improving service management and strengthening security measures.

On June 30, 2021, the MEE released the *Implementation Opinions on Strengthening the Building of Comprehensive Administrative Law Enforcement Teams for Ecological and Environmental Protection* (the *Implementation Opinions*). The *Implementation Opinions* requires the strict implementation of the certification and qualification management system for law enforcement officials, the establishment of an appraisal and reward & punishment system, the active implementation of the law enforcement archives review and appraisal system, the establishment of an accountability and exemption system, the establishment and the implementation of an investigation and accountability system for leaders and cadres who violate laws and regulations to interfere in law enforcement activities and step in specific environmental protection cases, as well as the improvement of three mechanisms, including the error correction and accountability mechanism.

4.7 Regional and International Engagement

4.7.1 New advances in greening the “Belt and Road Initiative”

The 2020 CCICED Policy Recommendations proposed to continue to participate in multilateral processes for environment and development, promote the development of Green BRI and global green supply chain, strengthen green international cooperation, facilitate the realization of global green prosperity, and build a shared future for all life on earth. To this end, it is necessary to give full play to the role of the BRI International Green Development Coalition, the Belt and Road Sustainable Cities Alliance and other platforms to advance green, environment friendly and renewable energy demonstration projects, support infrastructure projects for clean and efficient energy, strengthen case study and promotion of experiences for the green transformation of BRI-related countries, and seize the strategic opportunity of economic recovery after the COVID-19 epidemic to boost green development.

Since 2020, in the face of a complex international situation, especially the impact of the COVID-19 epidemic, China has worked with the relevant countries to overcome the difficulties and promote the development of the BRI. A series of new progresses and new results have been achieved.

At the 9th Meeting of the Central Finance and Economics Committee on March 15, 2021, it was pointed out that the 14th Five-Year Plan period is a critical period and window period for peaking carbon emissions, and that China should strengthen international cooperation on climate change and promote the formulation of international rules and standards to build a green Silk Road. On April 20, 2021, in his keynote speech (video speech) at the opening ceremony of the Boao Forum for Asia Annual Conference 2021, Chinese President Xi Jinping proposed to perfect the

BRI International Green Development Coalition, the Belt and Road Green Investment Principles and other multilateral cooperation platforms for the building of closer partnerships on green development.

On June 23, 2021, the Asia and Pacific High-level Conference on Belt and Road Cooperation was held in Beijing via video conferencing. The meeting announced the Initiative for Belt and Road Partnership on COVID-19 Vaccines Cooperation and the Initiative for Belt and Road Partnership on Green Development jointly initiated by 29 countries, emphasizing that mankind has only one earth and that protecting the ecological environment is the common responsibility of all countries. Countries were required to work together to promote green, low-carbon, and sustainable development, take actions to deal with climate change, carry out international cooperation to achieve a green and sustainable economic recovery and promote a low-carbon, resilient and inclusive economic growth after the epidemic, support the construction of the green Silk Road, strengthen cooperation in green infrastructure, green energy, and green finance, and facilitate green, low-carbon, and sustainable development.

On July 16, 2021, the Ministry of Commerce and the Ministry of Ecology and Environment issued a notice on the issuance of the *Guidelines for Green Development in Foreign Investment Cooperation*. The *Guidelines* pointed out that the key tasks for China's future development include supporting foreign investment in clean energy, such as solar energy, wind energy, nuclear energy, and biomass energy, participating in the global energy production and consumption revolution, and building a clean, low-carbon, safe and efficient energy system. Upholding the concept of a community with a shared future for mankind, the document shows China's ideas and positive attitude toward green development. It proposed to build a database of cases of Chinese enterprises making green investment and building green infrastructure, compile the green development index for the overseas investment by Chinese enterprises, and publish the report on green development resulting from such investment.

4.7.2 International cooperation on climate change

2020 is the last year before the formal implementation of the *Paris Agreement* on climate change, and also a crucial year for countries to submit and renew their nationally determined contributions (NDCs) under the *Convention*. However, the sudden outbreak of COVID-19 forced the scheduled United Nations Climate Change Conference to be postponed. In September 2020, at a critical moment when the global climate governance process may regress, China put forth the new emission reduction targets that it will strive to peak its carbon dioxide emissions by 2030 and achieve carbon neutrality by 2060. This move of China has boosted the confidence

of the international community in tackling climate change and driven a new upsurge in international climate cooperation.

At the Leaders Summit on Climate on April 22, 2021, President Xi Jinping, based on China's practice in promoting ecological progress and addressing climate change, proposed that "we must be committed to harmony between man and Nature, green development, systemic governance, people-centered approach, multilateralism and the principle of common but differentiated responsibilities", clarifying the direction for China to participate in international climate governance.

On June 17, 2021, the Permanent Mission of China to the United Nations deposited with the Secretary-General of the United Nations an instrument of ratification by the Chinese government of the *Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer*. The *Amendment* will take effect in China on September 15, 2021 (not applicable to the Hong Kong Special Administrative Region of China for the time being). After the *Kigali Amendment* was approved, the *Montreal Protocol* opened a new chapter in the history marked by coordinated response to ozone layer depletion and climate change. As the largest developing country, despite many difficulties, China has decided to accept the *Kigali Amendment* and will make new contributions to the protection of the global ozone layer and to the response to climate change.

By actively taking on international responsibilities, China has injected new impetus into the global fight against climate change and the promotion of green recovery. The international community has become increasingly aware that China not only played a key role in the reaching of the *Paris Agreement*, but also led its implementation.

4.7.3 Global ocean governance

The 2020 CCICED Policy Recommendations proposed to step up comprehensive ocean management, improve the resilience of the marine ecosystem, and support the sustainable growth of the marine economy.

The Chinese government has vigorously participated in international processes in response to marine litter and plastic pollution, joined the UNEP Regional Seas Programme, carefully observed the *Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal*, and facilitated the introduction of documents such as the *East Asia Leaders' Statement on Combatting Marine Plastic Debris* and the *Implementation Framework of the G20 Action Plan on Marine Litter*, with the aim of working together to promote global marine litter and plastic pollution prevention and control. Meanwhile, China has actively advanced bilateral cooperation and established a cooperation mechanism for marine litter prevention and control with Japan, Canada and the United States.

On October 11, 2020, the first *Industry Report on Ocean Protection in China*

(2020) in the field of marine protection was released. By the end of 2019, China had established 271 marine protected areas. China's first national five-year plan specifically for marine eco-environment protection, the *14th Five-Year Plan for the Protection of the Marine Ecological Environment Nationwide*, is about to be completed, which shows that China will coordinate matters related to marine protection with a greater determination and at a higher strategic level.

On June 23, 2021, the 31st Meeting of States Parties to the United Nations Convention on the Law of the Sea was held. Over the years, China has vigorously participated in the work of the three major bodies of the *Convention*, supported developing countries in strengthening capacity building, resolutely safeguarded the integrity and seriousness of the *Convention*, and made positive contributions to the construction of a modern maritime order.

China has been actively fulfilling its commitment to ocean protection by participating in related international cooperation. It put forth the concept of a maritime community with a shared future. It has established maritime partnerships with Portugal, the European Union, and Seychelles with the aim of jointly pushing the global ocean governance system to perfection. China has also promoted the application of autonomous marine environment security technology in countries along the 21st Century Maritime Silk Road, providing Chinese technologies and solutions in marine observation and monitoring, marine environmental forecasting, and marine ecological protection.

4.8 Conclusions

Over the past year or so, the CCICED has continued to act as a high-end think tank for promoting progress in China's environment and development, and has put forward many systematic and forward-looking policy recommendations, which fully reflect the superb ability of the CCICED members, special advisors, Chinese and foreign experts to predict the situation at home and abroad, as well as their insights into the international environment and the laws of development. The CCICED Policy Recommendations continue to receive great attention from the Chinese government and have been reflected to varying degrees in policy practice and exploration. For example, the 2020 policy recommendation that we should maintain the strategic focus on making ecological progress and align the green development targets in the 14th Five-Year Plan with the United Nations 2030 Agenda for Sustainable Development, especially with the climate change mitigation and adaptation actions has been fully reflected in the *14th Five-Year Plan for National Economic and Social Development* and the *Long-Range Objectives Through the Year 2035*. Another example is that the CCICED proposed to incorporate climate change tackling into the central ecological and environmental protection inspection system,

strengthen local institutions, teams and capabilities for climate change tackling, make full use of the advantages of the existing ecological and environmental protection inspection system, and effectively advance the implementation of climate change work, which fully demonstrate the forward-looking nature of the CCICED recommendations.

Over the past five years, China has made significant achievements in ecological & environmental protection and economic & social development, attracting worldwide attention. Blue sky, clear water and green land have become the new normal in many cities and regions, and a solid step has been taken in pursuing beautiful China. It took less than ten years for China to basically realize the transition to green and clean development that took industrialized countries more than 30 years or even longer. The transformation in China's environment and development has accelerated both its own and the world's sustainable development process.

Although the future world may face many uncertainties due to the impact of the epidemic and the tension in international politics, it has become an inevitable trend for countries to be open and to work together to build a community with a shared future for mankind. To address issues including global climate change, ocean governance, and biodiversity conservation, the international community will need to make concerted efforts. In view of the *14th Five-Year Plan for National Economic and Social Development* and the *Long-Range Objectives Through the Year 2035*, China will continue to conduct comprehensive cooperation with the international community with an even more open attitude.

2021 marks the first year in China's 14th Five-Year Plan period. This year, the CCICED has provided many positive and effective suggestions based on various national planning outlines and long-term objectives. In the future, the CCICED will more accurately grasp the features of the new era and the development trend of the domestic and foreign environment when conducting policy research, focus on delivering innovative and forward-looking research results, and provide more strategic policy recommendations on green and sustainable development, climate governance, low-carbon transition and other issues of concern at home and abroad.

Managing River Areas in Times of Climate Change Report on Gender Mainstreaming in SPS Research for the Period 2020–2021

CCICED Secretariat^①

Executive Summary

In 2018, the CCICED Executive Committee identified gender equality as a cross-cutting theme and research priority. To support the integration of gender considerations as part of the Special Policy Studies for 2020–2021, the CCICED Secretariat International Support Office prepared this report.

The purpose of this report is two-fold: first, to highlight some of the research findings and recommendations of CCICED’s 2020–2021 research work specific to gender, drawing on the final research papers from the Special Policy Studies; second, to provide recommendations for mainstreaming gender perspectives in the forthcoming phase of the research.

Three key findings of CCICED’s recent work are: (a) gender equality is an important issue that cannot be ignored—if progress on the SDGs is to take place, gender equality is seen as a “multiplier of sustainability”; (b) gender equality awareness and action must be mainstreamed into environmental policies, strategies, and programs; (c) women have an important role to play as stakeholders (through the participation of women in consultations or involvement of women’s business associations or community groups) and agents of change (women as leaders of social networks, as gatekeepers and communicators, as conscientious consumers, or as entrepreneurs). While there is a strong acknowledgment that gender equality is important and must be addressed, the how remains a significant challenge.

5.1 Gender Equality and the International Framework

China’s domestic and international commitments to gender equality and sustainable development include:

- Convention on the Elimination of all Forms of Discrimination Against

^① Drafted by the WPS Group, Kristine St-Pierre, and Jennifer Savidge. Delivered on September 2, 2021

Women (CEDAW 1979)

- United Nations Conference on the Environment and Development and Agenda 21 (UNCED 1992)

- United Nations Conference on Women and Platform for Action (Beijing 1995)

- Millennium Development Goals (MDGs)

- 2030 Agenda for Sustainable Development and SDGs

- China National Program for Women's Development (2011–2020).

Parties to the **United Nations Framework Convention on Climate Change (UNFCCC)** have also recognized the importance of involving women and men equally in UNFCCC processes and in the development and implementation of national climate policies that are gender-responsive by establishing a dedicated agenda item under the Convention addressing issues of gender and climate change and by including overarching text in the Paris Agreement. There have also been calls to engage women's groups and national women and gender institutions in developing and updating climate policies, plans, strategies, and actions.

SDG 5 is a **standalone goal** for gender equality and the empowerment of women and girls. It includes promoting women's access to natural resources and enabling technologies, as well as increasing women's participation in environmental decision-making processes. It calls on, among other things, SDG 5.5, ensure women's full and effective participation and equal opportunities for leadership at all levels of decision-making in political, economic, and public life, and SDG 5.A, undertake reforms to give women equal rights to economic resources, as well as access to ownership and control over land and other forms of property, financial services, inheritance, and natural resources, in accordance with national laws. The goal also seeks to eliminate all forms of gender-based discrimination in all areas of social, political, and economic life and fight stereotypes.

SDG 5 is also a **cross-cutting priority** because it is not only connected to other goals but can also accelerate progress towards them—for instance, for goals related to climate change, health, energy, oceans, and ecosystem management. For example, SDG 13 on climate action highlights the utmost importance of women's greater inclusion in climate change-related planning. In addition, addressing the gender perspective is significant for SDG 3 on health and environment, SDG 7 on energy, SDG 11 on disaster risk reduction, and SDG 15 on ecosystems and forests. The cross-cutting priority of gender equality within other SDGs provides multiple opportunities for men and women to benefit more equitably from China's progress toward achieving these goals. SDGs are substantially less likely to be attained if 50% of the population is not considered or listened to.

5.2 CCICED's 2021 Gender-Related Work Through Special Policy Studies (SPSs): Key Observations

This section presents key observations on the importance of gender equality within each SPS research area, as identified through gender guidance notes. The section also identifies opportunities to further advance gender equality within environmental policy development and governance.

5.2.1 Biodiversity

There is currently a global drive to integrate gender perspectives into biodiversity approaches, exemplified by the *CBD Gender Plan of Action 2015-2020*, demonstrating its importance. Women and men generally have different roles in using and managing natural resources because of gender norms. Understanding these roles is a key to combating biodiversity loss and ensuring equitable access to limited and life-giving resources, especially in developing countries. Gender-differentiated responsibilities vary from region to region. Still, in many communities around the world, women act as primary caretakers and natural resource managers, procuring water and firewood, managing waste, and providing health care, often through plant-based medicines. Women's activities are directly impacted by biodiversity loss, and the related impacts on women's lives in terms of health, safety, and education reinforce unequal rights and access to decision making. As such, it is critical that women are engaged in all stakeholder consultation processes regarding biodiversity conservation; that sex-disaggregated data is used to inform the design and monitoring of conservation measures; and that the differing risks, costs, and benefits to women and men are considered within planning and implementation.

The *2021 Special Policy Report on Post-2020 Global Biodiversity Conservation* has very effectively integrated key gender equality concepts and context relevant to post-2020 biodiversity conservation. The importance of gender equality to biodiversity conservation is first introduced in the Executive Summary and Background and is addressed at length in a gender-focused section of the report within Section 7.4, Gender Gaps. The gender section of the paper provides a thorough overview of gender and biodiversity and associated initiatives relevant to post-2020 biological conservation, as well as key commitments and recommendations made in this area. It makes clear its importance to discussions at the Convention on Biological Diversity 15th Conference of the Parties (COP 15). Importantly, gender equality is also included in Recommendation 4.

In addition, a *Gender, Biodiversity and Ecosystems* working paper was produced in association with the SPS that provides an excellent overview of gender and biodiversity and associated initiatives. This working paper offers an impressive source of in-depth information on gender and biodiversity for reference, along with

the above SPS.

Future research areas could include showcasing a gender analysis of a biodiversity conservation measure, demonstrating the importance of collecting and analyzing sex-disaggregated data, and consulting with women and men to understand how their different gender roles intersect with the ecosystem. Additional research could highlight the disproportionate impact of COVID-19 on women and girls, women's critical roles related to biodiversity, and the need to ensure women's voices and leadership are included in recovery and resilience efforts.

5.2.2 Global Climate Governance

The link between climate change and gender equality is not new. There is considerable research looking at the impact of climate change on communities, and women more specifically. Improvements in gender equality have been found to improve the efficiency and effectiveness of environmental policies, enhance economic growth and sustainability, and ensure the protection of the basic human rights of both women and men. The impacts of climate change and its associated security risks have important gender dimensions that shape how men and women of different backgrounds experience or contribute to insecurity. An increasing amount of literature now suggests that the impacts of climate change and related disasters exacerbate gender differences. Women tend to be affected more adversely by climate change than men. In fact, the risk of not considering gender is that policies or initiatives unintentionally aggravate existing inequalities or hamper efforts to address climate change and environmental degradation.

Despite this evidence, there remains limited research when it comes to the role of gender—and of women specifically—in climate governance, and more pointedly, emissions management and reduction and connected areas such as climate finance, green technology, and green recovery. Evidence from the ground also suggests that the impacts of climate change are leading to significant socio-economic shifts, including transforming traditional gender norms that determine economic activity, social relationships, and leadership. If carefully managed, shifting social norms can create entry points for women's economic empowerment, as well as for their participation in decision-making, conflict prevention, and peacebuilding.

The *2021 Special Policy Report on Global Climate Governance and China's Role* has integrated gender considerations in an effective way. The paper acknowledges the link between gender equality and sustainable development and recognizes the importance of gender equality in tackling global climate change. The report views gender equality as an important cross-cutting issue that “should be mainstreamed into all climate change policies, strategies and programs.” In doing so, the paper includes a specific section on gender analysis in which the authors consider gender implications in three particular areas of work: 1) gender and climate

as cross-sectoral; 2) women’s participation in the carbon-neutral job market; and 3) women’s safety and transportation. This section presents an important contribution to the climate governance analysis by looking specifically at data from a gender perspective and by providing specific recommendations for ensuring equity in opportunities and outcomes for women and men as part of green and low-carbon development.

Additional areas of research for the future could include the gendered dimensions of different policies around carbon pricing, renewable energy development policy, and green finance; further looking at how infrastructure developments and the expansion of commodity trade impact women and men differently, and how women may suffer disproportionate consequences, especially when they are members of already-marginalized and vulnerable communities; improving the quantity and quality of participation of women and women’s organizations in climate change governance; and investing in women’s skills and capacity by supporting capacity development of different groups, including communities and women’s organizations, around climate risks awareness as well as adaptation and mitigation.

5.2.3 Global Ocean Governance

Gender equality is recognized as essential for the effective protection of oceans, the sustainable management of ocean and marine resources, and the accomplishment of the SDGs. However, there is still very little data and research on these issues—an area of opportunity for this SPS. The contributions of women in ocean governance continue to be routinely ignored or underestimated in research, management, and policy. For example:

- According to UNESCO, women today account for only 38% of the world’s researchers in ocean science, and the rate is even lower for women from developing countries.
- The maritime industry is almost completely managed by men. In 2016, only one of the top 100 seafood companies was run by a woman.
- Although many initiatives have been adopted at the global, regional, and national levels to advance opportunities for women in emerging sectors such as science, technology, engineering, and mathematics (STEM) and the Blue Economy, the participation of women from least-developed countries (LDCs), landlocked developing countries (LLDCs), and Small Island Developing States (SIDS) remains low in these sectors. More efforts must be mobilized to enhance their participation.

The *2021 Special Policy Report on Global Ocean Governance* effectively highlights the importance of considering “gender-related aspects of ocean activities

and management” and touches on the role of women in greening the blue economy—including looking at how women’s participation in decision making can be strengthened. Two special task force reports were also developed looking at establishing China’s sustainable fisheries policy and marine pollution. These areas provide an important opportunity to incorporate gender issues as they relate to sustainable fisheries and marine pollution. Some entry points include the following:

- Conducting research on the gendered dimensions of a disruption in the nutrient cycle.
- Undertaking an assessment of the impact of mercury from a gender perspective. As part of the assessment, consider 1) the importance of sex-disaggregated data to understand the impact of mercury pollution on diverse populations and 2) looking specifically at research on the effects of mercury pollution on women and children.
- Promoting a multi-stakeholder approach to ensure the participation of women and vulnerable populations in policy development and decision-making processes.
- Raising awareness of the linkages between chemical exposures, the effects on human health and the environment, and gender differences in risks and impact.
- Supporting women’s improved access to, use, and control of marine resources, including fisheries.
- Enhancing women’s participation and role in ocean governance decision-making processes, with women as agents of change at all levels.
- Targeting women as specific beneficiaries by increasing awareness of the roles of women and men in the sustainable management and use of resources.
- Investing in women’s skills and capacity by supporting the capacity development of different groups, including communities and women’s organizations.

5.2.4 Global Green Value Chains

Global value chains (GVCs), including global green value chains (GGVC), impact women and men in different ways given their different gender roles as consumers, producers, and workers—often to the disadvantage of women. Some of the main ways GVCs impact women differently than men as workers and producers include the following:

- Expanded employment opportunities for women in lower value-added sectors and for men in higher value-added sectors.
- Perpetuation of a gendered division of labour in which women are relegated to low wage, low skill jobs with limited protections and excluded from

decision-making and leadership positions.

- The tendency for women producers to have less access than men to resources required to meet the standards of export markets, such as technical training, credit, land, or skills.

To develop systems and initiatives that support the development of GGVCs and that promote the circular economy, it is important that attention is paid to the different roles women and men play within GGVCs and that policies and programs are implemented in a gender-responsive manner that considers women’s and men’s unique perspectives, needs, and capacities. This is important to ensure a “Do No Harm” approach and to promote gender equality *and* sustainable development within GGVCs. It is also important to enable mechanisms that support GGVCs that capitalize on women’s capacities to promote green consumption and production practices, particularly given the evidence of their greater interest and willingness to prioritize environmental and sustainability considerations within their practices.

Understanding the roles, needs, and capacities of women and men within GGVCs can be done by conducting gender-sensitive value chain analyses or gender analyses of processes relevant to GGVCs. The results of these analyses could then be used to inform the development of gender-responsive legislation, policies, and practice towards GGVCs, which promote rather than hinder gender equality and the empowerment of women and girls while also supporting green outcomes.

Future SPS research could include examining the impacts of legality and traceability systems on both women and men by doing a gender-sensitive value chain analysis that looks at women’s and men’s different and distinct roles within GVCs, how these intersect with traceability measures, and how policy development could take gender considerations into account and thus mitigate risk and contribute to equitable benefits. It would also be useful to demonstrate gender considerations within GVCs using a case study or example—such as the apparel sector in which women tend to be concentrated—and how gender-related challenges could be mitigated within GGVCs. Research could also explore the capacity of women to influence the circular economy, given their roles as consumers and producers and greater interest in behaviours related to environmental outcomes.

5.2.5 Green Belt and Road Initiative (BRI)

Women and men are impacted differently by infrastructure projects, including the green BRI. While there are many benefits to such projects, they can also have negative social and economic impacts, such as loss of livelihoods, land, or community displacements. Due to rigid gender roles and gender inequalities in access to resources, input into decision-making, and access to their rights, women are often disproportionately impacted by such projects.

Environmental and social frameworks for green BRI investments, including risk assessments and environmental management practices, are made more effective and equitable by mainstreaming gender considerations within their policies and practices. Gender mainstreaming allows for the development of approaches that account for and mitigate the impact on and different needs and capacities of both women and men. A key part of this process is stakeholder consultations that include women and girls, women’s organizations, or other organizations representing their interests. This process helps to ensure that neither women nor men are disproportionately impacted and can equitably benefit from and contribute to the initiative. Not doing so risks implementing approaches that exacerbate gender inequalities and disproportionately impact the most vulnerable groups, including women, while neglecting to capitalize on their capacities.

Gender-sensitive impact assessments, including those focused on environmental impacts, can be effective in reducing the adverse social impacts of development and entail ensuring that the environmental impacts of a project are assessed using an intersectional gender lens. That lens can assess the different impacts on women and men from diverse backgrounds based on gender roles and their different needs, capacities, and perspectives. Gender impact assessments can be standalone or part of environmental or social impact assessments.

In recent years, multilateral institutions and international investment banks have strengthened their approach to managing the environmental and social risks and impacts of investment projects through the establishment of environmental and social frameworks and policies. These frameworks guide the integration of environmental and social considerations throughout all phases of investment projects. Gender equality and inclusion are increasingly integrated throughout environmental and social policies and practices, including within stakeholder consultations, to ensure projects are gender-sensitive, gender-responsive, and inclusive. Mitigation measures can enlist the full participation of women and men from diverse backgrounds by drawing upon their unique capacities and knowledge.

Similarly, women and men are affected differently by investment projects within the resource development and utilization industries due to their different gender roles and expectations within communities: women often bear the brunt of negative impacts, including those related to the environment. As such, it is necessary for investment projects in these areas to use mechanisms to identify, respond to, and mitigate the different impacts on women and men.

The first draft of the *2021 Special Policy Report on Green BRI and 2030 Agenda* contains a text box entitled “Transparency Plus: Special considerations regarding gender and ethnicity.” This section provides a good overview of gender roles as they relate to greening the BRI and emerging DFI considerations,

particularly as it relates to consultations with the community, drawing out some important lessons.

Future research could highlight progress made in relation to the integration of gender considerations into BRI eco-environmental management practices, either standalone or integrated within environmental or social management mechanisms, or to propose a standardized system for integrating gender considerations meaningfully into environmental management guidelines for green BRI projects. In addition, it would be useful to develop case studies that demonstrate standards and tools that jointly address the assessment and management of gender impacts of infrastructure projects to bring attention to the interconnectedness of gender and environmental impacts, which could be applied to greening the BRI.

5.2.6 Green Finance

The integration of gender considerations and the promotion of gender equality is important to the development and implementation of green finance. As a result of gender norms, women and men have different roles in the use and management of natural resources and are impacted differently by conservation measures. Despite the importance of biodiversity to women's lives, women are often excluded from participating in decision-making and capacity-building that informs biodiversity initiatives due to discriminatory gender norms. Understanding women's and men's different roles, needs and capacities, and incorporating them into the design, implementation, and monitoring of green finance initiatives are important for addressing biodiversity loss.

Finance instruments incorporating the nature-positive principle can be strengthened by incorporating objectives that promote gender equity. Lessons and approaches can also be drawn from innovative finance instruments such as gender-lens investing and blended finance instruments that integrate the gender-climate nexus, requiring accountability on both fronts, which are important models of how gender equality and biodiversity considerations can be promoted amongst environmentally - and socially conscious investors. Ensuring women's access to biodiversity agricultural subsidies not only helps to support conservation outcomes but also contributes to gender equality by providing resources for women to expand their livelihoods, addressing a key barrier to women's economic empowerment.

Gender considerations are effectively integrated into the *2021 Special Policy Report on Promoting Conservation and Biodiversity Finance*, which highlights the recognized links between biodiversity, gender roles, and gender equality and brings attention to the complementarity of gender mainstreaming in the nature-positive principle. The intersection between women and green finance is given a focused approach in section 3 - Encouraging institutional investors to focus on women's rights when developing eco-protective finance, and section 5 - Focus on supporting

women farmers. This integration is further reflected in the inclusion of gender-focused policy recommendations, such as a focus on women farmers, and gender-integrated policy recommendations, such as the inclusion of gender considerations into nature-aligned funds.

Future research could take a close look at how biodiversity agricultural subsidies could take gender considerations into account, based on a gender analysis, to ensure that access to and the benefits of subsidies are equitably shared and support women to expand their livelihoods while protecting biodiversity. Additionally, the importance of gender mainstreaming within biodiversity protection mechanisms resulting from debt swaps could be examined. Doing so would allow considering structural and sociocultural gender-related barriers that women commonly encounter and that inhibit their access to their rights, participation in decision-making, and access to and control of resources. Case studies or gender analysis of a range of green finance mechanisms would also be worthwhile subjects.

5.2.7 Green Technology

The shift to sustainable green energy is an opportunity to tackle gender inequalities and discrimination within society and promote inclusive and equitable communities and cities. The sector of innovation and technology provides unprecedented opportunities to reach women as well as others who are most likely to be left behind. This is key as women and girls continue to bear the brunt of increasing climate-related disasters, yet they are rarely able to affect change. Recognizing women's important roles both in the reproductive and productive spheres of society in the areas of water, energy, transportation, construction, land, and food, it is critical to consider their needs and perspectives and involve them as full stakeholders and innovators in green development. In fact, creating a gender-responsive environment and realizing the potential of women are two of the paramount goals for urban and community-level development in China.

Opportunities for the advancement of gender equality will require a gender analysis to identify the roles of men and women in the sector and the constraints and opportunities to women's participation as well as access to and benefits from resources and decision making. It could also look at how women and men can contribute to the design and implementation of green technologies. This is even more important considering the under-representation of female innovators in the green tech space: women make up only 1% of leadership positions in tech today, meaning they still don't have a legitimate seat at the table in the tech and innovation space. A recent study by UN Women also found that the following barriers sustain a gender gap when it comes to innovation and technology: limited market awareness and investment in innovations that meet the needs of women, gender-blind

approaches to innovation, and under-representation of women as innovators and entrepreneurs.

The need to make the green transition diverse and inclusive is becoming increasingly apparent, and governments can use the shift towards sustainable energy to tackle systemic gender discrimination within societies. In doing so, it will be important to capture key best practices in terms of gender policies for green technology as well as for green product research and development. Additionally, documenting global experiences in terms of gender-sensitive green technologies at city and community levels would be critical. Success will mean women are contributing to the transition on an equal footing with men.

The *2021 Special Policy Report on Major Green Technology Innovation and Implementation Mechanisms* effectively introduced and discussed gender considerations in a standalone chapter. The chapter, entitled *Gender and Population-Group Perspectives: Sharing and Public Participation*, includes a section on the role of women in green community development and a section on community renewal that is favorable for elderly people and children. The section on women specifically is extremely relevant, as it not only underscores the role of women in green lifestyles, but it also emphasizes the necessity of women’s engagement and leadership “to improve the government’s capability in responding to climate change,” and “the opportunity to address gender gaps and discrimination, and promote inclusion and equality” by using technology-driven green transition and involving more women.

Future research could consider further supporting women’s improved access to, use, and control of green technologies and innovations by, for example, enhancing their participation and role in green technology decision-making processes as agents of change at all levels. Another area could be targeting women as specific beneficiaries by increasing awareness of the roles of women and men in the sustainable management and use of green technologies. Finally, future research could consider investing in women’s skills and capacity by supporting the capacity development of different groups, including communities and women’s organizations.

5.2.8 Green Transition/ Consumption

Green transitions, including green consumption and production, provide opportunities to tackle systemic gender-based inequalities and enable societies to reap the benefits of a more diverse workforce. Green transition and sustainable social governance policies have many gendered implications.

The burden of green or sustainable consumption is usually placed on women, based on their roles in the reproductive sphere of society, including childcare; the stereotype of women being nurturing, primary consumers; and the linkages made

between femininity and nature. Several areas of consumption have a strong gender dimension, and studies in developing countries have found major differences between women's and men's consumption preferences. Additionally, international literature indicates women are key decision makers and drivers of consumption in urban and rural areas (making 85% of purchasing decisions in some European countries).

The *2021 Special Policy Report on Green Transition and Sustainable Social Governance* recognizes the importance of considering the gender dimensions of sustainability given women's and men's differing patterns of production and consumption, and the differentiated impact of this production and consumption. The report also includes a section on gender, which provides an important overview of Germany's, Sweden's, and Japan's approaches to gender equality as they relate to sustainable societal development. Finally, the report also includes a specific recommendation to promote gender equality in all aspects of product development and use.

It would be important for future research to include a gender analysis that includes sex-disaggregated data for both green production and green consumption, highlighting differences between key regions in China as well as between the rural and urban settings. Other aspects of the research could look at factors that influence women's participation in green growth and explore gender differences in consumption patterns and priorities, as well as how to target messages on green lifestyle, the role of women's organizations, and the role of women-owned businesses in the green industry.

While conducting the research of relevant international experiences, it is suggested that this includes documenting pertinent policy experience and good practice related to the promotion of gender equality and women's empowerment in each of the sub-areas of research on green transition. For example, national and local policies and practices of related industries such as iron and steel, construction material, and automobiles will need to consider gender issues, as well as women's roles, needs, and capacities more specifically. For the automobile industry, it will be important to consider where women are located with the upper and lower reaches of the supply chain while ensuring that women business leaders are involved in the development of eco-design tools.

5.3 Recommendations to CCICED for the forthcoming research phases

To strengthen the integration of gender within the SPS topics, we recommend adding the following considerations to the current process:

- **Consideration should be given to commissioning a dedicated gender**

analysis for each SPS topic. This should be done at the early stages of identification of the research topic and prior to the development of a detailed research outline, which would facilitate where and how gender should be considered within the topic. Integrating gender considerations at the planning stage is easier and more effective than if introduced at a later stage and can help to set the stage for the research.

- **Based on the SPS-specific gender analysis, gender training sessions specific to each SPS should be carried out with SPS team members.** This should be carried out early in the research process, prior to the formalization of the research outline, to inform the identification of gender-focused areas of the research and the integration of gender considerations across the study.
- **Each SPS should be encouraged to commit to integrating gender considerations throughout their paper as a standard of practice.** This should be done using gender-sensitive language and sex-disaggregated data, as well as highlighting gender aspects where relevant. For example, SDG 5 should be referenced in each paper, and the linkages to other SDGs defined and explained (see Climate SPS as a good practice). In addition, each SPS should recognize women’s underrepresentation in natural resource decision making and leadership and ensure that all stakeholder consultations involve women or women’s organizations and include specific provisions for how they will be involved. Each SPS should also recognize the link between gender-based violence and environmental governance and include specific references to how to mitigate it.
- **Consideration should also be given to mandating the inclusion of a section of each SPS focused on gender equality and its intersection with the relevant topic.** The gender-focused sections that were carried out in some papers were very effective at addressing gender-related issues in-depth. If the necessity of focused sections was identified early, prior to and during the formulation of the initial SPS outline, this could also enable the identification and inclusion of SPS team members with the interest and capacity to carry out gender-focused research and drafting of relevant sections.
- **Appoint a gender focal point for each SPS team.** The gender focal point should have an interest in gender-related issues and an adequate level of authority to encourage other SPS research members to integrate gender into their respective research. The focal point would also be the primary point of contact for the contracted gender specialists.
- **Consideration should be given to mandating the inclusion of a**

gender-focused case study or example within each SPS. Such practical tools would greatly assist the understanding of team members and readers of the relevance of gender considerations within each SPS topic.

- **Consideration should be given to mandating the inclusion of a minimum of one gender-focused recommendation in each SPS.** This is important to ensure that the gender dimension is not neglected as the recommendations are addressed. It is inefficient to include gender within the text but not within the recommendation for achieving or contributing to results and recognition at the higher levels. In addition, team members should be strongly encouraged to integrate gender considerations within other recommendations.

ANNEX 6:

CCICED Phase VI Members(as of December 2021)

Chinese Members:

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|---|--------------------|--|
| 1 | Mr. HAN Zheng | Chairperson of CCICED |
| 2 | Mr. HUANG Runqiu | Executive Vice Chairperson of CCICED
Minister, Ministry of Ecology and Environment |
| 3 | Mr. XIE Zhenhua | Vice Chairperson of CCICED
China's Special Envoy on Climate Change |
| 4 | Mr. ZHOU Shengxian | Vice Chairperson of CCICED
Former Minister of Environmental Protection |
| 5 | Mr. ZHAO Yingmin | Secretary General of CCICED
Vice Minister, Ministry of Ecology and Environment |
| 6 | Mr. LIU Shijin | Chinese Chief Advisor of the Council Vice
Chairman, China Development Research
Foundation; and Former Deputy President,
Development Research Center of the State
Council |
| 7 | Mr. HAN Wenxiu | Vice Minister, the Office of the Central Financial
and Economic Affairs Committee |
| 8 | Mr. YANG Weimin | Deputy Director, Committee for Economic
Affairs of the 13 th National Committee of the
Chinese People's Political Consultative
Conference; Former Vice Minister, the Office of
Central Leading Group on Financial and
Economic Affairs |
| 9 | Mr. MA Zhaoxu | Vice Minister, Ministry of Foreign Affairs |

- 10 Mr. XIN Guobin Vice Minister, Ministry of Industry and Information Technology
- 11 Mr. ZHU Zhongming Vice Minister, Ministry of Finance
- 12 Mr. WANG Hong Vice Minister, Natural Resources; Director of State Oceanic Administration
- 13 Mr. WANG Shouwen Vice Minister, Ministry of Commerce; Deputy China International Trade Representative
- 14 Mr. ZHOU Wei Former Chief Engineer, Ministry of Transport
- 15 Mr. CHEN Yulu Vice Governor, the People's Bank of China
- 16 Mr. CHEN Li Member, the Overseas Chinese Affairs Committee of the 13th National People's Congress; Former Vice President, Chinese Academy of Governance
- 17 Mr. WANG Feng Member, Supervisory and Judicial Affairs Committee of the National People's Congress; Former Deputy Director, State Commission Office of Public Sectors Reform
- 18 Mr. XU Xianping Counsellor, the State Council; Specially-appointed Professor, Guanghua School of Management, Peking University
- 19 Mr. QIU Baoxing Counsellor, the State Council
- 20 Ms. LI Xiaolin Former President, the Chinese People's Association for Friendship with Foreign Countries
- 21 Mr. TANG Huajun Member, the Leading Party Group of the Ministry of Agriculture; President, the Chinese Academy of Agricultural Sciences; and Academician, the Chinese Academy of Engineering
- 22 Mr. ZHANG Yaping Vice President, Member of the Leading Party Group; and Academician, the Chinese Academy of Sciences
- 23 Mr. CAI Fang Former Vice President, Chinese Academy of Social Sciences

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| 24 | Mr. HAO Jiming | Professor, Department of Environmental Engineering, Tsinghua University; and Academician, the Chinese Academy of Engineering |
| 25 | Mr. XUE Lan | Dean of Schwarzman College in Tsinghua University; Co-Chair of the Leadership Council of the UN Sustainable Development Solution Network (UNSDSN); Professor at School of Public Policy and Management at Tsinghua University |
| 26 | Mr. SHU Yinbiao | Chairman and Secretary of the Leading Party Group, China Huaneng Group.,Ltd.;Former Chairman and Secretary of the Leading Party Group, State Grid Corporation of China; the 36 th President of International Electrotechnical Commission |
| 27 | Mr. FU Yuning | Former Chairman, China Resources (Holdings) Co., Ltd. |
| 28 | Mr. QIAN Zhimin | Chairman of the Board, State Power Investment Corporation Limited |
| 29 | Mr. WANG Xiaokang | President, China Industrial Energy Conservation and Clean Production Association; and Former Chairman, China Energy Conservation and Environmental Protection Group |
| 30 | Mr. WANG Tianyi | Executive Director and the Chief Executive Officer, China Everbright International Limited |
| 31 | Ms. Marjorie YANG | Chairman, Esquel Group |

International Members:

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|---|------------------------|---|
| 1 | Mr. Jonathan Wilkinson | Executive Vice Chairperson
Minister, Environment and Climate Change
Canada |
| 2 | Mr. Achim Steiner | Vice Chairperson
Administrator, The United Nations Development Programme |

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| 3 | Ms. Inger Andersen | <p>Vice Chairperson
Executive Director, The United Nations Environment Programme</p> |
| 4 | Ms. Kristin Halvorsen | <p>Vice Chairperson
Director, CICERO Center for International Climate Research; Former Minister of Finance of Norway</p> |
| 5 | Mr. Erik Solheim | <p>Vice Chairperson
Advisor, World Resources Institute; Former Executive Director, The United Nations Environment Programme</p> |
| 6 | Mr. Scott Vaughan | <p>International Chief Advisor of the Council
Former President and CEO, International Institute for Sustainable Development</p> |
| 7 | Mr. Joachim von Amsberg | <p>Vice President, Asian Infrastructure Investment Bank</p> |
| 8 | Mr. Peter Bakker | <p>President and CEO, World Business Council for Sustainable Development</p> |
| 9 | Mr. Francesco La Camera | <p>Director-General, the International Renewable Energy Agency; Former Director General, Sustainable Development, Environmental Damage, European Union and International Affairs, Ministry for the Environment, Land and Sea of the Republic of Italy</p> |
| 10 | Mr. Srun Darith | <p>Secretary of State, Ministry of Environment, Cambodia</p> |
| 11 | Mr. John J. DeGioia | <p>President, Georgetown University</p> |
| 12 | Mr. Jan Hendrik Dronkers | <p>Secretary General, the Ministry of Infrastructure and Water Management, the Netherlands</p> |
| 13 | Mr. Richard Florizone | <p>President and CEO, the International Institute for Sustainable Development</p> |
| 14 | Mr. Hans Friederich | <p>Ambassador, World Bamboo Organisation; Former Director General, International Network for Bamboo and Rattan</p> |

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| 15 | Mr. Stephen P. Groff | Governor, National Development Fund of Saudi Arabia; Former Vice President, Asian Development Bank |
| 16 | Ms. Kate Hampton | CEO, Children’s Investment Fund Foundation |
| 17 | Mr. Arthur Hanson | Senior Advisor and former president of International Institute for Sustainable Development |
| 18 | Mr. Eric Heitz | Former CEO and Co-founder, the Energy Foundation |
| 19 | Mr. Stephen Heintz | President and CEO, the Rockefeller Brothers Fund |
| 20 | Mr. Nuritdin Inamov | Director, Department for International Cooperation, Ministry of Natural Resources and Environment of the Russian Federation |
| 21 | Ms. Naoko Ishii | Professor, Executive Vice President and Director of the Center for Global Commons, University of Tokyo; Former CEO and Chair, Global Environment Facility |
| 22 | Mr. Rodolfo Lacy | Director for the Environment Directorate, Organization for Economic Co-operation and Development |
| 23 | Mr. Marco Lambertini | Director General, World Wide Fund for Nature |
| 24 | Mr. Yong Li | Director General, The United Nations Industrial Development Organization |
| 25 | Mr. Ajay Mathur | Director General, First Special Session of the ISA Assembly; Former Director General, the Energy & Resources Institute of the Republic of India; Member of Prime Minister Modi's Council on Climate Change |
| 26 | Mr. Michael McElroy | Gilbert Butler Professor of Environmental Studies, Environmental Studies, Harvard University |
| 27 | Ms. Kathleen McLaughlin | Executive Vice President and Chief Sustainability Officer for Walmart Inc. and President, Walmart Foundation |
| 28 | Mr. Dirk Messner | President, German Federal Environment Agency |
| 29 | Mr. Andrew Metcalfe | Secretary, Department of the Agriculture, Water and Environment of the Commonwealth of Australia |

- 30 Mr. Hideki Minamikawa President, Japan Environmental Sanitation Center
- 31 Mr. Oliviero Montanaro Directorate General, Nature and Sea Protection, Ministry of the Environment, Land and Sea, Italy
- 32 Ms. Jennifer Morris Chief Executive Officer, the Nature Conservancy
- 33 Mr. Bruno Oberle Director General, the International Union for Conservation of Nature
- 34 Mr. Félix Poza Peña Chief Sustainability Officer, Inditex Group
- 35 Ms. Diane Regas President and Chief Executive Officer, the Trust for Public Land
- 36 Mr. Frank Rijsberman Director General, Global Green Growth Institute
- 37 Ms. Åsa Romson Expert in environmental law & policy, IVL Swedish Environmental Research Institute; Former Deputy Prime Minister and Minister for Climate and the Environment, the Kingdom of Sweden
- 38 Ms. Gwen Ruta Executive Vice President, Environmental Defense Fund
- 39 Mr. Ahmed M. Saeed Vice President (Operations 2), Asian Development Bank
- 40 Mr. Andrew Steer President and CEO, Bezos Earth Fund
- 41 Mr. Mark Tereck Former CEO, the Nature Conservancy
- 42 Mr. Frans Timmermans Executive Vice-President for the European Green Deal, European Commission
- 43 Ms. Nomfundo Tshabalala Director-General of the Department of Environment, Forestry, and Fisheries, the Republic of South Africa
- 44 Mr. Juergen Voegelé Vice President for Sustainable Development, the World Bank
- 45 Mr. Jan-Gunnar Winther Director, Centre for the Ocean and the Arctic, Nofima; Specialist Director, Norwegian Polar Institute
- 46 Mr. Seung-Joon Yoon Professor, Seoul National University; Former President, Korea Environmental Industry & Technology Institute

CCICED Phase VI Special Advisors

Chinese Special Advisors

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| 1 | Mr. ZHANG Yong | Director-General, Bureau of General Affairs, the Office of the Central Financial and Economic Affairs Committee |
| 2 | Mr. FAN Bi | Invited Research Fellow, China Center for International Economic Exchanges |
| 3 | Mr. LI Junfeng | Director, Academic Committee of the Energy Research Institute of the National Development and Reform Commission; Former Director General, National Center for Climate Change Strategy and International Cooperation |
| 4 | Mr. LI Pengde | Deputy Director General, China Geological Survey |
| 5 | Mr. JI Yongjun | Deputy Director General, Personnel Department of the Chinese People's Association for Friendship with Foreign Countries |
| 6 | Mr. HU Baolin | Honorary Dean of Research Institute of China Green Development of Tianjin University; Former Deputy Director, Executive Office of The Three Gorges Project Construction Committee of the State Council |
| 7 | Ms. DONG Xiaojun | Deputy Director, Division of Economics of the Chinese Academy of Governance |
| 8 | Mr. ZHANG Yongsheng | Director-General and Research Fellow, Research Institute for Eco-civilization, Chinese Academy of Social Sciences |
| 9 | Mr. ZHANG Yuanhang | Dean, College of Environmental Sciences and Engineering of Peking University; and Academician of the China Academy of Engineering |
| 10 | Mr. HE Kebin | Dean and Professor, School of Environment, Tsinghua University; and Academician of the China Academy of Engineering |

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| 11 | Mr. ZHAO Zhongxiu | President, Shandong University of Finance and Economics |
| 12 | Mr. YE Yanfei | Senior Inspectorate Advisor, Policy Research Bureau of the China Banking and Insurance Regulatory Commission |
| 13 | Mr. CHEN Xinjian | Vice President, Industrial Bank |
| 14 | Mr. MA Jun | Chairman, Green Finance Committee of China Society for Finance and Banking; and Former Chief Economist, Research Bureau of the People's Bank of China |
| 15 | Ms. LIU Kun | General Manager, Medical and Health Division, China General Technology (Group) |
| 16 | Mr. LIU Tianwen | Founder, Chairman and CEO, iSoftStone Holdings Ltd. |
| 17 | Mr. ZHAI Qi | Executive Secretary General, China Business Council for Sustainable Development |

International Special Advisors

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| 1 | Mr. Iskandar
Abdullaev | Deputy Director, Central Asia Regional Economic Cooperation Institute; Former Executive Director, The Regional Environmental Center for Central Asia |
| 2 | Mr. Knut Halvor
Alfsen | Former Head Research Director, Center for International Climate and Environmental Research |
| 3 | Mr. Howard Bamsey | Chair, Global Water Partnership; Honorary Professor in the School of Regulation and Global Governance at the Australian National University |
| 4 | Mr. Manish Bapna | President and Chief Executive Officer, the Natural Resources Defense Council |
| 5 | Mr. Dimitri de Boer | China Country Director, ClientEarth |
| 6 | Mr. Guillermo
Castilleja | Former Senior fellow, the Gordon and Betty Moore Foundation |

7	Ms. Galit Cohen	Deputy Director General for Policy and Planning, Ministry of Environmental Protection of the State of Israel
8	Mr. Stephan Contius	Commissioner for the 2030 Agenda for Sustainable Development, the Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Germany
9	Ms. Jeanne-Marie Huddleston	Director General of Bilateral Affairs and Trade, the International Affairs Branch of Environment and Climate Change Canada
10	Mr. Yannick Glemarec	Executive Director, Green Climate Fund
11	Ms. Isabel Hilton	Senior Advisor, China Dialogue
12	Ms. Lisbeth Jespersen	Former Head of International Partnerships and Fundraising, IDH, the Sustainable Trade Initiative; Former Head of Secretariat, Global Green Growth Forum
13	Mr. Johan C.I. Kuylenstierna	Research Leader, Stockholm Environment Institute
14	Ms. Bernice Lee	Research Director - Futures, Chatham House
15	Mr Zafar Makhmudov	Executive Director, the Regional Environmental Centre for Central Asia
16	Ms. Jane McDonald	Executive Vice President, the International Institute for Sustainable Development
17	Ms. Désirée McGraw	Former President and Head, College of Pearson College UWC
18	Mr. Hans Mommaas	Director-General, PBL Netherlands Environmental Assessment Agency
19	Mr. Ismo Tiainen	Director-general, Administration and International Affairs, Ministry of the Environment, the Republic of Finland
20	Mr. Hau Sing Tse	Executive Director, African Development Bank for Canada, China, South Korea and Kuwait

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| 21 | Mr. Dominic Kailash
Nath Waughray | Former Managing Director and Head of Centre
for Global Public Goods, World Economic Forum |
| 22 | Mr. ZHANG Hongjun | Partner, Holland & Knight |
| 23 | Mr. ZHANG Jianyu | Vice President and China Project Director,
Environmental Defense Fund |
| 24 | Mr. ZOU Ji | CEO & President of Energy Foundation China |