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Implementation Pathways, Priority Areas, and Policy Measures for the New Round of NDC Targets



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Implementation Pathways, Priority Areas, and Policy Measures for the New Round of Nationally Determined Contribution Targets

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Executive Summary

This year's study focuses on the implementation pathways, key areas, and policy measures for the new round of Nationally Determined Contributions (NDCs). Against the backdrop of evolving global climate governance and energy transition, the study reviews global climate governance trends, analyzes China's role and contribution in global climate governance, examines pathways for aligning China's new round of NDCs with the 15th Five-Year Plan and the 2035 NDC targets, and explores implementation approaches in key areas including energy systems, industrial systems, technological innovation and institutional reform. The study aims to provide policy recommendations for China's efforts to advance carbon peaking and carbon neutrality, improve the quality of green and low-carbon transformation, and participate in global climate governance cooperation.

Currently, global climate governance is facing an increasingly complex international environment. On the one hand, climate risks continue to intensify, with the impacts of climate change, including global warming and extreme weather events, becoming increasingly evident. Climate risks are increasingly intertwined with issues such as food security, energy security, industrial chain stability, financial security, and social equity. On the other hand, geopolitical conflicts, energy price fluctuations, industrial competition, trade frictions, and fiscal constraints are affecting countries' climate policy priorities. Multilateral climate governance faces challenges including insufficient political momentum, inadequate financial support, and weak implementation capacity. Meanwhile, endogenous momentum for global low-carbon transformation continues to grow. Clean energy technologies such as solar photovoltaics, wind power, energy storage, and electric vehicles are advancing rapidly, and clean energy investment continues to expand. Low-carbon transformation is becoming an important direction for economic growth, technological innovation, and industrial upgrading. However, challenges related to grid integration, market mechanisms, green finance, carbon emission data, critical material supply, and international rule coordination continue to constrain global low-carbon transformation.

The 15th Five-Year Plan period represents a critical phase for China to achieve carbon peaking, advance the carbon emission dual-control system, and promote comprehensive green transformation of economic and social development. It is also a critical period for implementing the new round of NDCs and establishing a pathway toward stable emission reductions after the emissions peak. In recent years, China has established a policy framework for achieving carbon peaking and carbon neutrality, and has made progress in renewable energy development, green and low-carbon industries, carbon markets, and green finance. At the same time, China's green and low-carbon transformation faces challenges including optimizing the development model of renewable energy industries, building a new-type power system, improving carbon emission management systems and responding to changes in international green trade rules. Further efforts are needed to coordinate energy transition, carbon emission management, industrial policies, market mechanisms, fiscal and financial policies, and international cooperation, and to develop a more systematic pathway for green and low-carbon transformation.

The report includes the following aspects: first, it reviews new developments in global climate governance and energy transition, analyzing changes in the global climate governance system, competition in green and low-carbon industries, and the opportunities and challenges facing China in playing a constructive leadership role. Second, it examines implementation pathways for China's new round of NDCs in alignment with the 15th Five-Year Plan and the 2035 targets, focusing on energy systems, industrial systems, technological innovation,

and institutional reform. Third, it addresses gender mainstreaming in the energy transition process and proposes relevant recommendations for promoting women's participation in green industries. Finally, based on changes in domestic and international circumstances, the report puts forward policy recommendations for implementing China's new round of NDCs, advancing green and low-carbon transformation, and strengthening global climate governance cooperation.

The main findings and conclusions of the report are as follows:

First, global climate risks are intensifying, while global low-carbon transformation continues to maintain momentum. The impacts of climate change are becoming increasingly evident, and global climate governance faces challenges including insufficient political momentum, inadequate financing, and limited implementation capacity. At the same time, clean energy technologies continue to advance, global clean energy investment continues to grow, and renewable energy is becoming an important source of new electricity supply. Future global climate governance needs to further strengthen implementation capacity and promote synergies between climate objectives and goals related to economic development and energy security.

Second, global low-carbon transformation is moving from a stage of technological development toward systemic adjustment. Emerging technologies and approaches, including wind power, solar photovoltaics, energy storage, smart grids, virtual power plants, demand-side response, and end-use electrification are driving changes in energy systems. However, challenges related to grid development, market mechanisms, green finance, critical material supply and supply chain coordination remain important factors affecting the quality and pace of transformation.

Third, China faces increasing expectations in global climate governance and needs to further enhance its constructive leadership role. China has accumulated important experience in renewable energy development, green and low-carbon industries, energy transition practices, and South-South cooperation. Against the backdrop of widening gaps in global climate governance, intensified competition in green industries, and growing green transition needs among developing countries, China needs to further promote the transformation of its domestic practices into approaches for international cooperation.

Fourth, implementing the new round of NDCs requires stronger coordination among energy, industrial, and institutional systems. China's green and low-carbon transformation requires not only adjustments in the energy structure, but also improvements in carbon emission management systems, development of green industries, strengthening of technological innovation, and optimization of fiscal and financial policy systems, thereby creating conditions for further emission reductions.

Fifth, gender mainstreaming in the energy transition process needs to be further promoted. The green and low-carbon transition will bring changes in industrial structures and employment patterns. Attention should be given to women's participation opportunities in green industries, capacity building should be strengthened, and gender equality objectives should be integrated into climate governance processes.

Based on the above analysis, the report puts forward the following policy recommendations:

First, strengthen China's constructive leading role in global climate governance and low-carbon transition, proactively contribute to global climate public goods, and gradually enhance China's global climate leadership. China should continue to uphold the multilateral climate governance system centred on the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement; strengthen communication and cooperation with the European Union, the United Kingdom, Brazil, and other partners; and promote global climate governance processes. China should also enhance cooperation in areas including global climate science,

early warning capacity building, and the mitigation of non-carbon dioxide greenhouse gases and short-lived climate pollutants.

Second, promote effective alignment between the new round of NDCs and the 15th Five-Year Plan, and accelerate transformation of energy systems and green low-carbon industries. China should promote the development of renewable energy, strengthen the construction of a new-type power system, advance green and low-carbon industries, and facilitate the transition of energy systems toward a lower-carbon, more efficient, and secure direction.

Third, improve the institutional system and market incentive mechanisms for the "Dual Carbon" goals to lay an institutional foundation for emission reductions after carbon peaking. China should further refine its legal and regulatory framework related to climate change; strengthen carbon emission accounting, monitoring, reporting, verification, and data management; enhance the role of the carbon market; and coordinate reforms of green fiscal and taxation policies, industrial policies, and relevant market mechanisms, so as to underpin long-term transition through green demand and effective investment.

Fourth, promote open, inclusive, and mutually beneficial global green and low-carbon cooperation. China should strengthen cooperation on green and low-carbon technologies and industries; support green transformation in developing countries; enhance cooperation on clean energy, green infrastructure, and capacity building; and advance more practical cooperation outcomes.

Fifth, advance gender equality in climate governance. China should boost women's participation and capacity building in green industries and climate governance, and advance the further implementation of gender equality considerations throughout the climate governance process.

Key words:

global climate governance; Nationally Determined Contributions (NDCs); the 15th Five-Year Plan; green and low-carbon transformation; energy transition; carbon peaking and carbon neutrality goals; climate governance co-benefits; South-North-South Cooperation; South-South Cooperation

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1. Introduction

Addressing climate change remains a critical issue for global sustainable development and international cooperation, yet global climate governance has entered a more complex phase. On the one hand, the physical impacts of climate change continue to intensify. Global temperature rise, ocean heat content, sea level rise, glacier retreat, and extreme weather events are repeatedly breaking historical records. Climate risks have evolved from long-term environmental risks into systemic risks that undermine food security, energy security, industrial chain stability, financial security, and social equity. On the other hand, geopolitical conflicts, energy price volatility, industrial competition, trade frictions, and fiscal constraints are reshaping national policy priorities. Climate issues are becoming more closely intertwined with economic security, industrial security, and supply chain security. Multilateral climate governance is confronted with challenges including insufficient political momentum, poor delivery of finance, and weak accountability.

At the same time, the underlying momentum for the global low-carbon transition continues to strengthen. The costs of clean energy technologies such as solar PV, wind power, energy storage, and electric vehicles continue to fall; clean energy investment has surpassed fossil energy investment; and renewable energy is becoming an important source of new power supply. In particular, a new energy system represented by renewable energy, new energy storage, smart grids, virtual power plants, demand-side response, and end-use electrification is reshaping the meaning of energy security and industrial competitiveness. The low-carbon transition is no longer merely an emissions constraint; it is also becoming an important driver of economic growth, technological innovation, industrial upgrading, and employment restructuring. However, growth in clean energy investment does not automatically translate into stronger institutional momentum. Grid connection, market mechanisms, green finance, carbon emissions data, critical material supply, and coordination of international rules remain key bottlenecks affecting the quality and speed of the transition.

The 15th Five-Year Plan period will be a critical stage for China to peak carbon emissions, advance the development of the dual control system for carbon emissions, and establish a stable downward trend after the peak. It will also be an important window for China to update and implement the new round of Nationally Determined Contribution (NDC) targets and advance the comprehensive green transformation of economic and social development. At the same time, scaling up controls on non-CO_2 greenhouse gases—including methane, nitrous oxide, and fluorinated gases—is critical for achieving China's economy-wide climate targets. These pollutants offer significant near- and long-term mitigation potential across the energy, industrial, agricultural, and waste sectors. China has largely established the "1+N" policy framework for dual carbon goals[1], and has made significant progress in installed renewable energy capacity, green and low-carbon industries, carbon market development, and green finance. By the end of 2025, China's total installed renewable energy capacity was approximately 2,340 GW, accounting for about 60% of total installed capacity. Combined installed wind and solar PV capacity increased from 530 GW in 2020 to 1,840 GW in 2025, historically surpassing thermal power. New technologies and models such as new energy storage, virtual power plants, vehicle-grid interaction, and the coordination of generation, grid, load, and storage, have also accelerated. These developments have laid

[1] The "1+N" policy system constitutes China's top-level policy framework for the dual carbon goals. The "1" refers to the overarching guiding document for dual-carbon work, while "N" denotes a set of supporting implementation plans and guarantee policies for different sectors, industries, and regions.

the foundation for China to build a new energy system with non-fossil energy as the mainstay and to make green and low-carbon industries a new driver of economic growth.

At the same time, China's green and low-carbon transition is facing new stage-specific challenges. In parts of the new energy industry, capacity expansion has outpaced the release of application scenarios, price competition has intensified, and profit margins have fallen. The development of a new power system is still constrained by grid dispatch, market mechanisms, long-duration energy storage, capacity compensation, and ancillary service mechanisms. As the carbon emissions management system shifts fully toward dual controls on carbon emissions, capacities for carbon emissions statistical accounting, monitoring, reporting and verification, local assessments, carbon market based on cap-and-trade, and rule-of-law-based data management still need to be strengthened. Internationally, green trade barriers, security of supply chains, competition over critical minerals, and divergence in technical rules are also raising the bar for China's international cooperation in green industries. These issues mean that China's next-stage climate policy cannot rely only on target setting. It must coordinate energy transition, carbon emissions governance, industrial policy, market mechanisms, fiscal and financial tools, and international cooperation into a more systematic implementation pathway.

This report studies the implementation pathways, priority areas, and policy measures for the new round of NDC targets. It first assesses new developments in global climate governance and energy transition, and analyzes the opportunities and challenges China faces in playing a constructive leading role in global climate governance. It then reviews the implementation pathways for the energy system, industrial system, technological innovation, and institutional reform in relation to China's new NDC, the 15th Five-Year Plan, and the 2035 targets. The report also focuses on gender mainstreaming in the energy transition and proposes pathways to strengthen women's capacity to participate in green industries. Finally, based on current domestic and international conditions, it puts forward policy recommendations for the 15th Five-Year Plan, NDC implementation, and global climate governance cooperation. The report aims to provide decision-making reference for China to prudently advance carbon peaking and carbon neutrality, improve the quality of the green and low-carbon transition, and strengthen its constructive role in global climate governance.

2. Enhancing China's Leading Role in Global Climate Governance and Low Carbon Transition

2.1 Assessment of the Global Climate Governance Landscape: Climate Risks Are Intensifying, While Political and Institutional Momentum is Slowing, Requiring a Shift From Target-Driven Governance to Benefit-Driven and Implementation-Driven Governance

2.1.1 The Physical Realities of Climate Change Continue to Intensify, While the Political Priority of Climate Issues is Declining

According to the World Meteorological Organization's State of the Global Climate 2024, released in March 2025, 2024 was the hottest year on record, with the global mean near-surface temperature 1.55 +/- 0.13 C above the pre-industrial period (1850 to 1900). It was the first calendar year in 175 years of observations in which the annual mean temperature exceeded the 1.5 C threshold. Independent data from the EU Copernicus Climate Change Service (C3S) confirmed the same milestone. It should be noted that a temporary one-year exceedance of 1.5 C is not equivalent to the long-term breach referred to in the Paris Agreement. Nevertheless, this event sends a strong warning signal: the long-term warming trend is approaching irreversible tipping points faster than expected.

Since 2024, the frequency, intensity, and scope of extreme weather events have all set new records. The WMO expects a strong El Niño may form in 2026, bringing cascading impacts including heatwaves, floods, and droughts.

Heat impacts are highly pronounced. In 2026, many countries and regions, represented by European nations, have been hit by exceptionally early and intense heatwaves. In late May, Western Europe experienced a rare early-season heatwave, with daily average temperatures in western France, England, Wales, and other areas exceeding the seasonal average by more than 10 ℃. Portugal, the United Kingdom, Ireland, and other countries recorded their highest May temperatures, and France experienced its hottest day in May on record. In late June, the European heatwave intensified and expanded into Central, Eastern, and Southern Europe, and the Balkans, with many countries issuing red heat alerts. Germany, the Netherlands, Austria, Hungary, and other countries set national or regional temperature records, with some areas exceeding 40 ℃. Extreme heat directly affected energy system stability. In France, rising river temperatures and cooling-water restrictions forced reductions in nuclear output. EDF data showed that French nuclear output fell by about 4.1 GW at one point,

equivalent to about 7% of total power demand at the time, and two reactors were temporarily shut down to meet environmental requirements for protecting river ecosystems[1]. This shows that climate risks affect not only the energy demand side, but also the supply capacity of traditional stable power sources.

Flood disasters have also occurred frequently. In early 2026, heavy rainfall and cyclones caused widespread flooding in Southern Africa, affecting about 1.5 million people in Mozambique, Madagascar, South Africa, Zambia, and other countries, killing more than 300 people and displacing more than 170,000[2]. In July, fueled by a tropical storm and persistent heavy rainfall, severe flooding hit Guangxi and other regions in southern China, causing dozens of fatalities and large-scale population displacement[3].

Drought is also a serious concern. The Amazon basin experienced a once-in-a-century drought in 2024, with major tributaries falling to record-low levels, severely affecting navigation, fisheries, and the livelihoods of riverine communities. Several countries in Southern Africa have faced consecutive years of agricultural drought, posing severe threats to food security.

Analyses by World Weather Attribution (WWA) indicate that the probability and intensity of most of these extreme events have been significantly increased by human-induced climate change.

The risk of climate tipping points is moving from academic debate to practical concern. The Global Tipping Points Report 2025, released in October 2025, notes that global coral reef ecosystems have formally crossed their climate tipping point: the fourth global bleaching event has covered most coral reef regions, and iconic ecosystems such as the Great Barrier Reef face fundamental threats to survival. This is the first key element in the Earth's climate system scientifically confirmed to have crossed a tipping point[2]. Meanwhile, other tipping points are approaching rapidly. Instability and melting of the Greenland ice sheet and the West Antarctic Ice Sheet are accelerating; if they collapse completely, sea levels could rise by several meters or even more than 10 meters. Parts of the Amazon Rainforest have shifted from carbon sinks to carbon sources, creating a dangerous feedback loop between forest degradation and climate warming. The weakening of the Atlantic Meridional Overturning Circulation (AMOC) has been confirmed by multiple observational studies; if it collapses, it would fundamentally alter climate patterns in Europe and Africa. These tipping points may trigger one another: the collapse of one system could increase the probability that other systems cross their thresholds. This "compound tipping-point risk" means that the window for climate action may be more urgent than previously estimated.

Contrary to rising physical risks, the priority of climate issues on the international political agenda is declining. Cyclical swings in U.S. climate policy have weakened stable expectations for the multilateral system and increased doubts about the continuity of compliance by major emitting economies. Although the European Union continues to uphold its 2050 climate neutrality direction, its policy focus in recent years has clearly shifted toward competitiveness, strategic autonomy, energy prices, and industrial resilience. Climate policy increasingly needs to accommodate industrial affordability, employment impacts, and supply chain security objectives. In other words, major economies including Europe and the United States have not denied climate risks, but they are increasingly embedding climate goals into their economic security and industrial competition frameworks.

The efficiency and effectiveness of multilateral climate governance are also facing greater scrutiny. The COP process remains the main channel for global climate governance, but negotiations on finance delivery, adaptation indicators, loss and damage, technology transfer, and transparency accountability have advanced

[2] https://www.who.int/publications/m/item/public-health-situation-analysis---flooding-across-southeast-africa.

[3] https://news.southcn.com/node_47a8059d6c/3eee5293c0.shtml.

slowly. Some countries have been slow in submitting or updating their new NDCs, weakening confidence in the 2035 target pathway. Around COP31, global climate governance will face a sharper question: if climate risks accelerate while political mobilization, finance supply, and implementation accountability remain insufficient, how can the multilateral system re-prove its effectiveness? Climate governance therefore cannot rely only on target consensus to maintain momentum; it must rebuild political feasibility through more concrete finance, technologies, industries, and development benefits.

This also means that the key to addressing climate change in the future is not only to "raise ambition," but also to reinterpret the relationship between climate action and economic and social benefits. The COP30 decisions also stress reorienting work priorities towards implementation[3]. In the past, global climate governance was largely narrated around long-term emission reduction responsibilities and global public goods. Today, confronted with realities including high inflation, volatile energy prices, mounting debt pressure, and intensifying industrial competition, national governments face greater needs to demonstrate that climate policies can deliver lower energy costs, job creation, industrial upgrading, improved public health, and reduced disaster losses. If climate issues cannot be clearly linked to these short- and medium-term benefits, their political priority will continue to be squeezed by security, growth, and fiscal concerns. Therefore, the next phase of climate governance must shift from a "target-driven" model toward "benefit-driven" and "implementation-driven" models.

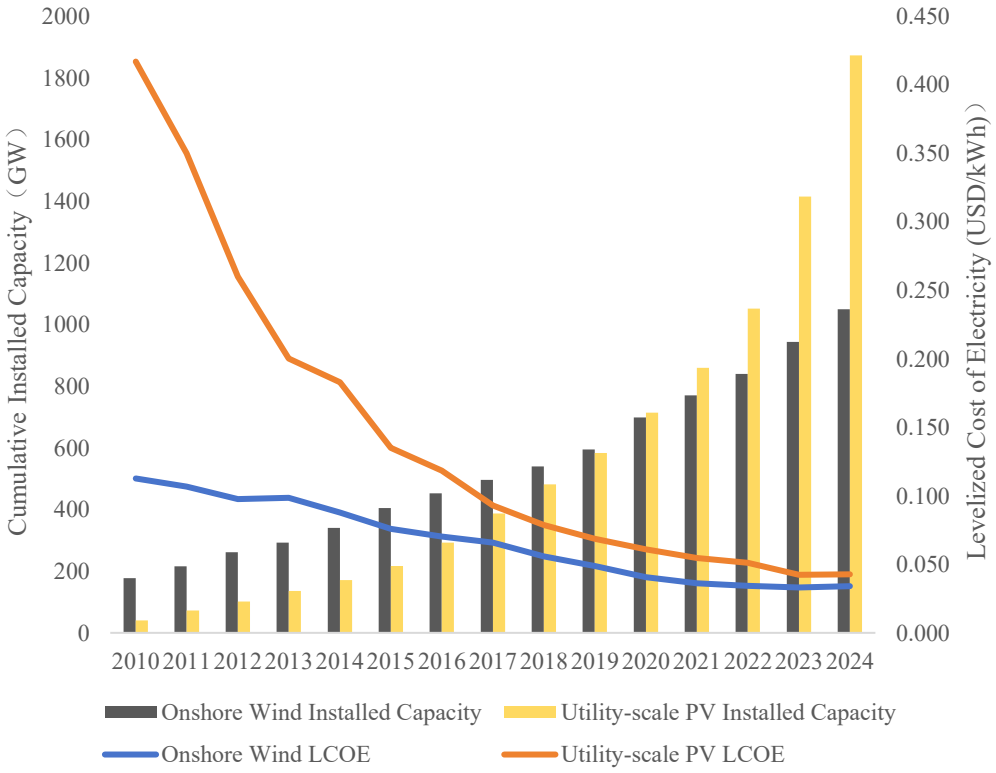
2.1.2 Clean Energy Investment Has Reached a New High, but Institutional Momentum for the Global Low-Carbon Transition Has Slowed Significantly

Global clean energy investment and technology deployment continue to expand, which is the most certain positive variable in current climate governance. IEA's Global Energy Review 2026 shows that global energy investment reached USD 3.3 trillion in 2025, of which USD 2.3 trillion went to clean energy. Renewable energy and nuclear power together contributed about 42% of global electricity generation, and new renewable energy capacity approached 800 GW[4]. The IEA's World Energy Investment 2026 states that global energy investment will reach USD 3.4 trillion in 2026, of which about USD 2.2 trillion will flow to grids, storage, renewable energy, nuclear power, electrification, and low-emission energy, accounting for nearly two-thirds of total investment. By contrast, oil investment has declined for a third consecutive year[5]. These data show that the industrial and technological foundations of the low-carbon transition have not reversed; clean energy remains an important direction for global energy investment and manufacturing competition.

According to IRENA, from 2010 to 2024, the total installed cost of global utility-scale solar PV fell by 87%, with the levelized cost of electricity (LCOE) dropping to USD 0.043/kWh, 41% cheaper than the lowest-cost fossil fuel alternative. The total installed cost of onshore wind fell by 55%, and its LCOE dropped to USD 0.034/kWh, making it one of the cheapest new power sources globally and 53% cheaper than fossil fuel power generation. Offshore wind LCOE fell by 62% from 2010. In 2024, 91% of newly commissioned utility-scale renewable power projects had lower costs than the cheapest new fossil fuel alternative[6] (Figure 2-1). The decline in storage prices has also exceeded market expectations. Ember reports that prices of stationary storage battery packs fell another 45% in 2025 from 2024, reaching a record low. The sharp fall in storage costs gives power grids strong time-shifting dispatch capability. IRENA's analysis shows that around-the-clock wind-solar-storage systems are becoming cost-competitive with fossil energy: with moderate overbuilding of wind and solar capacity combined with battery storage, new green power assets can provide reliable round-the-clock

supply at competitive cost. Most utility-scale solar PV projects commissioned in China in 2024 have already reduced around-the-clock solar-storage costs to below USD 0.1/kWh. Under a 99% reliability target, the lowest costs for some solar-storage projects were only USD 0.046/kWh, lower than the cost of new coal and gas power. IRENA projects that in high-quality global wind and solar resource areas, the cost of around-the-clock solar-storage electricity will fall by another 30% by 2030. This means future global power systems can rely on increasingly affordable around-the-clock wind-solar-storage clusters to replace traditional fossil energy with higher quality and lower cost.

Figure 2-1. Cumulative installed capacity and levelized cost of electricity for wind and solar PV, 2010–2024 (GW, USD/kWh)



Data source: compiled from IRENA (2025)[7]

However, investment growth and cost reduction have not been accompanied by stronger institutional momentum. The World Economic Forum notes that global energy transition progress in 2026 has almost stalled, and transition readiness[4], or enabling conditions for transition, declined for the first time in more than a decade. The finance and investment dimension fell by 1.8%, regulation and political commitment by 1.2%, innovation by 1.1%, and infrastructure also edged down[4],[5]. This indicates a mismatch in the global low-carbon transition:

[4] Policy, finance, innovation, infrastructure, and human capital foundational conditions that sustain energy transition progress.

[5] The figures above represent year-on-year changes in the average scores of the 120 countries covered by the World Economic Forum's Energy Transition Index (ETI) across the respective dimensions. Each dimension is assessed using multiple indicators: finance and investment covers sovereign credit ratings, domestic credit to the private sector, restrictions on foreign direct investment, and clean energy investment; regulation and political commitment covers energy regulation, net-zero commitments, policy stability, and carbon pricing; innovation covers the innovation environment, R&D expenditure, and the diffusion of environmental technologies; and infrastructure covers renewable energy capacity development, transport and digital infrastructure, AI readiness, and exposure to critical-mineral supply chains. Individual indicators are normalized to a 0–100 scale using a min–max method and then aggregated through the ETI framework. Global averages are calculated as the simple average of country scores and are not weighted by population or GDP.

technologies and capital continue to move forward, while institutional and political support is slowing. Clean energy is increasingly cost-competitive, but grid access, permitting, long-term finance, cross-border supply chains, and policy stability have become more prominent constraints. More than 2,500 GW of renewable energy, storage, and large new load projects are still waiting for grid connection worldwide[4], showing that growth in clean energy capacity does not automatically translate into systemic emissions reductions.

This divergence has pushed the global transition into a new bottleneck stage. Over the past decade, policy debate focused mainly on whether clean energy could become cheaper than fossil energy. In the next decade, the key question will be whether clean energy can be absorbed at scale, stably, and fairly, into grids, markets, finance, and industrial rules. Therefore, the low-carbon transition is not a simple process of technological substitution; it requires simultaneous adjustment of power systems, financial systems, trade rules, industrial policies, and social distribution mechanisms.

The slowdown in institutional momentum has multiple overlapping causes. High interest rates and inflation have raised project capital costs, making it especially difficult for clean energy projects in emerging economies and developing countries to obtain long-term low-cost financing. Delays in grids and permitting prevent many renewable energy projects from being connected in time. Shrinking scope for fiscal subsidies, compounded by shifting political cycles, erodes policy continuity. Faced with trade barriers, investment screening, and localization requirements, green industries see further heightened uncertainty in cross-border supply chains.

At the same time, the current energy transition is becoming more uneven globally. Only about 24% of economies have improved their energy systems simultaneously across security, affordability, and sustainability[4]. This reveals a structural challenge: if clean energy investment is concentrated only in a small number of economies with better financing conditions and stronger institutional capacity, record-high global investment will not automatically produce a universal transition. Clean energy investment growth is necessary but not sufficient. Only when grids, market mechanisms, fiscal policies, financial tools, and social affordability improve together can investment be truly converted into emissions reductions, energy security, and development benefits.

In fact, the current global challenge is not a lack of capital, but a lack of effective financing mechanisms that can channel capital into green projects in developing countries. Many green projects in developing countries face excessive financing costs, often several times those of comparable projects in developed countries. IEA research shows that financing costs have become a decisive factor in renewable energy project economics[8]. In African renewable energy projects, 60% to 90% of financing costs in 2022 came from country-level risk premiums, compared with only 10% in developed countries, rather than from energy technologies themselves. Exchange-rate instability, sovereign credit risk, inadequate guarantee mechanisms, policy and regulatory uncertainty, and immature local financial markets jointly push up green project financing costs.

In the long term, climate finance gaps and investment opportunities coexist. Climate finance needs to shift from “pledging more money” to “reducing the cost of delivering capital.” There is huge investment demand in global new energy, green infrastructure, and climate adaptation. It is urgent to improve risk-sharing mechanisms, promote blended finance, deepen multilateral development bank reform, and innovate green guarantee mechanisms to improve project bankability and mobilize more commercial capital into developing country markets. Zambia’s Scaling Solar project shows that risk mitigation instruments such as sovereign guarantees, political risk insurance, and concessional financing can significantly reduce financing costs and attract private capital[9]. Therefore, future global climate governance should continue to urge developed countries to fulfill

their finance commitments and ensure the delivery of multilateral finance, while also shifting climate finance from limited public support toward large-scale mobilization of market capital.

In recent years, China has become an important driver of global clean energy technology innovation and industrialization. Through cooperation mechanisms such as the Belt and Road Initiative, China has expanded the application of its technologies and industrial capabilities in solar photovoltaics, wind power, energy storage, electric vehicles, and other clean energy sectors to global markets. For example, in the United Arab Emirates, Chinese companies have participated in the development of the Mohammed bin Rashid Al Maktoum Solar Park, where Chinese photovoltaic enterprises have provided components and technologies, while the Silk Road Fund has participated in project investment, contributing to large-scale solar energy deployment in the country[10]. In Pakistan, the Karot Hydropower Project, in which Chinese companies participated in construction, represents an important achievement of green energy cooperation under the Belt and Road Initiative. The project, with a total installed capacity of 720 MW, was jointly invested and developed by companies affiliated with China Three Gorges Corporation and commenced commercial operation in 2022[11]. It provides Pakistan with stable clean electricity and serves as a representative example of China's overseas cooperation in hydropower technology and green infrastructure development. By expanding cooperation on green and low-carbon technologies and overseas clean energy investment, China is providing important support to developing countries in reducing transition costs and improving the bankability and implementation capacity of clean energy projects.

2.1.3 Trade, Industrial Chains, and Technological Competition are Reshaping Climate Governance, Making Climate Issues More "Economic-Security Oriented"

Climate governance is evolving from a relatively independent emissions reduction agenda into an economic-security agenda deeply intertwined with trade, industrial chains, and technological competition. As the low-carbon transition enters the industrialization stage, emissions reduction targets are increasingly bound to industrial competitiveness, supply chain autonomy, and technological leadership. Climate policy tools have expanded from traditional environmental regulations such as carbon pricing and emissions standards to measures with economic-security attributes, including trade barriers, industrial subsidies, and export controls.

The EU Carbon Border Adjustment Mechanism (CBAM) entered its definitive phase on January 1, 2026, integrating carbon costs directly into the compliance framework for imported goods, establishing a more explicit institutional linkage between emissions information, carbon pricing, and international trade rules. Policies such as the EU Battery Regulation, the Net-Zero Industry Act, and the Critical Raw Materials Act have also incorporated carbon footprints, supply chain due diligence, local manufacturing, and strategic raw material security into climate policy frameworks. These rules promote decarbonization, but they also increase compliance costs for exporters, making carbon data, product carbon footprints, third-party verification, and supply chain traceability new thresholds for international competition.

At the same time, competition in green industrial chains is strengthening the use of tariffs and investment review tools. In 2024, the United States announced higher Section 301 tariffs on Chinese electric vehicles, solar cells, lithium batteries, critical minerals, steel and aluminum, semiconductors, and other products. Tariffs on electric vehicles were raised to 100%, those on solar cells to 50%, and those on lithium-ion batteries and battery components to 25%[12]. The European Union also imposed countervailing duties on Chinese electric vehicles in 2024, with rates covering BYD, Geely, SAIC, and foreign-invested brands produced in China, and a maximum

rate of 35.3%[13]. These measures show that although green and low-carbon products serve global emissions reductions, their cross-border flows are increasingly constrained by domestic objectives related to industrial security, employment, supply chain resilience, and strategic autonomy. Meanwhile, policy interactions in this area have shown a trend of mutual reinforcement. In response to the strengthening of export controls, investment screening, and green industrial protection measures by some economies, China has also taken measures to address external policy changes by improving its export control framework, strengthening the management of critical resources, and utilizing multilateral trade dispute settlement mechanisms. For example, China introduced export controls on certain items related to medium and heavy rare earths in 2025 and initiated a case at the World Trade Organization (WTO) concerning the European Union's definitive countervailing measures on Chinese electric vehicles.

As a result, the competitive focus of climate governance is shifting from "who pledges more emissions reduction targets" to "who defines the rules for low-carbon products, low-carbon supply chains, and green investment." This has a dual impact on China. On the one hand, China's scaled green industrial capacity has significantly reduced global low-carbon technology costs and provided practical support for global emissions reductions. On the other hand, precisely because this industrial advantage is prominent, China is more likely to become the target of trade remedies, supply chain reviews, and rule-based exclusion.

From a governance perspective, the economic securitization of climate issues will also change negotiation actors and policy tools. In the past, climate negotiations were mainly led by environmental departments and relied on emissions targets, carbon markets, finance commitments, and technology transfer. Today, fiscal, trade, industrial, energy, diplomatic, and security departments are deeply involved, and tools now include tariffs, subsidies, procurement rules, investment screening, export controls, data rules, and critical minerals agreements. This change brings climate governance closer to economic reality, but also makes it more vulnerable to short-term industrial interests. When participating in international rule-making, China needs to consider climate change, industrial development, trade, and finance together in order to propose solutions that combine emissions reduction effectiveness with economic feasibility.

It should be emphasized that the security risks of green and low-carbon technologies are generally different from fossil energy dependence. Once deployed, solar PV modules, batteries, wind power equipment, and electric vehicles become local energy assets and emissions reduction capacities, and do not inherently create continuous fuel import dependence. What truly needs to be managed are specific issues such as data security, supply chain transparency, critical mineral sourcing, labour rights, and environmental and social risks, rather than securitizing low-carbon technologies as a whole. There remains significant space for international cooperation. The key is to manage risks through transparent standards, mutual recognition of carbon data, supply chain due diligence, and localized benefit sharing, rather than raising global transition costs through broad securitization.

Therefore, in the future, China's participation in global climate governance should not focus solely on its domestic emissions reductions and contributions to green industries, but should also develop more internationally acceptable institutional approaches to carbon accounting, product standards, green finance taxonomies, supply chain due diligence, and mechanisms for localized cooperation. This would help better demonstrate the emissions-reduction value of China's industrial contributions; address international concerns regarding environmental impacts, supply chain risks, and the distribution of benefits; and reduce regulatory frictions facing Chinese green products and technologies as they enter global markets.

2.1.4 Geopolitical Conflicts Are Redefining Energy Security, and the World Stands at a Three-Way Crossroads in Energy Transition

Continued tensions in the Middle East, the prolonged Russia-Ukraine conflict, and risks to key maritime routes have brought energy price volatility, oil and gas supply, price stability, strategic reserves, and trade-route security back to the centre of national policy. If energy transport corridors such as the Strait of Hormuz are disrupted, oil and gas prices, insurance costs, and supply stability will all be affected. Economies highly dependent on imported fossil fuels will be more vulnerable to inflation and fiscal pressure. Under such pressure, some economies may delay the phase-down of coal, oil, and gas, emphasize domestic (regional) fossil energy supply, traditional power sources as backstops, and short-term energy price stability, thereby weakening climate target constraints in the near term.

Against this backdrop, the meaning of energy security is changing. Energy security is no longer only about fuel supply, but also about comprehensive capacity covering grids, minerals, infrastructure, reliability, and resilience[4]. It is not only about whether oil and gas can be purchased, but also about whether high-share clean energy systems can be operated at low cost, stably, and securely. Once wind power, solar PV, storage, and demand-response resources are deployed locally, they have long-term security attributes by reducing dependence on imported fuels and improving system resilience. The prerequisite is that grids, storage, regulating resources, and digital operations and maintenance capabilities keep pace. At the same time, clean energy systems also depend on the supply security of grids, storage, critical minerals, inverters, batteries, digital systems, and cross-border supply chains.

The world is now moving along three possible pathways. The first is to reinforce fossil energy supply security. Amid rising geopolitical conflict, price volatility, and supply chain uncertainty, some countries are again emphasizing oil and gas and domestic resource development, seeking to ease energy security anxieties by expanding domestic fossil energy supply, locking in long-term oil and gas contracts, and strengthening control over resources. This pathway may help stabilize supply and reduce political risks in the short term, but it will also reinforce high-carbon infrastructure lock-in, raise future emissions reduction costs, and keep energy systems exposed to international fuel price fluctuations and geopolitical shocks. The second pathway is to treat clean energy as a public good that reduces fossil fuel dependence, enhances energy autonomy, and improves system resilience, and to lower global transition barriers through open trade, technology cooperation, and financing support. Under this pathway, wind power, solar PV, storage, grids, demand response, and energy efficiency are not only emissions reduction tools, but also important means of strengthening energy security. The scaled diffusion, cost reduction, and cross-regional cooperation of clean technologies can reduce structural dependence on imported fossil fuels and improve developing countries' access to affordable, reliable, and sustainable energy services. The third pathway is to incorporate clean technologies, critical minerals, batteries, and grid equipment into the toolkit of geopolitical competition, strengthening supply chain barriers, investment reviews, and technology blockades. This may improve domestic manufacturing capacity and supply chain security to some extent, but it may also cause market fragmentation, rising costs, slower technology diffusion, and a wider transition gap between the Global North and the Global South. The current global trajectory is swinging among these three pathways. Clean energy technologies are diffusing rapidly, and wind power, solar PV, batteries, and electric vehicles have entered scaled development, with stronger economic and security attributes. At the same time, industrial policy competition around batteries, solar PV, critical minerals, and

electric vehicles is intensifying, and green trade frictions and supply chain restructuring are becoming new structural variables. In this context, the key to future global energy security lies in whether a new balance can be formed among ensuring supply chain resilience, maintaining open cooperation, and accelerating the low-carbon transition.

2.2 Rising Expectations for Global Climate Governance and Intensifying Green Competition Place Higher Demands on China's International Climate Leadership

Against the backdrop of widening global climate governance gaps, intensifying clean technology competition, and rising transition needs in the Global South, China needs to play a larger role in global climate governance. This role is not simply about making more international statements. It is about translating China's practical capabilities in green and low-carbon technologies, engineering construction, industrial chain organization, energy transition policy, and South-South cooperation into international solutions that are easier to understand, cooperate on, finance, and replicate. However, a larger Chinese role does not mean the external environment will naturally improve. On the contrary, as China's green industrial advantages become more prominent, global governance gaps become more evident, and major economies become more sensitive to industrial security, China faces rising international expectations, rule constraints, and narrative pressure at the same time.

2.2.1 The Global Climate Governance Gap Is Widening, and International Expectations for China Are Rising Significantly

UNEP data show that even if all existing NDCs are fully implemented, warming this century could still reach 2.3 to 2.5 ℃, leaving a clear gap from the Paris Agreement goals. To return to a 1.5 ℃ pathway by 2035, global emissions would need to fall by 55% from 2019 levels[14]. This means that the international community will need not only more emissions reduction commitments, but also practical solutions that reduce transition costs, expand clean technology supply, improve financing availability, and support capacity building in developing countries. Amid swings in U.S. climate policy, shrinking fiscal space in some developed economies, and insufficient delivery of global climate finance commitments, China, as the largest developing country, a major emitter, a clean energy manufacturing centre, and an important partner of the Global South, will inevitably face higher external expectations.

These expectations are dual in nature. On the one hand, the international community expects China to continue advancing its domestic low-carbon transition, present clearer medium- and long-term emissions reduction pathways, and stabilize expectations for global climate governance. On the other hand, many developing countries expect China to provide lower-cost technologies, equipment, engineering, and financing cooperation to help them avoid high-carbon lock-in. If China emphasizes only domestic contributions, it may not be enough to respond to the global governance gap. If it assumes excessive costs in external cooperation, it will face constraints related to its domestic development, industrial security, and risk management. China therefore needs to define clearer policy boundaries among its three identities as a responsible major country, a

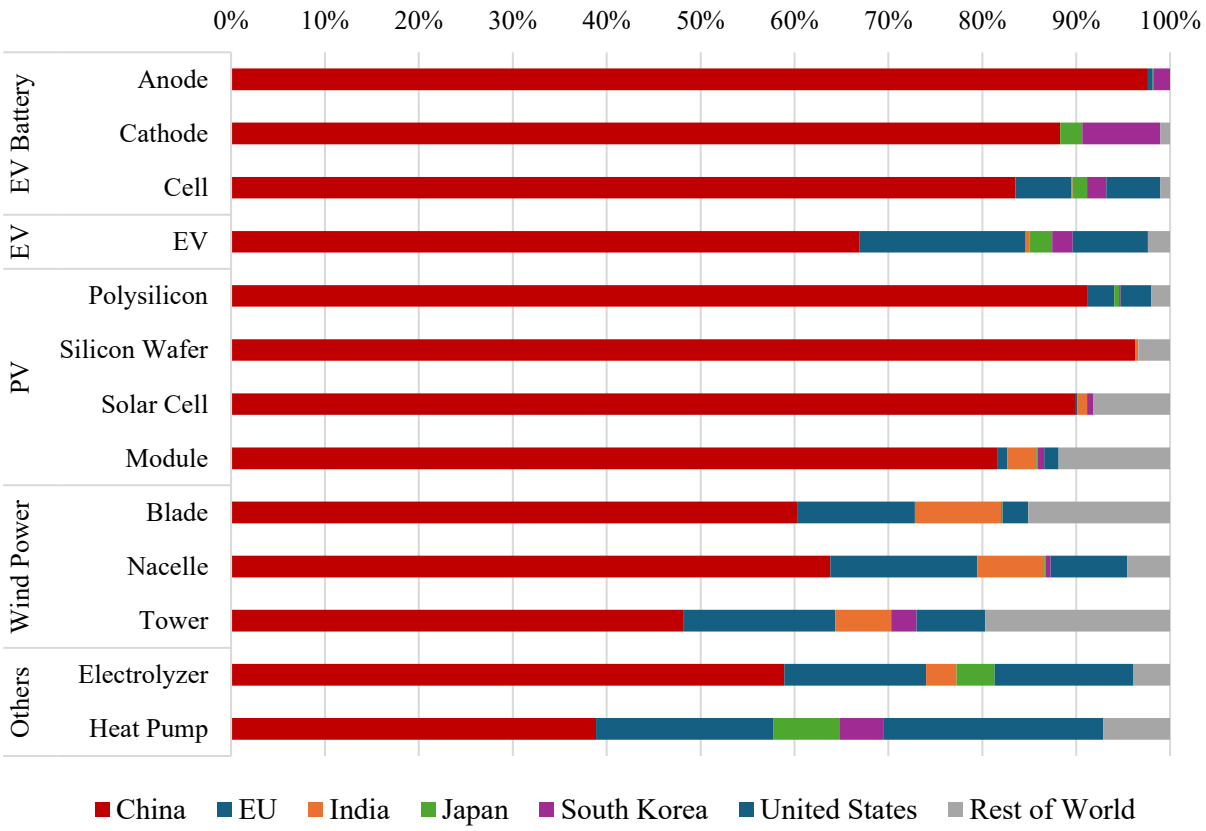
partner of developing countries, and a green industrial power. It should provide constructive public goods while avoiding passively accepting asymmetric transfers of responsibility.

The essence of this challenge is that China needs to move further from being a participant to being a provider of solutions. International expectations for China include both the stability of its domestic energy transition and whether it can provide low-cost technologies, infrastructure experience, and green finance tools for the Global South. But China is still in the process of development and transition, and must balance domestic industrial upgrading, energy security, regional development, and employment stability. Therefore, China's provision of public goods externally must adhere to the principle of common but differentiated responsibilities, and expand contributions within the boundaries of available capacity, controllable risks, and mutual benefit.

2.2.2 Green Industrial Advantages Are Encountering Trade Rules and Geopolitical Constraints

China has developed significant scale, cost, supply chain, and engineering advantages in solar PV, batteries, electric vehicles, wind power, and energy storage, substantially reducing the overall cost of the global low-carbon transition. Data show that in 2023, across different segments of clean energy supply chains, the combined production capacity of the top five producing countries exceeded 80% in all areas except heat pumps. In solar PV and battery technologies, the largest producing country, China, accounted for more than 80%, showing objectively high supply chain concentration in clean energy production[1] (Figure 2-2). However, this concentration has triggered concerns in many countries over economic and energy security risks. It has also made "overcapacity" a new policy criticism raised by Europe, the United States, and other economies against China's green industries, leading to a significant increase in trade barriers and frictions in related fields.

Figure 2-2. Share of production capacity across clean energy supply chain segments, 2023



Major economies are incorporating green industries into frameworks of industrial security and geopolitical competition, reshaping market access conditions through tariffs, countervailing investigations, local content requirements, foreign investment reviews, supply chain due diligence, and carbon border rules. In its countervailing investigation into electric vehicles, the European Union argued that China's electric vehicle value chain benefited from unfair subsidies and posed a threat of economic injury to EU producers, eventually imposing countervailing duties on battery electric vehicles imported from China starting in October 2024. The United States has also listed solar PV, electric vehicles, and lithium-ion batteries as key areas of so-called overcapacity, claiming that Chinese investment and exports affect global prices, enterprise competition, and employment. The interaction of these rules means that Chinese enterprises no longer face single-dimensional trade frictions, but a new type of institutional barrier composed of market access, carbon data disclosure, rules of origin, investment security review, and localization responsibilities.

At the same time, for industrial security reasons, Chinese enterprises must strictly comply with export controls on key low-carbon technologies, such as advanced solar wafer and lithium battery manufacturing technologies, as well as overseas investment review requirements. Internal and external constraints together have significantly increased the difficulty and compliance requirements for enterprises' cross-border deployment.

These constraints are forcing the internationalization of China's green industries to shift from "products going global" to "capabilities embedded locally." Taking the battery industry as an example, globalization in the global battery sector has not ended; rather, it has entered a new stage centred on localization, rules, and partnerships. The key to the next round of internationalization by Chinese enterprises is no longer simply selling products abroad, but embedding capabilities, building relationships, and leaving value locally. This means Chinese enterprises need to pay greater attention to host-country employment, technology diffusion, environmental and social governance, supply chain localization, carbon footprint management, and benefit-sharing mechanisms. Otherwise, low-cost advantages may be framed externally as "capacity shocks" or "dependency risks," weakening the positive contribution of China's green industries to the global transition.

In enterprise practice, external constraints have changed the core variables of overseas investment decisions. In the past, enterprises mainly compared land, labour, logistics, and market size. Today, they must also assess rules of origin, subsidy eligibility, carbon footprint accounting, foreign ownership restrictions, data compliance, export controls on key technologies, political acceptability in host countries, and the regulatory environment. The internationalization of green industries is no longer a simple commercial expansion; it is a comprehensive project involving industrial capabilities, rule adaptation, and public communication. If China cannot quickly develop higher-level compliance, ESG, and local value creation capabilities, its market space may be weakened by rule thresholds even when it has technological advantages.

2.2.3 Gaps Remain Between China's Practice and International Perceptions, and Narrative Capacity Needs to Be Strengthened

China has accumulated extensive practical experience in large-scale renewable energy deployment, power system integration and consumption, electric vehicle adoption, green finance, carbon market development, industrial chain cost reduction, and South-South cooperation. Yet in international communication these experiences are often simplified into "manufacturing advantages," "government subsidies," or "overcapacity." In international climate governance, rule influence comes not only from facts themselves, but also from the

ability to translate facts into concepts, indicators, cases, and institutional language that the international community can understand, verify, and adopt. Many of China's practices remain at the project, enterprise, or department level, and have not yet been fully transformed into systematic international knowledge products and rule initiatives.

Insufficient narrative capacity will exert tangible impacts at the policy level. First, the international community tends to underestimate China's contribution to global emissions reductions and cost decline in green industries, while amplifying subsidy, capacity, and security risks. Second, China's project experience in cooperation with the Global South, if lacking transparent indicators for environmental and social impact assessment, carbon emissions reduction accounting, employment, and local capacity building, can easily be interpreted by competing narratives as resource acquisition or market expansion. Third, China's complex domestic transition experience, including adjustment of the role of coal power, renewable energy integration, power market reform, local industrial transition, and green finance risk management, will find it difficult to enter global rule discussions if it cannot be expressed in comparable international language. In the future, China needs to further translate "what has been done" into "why it works, how it can be replicated, how risks are managed, and what long-term value it brings to partner countries," so that practical experience becomes a governance solution that can be communicated, verified, and cooperated on.

2.3 China Can Play a Constructive Leading Role in Global Climate Governance and the Low-Carbon Transition

China continues to improve the top-level design for addressing climate change, and has made systematic arrangements for the target direction, priority tasks, and international positioning of climate action in the new stage. This provides an important foundation for China to play a constructive leading role in global climate governance. The white paper *Carbon Peaking and Carbon Neutrality: China's Plans and Solutions* notes that China's advantages in green and low-carbon industrial development are continuously strengthening and that digitalization and greening are accelerating in synergy. It also states that China will firmly uphold multilateralism and promote international cooperation, leading a new pattern of global climate governance with Chinese concepts and practices. The *Outline of the 15th Five-Year Plan for National Economic and Social Development of the People's Republic of China (2026–2030)* states that China will actively participate in and lead global climate governance, uphold the principle of common but differentiated responsibilities, fully implement the UNFCCC and the Paris Agreement, and deepen South-South cooperation on climate change. The National Plan for Addressing Climate Change During the 15th Five-Year Plan Period further arranges China's work on actively participating in and leading global climate governance. These strategic arrangements show that China's future leadership role in global climate governance will be reflected not only in its own continued strengthening of climate action and high-quality implementation of NDC targets, but also in maintaining and improving the multilateral climate governance system, promoting green and low-carbon development in the Global South, advancing green technology innovation and international cooperation, and exploring governance rules in emerging areas.

2.3.1 Promote Joint Leadership Under the Multilateral Framework to Maintain Momentum in Global Climate Governance

After the United States withdrew from the Paris Agreement again, global climate governance faces challenges including a leadership gap, fluctuating policy expectations, and declining confidence in international cooperation. From the perspective of international institutions, however, the UNFCCC and the Paris Agreement remain the core institutional platforms with the greatest legitimacy, inclusiveness, and broadest participation in global climate governance, and remain the main battlefield for advancing global climate action. Although domestic political changes in some countries may affect the continuity of their climate policies, the vast majority of countries continue to advance key agendas such as NDC updates, the global stocktake, climate finance, and adaptation action through the UNFCCC framework. Against this backdrop, China should continue to firmly uphold the multilateral climate governance system centred on the UNFCCC, promote a more stable, inclusive, and pragmatic pattern of joint leadership, and ensure that the global climate governance process does not deviate because of policy changes in individual countries.

China-EU and China-UK cooperation are important foundations for maintaining momentum in global climate governance. The EU, the United Kingdom, and China have all put forward long-term climate targets and share broad common interests in new energy development, green industry cultivation, carbon market development, green finance, and climate adaptation. In recent years, the EU-China High-Level Environment and Climate Dialogue and the China-UK climate cooperation mechanism have continued to play a role in communication and coordination, providing important support for advancing the global climate agenda. However, economic and trade frictions between China and the EU in areas such as electric vehicles and solar PV products have increased, and geopolitical factors have also caused uncertainty in climate cooperation. China should insist on treating climate change as an issue of cooperation rather than competition, encourage the two sides to seek common ground while managing differences in addressing climate change, green technology innovation, green trade, and industrial investment, and explore more stable green economic and trade cooperation mechanisms to achieve synergies between climate goals and economic development.

Global climate governance also depends on solid scientific support. The current U.S. reduction of investment in international climate science cooperation and withdrawal from some international cooperation mechanisms may have negative impacts on global climate observation, data sharing, and scientific assessment systems. Against this backdrop, China should continue to firmly support the work of the Intergovernmental Panel on Climate Change (IPCC), and maintain the stability and authority of the global climate science cooperation system. In 2025, the 62nd Session of the IPCC was held in Hangzhou, and China and France jointly hosted the Technical Support Unit (TSU) of Working Group I (WGI) for the IPCC Seventh Assessment Report cycle (AR7), providing important public goods and institutional support for global climate science assessment. In the future, China can further strengthen scientific cooperation with Brazil, South Africa, India, Egypt,[6] and other Global South countries; support scientists from developing countries in participating in international climate assessment and joint research; and improve the participation and representation of the Global South in climate science knowledge production. In addition, in response to potential gaps caused by reduced U.S.

[6] These countries represent key regions of Latin America, Southern Africa, South Asia, and North Africa, respectively, and have significant influence in Global South cooperation and international climate governance, while also possessing established capacities for climate science research and international collaboration.

scientific data and international cooperation resources, China can work with the EU, the UK, and Global South countries to strengthen global climate observation networks, data-sharing platforms, and joint research programs, improving the openness, continuity, and resilience of the global climate data system and avoiding excessive dependence of the global climate assessment system on a small number of countries.

As COP31 will be held in Antalya, Türkiye, in November 2026, global climate governance will enter a new stage focused on implementing the Paris Agreement goals and accelerating action. COP31 will focus on implementation, finance, and just transition, and will seek to translate existing commitments into concrete action while strengthening climate finance, energy transition and electrification, capacity building, and multi-stakeholder partnerships. At present, rising uncertainty in U.S. climate policy, continued geopolitical conflicts, and slower global economic growth are creating new challenges for international cooperation, making it even more important for major economies and developing countries to jointly maintain the stable operation of the multilateral process. China should actively support the host, strengthen communication and coordination with the EU, the UK, Australia, Türkiye, Brazil, and Global South countries, and help build consensus on key issues including finance delivery, climate change adaptation, just transition, climate-trade coordination, and capacity building. This will enable China to play a constructive role in achieving pragmatic COP31 outcomes and maintaining continuity in global climate governance.

2.3.2 Support the Green and Low-Carbon Transition of the Global South and Build a Fairer and More Inclusive Global Transition Partnership

As the global energy transition deepens, more Global South countries are beginning to view green and low-carbon development as an important opportunity to promote economic growth, enhance energy security, and advance industrial upgrading. Some Global South countries have abundant solar, wind, hydro, and critical mineral resources. Africa has rich renewable energy resources, with solar, wind, and hydro potential accounting for 40%, 32%, and 12% of the global total, respectively[15]. IRENA estimates that Africa's renewable energy potential is 1,000 times its projected electricity demand in 2040[16]. Some areas in the eastern Sahara have more than 4,000 hours of clear sunshine annually, accounting for more than 91% of daylight hours, making them ideal for solar power development[17]. In minerals, about 55% of known global cobalt reserves are concentrated in the Democratic Republic of the Congo[18], the "lithium triangle" of Chile, Argentina, and Bolivia holds more than 50% of global lithium resources[19], and Indonesia has the world's largest nickel reserves, accounting for about 42% of the global total. In terms of resource endowments, the Global South has the conditions to become an important engine of future global green growth.

Nevertheless, many developing countries still face multiple challenges in the green transition, including high financing costs, weak infrastructure, insufficient industrial chain support, limited technical capacity, and worsening climate risks. Some countries have long remained at the raw material export stage and find it difficult to share the industrial value-added benefits brought by the energy transition. Against the backdrop of rising global trade protectionism and intensified geopolitical competition, Global South countries need more stable support in finance, technology, markets, and capacity building to achieve green transition. Building a fairer and more inclusive global green transition partnership to help developing countries translate resource advantages into development advantages has therefore become an important task of global climate governance.

In this context, trilateral and multilateral cooperation models have broad prospects. China has a complete new energy industrial chain, rich infrastructure construction experience, and strong engineering implementation

capacity. European countries, the Republic of Korea, Gulf countries, and multilateral development banks have advantages in green finance, risk management, and capacity building. Global South countries have abundant resources and broad market space. Through trilateral or multilateral cooperation, industrial, financial, technological, and institutional advantages can be effectively combined to provide developing countries with more systematic green transition solutions. Multi-party participation can also improve project transparency and international recognition, reduce political and operational risks faced by single-country investors, share benefits and risks, and enhance the sustainability of green transition cooperation.

Regional cooperation platforms can also play an important role in promoting cooperation on climate change and green development. For example, under the Forum on China-Africa Cooperation, green development has become an important part of bilateral cooperation. The 2024 FOCAC Beijing Summit proposed implementing a China-Africa Green Development Partnership Action, covering clean energy, green infrastructure, climate adaptation, and ecological protection. In recent years, Chinese enterprises have participated in building wind, solar PV, and storage projects in South Africa, Egypt, Kenya, and other countries, supporting local energy transition and industrial development. Under the China-ASEAN cooperation framework, both sides have continued to deepen green development cooperation, issued outcome documents such as the ASEAN-China Joint Statement on Strengthening Common and Sustainable Development, and carried out practical cooperation in new energy vehicles, solar PV, green electricity, and low-carbon industrial chains. China and ASEAN countries are also actively promoting the Green Belt and Road and strengthening clean energy investment and green infrastructure connectivity. Through platforms such as FOCAC, China-ASEAN cooperation, and high-quality Belt and Road cooperation, China has made green and low-carbon development an important part of cooperation with the Global South and has played a positive role in promoting regional green transition and sustainable development.

In critical minerals, many mineral-resource countries in the Global South have natural resource endowments but face development constraints such as funding shortages, lagging processing and smelting technologies, talent shortages, and weak supporting infrastructure. China has significant systemic advantages in green refining of minerals, low-carbon equipment manufacturing, and efficient supply chain integration. Therefore, deepening mutually beneficial cooperation between China and Global South countries in minerals around the core concepts of green and low-carbon development, development, and security—and building a more inclusive global energy transition and critical minerals partnership from the perspective of the Global South through South-North-South cooperation—can help these countries achieve local value addition and green industrialization. It will also provide strong resilience support for the security, stability, and inclusiveness of global energy transition supply chains. Meanwhile, the development of critical minerals must not undermine existing climate and ecological gains. Mining and processing of cobalt, lithium, and nickel can create significant risks to tropical forests, peatlands, biodiversity, water resources, and the livelihoods and rights of Indigenous Peoples and local communities. China and its Global South partners should therefore strengthen environmental and social safeguards throughout critical-mineral supply chains, including rigorous environmental and social impact assessment, protection of high-value ecosystems, transparent supply-chain traceability, responsible mine-site management, meaningful consultation with affected communities, and fair benefit sharing.

Box 1. Current status and future opportunities for China-Indonesia cooperation in the nickel industrial chain

Indonesia is richly endowed with mineral resources and has the world's largest nickel reserves. Its proven nickel reserves reached 55 million tonnes in 2025, accounting for about 42% of the global total[20]. To make use of this resource advantage and break the traditional "resource curse," the

Indonesian government is actively advancing a "downstreaming" strategy in the mining sector. Through administrative measures such as bans on raw ore exports, it requires resources to be processed domestically, thereby increasing product value added, creating jobs, and driving the country's broader industrialization. During Indonesian President Prabowo's visit to China in 2024, the two countries signed the Joint Statement Between the People's Republic of China and the Republic of Indonesia on Advancing the Comprehensive Strategic Partnership and the China-Indonesia Community with a Shared Future, as well as a number of bilateral memoranda of understandings (MOUs). The two sides identified new energy vehicles, lithium batteries, and green mineral development as new drivers of bilateral economic and trade cooperation[21].

Indonesia has now become one of the world's largest nickel production and processing centres. In 2024, Indonesia accounted for 46% of global primary nickel production, surpassing China[22]. Drawing on the advanced technologies and engineering capabilities of Chinese enterprises, bilateral cooperation is rapidly moving toward higher-value battery materials and manufacturing, giving Indonesia an initial industrial chain framework covering nickel smelting and processing-battery materials. China's BTR has built the largest anode material plant outside China in the Kendal Industrial Park[23]. Huayou Cobalt and GEM have achieved integrated production from laterite nickel ore to precursors and ternary cathode materials[24][25]. In addition, CATL, together with the Indonesia Battery Corporation (IBC) and Antam, has launched a nickel resource and battery industrial chain project in Indonesia, with plans to build an integrated system covering nickel mining and smelting, battery materials, cell manufacturing, and recycling[26].

Overall, Indonesia has gradually shifted from being merely a resource exporter to becoming a regional new energy manufacturing centre. However, its battery and electric vehicle industries remain in a foreign-investment-driven growth stage, and local enterprises still have relatively limited capabilities in core technologies, cell manufacturing, high-end materials, and branded complete vehicles. Further downstreaming of the nickel industry still faces a series of challenges. First, Indonesia's domestic new energy vehicle market remains relatively limited, while charging infrastructure, supply chain support, and the technical talent system are not yet fully developed. Second, Indonesia will begin implementing a gradually tightened local content requirement (TKDN) policy for electric vehicles in 2027[7],[27], which may raise compliance and supply chain development costs for multinational companies in the short term and discourage foreign investment in downstream industrial chains in Indonesia. Yet excessive reliance on external technology and capital may also constrain domestic technological absorption and autonomous controllability. Third, Indonesia's nickel smelting sector remains trapped in a high-carbon emission lock-in predicament. Although nickel is a critical mineral for the advancement of renewable energy, Indonesia's nickel industry predominantly adopts the carbon-intensive pyrometallurgical rotary kiln-electric furnace (RKEF) process and relies heavily on captive coal-fired power generation. In 2023, the nickel industry became Indonesia's largest source of industrial carbon emissions, contributing 22% of the country's total emissions from energy and Industrial Processes and Product Use (IPPU)[28]. Fourth, Indonesia faces green barriers and rules-of-origin compliance restrictions from Europe and the United States, including the EU Battery Regulation, the Carbon Border Adjustment Mechanism, and the U.S.' strict definition of "foreign entities of concern" (FEOC)[29], all of which impose stringent market-access barriers on Indonesian nickel and downstream products. Fifth, policy adjustments are creating multi-dimensional pressure on foreign investment. Indonesia's strengthening of resource nationalism, such as tighter mining quota approvals under RKAB, proposed increases in royalty rates, and adjustments to nickel ore pricing mechanisms[30], is raising costs for hydrometallurgical nickel processing enterprises amid geopolitical tensions, squeezing profit margins, and creating some disturbance to the production and investment stability of nickel mining enterprises.

Against the backdrop of increasingly intense global competition in new energy vehicles and rapid changes in technology pathways, Indonesia needs to strengthen international cooperation if it is to transform resource advantages into industrial competitive advantages. As China is a major

[7] Pursuant to Presidential Decree No.79/2023, the local content requirement (TKDN) threshold for four-wheeled passenger new energy vehicles remains 40% in 2026, rises to 60% in 2027, and reaches 80% in 2030.

partner deeply involved in Indonesia's nickel industrial chain, the two sides have unique industrial complementarity and strategic cooperation opportunities. First, downstreaming can be promoted through "market for development." Chinese automakers such as Wuling and BYD can increase complete-vehicle manufacturing and local supply chain deployment in Indonesia, and jointly cultivate the new energy vehicle consumption market and charging infrastructure ecosystem in Indonesia and the wider ASEAN region through cost-effective products. Second, technological empowerment can support the green transition of the nickel industry. By leveraging China's clean technology and production capacity advantages, cooperation can be advanced in green technology exports in areas such as replacing captive coal power with clean power generation, including solar PV, wind power, and biomass; advanced high-pressure acid leaching (HPAL) technologies; and dry tailings stacking. This can help Indonesian mines and smelting parks reduce carbon emissions and improve efficiency, responding to EU green trade measures and downstream customers' demand for green supply chains. Third, the two sides can build Global South partnerships. Under frameworks such as BRICS, the G20, and China-ASEAN cooperation, China and Indonesia can advocate the establishment of a multilateral and open global south partnership for critical minerals security and inclusion, and jointly develop green nickel production standards and ESG indicator systems that are suited to the circumstances of Global South countries while remaining compatible with international standards.

In addition, there is broad potential to build new growth areas for South-South cooperation around the governance of short-lived greenhouse gases such as methane. The new round of Nationally Determined Contribution (NDC) targets submitted by China in 2025 proposed for the first time coverage of the whole economy and all greenhouse gas categories. This marks China's climate governance shift from a focus mainly on carbon dioxide emissions reduction toward coordinated governance of all greenhouse gases, and it also creates space for new climate cooperation between China and Global South countries. According to the Global Methane Assessment released by the United Nations Environment Programme (UNEP) and the Climate and Clean Air Coalition (CCAC), using existing technologies and measures could reduce global anthropogenic methane emissions by 45% by 2030 and avoid about 0.3°C of global warming by 2040. Around half of existing methane mitigation measures have negative-cost characteristics, meaning that revenue from recovered and utilized methane can cover the cost of mitigation. For many developing countries, methane governance is therefore not only an emissions reduction measure, but also a development opportunity with economic returns.

Moreover, environmental and social safeguards should become an integral part of the next stage of Indonesia-China nickel cooperation. Rapid expansion of nickel mining and processing needs to be accompanied by stronger protection of forests, peatlands, coastal, and other sensitive ecosystems, as well as safeguards for local communities and Indigenous Peoples where relevant. Chinese and Indonesian enterprises should strengthen environmental and social impact assessment, supply-chain traceability, responsible mining practices, rehabilitation of mining sites, water and waste management, and mechanisms for local employment, consultation, and benefit sharing. This would help ensure that nickel industrialization contributes to both economic development and the long-term climate and ecological resilience of Indonesia.

In addition, fostering new growth drivers for South-South cooperation centred on the abatement of short-lived greenhouse gases such as methane boasts promising prospects. China’s updated Nationally Determined Contribution (NDC) submitted in 2025 for the first time covers the entire economy and all categories of greenhouse gases. This marks a shift in China’s climate governance from carbon dioxide emission reduction-focused action to coordinated governance of all greenhouse gases, opening up new avenues for climate cooperation between China and Global South countries. According to the Global Methane Assessment released by the United Nations Environment Programme (UNEP) and the Climate and Clean Air Coalition (CCAC), existing technologies and interventions can cut anthropogenic methane emissions worldwide by 45% by 2030 and avert approximately 0.3°C of global warming by 2040. Around half of the available methane mitigation measures deliver negative abatement costs, meaning revenues generated from methane recovery and utilization

are sufficient to offset treatment expenses. For many developing countries, methane mitigation serves not merely as an emission reduction measure but also as a development opportunity with tangible economic returns. While deep CO_2 reductions drive long-term stability, rapid methane abatement delivers immediate, tangible co-benefits—from air quality and public health improvements to strengthened crop yields and food security, mine safety, resource efficiency, and climate resilience.

China has accumulated substantial experience in methane governance. The Methane Emission Control Action Plan released in 2023 systematically deployed methane emissions reduction work in the energy, agriculture, and waste sectors. In the energy sector, China has developed relatively mature models for coalbed methane development and utilization. In the waste sector, landfill gas recovery and utilization have been widely applied in power generation and gas use. In the agriculture sector, China has also explored and developed technical pathways such as resource utilization of livestock and poultry manure and emissions reduction in rice cultivation. These approaches should be adapted to local conditions through joint demonstration projects; local capacity building; and fit-for-purpose monitoring, reporting, and verification (MRV) systems. Progress should be assessed not only in tonnes of greenhouse gases reduced but also through tangible socio-economic gains, including: resource resilience in energy savings and agricultural productivity; public welfare benefits such as health gains and local pollution reduction; and economic opportunity creation such as job creation and green industrial growth.

At the same time, governance of fluorinated greenhouse gases (F-gases, including hydrofluorocarbons [HFCs]) will also become an important direction for future cooperation. As cooling demand grows rapidly in Southeast Asia, Africa, the Middle East, and other regions, the choice of cooling equipment will directly shape greenhouse gas emissions pathways over the coming decades. China has become the world's largest producer and exporter of thermal comfort technologies such as room air conditioners, with air conditioner exports reaching 87.42 million units in 2024[31]. China can combine its manufacturing capacity with South-South cooperation on high-efficiency equipment using lower Global Warming Potential (GWP) transitional refrigerants[32] or ultra-low-GWP refrigerants where technically and safely appropriate. Cooperation could cover international mutual standard recognization on cooling efficiency, product testing and certification, technician training, leakage prevention, refrigerant recovery and recycling, and safe servicing and end-of-life practices. In doing so, it would reinforce the Kigali Amendment, support its implementation, alleviate strain on power grids from rising cooling demand, and broaden access to affordable cooling in climate-vulnerable regions.

F-gas initiatives could be advanced through established regional and multilateral platforms—including China–ASEAN frameworks, the Forum on China-Africa Cooperation (FOCAC), the Forum of China and Community of Latin American and Caribbean States (China-CELAC), the Belt and Road Initiative, and BRICS, complemented by engagement with UNEP, the Climate and Clean Air Coalition (CCAC), FAO, and interested multilateral development banks and other donor partners. Collaborative research, capacity-building programs, and joint technology demonstration projects would help translate technical mitigation potential into scalable, market-ready solutions. By aligning emissions abatement with industrial modernization, energy and food security, public health, and local job creation, non-CO_2 greenhouse gas mitigation—particularly the species of non-CO_2 short-lived climate pollutants—could become the high-impact cornerstone of China’s global climate governance and international cooperation.

2.3.3 Strengthen Multi-Level Cooperation Beyond the Multilateral Framework and Actively Shape the Implementation Ecosystem for Global Climate Governance

Mechanisms outside the UNFCCC have become an important component of global climate governance and are playing an increasingly important role. China actively participates in and proactively leads the development of new mechanisms in areas where it has advantages. On key issues such as carbon markets, green finance, climate early warning systems, climate-friendly technologies and capacity, China has the capability and potential to use channels outside the UNFCCC to mobilize multiple stakeholders to participate in global climate governance, complement the UNFCCC main channel, and promote the shift of global climate governance from commitments to pragmatic action.

China-U.S. climate cooperation still has important strategic value. Although the United States federal government has withdrawn from the Paris Agreement again, some U.S. states, cities, enterprises, universities, and civil society organizations continue to actively advance the low-carbon transition. For example, subnational governments such as California continue to implement proactive emissions reduction policies, and many U.S. companies still view green transition as an important opportunity to enhance competitiveness. China should therefore continue to maintain the social foundation and civil networks of China-U.S. climate cooperation, and keep practical cooperation in clean energy, green technologies, climate adaptation, and carbon markets through provincial-state cooperation mechanisms, enterprise cooperation platforms, exchanges between universities and research institutions, and NGO dialogues. At the same time, greater emphasis should be placed on academic cooperation and scientific exchanges in supporting climate research, technological innovation, and capacity building. Long-term and stable collaboration among universities, research institutions, and experts from China and the United States can provide knowledge support and technical foundations for future climate cooperation. Besides, China can explore multilateral cooperation models in which Chinese and U.S. enterprises jointly participate with third countries, using joint investment, technology cooperation, and industrial collaboration to share benefits and risks, reduce geopolitical risks, expand green cooperation results, and preserve space and a foundation for the future restoration of official China-U.S. climate cooperation.

During COP30, China actively responded to the initiative of the host country Brazil. On November 7, 2025, China signed and adopted the Declaration on the Open Coalition on Compliance Carbon Markets together with 10 other countries.[8] This sent a strong signal that China would deeply participate in multi-level and issue-based climate multilateral cooperation. Brazil chairs the coalition for its first two years, with China and the European Commission serving as co-chairs. In May 2026, the European Commission, Brazil, and China formally launched the coalition. It aims to enhance the effectiveness, transparency, and integrity of global carbon markets[33]; complement existing international carbon pricing platforms; improve monitoring, reporting, and verification (MRV) systems; develop reliable carbon accounting methodologies; and use high-integrity offset mechanisms to promote environmental integrity. Its long-term goal is to promote interoperability and standards compatibility among regional compliance carbon markets, unify accounting standards, facilitate cross-border mutual recognition of carbon credits, regulate international carbon trading, support the achievement of countries' NDC

[8] At COP30 held in Belém in November 2023, Brazil's proposal for an Open Coalition on Compliance Carbon Markets received support from 11 countries. Brazil, China, the European Union, the United Kingdom, Canada, Chile, Germany, Mexico, Armenia, Zambia, and France all endorsed the document.

targets[34], reduce regulatory conflicts, and ease global trade frictions caused by geopolitical tensions and unilateral trade measures such as the EU CBAM. As of now, 18 countries[9], including China, the EU, Brazil, the UK, Canada, Germany, France, New Zealand, Singapore, and Norway, have formally joined[35]. The coalition secretariat and its first work plan were formally established and adopted on September 15, 2026, at the China Carbon Market Conference in Wuhan, China[36]. This is the first time China has served as co-chair of a high-level coalition jointly launched by developed and developing countries and involving international carbon rules. It reflects China's accelerated efforts to build a more effective, dynamic, and internationally influential carbon market, and its willingness to share practices in green and low-carbon development and carbon market construction with the international community, working with all parties to build the Coalition into an open, inclusive, pragmatic, and efficient platform for international carbon market cooperation and to contribute positively to global climate governance[37].

In climate early warning, during COP29 China hosted the high-level meeting "Strengthening Early Warning and Building a Future of Climate Adaptation," and released the China Action Plan for Early Warning for Climate Change Adaptation (2025–2027)[38]. Outside the UNFCCC channel, China has also actively implemented this mechanism through South-South cooperation by sharing Fengyun meteorological satellite data with climate-vulnerable regions such as Africa, Southeast Asia and South Asia, and Pacific island countries, and by supporting cloud-based meteorological disaster early warning platforms, transforming the global Early Warnings for All initiative into physical infrastructure projects[39].

In green industry, at the G20 Summit in November 2025, China and South Africa announced the Initiative on Cooperation Supporting Modernization in Africa, creatively integrating clean energy consumption with Africa's local industrialization processes such as sustainable mining and clean low-carbon manufacturing, in close alignment with the African Union's Agenda 2063[40]. In tropical rainforest protection, at COP30 China and more than 50 other countries signed and adopted the declaration on the Brazil-led Tropical Forest Forever Facility (TFFF)[41], expressing support for the sovereignty of tropical forest countries and the value of ecosystem services. Such engagement could provide a strong signal of support for tropical forest protection and more sustainable global supply chains.

In finance, Chinese financial institutions and industry associations are helping drive the low-carbon transition of global industrial chains through deep alignment and co-development with international initiatives and standards. In November 2024, the People's Bank of China (PBOC), the European Commission's Directorate-General for Financial Stability, Financial Services and Capital Markets Union (FISMA), and the Monetary Authority of Singapore (MAS) jointly launched the Multi-Jurisdiction Common Ground Taxonomy (M-CGT), achieving systematic mutual recognition and alignment among Chinese, EU, Singaporean, and ASEAN green classification standards[42] and providing reference for other regions to develop green taxonomies and improve interoperability[43]. In addition, the Green Investment Principles for the Belt and Road (GIP), jointly launched by China and the UK, have become a prominent example of informal multilateral financial governance outside the UNFCCC. Since its launch in 2018, GIP has continued to expand its membership and now includes more than 50 member institutions from China, the UK, Europe, and multiple emerging markets, jointly managing more than USD 40 trillion in assets[44].

[9] Current participating parties include Brazil, China, the EU, the United Kingdom, Canada, Chile, Germany, Mexico, Armenia, Zambia, France, Rwanda, Andorra, Guinea, New Zealand, Monaco, Singapore, and Norway.

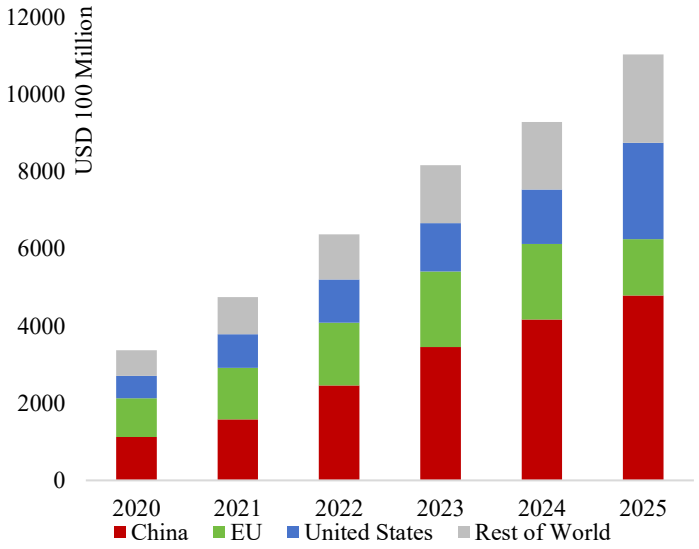
At the enterprise level, Chinese enterprises and industry organizations are moving from passive participants in international multilateral initiatives to active contributors and initiators. At the 2026 Climate Group Asia Action Summit, the Climate Group released the RE100 China Guidebook, promoting Chinese companies such as JinkoSolar, LONGi, and Envision Energy as global benchmark cases in green electricity consumption. The Climate Group and the Electric Power Planning and Engineering Institute (EPPEI) also officially launched the RE100 Ready (China) IDZ Initiative, which aims to support participating industrial development zones (IDZs) in exploring scalable approaches to renewable electricity adoption and green industrial transformation[45]. Between 2025 and 2026, Chinese enterprises and think tanks worked through the China-Africa Renewable Energy Partnership with industry associations in China and multiple African countries, such as the Chinese Renewable Energy Industries Association (CREIA) and its African partners, to jointly establish a renewables centre program and implement pilot distributed solar PV and motorcycle charging station projects in African countries including Kenya, Rwanda, and Ethiopia[46].

In the future, China can more constructively mobilize multiple stakeholders and lead international processes in areas where it has advantages, such as green and low-carbon technologies and climate adaptation. It should deepen South-South cooperation and third-party market cooperation, help Global South partners develop independent mitigation and adaptation capabilities, fully mobilize enterprises, industry associations, NGOs, and other non-state actors, strengthen multilateral mechanisms and multi-level cooperation, and jointly advance global climate governance toward implementation.

2.3.4 Work With Partners to Promote Investment and Trade in Green Product Technologies and Contribute to Accelerating the Global Low-Carbon Transition

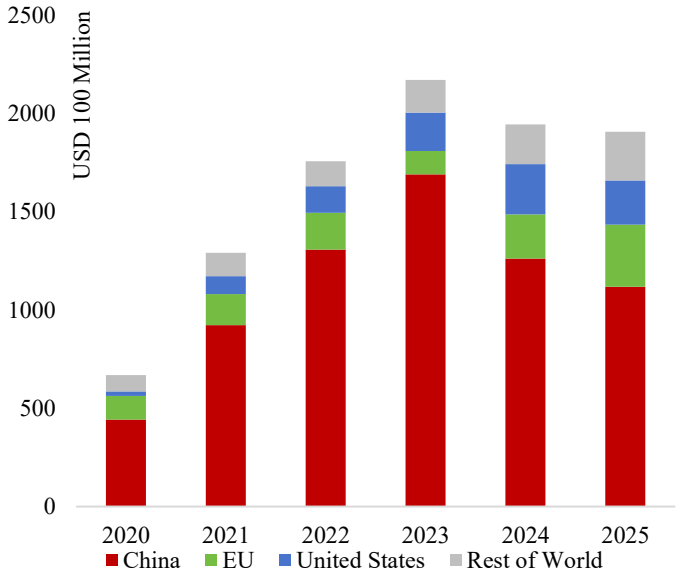
Relying on its vast domestic market and guided by globally leading technology investment, China has developed a clean energy technology system with relatively low costs and complete industrial chains. China has been the world's largest demander and an important investor in clean energy technologies for many consecutive years (Figures 2-3 and 2-4), and has developed advantages in scaled manufacturing and engineering implementation in solar PV, wind power, batteries, electric vehicles, heat pumps, and electrolyzers. The core significance of cooperation on green product technologies is not only to expand China's exports, but also to lower global transition barriers through lower costs, more mature technologies, and more complete supply chains, helping more countries enter low-carbon development pathways at affordable cost.

Figure 2-3. Domestic market demand for solar PV, wind power, batteries, electric vehicles, heat pumps, and electrolyzers in major economies, 2010–2025



Data source: compiled from IEA (2026)

Figure 2-4. Annual investment in solar PV, wind power, batteries, electric vehicles, heat pumps, and electrolyzers in major economies, 2010–2025



Data source: compiled from IEA (2026)

However, as green industries become framed through economic security, China also needs to adjust its cooperation models. A more sustainable future model is to jointly build local manufacturing, local employment, carbon footprint management, recycling systems, technical training, and supply chain resilience mechanisms with host countries. In this way, China's industrial advantages can be translated into development benefits that partner countries can perceive, while also helping reduce trade friction and investment review risks.

In practice, China has gradually upgraded external cooperation in the new energy industry from product exports to capability embedding. Reports show that China's outward direct investment in green and low-carbon

technologies has exceeded USD 180 billion since 2023[47], with investment covering upstream material mining and processing, midstream equipment manufacturing, and downstream power generation facilities. Southeast Asian countries have made new energy manufacturing an important strategic choice for industrial upgrading and participation in global green industrial chains; Chinese investment and cooperation have accelerated industrial clustering and helped the region become the world's second-largest solar PV production base. Chinese enterprises in Indonesia have invested not only in nickel mining and precursor material processing, but also in downstream battery manufacturing. CATL's battery plant, with investment exceeding USD 6 billion, is expected to begin formal operation by the end of 2026[48]. At the same time, China's overseas clean energy investment is not limited to developing countries and regions such as Southeast Asia and Brazil, but also extends to developed economies such as the EU, where it has become an important investor in clean energy technologies. For example, BYD's electric vehicle plant in Hungary, with investment exceeding USD 4.5 billion, is designed for annual production of up to 200,000 vehicles and is expected to create more than 10,000 local jobs at peak[49].

This upgrading process especially needs to manage the relationship between low-cost diffusion and local value creation. In the past, Chinese enterprises significantly reduced global costs for solar PV, batteries, and electric vehicles through scaled manufacturing capacity. In the future, host countries will care more about whether green industries leave tax revenues, jobs, technologies, and supply chain capabilities locally. China can help partners transform green product consumer markets into green industrial ecosystems through joint ventures, licensing, joint research and development, supplier cultivation, vocational education, and recycling network development, thereby reducing the space for protectionist narratives.

At the same time, China needs to strengthen narrative capacity in the climate field to improve understanding and trust in the international community and reduce friction in investment and trade. Strengthening narrative capacity does not mean simply increasing publicity, but rather developing more solid knowledge products and evaluation systems. China can build international case libraries and methodologies around renewable energy integration, power market reform, green finance, low-carbon industrial parks, South-South cooperation projects, and overseas cases of Chinese enterprises; use indicators such as emissions reductions, cost decline, financing leverage, job creation, local procurement shares, skills training, and environmental and social impacts to demonstrate project value; and improve credibility through third-party evaluation, English-language reports, multilateral platforms, and international think tank cooperation. Only by translating practice into verifiable public knowledge can China's experience enter international rule discussions more effectively.

Box 2. New pathways for China-EU cooperation amid the regionalization of the global battery industry

The global battery industry is entering a new stage in which regionalization, rule-based development, and partnership-based cooperation are unfolding in parallel, moving beyond simple global expansion. Research indicates that demand for new batteries will rise to 7.9 TWh over the next decade, representing growth of more than four times. Batteries will account for about 76% of demand, while energy storage batteries will account for about 22%. Lithium iron phosphate (LFP) and nickel manganese cobalt (NMC) battery pathways will continue to dominate over the long term. This means that the battery industry will not stop diffusing globally because of trade frictions; what is truly changing is the mode of diffusion. Major markets increasingly require local manufacturing, sustainable materials, carbon footprint disclosure, supply chain due diligence, recycling systems, and employment contributions. For China, the focus of battery industry internationalization is no longer only cost and capacity, but whether mature technologies, manufacturing experience, supply chain coordination, and engineering capabilities can be translated into cooperation solutions that are acceptable locally.

The United States and European Union are developing different pathways. The United States places greater emphasis on tariffs, restrictions on tax credit eligibility, support for domestic capacity, and exclusion of China-linked supply chains. Its policy logic is closer to de-coupling or exclusionary of localization. By contrast, although the European Union is also raising thresholds and strengthening localization requirements, its core objective remains to enhance industrial resilience, reduce external dependence, and fill local capability gaps, rather than completely closing the door to cooperation. For this reason, the European Union is not the easiest market to enter, but it is the one most likely to become a testing ground for a new round of high-quality international cooperation.

China and Europe have strategic alignment and complementary capabilities. Both sides face energy transition pressures and have set clear climate targets. The European Union has markets, institutions, standards, a foundation in the whole vehicle industry, and high-end innovation capabilities, while China has mature technologies, engineering capabilities, industrial coordination, cost control, and advantages in scaled implementation. Therefore, the most practically meaningful form of China-EU cooperation is not traditional trade complementarity, but deeper capability complementarity and embedded cooperation: the European Union provides rules, markets, and application scenarios, while China provides efficiency, manufacturing, and industrialization capabilities.

Over the past few years, the European Union's electrification and battery industries have relied more on top-down policy support than on organic market demand. As market acceptance, cost affordability, and industrial maturity have all fallen short of expectations, the originally aggressive transition pathway has also begun to be recalibrated. This has already become fully evident at the enterprise level. As the pace of electrification has slowed, automakers have lowered targets one after another, and investment, procurement, and capacity deployment have become more cautious. This means that policy can indicate the direction and provide protection, but what determines the success or failure of projects remains technological maturity, cost competitiveness, and supply chain execution capacity. What the European Union truly needs is not further policy intensification, but to use market forces to find a more pragmatic and sustainable industrial pathway. Chinese enterprises, meanwhile, also need to shift from a product export mindset to a localized operating mindset, adapting to European rules in governance structures, intellectual property arrangements, data compliance, ESG transparency, labour union relations, and talent development.

From the perspective of enterprise practice, Chinese and European companies are already actively seeking more pragmatic commercial solutions around the battery industrial chain, focusing on three core needs: innovation capability, supply security, and cost advantages. Volkswagen has obtained advanced battery technologies through strategic equity investment. In 2020, it invested EUR 1.1 billion to acquire about 26% of Gotion High-Tech and made the company a technology partner for its Salzgitter cell factory. At the same time, Volkswagen is building a centralized internal battery platform and a European gigafactory network through PowerCo, aiming to achieve 50% internal battery supply. Through its unified cell strategy and the establishment of IONWAY as a joint venture with Umicore, it is also advancing localization of cathode materials and precursors. Stellantis, for its part, is introducing mature LFP technology by working with CATL to build a roughly 50 GWh LFP gigafactory. By signing a lithium supply agreement with Vulcan and increasing investment to strengthen the partnership, Stellantis is anchoring key battery inputs in Europe. It has also explored battery recycling through cooperation with Orano to reduce material costs. Overall, European enterprises are shifting from policy-driven development toward market- and industrial-capability-driven development, and are addressing battery industrial chain weaknesses through equity investment, joint ventures, local procurement, integration of critical materials, and the circular economy. These practices also offer policy-makers insights that are more closely aligned with market realities.

Looking ahead, China-EU battery industry cooperation should be upgraded from product exports to capability embedding, forming a mutually beneficial partnership model. First, benefit-sharing and governance empowerment mechanisms should be established, with clear rules on equity structures, board arrangements, intellectual property use, profit distribution, and local procurement. Second, genuine local leadership should be promoted, giving European local teams substantive decision-making authority in market execution, supplier management, customer

relations, and compliance communication. Third, technology transfer and local innovation should be advanced by combining China's experience in LFP batteries and cell manufacturing, material systems, equipment commissioning, and capacity ramp-up with Europe's strengths in standards, software, vehicle platforms, recycling, and high-end research and development. Fourth, talent development and corporate culture integration should be treated as core elements of cooperation. Through vocational training, supplier capability building, and industry-education cooperation, cooperative projects can become platforms for local skills accumulation and industrial upgrading in Europe. If the two sides can develop replicable experience in local value creation, mutual recognition of standards, technological synergy, and the circular economy, China-EU battery cooperation will provide a new institutional model for maintaining low-carbon technology diffusion against the backdrop of rising protectionism.

2.3.5 Explore Best Practices for AI-Enabled New Energy System Development

The expansion of artificial intelligence (AI) data centres, the adoption of electric vehicles, and electrification in buildings and industry are jointly making electricity the core of end-use energy supply. Generative AI data centres are especially noteworthy as a rapidly rising driver of global electricity demand growth. According to the IEA report *Energy and AI,* global data centre electricity consumption in 2024 was about 415 TWh, or around 1.5% of global electricity demand, and is expected to more than double to over 945 TWh by 2030, accounting for nearly 3% of total global electricity demand. AI servers will contribute half of the net increase in data centre electricity consumption, while traditional servers account for only about 20%. From 2024 to 2030, data centre electricity consumption is expected to rise at a compound annual growth rate of about 15%, more than four times the growth rate of total electricity consumption in all other industries[50].

AI and electrification will first cause large-scale growth in electricity demand and further intensify grid access pressure in areas where loads are concentrated. AI data centres, electric vehicles, and electrification in buildings and industry are jointly shifting end-use energy demand toward electricity. AI data centres are characterized by large load size, rapid growth, high power reliability requirements, and spatial concentration. According to Energy Foundation data, China’s data centre electricity consumption in 2025 was about 237 TWh, accounting for 2.3% of total electricity consumption, with intelligent computing facilities already becoming the main consumers, accounting for about 64%. With accelerated AI development, future data centre electricity demand will continue to grow. By 2035, China's total annual data center electricity consumption is projected to reach approximately 550 TWh under the baseline scenario and 810 TWh under the high-penetration scenario, with its share of national electricity consumption rising from approximately 2.3% in 2025 to 3.6%–5.3% in 2035.

The National Energy Administration also noted that in 2025 China’s computing centres consumed 170 billion kWh of electricity, accounting for 1.6% of total electricity consumption, and that electricity demand from the eight hub nodes of the national integrated computing network has become a main source of incremental demand, with an average growth rate of about 39.5% over the past three years, far higher than the average growth rate of total electricity consumption. This means that new electricity demand from AI will not be evenly distributed, but may be concentrated in already congested urban clusters, industrial parks, and computing hub grids, further increasing pressure on local distribution grid expansion, main grid access, reserve capacity, power quality, and green electricity supply. How to meet AI-driven rapid electricity demand growth while avoiding crowding out grid carrying capacity, raising system operating costs, or even forcing a rebound in fossil energy will be one of the core tests for energy and climate policy over the next 5 years.

On the other hand, AI also brings important technological innovation opportunities for energy system optimization. AI can provide key intelligent decision support for the new power system. By accurately forecasting electricity load and renewable power output, it can significantly improve system operating efficiency and stability. AI data centre loads also show task schedulability and flexibility in cross-regional workloads. Such elastic resource dispatch can deliver significant cost, power, and environmental benefits and improve renewable energy integration and consumption. Research suggests that treating data centres as flexible power loads rather than traditional fixed peak loads can help ease grid connection bottlenecks; reduce system operating costs and network congestion; and under different locations, flexibility ranges, and grid load conditions, AI data centre load flexibility can reduce grid investment and operating costs by about 3% to 21%[51]. AI is deeply empowering the new energy system by optimizing energy production, reducing operating costs, and efficiently integrating renewable energy, thereby significantly improving overall operating efficiency while providing strong support for predictive maintenance, grid stability, and safety management.

China has combined advantages in new energy installed capacity, digital infrastructure, grid dispatch, and AI application implementation, and can take the lead in exploring systematic integration of AI and energy. On May 26, 2026, China's National Energy Administration released 51 typical application scenarios for "AI + energy"[52], showing that AI is systematically reshaping production and operation models in China's energy industry. China is committed to green development through coordination between computing and electricity, and is exploring AI-enabled energy system practices across multiple links. At the infrastructure level, China is actively using AI systems and natural resources to reduce data centre energy consumption. For example, some data centres in Qinghai combine plateau climate, distributed solar PV, and storage to achieve natural cooling for 314 days a year, reducing power usage effectiveness (PUE) to below 1.2[53]. China Mobile's real-time computing centre in Shaoguan, Guangdong, relies on indirect evaporative cooling air conditioning and an AI whole-process optimization system to keep PUE below 1.25, even in the hot and humid climate of South China[54]. The energy efficiency of these new computing facilities already outperforms that of international leading companies such as Google and Microsoft.

At the system operation and dispatch level, China is deeply integrating large AI models into core grid operations. In load forecasting and coordinated dispatch, a new independent energy storage station in Binzhou, Shandong, uses an AI trading agent to accurately forecast day-ahead and real-time electricity prices, with forecast accuracy of up to 95% for peak-valley price spreads. Based on multi-spatiotemporal weather forecasts and AI multi-cycle algorithms, grids have achieved high-precision forecasting of wind and solar output and coordinated regulation of generation, grid, load, and storage at the distribution network level, greatly increasing the share of green electricity consumption[55]. In system safety operations, wide use of visual large models, acoustic detection, and unmanned equipment such as drones and robots is advancing defect diagnosis for high-voltage transmission lines and predictive maintenance of wind and solar plants, comprehensively ensuring safe and stable operation of a vast energy network[56]. According to the arrangements laid out in the Special Action Plan for Green and Low-Carbon Development of Data Centers, China's annual growth rate of renewable energy utilization for data centres should reach 10% by the end of 2025, and newly built data centres at national hub nodes should achieve a green power proportion exceeding 80%.

China has not only application scenarios in this field, but also the capacity to organize international scientific cooperation. The international big science program incubation project on carbon neutrality and energy interconnection, led by Tsinghua University, focuses on global carbon flow monitoring, energy interconnection, digital twins, and key low-zero-negative carbon technologies. It explores new pathways for using AI to optimize

energy system decision-making, reflecting China's practical foundation and leadership potential in the cross-cutting field of AI, energy, and carbon neutrality.

As a country with significant advantages in both global new energy installed capacity and AI application implementation, China can play a leading role in both new energy and AI and take the lead in exploring best practices for AI-enabled new energy system development. The Action Plan for Boosting Two-Way Empowerment Between Artificial Intelligence and Energy was issued in April 2026. It mandates to steadily advance the statistical work on the proportion of green power consumption and carbon emission accounting for computing power infrastructure, strengthen policy guidance for direct green power connection, continuously improve the energy efficiency and carbon efficiency of computing power facilities, and establish a full-chain green and low-carbon development system featuring coordinated green power supply, efficient energy utilization, and carbon emission control. China is actively promoting AI as an inclusive global public good, aiming to create opportunities for Global South countries to participate in "AI + energy" practices[57]. Specifically, developing countries with weak traditional large-grid infrastructure can use lightweight AI technologies together with microgrids and distributed renewable energy to upgrade their power systems. These countries can also rely on their superior renewable resource endowments to use AI for high-value scenarios such as smart agriculture and green industry. By building inclusive cooperation frameworks, developing countries will be able to participate more deeply in this global transformation of digitalization and energy.

3. Pathways and Policies for China to Implement the New NDC Targets and the 15th Five-Year Plan

In September 2025, Chinese President Xi Jinping announced China's new round of NDC targets at the United Nations Climate Change Conference. On November 3, China formally submitted China's 2035 Nationally Determined Contribution Report to the UNFCCC secretariat. This is the first time China has put forward an absolute net emissions reduction target covering the whole economy and all greenhouse gases. It marks a major leap in carbon emissions control from a focus on intensity control to equal emphasis on total volume and intensity, and a gradual transition toward total volume control. The Outline of the 15th Five-Year Plan, released in March 2026, makes it clear that China will advance carbon reduction, pollution abatement, ecological expansion and growth in a coordinated manner, guided by the goals of carbon peaking and carbon neutrality. The new round of Nationally Determined Contributions (NDCs) and the 15th Five-Year Plan are aligned and mutually supportive, together forming the overarching action framework for China's green and low-carbon transition over the next 5 to 10 years. Based on an assessment of the potential macroeconomic impacts of the new-round NDCs, this chapter systematically sorts out priority areas and key technological pathways for NDC implementation.

3.1 Potential Impacts of the New NDC Targets and the 15th Five-Year Plan

The new NDC sets out a comprehensive framework that combines an overarching emission reduction goal, enhanced commitments in existing areas, and new targets for key aspects of the low-carbon transition. First is the total volume target: by 2035, economy-wide net greenhouse gas emissions will fall by 7% to 10% from their

peak, with efforts to achieve further reductions, and non-CO_2 greenhouse gases such as methane, nitrous oxide, and fluorinated gases will be included in total volume control for the first time. Second, three quantitative indicators will be further strengthened: the share of non-fossil energy consumption in total energy consumption will reach more than 30%; total installed capacity of wind and solar power will reach more than six times the 2020 level, with efforts to reach 3.6 billion kW; and forest stock volume will reach more than 24 billion cubic meters. Third, three new qualitative indicators will be added: new energy vehicles will become the mainstream of new vehicle sales, the national carbon emissions trading market will cover major high-emission industries, and a climate-adaptive society will be largely established. The introduction of absolute emissions reduction constraints marks a shift from "relative decoupling" to "absolute decoupling" between carbon emissions and economic development, which will exert profound structural impacts on the macro-economy and industrial structure.

3.1.1 Help Foster New Growth Drivers and Promote Green Economic and Social Development

Achieving a per capita GDP level comparable to that of a medium-developed country by 2035 is a core marker of China basically realizing socialist modernization. This implies that GDP needs to rise from about CNY 100 trillion in 2020 to about CNY 200 trillion in 2035, requiring average annual growth of about 5% during the 15th Five-Year Plan period and about 4% during the 16th Five-Year Plan period, with an overall average annual growth rate of about 4.7% over the next decade[58]. Against this macroeconomic backdrop, emissions reduction targets are both development constraints and new drivers of economic growth, helping promote high-quality economic and social development. The implementation pathway of the NDC will not crowd out medium- and long-term economic growth; on the contrary, it will become one of the most important growth poles[59].

Emissions reduction targets will accelerate the shift of industrial structure toward low-carbon, high-end, and service-oriented development through both supply-side hard constraints and demand-side pull. **In the energy sector**, the NDC sets out to achieve substantive progress in building a new-type of power system and a new energy system, which entails driving the historic shift of the energy mix from fossil-energy-dominated to non-fossil-energy-dominated. This is not only a change in energy supply, but also an infrastructure upgrade that will continuously release demand for solar PV, wind power, new energy storage, smart grids, and related industries. By 2025, China's non-fossil energy installed capacity share exceeded 60%,[10] and clean energy growth momentum was strong. Research by the Centre for Research on Energy and Clean Air (CREA) indicates that under a high-ambition scenario, China's clean energy industry could double in scale by 2035, with total contribution reaching CNY 15 trillion, or about USD 2.1 trillion.

In the industrial sector, the NDC proposes to elevate the scale of green industries to new heights, bring the energy and resource-use efficiency of key industries and products up to internationally advanced levels, and make green development a prevailing feature of new-type industrialization. As of March 2026, China has fostered a total of 8,336 green factories, whose output value accounts for 22%[11] of the total output value of above-scale manufacturing. During the 14th Five-Year Plan period, the iron and steel sector deepened supply-side structural reform, cutting crude steel output by over 100 million tonnes in total. By the end of 2025, ultra-low-emission retrofits had been completed for approximately 940 million tonnes of national crude steel

[10] Data source: National Energy Administration of China.

[11] Data source: Interpretation of the Notice of the General Office of the Ministry of Industry and Information Technology on Publishing the List of Green Factories and Green Industrial Parks (2025), website of the Ministry of Industry and Information Technology.

production capacity.[12] In 2026, the National Development and Reform Commission and other departments issued a Notice on Carrying Out a Three-Year Action to Tackle Energy Conservation and Carbon Reduction Retrofits in Key Industries, focusing on nine industries: steel, electrolytic aluminum, cement, flat glass, oil refining, ethylene, synthetic ammonia, methanol, and coal power. The 15th Five-Year Plan for Industrial Green and Low-Carbon Development, released in July 2026, lays out seven key tasks, including further implementing the carbon peaking action in the industrial sector, enhancing industries' capacity for green value creation, boosting the supply capacity of green equipment and products, strengthening scientific and technological innovation capacity for green and low-carbon development, improving the integrated development capacity of intelligence and green transition, improving the industrial resource recycling system, and perfecting the green manufacturing and service system, so as to further implement the carbon peaking action in the industrial sector. The policy signal is clear: during the comprehensive shift from dual controls on energy consumption to dual controls on carbon emissions, it is both a hard constraint forcing industrial upgrading and a new engine activating green growth. Looking ahead to the 15th Five-Year Plan period, the industrial green manufacturing system will continue to improve, the value-added share of high-end low-carbon materials, energy-saving equipment, carbon services, and other segments will rise steadily, and traditional heavy chemical industries will shift toward low-carbon feedstocks, intelligent processes, and high-end products. **In the building sector,** the NDC targets notable progress in the coordinated development of intelligent construction and building industrialization. By the end of 2024, the share of newly built green buildings in new urban buildings exceeded 97%, and the cumulative area of energy-efficient buildings exceeded 66% of existing urban building area. Building-integrated photovoltaics (BIPV) had entered scaled application, and by 2025 around 41 million households in northern rural areas had completed replacement of dispersed coal use[60]. **In the transport sector,** the NDC aims to achieve carbon-neutral growth in civil aviation transport, complete the development of a modern comprehensive transport system, and make new-energy vehicles the mainstream choice for new vehicle sales. Guided by transport structure adjustment and new-energy vehicle promotion policies, this will drive the expansion of industries including the whole industrial chain of new-energy vehicles, charging-swapping infrastructure, and electrified transport. In 2025, railway and waterway freight volumes increased by 2.0% and 3.2% year-on-year, respectively[61], and container rail-water intermodal transport grew by 13.9%[62]. The railway electrification rate rose from 52.3% in 2012 to 72.1% in 2025[63]. NEVs grew rapidly: new energy vehicle sales in China accounted for more than 50% of total domestic new car sales for the first time, production and sales both exceeded 16 million vehicles, accounting for more than 70% of the global total. New energy buses accounted for 82.7%, and sales of new energy heavy trucks reached 45,300 in December 2025, up 198% year-on-year[64]. By 2024, 35,000 charging piles had been built in highway service areas nationwide, with coverage reaching 98%[65]. Supporting infrastructure is gradually improved. By 2035, NEVs will become mainstream in the market, and the value-added share of intelligent connected vehicles, green logistics, and mobility services will further increase, transforming the transport industry toward high-end intelligent equipment manufacturing and service operations. In summary, green and low-carbon industries have shifted from policy targets to macroeconomic growth variables that cannot be ignored; they are not only tools for emissions reduction, but also important drivers of investment, manufacturing, and export competitiveness.

The all-greenhouse-gas scope of the new NDC unlocks domestic development dividends that extend beyond energy-sector CO_2 reduction[66][67]. Targeted methane abatement can improve coal-mine safety, reduce

[12] Data source: Work Report delivered by Huang Runqiu, Minister of the Ministry of Ecology and Environment, at the 2026 National Conference on Ecological and Environmental Protection, January 2016.

energy resource waste, and strengthen waste management. Simultaneously, cutting methane alongside black carbon (soot) controls drives further improvements in air quality and reduces tropospheric (ground-level) ozone damage to agricultural crop yields. In agriculture, precision nitrogen management can lower agricultural input costs and run-off (non-point source) pollution while controlling N_2O emissions. Within cooling, transitioning to next-generation cooling systems can reduce peak electricity demand while supporting Chinese manufacturers. Furthermore, mitigating industrial N_2O and fluorinated-gases stimulates commercial markets for monitoring equipment, catalysts, destruction technologies, refrigerant recovery, engineering services, and emissions verification. Together, these multi-sectoral gains establish the new NDC as a strategic catalyst for public health, food and energy security, industrial upgrading, and high-quality growth.

From the perspective of investment and consumption structure, constraints will guide resources toward higher value-added links. Tsinghua University estimates that China will need a total investment of CNY 140 to CNY 260 trillion between 2020 and 2060[13] to achieve carbon neutrality. In the short and medium term, since the dual carbon goals were announced, tens of trillions of yuan in green and low-carbon investment have created strong industrial capital accumulation and market expectations[68]. On the consumption side, demand for end-use green consumption such as NEVs, ultra-low-energy buildings, zero-carbon heat sources, green appliances, and green food is expanding rapidly. This will shift China's consumption structure from a model driven by traditional durable goods and real estate chains to one driven by green consumer goods and service consumption. In terms of stabilizing growth and expanding domestic demand, green investment has long chains, strong spillover effects, and strong alignment with new urbanization and a modern industrial system. Taking the new power system as an example, Tsinghua University estimates that cumulative power sector investment demand from 2020 to 2060 will be about CNY 73.8 trillion, with generation, grid, and storage investments accounting for about 55%, 35%, and 10%, respectively. As these investments are gradually released during the 15th Five-Year Plan period, they can offset external demand volatility and stabilize economic growth in the short term, while cultivating technically and economically mature emerging industries in the medium and long term, creating a virtuous cycle of pollution and carbon reduction and growth benefits. If rooftop solar PV, household storage, park microgrids, heat pumps, electric vehicles, and other resources are effectively aggregated, new space for green consumption and green investment can be created without significantly increasing risks to centralized systems.

In employment, as the value-added share of traditional high-energy-consuming industries declines and that of strategic emerging industries such as new energy, new energy storage, energy conservation and environmental protection, and green technology services rises rapidly, employment structures will shift from high-carbon jobs to green jobs. Solar PV, wind power, storage, NEVs, green hydrogen, green construction, CCUS, carbon management, and carbon finance services will create many high-quality jobs. IEA research shows that by 2030 accelerated domestic action will increase employment in China's clean energy supply sector by 3.6 million, while reducing jobs in fossil fuel supply and fossil fuel power plants by 2.3 million[69]. Multi-scenario simulations by the Chinese Academy of Sciences further indicate that under a deep transition pathway toward 2035, wind and solar PV alone could add 1.87 million and 3 million jobs respectively compared with a conventional transition scenario, while coal mining and coal power together would lose about 710,000 jobs. The job creation effect of green industries is significantly larger than employment contraction in traditional high-carbon industries[70]. UNDP long-term trend projections show that compared with 2020, employment in

[13] Calculation results from this research model.

China's wind and solar PV power sectors will double and quadruple respectively by 2060, and overall power sector employment will increase by 68%. NEVs, new energy storage, green hydrogen, CCUS, and other emerging technology tracks, as well as green construction and carbon services, will become core carriers of medium- and long-term employment growth[71].

In 2024, the Ministry of Human Resources and Social Security included 137 occupations, such as carbon emission manager, in the national green occupation classification. During the 14th Five-Year Plan period, the talent demand in the dual-carbon sector has reached the million-person level. However, constrained by the lagging establishment of matching university majors and the imperfect social-oriented training system, China currently has only over 100,000 professionals in the dual-carbon field, which is far from meeting market demand. High-end interdisciplinary talent with both technical expertise and industry experience in green finance assessment, carbon asset management, and CCUS project operations is especially scarce[72]. Traditional energy-rich regions such as Shanxi, Inner Mongolia, Shaanxi, Ningxia, and Xinjiang will face urgent just transition tasks and need policy support in transition planning, re-employment training, and social security, while preventing transition risks such as stranded fossil energy assets and regional unemployment.

3.1.2 Help Fundamentally Enhance the Resilience of the Energy System, Yet the Transition Process Also Presents Energy-Security Challenges at Various Levels

A new energy system oriented toward carbon neutrality is fundamental to achieve long-term energy security in China. By the end of 2025, China's total installed renewable energy capacity reached 2.34 billion kW, accounting for around 60% of total installed capacity. Combined installed wind and solar PV capacity rose from 530 million kW in 2020 to 1.84 billion kW[14], historically surpassing thermal power and significantly strengthening local clean electricity supply capacity. By 2030, China's energy-related carbon dioxide emissions will peak and "stabilize with a downward trend"; by 2035, they will drop by 7% to10% or more from the peak, while CO_2 emissions per unit of GDP will be more than 75% lower than in 2005 and non-fossil energy will account for more than 30% of total energy consumption. Toward the carbon neutrality goal, the share of non-fossil energy in primary energy consumption must rise from the current level to more than 80% by 2060. Wind and solar PV will move from supplementary energy to main energy sources, shifting energy supply from resource dependence to technology dependence and turning abundant wind and solar resources into a new resource endowment. This will fundamentally reduce China's dependence on foreign oil and gas and geopolitical constraints, and is the necessary path to long-term energy security.

It should be noted that the low-carbon energy transition cannot be achieved overnight. In the process of achieving the dual carbon goals, China faces energy security challenges at different levels. First are strategic security risks. China's dependence on imported crude oil and natural gas remains high. If geopolitical conflict triggers sharp energy price fluctuations, economic operations will be affected. Middle East geopolitical conflicts have aggravated energy supply volatility, and tensions in the Strait of Hormuz have tightened supplies of critical materials such as sulfur, helium, and naphtha, which may affect production of solar panels, batteries, and other equipment, creating strategic risks for energy and critical material supply. Second, the fundamental balance of the energy system is affected by domestic capacity layout, supply elasticity, policy regulation, and market

[14] Data source: National Energy Administration of China.

dispatch, creating operational security risks. Third, stable energy system operation is affected by extreme weather and emergencies, creating emergency security risks.

Therefore, against the backdrop of oil and gas supply security constrained by geopolitics and import dependence, the energy system needs to address both near-cycle stability and long-cycle low-carbon transition. Existing coal and coal power systems should continue to play a security support role, while incremental investment gradually shifts toward renewable energy and grid flexibility. As renewable energy costs decline, electrification accelerates, and technologies advance, energy security, climate change, economic growth, and air quality have formed synergies. In some areas, the traditional "energy trilemma" has begun to be broken.

From the stock system perspective, coal power remains the most mature, stable, and regulating support power source in China's power system. During the energy system transition, coal's main role is shifting toward ensuring power system stability, supporting new energy integration and consumption, and safeguarding power operation under extreme weather conditions. During the 15th Five-Year Plan period, the positioning of coal power is shifting from a main power source to a regulating and security power source. By the end of 2024, national coal-fired power capacity was 1.195 billion kW, accounting for 35.7% of total installed power capacity; by the end of 2025, its share had fallen to 32.4%, reflecting the clean transition of the power structure. China's summer peak load reached 1.5 billion kW in 2025,[15] and coal power still played an important role in supply security. Against the backdrop of frequent extreme weather and rapid growth of new loads such as AI data centres, power systems have much higher requirements for stability and flexibility. But stabilizing existing capacity does not mean continuing large-scale expansion of traditional coal power. It means stabilizing the existing coal power base, improving flexibility retrofits, and promoting the transition of coal power from main power source to basic security and system-regulating power source. In the future, coal power's core functions will be reflected more in ensuring energy security, supporting new energy integration and consumption, and maintaining stable power system operation. This transition must balance energy security, economics, and low-carbon goals. Existing coal power units in China currently have an average operating age of about 17 years and a design life of about 30 years, meaning most still have 10 to 15 years of operating life. Large-scale early retirement would create significant asset impairment and sunk costs and may affect the smooth transition of the energy system. Orderly retirement according to equipment life cycles and system regulation needs can recover depreciation and reasonable returns while buying time for new energy system development. Existing coal power should be managed through classified flexibility retrofits, capacity compensation, and orderly retirement. New coal power projects should be strictly justified and tied to new energy integration, system regulation, and carbon emissions constraints to prevent new high-carbon lock-in in the name of energy security.

Table 3-1. Comparison of key data for coal power and renewable energy in China

Indicator	2021	2024	2025
Coal-fired power capacity	1.10 billion kW	1.195 billion kW	1.259 billion kW
Share of coal-fired power capacity	47%	35.7%	32.4%
Coal-fired power generation	5.34 trillion kWh	5.43 trillion kWh	5.55 trillion kWh
Share of coal-fired power generation	About 60%	54.8%	51.1%
Coal-fired power utilization hours	4,586 hours	4,628 hours	-
Thermal power utilization hours	4,448 hours	4,400 hours	-

[15] https://www.news.cn/energy/20250718/85f6b942c2e14089993d209e196c908a/c.html.

Average utilization hours of power generation equipment	3,817 hours	3,442 hours	3,119 hours
Renewable energy generation	2.48 trillion kWh	-	3.99 trillion kWh
Share of renewable energy generation	29.7%	-	38.3%

China faces more prominent constraints in oil and gas resources. In 2025, China produced about 216 million tonnes of crude oil[16] and imported about 578 million tonnes,[17] with import value close to USD 300 billion and import dependence of about 70%.[17] China's natural gas production in 2025 was 262.06 billion cubic metres, imports were 176.5 billion cubic metres, import value was about USD 56.74 billion, and import dependence was about 40%. Against the background of global energy system restructuring, simply expanding oil and gas imports cannot fundamentally solve energy security challenges. China's future oil and gas development should follow a structural optimization direction of ensuring strategic uses and reducing fuel dependence, allocating limited resources more to hard-to-substitute areas such as chemical feedstocks, aviation and shipping, and industrial high-temperature processes, with priority on ensuring chemical feedstock demand. On the one hand, China should continue strengthening domestic oil and gas exploration and development to improve domestic production capacity. On the other hand, it should accelerate fuel substitution in transport and buildings.

In recent years, China's wind and solar PV have entered a stage of rapid growth. In 2025, their share of installed capacity exceeded 47%, historically surpassing thermal power, while their share of total power generation was about 22%. However, further improvements are needed in new energy integration, grid regulation, and system flexibility still need further improvement. Energy Foundation estimates suggest that if wind and solar PV maintain their current growth trends, by 2030 their share of installed capacity could approach 60%, their share of generation could approach 40%, and annual generation could exceed 5 trillion kWh. Continued expansion of new energy increments will gradually drive optimization of the overall energy structure and realize a smooth transition pathway of replacing stock with increments.

Therefore, expanding increments means not only expanding wind and solar PV capacity, but also using incremental breakthroughs to drive optimization of the entire energy structure. This includes large-scale development of energy storage, promotion of integrated generation-grid-load-storage development, strengthening demand-side response, and enabling flexible resources such as virtual power plants to play a larger role. Especially amid rapid expansion of AI data centres, coordinated development of new energy and storage will become a key pathway to meet new electricity demand, reduce fossil energy dependence, and ensure long-term energy resilience.

3.1.3 Help Accelerate the Iterative Upgrading of Green and Low-Carbon Technologies

The new NDC will promote breakthroughs and scaled application of green and low-carbon technologies, making green technological innovation a new source of total factor productivity. First, installed new energy capacity needs to double within ten years. By the end of 2024, China's cumulative grid-connected installed capacity of wind and solar power was about 1.4 billion kW, completing the international commitment of 1.2 billion kW by 2030, more than six years ahead of schedule. To achieve the 2035 target of 3.6 billion kW of combined wind and solar capacity, China needs to add about 2.2 billion kW of grid-connected capacity between

[16] https://news.cnpc.com.cn/system/2026/01/23/030184532.shtml.

[17] https://www.huaon.com/channel/tradedata/1144105.html.

2025 and 2035, or at least 200 million kW annually, including at least 100 million kW of new wind power capacity each year[73].

Second, the market for new power system equipment and services will expand significantly. Demand for technologies and equipment will accelerate, including ultra-high-voltage transmission, flexible direct current, grid-forming energy storage, virtual power plants, grid digitalization upgrades, and coordination of generation, grid, load, and storage. By the end of 2025, China's installed new energy storage capacity in operation reached 136 million kW / 351 million kWh, more than 40 times the level at the end of the 13th Five-Year Plan. The theoretical regulating capacity of virtual power plants exceeded 16 million kW, and aggregated vehicle-grid interaction resources exceeded 19 million kW[74]. In March 2025, the National Development and Reform Commission and the National Energy Administration issued Guidelines on Accelerating the Development of Virtual Power Plants, defining virtual power plants for the first time as "new business entities." The guidelines propose reaching national regulating capacity of more than 20 million kW by 2027 and more than 50 million kW by 2030, and shifting revenue mechanisms from subsidy-driven models toward diversified market-based revenues such as spot markets, ancillary services, and demand response. Shanghai, Shenzhen, and other cities have already formed operational demonstrations that aggregate commercial buildings, charging and battery-swapping facilities, storage, and other resources.

Third, markets for end-use electrification and low-carbon process equipment are rapidly emerging. In buildings, in 2024, electricity accounted for more than 55% of building end-use energy consumption[75]. The Work Plan for Accelerating Energy Conservation and Carbon Reduction in Buildings further proposes that by 2025 the area of newly built ultra-low-energy and near-zero-energy buildings should increase by more than 20 million square metres from 2023, and markets for solar-storage-direct-current-flexible systems, efficient heat pumps, electric cooking, and other technologies and equipment should enter rapid development. In industry, markets are emerging for electric kilns, electric boilers, short-process electric furnace steelmaking, hydrogen metallurgy, CCUS integrated systems, and green and low-carbon process equipment. In transport, markets for NEVs, charging and battery-swapping infrastructure, sustainable aviation fuels (SAF), and green marine fuel bunkering are accelerating. In 2025, China's NEV production and sales reached 16.6 million and 16.5 million vehicles respectively, up 29% and 28.2% year-on-year, ranking first globally for the eleventh consecutive year. NEVs accounted for 47.9% of new vehicle sales overall, and for the first time exceeded 50% of domestic new vehicle sales, reaching 50.8%, continuing to drive rapid growth in charging and battery-swapping infrastructure and green transport equipment.

Fourth, climate adaptation will become an important aspect of technological innovation. In response to climate-related risks such as frequent extreme weather, ecosystem damage, and agricultural production volatility, strengthening climate adaptation capacity will promote technology research and application in climate risk monitoring and early warning, disaster emergency prevention and control, ecosystem restoration, climate-adaptive agricultural breeding, and coastal protection, while also opening broad market space.

Overall, transition needs created by the new NDC, including new energy system development, non-CO_2 greenhouse gas reduction, and climate adaptation, will accelerate the iteration of green, low-carbon, and sustainable technologies and speed up breakthroughs in key core technologies.

3.2 NDC Implementation Pathways and Challenges

3.2.1 Long-Term Transition Pathway and Priority Areas

The long-term low-carbon transition pathway toward carbon neutrality should be divided into three stages to progressively achieve deep decarbonization.

The first stage is the carbon emissions peaking period, from the present to 2030. Energy-related carbon dioxide emissions will enter a peak-plateau phase after 2025, achieving emissions stabilization with a downward trend before 2030. By 2030, CO_2 emissions per unit of GDP will fall by more than 65% from 2005 levels, economic growth and carbon emissions will achieve absolute decoupling, and carbon emissions will continue to decline steadily while GDP doubles from 2020 to 2035. This is a critical transition period. China should clarify the top-level design and implementation pathway for the carbon neutrality strategy as early as possible; comprehensively deploy high-quality peaking actions before 2030; promote early peaking in qualified provinces, cities, regions, and high-energy-consuming industries; build society-wide consensus; and prepare forward-looking policy, technology, and financing arrangements.

The second stage is the deep emissions reduction period from 2030 to 2050. After carbon peaking, China will accelerate economy-wide greenhouse gas reduction and strive to reduce CO_2 emissions by more than 80% from the peak year by 2050, to about 2 billion tonnes, comparable to the global per capita CO_2 emissions level at that time of 1.0 tonnes to 1.5 tonnes. Non-CO_2 greenhouse gases will be substantially reduced by about 50% from their peak, laying a solid foundation for carbon neutrality before 2060. During this period, urbanization is expected to stabilize and the economy will enter a medium-to-low growth stage, with average annual growth of about 3.5%. The low-carbon transition of the energy structure will accelerate further, zero-emission and negative-emission technologies will enter large-scale application, and annual greenhouse gas reductions will reach 400 million to 500 million tonnes CO_2 equivalent. This period requires coordinated efforts across all sectors of the economy, steady advancement of a fair and just transition for society as a whole, and prevention of risks such as stranded fossil energy assets, employment decline, and economic downturn.

The third stage is the carbon neutrality period from 2050 to 2060. China will achieve further deep CO_2 reductions, accelerate reductions of non-CO_2 greenhouse gases, and strive to achieve carbon neutrality for all greenhouse gases before 2060. Achieving carbon neutrality for all greenhouse gases requires not only reducing energy-related CO_2, but also reducing CO_2 from industrial processes and non-CO_2 greenhouse gases. It also requires considering negative emissions from carbon capture and storage (CCS), bioenergy with carbon capture and storage (BECCS), and increased carbon sinks in agriculture and forestry, so that negative emissions offset remaining greenhouse gas emissions.

To further describe energy consumption and carbon emissions by sector and time node along the above pathway, the Tsinghua University research team used a combination of top-down and bottom-up approaches to study China's pathway to carbon neutrality through 2060 and proposed core pathways toward carbon neutrality.

(1) Deep decarbonization of the energy system. The share of non-fossil energy in primary energy consumption needs to rise from the current level to more than 80% by 2060. Wind and solar PV will move from supplementary energy sources to main energy sources, with total installed capacity expected to reach the tens of billions of kilowatts. Nuclear power and hydropower will develop steadily, while biomass, geothermal, and other resources will be used in diversified ways. The power system will shift toward a high share of renewable

energy and high flexibility, supported by large-scale storage, smart grids, and coordination of generation, grid, load, and storage. Under this scenario, coal's main role will be to ensure power system stability; support new energy integration and consumption; and balance power supply security, heating demand, and safe power operation under extreme weather and climate conditions.

(2) Clean and efficient end-use energy consumption. Achieving low-carbon end-use energy consumption requires vigorous energy conservation while strengthening the substitution of electricity for fossil energy in end-use consumption, and continuously increasing electricity's share in primary energy consumption to create space for rapid growth in renewable electricity. In industry, China should deepen supply-side structural reform, widely deploy advanced energy-saving technologies and equipment, steadily increase industrial electrification and clean energy use, and adopt revolutionary process routes using hydrogen and biomass fuels as fuels or feedstocks. Processes that still use fossil fuels should be equipped with industrial CCUS technologies. Intelligent manufacturing and refined big-data management should improve overall efficiency. Circular economy development should be advanced, use of recycled resources such as scrap steel and non-ferrous metals should increase, and capacity optimization and demand-side management should be strengthened in high-energy-consuming and high-emission industries such as steel and cement to reduce demand and output of industrial products based on primary resource routes. In transport, China should develop intensive and intelligent transport, optimize transport structure, and improve technology and energy efficiency. It should keep vehicle ownership below 600 million vehicles, accelerate electrification and hydrogen use, substantially replace current oil product consumption in transport, achieve near-full electrification of on-board operations during railway passenger and freight operations and ship berthing, raise NEVs to more than 90% of passenger vehicle stock, and widely promote biofuels and hydrogen-based fuels in aviation and maritime transport. In buildings, China should control building scale, optimize regional layout and design, improve electrification of building end-use energy consumption, achieve comprehensive electrification in urban areas and mainly electrification in rural areas supplemented by efficient biomass use, promote technologies such as BIPV, develop low-grade waste heat utilization for building heating, and reduce overall energy consumption through technological improvement.

(3) Deep reduction of non-CO_2 greenhouse gases. During the 15th Five-Year Plan period, China should strengthen the monitoring, reporting, and verification (MRV) architecture for methane, N_2O, and fluorinated greenhouse gases, establishing robust sector-specific baselines and reduction milestones to anchor implementation. Strategic priorities should address key non-CO_2 sources: controlling methane across coal mining, oil and gas operations, livestock, rice cultivation, landfills and wastewater; reducing N_2O from adipic acid, nitric acid, and caprolactam facilities while boosting agricultural nitrogen-use efficiency; and managing fluorinated gases across the entire equipment lifecycle, from manufacturing and servicing to end-of-life recovery. Realizing these priorities requires combining multiple MRV tools—including facility reporting, ground-level monitoring, satellite remote sensing, and atmospheric observations (i.e., "top-down" atmospheric inversion)—to improve emission inventories and pinpoint major emission sources. Concurrently, policy-makers should coordinate mandatory emissions standards, environmental impact assessments (EIAs) mechanisms, product carbon-footprint policies, green finance, and market incentives into standard sectoral oversight. Ultimately, non-CO_2 mitigation policy design must systematically evaluate near-term co-benefits, in particular air quality, public health, food and energy security, and industrial upgrading and high-quality growth, alongside climate mitigation benefits.

(4) Scaled application of negative-emission technologies. Large-scale deployment of CCUS should address emissions that are difficult to avoid completely, such as some industrial processes and associated emissions

from biomass energy use. Carbon sink capacity should be continuously improved through ecological protection and restoration, sustainable forest management, soil carbon sequestration, BECCS, and other approaches, supporting the realization of carbon neutrality.

3.2.2 Sector-Specific Transition Roadmap Aligned with the 15th Five-Year Plan and 2035 Goals

The green and low-carbon transition shall proceed in progressive phases: the carbon peaking tackling phase (present to 2030), the stable carbon reduction and in-depth integration phase (2030 to 2035), the deep decarbonization tackling phase (2035 to 2050), and the carbon neutrality decisive phase (2050 to 2060). Drawing on research from Tsinghua University and relevant literature, this study identifies the key milestones, directions for technological breakthroughs, and industrialization timelines for each phase.

1) Industrial Sector

To achieve peaking of carbon dioxide emissions by 2030 and reach internationally-advanced energy and resource-use efficiency for key industries and products by 2035, with green development becoming a prevailing feature of new-type industrialization, China needs to deepen supply-side structural reform in industry, popularize advanced energy-saving technologies and equipment, and steadily increase electrification and clean-energy utilization.

In the medium- and long-run, as the emission-reduction potential of existing technologies gradually tapers off, China must strengthen innovation in industrial energy technologies and process upgrading. Meanwhile, electricity substitution should be widely scaled up to lift the electrification rate from around 25% in 2020 to approximately 55% by 2060. Revolutionary process routes adopting hydrogen and biofuels as fuels or feedstocks shall be deployed, and industrial carbon capture and storage (CCS) retrofits shall be installed for processes still relying on fossil fuels. Overall efficiency will be improved via smart manufacturing and refined big-data-driven management. The circular economy will be vigorously developed to cut output of industrial products based on virgin-resource inputs.

2) Building Sector

To cut direct carbon emissions per unit of building floor area by 3% by 2030, China shall rationally guide residents' lifestyles and energy-use patterns, appropriately deploy and steadily scale up various building technologies, and push forward electrification in a phased manner. After carbon peaking in the building sector, stricter control over building floor area is required. Efforts should be made to foster low-carbon lifestyles and behaviours, continuously improve building performance and equipment energy efficiency, advance building-integrated photovoltaics (BIPV), scale up heat-pump deployment in buildings tailored to local conditions, and contain per-capita building-energy demand through substantially higher electrification rates. By 2035, notable progress will be achieved in the coordinated development of intelligent construction and building industrialization, paving the way for near-zero emissions by 2050.

3) Transport Sector

By 2030, China will keep increasing the share of low-carbon transport vehicles and travel modes, targeting a 30% proportion of new-energy vehicles in the total vehicle stock. Following emissions peaking, low-carbon pathways including accelerated electrification and hydrogen deployment will be continuously pursued. By 2035, civil aviation transport will strive for carbon-neutral growth, a modern comprehensive transport system will be basically completed, and new-energy vehicles will dominate new-vehicle sales. Ultra-low emissions will be attained between 2050 and 2060. Specifically: first, develop intensive and intelligent transport, optimize transport structure, and boost technological performance and energy-use efficiency; second, exercise reasonable

control over vehicle stock; third, speed up electrification and hydrogen-energy application to substantially displace conventional oil-based transport fuels, while achieving near-complete electrification of railway passenger and freight operations, as well as onboard operations on ships at berth; and fourth, widely deploy biofuels and hydrogen-based fuels in aviation and shipping.

4) Energy Sector

While pursuing vigorous energy conservation and energy-mix optimization, greater efforts shall be made to substitute fossil fuels with electricity in the final-energy consumption mix. The low-carbon transition of the energy system must be grounded in China's national conditions and resource endowments, firmly follow the development principle of "establish the new before phasing out the old," and accelerate the integrated development of fossil-energy and new-energy sources.

By 2030, a clean, low-carbon, safe, and efficient new-type energy system will take shape. Coal and oil consumption will peak, the share of non-fossil energy in total energy consumption will reach 25%, wind and solar power will account for over 50% of installed power capacity and become the mainstay of power installations, and non-fossil energy will contribute 50% of power generation and dominate electricity output. A robust, resilient, green, low-carbon, integrated, smart, and efficient new-energy infrastructure system will be accelerated, and a new-type power system will be built.

By 2035, substantial progress will be made in developing the new-type power system and new-type energy system. To achieve carbon neutrality, China will establish a clean-energy system dominated by non-fossil energy, transforming China from a large energy-consuming country into a leading energy nation.

3.2.3 Challenges

(1) Industrial involution still exists. In solar PV, energy storage, and other fields, signs of involution characterized by high growth, low returns, and overcapacity have emerged, and simply suppressing capacity cannot address the root causes. In recent years, involution-style competition has been common across multiple industries, manifested in price wars, product homogenization, and insufficient technological innovation. Capacity expansion in mainstream tracks such as solar PV, new energy storage, and NEVs has been much faster than the release of domestic application scenarios. Combined with homogeneous layouts caused by local competition for industrial investment, these sectors show a high-growth, low-return pattern. In the automotive sector, involution has been especially evident. In 2025, China's auto industry profit margin was only 4.1%, down 5% year-on-year, and fell further to 3.4% in the first five months of 2026. With the rapid development of NEVs, traditional fuel vehicle enterprises have also joined the competition, causing frequent price wars across the market and compressing profit margins. Similar competition is widespread in solar PV, lithium batteries, steel, and other industries. It affects enterprise profitability, challenges healthy industry development, wastes resources, and reduces innovation vitality.

(2) New power system development faces both institutional and technological bottlenecks. Building a new power system is the core bottleneck determining whether the green and low-carbon transition can continue. Rapid cost declines in solar PV and storage make it possible to break the "clean, affordable and secure energy trilemma," but current grid systems, market mechanisms, capacity compensation, ancillary services, direct green electricity connection, and distributed energy integration remain institutional bottlenecks. Building a diversified, reliable power balance and security stability system requires scaled deployment of new energy storage and pumped-storage hydropower; demand-side response and virtual power plants; optimized cross-regional power resource allocation; and improved spot markets, ancillary services and capacity mechanisms to provide

institutional support for continued new energy expansion. High-share renewable energy integration poses unprecedented challenges to power system regulation, stability, and security. Long-duration storage and power supply security under extreme weather remain insufficient; current storage technologies are mainly short-duration, and cross-seasonal long-cycle storage technologies are not mature enough to handle sharp renewable output declines during continuous rainy days or extreme weather. Power market mechanisms remain incomplete, with weak coordination among capacity markets, ancillary service markets and spot markets, unresolved institutional bottlenecks in direct green electricity connection and behind-the-metre electricity sales, and unclear market status for distributed energy. As the share of coal power units declines, grid inertia support and voltage stability face new challenges, requiring faster deployment of synchronous condensers, virtual synchronous generators (VSGs), and advanced inverter control. Cross-provincial and cross-regional power dispatch still operates mainly on a province-centred model, making it difficult to match the cross-regional integration needs of large new energy bases, and regional optimized dispatch and unified flexible resource pools have not yet formed[76].

(3) Insufficient technology innovation supply has become an important constraint. On the one hand, disruptive decarbonization technologies remain immature. Long-duration storage, green hydrogen production and transport, CCUS, advanced nuclear power, and other technologies are still at the demonstration and validation stage. Their economics for scaled application remain insufficient, and cost reduction is slower than expected, making it difficult to support deep emissions reductions in industry, power, and other sectors. On the other hand, end-use decarbonization technologies have clear weaknesses. In industrial process redesign, ultra-low-energy buildings, efficient electrification equipment, and other areas, core components and high-end control systems still depend on imports, and independent controllability is insufficient. The adaptation of digital and intelligent control technologies to power systems and end-use terminals needs improvement, and the accuracy of renewable power forecasting and system dispatch under extreme weather needs to be strengthened. In addition, cross-field innovation integrating green technologies with digital and materials technologies remains insufficient, limiting the full release of technology synergies for emissions reduction.

(4) International cooperation and competition coexist. The evolution of global climate governance and green trade rules creates multiple challenges for international cooperation in the low-carbon transition. Developed economies and developing economies, driven by the dual needs of developing local industries and ensuring supply chain security, have introduced trade and industrial policies to localize and restructure supply chains, creating pressure on international trade in solar PV and NEVs. China's solar PV, wind power, and other industries have already faced trade barriers and investment obstacles. Combined with core technology bottlenecks and demand volatility, China's new energy industry has entered a deep adjustment period under internal and external pressure. Technology cooperation faces geopolitical barriers, and cross-border technology transfer and joint research and development in high-end decarbonization technologies and core equipment are constrained. Global green standards remain fragmented, and international mutual recognition mechanisms for carbon footprint accounting, green product certification, and carbon emissions measurement are lacking, increasing compliance costs and constraining global coordination of green industrial chains. Global climate governance is also showing signs of fragmentation, with insufficient multilateral climate cooperation action and large gaps in international climate finance and technology support, making it difficult to support coordinated transition worldwide.

(5) Critical material supply has become a transition risk. Rapid expansion of new energy and low-carbon industries makes the supply security of critical minerals and core materials an important risk. Dependence on

imported strategic resources is high: lithium, cobalt, nickel, and other critical minerals for batteries and storage remain highly import-dependent, and concentrated global mineral distribution and intensified geopolitical conflicts have significantly increased supply chain volatility risks[77]. Independent supply capacity for high-end materials is insufficient: high-grade proton exchange membranes, high-end storage electrode materials, and high-end silver paste for solar PV still rely on imports, and weaknesses in deep processing and high-end manufacturing constrain value-added upgrading of industrial chains. Supply security for emerging technology materials is inadequate: platinum group metals, special catalytic materials, and other materials required for emerging tracks such as green hydrogen, CCUS, and long-duration storage have limited production capacity and immature supply chain systems, making it difficult to match the pace of scaled industrial development. In addition, incomplete recycling systems for critical materials and low secondary resource utilization further aggravate supply pressure.

3.3 Deepening Institutional and Policy Reform

Achieving carbon neutrality is a broad and profound systemic economic and social transformation. China must accelerate systemic institutional restructuring around the green and low-carbon transition of the energy system and development model, break institutional and mechanism barriers through deeper reform, improve incentive and constraint mechanisms, fully mobilize the initiative of all types of market entities to transform independently, and provide stable and predictable institutional support for achieving the carbon neutrality goal.

3.3.1 Use the Dual Control System for Total Carbon Emissions and Carbon Intensity as the Key Lever to Anchor Target Achievement and Whole-Society Participation

The 15th Five-Year Plan period will be the first five-year period for full implementation of the dual control system for total carbon emissions and carbon intensity. In 2023, the Central Comprehensively Deepening Reforms Commission adopted the Opinions on Gradually Shifting from Energy Consumption Dual Control to Carbon Emission Dual Control. In August 2024, the General Office of the State Council issued the Work Plan for Accelerating the Establishment of a Carbon Emission Dual Control System, proposing intensity control as the main focus with total volume control as a supplement during the 15th Five-Year Plan period, and total volume control as the main focus with intensity control as a supplement after carbon peaking. It also deployed a full-chain management system covering five areas: local carbon assessment, industry carbon regulation, enterprise carbon management, project carbon evaluation, and product carbon footprints. At the assessment level, in April 2026 the CPC Central Committee and the State Council issued the Comprehensive Evaluation and Assessment Measures for Carbon Peaking and Carbon Neutrality. The measures set five control indicators: total carbon emissions, reduction in carbon intensity, total coal consumption, total oil consumption, and the share of non-fossil energy consumption, as well as nine supporting indicators including energy conservation, industry, urban and rural construction, transport, public institutions, carbon emissions trading, and forest stock volume. They require shared responsibility of Party and government and dual responsibilities for one post, linking assessment results to comprehensive evaluation, selection, and appointment of local Party and government leadership teams, thereby transforming dual carbon efforts from soft tasks into hard constraints.

Overall, the carbon dual control system will, on the basis of implementing national-level overall control targets, promote the decomposition of targets down to localities, industries, and key enterprises; improve target responsibility assessment and evaluation mechanisms; and strengthen hard constraints on local low-carbon development. At the same time, it will anchor medium- and long-term renewable energy development targets, promote orderly reduction and substitution of fossil energy, gradually reduce dependence on fossil energy while ensuring energy security, guide localities to optimize energy structures according to their resource endowments and industrial foundations, balance transition pace with development needs, and promote a smooth and orderly green and low-carbon transformation of economic and social development.

Implementation still faces three bottlenecks. First, supporting policies are incomplete. Detailed local carbon assessment rules and industry carbon emissions monitoring and early-warning mechanisms are delayed, and the total allowance cap in the national carbon market has not yet been effectively connected with the national total carbon emissions target. Second, unclear carbon emissions baselines and weak accounting foundations are the biggest shortcomings. Non-energy carbon emissions from industrial processes, agriculture, forestry, animal husbandry and fisheries, and waste treatment lack normalized statistics, with unclear baselines, boundaries, and factors. The current "factory method" of energy statistics merges building and transport energy use into their respective industries, making it difficult to separate them. Because of differences in statistical survey methods, the sum of provincial energy consumption data has long been higher than the national total, creating difficulties in decomposing targets to localities. Third, after management system adjustments, staffing and capacity building lag behind. Professional capacity reserves in carbon accounting and carbon monitoring are insufficient, and cities, districts, and counties commonly lack dedicated institutions, full-time personnel, and special funding, while cross-department coordination mechanisms remain weak.

3.3.2 Deepen Market Mechanisms for Green and Low-Carbon Development

Market mechanisms are an important force for reducing pollution and carbon emissions. China should coordinate the carbon emissions trading market, the voluntary greenhouse gas emissions reduction market, green certificate and green electricity markets, and other markets to form a dual mechanism of administrative control plus market incentives. The new NDC proposes an absolute emissions reduction target for the first time, placing the national carbon market at a critical stage of transition from intensity control to absolute volume control. The first two rounds of NDCs centred on intensity reduction, and the carbon market accordingly used intensity-based allowance allocation, making emissions constraints relatively flexible. Absolute volume targets require the carbon market to gradually set annual absolute caps aligned with national emissions reduction targets, and through scope expansion and mechanism upgrading, decompose national emissions reduction totals into binding constraints for industries and enterprises[78].

Following the principle of including sectors when they are mature, carbon market expansion follows a clear timetable. In March 2025, the Ministry of Ecology and Environment issued a work plan that included steel, cement, and aluminum smelting in the national carbon market for the first time. By 2027, the market will cover major emitting industries in the industrial sector, with total allowance control first applied to industries whose total emissions are relatively stable. By 2030, a carbon market based on absolute allowance control and combining free and paid allocation will be largely established. By 2035, the market will cover major high-emission industries and become an internationally influential carbon market system. The first round of expansion shows three types of diversification: coverage expands from about 2,200 power enterprises and about 5 billion tonnes, around 40% of national emissions, to about 3,500 enterprises in four major categories and

about 8 billion tonnes, around 60% of national emissions; regulated emissions expand from CO_2 to tetrafluoromethane and sulfur hexafluoride; and regulated activities expand from energy-related emissions to include industrial process emissions.

As of July 14, 2026, cumulative trading volume of carbon allowances in the national carbon market reached 924 million tonnes, with cumulative transaction value exceeding CNY 62.2 billion. Since the national voluntary greenhouse gas emissions reduction (CCER) market was launched in January 2024 and completed first-batch certified emissions reduction registration in March 2025, cumulative trading reached 3.18 million tonnes and transaction value CNY 267 million by the end of September 2025, making the carbon market China's main carbon pricing method[79]. It is worth noting that the expansion scheme regulates only direct emissions from key industries and avoids double counting with indirect emissions from electricity consumption. This boundary is basically consistent with the EU Emissions Trading System (EU ETS), creating conditions for interconnection, mutual recognition of allowances, and responding to CBAM.

Expansion also brings systemic challenges from single-sector governance to cross-sector, cross-gas, and cross-mechanism governance. First are risks in data accuracy and MRV systems: industrial process emissions are difficult to monitor, accounting methodologies for newly included gases are immature, regulatory capacity is insufficient, and distorted data would weaken the binding force of total volume targets. Second are sectoral differences and fairness challenges in allowance allocation, as process routes, emissions reduction potentials, and historical data quality vary widely across industries, creating risks of structural imbalance in allowances. Third are market liquidity and price volatility risks, as tidal trading patterns, sharp carbon price fluctuations, and regional supply-demand imbalances may interfere with enterprise emissions reduction expectations. Fourth are enterprise transition and compliance cost pressures, as newly included enterprises face funding burdens for monitoring equipment upgrades, accounting system development, and low-carbon retrofits.

3.3.3 Improve Pricing, Taxation, Fiscal, and Financial Policies, Legal Systems, and Regulatory Mechanisms

(1) **Coordination among carbon pricing, taxation, fiscal tools, and green finance**. China should systematically align the synergies among carbon pricing, tax incentives, fiscal subsidies, and green finance tools; precisely support investment that stimulates green demand; and cultivate technologies and industries with relatively mature technical and economic performance and large market potential over the next five to ten years. According to estimates by Professor Wang Ke's research team at Renmin University of China, the "two new" policies[18] in 2024 to 2025 contributed 209.03 million tonnes of carbon emissions reductions and 88.71 million tonnes of coal-equivalent energy savings in the current period, while driving about CNY 7 trillion in direct consumption and equipment investment and about CNY 5.72 trillion in GDP. China's green finance system has also reached significant scale: by the end of 2025, green loan balances were about CNY 44.8 trillion and green bond balances exceeded CNY 2.4 trillion. By the end of the second quarter of 2025, the carbon emissions reduction support tool had guided financial institutions to issue more than CNY 1.38 trillion in carbon reduction loans.[19] Next, China should advance paid allowance allocation reform; establish special funds for low-carbon

[18] The "two new" policies refer to the policies for large-scale equipment upgrading and consumer goods replacement for old ones.

[19] Data source: People's Bank of China.

technologies; invest carbon revenues mainly in hydrogen, electrification, CCUS, and other areas; develop green public procurement; close green premiums; and cultivate green market demand.

(2) **Implementation of transition finance and green finance: the Linfen and Ningbo cases**. Transition finance is an important tool for supporting the orderly low-carbon transition of high-carbon industries, and both transition finance and green finance are important tools for local green and low-carbon transition. Current local transition finance practices face four constraints: lack of coordination in regional target setting, shortage of low-carbon assets and weak green finance infrastructure in high-carbon regions, insufficient professional capacity among local financial institutions, and weak transition planning capacity among high-carbon enterprises. Linfen, a typical coal resource-based city, faces challenges including a heavy industrial structure, large funding needs for high-carbon industry retrofits, and insufficient ability among financial institutions to identify green and transition projects. Its core approach is to use air quality improvement and low-carbon transition goals as guidance; systematically identify key projects in steel, coking, clean heating, and green transport; form a low-carbon asset list; and explore a transition finance mechanism combining standards, diagnostics, and finance. The Shanxi Branch of the People's Bank of China and seven agencies jointly developed a transition finance support catalogue for coking and non-ferrous industries; the Shanxi Energy Conservation Center organized experts to conduct systematic energy-saving diagnostics for coking and non-ferrous industries; and Industrial Bank Taiyuan Branch and the Industrial Bank Carbon Finance Research Institute launched front-loaded transition finance services, shifting from passive credit approval to proactive empowerment. This provided CNY 960 million in credit for coal chemical technology upgrading projects, expected to reduce CO_2 emissions by 266,100 tonnes annually, place more than 300 workers, and support more than 2,000 surrounding jobs.

Local blended finance innovation faces three challenges: insufficient leveraging effect, difficulty screening projects, and inadequate risk sharing. With support from the Asian Development Bank and the Energy Foundation, Ningbo provides long-term, low-cost financing for green and low-carbon projects through philanthropic grants, sovereign loans from multilateral development institutions, on-lending by local commercial banks, and local government special bonds. It also carries out climate finance capacity building for local governments, commercial banks, and micro, small and medium-sized enterprises. The project focuses on building environmental and social risk management systems; improving ESG and sustainability disclosure capabilities; developing green project pipelines and climate finance platforms; and helping financial institutions better identify low-carbon technologies, energy-saving retrofits, and SME green transition projects. Ningbo's practice shows that green finance must not only solve where money comes from, but also improve the bankability and sustainability of green projects through capacity building, risk management, and project development mechanisms.

(3) **Legal systems and regulatory mechanisms**. China should advance rule-of-law development in the field of addressing climate change and establish a comprehensive governance mechanism covering target setting, supervision, and accountability. Already issued laws and regulations include the Ecological and Environmental Code, which has established a special chapter on addressing climate change; the Energy Law; the Wetland Protection Law; and the Interim Regulations on the Administration of Carbon Emissions Trading. Next, China should accelerate specialized legislation such as a Climate Change Law, and revise supporting laws such as the Energy Conservation Law, Electric Power Law, Coal Law, Renewable Energy Law, and Circular Economy Promotion Law, where appropriate. Together, this will help to build a comprehensive legal system composed of the Environmental Code's climate chapter, dedicated climate legislation, special regulations, and local legislation; improved coordination between administrative enforcement and criminal justice; and improved

climate public interest litigation systems[79]. In regulatory mechanisms, China should improve data verification, traceability, and penalty mechanisms; include carbon data fraud in the social credit and administrative enforcement systems; improve coordination among energy conservation review, environmental impact assessment, and carbon evaluation; and fully integrate carbon emissions evaluation into fixed-asset investment project energy conservation review and environmental impact assessment processes, controlling incremental project carbon emissions at the source and providing hard institutional safeguards for the green and low-carbon transition.

3.3.4 Improve Supporting Institutions, Support Policies, and Risk Prevention Mechanisms for Coal and Coal Power Transition

China is currently in a critical period of comprehensive transition from dual controls on energy consumption to dual controls on carbon emissions. The smooth exit of coal and coal power is one of the most challenging issues in this transition and still faces multiple deep contradictions. Systematic institutional and policy reform is urgently needed to resolve risks and ensure a just transition.

Coal and coal power transition faces multiple difficulties. Although coal power remains the cornerstone of energy security, its position on the power supply side continues to weaken, and its role is shifting from main power source to regulating power source. Many challenges still remain: some regions still rely heavily on coal power for supply security, especially for winter heating and extreme weather, and coal power's backstop function cannot be fully replaced in the short term. Coal-producing regions such as Shanxi, Inner Mongolia, and Shaanxi depend heavily on the coal industry in their economic structures, and transition will bring socio-economic risks including regional employment decline and reduced fiscal revenues. Stranded coal power asset risks involve not only financial revaluation, but also deeper social issues related to regional employment placement, social security, and livelihood stability.

To address these challenges, China should first improve market-based support mechanisms for the orderly exit of coal power. Capacity market mechanisms should be accelerated and improved, and capacity compensation prices should be clarified for coal power as regulating and security power sources, so that coal power can receive reasonable returns as utilization hours decline and supply security expectations remain stable. Spot markets, ancillary service markets, and capacity markets should be effectively linked, using market signals to guide orderly functional transition of coal power rather than one-size-fits-all shutdowns, thereby avoiding systemic supply security gaps.

Second, China should establish a special just transition fund and strengthen fiscal and financial support for resource-based regions. International experience, such as EU special fiscal allocations to severely affected high-carbon regions, shows that transition regions need more funding during transition to promote economic diversification and employment retraining. The central government should establish a transition fund for major coal-producing regions, mainly to offset local tax losses caused by industrial contraction and to support targeted retraining and social security continuity for unemployed workers. Transfer payment systems should be optimized by making transition needs an important consideration in local government debt quota allocation, and green finance, transition bonds, and other tools should mobilize social capital to support local green industries and replacement industries. In addition, just transition planning should assess the differentiated impacts of the transition on different gender groups in terms of employment, care-giving, income and social security, and ensure the substantive participation of women in local transition processes.

Third, financial tools should be innovated to systematically resolve coal power stranded asset risks. Coal power asset disposal should be deeply integrated with just transition. Financial institutions should be encouraged to develop transition finance products such as sustainability-linked loans and low-carbon transition bonds that link financing costs to enterprise carbon reduction targets and incentivize greening of existing assets. China should explore establishing coal power stranded asset disposal funds, smoothing the impact of asset value revaluation on the financial system through equity participation, restructuring, or asset securitization. Asset disposal plans should be linked with employee placement plans to ensure that resolving financial risks does not undermine livelihood stability.

Fourth, China should improve the dual control system for carbon emissions and implement differentiated regional management. Carbon intensity and total volume requirements should be combined with regional resource endowments, industrial characteristics, and functional positioning. Coal-producing regions should receive reasonable buffer periods and assessment conditions, and regional differentiated assessment mechanisms and local flexible compliance mechanisms should be implemented scientifically.

Fifth, China should accelerate power market development and improve coordination among medium- and long-term markets, spot markets, ancillary service markets, and capacity markets. Market prices should guide resource allocation and investment in flexible resources, enabling new entities such as storage, demand response, virtual power plants, and distributed energy to participate fairly in power markets. Price mechanisms should reflect flexibility value, capacity value, and environmental value. Continued transmission and distribution tariff reform and development of interprovincial and interregional power trading mechanisms should improve cross-regional optimized allocation of new energy and create a better market environment for coal power to gradually shift from being a main power source to a regulating and security power source.

4. Pathways for Gender Mainstreaming in Climate Change

Among the various policy areas mentioned above, China should ensure that the implementation of the new NDC is both economically efficient and environmentally effective, as well as socially inclusive. Among these, issues such as energy security and energy affordability, women's participation in climate governance, women's access to emerging green employment opportunities, and women's participation in climate-related investments and international cooperation are closely related to the quality and inclusiveness of the green and low-carbon transformation. For China, this means that the implementation of the new NDC should not only focus on emission reduction, technological transformation, and economic efficiency, but also on whether women can equally participate in the transformation, benefit from it, and contribute to it.

4.1 Prioritization of Energy Security Squeezes Policy Space for the Gender

Equality Agenda

Since late February 2026, the Iran conflict has triggered sharp increases and sustained volatility in international oil and gas prices, driving up the costs of electricity, gas, fuel, and other household energy uses,

and transmitting impacts to society and the economy through inflation and living costs[80]. This has multiple implications for the gender equality agenda.

At the household level, energy price transmission into household spending can compress women's opportunities for education, employment and participation in public affairs. In most countries, energy is an important household expenditure item after food and housing. At the peak of the 2022 energy crisis, global household energy bills rose 16% year-on-year[81]. Energy price increases may force some low-income households to return to traditional biomass fuels such as firewood and charcoal[82], further increasing the labour burden of women and girls in fuel collection, cooking, and household care[83]. Higher energy prices are also transmitted to food, daily chemical products, and other necessities, continuously widening global gender inequality. When households cope with rising living costs, they often reduce spending on external services and increase internal household care labour, and this additional labour is usually borne mainly by women[20]. This directly exacerbates women's time poverty [21] and severely limits opportunities for further education, employment, and income growth, and participation in public affairs.

At the macro-governance level, tight energy supply and price volatility push countries to shift policy focus toward short-term energy security and supply stability, lowering the strategic priority of climate governance. This further marginalizes social equity and gender equality issues in climate governance, including delays in gender-responsive policy design, gender data monitoring, and women's empowerment projects, further weakening women's development needs.

4.2 Women's Influence Remains Limited in Key Areas of Climate Governance

According to the 2025 UNFCCC Synthesis Report on Nationally Determined Contributions, 89% of Parties provided gender-related information, and 80% indicated that gender considerations would be taken into account in the implementation of their NDCs. Among these, 73% of Parties referenced gender-related policy and legal frameworks; 66% reported adopting concrete tools and approaches such as gender analysis, gender indicators, sex-disaggregated data, and gender-responsive budgeting to integrate gender considerations into NDC implementation; and 58% stressed that capacity building, funding, and technical support should be provided for gender-related actions[84], [22].

However, progress in policy texts and institutional frameworks has not fully translated into equal participation and increased influence of women in climate governance decision-making. During COP30/CMP 20/CMA 7, women accounted for 43.6% of Party delegations and 36.5% of heads and deputy heads of delegations, showing that women's participation in the core decision-making levels of climate governance remains clearly insufficient. The report also indicates a significant negative correlation between the share of women representatives and age: as age rises, the share of women declines. Women's participation also varies significantly across issues and governance areas. In institutions involving key resource allocation such as

[20] ILO data shows women undertake approximately 76.2% of global unpaid care labour hours, over three times that of men; about 708 million women worldwide exit the labour market due to caregiving responsibilities.

[21] Time poverty refers to a state where individuals are burdened with excessive paid work and unpaid care labour, lacking sufficient discretionary time for education, employment, and leisure.

[22] Data from 2024: 81.5%, 48%, 63%, 41%, 36%, respectively.

climate finance, market mechanisms, and technology governance, women are generally underrepresented. For example, women accounted for only 31%, 20%, and 32% respectively, in the Adaptation Fund Board, the Clean Development Mechanism Executive Board, and the Technology Executive Committee. This reflects continued structural imbalance at the core levels of global multilateral climate governance, and women remain relatively underrepresented in key issues including mitigation, finance, technology, and energy governance[85].

4.3 Gender Inequality Persists in the Distribution of Benefits from Energy Transition

The green transition involves employment substitution, energy access, and financing restructuring. Whether women can participate fairly is not only a matter of social equity, but also affects the effectiveness and sustainability of transition policies. Gender inequality in employment and resource distribution remains significant in the energy transition. The IEA notes that women account for only 20% of the global energy workforce, and employment expansion in the sector[23] has not improved gender structure. The core reason is that new jobs in the energy industry are concentrated mainly in technical occupations traditionally dominated by men, such as welding, electrical work, and line construction, where women typically account for less than 5%[86]. In green energy industries, women account for 32% of full-time renewable energy jobs globally, higher than in traditional fossil energy industries but still far below the global labour market average.[24] Women are also underrepresented in technical and decision-making positions in green energy industries, accounting for only 28% of STEM（Science, Technology, Engineering, and Mathematics） technical jobs, 22% of medium-skilled construction jobs, and 19% of executive and board-level core positions.

Women's insufficient participation in green energy industries is not mainly due to lack of skills or willingness, but is constrained by structural factors such as unequal education opportunities, barriers to vocational training, gender bias in the workplace, and unequal distribution of care responsibilities. As global renewable energy industries continue to expand, IRENA expects global renewable energy employment to reach 30 million jobs by 2030. Without inclusive employment support and skills development policies, the large-scale employment dividend from the green energy transition will not fairly benefit women, and may instead further entrench gender stratification and income inequality in the energy sector[87].

While promoting green and low-carbon development, China has continuously internalized gender equality as an institutional advantage in its national development agenda. China's 15th Five-Year Plan Outline[88] clearly proposes upholding the basic state policy of gender equality, ensuring women's equal participation in economic and social development, equal exercise of democratic rights, and equal sharing of the fruits of reform and development. It also plans for the safeguarding of women's equal rights to education and employment, protecting rural women's membership rights in collective economic organizations and land contract management rights in accordance with the law, and supporting women's participation in grassroots governance.

[23] IEA data show the energy sector created 5.4 million new jobs from 2019 to 2024, accounting for roughly 2.4% of all new global employment in the same period. The power sector became the largest job creator in the energy industry for the first time, generating about 3.9 million new jobs, nearly three-quarters of all new energy sector jobs. The photovoltaic industry contributed half of these new positions, followed by nuclear power, power grids, and energy storage, which combined accounted for a quarter.

[24] 2025 ILO data: women make up approximately 40% of the global labour force.

The 2026 APEC Women and the Economy Forum was held in Shanghai under the theme of advancing women's economic empowerment and promoting common prosperity in the Asia-Pacific, emphasizing the opportunities of the new round of technological revolution and industrial transformation and using scientific and technological innovation to create conditions for women's economic empowerment. At the same time, women's role in ecological and environmental protection and green development practices continues to grow. According to the white paper Practices and Achievements of China in Promoting Women's All-Round Development in the New Era, released in September 2025[89], women actively participate in industrial green development, transformation of agricultural production methods, and green development of the service sector. In 2024, women entrepreneurs in the green economy participated in 445,000 enterprises nationwide, accounting for 27.4% of relevant enterprises and covering clean energy, organic agriculture, ecological protection and other areas, demonstrating women's important role in green industrial development.

However, there remains significant room for improvement in the gender balance of employment in China's renewable energy industry. According to ESG reports disclosed by some listed Chinese new energy companies in recent years, the share of female employees is generally between 20% and 26% [25], below IRENA's global renewable energy industry average of 32%. Women remain relatively underrepresented especially in R&D, engineering, production manufacturing, and other STEM-related positions, as well as senior management. In recent years, some enterprises have begun to disclose more detailed gender statistics in ESG reports, including employee composition by age; job level such as ordinary employees, middle management and senior management; and by technical and management positions, as well as explanations of women manager and technical talent development. This reflects positive progress in gender information disclosure. However, China's new energy industry still lacks a unified and systematic gender employment statistical system. Existing data mainly come from large listed enterprises and focus mostly on upstream manufacturing links, with limited coverage of downstream operations and services, SMEs, and non-listed enterprises. The overall gender structure of the industry therefore needs further research and improved statistical monitoring.

4.4 Gender Inclusion Challenges in the Green Transition of Developing Countries

Developing countries face increasingly prominent pressures related to energy security and green transition, but due to insufficient technology, finance, policy tools, and institutional capacity, their transition processes still depend to a large extent on international climate governance, investment, and assistance mechanisms. In recent years, international climate conventions and assistance programs have increasingly integrated gender equality into climate cooperation mechanisms. Multilateral development banks have also incorporated gender considerations into climate finance frameworks and evaluation systems. These efforts have encouraged developing countries to adopt gender-responsive approaches in areas such as energy transition, climate finance, green and low-carbon supply chains, and climate adaptation. Through policy reforms, skills development, and entrepreneurship support, these countries are promoting greater participation of women in the green transition and advancing a more inclusive just transition.

For example, the international green finance and assistance system is effectively promoting gender-inclusive finance upgrading by deeply integrating gender equality goals with climate action. IFC research shows

[25] Data source: latest ESG reports of CATL, LONGi, JinkoSolar, Tongwei, Trina Solar, and other listed new energy enterprises.

that for every one percentage point increase in women's share of corporate management, corporate CO_2 emissions reduction performance improves accordingly, but in reality women founders account for only about 7% of the global energy industry, and investment capital received by women entrepreneurs is significantly lower[90]. Against this backdrop, IFC launched the She Wins Climate program in 2025 for Southeast Asia, South Asia, Central Asia, and other regions, focusing on improving investment access and financing capacity for women climate entrepreneurs. Its core is not simple subsidies, but helping women-led new energy and climate technology enterprises leverage follow-on sustainable venture capital and climate fund support[91]. At the same time, in 2025, AIIB and Keppel worked together to raise USD 1.5 billion for renewable energy and digital infrastructure projects in the Asia-Pacific region, directing part of the funds to women-led SMEs to improve their participation and leadership in green energy industrial chains and ensure that women obtain equal rights and power in addressing climate change[92].

However, gender mainstreaming arrangements in developing countries still largely remain at the policy or principle level. ASEAN countries have generally incorporated gender equality into policy frameworks and strategic documents in climate change and energy transition, but there is still a clear gap between policy commitments and project implementation. Projects that truly land are often scattered demonstration practices with dispersed focus, and models may be difficult to replicate and scale systematically[93], limiting their overall effect on regional gender equality. Chinese overseas new energy and infrastructure projects have begun exploring arrangements that include women's employment, skills training, and local women's participation in implementation. But these practices are mostly project-level social benefit arrangements, and their social impacts are limited to local areas, without yet forming a systematic gender equality and inclusion framework. For example, PowerChina has built the largest solar PV project in the Philippines in San Marcelino, where gender-responsive employment practices are reflected through job matching and local women's employment[94], effectively empowering rural economies and energy access in the Philippines. However, the local female workforce is only about 100 people, and the project's effect on regional gender equality is limited. Institutional integration of women in enterprise participation, supply chain procurement, and project governance remains insufficient.

4.5 Pathway Recommendations for Gender Mainstreaming in the Energy Transition

Based on the above analysis, this study concludes that under current geopolitical and climate governance conditions, gender-responsive climate policies should not merely treat women as a vulnerable group; they should further strengthen women's capacity to participate in green industries and exercise influence. Women are not only beneficiaries of climate action; they should be regarded as leaders, investors, entrepreneurs, and drivers. Specific recommendations include the following.

First, in the context of prioritizing energy security, efforts should be sustained to embed gender equality throughout the global climate-governance agenda. Measures include strengthening social protection mechanisms for women and women-headed households amid energy price shocks, integrating gender perspectives into energy subsidies and energy poverty alleviation policies, accelerating gender mainstreaming

in global climate issues with a focus on gender equality in NDC implementation, incorporating the share of women in core climate governance decision-making into indicator systems, increasing women's participation in core issue groups, and supporting women through multilateral mechanisms and international cooperation to access relevant technical training, build transition adaptation capacity, and improve access to high-skilled green jobs.

Second, China should further strengthen the binding force and implementation of gender equality in its dual carbon policies and 15th Five-Year Plan green transition-related plans, and explicitly embed women's development indicators in relevant policies. Gender-responsive policy tools can be explored in carbon markets, green finance, and industrial transition policies. At the local implementation level, gender-responsive measures should be designed in coordination with rural revitalization, energy transition, and ecological governance, ensuring rural women's institutional rights to benefit from clean energy, ecological compensation, and green agriculture. In key industries such as new energy, storage, solar PV, and green manufacturing, women's career development support systems should be established, including skills training subsidies, job conversion support, and special training programs for women with technical talent, to increase women's share of high-skilled positions. In green entrepreneurship and supply chain systems, financial and policy support for women entrepreneurs should be strengthened, and the coverage of green credit, guarantee mechanisms, and entrepreneurship incubation platforms for women-led enterprises should be expanded.

Third, China and the EU can work with third countries to jointly advance gender-responsive climate finance and just transition cooperation. Since 2020, China-EU climate dialogues have continued to focus on just transition, with attention to gender equality, green employment, and fair distribution. Building on this cooperation foundation, the two sides can deepen collaboration across multiple dimensions: integrating gender equality indicators into climate finance for developing countries and increasing green financial support for women entrepreneurs; exporting mature gender-friendly technical training systems for green industries to help local women improve professional capacity and transition adaptation; jointly issuing guidance on social impacts of overseas investment and implementing comprehensive social assessments and regular gender mainstreaming analysis in green investment and assistance projects; and using green trade and low-carbon supply chain cooperation to open global market channels for women-led new energy MSMEs, supported by technology, standards, and financing linkages.

5. Policy Recommendations

5.1 Build a New Energy System with Renewable Energy as the Mainstay and Better Integrate Energy Transition with Economic and Social Development

First, China should make the development of a new energy system a comprehensive lever during the 15th Five-Year Plan period for stabilizing growth, expanding domestic demand, ensuring security, and reducing carbon emissions. It should promote energy-mix optimization to achieve multiple policy goals such as climate mitigation and air quality improvement in parallel, and scale up synergies between pollution control and carbon

reduction. Around renewable energy bases, new power systems, storage and regulating resources, end-use electrification, green transport and substitution of industrial energy use, China should establish graded major project pipelines and use emissions reduction contribution, energy cost, industrial spillovers, employment absorption, and access to equitable opportunities as selection criteria. Budgetary investment, policy finance, green bonds, transition finance and infrastructure real estate investment trusts (REITs) should be used to stabilize long-term investment expectations and guide green and low-carbon investment into domestic demand, infrastructure renewal, and industrial upgrading. Additionally, it is recommended to establish a dedicated just transition fund targeting major coal-producing regions and other resource-dependent areas, focusing on supporting economic diversification, worker retraining and reemployment, social security, and the orderly phase-out of high-carbon assets.

Second, China should establish a coordinated mechanism for existing energy security and incremental green substitution. The global energy system is currently in a transition stage where old and new energy develop in parallel. Rapid growth of low-emission energy has not yet brought a clear exit of fossil energy investment, and energy security still deeply influences investment decisions. China should implement the new NDC and 15th Five-Year Plan targets while ensuring energy security, and coordinate the relationship between stock and increments, short term and long term, operational security and strategic security. For coal, especially coal power, China should promote its functional shift from main power source and baseload supply toward peak regulation reserve, capacity support, emergency security, and system security services, preventing high-carbon lock-in in the name of energy security. Existing coal power units should be managed through classified flexibility retrofits, capacity compensation, and orderly retirement. New coal power projects should be strictly justified and bound to new energy integration, system regulation, and carbon emissions constraints. New energy demand should be met first by non-fossil energy, demand-side management, and energy efficiency improvement. New energy storage and pumped-storage hydropower should be deployed at scale, and demand-side response and virtual power plants should be developed as economically reliable alternatives to coal power baseload and backstop supply, gradually shifting the foundation of energy security toward local renewable energy, strong and flexible grids, storage systems, and diversified regulating resources.

Third, China should build a safe, stable, reasonably profitable, and affordable new power system under conditions of high shares of new energy. Low-cost power supply should be an important constraint in the power transition, preventing opaque system costs, unreasonable allocation of regulation costs, and inefficient grid investment from raising energy costs for the real economy. Around large-scale new energy access and local consumption, China should coordinate transmission corridors, distribution grid upgrades, virtual power plants, storage, and demand-side response. Power market reform should be accelerated, and medium- and long-term trading, spot markets, ancillary services, capacity mechanisms, green electricity and green certificates, and the carbon market should be linked so that regulation capacity, reliable capacity, and demand response receive reasonable returns. Local governments and grid enterprises should be assessed using indicators centred on system cost, power supply reliability, non-fossil energy consumption rates, and stability of end-user electricity prices.

Fourth, China should shift energy technology policy from single technology deployment to system integration innovation, forming a group of replicable and scalable engineering solutions. Technology deployment should move from single-equipment subsidies and single installed-capacity targets toward system-value-oriented technology combinations, with priority support for long-duration storage, smart grids, flexible direct current, virtual power plants, vehicle-grid interaction, adjustable loads, and green hydrogen coupling. For

high-share new energy systems before the 15th Five-Year Plan and 2035, AI should be used as a key tool to improve system efficiency and resilience, focusing on renewable power forecasting; power meteorology; coordinated dispatch of generation, grid, load, and storage; demand response aggregation; optimized storage configuration; grid risk early warning; and medium- and long-term planning simulation. New electricity loads such as data centres should be incorporated into new energy system planning, and computing layout, green electricity supply, storage configuration, and waste heat utilization should be coordinated to prevent AI electricity demand growth from increasing local grid pressure. In governance, data and planning boundaries across energy, power, industry, transport, buildings, and data centres should be opened, cross-sector energy data platforms and AI application standards should be developed, and the new energy system should shift from expansion to more efficient use, lowering costs, and strengthening resilience. In addition, efforts should be made to accelerate the improvement of energy efficiency in the fields of industry, construction, transportation, and end-use energy equipment. This includes strengthening mandatory energy efficiency standards and energy-saving renovations, expanding the market-based incentive mechanisms for energy efficiency improvement, and enhancing international cooperation in energy efficiency technologies and standards.

5.2 Improve the Dual Control System for Carbon Emissions and Coordinate Hard Constraints with Flexible Market Mechanisms

First, China should establish an operational mechanism that combines hard constraints and flexible compliance around implementation of the carbon dual control system. The Comprehensive Evaluation and Assessment Measures for Carbon Peaking and Carbon Neutrality have been issued and will play an important role in consolidating local and departmental responsibilities and advancing the shift from dual controls on energy consumption to dual controls on carbon emissions. During implementation, China should guard against negative effects of excessive rigidity. It is recommended that, based on the national overall targets and regional differences in development, an interprovincial carbon emissions allowance trading and adjustment mechanism be established, with consideration given to linking it with the carbon market, thereby creating an institutional arrangement under which basic responsibilities are strictly fulfilled, marginal gaps are addressed through market mechanisms, and trading revenues are used to support low-carbon transition. For energy resource exporting regions, industrial transfer receiving regions, and clean energy consuming regions, differentiated accounting, transfer, and benefit compensation rules should be established to avoid simply allocating carbon constraints by administrative boundaries. Revenues from interprovincial adjustment should be used mainly for coal power flexibility retrofits, industrial energy conservation and carbon reduction, green transition in less-developed regions, and employment placement, preventing the mechanism from becoming a channel for high-carbon project expansion.

Second, China should accelerate the transition of the national carbon market from intensity-based caps to absolute caps, gradually forming a mechanism for declining allowances covering key emitting industries. A connection mechanism between the power sector and the absolute carbon emissions cap should first be established, then expanded in an orderly manner to steel, cement, non-ferrous metals, petrochemicals, chemicals, building materials, and other key industries, with clear sectoral emissions caps, allowance allocation methods

and annual reduction pathways. For industries whose emissions are stabilizing, allowance allocation plans should be developed according to absolute controls on emissions. Allocation should gradually shift from mainly free allocation to a combination of free allocation, paid allocation and auctions, with a market stability reserve and price volatility adjustment mechanism. Voluntary emissions reduction methodologies should be expanded to enhance the supplementary incentive role of the voluntary carbon market and support the development of emerging low-carbon technologies, including renewable energy. A carbon pricing mechanism under total carbon caps should be developed to send clear market signals and guide social capital to support carbon reduction action. At the same time, China should improve connection rules among the carbon market, green certificates, green electricity trading, the voluntary greenhouse gas emissions reduction market, and energy-use rights trading; unify accounting boundaries and offset conditions; avoid double counting, double benefits, and policy signal conflicts; and clarify the relationship among green electricity consumption, renewable energy integration, and enterprise compliance costs.

Third, China should strengthen carbon emissions data and information management through the rule of law, consolidating the shared foundation for carbon dual controls, the carbon market, and green fiscal and taxation policies. China should advance foundational legislation in the field of climate change and, in response to the needs of climate governance, accelerate the improvement of the legal and regulatory framework supporting low-carbon transition. This should include promoting revisions to relevant laws, such as the Energy Conservation Law, Renewable Energy Law, Electricity Law, Coal Law, and Circular Economy Promotion Law, in order to further strengthen institutional coherence among energy transition, resource utilization, carbon emission management, and green development. On this basis, systems and rules should be formulated or improved for carbon emissions statistical accounting, enterprise emissions reporting, third-party verification, data quality supervision, information disclosure, and data correction, clearly defining responsibilities of government departments, emitting entities, verification institutions, trading institutions, and data service providers. For key industries and enterprises, digital ledgers should be established covering activity data, emissions factors, energy consumption, green electricity use, product carbon footprints, and allowance compliance, promoting data sharing across departments and traceability across regions. Public disclosure, enterprise reporting, verification confirmation, and subsequent modification of carbon emissions data should strictly follow legal procedures and technical standards, ensuring that modifications have a basis, processes are tracked, results can be reviewed, and responsibilities can be traced. Data should not be adjusted arbitrarily because of changes in departmental boundaries, local management needs, or enterprise compliance pressure. For false reporting, concealment, data tampering, illegal modification, and verification negligence, administrative penalties, credit sanctions, market bans and legal accountability mechanisms should be improved, making carbon emissions data a public governance foundation that is regulable, verifiable, tradable, and accountable.

Fourth, China should accelerate green fiscal and taxation reform and coordinate fiscal and financial policies with green and low-carbon industrial policy, energy security policy, environmental protection, and climate change policy. Around new fields that contain future new quality productive forces and strong undeveloped market demand, China should accelerate technological upgrading and the shift of growth drivers. Higher targets should guide market expectations, and fiscal funds, tax incentives, government procurement, transfer payments, and special funds should be directed more toward new power systems based on high shares of wind and solar, supporting distribution networks and microgrids, storage, virtual power plant construction and operation, energy conservation and carbon reduction, low-carbon technology retrofits, zero-carbon parks, green transport, and

low-carbon buildings, while gradually reducing implicit subsidies for high-energy-consuming and high-emission projects. Meanwhile, policy performance evaluation and audit mechanisms should be improved to regularly assess the effectiveness of different policy instruments, their level of coordination, and their contribution to green and low-carbon transition objectives, thereby promoting more effective alignment and coherence among policy measures. China can explore using revenues from carbon market auctions, interprovincial allowance trading, and environmental taxes and fees to support deep emissions reductions in key industries, transition in less-developed regions, measures to mitigate energy burdens for low-income groups, and worker retraining. When conditions are mature, coordination mechanisms among carbon taxes, resource taxes, consumption taxes, environmental protection taxes, and the carbon market can be studied, forming a green fiscal and taxation framework in which emissions have costs, reductions have benefits, and transition receives support. At the same time, efforts should be accelerated to improve the transition finance support system by drawing on and scaling up local pilot experiences, and by establishing transition activity catalogues and classification standards covering key industries. This would provide a unified basis for financial institutions to identify, support, and evaluate low-carbon transition projects.

Fifth, China should expand green demand and improve market mechanisms to move key green industries from low-price competition toward high-quality development. Current involution in some green industries results from multiple factors, including overly rapid supply expansion, local government competition, insufficient release of application scenarios, imperfect market mechanisms, and low-price low-quality capacity squeezing out high-quality capacity. China should expand domestic application scenarios for high-quality green products, improve electricity pricing, capacity pricing, and carbon pricing mechanisms; support end users in using green electricity and storage; and increase the market value of green products and services. Enterprises should be supported in shifting from single product exports to exports of equipment, services, operations, and system solutions. International cooperation on standards, carbon footprints, and green certification should enhance premiums for high-quality capacity, turning involution pressure into momentum for industrial upgrading.

Sixth, China should strengthen the talent and professional-service infrastructure for carbon accounting and carbon-market development. In response to the growing demand for carbon accounting, monitoring, verification, emissions trading, carbon asset management, and green finance, China should expand relevant university programs; professional certification, and continuing education; encourage interdisciplinary training across climate science, engineering, economics, finance, and law; and establish targeted training and employment programs for young professionals and workers transitioning into green occupations. Public and private institutions should be encouraged to develop high-quality professional services and international training programs, helping address the current gap between the supply of dual-carbon professionals and the much larger market demand.

5.3 Reshape Pathways for International Climate Cooperation and Support the Global Green Transition Through Pragmatic Joint Action

First, China should play a constructive leading role in global climate governance and explore new models of international cooperation and climate leadership. The focus of global climate governance is shifting from target commitments to action implementation, and China's role should more clearly highlight implementation capacity, solution provision capacity, and international cooperation organization capacity, including supporting Türkiye and Ethiopia in hosting successive COPs and strengthening the leadership role of the Global South in global climate governance. Facing global emissions and finance gaps, China can combine green technologies, industrial chain capabilities, development finance tools, policy experience, and multilateral diplomatic resources to provide countries with affordable, financeable, and replicable transition solutions. Next, under multilateral and bilateral platforms such as the United Nations, G20, BRICS, China-Africa, China-Latin America and Caribbean, and China-ASEAN mechanisms, China should deepen cooperation with countries in Africa, Southeast Asia, and Latin America, strengthen coordination with partners such as the EU, the UK, and Brazil, and explore third-party market cooperation and joint leadership practices. A group of operational, demonstrable, and scalable cooperation projects should be developed in technology transfer, low-carbon supply chains, green standards, project finance, and local capacity building. By combining concrete problem solving, project implementation and cooperation alliance building, China can develop more pragmatic, open, and constructive leadership in the implementation era of global climate governance.

Second, strengthen international cooperation on climate science, early warning systems, and the mitigation of non-carbon dioxide greenhouse gases to enhance China's contribution to global climate governance public goods. Scientific foundations, climate monitoring data, risk assessments, and early warning systems are essential for supporting global climate action and adaptation decision-making. China should leverage global governance networks, including UNFCCC, the World Meteorological Organization (WMO), and IPCC, as well as regional and South-South cooperation platforms, to enhance international collaboration on climate science, data sharing, scenario analysis, risk assessment, and technical capacity building, thereby supporting developing countries in strengthening their climate monitoring, early warning, and adaptation capacities. Meanwhile, efforts should be further strengthened in scientific research on short-lived climate pollutants, exchanges on emission-reduction technologies, and policy coordination, so as to foster synergies among their mitigation, greenhouse gas emissions reduction, air quality improvement, health protection, food security, local employment, and economic development objectives. International cooperation on non-CO_2 greenhouse gases, clean air, and sustainable cooling should be advanced with a focus on action and benefits. China can leverage its industrial scale, accumulated engineering and technological expertise, experience in standardization, and digital monitoring capabilities to carry out technical training, joint research, and demonstration projects in relevant countries and regions, thereby further strengthening its important role in global climate governance capacity building and the provision of international climate public goods.

Third, China should use a portfolio of investment, trade, technology, and industrial policy tools to support green development in the Global South. Trade and investment in green products have entered a new stage centred on localization, rules, and partnerships. For Global South countries, priority should be given to

supporting local green industrial capacity and stable market demand, including renewable energy development, smart grids, storage, electric transport, green buildings, cooling efficiency, green agriculture, and industrial low-carbonization. Project design should take reduced energy costs, local job creation, industrial supporting capacity, livelihood improvement, and climate resilience as basic requirements, encouraging enterprises to shift from going global to co-building supply chains, service systems, and training systems with local partners. In trade policy, green product free trade corridors, mutual recognition of green standards, low-carbon supply chain cooperation, and sustainable import standards can be explored to reduce the obstruction of protectionism to global low-carbon technology diffusion and better enable green trade to serve the global low-carbon transition.

Fifth, China should make fuller use of climate finance and development finance, shifting finance support from simple capital transfer to risk reduction, investment mobilization, and project capacity development. Under the South-South cooperation framework, China can combine policy banks, development finance institutions, equity investment funds such as the Silk Road Fund and green investment funds, export insurance and guarantee institutions, and foreign aid funds to provide concessional financing, risk sharing, and project preparation support for clean energy, adaptation capacity building, ecosystem restoration, green transport, and low-carbon industrial parks in developing countries. At the same time, China should strengthen coordination with multilateral development banks, regional development banks, international climate funds, and European development finance institutions, using blended finance, exchange-rate and political risk guarantees, results-based finance, sustainability-linked loans, and other tools, and pay attention to women's participation, financing access, and benefit-sharing, to reduce financing costs for green projects in developing countries and help expand climate investment while maintaining debt sustainability.

Sixth, China should promote participation of diverse actors in climate governance, especially enterprises. Enterprises, financial institutions, industry associations, research institutions, civil society organizations, and other actors should be further encouraged to participate actively in climate governance. Together, these actors can form a symbiotic process of government guidance, market drive, and social coordination. Enterprises should not only be viewed as implementers of climate policy, but also as important drivers of climate governance and green transition. They are the main actors in energy consumption, industrial investment, and technological innovation, and important forces in forming green supply chains, green trade, and low-carbon product markets. China should support enterprises in incorporating climate goals into development strategies and investment decisions and building scientific carbon emissions accounting and information disclosure systems. Leading enterprises can be encouraged to drive upstream and downstream partners in energy conservation and carbon reduction, green procurement, and clean energy substitution. In addition, green finance, transition finance, public procurement, and certification tools can be improved to provide a more stable institutional environment for enterprise low-carbon technology innovation, business model exploration, and international cooperation. Meanwhile, China should ensure the meaningful participation and leadership of women experts, women-led organizations, and other underrepresented groups in relevant dialogues, consultations, and cooperation mechanisms.

Seventh, China should strengthen its narrative capacity in the climate field to enhance international understanding and trust and reduce friction in investment and trade. China can build international case libraries and methodologies around renewable energy integration, power market reform, green finance, low-carbon industrial parks, South-South cooperation projects, and overseas enterprise cases. Clear indicators such as emissions reductions, cost decline, financing leverage, job creation, local procurement shares, skills training, and environmental and social impacts can be used to explain project value. Finally, third-party evaluation,

English-language reports, multilateral platforms, and international think tank cooperation can help to improve credibility.

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