

Chapter 1

Carbon Dioxide Emissions Peak and Carbon Neutrality Policy Measures and Implementation Pathways



1 Review of COP26 Negotiation Processes and Trend Outlook

The importance of global climate change in the international agenda is constantly increasing. All the countries have reached a basic consensus on actively implementing international conventions, strengthening climate targets and practical actions, despite the impact of the pandemic and short-term recovery. Under this background, the 26th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP26) was held in Glasgow, UK after a one-year delay, and achieved the expected results. Through observation, discussion and analysis, this paper conducts a systematic evaluation on the effectiveness of the COP26, and predicts the trend of climate negotiations after the COP26. Generally, the COP26 has achieved a balanced and inclusive package of results thanks to joint efforts of all parties. The conference marked an end to the six-year negotiation on the implementation rules of the *Paris Agreement*. It can be said that the COP26 is another major milestone regarding global climate governance after the implementation of the *Paris Agreement*. Meanwhile, the *Glasgow Climate Pact* consolidated the global consensus on accelerating climate actions in the next decade, and reached certain breakthrough consensus on coal reduction, methane control, and halting deforestation. In the post-COP26 era, we still need to take concrete actions to implement the outcomes of the *Paris Agreement* and the *Glasgow Climate Pact*, create paths to accelerate CO₂ emission reduction, and continue to strive for breakthroughs in important issues such as funding, technology, adaptation, and cooperation, avoid intensifying international conflicts, work together to properly handle the relationship between energy security, carbon reduction and development, and promote all the countries to achieve sustainable development goals including climate. China will continue to maintain the existing multilateral mechanisms and processes of climate governance, continue to take concrete actions

to respond climate change, promote its own comprehensive green transition and global carbon neutrality cooperation, and contribute constructively to global climate governance.

1.1 COP26 Was Initiated in the Context of New Development

Due to the impact of the COVID-19 pandemic, the COP26 originally scheduled in 2020 was postponed to be held in 2021 in Glasgow, UK. The outbreak of the pandemic has triggered a profound reflection in the international community, which has deepened people's understanding of non-traditional security issues. On August 9, 2021, the IPCC released the report from the first working group for the sixth assessment report (AR6). The observation data showed that the average temperature rise during the period from 2011 to 2020 was 1.09 °C higher than that before industrialization (1850–1900). In the coming decades, climate change in all regions will further intensify [1]. Although the pandemic has reduced carbon emissions in multiple countries in the short term, the trend is unsustainable in the long run, and carbon emissions may rebound after the end of the pandemic [2]. A new global energy crisis is also hindering a green recovery of post-pandemic economy [3]. In this context, the COP26 was postponed for one year, which overcame many difficulties and is of special significance, reflecting the basic consensus among countries in actively implementing international conventions, reinforcing climate targets and practical actions.

As the first conference of the signatory parties held after the United States returned to the *Paris Agreement*, the COP26 attracted great attention from various parties. It sought to achieve climate targets in four directions, i.e. mitigation, adaptation, funding and cooperation, specifically: First, the global response to climate change is still insufficient, and the current total NDCs of all countries are still difficult to achieve the 2 °C target, not to mention that there is still a gap in performance [4]; Second, the issue of adaptation has attracted more and more attention. Developing countries are very concerned about the construction of adaptation infrastructure. It is also very important to improve the collaborative governance of biodiversity and climate change proposed in the Kunming Declaration; Third, the climate governance capacity building is still insufficient, especially the widely criticized climate funding commitment still faces a large gap; and Fourth, the negotiation on the implementation rules of the *Paris Agreement* has not yet been completed, and it needs to be advanced as soon as possible so that the *Paris Agreement* can be fully implemented. At this conference, the organizer conducted a lot of pre-conference communication, and set the core goals and agenda of the negotiation around the above four issues. It can be said that the COP26 has properly set topics for discussion in key areas of global climate governance, and promoted significant progress in various fields during the conference.

1.2 *Progresses and Outcomes at the COP26*

The conference of the signatory parties under the United Nations Framework Convention on Climate Change is an important link in the global climate governance mechanism. Before the COP26, the host country made great efforts to promote relevant subjects to reach a consensus on key issues of global climate governance through a lot of communication, laying the foundation for the effective convening of the conference.¹ During the process of the COP26, the organizer actively created opportunities and built a platform by setting topics for discussion, etc., so that multiple stakeholders could fully discuss specific topics, and finally achieved a series of results on the issues like coal exit, deforestation reduction, and methane emission reduction. As stated in the COP26 WORLD LEADERS SUMMIT—PRESIDENCY SUMMARY, COP26 launched a decade of accelerated climate action to ensure that the *Paris Agreement* works, and progress is made in key areas.

1.2.1 **The COP26 Developed Issues Through a Lot of Pre-conference Communication, and Drew on the Experience of the *Paris Agreement* in Promoting International Cooperation, Laying the Foundation for the Formation of a Consensus**

Before the COP26 was held, all stakeholders had conducted close consultations on a number of issues of their own concern. For example, China, the United States, and the EU had close bilateral climate consultations before and during the COP26 to enhance their respective positions and understandings on the key issues of global climate governance, which facilitated the formation of a consensus. Based on the extensive pre-conference communication, the host country finally set a series of ambitious goals in four major aspects, including: To ensure the global net zero by 2050 is achieved and the global temperature rise is controlled within 1.5 °C during this century by means of coal exit, deforestation reduction, accelerating the development of electric vehicles, and promoting investment in renewable energy, etc.; to adapt to protective communities and natural habitats, by means of ecosystem protection and restoration, adaptation investments, etc.; to fully mobilize funds to ensure that developed countries realize the \$100 billion commitment in climate finance, and promote the active participation of international financial institutions in the global climate process; and to make efforts together for the climate governance targets, including the co-preparation and finalization of the Paris Rules, as well as multi-agency action and cooperation.

¹ COP26 President concludes constructive discussions with China on climate action, <https://www.gov.uk/government/news/cop26-president-concludes-constructive-discussions-with-china-on-climate-action>.

1.2.2 The COP26 Adhered to the Goals, Principles and Policy Orientation of the Paris Agreement, and Achieved a Balance Between Ambitious Goals and Practical Actions, Laying a System and Capacity Foundation for Subsequent Global Climate Governance

The COP26 is another important milestone in global climate governance after the implementation of the *Paris Agreement*. In the conference, certain consensus and progresses were achieved in all aspects including mitigation, adaptation, funding, technology transfer and capacity building. Before the COP26, 156 countries proposed or updated NDC goals based on their national conditions, of which 93 countries proposed more ambitious emission reduction goals. During the COP26, Thailand, Israel, Vietnam, Nigeria, India and other countries proposed carbon neutrality goals. The *Glasgow Climate Pact* reiterated that the global temperature rise should be controlled within 2 °C, with 1.5 °C as a striving goal, emphasizing that the realization of the 1.5 °C target requires intensified efforts to reduce emissions. All countries have joined hands to initiate a decade of accelerated climate actions, and “actions speak louder than words” has become a major trend, which involves boosting ambition, expanding funding, strengthening public–private cooperation, and conducting a global inventory. **The COP26 marked an end to the six-year negotiation on the implementation rules of the *Paris Agreement***, and the issues including Articles 6 and 13 of the Implementation Rules have formed pragmatic and balanced results. Specifically, the construction framework of the global carbon market was established; it was determined that 5% revenue share would be levied in the transactions under Article 6.4 and transferred to the adaptation fund, and repeated counting should be avoided; the transition mechanism for the clean development mechanism was confirmed, and the system frame to enhance the transparency under Article 13 was determined.

1.2.3 COP26 Finally Reached a Breakthrough Consensus on Key Issues of Concern to Several Parties, and Determined a Series of New Orientations for the Global Response to Climate Change, Such as Emission Reduction Goals, Coal Exit, Stop of Deforestation, Methane, Climate Finance, Etc.

The *Glasgow Climate Pact* emphasized that the realization of the 1.5 °C target requires the global CO₂ emission is reduced by 45% by 2030 compared with the 2010 level; confirmed the global inventory starts in 2022; proposed that the unabated coal-fired power should be gradually reduced for the first time; required the coal-fired power plants without carbon reduction facilities should be reduced, and the inefficient fossil fuel subsidies should be eliminated. Although there is a risk of failure again, it still proposed a more ambitious climate funding target, requiring that the deliberation on the new quantitative funding targets after 2025 should be completed in 2024 and urging the doubling of the adaptation funds provided to

developing countries in 2025 on the basis of that in 2019; decided to establish and immediately initiate the Glasgow–Sharm el-Sheikh Two-year Work Program on the Global Goal on Adaptation; decided to start the San Diego Network as early as possible, to provide developing countries with technical assistance in their response to and mitigation of loss and damage; and also decided to carry out the Glasgow Dialogue on the financial mechanism of loss and damage. In addition to the *Glasgow Climate Pact*, 23 countries pledged to stop using coal for the first time in the *Global Coal to Clean Power Transition Statement*. More than 120 countries signed the *Glasgow Leaders' Declaration on Forests and Land Use*, with the goal of halting and reversing forest loss and land degradation by 2030, providing funding and making 75% of forest commodity supply chains sustainable. More than 100 countries signed the *Global Methane Pledge*, committing to reduce methane emissions by 30% by 2030. China did not sign the pledge but it proposed to carry out methane emission reduction work in the U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s.

1.2.4 The Conference Created Opportunities for Multiple Relevant Subjects to Actively Participate in Relevant Issues, and Effectively Promoted the Participation of Stakeholders and Actors in Global Governance

Before and during the COP26, a large number of business entities, industry associations, banking institutions and other non-governmental subjects and actors actively participated in the discussions on carbon reduction governance in relevant industries, and finally created conditions for the formation of a consensus on carbon reduction goals in the industry. Through the COP26, a consensus was finally reached on carbon reduction in several key industries, including that it proposed the net zero will be achieved in the cars and vans that are sold in the leading markets by 2035 and newly-sold across the world by 2040, in the Declaration on Accelerating the Transition to 100% Zero Emission Cars and Vans. A similar memorandum of understanding was signed for medium and heavy-duty vehicles, which proposed the proportion of sold net-zero emissions vehicles should reach 30% by 2030 and reach 100% by 2040. At the COP26, the International Aviation Climate Ambition Coalition composed of 23 countries including the United Kingdom, the United States, and France proposed in the *International Aviation Climate Declaration* in which they committed that the aviation industry will achieve net-zero carbon dioxide emissions by 2050. In a joint statement on the Nature, People and Planet, the multilateral development banks committed to achieve mainstreaming of nature issues in terms of policy, analysis, assessment, advice, investment and business.

As we see, the COP26 set a series of governance issues to respond to the concerns of multiple subjects, and progresses have been made in addressing key issues such as mitigation, adaptation, funding, technology, and capacity building involved in the *Paris Agreement*. Before and during the conference, it created conditions and opportunities for relevant subjects under different issues to participate in climate

governance, and promoted full discussion and the formation of a consensus on the issues, by means of the theme day, leaders summit, ministerial meeting, negotiation and consultation, etc. Ultimately, a series of climate governance mechanisms were formed through the conference, including: the negotiation on the implementation rules of the *Paris Agreement* which was completed before the COP26 was completed; the coal reduction was mentioned for the first time, ensuring that it is still possible to achieve the 1.5 °C temperature rise target. It further clarified the guarantee mechanisms such as global inventory and transparency, and strengthened the scope and degree of existing climate governance [5]. It can be said that the COP26 has successfully maintained and implemented the basic principles and goals of the *Paris Agreement*, continued the effectiveness of the UNFCCC-based multilateral governance system to tackle climate change, and promoted the process of global climate governance. Therefore, we can say that the COP26 is another major milestone in the global climate governance after the *Paris Agreement* was signed.

1.3 Post-COP26 Trends and Prospects

The COVID-19 pandemic is still raging, and the international geopolitical environment gets more complex and even deteriorating, but climate change gradually affects the entire socio-economic system, and our climate governance requires more tenacious global system thinking and transformation [6]. The COP26 effectively promoted the formation of a consensus among all countries, but there are still a lot of differences and problems that need concerted efforts of all countries. For example, there is lack of full implementation of specific actions, the cooperation on the “hardest nut” is still insufficient, addressing climate change may even exacerbate conflicts, all countries have not yet gotten rid of their dependence on fossil energy, the energy security and energy poverty coexist, and the collaboration between addressing climate change and actions in other areas is still insufficient. Therefore, all countries should adopt a practical attitude to reach a constructive consensus and take concrete actions on the issues mentioned above.

1.3.1 Taking Concrete Actions to Actively Respond to the Climate Crisis Should Become the Mainstream, and It Is an Urgent for Multiple Subjects to Actively and Systematically Participate in Climate Governance

Boosting climate ambitions is important, but actions are far more valuable than goals [7]. All countries should have an open attitude to extensively discuss diverse issues such as boosting global climate ambitions, non-CO₂ gas governance and climate collaborative governance. However, actions speak louder than words, it is urgent for all countries to take concrete actions to achieve the goals of the *Paris Agreement* [8]. Especially, developed countries need to realize climate action goals and

implement climate finance commitments to avoid failure again [9]. At the same time, they should also avoid uncertainty about the rule of law to address climate change. Concrete actions are inseparable from the active participation of all sectors of society and diverse subjects. All countries need to mobilize the enthusiasm of multiple subjects to participate in climate governance based on their national conditions to establish a green production and consumption system, actively explore the best practices for promoting the active participation of multiple subjects in economic and social transition, and provide experience and reference for developing countries to address climate change.

1.3.2 Global Climate Cooperation Should Strive to Make Positive Progresses in the Implementation Pathway for Addressing Climate Change and Core Emission Reduction Issues

The agenda in future climate cooperation should not bypass any difficulty, and the cooperation should focus on key issues and critical links. Firstly, in the current climate cooperation, two pairs of ease and difficulty relationships have appeared: **Firstly**, it is difficult for all interested parties to reach a consensus on the implementation path and specific actions to address climate change, including funding, technology, etc., while they intend more to reach a consensus on ambitions to address climate change; **Secondly**, it is difficult to form a consensus on the core CO₂ emission reduction in addressing climate change, and all the parties prefer to reach a consensus on non-CO₂ reduction such as methane emission reduction and curbing deforestation; and, **Thirdly**, if the manufacturing powers represented by China restrict the development of energy-intensive industries and their products in order to reduce emissions, then a huge challenge that the world will face is how to meet the demand for relevant products, as well as how and who to invest in the production utilizing more advanced, energy-saving and low-cost technologies. It must be acknowledged that all relevant issues will make great contributions to addressing climate change. However, it will be difficult to form effective climate governance by only boosting ambition without clear implementation path, and only promoting the non-CO₂ emission reduction issues without actually tackling CO₂ emission reduction. Therefore, all parties should strengthen communication and cooperation on the “hardest nut” issues.

1.3.3 The International Cooperation and Competition Should Not Jeopardize the Response to Climate Change, and the Specific Implementation of Carbon Pricing and Funding Mechanisms Should Avoid Exacerbating International Conflicts

Climate change has always been a major threat to human survival, and the confrontation in the international political and economic situation is intensifying. Promoting international political and economic cooperation is indeed beneficial to combating climate change [10]. All countries should take responsible actions, strengthen

communication and cooperation to avoid misjudgment, and ensure that both competition and cooperation can benefit rather than harm response to climate change. During the process of building a global carbon pricing mechanism, the differences in national conditions of different countries should be fully respected, and carbon pricing and funding mechanisms should be set up with the goal of driving the green and low-carbon structural transformation of the trade and financial systems, rather than setting up green barriers. A one-size-fits-all approach to carbon pricing, financial mechanisms, and product standards is prone to harm the interests of developing countries and their willingness and ability to engage in addressing climate change [11]. All countries should work together to strengthen the connection of carbon pricing and financial mechanism changes, and carry out the mechanism design. We should take into account the differences between countries in transition, avoid more conflicts and uncertainties, and avoid undermining international cooperation on climate change.

1.3.4 Although Different Countries Are at Different Energy Transition Stages, All Countries Should Make Joint Efforts to Properly Handle the Relationship Between Energy Security, Carbon Reduction and Development

The schedules and paths of low-carbon energy transition in different countries are not exactly the same due to their different development stages and resource endowments [12]. What's doubtless is that the process of low-carbon energy transition will not be a smooth sailing no matter for developed countries or for developing countries. The new round of global energy crisis that began in the first half of 2021, and the soaring prices of fossil energies represented by natural gas and coal, may significantly affect the policy path selection of governments in terms of energy security and addressing climate change [13, 14], which has brought new uncertainties to the global low-carbon energy transition and fully demonstrated the arduousness and complexity of the low-carbon energy transition. There may be national conditions-based differences in the transition stages and paths of different countries, but taking into account energy security, carbon reduction and development is the common challenge faced by them, so their solutions and technical routes may be used for mutual reference. Successful coal exit needs new development models and policy measures in addition to a lot of efforts [15, 16], and European and American countries need to synchronously solve the problems of oil and gas exit. Developed countries have the responsibility to work with developing countries to explore the energy decarbonization of coal and gas exit, so as to create space for global response to climate change and in-depth climate cooperation [17].

1.3.5 Enhance the Capacity to Adapt to Climate Change and Strengthen Synergistic Governance in Multiple Areas Including Climate Change and Biodiversity

With the increase of the risks from climate change, the necessity for all countries to work together to strengthen the adaptive ability is increasing as well. They should try to achieve a balance between mitigation and adaptation. A problem which is certainly encountered during the improvement of the adaptive ability is funds. At the COP26, the developed countries enhanced their ambitions in terms of fund support, but which are most likely to fail once more and affect the overall situation of global climate governance. On the issue of climate funding, developing countries are increasingly demanding to increase the proportion of adaptation in climate funds [18]. At the COP26, discussions on the related topics such as curbing deforestation, sustainable supply chain, and biodiversity protection were added, which promoted the collaboration of topics in multiple fields. An important direction of the multilateral process of climate and environment in the future is to promote positive progress in sustainable development goals including climate, and we look forward to strengthening the discussion on the collaborative governance of climate change in the second session of CBD COP15. The COP27 will be held by Egypt, a developing country. Then, the issues such as adaptation to climate change and reduction of losses and damage will become the focus of discussion. Sharm El Sheikh is also the host of CBD COP14, and it may be a meeting place for the collaborative governance of biodiversity and response to climate change. Therefore, a greater progress on this aspect is expected during the COP27.

1.4 China Will Actively Maintain and Participate in Global Climate Governance Through Concrete Actions

As President Xi Jinping stressed in his written address to the COP26 World Leaders Summit, “successful governance relies on solid action”. China believes that the global response to climate change requires actions rather than words. China has incorporated the dual-carbon goal into the Five-Sphere Integrated Plan, and will make unswerving efforts to achieve the dual-carbon goal and promote its own comprehensive green transition. Before the COP26, China successively issued the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy*,² the *Action Plan for Carbon Dioxide Peak Before 2030*,³ and the white paper with the title of *China’s Policies and Actions for*

² Full Text: Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy, http://english.www.gov.cn/policies/latestreleases/202110/25/content_WS61760047c6d0df57f98e3c21.html.

³ Full Text: Action Plan for Carbon Dioxide Peaking Before 2030, http://english.www.gov.cn/policies/latestreleases/202110/27/content_WS6178a47ec6d0df57f98e3dfb.html.

Addressing Climate Change, and submitted the *China's Achievements, New Goals and New Measures for Nationally Determined Contributions and the China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy*, which clarified the general idea and roadmap for achieving carbon emission peak by 2030 and achieving carbon neutrality by 2060 [19]. At present, China is stepping up the improvement of the 1 + N policy system involving carbon emission peaking and carbon neutrality, so that it will finally become a two-stage policy and measure system for various fields and industries, covering the whole country and local areas. The 1 + N policy system will provide all-round support for realization of China's dual carbon goals, paths and policies, and ultimately form China's carbon peak and carbon neutral solutions [20, 21].

China firmly supports and maintains multilateral mechanisms and processes of climate governance, attaches great importance to working with the international community to address the global climate crisis, and promotes global carbon neutrality cooperation. It carried out close consultations with the UNFCCC secretariat, the UK (presidency), the United States and Europe and other parties before and during the conference. China, as always, supports and maintains the UNFCCC and the *Paris Agreement*, adheres to the goals, principles and policy orientation of the *Paris Agreement*, achieves a balance between ambitious goals and practical actions, and is willing to play an active role and adopt a systematic approach in coping with climate change. Besides, China has committed not to build any new overseas coal-fired power project, and vigorously supports the green and low-carbon development of energies in developing countries. In the future, China will actively carry out green BRI and South-South cooperation to help developing countries respond to climate change.

China attaches great importance to inheriting the successful experience of the *Paris Agreement*, and promotes the process of multilateral governance through bilateral cooperation. The bilateral climate cooperation between China and the United States has made a breakthrough in Glasgow. China and the United States conducted intensive climate talks and communication in 2021, which laid the foundation for the release of the U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s during the COP26. On the basis of the *Joint Statement Addressing the Climate Crisis of April 17th, 2021*, China and the United States reached a major consensus in four aspects: strengthening actions, cooperating to promote the success of the COP26, actively implementing the joint statement, and establishing "a working group on enhancing climate action". The two sides signed the *U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s*, which will accelerate the implementation of China-US climate cooperation and facilitate the formation of a consensus on the *Glasgow Climate Pact*. China will continue to actively carry out climate cooperation dialogues with Europe, the United States and other economies through bilateral mechanisms and achieve a series of positive results.

China will continue to develop the benefits of collaborative climate governance and promote the combination of climate governance with other issues. China attaches great importance to the combination of climate change and economic and social system transition, accelerates the formation of industrial structures, production

methods, lifestyles, and spatial patterns that are conducive to resource conservation and environmental protection, and promotes a comprehensive green transition of economic and social development while adhering to the collaborative promotion of carbon reduction, pollution decreasing, green expansion, and growth. The collaborative governance of climate and environment is also a key task, and we will continue to promote the synergy of pollution decreasing and carbon reduction. Meanwhile, we will also focus on the combination of climate and biodiversity governance, and support the promotion of the second session of COP15 to achieve collaborative benefits in addressing climate change.

2 Path and Policy Security for Green and Low-Carbon-Oriented Energy Transition Under the New Situation

The success of the COP26 has boosted global confidence in climate governance. The energy transition to green and low-carbon should have heated up rapidly in 2021, but it is facing severe challenges instead, due to the impact of a new round of global energy crisis. In 2021, the global energy market fluctuated violently, and the sharp rise in traditional energy prices triggered a new round of global energy crisis, which is further intensified by the geopolitical conflict between Russia and Ukraine in 2022. As the result, the energy security of multiple countries has been seriously threatened, and the process of global economic recovery and green transition of energy are also facing huge obstacles. Under the new situation with coexistence of crisis and transition, how can the global green and low-carbon-oriented energy transition continue to advance in an orderly manner on the premise that the energy security is ensured? This chapter will analyze the causes of this round of global energy crisis, analyze the trend of energy transition in the future, and put forward suggestions for China to orderly promote green and low-carbon energy transition in the next step.

2.1 Analysis on the Causes of the New Round of Energy Crisis and Judgment on the Development Situation

2.1.1 The Energy Crisis Started in Europe, and the Economic Development and Social Security of Multiple Countries Have Been Adversely Affected Greatly

In 2021, the prices of the world's three major traditional energies i.e. natural gas, coal and oil rose rapidly, and the energy crisis started in Europe and eventually spread across the world. Since the beginning of 2021, the price of natural gas in

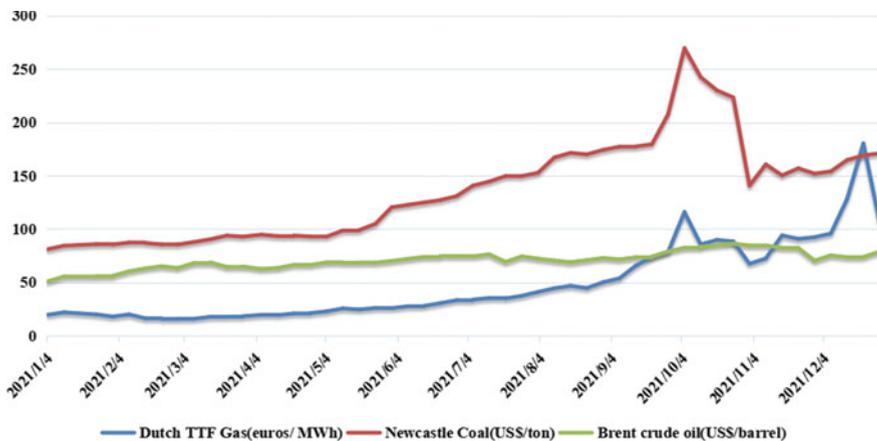


Fig. 1 Global representative prices of natural gas, coal and oil in 2021. *Source of Data* [investing.com](https://www.investing.com)

Europe has shown a trend of rapid rise, and continued to break through record highs, triggering the European energy crisis. With the future price of Dutch TTF natural gas as an example, the lowest and highest prices of TTF futures during the whole year of 2021 were 15.485 euros/MWh on March 3rd and 187.785 euros/MWh on December 21st, respectively, and the difference between the two was about 12.13 times (see Fig. 1). The sharp rise in the price of natural gas stimulated the demands for its substitutes i.e. coal and oil, which was also reflected in the form of a sharp rise in prices. During the full year of 2021, there was a difference of about 3.4 times between the highest and lowest prices for Newcastle coal futures, and 1.715 times for Brent crude oil futures (see Fig. 1). The sharp rise in the prices of the three major traditional energies spread across the world along with the global trade chain, eventually triggering a global energy crisis.

The global energy crisis has had a serious adverse impact on the economic development and social security of multiple countries. In **Europe**, since the beginning of 2021, electricity prices in multiple countries has been rising rapidly due to the impact of natural gas prices, and electricity costs had risen by about 500% by the end of the year (see Fig. 2). In the industries like metals, fertilizers and foods, enterprises had to reduce their production significantly, and even got bankrupt due to severe hit by high electricity costs. The energy commodities are facing an inflation rate of 23%, nearly 35 million people are involved in energy poverty and their basic demands for power supply and heating cannot be met; In **China**, during September 2021, coal-fired power plants suffered serious operating losses due to high domestic and foreign coal prices, and the sharp decline in thermal coal stock eventually led to the occurrence of the national “electricity shortage” event, and power rationing has been implemented in about 20 provinces across the country (see Table 1). According to statistics, the coal procurement cost of coal-fired power enterprises across the country increased by about 600 billion yuan in 2021, and the cumulative loss for the

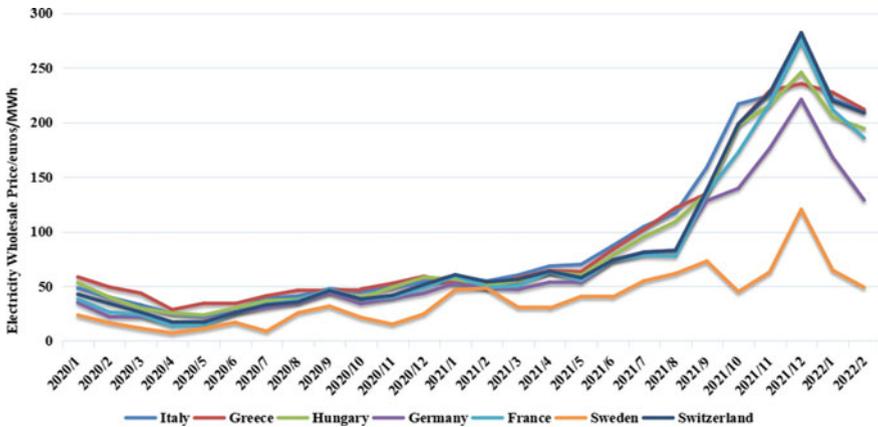


Fig. 2 Average monthly electricity wholesale prices of major European countries from 2020 to 2022. *Source of Data* Statista

whole year reached about 80% [22]; In **India**, influenced by the sharp rise in prices, the coal stock of domestic coal-fired power plants dropped sharply in October 2021, and power outages occurred in many areas. According to data from the Central Electricity Authority of India, 16 of India's 135 coal-fired power plants had zero coal data. In addition, more than half of the power plants have the stock for less than 3 days of operation, and more than 80% of the power plants have a stock for less than a week's operation. According to the Global Times, in the first 12 days of October 2021, India's electricity supply shortage reached about 750 million kW-h, and the electricity supply gaps in northern regions such as Rajasthan, Punjab and Uttar Pradesh, as well as the eastern regions like Jharkhand and Bihar ranged from 2.3 to 14.7%.

2.1.2 Analysis on the Causes of a New Round of Energy Crisis

The Factors Like the COVID-19 Pandemic and Monopoly Have Caused the Shortage of Traditional Energy Supply, and It Is Difficult to Meet the Increasing Energy Demands

Affected by factors such as the COVID-19 pandemic and monopoly, the global traditional energy supply has been limited and continued to tighten. On the one hand, the COVID-19 pandemic continues its adverse impact on the resumption of work and production across the world. The traditional energy production is much lower than the pre-pandemic level although it showed a rebound, and the coal and oil yields increased by 4.5% and 1.3% year-on-year respectively in 2021

Table 1 Power rationing in various provinces of China in 2021

Province	Time	Power rationing policies
Jiangsu	September 15	Electricity rationing was implemented in part of areas, which was tentatively scheduled for 15 days. Power was cut for industrial use, but available for domestic use. Air conditioners in offices were not allowed to operate, and street lights were halved to be on at night
	September 19	Enterprises were subject to power cuts and production limits by levels. 1096 companies followed the “two days enabled and two days disabled in a week” policy and 143 companies were completely closed down
Guangdong	September 16	The five-level orderly electricity consumption based on the “two days enabled and five days disabled in a week” was implemented, and the security load on off-peak days was kept below 15% of the total load
	September 26	It was recommended that the air-conditioning cooling temperature should not be lower than 26 °C, and the elevators should not be used for the floors below the 3rd floor in the office buildings
Shandong	September 15	Rizhao City issued an emergency warning of a large power supply gap that could last until the end of September
	September 13	Zaozhuang City issued a notice, with priority to demand response, meeting the basic requirement for orderly power supply
	September 12–18	The power rationing policy of the Zibo plant was continuously upgraded, and the power rationing schedule was finally adjusted to be the periods of 16:00–20:00 and 7:30–24:00
Shanxi	September 13	The “two-height” projects that were put into production in the year was subject to production limit by 60% of the previous month’s output. Other “two-height” enterprises were required to reduce the operating load of the production line, shut down the submerged arc furnace, and ensure that the production limit would reach 50% in September, and the covered period was from September to December
Guangxi	September	From September, the monthly electricity load of electrolytic aluminum enterprises was reduced by 35% for the whole period on the basis of the average monthly electricity load from January to June. Industrial and commercial enterprises were required to use electricity in an orderly manner and take the initiative to stagger the electricity consumption and avoid peaks

(continued)

Table 1 (continued)

Province	Time	Power rationing policies
Yunnan	September 11	The production control on key industries was strengthened, and the production limits involved the industries like steel, cement, electrolytic aluminum, and coal-fired power generation, and it was ensured that the average monthly output of green aluminum enterprises from September to December was not higher than the output in August
Guizhou	September 10	According to the power gap scale of the province, the early warning was made by 4 levels, and the corresponding level of response was activated. Unlike the power rationing and production limits implemented by other provinces due to the dual control of energy consumption, Guizhou Province took an early warning measure based on the possible shortage of power resources
Inner Mongolia	August 31	It was recommended to limit the electricity load by implementing an orderly electricity consumption plan in the period from August to December
Xinjiang	August 25	Changji State strictly controls the production capacity and outputs of electrolytic aluminum enterprises. From August, the total monthly output of the five enterprises in the region should not exceed 238,000 tons
Qinghai	August 20	Part of the electrolytic aluminum enterprises received a power cut warning notice from the State Grid Xining Branch, which mentioned that the enterprises should get ready for orderly power consumption in advance, but the notice didn't involve the specific power rationing schedule and plan
Ningxia	July 12	The production of high energy consuming industries such as cement, calcium carbide and titanium alloy were suspended for one month
Sichuan	August 5	Non-essential production, lighting, office electricity loads were suspended
Henan	August 9	Part of the processing enterprises were implemented with power rationing for more than three weeks. Some aluminum processing enterprises in Zhengzhou and Luoyang were notified of power cuts. Large industrial enterprises were subject to power rationing by 50%, depending on actual situations, and all industrial enterprises with the capacity below 10 kV stopped production
Chongqing	September 26	The plan of orderly power consumption was implemented across the city to respond to the reduction of power load
Liaoning	September 10–22	A total of 6 rounds of Level III (load gap: 5–10%) and 3 rounds of level IV (load gap: 5% and below) orderly electricity consumption measures were implemented, and the coverage was limited to part of industrial enterprises

(continued)

Table 1 (continued)

Province	Time	Power rationing policies
	September 23–25	The power supply gap was increased to a serious level. To prevent the entire grid from collapsing, the “power rationing to avoid accident shutdown of the power grid” was implemented, and the coverage was extended to residents and enterprises that are not subject to orderly electricity consumption measures
	September 26	The Provincial Department of Industry and Information Technology held a meeting on the power security work of the province, requiring minimizing the possibility of power cuts
Heilongjiang	September 24	Since September 10, the orderly electricity consumption would be implemented simultaneously in Liaoning, Jilin and Eastern Mongolia. Some enterprises’ failure to follow the above electricity consumption policy caused the urgent power rationing on September 23. The relevant authority made explicit requirements, and any individual or enterprise’s refusal to follow the policy would be held accountable
	September 26	Except for the Central Street business district, Qiulin business district and all fresh food supermarkets, all commercial enterprises in the city should subject to the off-peak power consumption policy and close their stores from 16:00 every day
Jilin	September 23	According to the order of the Northeast Power Grid, power rationing was implemented at 16:37, which covered nine urban areas in the province, and part of the users in Yanbian Area were subject to power cuts
	September 26	Jilin Xinbei Water Affairs Co., Ltd. issued an announcement that power rationing would be implemented in the irregular and unscheduled form, without prior notice; this situation would continue until March 2022, and power and water outages would become normal. On September 27, the company made an apology and said that there was “improper wording and inaccurate content” in the announcement
Hunan	September 22	An orange warning was issued for the security of Hunan Power Grid, and the electricity load was controlled below 26 million kW
Anhui	September 22	The orderly electricity consumption plan was implemented across the province, high-energy-consuming and high-emission enterprises were first arranged to follow the off-peak power consumption policy, and the landscape lighting and lighting projects were taken the initiative to shut down

(continued)

Table 1 (continued)

Province	Time	Power rationing policies
Zhejiang	September 21	High-energy-consuming enterprises such as printing and dyeing plants, sewage treatment plants, and chemical plants would be closed down from September 21 to 30, and related enterprises in Keqiao District, Shaoxing City, where printing and textile enterprises gather, would halt production

Source of Data Provincial development and reform commissions, energy bureaus, power grid companies and other government and enterprise institutions

[23]⁴; **On the other hand, monopoly organizations strictly control the supply of traditional energies in order to protect their own monopoly interests.** With oil as an example, OPEC+, the world's largest oil monopoly, has maintained a prudent production increase plan of 400,000 barrels per day under the situation that the global oil supply is in shortage of 2021, which is to control the international oil price within a reasonable price range that can maintain common interests of the entire alliance.

The limited supply of traditional energies and the continuous growth of demands form a stark contradiction, and the global energy supply and demand is significantly unbalanced. In 2021, the global demands for natural gas, coal, and oil increased by 3.2%, 4.5%, and 6% year-on-year, respectively [3]. Except for oil, the demands for coal and natural gas were higher than the pre-COVID-19 level. There was a sharp contradiction between the rising demand of traditional energy and the continuous tightening of traditional energy supply. The gap of traditional energy supply was gradually widening, the balance of energy supply and demand was broken, and the energy situation in short supply was presented by the rapid rise in prices, which eventually led to a new round of global energy crisis.

The Economic Stimulus Policies Implemented by Major Economies Have Triggered Global Inflation and Exacerbated Sharp Rises in Energy Prices

The United States and other major economies implemented economic stimulus policies, which prompted a large amount of currency to enter the market, causing domestic inflation. In 2021, the world's major economies led by the United States promulgated a series of economic stimulus policies in order to counteract the downward pressure on the economy and achieve post-pandemic economic recovery. Of such policies, the Federal Reserve's unlimited quantitative easing monetary policy, and Biden's various economic stimulus acts are the most representative, the total expenditure of which reached trillions of dollars. This directly led to the over-issue of the dollar currency, and a large number of dollars entered the domestic market of the United States, driving up consumer demand. However, due to the limited

⁴ OGJ: The global oil production rose 1.3% in 2021. <https://new.qq.com/omn/20220216/20220216A0965W00.html>.

recovery of the domestic industrial chain and the shortage of labor in the United States, its productivity could not meet the rising consumer demands, thus resulting in the intensified contradiction between supply and demand in the market, pushing up the terminal consumer price, and ultimately causing domestic inflation.

The domestic inflation of the United States spreads globally due to its global currency characteristic, fueling further sharp rise in energy prices. Because of the dominance of the US dollar in the international currency, a large amount of funds in the US domestic market would flow to the world market in search of investment returns, resulting in the flood of US dollar liquidity. Similarly, the entry of a large number of U.S. dollars into the international market has pushed up global consumer demands, and due to the continued adverse impact of the COVID-19 pandemic, the repair progress of the global industrial chain was significantly lagged behind the growth rate of demands, and the mismatch between supply and demand caused global inflation, which was manifested in the rise of prices of terminal products, and energy prices would naturally face a sharp rise due to its commodity attributes.

The Renewable Energy Power Generation Failed to Reach the Expected Level Due to Extreme Weather, and It Is Difficult to Meet the Rapidly Increasing Power Demand

Extreme weather may have certain adverse impacts on renewable energy generation, resulting in a lower-than-expected generation capacity. In 2021, as the occurrence frequency of extreme weather such as ultra-high pressure weather and drought was significantly higher than that in previous years, the output of renewable energy power generation declined and failed to reach the expected level, with hydropower and wind power being the most representative ones. In 2021, the global hydropower generation capacity remained at 2020 levels, ending the growth since 2001, which was mainly due to significant declines in countries such as Brazil, the United States, China and Turkey caused by drought. Affected by ultra-high pressure weather in Europe, the overall wind force was obviously insufficient in 2021, and the EU's annual wind power generation fell by 3% year-on-year, which was the first decline in the past three decades. According to the International Energy Agency (IEA), if there were no extreme weather in 2021, the global renewable energy generation capacity will increase by nearly 9% year-on-year [24].

Under the impact of extreme weather, the supply of renewable energy maintains a relatively high growth rate, but the global power demand grows more rapidly, and the contradiction between power supply and demand is sharp. In 2021, the global renewable energy generation capacity increased by 6% year-on-year, 500 TWh higher than that in 2020, creating a record high [24, 25]. However, the global electricity demand was growing at an even higher rate, with an increase of 1538 TWh compared to that in 2020, more than three times the increase in renewable energy generation capacity [3]. Therefore, the renewable energy power generation capacity was difficult to meet the rapidly-rising demand for electricity, which resulted in the gradual intensification of the contradiction between global power supply and

demand. The existence of power supply gap stimulated the demand for substitutes of power generated with traditional energy in various countries. In the context of the continuous tightening of traditional energy production capacity, the situation with traditional energy in short supply and prices sharply rising gradually emerged, and the pressure on energy use in countries around the world has gradually intensified, eventually triggering a global energy crisis.

2.1.3 The Impact of the Russia-Ukraine Conflict on the Future Global Energy Pattern

On February 24, 2022, Russian President Vladimir Putin announced the launch of a “special military operation” against the Donbas region of Ukraine. The military conflict between Russia and Ukraine officially broke out. European and American countries successively imposed sanctions on Russia in terms of energy and finance. As an important energy exporter, Russia plays a pivotal role in global energy supply, especially for Europe. For a long time, about 35% and 25% of Europe’s natural gas and oil imports respectively are from Russia (see Figs. 3 and 4). Therefore, the outbreak of the Russia-Ukraine conflict will trigger turmoil in the global energy market, which will have a considerable impact on the global energy supply situation and the future global energy pattern.

In the short term, the Russia-Ukraine conflict has further pushed up energy prices, especially oil and gas prices. However, it is a matter of caution whether they will continue to rise, thus exacerbating the global energy crisis. The prices of Brent and New York crude futures both broke through the US\$100/barrel mark on

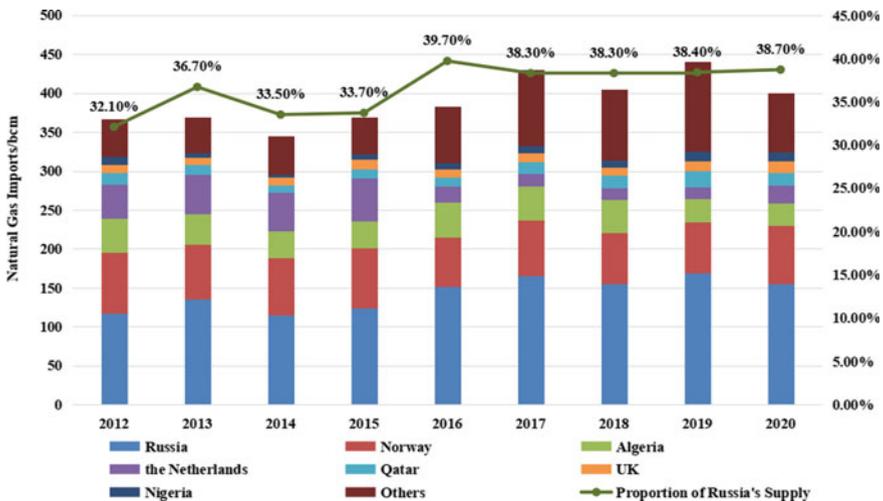


Fig. 3 Distribution of natural gas imports and importing countries of Europe from 2012 to 2020. *Source of Data* Eurostat

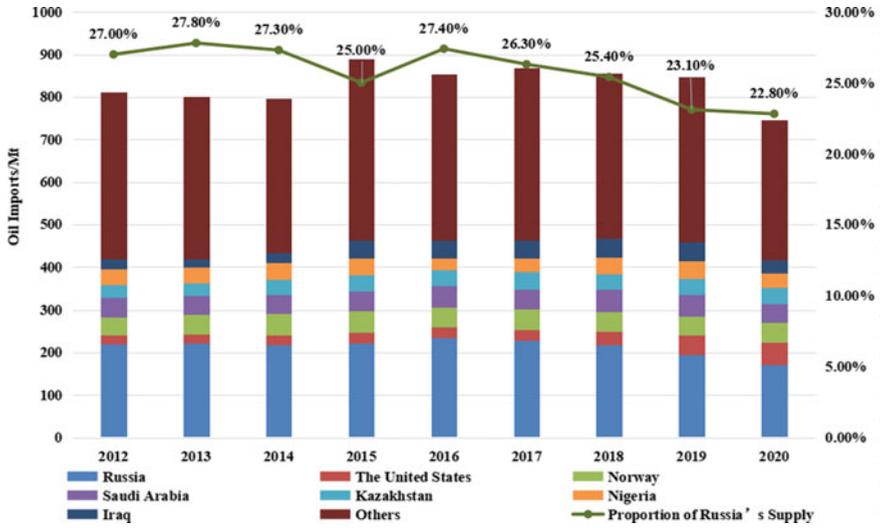


Fig. 4 Distribution of oil imports and importing countries of Europe from 2012 to 2020. Source of Data Eurostat

February 24, the day the conflict erupted, creating a record high and further rising on that basis. There are two reasons for the sharp rise in energy prices triggered by the Russia-Ukraine conflict: Firstly, Russia is an important exporter in the global energy market. Sanctions against Russia by the United States, Europe and other countries have directly or indirectly affected Russia's supply of global energy, which led to tight global energy supply and push up prices. Secondly, oil and gas are special commodities with strategic attributes, closely related to geopolitics. The outbreak of geopolitical conflict increased the market's concerns about the production and supply of oil and gas, which in turn caused a rapid rise in oil and gas prices. However, the high energy prices caused by the Russia-Ukraine conflict was mainly driven by the market risk aversion and has limited impact on the output and transportation supply of energy exporting countries, especially Russia. Therefore, the future trend of energy prices will be determined by the situation of the Russia-Ukraine conflict. If the situation continues to ferment, energy prices may continue to go higher; otherwise, energy prices are likely to peak and fall steadily.

In the long run, the Russia-Ukraine conflict may affect the global climate process and the energy pattern. Firstly, the Russia-Ukraine conflict may reconstruct the traditional energy trade pattern. On the one hand, due to the substantial restrictions imposed by European and American countries on oil and gas imports from Russia, Russia will look for other export sources for its redundant oil and gas to replace Europe, and China will be the main potential incremental direction of Russia's natural gas exports in the future; on the other hand, in light of the rigid demand for oil and gas imports in the short term, Europe will look for other import sources to replace Russia, the oil and gas supply from the Gulf region as well as the

liquefied natural gas export from the United States, Qatar, etc. will be its stable energy sources. **Secondly, the Russia-Ukraine conflict may accelerate the formation of a renewable energy pattern.** The European Commission's Energy Independence Plan, entitled Joint European Action for More affordable, Secure and Sustainable Energy released on March 8, 2022, fully demonstrated Europe's determination to get rid of energy dependence on Russia by accelerating the development of renewable energy. The Russia-Ukraine conflict is likely to become a catalyst for Europe to accelerate the green transition of energy, prompting Europe to accelerate its investment in renewable energy technologies and enterprises in its own territory, and to accelerate the formation of an energy industry chain based on new energy technologies in Europe, thereby securing its energy future. At that time, the global renewable energy pattern will be formed in an accelerated way, and the global energy industry chain structure based on new energy technologies will undergo major changes, and the core of energy may gradually shift to Europe, making Europe in the leading position during the process of energy transition.

2.1.4 Judgment on the Future Trend of Energy Transition

Properly Deal with the Medium and Long-Term Energy Low-Carbon Transition and the Medium-Term Energy Supply Security

The energy crisis is only a short-term fluctuation in the transition process. Countries should maintain strategic focus and continue to adhere to the mainstream trend of green and low-carbon energy transition. At present, the growth rate and investment level in renewable energy are still not enough to support the achievement of global climate targets as expected. To promote the realization of the global net-zero goal by 2050, the renewable electricity generation capacity needs to grow at an average rate of nearly 12% between 2021 and 2030, which is almost double the rate during the period from 2011 to 2020; meanwhile, the global investment in clean energy remains well below what is required to avoid severe impacts of climate change, the amount of which should to be doubled during the 2020s to keep the temperature rise is far below 2 °C. The amount of investment would need to be increased by more than double if the 1.5 °C temperature rise target under the *Paris Agreement* is achieved [26]. Therefore, all countries should still maintain their willpower for the transition, make greater efforts to promote the rapid development of renewable energy and make it gradually replace traditional fossil energy, so that a diversified, clean and low-carbon energy structure is established.

The energy transition is not accomplished overnight. The moderate investment in traditional energy is needed to ensure energy security in the near and medium term. Currently, the fossil energy meets more than 80% of the world's energy demand,⁵ and even in the global net-zero situation in 2050, the oil and gas

⁵ The data is from U.S. Energy Information Administration. <https://www.eia.gov/international/data/world>.

demand will account for about 35% of global energy demand [27]. In some industries, such as heating, and petrochemical industries, it is difficult to find clean industrial raw materials that can effectively replace traditional fossil energy in the short term, and the contribution of renewable energy to the entire process of these industries is quite limited. Therefore, during the process of short- and medium-term energy transition, it is necessary to invest in traditional energy moderately to meet the short-term demand for traditional energy and ensure the security of energy supply.

The Short-Term Fluctuation During the Process of Long-Term Energy Transition Should Be Treated Properly to Avoid Global Inflation Risks

The rise in short-term energy demand is in contradiction with the goal of energy green transition, and a short-term fluctuation upon an energy supply and demand imbalance are prone to occur in the transition process. In the long run, the trend of global green transition of energy requires the gradual reduction of fossil energy and replacing it with fast-growing renewable energy. However, in the short term, the renewable energy production capacity is insufficient, and to meet the rising energy demand still depends on fossil energy to a certain extent. The contradiction between the two is prone to cause a short-term imbalance of energy supply and demand in the transition process. Besides, external adverse factors such as the COVID-19 pandemic, monopoly, and geopolitical conflicts will have a certain impact on the stability of global energy supply, further triggering the occurrence of a short-term energy supply and demand imbalance.

The imbalance between energy supply and demand has led to a sharp rise in energy prices, which is prone to affect the finance sector and may trigger global inflation. At present, most of the energy is circulated in the global trade market in the form of commodities, and the imbalance between energy supply and demand will lead to a sharp rise in energy prices, and the sharp rise in its price will be transmitted from industrial production to various sectors of the global economy, which will significantly inhibit the total output and consumption of terminal products [28]. In addition, global energy commodities are generally capitalized and closely related to the financial sector. The sharp rise in energy prices will lead to excessive speculation and malicious speculation in the financial sector, resulting in the generation of energy commodity price bubbles, and cause energy prices to deviate far from the ones corresponding to their intrinsic values, thereby increasing the fluctuation risk in the financial market, impacting the real economy, and further triggering inflations.

In the Future, Extreme Weather Will Become an Important Consideration for Energy Security in the Transition Process

Extreme weather events will occur frequently in the future, which will adversely affect the balance of energy supply and demand. Affected by human activities and greenhouse gas emissions, extreme weather events will occur more frequently

in the future [1], both energy supply and demand will be affected by this. On the one hand, the current renewable energy technology is intermittent and fluctuant to a large degree due to limits of natural conditions. Besides, the related energy storage technology has not been well developed, and the occurrence of extreme weather such as sudden decrease of wind force and drought will cause a sharp reduction in the level of the renewable energy output. For example, the European Union and the United Kingdom were affected by the decrease of the overall wind force in the North Sea during the summer and autumn of 2021. From January to September, the wind power generation capacity fell by 17% and 25% year-on-year, respectively. Brazil was affected by a severe drought in 2021, with about 30 hydropower plants unable to generate electricity efficiently due to insufficient water storage. On the other hand, the occurrence of extreme weather will push up energy demand and increase the pressure on energy supply. In 2021, in addition to the rapid economic recovery, more extreme weather than that in 2020, such as a colder winter [29] were also the main factors driving global electricity demand to soar to a record high. Besides, **the global energy infrastructures have not shown sufficient climate resilience and adaptability, and the frequent occurrence of extreme weather will significantly affect its energy supply efficiency.**

The Supply Chain System with New Energy Technologies as the Core Will Become the Focus of Attention of All Countries in the Future Energy Transition

New energy technologies have become the strategic support for the global energy transition. The construction of supply chain with new energy technology as the core will accelerate the process of green energy transition. In recent years, with the vigorous development of new energy technologies, global energy has been brought into a new journey from resource dependence to technology dependence, and the key core role of new energy technologies has become increasingly prominent during the process of green transition of energy. Therefore, accelerating the construction of a supply chain system centered on new energy technology will be an important direction in the energy transition of various countries in the future. On the one hand, the formation of a complete supply chain system with new energy technologies as the core can improve the green energy supply capacity, reduce the dependence on traditional fossil energy, and accelerate the process of energy transition to build a green, low-carbon and efficient energy system earlier, so as to achieve the climate targets of various countries; on the other hand, new energy technologies have become the commanding height of the new round of technological revolution and industrial transformation competition. Some countries have issued or are issuing relevant policies and acts in order to guide their overseas new energy industries to return to their own countries, thereby stepping up the construction of a supply chain system with new energy technologies as the core in their own countries.

2.2 Present Challenges and Recommendations for China's Energy Green and Low-Carbon Transition

2.2.1 China's Primary Energy Structure Is Dominated by Coal, and the High Dependence on Coal Indicates the Necessity of Coal Reduction

China is rich in coal resources, and coal takes a dominant position in its primary energy production and consumption for a long time. Although the proportion is decreasing year by year, it still exceeds half. In 2020, the raw coal accounted for 67.6% of total primary energy production and coal accounted for 56.8% of total energy consumption in China (see Figs. 5 and 6). The balance and stability between coal supply and demand is directly related to China's energy security and economic development. China's power structure is also dominated by coal-fired power, and the power generation capacity is closely related to the supply of thermal coal. In the first half of 2021, the growth rate of China's raw coal production was 8.7 percentage points lower than the growth rate of coal-fired power during the same period, and the coal imports also fell by 19.7% year-on-year due to the rapid rise in global coal prices [30]. The serious imbalance between domestic coal supply and demand led to a sharp rise in coal prices, resulting in a rapid increase in fuel costs borne by the coal-fired power companies. However, the increased fuel costs could not be transmitted to the demand side through an effective price transmission mechanism, which caused the insufficient power supply of the coal-fired power industry as a whole, while the gas electricity and renewable energy power generation, etc. are difficult to make up for the coal-fired power output shortage of power gap, which eventually led to the occurrence of nationwide power rationing.

Currently, the high dependence on coal exposed in China's coal-dominated energy structure shows the lack of energy resilience in China, and it was affected by the sharp rise in coal prices during the global energy crisis, triggering the occurrence of nationwide power rationing. Therefore, based on the basic national conditions with the coal-dominated energy structure, China should effectively promote the green and low-carbon transition of the energy system, and build a diversified, clean and efficient energy structure, so as to present sufficient energy resilience and effectively ensure energy security, fundamentally avoiding the occurrence of similar domestic energy crises like the nationwide power rationing event.

2.2.2 China Has Made Clear Its Commitment to Coal Control and Coal Reduction and Issued Relevant Policies

On the basis of the dual carbon goal, the Chinese government has made clear coal control commitments, rooting in the basic national conditions of coal-dominated energy structure. It will build a carbon-peaking and carbon-neutrality "1 + N"

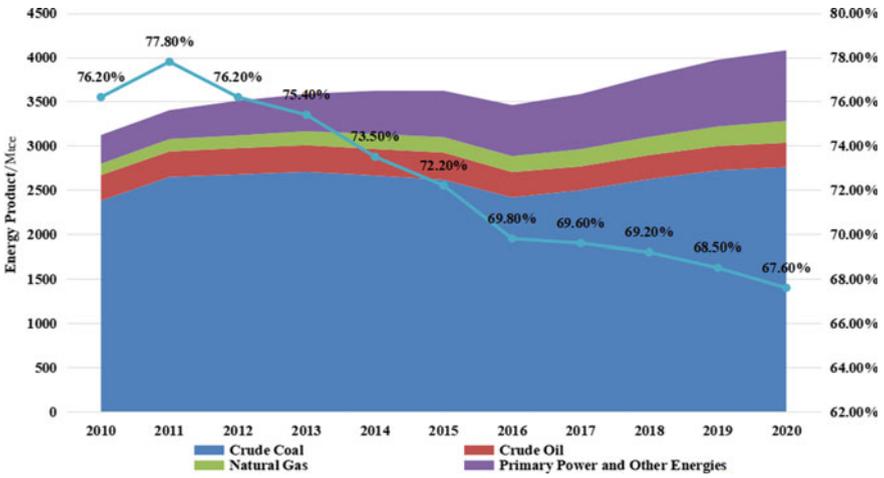


Fig. 5 Total primary energy production and composition in China. *Source of Data* National Bureau of Statistics

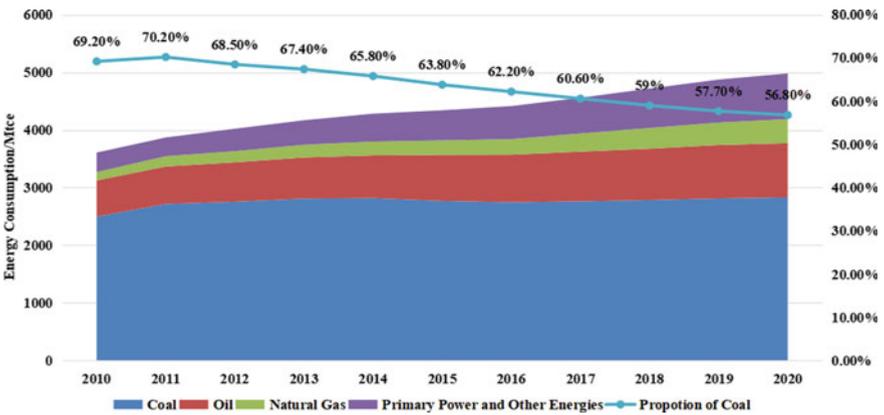


Fig. 6 Total primary energy consumption and composition in China. *Source of Data* National Bureau of Statistics

policy system to improve the top-level design and implement the new situation energy production and consumption revolution strategy. Besides, China has also issued relevant coal control policies to clarify the development direction in coal-fired power, key coal-consumption industries, bulk coal and other fields, so as to promote the effective implementation and advancing of coal control and reduction work under the general trend of energy transition advance (see Boxes 1 and 2).

Box 1 China's coal control and reduction commitments made at international conferences are as follows:

- On April 22, 2021, at the Leaders' Climate Summit, Chinese President Xi Jinping stated that China commits to strictly control coal power projects, and limit the growth of coal consumption during the 14th Five-Year Plan period, and make it gradually reduced during the 15th Five-Year Plan period.

- On September 21, 2021, at the 76th United Nations General Assembly, China further expanded its coal reduction commitments that it will no longer build new overseas coal power project to support the green and low-carbon development of energy in developing countries.

- On October 26, 2021, the State Council issued the Action Plan for Carbon Peaking before 2030. This is the core document on "N" in the carbon dioxide peaking and carbon neutrality and the "1 + N" policy system. It pointed out that China will promote the substitution, transformation and upgrading of coal consumption, and make additional supplements to the content of coal reduction in the Guidance. In terms of coal-fired power, it has added some contents to eliminate backward production capacity in an orderly manner, actively promote the transformation of heating supply, and advance the transition of coal-fired power to both basic security and system-regulating power sources; for the bulk coal, the government has increased efforts to promote the clean utilization of coal, taken multiple measures to actively promote the substitution of bulk coal in an orderly manner.

Box 2 China's relevant policy documents issued on the basis of coal control and reduction commitments are as follows:

- On October 24, 2021, the State Council issued the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy* (hereinafter referred to as the "Guidance"). This is the core document on "1" in the carbon dioxide peaking and carbon neutrality and the "1 + N" policy system. It pointed out that China will speed up the pace of coal reduction, strictly control the installed capacity in terms of coal-fired power, accelerate the energy-saving upgrade and flexibility transformation of existing coal-fired power units; and gradually reduce the use of bulk coal until it is completely prohibited.

- On October 26, 2021, the State Council issued the *Action Plan for Carbon Peaking before 2030*. This is the core document on "N" in the carbon dioxide peaking and carbon neutrality and the "1 + N" policy system. It pointed out that China will promote the substitution, transformation and upgrading of coal consumption, and make additional supplements to the content of coal reduction in the Guidance. In terms of coal-fired power, it has added some contents to

eliminate backward production capacity in an orderly manner, actively promote the transformation of heating supply, and advance the transition of coal-fired power to both basic security and system-regulating power sources; for the bulk coal, the government has increased efforts to promote the clean utilization of coal, taken multiple measures to actively promote the substitution of bulk coal in an orderly manner.

- On January 24, 2022, the State Council issued the *Comprehensive Work Plan for Energy Conservation and Emission Reduction during the 14th Five-year Plan Period*, and made further instructions on how to achieve coal exit and reduction in the coal power industry. The document pointed out that it is necessary to promote the transformation of cogeneration of large coal-fired power plants, and to carry out the “three-transformation linkage” of coal saving and consumption reduction transformation, heating transformation and flexibility transformation for the existing coal-fired power units.

- On February 24, 2022, the National Energy Administration released a summary of the reply to the CPPCC members’ Proposal on the High-Quality Development of the Coal-fired Power Industry under the Carbon Neutrality Goal, which clearly detailed the functional positioning, optimization direction and system value of the coal-fired power industry.

- On March 22, 2022, Vice Premier Han Zheng chaired a symposium on clean and efficient utilization of coal. Han Zheng pointed out that it is necessary to promote the clean and efficient utilization of coal from the actual situation of China, make the coal effectively play its role as a bottom-line guarantee and ensure the national energy security. For the clean and efficient production and washing of coal, the energy-saving and consumption-reducing transformation of key coal-using industries, and the governance of bulk coal, it is necessary to make overall planning, integrate resources, and exert the collaborative effect.

- On March 22, 2022, the National Energy Administration released the *14th Five-Year Plan for Modern Energy System*. The document elaborates and deploys multiple aspects including energy production, green transition and development pattern, and mentions other content about coal exit and carbon reduction, involving vigorous development as well as clean and efficient utilization of coal, strengthening of cutting-edge technologies such as intelligent green mining of coal, and improvement of the governance level of coal consumption areas.

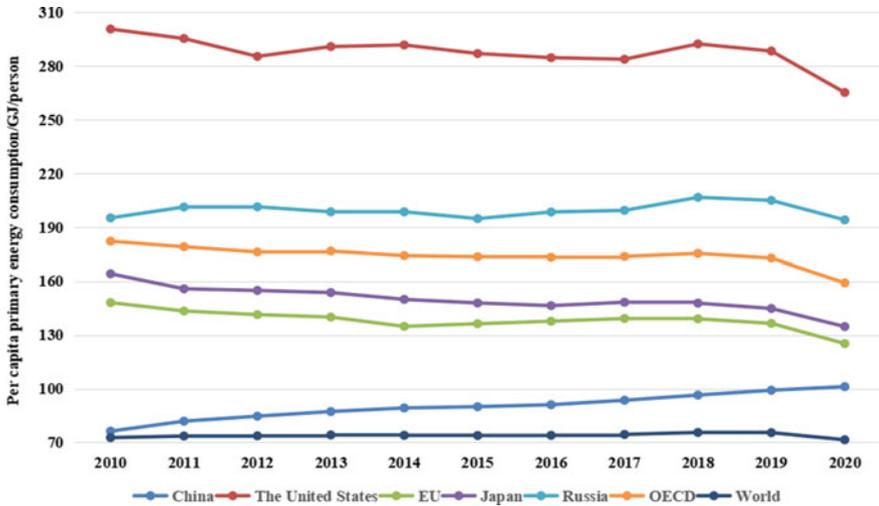


Fig. 7 Global per capita primary energy consumption from 2010 to 2020. *Source of Data* BP's Statistical Review of World Energy 2021

2.2.3 The Present Challenges of China's Short-Term and Medium-Term Low-Carbon Transition of Energy

Rapid Economic Development Needs Energy Security

In the short- and medium-term, the rising energy demand brought about by China's rapid economic development still needs to be met by coal. In recent years, with the rapid growth of China's economy, China's per capita primary energy consumption has gradually increased (see Fig. 7). Currently, China's economic development has entered a new normal, and the energy demand has entered a period of medium and low-speed growth, the rigid energy demand will exist for a long time even and the level of per capita energy consumption will continue to increase and move closer to developed countries [31]. Based on China's national conditions with the coal-dominated energy structure, even if the proportion of coal in the primary energy consumption structure gradually declines, it will still occupy a dominant position at present and in the future [32].

Under the background of the dual carbon goal, the green and low-carbon transition of China's energy structure has become an established trend, which objectively requires China to vigorously control and reduce the total coal consumption in the future, so as to promote the gradual transition of coal from the main energy status to the basic, and security status, which constitutes a serious contradiction with the objective reality that China's increasing energy demand will still be met by the use of coal in the future. China's energy supply and demand balance will be impacted, and energy security will face severe challenges. How to implement both breakthroughs, maintain the rhythmic coordination between the reliable replacement of clean energy

and the gradual exit of coal, and ensure the security of China's energy supply, this will be a major challenge during the process of China's coal reduction.

China's Coal-Fired Power Units Are Generally New and Early Decommissioning Faces a High Risk of Stranded Assets

China's power sector consumes a large amount of coal, and the decommissioning of coal-fired power units is its main direction for coal reduction. The power industry is an industry with the largest proportion of coal consumption in China. By the end of 2021, China's full-caliber coal-fired power generation capacity was 5.03 trillion kWh, accounting for 60.0% of the total power generation capacity [22]. Due to the high carbon lock-in effect of coal-fired power, the locked-in emissions of China's coal-fired power after 2018 are 102.3 (43.9–147.3) Gt CO₂, which will accumulate a large amount of carbon emissions in the future [33]. Therefore, the gradual decommissioning of coal-fired power units will become the main planning direction for coal exit and carbon reduction in China's power sector.

However, China's current coal-fired power units generally have a relatively short service duration and are far from reaching the decommissioning age. Early decommissioning will result in huge stranded assets, which will be prone to lead to conflicts of interest and financial risks. In 2020, the average service Duration of China's active coal-fired power units was only 11 years, of which more than 75% of the coal-fired power units had been in service for less than 15 years (see Fig. 8) [34], which is much lower than the average design life of 30 years. Under the scenario of early decommissioning of coal-fired power units, the assets with the remaining life will become to huge stranded assets, with a value of several trillion yuan, which will make coal-fired power companies face huge investment losses and cause disputes between companies and the government, and stimulate strong opposition from coal-fired power investors to coal reduction measures. At the same time, since coal-fired power plants require a relatively high level of upfront capital investment, which usually requires the participation of financial institutions, the huge amount of stranded assets will also have an adverse impact on the asset quality of relevant financial institutions, resulting in credit default risks, and may even cause a macroeconomic crisis, affecting financial stability [35].

The High Correlation Between Coal and the Industry in China Increases the Difficulty of the Coal Reduction

The coal industry is an important basic industry in China and has a high correlation with heavy industries such as electric power, steel, building materials, and chemicals. In 2020, the cumulative coal consumptions of the above four industries in China were 2.19 billion tons, 730 million tons, 490 million tons and 290 million

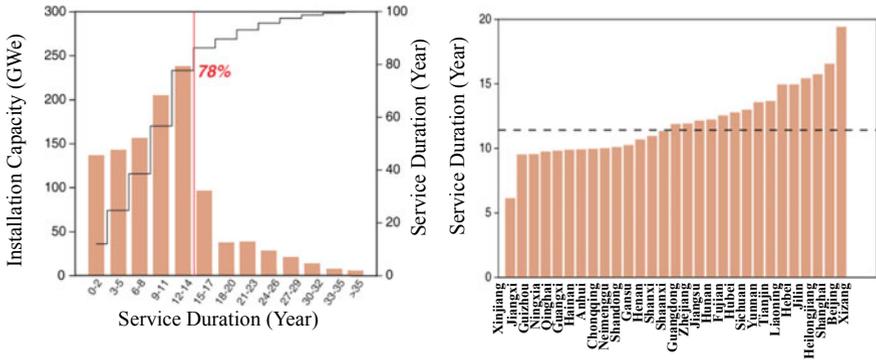


Fig. 8 Distribution of installed capacities and service durations of China’s active coal-fired power units and average service durations by province (autonomous regions and municipalities directly under the Central Government) in 2020 (the black dotted line on the right represents the national average service duration). *Source of Data* Global Energy Infrastructure Emissions Database

tons, respectively.⁶ In view of the high correlation between coal and the industry, the China’s coal reduction process means not only a strict control on the coal production capacity and consumption, but also a systematic project closely related to the transformation of the industrial structure. The production reduction of the coal industry shall not only meet the objective requirements in the coal reduction process, but also ensure the coordination with the reduction of coal consumption of its main downstream users to a certain degree. While maintaining the economic competitiveness of the downstream industry, it is also necessary to promote the green transition and upgrading of the industrial structure. At present, although some green manufacturing technologies in the industrial field have developed significantly, such as hydrogen energy steelmaking, electrolysis hydrogen production, etc., a series of green industrial products have been derived. However, these technologies face problems such as high costs and immature technologies, so they are impossible to replace the coal consumption in the industry to a large extent, and the derived green products have not yet developed enough market shares to bring enough market profits for industrial enterprises to maintain their competitiveness. Therefore, the high correlation between China’s coal and the industrial sector has increased the difficulty of China’s short- and medium-term coal reduction, and posed higher requirements for China’s coal reduction process. It is necessary to achieve the coordinated development of the coal and related industries.

⁶ Energy bureau: The proportion of coal consumption will fall below 56% this year. http://fjlib.net/zl/fjstsgjcx/jjzd/202104/t20210425_451104.htm.

The Coal Reduction Process May Bring About Social Justice Issues

The issues of re-employment and corporate subsidies will arise in coal and related industries, following the implementation of the coal exit policy. During the 13th Five-Year Plan period, China's coal industry withdrew 1 billion tons of outdated production capacity and had to re-employ about 1 million workers [36]. Those labors generally had relatively single skills, weak competitiveness, and poor adaptability to the transformation. They were less attractive to the enterprises in other industries, and had less space to be absorbed and re-employed through the job transfer training. Under the background of the dual carbon goal, the number of coal mines in China will constantly decrease, if such a traditional method is adopted, namely the redundant labors are to be arranged to continuous mines or contracting projects for re-employment, the difficulty is continuously increasing. Meanwhile, the coal exit process will inevitably have an impact on the coal production and coal-fired power companies, which may result in their early exit.

Coal resources and related industries in China are unevenly distributed. The regional difference caused by coal exit needs to be attached importance. China's coal resources are unevenly distributed. In the regions with rich coal resources, such as Inner Mongolia and Shanxi, the coal industry is usually an important pillar for economic development, and is crucial to local fiscal revenue, employment and social stability. Under normal circumstances, the coal-substituting industries in these regions emerged relatively late as their excessive reliance on the coal industry, so they have no advantages in terms of technological level and costs, as the results, no scaled substituting industries have formed there. In this case, the coal-based regions will be more affected and have larger fluctuations than other regions in terms of the economic development. Furthermore, these regions will face higher pressure from the adjustment in the industrial structure, local finance and employment structure [37].

2.2.4 Suggestions on China's Green and Low-Carbon Energy Transition

In general, China should, based on the basic national conditions with the coal-dominated energy structure, carry out the green and low-carbon energy policies in a reasonable and orderly manner on the premise of ensuring the energy security. To achieve the goals, we should follow the principles of exercising nationwide planning, prioritizing conservation, leveraging the strengths of the government and the market, coordinating efforts on the domestic and international fronts, and guarding against risk, while adhering to the concept of establishing the new in advance before abolishing the old, to seek progresses in stability. The gradual exit of traditional

energy should be established on the basis of the new energy's security and reliability.⁷ On the one hand, we will effectively promote the substitution, transition and upgrading of coal consumption, appropriately speed up the pace of coal reduction [38], to successfully achieve the transformation of coal from its main status in China's energy structure to a basic and security status. On the other hand, we should vigorously develop renewable energy, effectively increase the proportion of renewable energy in the primary energy structure, and rapidly achieve transition and development to a clean, reliable and efficient green modern energy system.

It is necessary to properly handle the energy demand during the process of low-carbon energy transition in the future, and to realize that the new energy demand is mainly met by renewable energy. China's medium-high economic growth will face rising energy demand, which will bring a lot of investment opportunities. Renewable energy investment projects should be prioritized among investment projects with potential stable growth, and capital flows should be actively guided to the field of renewable energy through policy means, to promote technological innovation in renewable energy, and to accelerate the construction of the integrated energy system covering "source, network, load, and storage and use", thereby improving the supply capacity of renewable energy to mainly meet the rising energy demand brought about by economic development. Traditional fossil energy as backup energy like coal, only plays a role in making up for a small amount of energy demand gap. Through these measures, the benign synergy between China's economic development and energy transition will be realized.

Effectively strengthen the coal-fired power flexibility transition process by means of technology, market and so on, and gradually promote the coal-fired power to be replaced by renewable energy power generation and achieve its transition from its dominant status to the basic and security status. On the one hand, technical innovation should be actively used to effectively enhance the peak shaving capability of coal-fired power units and improve the flexibility and regulation of thermal power, which can not only promote the orderly reduction of coal power generation based on the rapid growth of renewable energy generation, but also is expected to ensure the stable exit of most coal power units after their operation to a reasonable life (20 or 30 years), thereby effectively avoiding the risk of asset stranding caused by early retirement of coal power units. On the other hand, it is necessary to fully reflect the capacity value and adjustment service value of coal-fired power units through policies such as compensation and transaction of auxiliary services in the power market, so that coal-fired power enterprises can obtain the same value of income, thereby guiding more coal-fired power units to be involved in the flexibility transformation, making the coal-fired power units give full play to the capacity effect, effectively making up for the intermittent and fluctuating problems of renewable energy power generation, and exactly improving the consumption capacity of renewable energy.

⁷ An important speech delivered by Xi Jinping and Li Keqiang at the Central Economic Working Conference. http://www.gov.cn/xinwen/2021-12/10/content_5659796.htm.

The energy transition process along the entire industrial chain should be planned systematically to avoid the disconnecting of the upstream and downstream industries. The energy transition is a systematic project involving all industries in the entire industrial chain. The coal reduction of the coal industry should be coordinated and consistent with the coal saving and consumption reduction, energy efficiency improvement, green fuel substitution and green process innovation, as well as production capacity expansion of the renewable energy industry in the downstream high-coal-consuming industries. The transition process between various industries should complement and promote each other, so as to avoid the negative impact on the entire industry chain due to the inconsistent pace of transition. Under the condition of maintaining the continuous development of the core competitiveness of each industry, we should effectively promote and realize the high-quality green transition of all industries.

To achieve fairness and equity in the green and low-carbon energy transition, the following measures should be taken. Firstly, multiple strategies should be adopted to promote economic diversification in coal-producing areas and improve the “hematopoietic function” of affected areas. Consideration should be given to the reuse of coal assets, for example, the abandoned mines are used for CCUS, energy and hydrogen storage, cold chain refrigeration, etc.; the infrastructure advantages of coal production areas should be fully utilized, combined with specific location factors and business environment background, to achieve local economic diversification, such as developing warehousing and logistics centers, new industrial parks, tourism services and other industries. The combination of the coal industry and emerging strategic industries should be promoted, especially those related to new energy and energy efficiency, to minimize sunk assets in the coal industry, and identify opportunities for value transfer; **Secondly, the re-employment and re-settlement mechanism for coal workers should be improved.** The re-employment and re-settlement should be solved according to the factors like the education level, age, and local economic development situation, which are helpful to more accurately identify the different needs of the people facing re-employment problems. For the regions with difficulties in local re-employment, it is necessary to strengthen the construction of re-employment training institutions, especially the construction of cross-regional re-employment service platforms; for the employees with special economic difficulties, or the weak and disabled employees, they should be supported with priority to ensure they enjoy the social security, medical care, pension and other security mechanisms; for the personnel with low education levels or difficulties in changing jobs, they shall be given priority to have employment opportunities such as e-commerce and community services; it should be considered to use the taxes and profits of the coal industry, along with the central transfer payments to establish a special assistance fund for the people who are seeking re-employment and resettlement; and **thirdly**, we should provide financial assistance to coal and related enterprises that are negatively impacted in the transition process to make up for their economic losses through policy guidance.

The low-carbon energy transition has the risk of exacerbating gender inequalities, but may also bring an opportunity to enhance gender equality. In the coal industry,

decision makers and the majority of the workforce are dominated by men. The implementation of coal exit as well as the development of alternative energy and its related emerging industries, will provide females with more employment opportunities and make it possible to reduce the male-dominated lock-in effect in the energy industry. However, ignoring gender equality considerations in the transition process may further exacerbating inequalities between men and women in the job market and the provision of free domestic work.

3 Strengthening the International Cooperation to Promote the Low-Carbon Energy Transition Under the Belt and Road Initiative

3.1 Current Situation of Low-Carbon Energy Transition in the Belt and Road Countries

3.1.1 Current Situation of Economy, Energy and Emissions in the Belt and Road Countries

The Belt and Road countries have huge population bases and relatively low levels of economic development. In 2018, the population of the Belt and Road countries accounted for 64% of the world's total population, while the GDP accounted for only 39% of the world's total GDP, which formed a large contrast with the huge population base of more than 60% (see Fig. 9). The IMF data clearly shows that the economic growth prospects of the Belt and Road regions far exceed that of North America or Europe. Even if the predicted growth rate of the Belt and Road regions is halved, it will not be lower than that of North America or Europe, which means that for a period of time in the future, the Belt and Road regions will become an important engine driving the world's economic growth.⁸

The total energy consumption of the Belt and Road countries is relatively high, and the fossil energy remains the dominant energy source, so the low-carbon energy transition is imminent. In 2018, the energy consumption of the Belt and Road countries accounted for 58% of the global total, and the fossil energy was the main source (see Fig. 9). It should be noted that coal has a high weight in the energy consumption structure of the Belt and Road countries. In 2018, the coal consumption of the Belt and Road countries accounted for 73.6% of the world's coal consumption, and the consumption of natural gas, oil and renewable energy basically was the same as that of the non-Belt and Road countries (accounting for 56.6%, 50.5% and 46.7% of the world's total energy consumption, respectively). Except for China, the energy consumption structure of the Belt and Road countries

⁸ Sina Finance, 2017. The Belt and Road will become a major engine driving the world's economic growth. <http://finance.sina.cn/zl/2017-05-15/zl-ifyfeivp5713360.d.html?from=wap>.

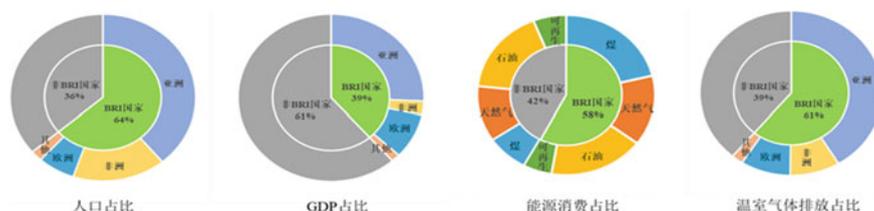


Fig. 9 Current situation of economic, social and energy emissions in the belt and road countries. *Source of Data* United Nations, World Bank, Energy Information Administration, Our World in Data

in Asia mainly consists of natural gas and oil, which account for 24% and 20% of the world's total, respectively; the annual energy consumption of the Belt and Road countries in Africa is not high, but it is nearly about the same in these different countries. The averaged consumption of various energies accounts for about 3% of the world's energy consumption, and that of oil accounts for the highest proportion, at 4.2%. The main energy consumed in the Belt and Road countries in Europe is natural gas, accounting for about 19% of the world's total natural gas consumption. Renewable energy in the Belt and Road countries only accounts for 9% of total energy consumption. In 2018, the GHG emissions of the Belt and Road countries accounted for 61% of the global carbon emissions (see Fig. 9). If the Belt and Road countries do not change the traditional economic growth path highly depending on fossil energy, under the current rapid economic growth, they will become potential high-carbon lock-in areas in the future.

3.1.2 Current Situation of Energy Investment Cooperation of the Belt and Road Countries

China is the largest trading partner of the Belt and Road countries, and energy is the most important area for China to participate in the investment and construction of the Belt and Road. Data from the General Administration of Customs shows that in 2021, China's total trade in goods with the Belt and Road countries was 11.6 trillion yuan, increasing by 23.6% compared to the previous year and creating a new high.⁹ It should be noted that in 2020, the import and export amount between China and ASEAN was 4.74 trillion yuan, with a year-on-year increase of 7%. For the first time, the two parties became each other's largest trading partners.¹⁰ In 2021, China participated in the construction of projects in 144 Belt and Road countries, totaling about US\$59.5 billion (about US\$13.9 billion in investment and

⁹ People's Daily Overseas Edition, 2022. Building the Belt and Road, following the Trend of Economic Globalization (hotspot dialogue). http://paper.people.com.cn/rmrhwb/html/2022-02/26/content_25905068.htm.

¹⁰ Foreign Economy, 2021. For the first time, China and ASEAN are each other's largest trading partners. http://shanghaibiz.sh-ic.net/article/dwjydw/202101/1508062_1.html.

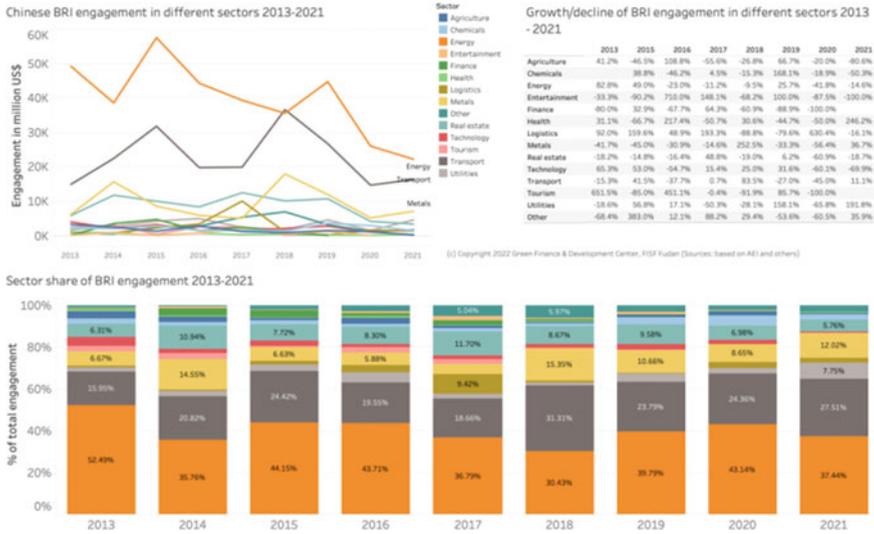


Fig. 10 Proportion of sectors in which China participated in the investment and construction of the belt and road regions from 2013 to 2021. *Source of Data* China’s Investments in the Belt and Road Initiative (BRI) in 2021

US\$45.6 billion in contracts) through financial investment and contractual cooperation. Among them, energy cooperation was the most important part of China’s investment and construction for the Belt and Road, accounting for 37.44% of the total investment and construction in 2021 (see Fig. 10) [39].

China’s participation in the investment and construction of the energy sector under the Belt and Road Initiative has gradually become cleaner, and renewable energy investment has become the main part. Since 2017, China’s renewable energy investment in the Belt and Road has gradually increased. In 2020, the proportion of renewable energy investment from China has reached 56%, becoming the main body of China’s energy investment in the “Belt and Road” countries. In 2021, Chinese President Xi Jinping promised in the general debate of the 76th United Nations General Assembly that China will no longer build new overseas coal-fired power projects. In the same year, China invested about US\$10 billion in renewable energy construction in the Belt and Road countries, which was mainly concentrated in solar and wind energy (31%) and hydropower (17%) (see Fig. 11).

3.1.3 Cooperation Mechanism for Energy Investment and Construction Between China and the Belt and Road Countries

Reach a consensus on development, cooperation and governance in the energy sector by virtue of dialogue mechanisms and platforms such as the Belt and

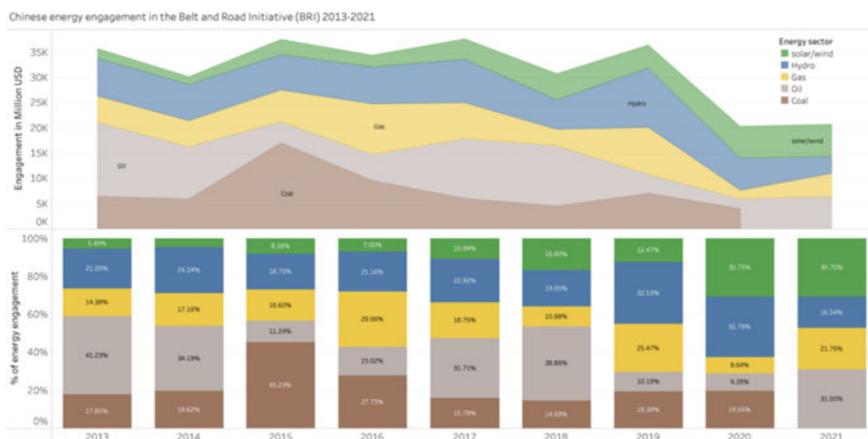


Fig. 11 China's energy cooperation in the belt and road regions by types from 2013 to 2021. *Source of Data* China's Investments in the Belt and Road Initiative (BRI) in 2021

Road Energy Ministerial Conference and the Energy Partnership. Energy cooperation is a key area in the joint construction of the Belt and Road. At the first Belt and Road Energy Ministerial Conference on October 18, 2018, China and other 17 countries jointly issued the *Joint Declaration on the Establishment of the Belt and Road Energy Partnership*. In March and April 2019, China and the member states under the partnership held two fruitful consultations, and reached a consensus on the establishment of the partnership, cooperation principles and practical actions. On April 25, 2019, during the 2nd Belt and Road Forum, 30 countries jointly established a partnership in Beijing. The partnership has become the first intergovernmental multilateral energy mechanism initiated by the Chinese government, providing a new platform for member states to solve problems faced by energy development and promote pragmatic cooperation in the field of higher quality, higher level and more sustainable energy. In December 2019, the first Belt and Road Energy Partnership Forum was held in Beijing, focusing on clean energy cooperation, aiming to promote the Belt and Road energy cooperation to deepen and solidify, achieve green development, and promote the implementation of energy cooperation demonstration projects. In December 2020, the 2nd Belt and Road Energy Partnership Forum was held in Beijing. With the theme of Green Energy Investment Promotes Inclusive Economic Recovery, the forum focused on global energy transition and green development after the outbreak of the pandemic, and promoted the inclusive economic recovery of the Belt and Road countries to achieve sustainable development goals.¹¹ On October 18, 2021, the 2nd Belt and Road Energy Ministerial Conference included an expansion ceremony and a cooperation network establishment ceremony, at which the *Charter on the Belt and Road Energy Partnership* was adopted, and the *Qingdao Initiative*

¹¹ Belt and Road Energy Cooperation, 2021. Special Report on the 2nd Anniversary of the Belt and Road Energy Partnership. <http://obor.nea.gov.cn/pictureDetails.html?id=2957>.

on Green Energy Cooperation for the Belt and Road and Best Practices in Energy International Cooperation was released.

Take pragmatic actions to promote the construction of energy infrastructure in the Belt and Road countries through project investment, engineering construction and other means, and gradually realize low-carbon transition.

Energy projects are the top priority of the China-Pakistan Economic Corridor, and it is also the field with the fastest progress and the most significant achievements. As of February 2020, 12 energy projects in the corridor have been in commercial operation or under construction, with a total installed capacity of 7.24 million kW, with a total investment of about US\$12.4 billion. The actual power generation of the corridor project in the 2018–2019 fiscal year was 17.728 billion kWh, accounting for 14.5% of the total power generation of the National Grid of Pakistan (NTDC), which can supply power for about 33 million people and provide more than 10,000 jobs.¹² The focus of energy cooperation between China and ASEAN is also shifting from traditional fossil energy to the investment and construction of renewable energy. In 2017, the *Vision and Actions for Promoting the Belt and Road Energy Cooperation* formulated by the National Development and Reform Commission of China and the Energy Administration pointed out that China will actively implement the China-ASEAN clean energy capacity building, and the new energy investment projects have gradually increased, and cooperation in renewable energy has become a key area [40]. China is a firm supporter of sustainable development in Africa, and the two parties have implemented hundreds of clean energy and green development projects within the framework of the Forum on China-Africa Cooperation.

Under the guidance of the concept of Urban Diplomacy, local governments in China have actively formed sister city cooperation agreements with important energy cities along the Belt and Road, and strengthened high-level visits and dialogues at the provincial level. Provinces and cities such as Xinjiang, Shaanxi, Ningxia and Gansu have concluded sister city cooperation agreements with many important energy cities along the Belt and Road. For example, Xinjiang has studied and formulated an implementation plan for participating in China-Kazakhstan, China-Tajikistan cooperation and the construction of the China-Mongolia-Russia Economic Corridor, and a total of 45 pairs of international sister cities have been established, including 7 pairs of sister cities with which Xinjiang has established the cooperation relationship with local governments at various levels in Pakistan, and it is the province with the largest number of sister city relations between China and Pakistan. Xinjiang Goldwind Science Technology Co., Ltd. has also become one of the first batch of Chinese wind power manufacturers entering Pakistan. Up to now, Goldwind has put 7 wind power projects in Pakistan into operation, which can provide more than 1.5 billion kWh of green power to the local area every year.

A number of capital financing projects have provided a solid financing platform for energy cooperation between China and the Belt and Road countries. Key financial institutions such as the Asian Infrastructure Investment Bank and the

¹² Belt and Road Energy Cooperation Network, 2020. China–Pakistan Energy Cooperation. <https://obor.nea.gov.cn/pictureDetails.html?id=2567>.

Silk Road Fund can provide long-term, stable and risk-controlled financial support for the Belt and Road regions. By the end of 2020, the AIIB had 47 climate-related investment projects, with a total investment and financing amount of US\$8.89 billion, accounting for 40% of the total scale, mainly in the energy sector. It also proposed that by July 1, 2023, all AIIB investment projects will be fully consistent with the relevant goals of the *Paris Agreement*, and will continue to increase the proportion of financing for addressing climate change. It is planned to achieve the goal that the proportion of climate financing reaches 50% by 2025. Its total cumulative climate financing is expected to reach US\$50 billion by 2030. Besides, China supports and encourages policy and development financial institutions to participate in the financial cooperation under the Belt and Road Initiative. The China Development Bank gradually assists the development of clean energy industry in partner countries by providing large and long-term financing services. According to statistics, by the end of 2018, it had released a total loan of US\$6.4 billion for the clean energy projects under the Belt and Road Initiative, of which the loans for renewable energy covered wind power, solar energy and other new energy utilization fields [41]. The Minas San Francisco Hydropower Station project in Ecuador supported by the Export–Import Bank of China has completed the final acceptance and handover in April 2021. According to the plan, it can provide 1.291 billion kWh of clean electricity every year, which will create more than 2000 jobs, meet the domestic electricity demand of about 1.2 million residents and the commercial electricity demand of 2000 production-oriented enterprises, and provide an important green energy guarantee for the social and economic recovery of Ecuador.

3.2 Low-Carbon Energy Transition Planning of the Belt and Road Countries

The Belt and Road countries are striving to improve their nationally determined contributions to achieve climate goals, and promote the global green and low-carbon energy by formulating relevant coal reduction and renewable energy development goals. With the continuous advancement of the global climate process, the Belt and Road countries headed by China are actively improving and striving to enhance their own Nationally Determined Contributions (NDCs), in order to achieve the goals of keeping global temperature rise within 1.5 °C and 2 °C by the middle of this century set in the *Paris Agreement* by driving their own active emission reductions. Meanwhile, along with the wave of global green and low-carbon energy transition, the Belt and Road countries have also accelerated the pace of coal exit and decarbonization of the energy system by establishing and formulating relevant energy strategic goals and plans, and vigorously developing renewable energy to improve and strengthen their proportion and position in the energy structure, and, are making efforts to promote the orderly construction and formation of a clean, low-carbon and efficient green energy system.

3.2.1 Nationally Determined Contributions (NDCs) of the Belt and Road countries

Most of the Belt and Road countries have set clear and quantitative emission intensity reduction goals in their Nationally Determined Contributions (NDCs), and most countries have proposed carbon neutrality or net zero emission goal. So far, except for Yemen and Libya, the other 147 Belt and Road countries have submitted their Nationally Determined Contributions (NDC) documents to the UNFCCC Secretariat. Table 2 shows the climate change mitigation goals proposed by the Belt and Road countries in their respective Nationally Determined Contributions (NDCs), which mainly include five types. Among the Belt and Road countries, the ones that proposed emission reduction goals relative to the baseline situation and the quantitative emission intensity goal relative to the baseline occupied the largest proportion, accounting for 69% of the Belt and Road countries. Only 5 countries have proposed absolute emission reductions, and another 6 countries have energy intensity reduction as their emission reduction goals. In addition, 21% of countries proposed a series of emission reduction actions instead of quantitative mitigation goals. Besides, so far, 128 countries in the world have proposed the carbon neutrality or net zero emission goals,¹³ including 93 Belt and Road countries which account for 73% of all. This fully shows that the Belt and Road countries are making efforts to actively improve its own emission reduction contribution.

3.2.2 Coal Reduction or Exit Plans and Goals in the Belt and Road Countries

The *Glasgow Climate Pact* was formulated at the COP26, which for the first time put forward clear requirements for countries to gradually reduce coal-fired power plants without installation of emission reduction facilities. In addition, more than 70 countries and organizations signed the *Global Coal to Clean Power Transition Statement*. Of the 70 countries, there were 32 Belt and Road countries, which fully demonstrates that the Belt and Road countries are actively participating and improving their own contributions to promote the global transition from coal to renewable energy. However, due to their own energy and economic development needs, most of the Belt and Road countries cannot completely get rid of their dependence on coal within a short period, and their coal reduction process still needs to be advanced steadily and orderly.

By mid-2021, 21 countries around the world have pledged to fully phase out coal within a fixed time frame, but they are mainly developed countries that are G20 and EU member states [42]. Schedule 1 lists the coal exit, coal reduction plans, goals and related policy documents of some Belt and Road countries. Among them, only European countries such as Italy, Portugal, Greece, Hungary and Slovenia have clearly set the target time for complete coal reduction (phasing out coal-fired power),

¹³ Net Zero Tracker. <https://zerotracker.net/>.

Table 2 Types of emission reduction goals in the Nationally Determined Contributions (NDC) of belt and road countries

Type of emission reduction goals	Countries
Emission reduction relative to baseline situation	Brunei, Cambodia, Kiribati, Philippines, Solomon Islands, Thailand, Vietnam, Indonesia , Iran, Iraq, Lebanon , Georgia, Salvador, Jordan, Palestine, Kyrgyzstan, Mongolia, Afghanistan , Bangladesh, Sri Lanka, Maldives, South Korea, Burundi, Comoros , Djibouti, Ethiopia , Kenya, Madagascar, Uganda, Benin , Côte d'Ivoire, Cameroon, Congo (Brazzaville), Ghana, Mali, Guinea-Bissau, Central Africa, Niger, Nigeria, Senegal, Sierra Leone, Chad, Togo , Angola, Lesotho, Tanzania , Zimbabwe, Algeria, Morocco, Albania, Bosnia and Herzegovina, North Macedonia, Turkey , Venezuela, Peru, Barbados, Costa Rica, Grenada, Jamaica, Panama, Trinidad and Tobago (61 countries)
Emission reduction relative to baseline year	Cook Islands, Federated States of Micronesia, Seychelles , Azerbaijan, Kazakhstan , Tajikistan, Gabon, Gambia , Equatorial Guinea, Mauritania, Zambia , Tunisia, Bulgaria, Cyprus , Czech Republic, Estonia, Hungary, Lithuania, Latvia, Malta , Poland, Romania, Slovakia, Slovenia, Austria, Greece, Italy, Luxembourg, Portugal , Belarus, Moldova, Ukraine, Croatia, Montenegro , Serbia, Russia , Dominica, Israel , Turkmenistan, Eritrea, Dominican Republic, New Zealand and Botswana (43 countries)
Energy intensity reduction	China, Malaysia, Singapore , Uzbekistan, Chile and Uruguay (6 countries)
Absolute emission reduction	Oman, Armenia, Guinea, Namibia and South Africa (5 countries)
Policy action	Fiji, Laos, Myanmar, Niue, Papua New Guinea, Timor-Leste, Tonga, Vanuatu, Samoa, United Arab Emirates, Bahrain , Kuwait, Qatar, Saudi Arabia, Nepal, Pakistan, Rwanda, Sudan, Somalia, Cape Verde, Liberia, Mozambique , Egypt, Guyana, Suriname , Bolivia, Ecuador , Syria, Antigua and Barbuda , Cuba, Democratic Republic of Congo and South Sudan (32 countries)
Non-NDC	Yemen and Libya (2 countries)
Carbon neutrality goal achieved	Bhutan (1 country)

Note Countries marked in bold are those that have proposed carbon neutrality or net zero emission goals

while most of the remaining countries set their coal reduction goals through policy documents, conference commitments, etc. Besides, such goals are all concentrated in the field of coal-fired power, and few countries have formulated clear goals and plans for comprehensive coal exit.

3.2.3 Renewable Energy Development Goals and Plans in the Belt and Road Countries

The Belt and Road countries generally begin to attach importance to the renewable energy development, and establish clear and quantified renewable energy development goals in national plans and policies, but they still face many problems and challenges. With the continuous innovation and popularization of renewable energy technologies and the continuous decrease of costs, the Belt and Road countries have gradually attached importance to the deployment and planning of renewable energy development, which have been reflected in relevant plans, policies and even legal documents. Schedule 2 lists the renewable energy development goals or plans of some Belt and Road countries. It can be seen that most countries have set clear and quantified renewable energy development goals. However, most of the Belt and Road countries are developing countries, and their renewable energy development faces many problems and challenges. All the countries still need to pay sufficient attention to these problems and challenges to ensure the healthy development of renewable energy. With ASEAN as an example, the high-speed growth demand brought about by economic development has led ASEAN countries to generally still rely heavily on traditional fossil energy, and the short- and long-term systematic plans for gradual reduction and exit of traditional energy are still unclear. Meanwhile, even though the cost of renewable energy in ASEAN is decreasing significantly, it still does not have a cost competitive advantage over traditional fossil energy. Except for Singapore, Brunei, Malaysia, and Thailand, other ASEAN countries generally have a low level of economic development, and will face a relatively large financial pressure to meet renewable energy growth by investment and financing in the future, so they need strong international financial support. In addition, the weak grid infrastructure of ASEAN countries also poses a lot of difficulties for the consumption and integration of renewable energy.

3.3 Risks and Challenges the Belt and Road Countries Face in the Low-Carbon Energy Transition

3.3.1 The Belt and Road Countries Face Many Challenges Such as Energy Security Risks, Asset Stranding, and Just Transition During the Process of Reducing the Use of Fossil Energy Such as Coal and Realizing Low-Carbon Energy Transition

Coal phase-out in the Belt and Road countries is the general trend, and more and more countries have given the schedule in terms of stopping the construction of coal-fired power projects. China, Japan, and South Korea are the top three financing countries for overseas coal-fired projects in the world, and they have all pledged not to build overseas coal-fired power plants anymore. In the face of changes in the macro

environment such as coal-fired power financing, fewer and fewer new coal-fired power projects are planned to be started. The Belt and Road countries, especially those countries with huge electricity demand and high dependence on traditional fossil energy such as coal-fired power, are facing many risks and challenges brought about by the transition.

Generally speaking, the Belt and Road countries are highly dependent on coal-fired power. If the green and low-carbon transition cannot be advanced in an orderly and stable manner, it may lead to energy security risks in these countries. According to data from the BP World Energy Statistical Yearbook, as of the end of 2020, the coal-fired power plants in 79 countries around the world were still in operation, and among them, there were 37 the Belt and Road countries.¹⁴ The regions with a large proportion of coal-fired power in the Belt and Road countries are mainly concentrated in Asia, and the proportion of coal-fired power in the countries like Indonesia, Malaysia, Vietnam and Kazakhstan is more than 50%. The coal-fired power generation in South Africa accounts for more than 85% of the total electricity supply. Besides, from the perspective of final power consumption, the electrification level will be greatly improved after the energy transition. Even under the same conditions of the whole society's energy consumption, the whole society's electricity consumption will also increase significantly, forcing the power supply side to provide more electricity, as the result, both the installed capacity and power generation capacity of the power system in China will increase significantly, and the accelerated exit of coal-fired power will further increase the mismatch between energy supply and demand and aggravate the risk of energy supply security.

The high cost in asset stranding following the exit of fossil energy may affect macroeconomic development. The gradual reduction of traditional fossil energy will break the original pattern of energy investment, production, and consumption, and reshape the industrial chain and supply chain in the green and low-carbon energy transition. Which will cause that the market supply and demand are mismatched or misaligned, resulting in risks of asset stranding and probably further leading to economic system risks. The global market value of fossil energy and related companies is about US\$18 trillion, accounting for 1/4 of the total market size; the relevant tradable bonds are about US\$8 trillion, accounting for 1/2 of the total market size [43]. It is estimated that about 59% of the global coal reserves under the 2 °C target will become stranded assets, while the proportion will rise to 84% under the 1.5 °C target [44]. A report released by the financial think tank Carbon Tracker pointed out that the global coal-fired power projects currently under construction or in the planning stage reached 499 GW, which may lead to stranded assets with a value of US\$638 billion, of which the value of the coal-fired power plants planned or under construction in Southeast Asia reaches a total of 78 GW, and the coal-fired power investment at risk is up to US\$124 billion [45]. China's current coal-fired power equipment is generally "young", with an average age of only 12 years. It is estimated that China's coal stranded assets may reach 3–7 trillion yuan [46]. In

¹⁴ Challenges from coal-fired power projects under the Belt and Road Initiative.

addition, the sharp falling in the profitability of traditional fossil energy companies will cause asset prices to collapse, which will potentially lead to huge debt defaults.

The exit of fossil energy will have an impact on traditional industries and trigger the challenge of just transition. The gradual reduction and exit of the fossil energy industry will have an impact on coal and other traditional fossil energy companies and workers, and cause social unemployment. Although energy creates more new jobs with the rapid development of the renewable energy industry, there is a mismatch in time, space and skills between job creation and job loss. When the traditional fossil energy industry is affected, and it is difficult for employment populations to fully find suitable positions in the newly created jobs. At present, the employment scale in China's coal industry is about 2.6 million people. According to estimates, under different scenarios, including policy and environmental factors, the employment scale in the entire coal industry will be halved by 2030, and may even be reduced to about 1 million people. In the long run, the number of employees in the entire coal industry may drop to 200,000 by 2050.¹⁵ South Africa has been extremely dependent on coal for a long time. Coal-fired power generation accounts for over 85% of South Africa's total electricity supply, and the employment of about 400,000 people is directly related to the coal industry [47]. In addition, due to the gap between energy supply and demand and the increase in energy costs, the increase in energy prices will lead to inflation when it is transmitted to the downstream, which will bring greater economic pressure to low-income populations and cause more social problems.

3.3.2 Challenges Faced by the Belt and Road Countries During the Process of Developing Renewable Energy

Most Belt and Road countries have abundant solar, wind, hydro, geothermal and biomass resources but their renewable energy development and utilization levels are relatively low. As the result, they will face many development obstacles such as policy, capital, technology, and environment during the process of promoting renewable energy.

Ambition is lack in the renewable energy development goals. The renewable energy development goals set by many Belt and Road countries are not enough to support the green and low-carbon energy transition. In the 2016–2025 cooperation action plan, ASEAN proposed that by 2025, the proportion of renewable energy in the primary energy supply structure will reach 23%, while Vietnam only plans that the proportion of renewable energy reach 21% of the total installed capacity by 2030. Lai plans that the proportion of renewable energy will be only 10% of the total installed capacity by 2035, which is lower than ASEAN's overall goal. Nigeria, Africa's largest economy, has set a target that its energy consumption from renewables will account for 10% of the total energy consumption by 2025, while South Africa, Africa's second-largest economy, has yet to set a clear goal. In addition, in the face

¹⁵ CNEnergyNews, 2020. Impacts of Coal Power and Coal Transition on Employment.

of economic recovery pressure, many countries will support fossil energy, which is set as the main content of the recovery plan.

Policy support to renewable energy is insufficient. The development of renewable energy requires support of relevant policies, such as price subsidies and power grid construction commitments. However, many Belt and Road countries lack support of relevant policies, which limits the development of renewable energy. The market consumption and pricing policy framework for renewable energy are not sound, affecting the “financeability” of renewable energy projects along the Belt and Road. Insufficient or frequent changes in feed-in tariff policy incentives make renewable energy development uncompetitive, while high feed-in tariffs in other countries have led to a surge in applications for specific types of power supply construction, and over-allocation has led to the termination of relevant incentive policies. In addition, most ASEAN countries still lack fully transparent land licensing procedures for renewable energy development. The procedures for acquiring, retaining and transferring land use rights are complicated. Long land acquisition periods and expensive acquisition fees also lead to project development delays and cost overruns [48]. The cumbersome and lengthy project permitting process, changing policies in the short term and unclear guidelines for grid-connected renewable energy generation have resulted in low investment efficiency in the industry, and the cost of solar and wind energy development in Southeast Asia is still higher than that in many other regions.

Insufficient funding restricts the development of renewable energy in the Belt and Road countries. According to the World Energy Outlook 2020 report released by the International Energy Agency, in 2021, the investment needs of the solar energy industry in Africa region in the south of Saharan alone will reach US\$ 6 billion, and there is a large funding gap. Vietnam has planned and approved a number of renewable energy projects, but the conversion rate is very low due to insufficient funding. Most projects are funded through international banks, and local banks only participate in project investment by providing guarantees. At present, Vietnam can only provide funds for renewable energy projects with an installed capacity of 1000–2000 MW, and there is still an urgent need to solve the financing of renewable energy projects with an installed capacity of 10 GW [49]. Due to financial constraints, there is no funding to replace existing thermal power plants, forcing these countries to maintain the current situation of energy development. In addition, investment and financing difficulties also restrict the development of renewable energy in the Belt and Road countries. Some Belt and Road countries have huge debts or weak power purchasers, and it is often difficult for renewable energy projects to obtain sovereign guarantees from host countries, which increases financing costs [34].

Insufficient renewable energy technologies and weak R&D capabilities for key core technologies cannot yet support the green and low-carbon energy transition. Renewable energy technology constraints are one of the main obstacles to the development of renewable energy in the Belt and Road region. ASEAN has certain deficiencies in innovation of renewable energy technologies, and the related photovoltaic technology and wind power technology capabilities are still weak, which restricts the development of renewable energy in ASEAN countries. Meanwhile, the current national grid foundation along the Belt and Road is not strong, the grid

structure of the countries along the route is weak, there are few high-voltage lines, and the power interconnection between countries is limited, which makes it difficult to achieve power grid connection and transmission of large-scale renewable energy [41]. For example, a unified power grid has not been formed among the islands of Indonesia, and areas with abundant resources but limited consumption capacity cannot transmit clean renewable energy power to areas with large power demand, which limits the development of renewable energy.

Inconsistent standards hinder international cooperation in renewable energy under the Belt and Road Initiative. Standardization is one of the main obstacles restricting Chinese companies to participate in renewable energy investments in the Belt and Road countries. Most the Belt and Road countries have mandatory requirements for equipment and products made in China to be imported only after certification, and only international standards are recognized as the construction standards. Therefore, wind power and photovoltaic enterprises have to pass the international certification for their products to be used in the overseas investment. In addition, they also have to pass different certifications due to different requirements of various countries. For example, the standards of African French-speaking regions, English-speaking regions and Portuguese-speaking regions are different, which has greatly hindered international cooperation in renewable energy [50].

3.4 Suggestions for Cooperation in Low-Carbon Energy Transition Under the Belt and Road Initiative

The Belt and Road countries should adopt a gradual low-carbon energy transition strategy based on their national conditions. **Firstly**, explore and formulate a schedule for the exit of fossil energy and specific goals in terms of the development of renewable energy according to local conditions, so as to provide macro guidance for the orderly exit of fossil energy and the reasonable substitution of renewable energy. **Secondly**, strengthen the clean and efficient utilization of fossil energy for a large number of existing fossil energy infrastructures, such as promoting the popularization and application of technologies such as the efficient coal combustion power generation technology, clean coal combustion technology, biological carbon sequestration and chemical carbon sequestration. **Thirdly**, design a package of policy systems with the systemic and synergistic policies considered, including the overall financial and technical guarantee policies, as well as the electricity market price stabilization policies, and the renewable energy subsidy support policies.

Carry out international cooperation in clean energy technology under the Belt and Road Initiative. **Firstly**, clarify the clean energy technology needs of different Belt and Road countries. **Secondly**, provide targeted technical cooperation programs according to the resource conditions and development conditions of different countries. In this process, we should attach great importance to providing

“small but beautiful” clean energy project solutions, and promote “big cooperation” with “small projects”. **Thirdly**, strengthen the capacity building through joint research and development, joint training of talents, etc., and effectively improve the technical level of international renewable energy development in the Belt and Road regions. **Fourthly**, strengthen the summary of China’s clean energy technology development experience, provide technical practice with reference significance, and deepen international cooperation in clean energy technology.

Deepen the promotion of green investment and financing cooperation under the Belt and Road Initiative. Improve the negative list system for overseas investment, and further strengthen the climate and environmental factors in overseas investment and financing policies. According to local conditions, develop green investment and financing tools suitable for developing countries participating in the Belt and Road Initiative, encourage innovation in green investment and financing products and services, and promote the establishment of green investment and financing standards applicable to the Belt and Road Initiative. Attach importance to ensuring fairness and justice in the green upgrade and transition process of traditional industries in the Belt and Road countries through emerging concepts and tools such as transformational finance. Explore debt conversion methods such as “debt-to-nature”, provide funds for vulnerable countries that are deeply troubled by climate change and environmental degradation, and support a green recovery in the post-pandemic era. In addition, support the construction of carbon markets of the Belt and Road countries, explore the Belt and Road carbon market linkage mechanism, and promote green and low-carbon transition with lower emission reduction costs.

Strengthen the awareness of fairness and inclusiveness in the transition process, and actively promote the just energy transition in the Belt and Road countries. **Firstly**, the Belt and Road countries should formulate their overall strategic plan for just energy transition from the overall strategic system layout, systematically plan the transition goals, technological innovation, talent training and other aspects of each region and industry, and ensure that all citizens share the benefits and costs brought about in the transition process. **Secondly**, for fossil energy and related enterprises that have been negatively impacted during the transition process, a just transition fund should be established, and corresponding subsidies should be given to help them alleviate the economic losses caused by the transition. At the same time, additional technical and talent support should be given to enterprises with transition potential. For the redundant unemployed labor force generated in the transition process, it should be properly resettled and retrained to the sustainable development industry, and they should actively guide alternative industries and emerging industries to create new employment opportunities to fully accommodate and accept this part of populations.

Strengthen the in-depth integration between the Belt and Road Initiative and relevant international cooperation initiatives, to jointly promote the process of low-carbon energy transition in the Belt and Road countries. We should actively promote the in-depth integration between the Belt and Road initiative and the European Union’s “Global Gateway” program and the US’ Build Back Better World initiative and other regional cooperation initiatives, to achieve open cooperation and

exchange in energy transition to a wider and larger field and deeper level. China, the United States, Europe and other parties should increase discussions on energy transition issues in their climate cooperation with the Belt and Road countries, actively share successful experiences and best practices during the process of energy transition, and give full play to their respective strengths in technology, capital, and talent. and other aspects, form a multi-party synergy effect, give full play to multi-party synergy, effectively enhance the capacity building of the Belt and Road countries in energy infrastructure, renewable energy technology, etc., and jointly promote the green and efficient transition of the Belt and Road countries in the energy field, to achieve multi-party mutual benefit and win-win situation.

4 Analysis of Gender Mainstreaming

Gender equality is a fundamental human right, so male and female alike should be treated equally in politics, economy, society, and family, as well as in mitigating and adapting to climate change. Failure to take gender equality into account in tackling climate change and a lack of supporting measures will limit women's full participation and contribution in this regard. What's more, if the perspectives and demands of women are not fully expressed or reflected, the corresponding solutions will not be gender-responsive, which may result in further gender inequality. In climate-related policy-making, not only do we need female leadership and perspectives, but also consider the situations bothering women, such as violence, demands for medical service, weak economic resilience, unpaid housework, etc., so that their predicament wouldn't be neglected because of single perspective. A synergy between gender equality and sustainable development is necessary.

At the 23rd session of the Conference of the Parties (COP23) to the UN Framework Convention on Climate Change in 2017, Parties adopted the Gender Action Plan and asked the Parties, subsidiary bodies, the UN organizations, observers, and other stakeholders to participate in the implementation of the Plan in order to incorporate gender-related issues into each and every aspect of climate action. In February 2020, at the 52nd Plenary Session of Intergovernmental Panel on Climate Change (IPCC), the expert panel adopted Gender Policy and Implementation Plan which aimed to improve gender equality and promote gender-inclusive environment. The Paris Agreement also mentioned gender equality and regarded it as one of the many issues that needed to be considered while taking actions on climate change. In NDCs in 2016, 64 Parties mentioned women or gender. When countries submitted new or updated NDCs, most included a reference to women and gender, indicating improved recognition and willingness to deal with the issue of gender equality in climate action.¹⁶

¹⁶ Quick Analysis—Gender Climate Tracker. <https://genderclimatetracker.org/gender-ndc/quick-analysis>.

Gender equality is part of China's basic national policy. In order to improve women's position and promote gender equality, China attaches great importance to ensuring equal opportunities for women and their equal participation in economic activities, employment, and starting business.¹⁷ In Outline for the Development of Chinese Women (2021–2030), Women and Environment was identified as one of the eight themes. However, China's gender awareness in environment and climate is not prominent enough, and there's still a gap between China and the international community which is experiencing neck to neck development in both gender and environment. Strengthening gender equality considerations and measures in environment and climate will, on the one hand, promote China's progress in realizing gender equality and provide multiplication effect for sustainable development, on the other hand, significantly improve China's international image. In this section, we propose three specific aspects which are major and practical to integrate gender equality and climate action in China.

4.1 Give Full Play to Women's Role as Participants and Facilitators in Climate Work and Enhance Women's Climate Leadership

At the Glasgow Climate Change Conference (COP26) in 2021, Glasgow Women's Leadership Statement¹⁸ was jointly released by the Scottish Government and UN Women, calling for the role of women and girls to be advanced in addressing climate change. Only ten of the 140 heads of delegations at COP 26 were women. Women are underrepresented in global governance systems for climate and environment. In 2020, just 15% of environmental ministers globally were women,¹⁹ and female employees only took up an average of 1/3 in public administration.²⁰ None of the seven leaders of Ministry of Ecology and Environment of the People's Republic of China is female.²¹

¹⁷ Women, U. N. "Gender Dimensions of Vulnerability to Climate Change in China." (2016).

¹⁸ Gender equality and climate change: Glasgow Women's Leadership statement. <https://www.gov.scot/publications/glasgow-womens-leadership-statement-gender-equality-climate-change/>.

¹⁹ Gender Equality Today for a Better Tomorrow. <https://www.cn.undp.org/content/china/zh/home/ourperspective/ourperspectivearticles/2022/gender-equality-today-for-a-better-tomorrow.html>.

²⁰ Gender Equality in Public Administration. <https://www.undp.org/publications/global-report-gender-equality-public-administration>.

²¹ Organization of the Ministry of Ecology and Environment of the People's Republic of China. <https://www.mee.gov.cn/zjhb/>.

Giving full play to women's leadership is vital in alleviating and addressing climate change. Rural areas are highly dependent on natural resources, therefore the impact of climate change bears on the livelihood of local people. Women, as a major part in agricultural production and household labor, are relatively more vulnerable to climate change. And actions on mitigating and tackling climate change will also exert more impact on them. As a group most significantly influenced by climate change, women should be fully represented in decision making of alleviating and addressing climate change. Only by empowering women can we better realize sustainable development and poverty alleviation.

UNFCCC encourages Parties to appoint and provide support for a National Gender and Climate Change Focal Point (NGCCFP) for climate negotiations, implementation, and monitoring. With the support of UNFCCC, NGCCFPs can achieve gender mainstreaming in climate work by the following effort²²:

- Awareness-raising and capacity-building within the delegation and/or at a national level on gender and climate change issues
- Point-of-contact within the delegation for questions on thematic issues e.g., climate finance and gender
- Coordination of the delegation's positions on gender within the gender and climate change agenda item and other thematic areas
- Coordination at the national level for climate planning e.g., between ministries on climate change and those dealing with gender, and to better connect the UNFCCC process to national process
- Participation in networking and capacity-building events organized by other entities in support of the UNFCCC progress e.g., WEDO, UN Women, IUCN etc.
- Point-of-contact for the secretariat (and others) to communicate about relevant events, information, training etc.
- Raising awareness and tracking progress on gender-responsive climate plans and communication (NDCs, NAPs, national communications etc.)
- Tracking progress on the delegation's goals on gender balance at UNFCCC and other meetings
- Advocating for gender balance in the delegation's or Group's nominations to constituted bodies and Bureaux.

NGCCFPs can effectively enhance their nations' capacity building in gender and climate change and help to incorporate gender into climate work. Up to now, 94 Parties have nominated their respective NGCCFP, excluding China. China's nomination of its NGCCFP will be a simple but effective and meaningful step in promoting gender mainstreaming in climate work.

²² Capacity Building and Training Needs of National Gender and Climate Change Focal Points. https://unfccc.int/sites/default/files/resource/NGCCFP_WebinarPPT_ChineseSim.pdf.

4.2 Promote Just Transition, Ensure Women's Equal Participation in Job Market, Achieve Win-Win Results in Low-Carbon Energy Transition and Promotion of Gender Equality

Just Transition is a framework to encompass a range of social interventions needed to secure workers' rights and livelihoods when economies are shifting to sustainable production, primarily combating climate change, and protecting biodiversity,²³ and it has been highlighted in the discussion on energy transition policies. In green transition, Just Transition aims to share the interests of transition and to support those participants who suffer economic loss, be it nations, regions, industries, communities, workers, or consumers. It should be noted that women, as a vulnerable group, are likely to suffer in the transition. In just transition, not only should we pay attention to laid-off workers in phased out industries, but also focus on female group affected by the transition.

Systematic transformation of economic structure is required to realize carbon neutrality, which will in return change the job market in a fundamental way, resulting in both risks of gender inequality and opportunities to promote gender equality. Take conventional industries with high carbon intensity like coal industry as an example. Originally, they are male-dominated industries with men as the major decision makers and labor force. However, the trend to withdraw coal and to develop alternative energy and relevant emerging industries brings about opportunities to reshape women's position in the job market and eliminate the lock-in effect in male-dominated energy sectors. According to the statistics from International Labour Organization (ILO), measures taken by energy sectors to limit global warming to 2 °C by the end of this century will create some 24 million jobs which will to a large extent offset job losses.²⁴ Men and women should have equal access to new jobs in emerging green industries, especially those that haven't been regarded as male arenas, including many technical positions and work related to climate change mitigation and adaptation policies and initiatives.²⁵ We have to make sure that gender inequality in traditional energy and industry sectors will not be shifted to the emerging green economy. Neglecting of gender equality in transition may lead to exacerbated inequality between men and women in job markets and unpaid housework.

To ensure equal job opportunities for women in emerging industries, there should be equal coverage of trainings for both male and female groups in the jobs. Reemployment trainings for former employees from phased out high-carbon industries are of great importance. However, if the reemployment is still male dominated, there will still be risks for male-dominated lock-in effect in the emerging industries. Therefore,

²³ Wikipedia: Just Transition. https://en.wikipedia.org/wiki/Just_transition.

²⁴ Bureau international du travail. World Employment Social Outlook 2018: Greening with Jobs. International labour office, 2018.

²⁵ Pearl-Martinez, R. "Women at the forefront of the clean energy future." Washington, DC: United States Agency for International Development (2014).

unemployed female groups should be equally covered in the trainings. Moreover, we need to promote gender equality education, carry out women's capacity-building programs, and improve the awareness and recognition of women in positions for green transition, especially their leadership positions. Policy and decision makers should make sure there's no gender discrimination whatsoever in policies for employment and capacity development in green positions. Meanwhile, businesses and other organizations should ensure high inclusiveness in recruitment.

Those who lost their jobs because of transition should be settled appropriately. Unemployment and poverty will squeeze space for women to survive and thrive, and a lack of resources and skills will not only force them to take more unpaid household service but also may exacerbate such issues as domestic violence. Just Transition will have positive influence on promoting gender equality from all perspectives, and special attention to female group during the transition will further enhance gender equality construction.

4.3 Take More Account of Social Impact in Overseas Green Investment and Aids, Conduct International Cooperation on Gender Equality, and Give Play to China's Leading Role in Global Climate Governance

Overseas investment and aids have not only an economic impact on the host country, but also significant social and environmental influence. Currently, China's overseas investment and aid projects, especially the green ones, have already had comprehensive consideration and recognition of the environmental impact; however, its understanding and management of the social impact is still at preliminary stage. When it comes to gender, we should focus on preventing harms to women and protecting the basic rights and interests of female workers in the construction of overseas investment and aid projects. Besides, contributions of the projects to bridging income gaps between genders and alleviating unequal social positions should be considered. Taking gender into account in those projects will promote the host country's social development, avoid project risks caused by harm to the vulnerable groups, and is conducive to improving China's international reputation as a responsible power.

So far, climate finance has taken little account of gender. Only 1.5% of climate-related ODA identified gender equality as a primary objective, while 2/3 of the projects and plans failed to consider gender equality in design, budget, and implementation. And only 0.2% of the ODA realized women's leadership and established women's organizations.²⁶ In China, however, there hasn't been any official policies or guidance in this regard.

In China's overseas green investment and aid projects, gender mainstreaming should be integrated into project objectives or evaluation indicators. At early stage,

²⁶ CLIMATE FINANCE SHADOW REPORT 2020. <https://oxfamlibrary.openrepository.com/bitstream/handle/10546/621066/bp-climate-finance-shadow-report-2020-201020-en.pdf>.

we should at least adhere to the principle of “do-no-harm”, i.e., to identify and avoid negative impact related to gender caused by the projects, and compensate for unavoidable impact; for example, we should avoid employment discrimination and unequal payment, avoid exacerbated inequality in men’s and women’s positions as well as gender-based violence. At later stage, we should take account of the projects’ contribution to promoting gender equality (do-good), for example, promoting equal employment, equal pay for equal work, equal right of speech and decision-making, as well as equal possibilities for individual development, etc.

5 Policy Recommendations

5.1 Synergistically Promote Steady Growth and Green Development, Inject New Drivers into China’s Economic Growth

First, remain committed to the overall strategy of green development, especially under the complicated and evolving international and domestic situations. Jointly pursue the goals of economic growth, energy security, environmental quality, climate protection, etc. A new Industrial Revolution based on low-carbon energy technology will be a breakthrough to jointly achieve green development and stabilized growth. The conventional tools to boost the economy based on projects with high energy consumption and high emission should come to an end. Instead, we should give full play to China’s advantages from its systems and institutions, market scale and economic resilience, as well as in new energy equipment manufacturing. Concrete efforts should be made in expanding green investment and consumption in such areas as the digital upgrading and green transformation of traditional industries, green and low-carbon urbanization and consumption, renewable energy, new power system construction and so on, so that investment related to carbon neutrality can be stimulated and provide significant momentum for economic growth by the middle of this century (direct investment in China’s carbon neutrality will reach at least 140 trillion RMB by 2050).

Second, remove the barriers to green growth investment and make them the new economic drivers for development in the short, mid, and long run. In the short term, we should prevent and control the epidemic in a well-targeted and scientific way, and actively expand green consumption through measures like financial support and consumption policy reform. Infrastructure investment in such areas as new energy can be made in advance in a moderate manner to drive economic growth. In the mid and long term, we should clarify emission reduction goals in different phases, set up stable expectations for investors and technology developers, accelerate the establishment of carbon pricing system, and guide investment towards emission reduction.

5.2 Accelerate Low Carbon Energy Transition Under the Premise of Energy Security

First, accelerate the investment in the construction of the new energy system (especially new power systems) with renewable energy as the key. Pilot projects and application of integrated energy systems should be sped up in different regions, which focus on renewable energy and integrate “power supply, power grid, power load, energy storage and utilization”. Further research in pilot projects and solutions “integrating wind, solar, hydro energy, and storage” should be explored to solve problems such as insufficient consumption within the province and uneven power transmission to surrounding regions, lacking coordinated power grid development in different regions, poor price transmission mechanism. Policies should be formulated to further reduce the cost for renewable energy sector, and enhance support for renewable energy development in terms of land assignment, IPO fast-tracking, targeted lending and reduction of the required rate of return. When it comes to investing in projects contribution to a stable growth in 2022, the priority should be given to renewable energy investment.

Second, guide the gradual and orderly phase out of coal power whose role in power system should shift from base-load power generation to peak-management power generation. Based on eliminating outdated production capacity, the existing coal power should be flexibly transformed so that most of the coal-fired power plants can withdraw in a stable way after operating for a reasonable period (20 or 30 years). Lessons learnt can be drawn from the international community (e.g., Germany and the UK) and guide the orderly withdrawal of coal power through market-oriented mechanisms. A bidding mechanism for power supply to the grid can be established to break the system of guaranteed of power generation hours and fixed power price for coal power units. And a spot market for power can be set up to provide economic returns for its flexibility service. We should also improve the construction of carbon market in China and guide the phase out of coal power by higher carbon price. In a nutshell, we should stabilize the stock of coal power and strictly control its increase.

Third, improve the green electrification degree of end-users. We should at least align our electrification goals with those of Europe and the U.S. or set even higher targets so that some Chinese industries (e.g., EV and renewable energy) which have overtaken the West can maintain their competitive edge. As the price of raw materials has soared (the price of lithium carbonate, the main material for battery, jumped ten times within a year), extending the industrial chain (e.g., car manufacturers and battery plants can set up joint ventures in the upstream) and enhancing battery recycling and reuse will ensure supply and help stabilize price.

5.3 Resort to Legal, Economic, and Administrative Measures to Establish Efficient and Coordinated Policy Systems and Institutional Mechanisms for Carbon Peaking and Carbon Neutrality

First, system development should adhere to the principle of “construction before destruction”, and the system for “dual control” of aggregate energy consumption and energy consumption intensity should be more carbon-reduction oriented. Schedules and roadmaps of “dual control” system for carbon emission are required. According to goals set for carbon peaking and carbon neutrality, absolute carbon emission objectives for each stage of the path towards carbon neutrality are needed, and a dynamic regulatory mechanism should be set up. The decomposition of carbon emission targets should take into consideration the development gaps among regions and industries, the flow of products among different regions, and the security of industrial supply chain. The “dual control” system for carbon emission should be incorporated into the provincial, municipal, and industrial action plans for carbon peaking and carbon neutrality. Carbon emission “dual control” pilot projects should be conducted as soon as possible in key areas and key industries before they are gradually promoted to the whole industry and the whole country.

Second, accelerate the establishment of legal and institutional systems centered on the absolute control of carbon emissions; built upon supporting systems such as carbon emission permits, carbon emission allowance trading, carbon emission information disclosure, carbon emission accounting report, carbon emission supervision and inspection, and carbon emission dispute settlement; and covering flexible execution mechanisms like clean development mechanism and voluntary emission reduction. Meanwhile, the formulation and revision of relevant laws should be put in place coordinately so as to achieve a systematic management of absolute carbon emission.

Third, coordinate the promotion of pollution reduction and carbon reduction, and make sure that the measures for pollution reduction and carbon reduction are highly aligned. We should focus on “dual high” regions and industries with high air pollutants emission and carbon dioxide emission, and strive for collaborative governance.

Fourth, establish a cohesive mechanism for absolute carbon emission control system and carbon trading market system, and improve the mechanism for carbon pricing. Accelerate the coordination and unification of carbon market, energy consumption rights market and green power market.

Fifth, strengthen the organizational leadership of the central leading group for carbon peaking and carbon neutrality, and improve its institutionalization and mainstreaming level in execution capacity as well as the overall planning and coordination ability. The intricate relation between carbon peaking and carbon neutrality and the social and economic development, should be made fully aware by enhancing communication and coordination among different departments, as well as coordinating international and domestic affairs in order to ensure alignment and coherence in policy directions and processes.

5.4 Lead Overseas Green Investment, Enhance International Cooperation and Trade in Low-Carbon Technologies, and Maintain a Resilient Supply Chain

First, actively support the Belt and Road Initiative countries in their low-carbon infrastructure construction, and strive to coordinate and connect with other international initiatives such as the Global Gateway by the EU and Build Back Better World by the U.S. in order to form synergies and jointly facilitate the low-carbon energy transition in BRI countries.

Second, make full use of the existing regional, multilateral, and bilateral cooperation mechanisms, enhance dialogues and exchanges among countries and regions, improve negative list system for overseas investment, and highlight climate and environment factors in policies for overseas investment and financing. By adopting such emerging concepts and tools as transition finance, we can help ensure the BRI countries to upgrade their conventional industries while ensuring a just and fair transition. Debt reconversion like “Debt for Nature Swap” should be explored so that vulnerable countries struggling with climate change and environmental deterioration can be funded to support green recovery in the post-pandemic era.

Third, summarize China’s successful experience and best practice in climate change and low-carbon transition, analyze its applicability in the BRI countries, and provide those countries with low-carbon transition experience and targeted guidance in accordance with their own conditions.

Fourth, pay attention to the progress in setting up a new round of green standards and trade systems in developed economies like the EU and the U.S., speed up the formulation of mid and long-term development strategies and policies for green supply chain in China, accelerate the development and improvement of green and low-carbon standard systems for key products in China, and explore mutual recognition and unification with global green and low-carbon standard systems in order to safeguard the stability and security of supply chains in China, and contribute Chinese Wisdom to the establishment of global green supply chain systems.

5.5 Enhance International Cooperation on Climate, and Promote Pragmatic and Balanced Progress in International Climate Governance

First, maintain the global climate governance framework based on the UN Framework Convention on Climate Change and the Paris Agreement, and promote pragmatic international cooperation on climate. Facilitate the implementation of the Paris Agreement, promote the execution of the COP 26 decision, and strive for breakthrough in such key issues as climate finance, technology, etc. We should take continuous and concrete actions to tackle climate change, promote comprehensive

green transition and global cooperation on carbon neutrality so that we can make constructive contributions to global climate governance.

Second, facilitate synergy between climate change tackling and relevant multi-field governance, and promote implementation of the UN 2030 Agenda for Sustainable Development. Make joint efforts to strike a balance between energy security, carbon reduction, and development, and focus on the impact of various crises such as energy, food, and supply chains on global climate governance. Promote the integration of global climate governance with overall global development initiatives, and drive the world to respond to the multiple global goods crises in a systematic manner that prevents systemic risks.

Third, continue to promote bilateral and multilateral dialogues and cooperation on climate. Actively move forward with the establishment of Sino-US Working Group for Enhancing Climate Action in the 2020s and the relevant work, strengthen climate cooperation and communication with the EU. Actively conduct Track II dialogues and exchange on climate, and create opportunities for Track 1.5 dialogue so as to enhance mutual trust, avoid miscalculation, and boost the establishment of policy linkage mechanisms.

Appendix

Schedule 1: Goal or Plans for Coal Exit and Reduction in Part of the Belt and Road Countries

Region	Country	Policy/Meeting/Event/Report	Coal exit and reduction goals/Plans
Asia	China	Leaders Summit on Climate	Strictly control coal-fired power projects; control the growth of coal consumption during the 14th Five-Year Plan period; and achieve gradual decrease of coal consumption during the 15th Five-Year Plan period
		The 76th Session of the UNGA	No new overseas coal-fired power projects will be built to support green and low-carbon energy development in developing countries
		The Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy	Promote coal consumption substitution, transformation and upgrading, and accelerate the pace of coal reduction

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Region	Country	Policy/Meeting/Event/Report	Coal exit and reduction goals/Plans
		The Action Plan for Carbon Dioxide Peak before 2030	
	Korea	Leaders Summit on Climate	Stop funding coal-fired power plants overseas
		The 9th Basic Plan for Power Supply and Demand (BPLE) (2020–2034)	Close all coal-fired power plants by 2034
		Global Coal to Clean Power Transition Statement	Stop building and licensing coal-fired power plants in domestic and phase out coal gradually
	Singapore	The Powering Past Coal Alliance	Phase out coal-fired power plants with no emission reduction by 2050 and limit direct financing to coal-fired power projects with no emission reduction
	Indonesia	PLN's 2021–2030 Electricity Supply Business Plan (RUPTL)	Cancel or delay the construction of the planned new plants with capacity of up to 15.5 GW, of which only about 2.3 GW are from renewable energy projects
		Global Coal to Clean Power Transition Statement	Stop building and licensing coal-fired power plants in domestic and phase out coal gradually
		China Policies and Regulations on Energy No. 79/2014	In 2025, coal supply will account for a minimum of 30% of primary energy supply, and a minimum of 25% in 2050
	Bangladesh	South and Southeast Asia's Last Coal Plants	In November 2020, Bangladesh's Ministry of Energy formulated a plan to cancel all coal-fired power plant projects not under construction, which will effectively cancel the 22.9 GW planned coal-fired power; however, Bangladesh has not committed to abandoning the use of coal as renewable energy is currently unable to meet the electricity demands of its large population

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Region	Country	Policy/Meeting/Event/Report	Coal exit and reduction goals/Plans
	Vietnam	Power Development Plan 8 (PDP8)	The proportion of coal-fired power will drop to 40% in 2030 and further to 30% in 2045
		Global Coal to Clean Power Transition Statement	Stop building and licensing coal-fired power plants in domestic and phase out coal gradually
	Philippines	Boom and Decline 2021—Global Coal Plant Tracker	In October 2020, the Philippine Department of Energy announced a moratorium on new coal-fired power plants that have not yet entered the approval process
	Pakistan	Climate Ambition Summit	No more new coal-based power projects will be built
Europe %	Italy	Global Status of Coal-fired power—Pre-Covid19 Baseline Analysis	Phase out all coal-fired power plants by 2025
	Portugal		Phase out all coal-fired power plants by 2023
	Greece		Phase out all coal-fired power plants by 2030
	Hungary		
	Slovenia		
	Poland	Global Coal to Clean Power Transition Statement	Stop building and licensing coal-fired power plants in domestic and phase out coal gradually
		Energy Policy of Poland until 2040 (EPP2040)	The proportion of coal-fired power will account for no more than 56% by 2030
Ukraine	Global Coal to Clean Power Transition Statement	Stop building and licensing coal-fired power plants in domestic and phase out coal gradually	
South America	Chile	No New Coal-fired power Compact	No more new coal-fired power plants will be built
		Phasing out Unabated Coal	Phase out all coal-fired power plants by 2040
Africa	South Africa	Boom and Decline 2021—Global Coal Plant Tracker	South Africa cancelled coal-fired power projects with capacity of 3.8 GW in 2020

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Region	Country	Policy/Meeting/Event/Report	Coal exit and reduction goals/Plans
	Egypt	Boom and Decline 2021—Global Coal Plant Tracker	Egypt had shelved or cancelled a total of 15.2 GW of planned new coal-fired power projects by 2021

Schedule 2 Renewable Energy Development goals or Plans in Part of the Belt and Road Countries

Region	Country	Policy/Meeting/Event/Report
China	The Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy	The proportion of non-fossil energy consumption will reach about 20% by 2025; about 25% by 2030; and above 80% by 2060
	The Action Plan for Carbon Peaking before 2030	
	Guidance on Energy Work in 2022	In 2022, the proportion of non-fossil energy in total energy consumption will increase to about 17.3%, and the proportion of wind power and photovoltaic power in the total electricity consumption will reach about 12.2%
	The 14th Five-Year Plan for Modern Energy System	By 2025, the proportion of non-fossil energy consumption will increase to about 20%, and the proportion of non-fossil energy power generation will reach about 39%; the installed capacity of conventional hydropower will reach about 380 million kW
Korea	The 9th Basic Plan for Power Supply and Demand (BPLE) (2020–2034)	It is planned that by 2034, the installed capacity of renewable energy power generation will reach 40%
Indonesia	PLN's 2021–2030 Electricity Supply Business Plan (RUPTL)	By 2030, 40.6 GW of new power generation capacity will be added, which will include 20.9 GW of renewable energy projects accounting for 51.6%. Among them, renewable energy will account for at least 23% and at least 31% of the overall energy structure of the industry in 2025 and 2050, respectively, and at least 23% and 28% of the power energy structure in 2025 and 2050, respectively

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Region	Country	Policy/Meeting/Event/Report
	China Policies and Regulations on Energy No. 79/2014	New and renewable energy will account for at least 23% of the primary energy supply in 2025 and at least 31% in 2050
Malaysia	Peninsular Malaysia Generation Development Plan 2019 (2020–2030)	The proportion of renewable energy generation will reach 20% by 2025
Philippines	Philippine Energy Plan Towards a Sustainable and Clean Energy Future (2020–2040)	Renewable energy will account for at least 35.0% of the total power generation mix by 2030, and further achieve a proportion of more than 50% by 2040
	PHILIPPINES: National Climate Change Action Plan (NCCAP) 2011–2028	Increase hydropower capacity from 3478 MW in 2010 to 7534 MW in 2030, wind power capacity from 33 MW in 2010 to 1018 MW in 2030, and solar power capacity from 6.74 MW in 2010 W to 85 MW in 2030, biomass power generation capacity from 75.5 MW in 2010 to 93.9 MW in 2030
Thailand	Power Development Plan of Thailand 2018–2037	Raise the share of renewable power generation to a goal of 30% by 2037, which will require an additional 56,431 MW of renewable power generation capacity
	Alternative Energy Development Plan 2018–2037 (AEDP 2018–2037)	Increase the proportion of renewable and alternative energy sources (in the form of electricity, heat and biofuels) by 30% by 2037
Vietnam	Power Development Plan 8 (PDP8)	Renewable energy will account for 32% of the power generation mix in 2030, 40.3% in 2040, and 43% in 2050
	National Energy Development Strategy to 2030 with vision to 2045	Renewable energy will account for 15–20% of the energy mix by 2030 and 25–30% by 2045
Italy	Integrated National Energy and Climate Plan	By 2030, renewable energy will account for 30% of the total terminal energy consumption; and the proportion of renewable energy is 55% in the power sector, 33.9% in the heating sector (heating and cooling), and 22% in the transportation sector
Poland	Energy Policy of Poland until 2040 (EPP2040)	Renewable energy will account for at least 23% of the terminal energy consumption, of which its proportion in the power industry will be at least 32% by 2030

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Region	Country	Policy/Meeting/Event/Report
Portugal	National Energy and Climate Plan of Portugal for 2021–2030	Renewable energy will account for 47% of the overall energy consumption, and about 80% of the electricity comes from renewable energy, of which 20% of the energy consumption in the transportation sector comes from renewable energy
Greece	National Energy and Climate Plan of Greece for 2021–2030	By 2030, renewable energy will account for at least 35% of the end energy consumption and account for at least 60% of the final power consumption
Panama	Panama First NDC (Updated submission)	30% of electricity will be produced with renewable energy sources such as wind and solar by 2050
Cuba	Cuba First NDC (Updated submission)	Renewable energy (RES)-based power generation in Cuba's electricity matrix will reach 24% by 2030
Morocco	Morocco First NDC (Updated submission)	By 2030, 52% of installed power generation capacity will come from renewable energy, of which 20% will come from solar, 20% from wind and 12% from hydro
Zimbabwe	System Development Plan 2017	By 2025, the scale of solar power generation will be expanded to 300 MW
Chile	Energy Compact	The participation rate of renewable energy in national power generation by 2030 will be 40% and it will become one of the largest exporters of green hydrogen in the world with cheapest green hydrogen by 2030
Uruguay	Uruguay First NDC (Updated submission)	If conditions are limited, the installed capacity of wind, solar and biomass power generation will reach 1450 MW, 220 MW and 160 MW, respectively by 2025, accounting for 32%, 5% and 4% of the installed capacity of the national grid system, respectively. If conditions allow, the electricity storage technology will be introduced, including electricity storage and pumping systems. Specifically, the installation capacity will be 300 MW by 2025, and the water source technology for power generation (small hydropower plants) will be popularized and the installed capacity will be 10 MW by 2025

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