Launch of the Outcome of the Research on China's Long-term Low-carbon Development Strategy and Pathway

Institute of Climate Change and Sustainable Development

Tsinghua University

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1. Context, topics and research framework——Context

- **The goal and the key strategies of achieving socialist modernization by 2050 was put forth at the 19th National Congress. Therefore, it is urgent to research and develop the long-term low-carbon development goals and strategies to address climate change and incorporate them into the overall strategy for national socio-economic development.**
- **To provide technical support for the low-term low GHG emission development strategy for the middle of this century which the Chinese government is going to submit in 2020 under the Paris Agreement; to study and demonstrate China's 2050 low-carbon development goals and pathways that are aligned with the long-term goals under the Paris Agreement.**
- **The Institute of Climate Change and Sustainable Development (ICCSD) at Tsinghua University has led more than a dozen major Chinese research organizations to study China's long-term low-carbon development strategy and pathways under a total of 18 topics.**

1. Context, topics and research framework——Topics and research teams (1)

Topic 1: Mid and long-term goals, strategies, and pathways of China's socioeconomic development, Zhu Baoliang, the State Information Center.

Topic 2: Coordinated economic development of eastern, central, and western China, and low-carbon development strategies and pathways in the process of urbanization, Pan Jiahua, Institute for Urban and Environmental Studies of Chinese Academy of Social Sciences.

Topic 3: Impacts and measures of global trade and industrial relocation on China's low-carbon development under globalization, Gu Xueming, Chinese Academy of International Trade and Economic Cooperation of Ministry of Commerce.

Topic 4: Mid- and long-term strategies and pathways of China's energy system transformation, Wang Zhongying, Energy Research Institute of National Development and Reform Commission.

Topic 5: Optimized composition and technology roadmap of power source and power grid, Li Zheng, Department of Energy and Power Engineering of Tsinghua University.

Topic 6: China's mid- and long-term energy conservation potentials, goals, policies and cost-benefit analysis, Dai Yande, Energy Research Institute of National Development and Reform Commission.

Topic 7: China's mid- and long-term emission reduction technology evaluation, cost-benefit analysis and technology roadmaps, Wang Can, School of Environment of Tsinghua University.

Topic 8: Transformation and upgrading of China's industrial sector and low-carbon emission strategies and pathways, Bai Quan, Energy Research Institute of National Development and Reform Commission.

Topic 9: Low-carbon emission strategies and pathways of China's building sector, Jiang Yi, School of Architecture of Tsinghua University.

1. Context, topics and research framework——Topics and research teams (2)

Topic 10: Low-carbon emission strategies and pathways of China's transport sector, Ouyang Bin, China Academy of Transportation Sciences of Ministry of Transportation

Topic 11: Study on investment strategies of China's mid- and long-term energy infrastructure transformation and development, Kang Yanbing, Energy Research Institute of National Development and Reform Commission.

Topic 12: Measures and pathways for consumption transformation and low-carbon society construction, Jia Feng, Department of Communications and Education of Ministry of Ecology and Environment.

Topic 13: Strategies, measures and pathways for China's non-energy-related CO_2 and other GHGs reduction, and carbon sink increase in AFOLU, Institute of Energy, Environment and Economy of Tsinghua University, Teng Fei

Topic 14: Coordinated measures and effect analysis of China's GHG emissions reduction and environmental governance, He Kebin, School of Environment of Tsinghua University.

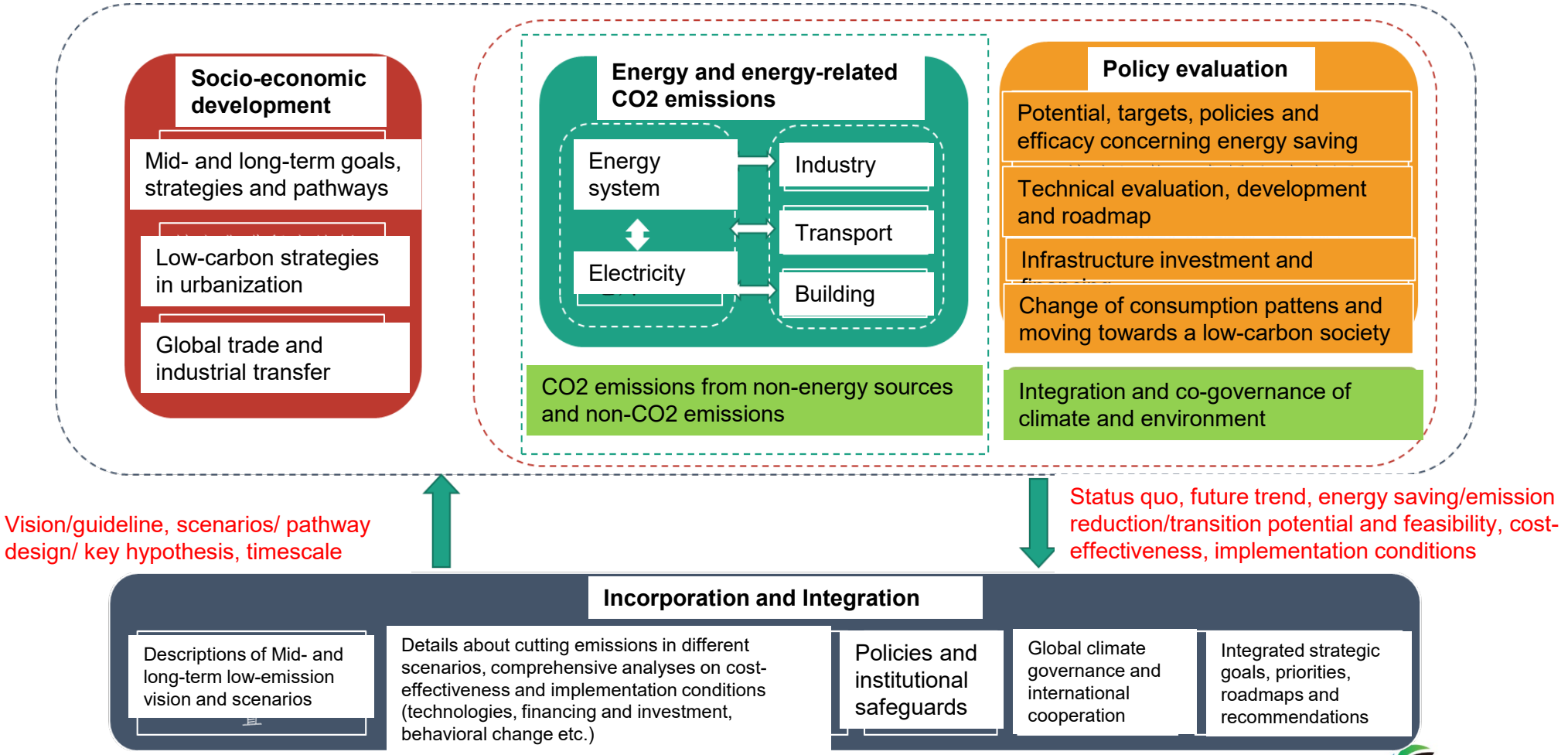
Topic 15: Building policy and institutional safeguard system for China's long-term low-carbon development, Wang Yi, Institutes of Science and Development of Chinese Academy of Sciences.

Topic 16: Strategies and measures in China's promotion of global climate governance and international cooperation, Xu Huaqing, National Center for Climate Change Strategy and International Cooperation.

Topic 17: Scenario analysis and pathways for China's mid- and long-term low-carbon development, Zhang Xiliang, Institute of Energy, Environment and Economy of Tsinghua University.

Topic 18: Comprehensive report on China's long-term low-carbon development strategy and pathway, He Jiankun, Institute of Climate Change and Sustainable Development of Tsinghua University.

1. Context, topics and research framework ——research framework



2. Guidelines and overall design (1)

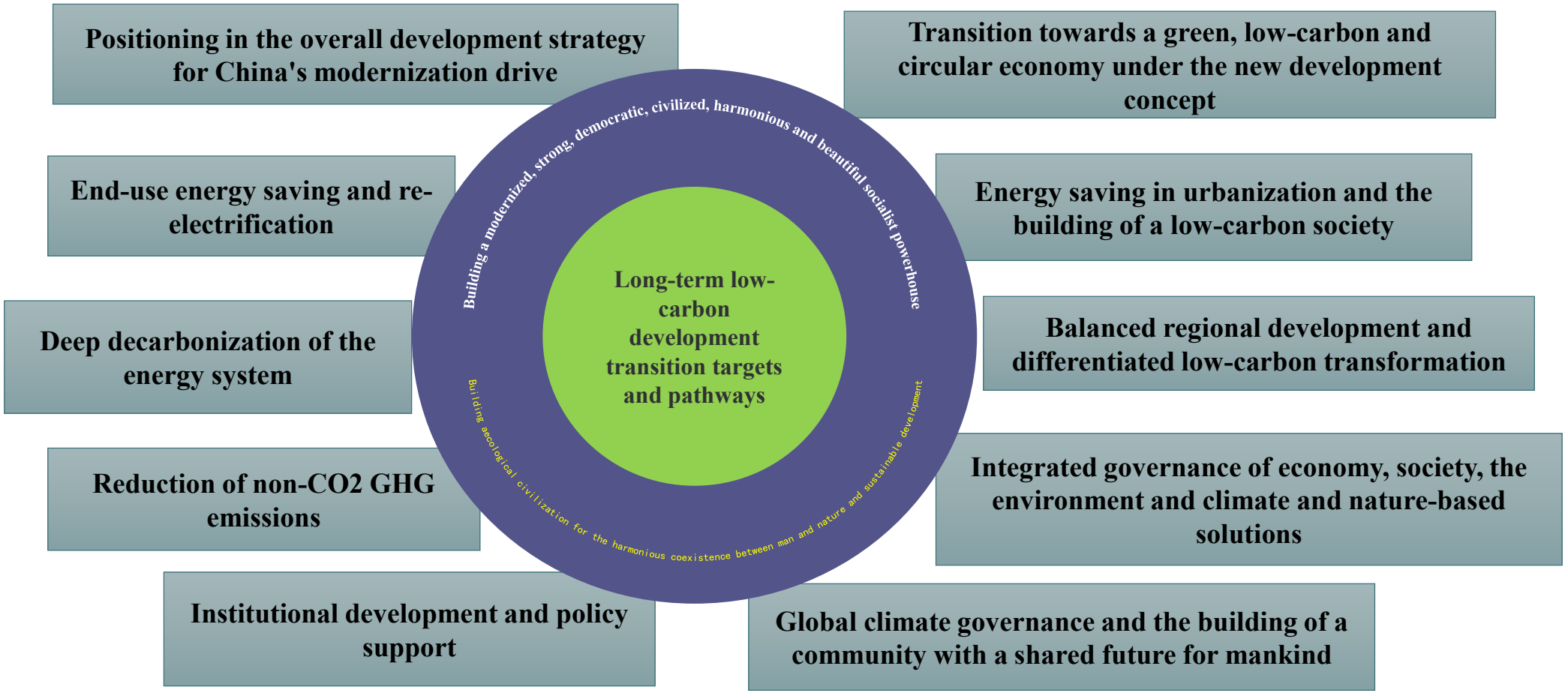
(1) A comprehensive development strategy

A long-term low-carbon development and transition strategy should be an integrated win-win strategy that seeks to balance the sustainable socio-economic development at home and the global fight against climate change. It should adapt to and lead the global trend of low-carbon development and transition, and strengthen the country's competitive advantage.

A long-term low-carbon development and transition strategy must be developed within an overall framework and supported by strategies and actions in all areas, which is an important part of the overall long-term national development goals and strategies.

The takeaways from the European Green Deal: The EU's low-carbon emission strategy is a "new growth strategy" first and foremost, which aims to promote social equity and prosperity, economic modernization, net-zero carbon emissions, resource efficiency and competitiveness in Europe by 2050. It also aims to push economic growth towards a more sustainable path, making the EU lead the world in sustainable transition.

2. Guidelines and overall design (1)



Strategic framework to pull off the long-term low-carbon transition

2. Guidelines and overall design (2)

(2) Attaining two goals at the same time

- **To realize the goals, basic strategies and key targets of socialist modernization in the new era, and to build a strong socialist modernized China as well as a beautiful China in 2050.**
- **To realize the emission reduction pathway under the Paris Agreement to limit the global temperature rise within 2°C while striving to achieve the emission reduction pathways under the 1.5 °C target, hence contributing to the endeavor of building a global ecological civilization.**

With the rapid economic development, the improvement of the environment at home and rising international influence, strengthening the target of deep CO_2 emission reduction is becoming more and more important in China.

2. Guidelines and overall design (3)

（3） Four scenarios

- **Policy scenario，** implementing and carrying on with the 2030 NDC targets;
- **Reinforced policy scenario，** strengthening the prior-2030 NDC scenario from bottom up and stepping up the emission reduction efforts.
- **2°C scenario,** achieving an emission reduction scenario aligned with the global 2°C target by 2050, with per capita CO_2 emission no higher than 1.5 metric tons.
- **1.5°C scenario,** achieving net zero CO_2 emissions and deep reductions of other GHGs by 2050.

The latter two scenarios highlight the emission reduction pathways driven by the long-term goals

2. Guidelines and overall design (4)

(4) Two-phased strategies

- In 2030 and 2035, guided by the goals of the Phase 1 modernization drive (socialist modernization is basically realized, there is a fundamental improvement in the environment; the goal of building a Beautiful China is basically attained), China must strengthen the low-carbon development policy, implement and reinforce the NDC targets, and achieve the "policy scenario" and “reinforced policy scenario".
- In 2050, while ensuring the realization of the goals of building a strong modernized socialist country and a beautiful China vision, China should align emission reduction pathways with global warming control targets of 2°C and 1.5°C.

2. Guidelines and overall design (5)

(5) Policy recommendations on 3 areas

- Recommendations for energy conservation and carbon reduction targets and policies in the 14th Five-Year Plan
- Recommendations for strengthening and updating the 2030 NDC targets
- Recommendations for China's goals and strategies for long-term low-emission development by 2050

Which happen to be the 3 areas the international community is following with great interest

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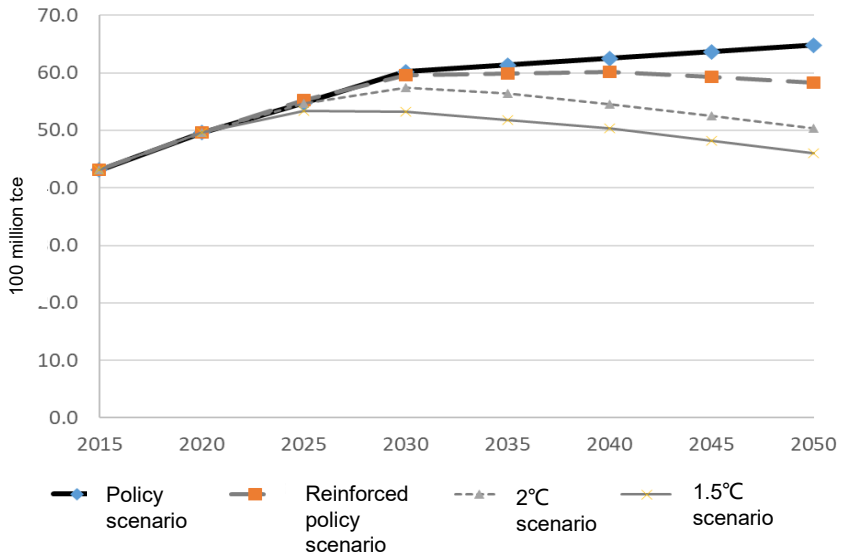
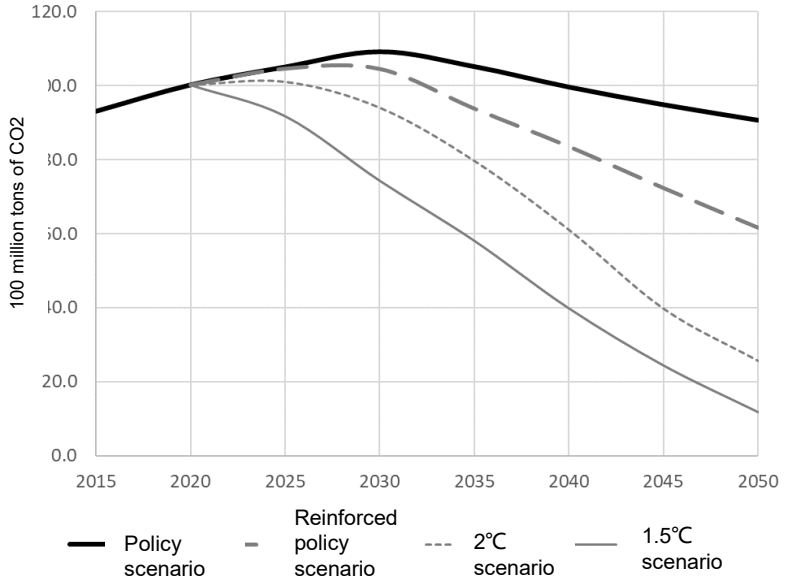
3. Several low-emission development and transition scenarios (1)

Energy demand from 2015 to 2050



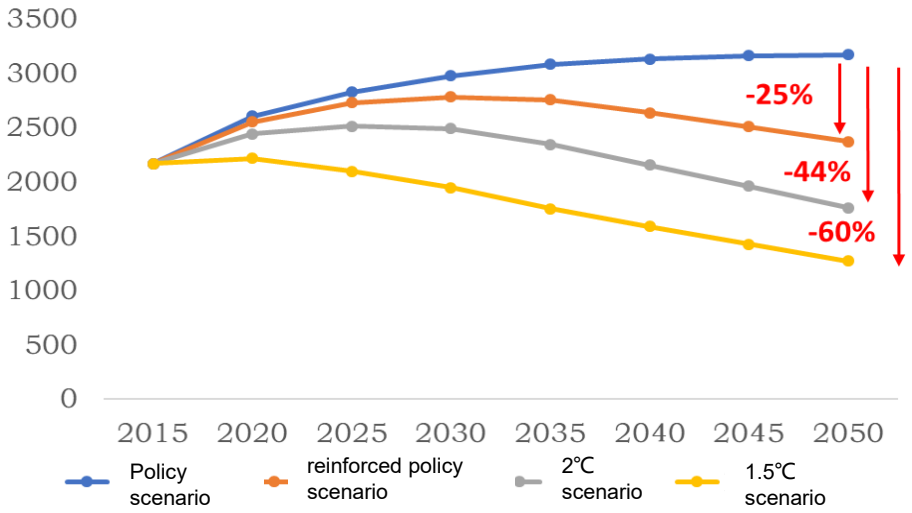
CO_2 emissions from 2015 to 2050



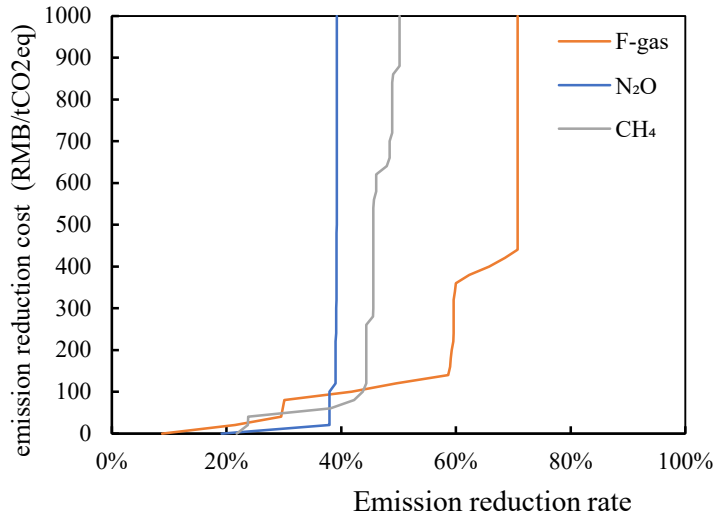
- **Policy scenario**: primary energy consumption will stabilize to about 6.2 billion tce by 2050, CO_2 emission will be about 9 billion tons.
- **Reinforced policy scenario:** primary energy consumption will be about 5.6 billion tce by 2050, CO_2 emission will be about 6.2 billion tons.
- **2°C scenario:** primary energy consumption will be about 5.2 billion tce by 2050, energy-related CO_2 emissions will be 2.9 billion tons, net CO_2 emission will be about 2 billion tons (taking into account industrial process emissions, CCS and agroforestry carbon sinks).
- **1.5°C scenario:** primary energy consumption will be about 5 billion tce by 2050, energy-related CO_2 emissions will be 1.4 billion tons, net CO_2 emission will reach zero (taking into account industrial process emissions, CCS and agroforestry carbon sinks).

3. Several low emission development and transition scenarios (2)

- **Non-CO2 emissions under different scenarios(million tCO2e)**



Non-CO2 emission reduction marginal cost curve (2050)

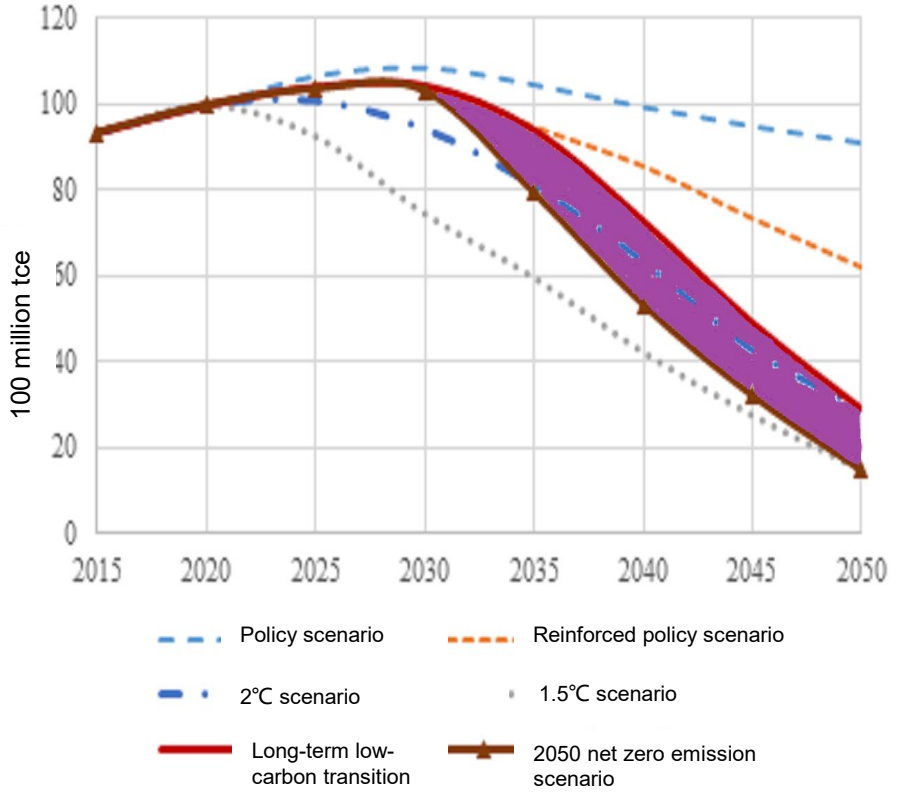


Unit：100 million tCO2e	2015	2020	2030	2040	2050
Policy scenario	21.68	26.02	29.73	31.31	31.70
Reinforced policy scenario	21.68	25.49	27.81	26.33	23.67
2℃ scenario	21.68	24.42	24.87	21.53	17.61
1.5℃ scenario	21.68	22.13	19.44	15.87	12.71

- The initial cost of non-CO_2 GHG reductions is low. But there is lack of effective technical support for deep emission reductions. As a result, the cost will be on a steep upward trend, making it the crux to achieve the goal of carbon neutrality.

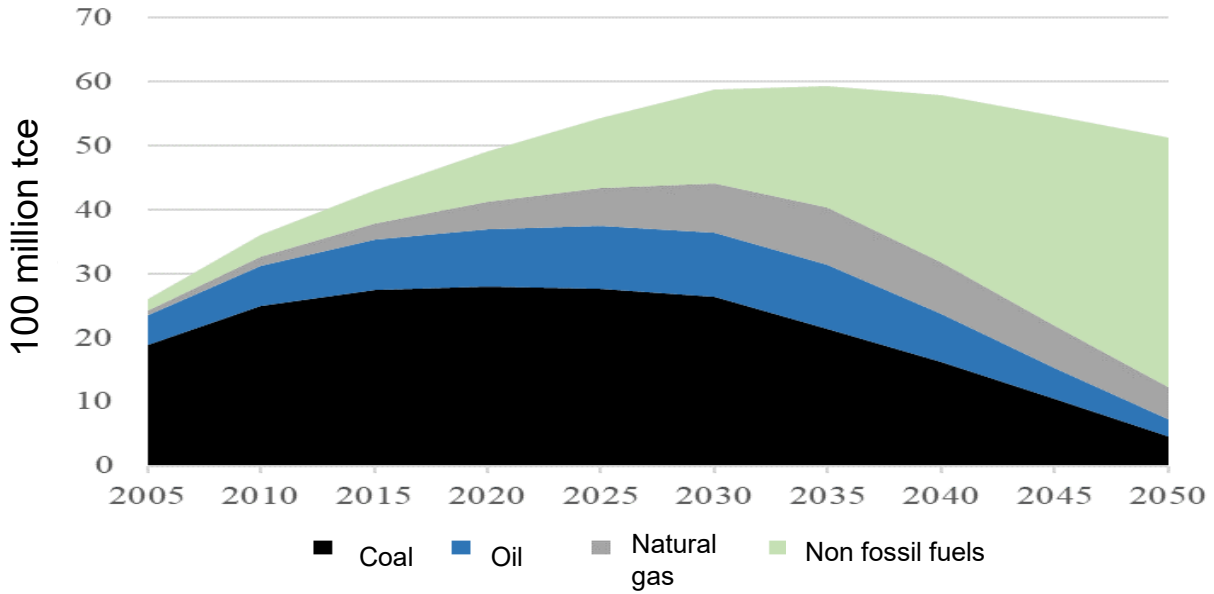
4. China's long-term low-carbon development goals and the choices of pathways

- If we carry on policy scenario and follow the reinforced policy scenario, an emission reduction pathway aligned with the global 2°C target will no longer be achieved in 2050.
- The inertia in the current energy and economic systems makes it difficult to quickly achieve the emission reduction pathway in the 2°C and 1.5°C scenarios.
- China's long-term low-carbon emission pathway - transitioning from the policy scenario to the 2°C and 1.5°C target scenarios.
- Striving to peak CO_2 emissions by 2030 and speeding up the transition towards the 2°C and 1.5°C emission reduction pathways.



5. Pathway for long-term low carbon transition under the 2℃ scenario (1)

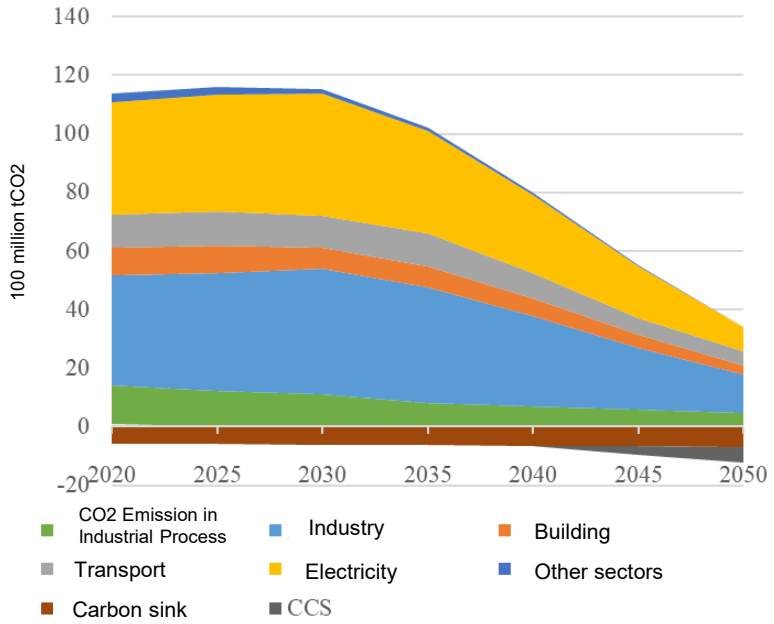
- Primary energy consumption and its mix in the long-term low-carbon development pathway



- Primary energy consumption after 2030 will have reached the plateau and begun to drop, till 5.2 billion tce in 2050 or so; in 2050 the share of coal will fall to less than 10%; non-fossil energy will account for more than 70%; the share of electricity generated by non-fossil sources in total electricity generation will increase from the current level of 32% to about 90%.
- The share of primary energy used for power generation, currently about 45%, will exceed 50% in 2030, and reach about 75% in 2050. The share of electricity in total end-use energy consumption will increase from about 25% at present to about 55%.

5. Pathway for long-term low carbon transition under the 2℃ scenario (2)

Total CO_2 emission and sources under the 2℃ scenario



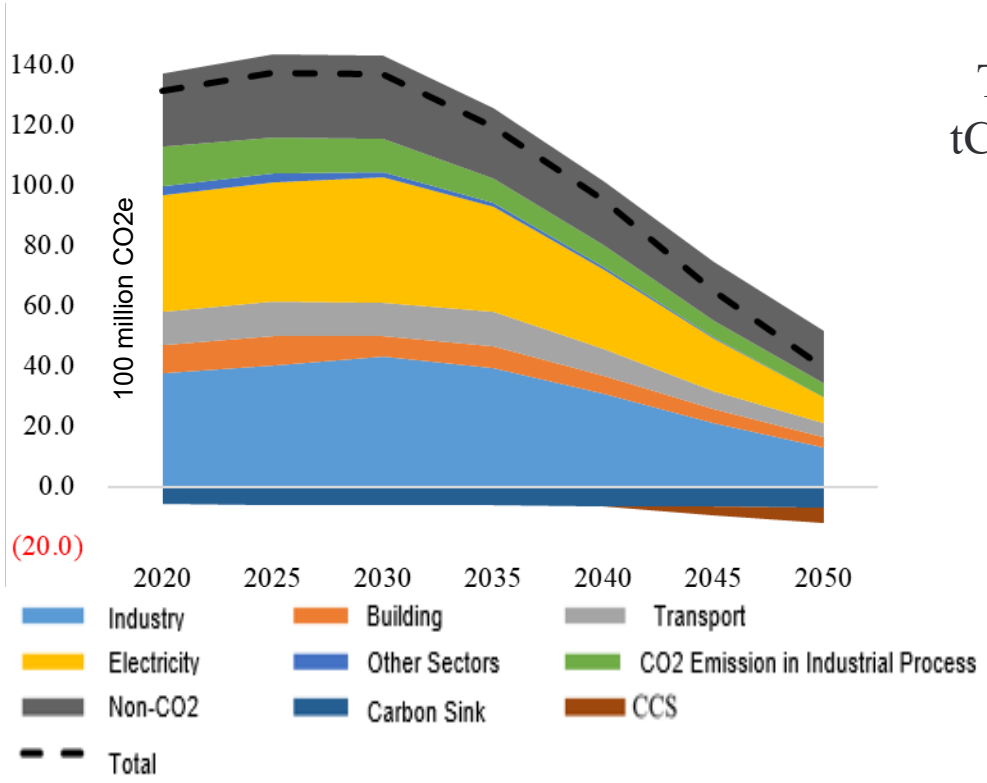
Total CO2 emissions and the sources under 2°C target (100 million tons)

	2020	2030	2050
CO2 emission in energy consumption	100.3	104.6	29.2
CO2 emission in industrial process	13.2	9.4	4.7
CCS+BECCS	0.0	0.0	-5.1
Carbon sinks	-5.8	-6.1	-7.0
Net carbon emissions	107.7	107.9	21.8

- By 2050, the total CO2 emissions will have included 2.92 billion tons from energy-related consumption, 470 million tons from industrial processes, 510 million tons from BECCS and 700 million tons from carbon sinks, resulting in net CO2 emissions of 2.18 billion tons, a decrease of 80 %from the peak year.
- Current energy-related CO2 emissions are mainly from the industrial sector and the power sector, each accounting for about 40%. By 2050, excluding CCS and carbon sinks, the two sectors will still have contributed 41 % and 28% emissions, respectively.

5. Pathway for long-term low-carbon transition under the 2°C scenario (3)

- Total net GHG emissions under the 2°C target



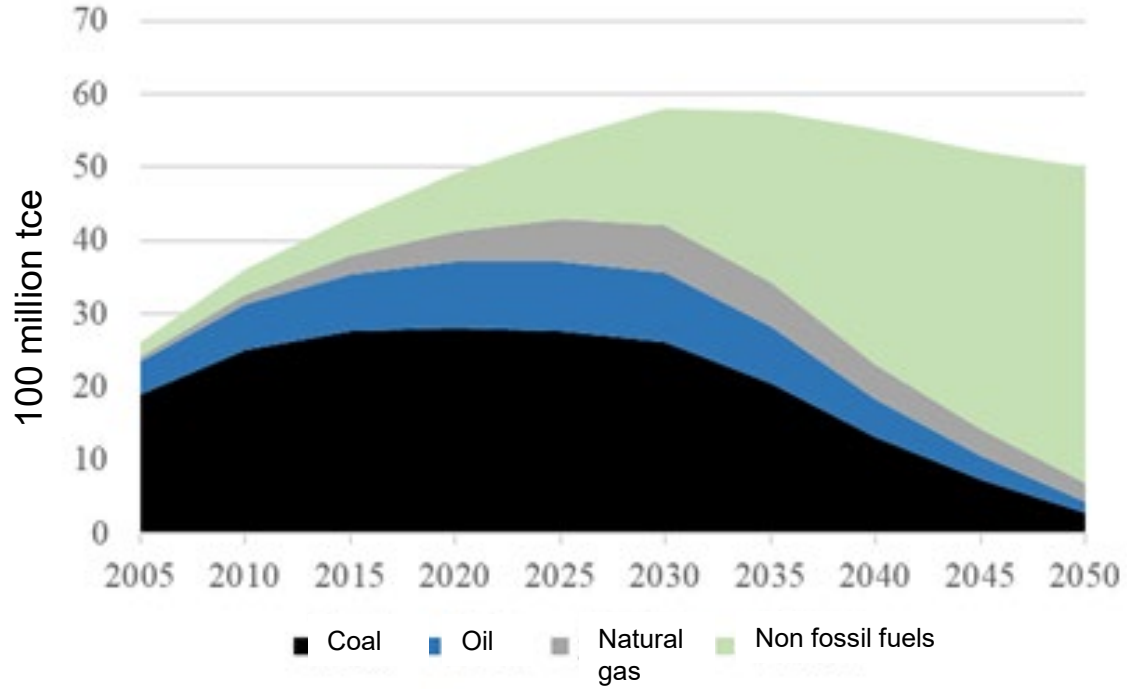
Total net GHG emissions under the 2°C target (100million tCO2e)

	2020	2030	2050
CO2 emission in energy consumption	100.3	104.6	29.2
CO2 emission in industrial process	13.2	11.0	4.7
Non CO2 GHG emissions	24.4	27.8	17.6
Forest sinks	-5.8	-6.1	-7.0
CCS+BECCS	0	0.0	-5.1
Net emissions	132.1	137.3	39.4

- Non-CO2 GHG emissions will stay at 1.78 billion tCO2e in 2050, accounting for 38.4 % of the total GHG emissions, excluding carbon sinks. The total GHG net emissions will reach 3.94 billion tCO2e, 70 %lower than that in the peak year.

6. Pathway for long-term low carbon transition under the 1.5℃ scenario (1)

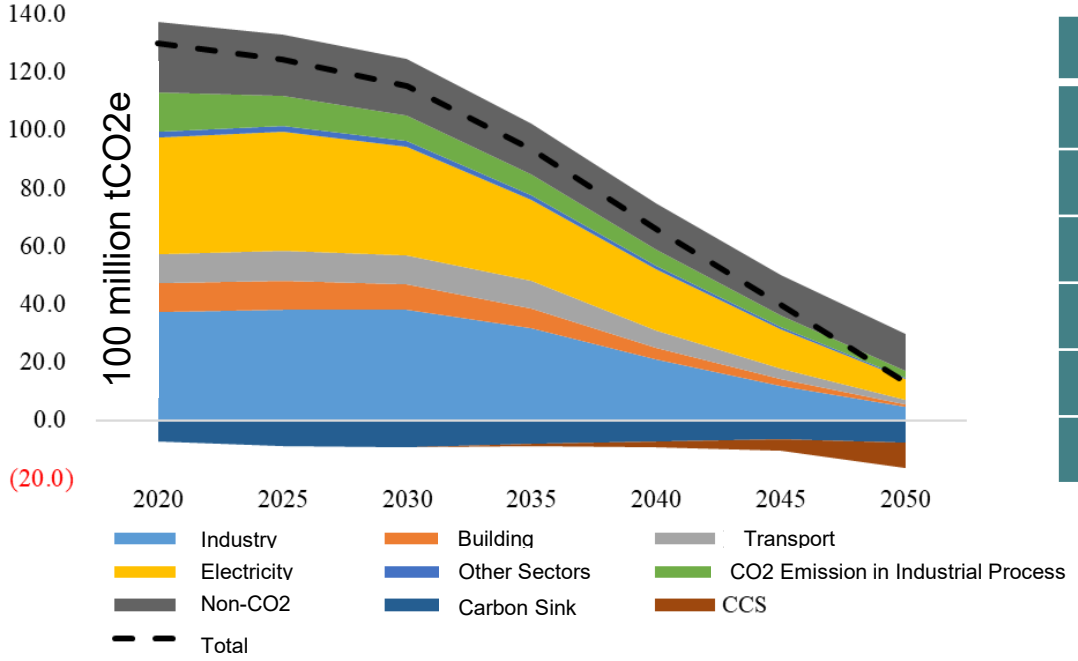
Primary energy consumption and the mix for net zero emission under the 1.5℃ scenario



- By 2050, total energy demand will have reach 5 billion tce, with non-fossil fuels accounting for over 85% in the energy mix. In the power sector, over 90% of the electricity will be generated by non-fossil fuels, and less than 5% by coal.
- The end-use sectors will see the increased use of electricity to replace direct combustion of fossil fuels. The share of primary energy for electricity generation will increase from the current 45 % to about 85 % by 2050, and the share of electricity in end-use energy consumption will increase from the current 25 % to about 68%.

6. Pathway for long-term low-carbon transition under the 1.5℃ scenario (2)

Total GHG emission and sources under the 1.5℃ scenario



unit: 100 million tCO_2e	2020	2030	2050
CO2 emission in energy consumption	100.3	104.5	14.7
CO2 emission in industrial process	13.2	8.8	2.5
Non CO2 GHG emission	24.4	26.5	12.7
Agricultural and forestry sinks	-7.2	-9.1	-7.8
CCS+BECCS	0.0	-0.3	-8.8
Net emissions	130.7	130.4	13.3

- **By 2050, all CO_2 emissions should be net zero and negative in the power sector. All GHG emissions will have been reduced by 90% from peak levels. Non-CO2 GHG emissions will remain over 1 billion tCO2e.**
- **By 2050, excluding CCS and carbon sinks, there will still be 1.47 billion tones of energy-related CO_2 emissions, with industry and power accounting for 31% and 49%, respectively.**

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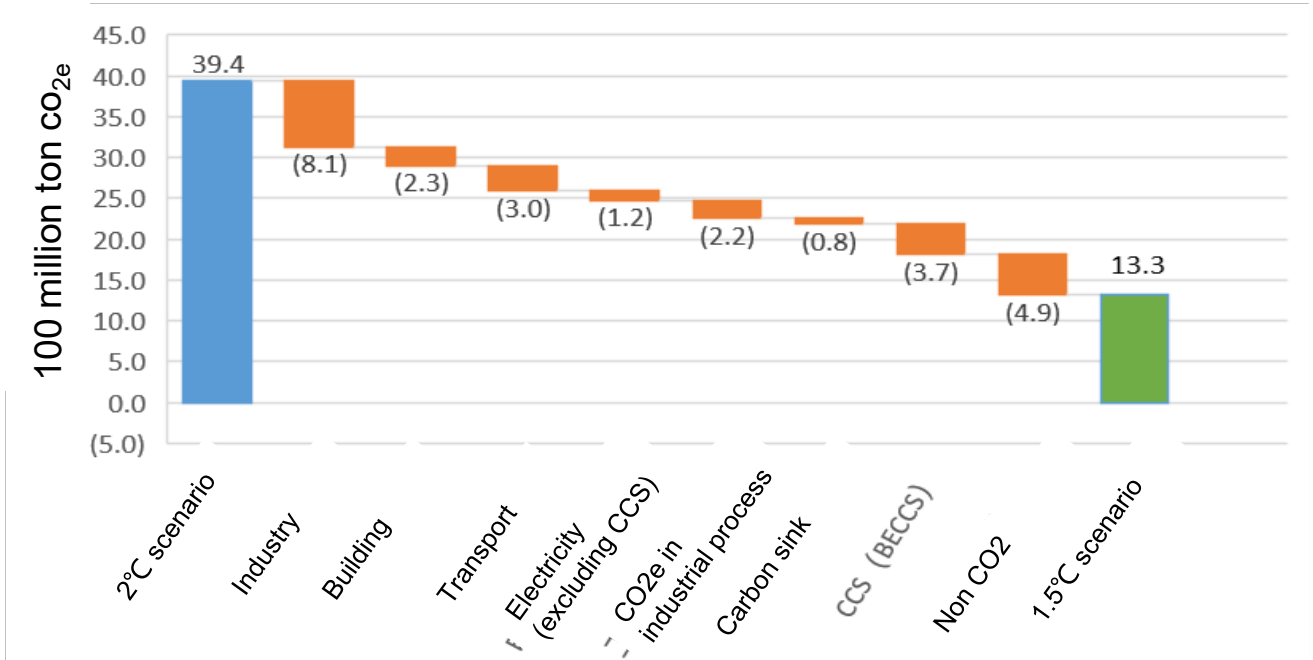
7. Different long-term low carbon transition pathways (1)

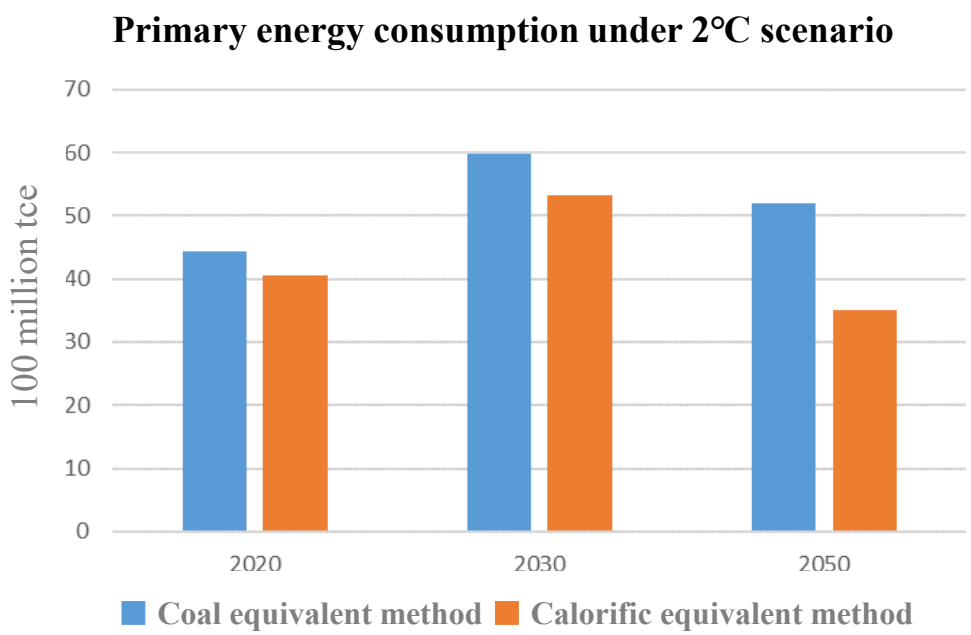
- **Contributions of each sector to total GHG emission reductions moving from 2°C scenario to 1.5°C scenario in 2050**



- **Moving from the 2°C pathway to the 1.5°C pathway requires all sectors to intensify their transition efforts, especially the hard-to-abate industries in the industrial sector, who need to further reduce their emissions. The application of hydrogen energy in the industrial sector, transport sector, and power sector need to be strengthened. Negative emission technologies such as CCS and carbon sinks also need to be scaled up.**

7. Different long-term low carbon transition pathways (2)

- **Primary Energy consumption comparison with converted renewable energy using coal equivalent method and calorific equivalent method respectively.**



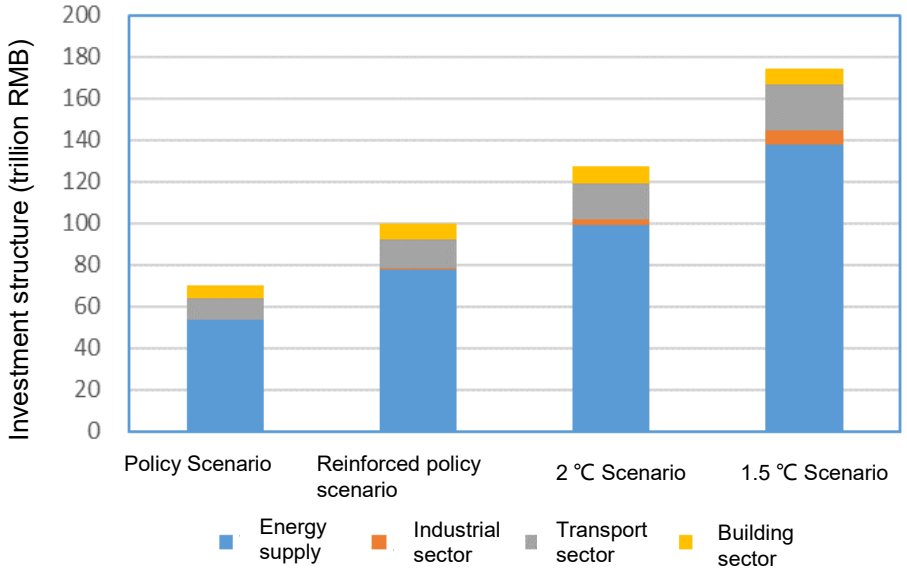
Primary Energy consumption under 2℃ scenario

	2030		2050	
	Coal equivalent method	Calorific equivalent method	Coal equivalent method	Coal equivalent method
Primary energy consumption (100 million tce)	59.8	53.5	52.0	35.0
Proportion of non-fossil energy (%)	25.0	16.1	73.2	60.2
CO_2 emission intensity (kg CO_2/kg ce)	1.75	1.96	0.56	0.83
CO_2 emission (100 million tons CO_2)	104.6	104.6	29.3	29.3

- **Renewables are converted to primary energy for comparison. Please note that China traditionally adopts coal equivalent method while IEA and OECD countries usually adopt calorific equivalent method. This report used coal equivalent method for calculation.**

7. Different long-term low carbon transition pathways (3)

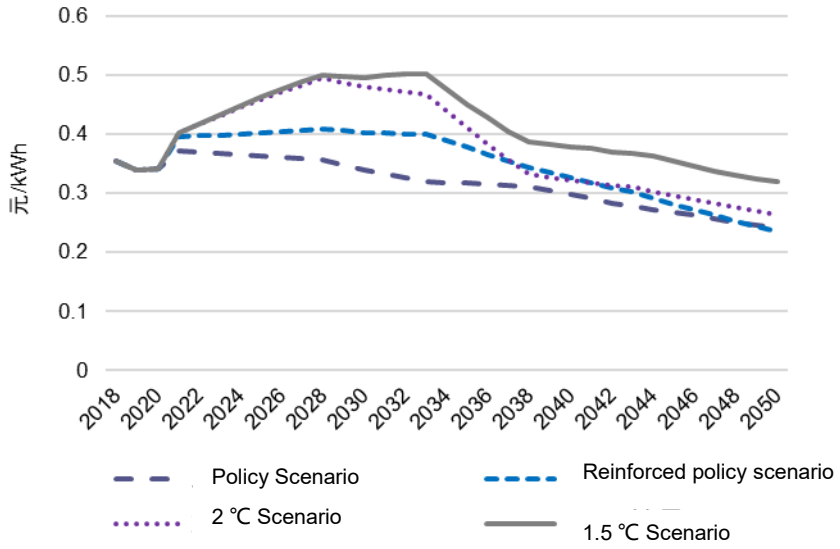
Investment in energy infrastructure in 2020-2050 under different scenarios



- **To achieve the 2°C transition pathway, the energy system will need new investment of about 100 trillion yuan in 2020-2050, around 1.5-2.0% of annual GDP.**
- **To achieve the 1.5°C transition pathway, the energy system will need new investment of around 138 trillion yuan, over 2.5% of annual GDP.**
- **The EU Green Deal sets the target to achieve 50-55% emission reduction by 2030, calling for an annual investment of €260 billion, or 1.5% of GDP in 2018.**
- **The transformation of the energy system will bring new growth drivers and new jobs - the renewable energy sector employs 1.5 to 3.0 times more people per unit of capacity than the traditional energy sector.**

7. Different long-term low-carbon transition pathways (4)

Analysis of supply costs for power and energy sectors



Total energy costs（trillion RMB）

	2020	2030	2050
Policy Scenario	9.5	12.2	12.3
Reinforced policy scenario	9.5	12.8	10.1
2℃ Scenario	9.5	13.4	9.1
1.5℃ Scenario	9.5	12.9	8.8

- The long-term cost of power supply is on a downward trend as the cost of renewable generation declines and the smart grid develops, but costs will rise in the near term as the power system transforms to accommodate a large share of renewables on the grid.
- The total energy cost for society as a whole tends to increase in the near term during the energy transition. However, in the long term, the cost will decrease with the establishment of the new energy system and the decline in total energy demand.

8. Policy Recommendations – Strengthening climate change targets and measures in the 14th Five-Year Plan (1)

- **The 14th Five-Year Plan will be closely watched by the world as a bellwether for global economic recovery from the epidemic.**
  - **China's success in fighting the pandemic gives it an opportunity to lead the world in economic recovery.**
  - **The world is watching the investment and policies of China's economic stimulus. China is expected to play a leading role in ensuring a "green recovery and low-carbon transition"**
- **Establishing ambitious energy-saving and emission reduction targets in the 14th Five-Year Plan.**
  - **Energy intensity of GDP decreases by no less than 14%, the share of non-fossil energy reaches about 20%, the CO_2 intensity of GDP decreases by 19~20%, total energy consumption is contained within 5.5 billion tce, and total CO_2 emissions less than 10.5 billion tons**
- **Publishing 10-year-plan for peaking emissions. Key cities and energy-intensive industries should take the lead in peaking CO_2 emissions**
- **Strict control of rebound in coal power capacity and total coal consumption , and strive to peak coal consumption or even achieve negative growth during the 14th FYP**
- **Improve the national carbon market and expand the scope of the sectors covered**
- **Control the emission of non CO_2 GHGs including CH_4; establish an MRV system.**

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8. Policy Recommendations -- Strengthening climate change targets and measures in the 14th Five-Year Plan (2)

- **Comparison between the recommended 14th FYP targets for energy conservation and carbon reduction and the 13th FYP**

	13th FYP		14th FYP
	Planned targets	Expected results	Recommended targets
Reduction in energy intensity of GDP （%）	15	14.3	14
Share of non fossil energy by the end of the FYP（%）	15	16.0	20
Reduction in CO_2 intensity of GDP （%）	18	19.5	No less than 19
Total energy consumption by the end of the FYP (100 million tce)	Less than 50	49.4	No more than 55
CO2 emission by the end of the FYP (100 million tCO2)		103.3	Less than 105

8. Policy Recommendations – Reinforcing and Updating the 2030 NDC targets

- **The Paris Agreement requires parties to report on the implementation and updating of NDC targets by 2020, and globally 114 countries have announced that they will update their NDC targets.**
- **China should and has the potential and the capacity to proactively reinforce and update the NDC to make it more ambitious.**
- **Reduction of CO_2 intensity per unit of GDP can be set at over 65% in 2030 compared to 2005 level**
  - **The 2020 NDC target of 40~45% reduction from the 2005 level has already been achieved ahead of time**
- **Consider to increase the share of non fossil energy to around 25%**
  - **Renewable energy is cost-competitive and can continue to grow at an average annual rate of about 7% during the 13th Five-Year Plan.**
- **Strive to peak CO_2 emission by 2030**
  - **Carbon emissions may reach the plateau in 2025 with peak emissions within 10.5 billion tons.**
- **Forest stock will increase by 5.5-6 billion m^3 by 2030 compared to 2005 level**

8. Policy Recommendations -- Reinforcing and Updating the 2030 NDC targets

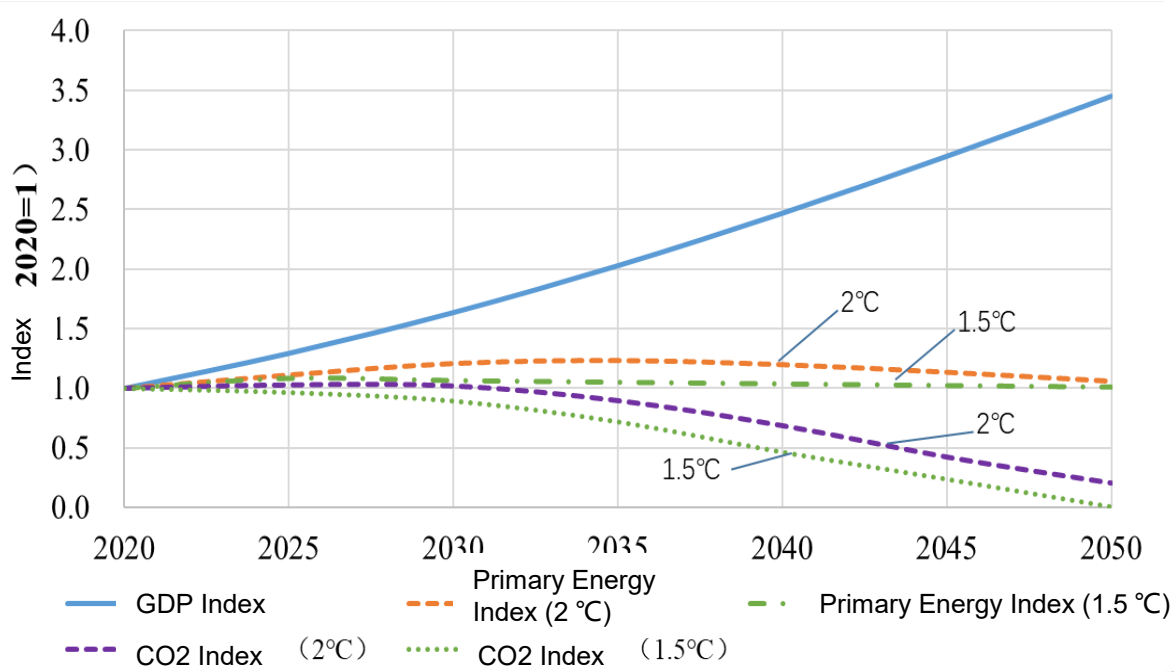
- **Scenario analysis of energy consumption and CO_2 emissions for the implementation and enhancement of 2030 NDC targets**

		2005	2010	2015	2020	2025	2030
Annual GDP growth rate（%）			11.3	7.9	5.9	5.3	4.8
5-year-reduction of energy intensity of GDP (%)			19.1	18.5	14.3	14.0	14.0
Energy consumption（100 million tce）		26.1	36.1	43.4	49.4	55.0	59.8
Energy consumption mix	coal（%）	72.4	69.2	63.7	57.0	51.0	45.0
	oil（%）	17.8	17.4	18.3	18.5	18.0	17.0
	Natural gas（%）	2.4	4	5.9	8.5	11.0	13.0
	Non-fossil fuels（%）	7.4	9.4	12.1	16.0	20.0	25.0
CO2 intensity per unit energy consumption ($kgCO_2$/kg ce)		2.32	2.25	2.16	2.03	1.90	1.75
CO_2 emissions（100 million t CO_2）		60.6	81.3	93.7	100.3	104.5	104.6
5-year-Reduction of CO_2 intensity of GDP（%）			21.5	21.2	19.7	19.4	20.6
Percentage down from the 2005 level（%）					50.3	60.0	68.2

8. Policy recommendations– Setting long-term low-carbon development goals and strategies for 2050 (1)

- **Two goals：to build a strong socialist modernized China; to limit the global temperature rise within 2°C, while striving to achieve 1.5 °C target**
  - In 2050, GDP will be about 3.5 times that of 2020, energy consumption will peak around 2035 and begin to decline, CO_2 emissions will peak by 2030. In 2050 CO_2 emissions will tend to be near-zero or net-zero.
  - The realization of low-carbon development goals, strategies and pathways consistent with long-term global emission reduction targets should be incorporated as an important part of the overall goals and strategies for achieving socialist modernization in the new era.

Index for GDP, primary energy consumption and CO2 emissions（2020=1）



8. Policy recommendations– Setting long-term low-carbon development goals and strategies for 2050 (2)

- **Guiding philosophies and principles：**
  - **Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era**
  - **Global Ecological Civilization and the concept of Building a Community with a Shared Future for Mankind**
  - **Adhere to the principles of the Convention and the Paris Agreement, make contributions commensurate with China's rising comprehensive national power and international influence, and take the initiative to shoulder international responsibilities**
- **Integrated and coordinated governance：**
  - **Integrated economic, social, resource, environmental and climate governance**
  - **Balancing situation at home and abroad；integrating short term and long term development（two-phased strategies）**
- **Achieving economic and social modernization and improving China’s competitiveness：**
  - **Economic modernization：digitalization and decarbonization, improving resource efficiency**
  - **Scientific and technological competitiveness：advanced energy technology, smart decarbonization technology**
  - **Evolution of international rules: international carbon pricing mechanisms, carbon border adjustment measures, international low-carbon standards and industry rules**

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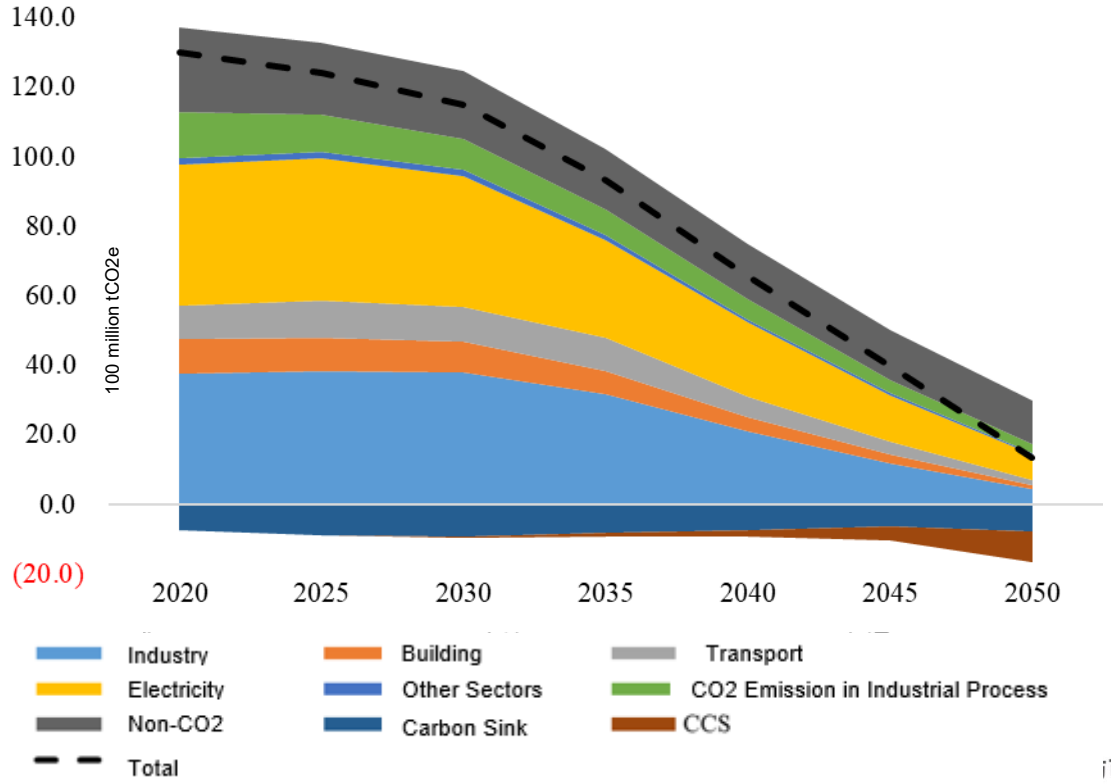
8. Policy recommendations– Setting long-term low-carbon development goals and strategies for 2050 (3)

- **The goal of achieving carbon neutrality by 2060 can be translated into achieving a long-term deep decarbonization transition pathways under the 1.5°C target.**
  - By 2050, net zero CO_2 emissions will be achieved, with a 90 % reduction in the emission of all GHGs, laying a groundwork for achieving carbon neutrality by 2060.
  - After 2050, China should further step up efforts to reduce emissions from all sectors, make breakthroughs in zero-emission or negative-emission technologies, achieve negative CO_2 emissions from energy systems, enhance the efforts to reduce emissions of non-CO2 GHGs, strengthen carbon sink absorption and CDR technologies, and achieving net zero emissions of all GHGs as soon as possible.

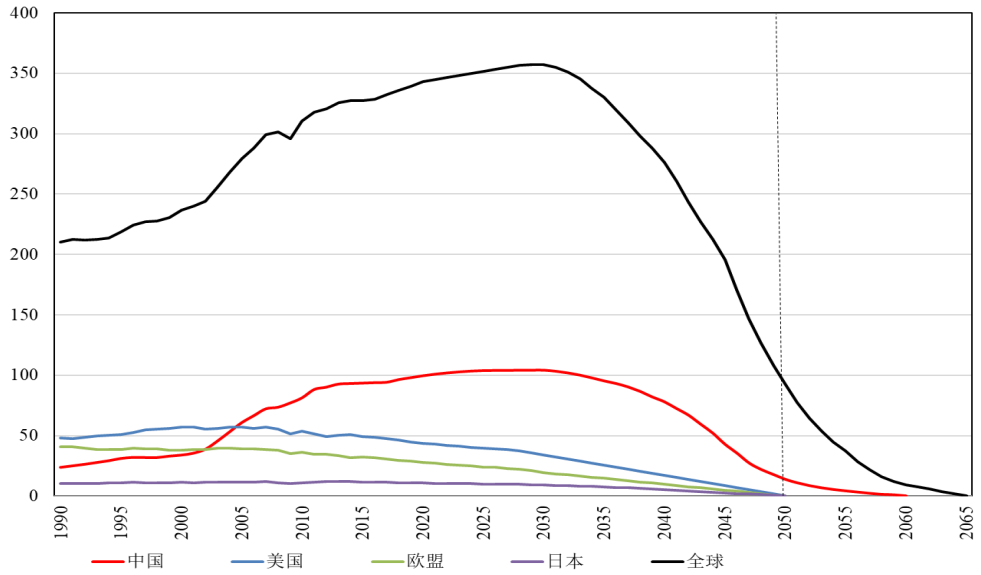
Total GHG emission and sources under the 1.5℃ scenario



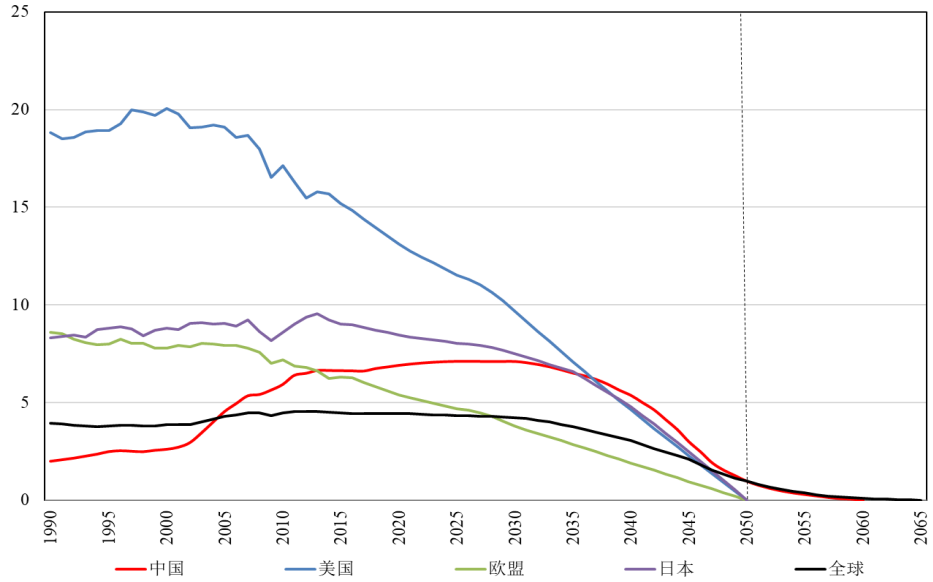
8. Policy recommendations- setting long-term low-carbon development goals and strategies for 2050 (4)

- Achieving carbon neutrality in the long run will entail great commitment from all countries, with developing countries facing graver challenges. It is even more so for China to achieve carbon neutrality by 2060, meaning China will have to work much harder than developed countries in achieving carbon neutrality by 2050.

Global and major countries' net GHG emissions (t CO2e)



Global and major countries' net GHG emissions per capita (t CO2e/person)



- It will take Europe and the US 50 to 70 years to transition from peak carbon to carbon neutrality, but the transitioning period for China is only 30 years. From 2030 to 2050, China will have to cut its emission at an annul average rate of 8 ~ 10%, much faster than that in developed countries.

9. Leading the global climate governance in the post-pandemic era

- **There is a growing consensus that a "green economic recovery" is important in the post-pandemic era. Addressing climate change will remain a race for major countries.**
  - Antonio Guterres: Climate change is the deeper environmental emergency facing the planet and addressing climate risks should be at the heart of all recovery measures.
- **China's targets of striving to peak CO_2 emissions by 2030 and achieving carbon neutrality by 2060 will play an important role in accelerating the country's post-pandemic green low-carbon transition and the implementation of long-term low-carbon strategies as well as facilitating the process of global climate governance.**
  - **Promoting the much-needed low-carbon transition at home has become an important target of socialist modernization in the new era and is at the core of building an ecological civilization.**
  - **Internationally, China's pledge will boost the confidence and willingness to act against climate change, lead global economic and technological transformation, and show that China is acting responsibly as a major country for the common cause of all mankind.**
- **Setting ambitious and powerful targets to peak CO2 emissions and achieve carbon neutrality and rolling out supporting policies and actions are vital for China to align its overall strategies both at the national and international level.**

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Thank you!

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