

WHAT TO EXPECT IN CHINA'S SECOND NATIONALLY DETERMINED CONTRIBUTION

TOWARDS A CARBON NEUTRAL
GLOBAL FUTURE

2021 Edition

CHEN MEIAN, YANG LI, HU MIN,
DIEGO MONTERO



绿色创新发展中心
Innovative Green Development Program



低碳政策库
Policy Mapping

About iGDP

Innovative Green Development Program (registration name: Beijing Green Partnership Consulting Company Limited) is a non-profit consultancy that focuses on green and low-carbon development. It works to strengthen China's low-carbon environmental policy design and implementation through interdisciplinary, systematic and empirical research. We work with all stakeholders to promote a zero-emissions future and tell the story of China's green and low-carbon development.

Innovative Green Development Program was initiated by Energy Foundation China. It is the secretariat of China's Green and Low-Carbon Development Think Tank Partnership, sits on China's Green Finance Association Experts Committee, and is a member of the North-East Asian Subregional Programme for Environmental Cooperation's Low Carbon City Platform.

Innovative Green Development Program's research, consulting and communications focus on the following areas:

- Macro-Level Climate Policy
- Urban Green and Low-Carbon Transformation
- Green Economic Policy
- Behavioral Change

Authors

CHEN Meian
Ph.D., Senior Analyst
chenmeian@igdp.cn

YANG Li
Ph.D., Project Director/Senior Analyst
yangli@igdp.cn

HU Min
Executive Director
humin@igdp.cn

Diego Montero
Strategy Director
diego@igdp.cn

The authors would like to thank Pieter Velghe and MA Yue for their important support on this updated 2021 edition of the report.

Disclaimer: The content of this report is based on publicly available information and other vetted data and aims to facilitate discussion. It represents the views of the authors only and cannot be considered to reflect the views or position of iGDP.

Suggested Citation: Chen, M., Yang, L., Hu, M., & Montero, D. (2021). What to Expect in China's Second Nationally Determined Contribution: Towards a Carbon Neutral Global Future 2021 Edition. Beijing, China: Innovative Green Development Program.

Contents

EXECUTIVE SUMMARY	3
PROGRESS	3
PROSPECTS.....	4
THE URGENCY OF AMBITIOUS CLIMATE ACTION.....	6
PROGRESS TOWARD CLIMATE GOALS.....	9
I. GLOBAL AND DOMESTIC SUSTAINABLE DEVELOPMENT TRENDS SINCE THE ADOPTION OF THE PARIS AGREEMENT.....	9
II. CHINA HAS ACHIEVED MULTIPLE TARGETS UNDER ITS NDC AHEAD OF SCHEDULE.....	11
III. CLIMATE GOALS OF THE 14TH FIVE-YEAR PLAN AND THE LONG-RANGE OBJECTIVES THROUGH THE YEAR 2035	13
IV. MID- AND LONG-TERM GOALS IN KEY SECTORS BECOME INCREASINGLY CLEAR.....	14
V. RESEARCH FOUNDATION FOR THE LONG-TERM EMISSION PATHWAY BY 2050 IS GETTING STRONGER... ..	19
PROSPECTS FOR CLIMATE ACTION.....	23
I. PROSPECTS: RAISING THE LONG-TERM GHG EMISSION REDUCTION VISION	23
II. TARGETS: SETTING ADDITIONAL TOTAL CARBON CONTROL TARGETS AND INTENSIFYING NON-CO ₂ GHG CONTROL TARGETS.....	27
1. TOTAL ENERGY-RELATED CO ₂ EMISSION CONTROL TARGETS.....	27
2. NON-CO ₂ GHG EMISSIONS REDUCTION TARGETS.....	30
III. ACTION: ENHANCE EMISSION REDUCTION ACTIONS BASED ON THE LATEST DEPARTMENTAL STRATEGIC MEASURES.....	34
1. THE CONTRIBUTION OF NEW POLICIES SINCE 2016 TO STRENGTHENING CHINA'S RESPONSE TO CLIMATE CHANGE ACTIONS	34
2.POLICY OPTIONS FOR THE NDC UPDATE (SEE TABLE 2)	36
IV. SUBNATIONAL AND NON-STATE CLIMATE ACTIONS	37
REFERENCES	41

Executive Summary

There is no doubt about the urgent need for a serious global response to climate change. In accordance with the Paris Agreement and ongoing climate negotiations, countries were expected to submit a second Nationally Determined Contribution (NDC) in 2020, to be reviewed every five years and continually updated. Due to the COVID-19 pandemic, however, by the end of 2020 only 44 countries had submitted a second NDC.¹ The remaining countries are working hard to formulate and update their respective NDCs.

As the world's top GHG emitter, China's second NDC is receiving special attention from the international community. In pursuit of the strategic goals of reducing environmental degradation (building "ecological civilization") and showing leadership in international climate change mitigation efforts, China has been strengthening its climate action. At the general session of the 75th session of the United Nations General Assembly in September 2020, President Xi Jinping declared that "China will increase its NDC and adopt more powerful policies and measures. We strive to peak CO₂ emissions before 2030 and achieve carbon neutrality before 2060". This 30/60 "dual carbon" goal provides a direction and guidance for target setting and periodic renewals of China's NDC.

In September 2019, iGDP released the report "What to Expect in China's Second Nationally Determined Contribution: Towards a Carbon Neutral Global Future". This report is a 2021 revision of the original edition. It first reviews both international and domestic sustainable development trends since the Paris Agreement. It then discusses the implementation of China's first NDC. Finally, drawing on newly issued strategic plans and policies during the 13th and 14th Five-Year plan periods, it explores the climate policy options that may shape China's second NDC.

PROGRESS

Since the adoption of the Paris Agreement, global climate governance has developed a "top down" pattern. Countries have been trying to strike a balance between national interests and the common interests of mankind, taking into account economic and social conditions at both the national and regional levels. In early 2016, the UN Sustainable Development Goals took effect; In October 2016, the contracting parties of the Montreal Protocol on Substances that Deplete the Ozone Layer unanimously adopted the Kigali Amendment, deciding to phase out the production and use of hydrofluorocarbons (HFCs). Together with the Paris Agreement, which went into effect in November 2016, these efforts kicked-off a new global low-carbon transition movement. During this time, China's economic growth entered a new stage. In October 2017, the 19th National Congress of the Communist Party of China was held, setting China's near-, mid- and long-term economic and social development targets and outlining an overall strategic direction for socioeconomic development (described below). In 2020, China's per capita national income reached USD 10,450, exceeding the average level of middle-income countries.²

China has achieved multiple targets under its first NDC ahead of schedule. The latest statistics show that among the 15 quantitative targets under China's first NDC in 2015, most have seen solid progress. Nine indicators achieved the 2020 target set in the NDC ahead of schedule. For example, CO₂ emissions per unit of GDP (hereinafter referred to as carbon intensity) in 2019 dropped 48.1% from the 2005 level, meeting the target of reducing carbon intensity between 40% to 45% ahead of schedule. In 2019, China's PV installed capacity reached 204 million kilowatts and installed wind power capacity reached 210 million kilowatts, both outpacing their 2020 targets. In 2019, the ratio of non-fossil energy to primary energy and the ratio of green buildings in new urban buildings also outpaced the 2020 target. The proportion of natural gas in primary energy consumption and the proportion of added value of strategic emerging industries in GDP are also in line with planning expectations. Data from 2017 and 2018 coal bed gas production and annual geothermal use, however, show that there is still a gap with the 2020 goals in these areas.

¹ (Josh Gabbatiss, 2021)

² (National Bureau of Statistics, 2021)

At the same time, post-2020 mid- and long-term goals in key sectors have become increasingly clear. Since its first NDC was submitted in 2015, China has issued 13th and 14th Five-Year plans. These plans consist of the concrete measures China is taking and will take to achieve a 2030 carbon peak. They also comprise an important basis for China to update its NDC. A succession of industrial development plans formulated by various departments and newer, more detailed, stronger and longer-term energy-saving and carbon-reducing targets, policies and measures have already been put forward. Key sectors have issued mid- and long-term strategic arrangements for 2025 and 2030, such as the *Energy Supply and Consumption Revolution Strategy (2016-2030)*, *Green and High-Efficiency Cooling Action Plan*, *Green Building Innovation Action Plan*, *Green Travel Innovation Action Plan*, *Mid- and Long-Term Development Plan for the Automobile Industry and Industrial Green Development Plan (2016-2020)*, and the *New Energy Automobile Industry Development Plan (2021-2035)*.

The research foundation for a long-term emission pathway is getting stronger. In recent years, domestic and foreign research organizations have jointly conducted multiple modeling development and scenario analyses on long-term green and low-carbon development in China, providing a robust technical foundation for China to create long-term GHG emission control goals. Most research findings agree on what China's emission trajectory will be through 2030. With full implementation of China's current emission reduction policies, China is very likely to meet carbon peak and carbon intensity goals before 2030.³ But to meet the 2°C goal, China will need to cut emissions more quickly after reaching this 2030 carbon peak.⁴ Related model analysis shows that under the "2-degree scenario", the total carbon emission of primary energy consumption needs to be reduced from 9.42 billion tons of CO₂e in 2030 to 2.92 billion tons of CO₂e in 2050.⁵ The *People's Republic of China Third National Communication on Climate Change*, submitted in June 2019, devotes a chapter to future CO₂ emission trends. Many research organizations have conducted analysis of non-CO₂ GHG emission trends and emission reduction actions, and have estimated potential emission reductions under stronger regulation scenarios.

PROSPECTS

The updates to China's NDC will likely reflect domestic and global development trends, as well as the latest long-term GHG emissions trend analyses and the specific goals and measures outlined in China's new strategic plans and policies. The following are items that China may include in its second NDC:

Vision - Establishing China's long-term GHG emission reduction roadmap. China recently announced targets to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. Observers are now closely watching to see what specific policies and measures are developed in service of these medium and long-term goals and how they will shape China's second NDC. Following the principle of common but differentiated responsibilities, and drawing upon other countries' existing national strategic plans, this new national roadmap toward carbon neutrality will lead to the setting of specific emission reduction measures and mechanisms with periodic evaluation and adjustment. The overall roadmap will be decided based on a foundation of low-carbon development research and China's developmental conditions. The resulting vision will then be incorporated into future mid- and long-term national economic and social development plans, and brought into alignment with the mid- and long-term plans of various sectors in a stable and consistent institutional framework to manage GHG control goals, actions and policies.

Targets - Setting up a carbon cap and enhancing non-CO₂ GHG emission reductions. Setting an energy-related CO₂ cap target for 2025 and 2030 should be seen as necessary for peaking CO₂ emissions around 2030. It would also help achieve the peak target ahead of schedule and have a positive impact on controlling China's long-term GHG emissions.⁶ A carbon cap target could be designed in terms of regions with a top-down approach or in terms of industries with a bottom-up approach. Although the carbon cap target would not necessarily lead to extra GHG emission reduction beyond the existing NDC, under China's new environmental and climate change regulations, setting a cap target would greatly stimulate the implementation of policies. An

³ (den Elzen et al., 2019; Gallagher, Zhang, Orvis, Rissman, & Liu, 2019; Ge, Liu, Wang, & Zheng, 2018; Q. Liu, Gu, Teng, Song, & Chen, 2017)

⁴ (Fu, Zou, & Liu, 2015)

⁵ (He et al., 2020)

⁶ (Q. Cai, Zheng, Zhao, & Xu, 2016; Tian, 2019; jinnan Wang, Cai, Cao, Zhou, & Liu, 2011; Xiong, Kang, Feng, & Zhao, 2015; Zhu, 2019)

energy-related CO₂ cap target is one of the most highly anticipated potential NDC revisions due to its great potential to strengthen China's GHG emission reduction actions. In addition, the latest research indicates that⁷ there are different policy options for non-CO₂ GHG emissions reduction target setting, including a non-CO₂ emissions peaking target, a total HFCs emission reduction target, and sector-specific methane emissions reduction targets. China promised to peak GHG emissions around 2030, but only targeted energy-related CO₂, not other GHGs. If China were to put forward emission reduction targets for non-CO₂ GHGs and strengthen their regulation policies, the global effort against climate change would receive a strong boost. Targets for non-CO₂ GHGs would also help create a long-term emission reduction vision encompassing all GHGs and all economic sectors.

Actions - Incorporating elements of upcoming long-term low-carbon development strategies and roadmaps into the new NDC. As indicated above, China formulated a series of departmental strategic plans for the implementation of the social and economic development goals set out in the 13th Five-Year Plan. Some of these departmental strategic plans proposed newer, more detailed, more robust and longer-term energy-saving carbon reduction targets and policy measures that will have a larger impact on China's future greenhouse gas emissions trends. This report sorts out these strategic plans, industrial policies, and action plans, compares these goals and measures to the different chapters of the 2015 NDC, and proposes ideas for how to incorporate them into the second NDC. Several highlights worth mentioning are the following: The Energy Production and Consumption Revolution Plan 2016-2030 calls for the renewable energy share to increase above 50% by 2050. The groundbreaking *National Green and High Efficiency Cooling Plan* issued in mid-June sets a 2030 goal of increasing the energy efficiency levels of cooling products by at least 25%. And the *Mid- and Long Term Strategic Plan for the Automobile Industry* sets ambitious goals for new energy vehicles and increased fuel economy efficiency in all vehicles. The actions needed to achieve these goals should be incorporated into China's second NDC.



Photo Credit: Diego Montero

⁷ (Lin, Khanna, & Liu, 2018; Song, 2019; Su, Li, & Xu, 2016)

THE URGENCY OF AMBITIOUS CLIMATE ACTION

There is an urgent need to strengthen the global response to climate change. The Paris Agreement aims to "hold the increase in the global average temperature to well below 2°C above pre-industrial levels by the end of this century." The scientific consensus is that only by achieving this goal will we have a chance to avoid catastrophic events caused by global warming. In October 2018, the Intergovernmental Panel on Climate Change (IPCC) released the *Special Report on Global Warming of 1.5°C*, which reiterated that global average warming had already reached 1°C above pre-industrial levels. At the same time, frequent extreme weather events and natural disasters are warning us that the climate is already changing. The world cannot afford the consequences of weak climate action. Immediate action to substantially cut greenhouse gas (GHG) emissions is urgently needed.

The Paris Agreement (the Agreement), adopted by 196 regions and countries at the end of 2015, reflects a consensus to greatly reduce emissions while accommodating the economic and social differences of various countries, and serves as a guideline for post-2020 global climate actions. Since the adoption of the Agreement, global climate governance has been characterized by a new "bottom-up" model, with 184 countries submitting their first Nationally Determined Contributions (NDCs) (UNFCCC, 2019). According to the framework of the Agreement and climate negotiation outcomes in recent years, contracting parties were to resubmit or update their NDCs in 2020 and do so every five years thereafter.

China is an important proponent of the Paris Agreement. President Xi Jinping attended the Paris Climate Change Conference in person, helping to drive the signing and activation of the Agreement. As a densely populated country, a large economy and a major GHG emitter, China has played an important role in the United Nations Framework Convention on Climate Change (UNFCCC), promoting the adoption of the Paris Agreement's implementing rules and emphasizing the importance of intensifying climate actions. Especially since the US under the Trump administration announced its withdrawal from the Paris Agreement (the Biden administration rejoined the Agreement), China has signaled that it is committed to help guide international cooperation on climate change.

On June 30, 2015, China submitted its *first Enhanced Actions on Climate Change: China's Nationally Determined Contributions* (NDC 2015) to the UNFCCC Secretariat, outlining China's nationally determined climate action targets by 2030: peaking CO₂ emissions around 2030 and making its best effort to peak early; lowering CO₂ emissions per unit of GDP by 60% to 65% from 2005 levels; increasing the proportion of non-fossil energy in primary energy consumption to around 20%; and increasing the forest growth stock by 4.5 billion cubic meters from 2005 levels.

China's 2015 NDC not only outlines a plan through 2030, but also elaborates how to enhance industrial policies and measures in fifteen areas, and sets multiple detailed and quantitative targets. Multiple research teams agree on the basic character of China's CO₂ emissions trajectory and peaking pathway: peaking CO₂ emissions around 2030 requires not only the strengthening of existing policies, but also new efforts and more innovative measures to be taken between 2020 and 2030 (Yang, 2015).

Even if China and the rest of the world achieve their targets, the actions in the NDCs submitted by contracting parties under the Paris Agreement will not limit warming to below 2°C. According to the United Nations Environment Program (UNEP), although the emission reduction actions proposed by the existing NDCs could limit global emissions to 53 billion to 56 billion tons of CO₂e by 2030, to meet the 2°C target, global emissions need to be limited to 40 billion tons of CO₂e (Levin, Fransen, & Ge, 2015).

There has been much discussion about how to enhance countries' ambition since the Paris Agreement took effect. At the G20 summit in June 2019, the foreign ministers of China and France and the UN Secretary-General issued a joint press declaration on climate change. The parties reaffirmed their commitment to "update their nationally determined contributions in a manner representing progress beyond the current one and reflecting the highest possible ambition, and to publish their long-term mid-century low greenhouse gas emissions development strategies by 2020 in the context of sustainable development." In an April 2021 meeting in Shanghai, China's special envoy for climate change Xie Zhenhua and his American counterpart John Kerry issued a statement on the China-US response to climate change, saying "The two sides recall the Agreement's aim in accordance with Article 2 to hold the global average temperature increase to well below 2°C and to pursue efforts to limit it to 1.5°C. In that regard, they are committed to pursuing such efforts, including by taking enhanced climate actions that raise ambition in the 2020s in the context of the Paris Agreement with the aim of keeping the above temperature limit within reach and cooperating to identify and address related challenges and opportunities."

What to Expect in China's Second Nationally Determined Contribution

Towards a Carbon Neutral Global Future 2021 Edition

Actively responding to climate change and cutting GHG emissions is consistent with China's pursuit of environmental protection and building what it calls an "ecological civilization." It also presents an opportunity for China to promote domestic energy and economic restructuring and shift to a high-quality, green and low-carbon pattern of economic development. The report of the 19th CPC National Congress calls for fostering growth in green and low-carbon sectors, creating new opportunities for development and boosting the quality and competitiveness of economic growth. Since it submitted its first NDC in 2015, China has fulfilled many of its commitments and met many targets ahead of schedule. It is important for China to continue to strengthen its actions in its second NDC. In September 2020, in a speech before the general debate of the 75th United Nations General Assembly, President Xi Jinping stated that "China will increase its National Determined Contribution and adopt more powerful policies and measures. We strive to peak CO₂ emissions before 2030 and achieve carbon neutrality before 2060".

How will the international and domestic situation affect China's future climate actions? What progress has China made in implementing its NDC? What preparations will China's policymakers make for longer-term actions? How will China's NDC be revised? This report takes a close look at these issues.



Photo Credit: Diego Montero

Figure 1 China's participation in international climate change actions in the last five years



PROGRESS TOWARD CLIMATE GOALS

I. Global and domestic sustainable development trends since the adoption of the Paris Agreement

Global

There have been several significant shifts in the global sustainable development landscape since 2015. With the adoption of the Paris Agreement, global climate governance has taken a new “bottom-up” approach where countries determine their own targets and how to reach them within a larger framework. Countries have been trying to strike a balance between national interests and the common global interests, while taking into account both national and regional economic and social conditions. China has also followed this principle, meaning that changes in the global and domestic situation will influence China’s second NDC.

The UN Sustainable Development Goals (SDGs) began to take effect in early 2016. The 17 goals adopted by 193 countries at the United Nations Sustainable Development Summit in September 2015 replaced the expired Millennium Development Goals (MDGs) and are now guiding the global development agenda from the end of 2015 through 2030. The SDGs aim to comprehensively address the world’s social, economic and environmental development problems. This is no easy task, requiring the balancing of the goals of responding to climate change with that of providing energy for all, for example.

In October 2016, the contracting parties of the *Montreal Protocol on Substances That Deplete the Ozone Layer* unanimously adopted the Kigali Amendment (the Amendment), deciding to phase out the production and use hydrofluorocarbons (HFCs). HFCs were originally designed to replace refrigerants that deplete the ozone layer, but they have proven to be potent GHGs. The Amendment was another milestone in tackling climate change after the Paris Agreement. As the biggest producer and consumer of refrigerants, China made a significant contribution to the adoption of the Amendment. According to the rules of the Kigali Amendment, China should freeze the consumption of HFCs at agreed baseline levels in 2024 and continue to reduce the production and consumption of HFCs.

In 2020, facing the impact of COVID-19 on the global economy and public health, the need to have an economic recovery plan that reinforced green and low-carbon development became a global priority. The Secretary-General of the United Nations and the leaders of Germany, Austria and Switzerland all called for climate change to be included in economic recovery plans⁸. Many countries also issued carbon neutrality targets during this time. By June 2021, 137 countries had put forward the goal of carbon neutrality, of which 124 countries set the goal at the year 2050⁹.

Domestic

In October 2017, the 19th National Congress of the Communist Party of China set China’s near-, mid- and long-term economic and social development targets, outlining an overall strategic arrangement of “two stages”. In the first stage, from 2020 to 2035, China will be already a “well-off society” but will continue to work toward what it calls “socialist modernization”. In the second stage, from 2035 to the middle of the century, China intends to build itself into a “powerful, democratic, civilized, harmonious and beautiful socialist modernization power.” At the 75th UN General Assembly in September 2020, President Xi Jinping announced China’s “30/60 dual goal” of reaching a carbon peak and carbon neutrality. This further clarified the goal and direction of China’s social and economic green and low-carbon transformation, and prompted various industries and local governments to formulate their own actions and roadmaps for achieving carbon peaking and carbon neutrality.

At the same time, China’s economic growth has entered a new stage. In 2018, China’s per-capita GDP reached RMB 72,447 (USD 10,450) (National Bureau of Statistics, 2021), exceeding the average level of mid-income countries. But while China’s

⁸ (Simon Evans & Josh Gabbatiss, 2020)

⁹ Data is from Visual capitalist website: <https://www.visualcapitalist.com/race-to-net-zero-carbon-neutral-goals-by-country/>

economy continues to expand, its average economic growth rate has decreased from double digits to an annual growth rate of 6.5% during the 13th Five-Year Plan period. Economists are also revising their forecasts of China's future economic growth rate (see box 1). Facing an economic downturn, the Chinese government is avoiding massive stimulus measures and issuing policies to boost domestic consumption. These efforts will directly affect consumption-related GHG emissions in the years to come, especially as the middle class grows.

Box 1 Chinas' social and economic strategic goals and prospects in the next 30 years

At the 19th CPC National Congress convened in October 2017, President Xi Jinping articulated the strategic goal of achieving "socialist modernization with Chinese characteristics for the new era":

From 2020 to 2035, on top of completing the building of a moderately prosperous society in all respects, China will work hard for another 15 years to achieve "basic socialist modernization." Within that time the goals are to increase considerably the proportion of China's middle-income population, greatly reduce the urban-rural gap in development and living standards, and ensure equal access to basic public services. Additionally, China aims to improve the quality of the natural environment (protect the "ecological environment" and a build a "beautiful China"). After achieving the 2035 modernization goals, China will work for another 15 years (2035 to 2050) to build itself into a great modern socialist country that is "prosperous, strong, democratic, harmonious and beautiful".

Domestic and foreign research organizations have interpreted these strategic goals differently. The basic outlook is:

Population: China's population growth will slow down between 2020 and 2030, and will peak around 2030, reaching 1.46 billion. After that, it will see negative growth. It is estimated that between 2031 and 2050, China's population will decline by 60 million. During this time, China's aging population will become increasingly prominent. By 2030 elderly people will account for 16.87% of the total population. **【This forecast is based on the World Population Prospects 2019 Revised Version (the Prospects) issued by the United Nations Economic and Social Council (United Nations, 2019). Countries usually take the Prospects as an important source for population data when doing research on low-carbon development trends.】**

Economic Growth: In the next 30 years, China's economic slowdown will be in line with the pattern of economic development of most countries. Between 2020 and 2030, China's annual GDP growth may decline from around 6% to around 5%. According to the forecasts of research organizations and scholars published between 2016 and 2018, China's GDP growth rate between 2020 and 2025 will be between 4.60% and 5.77% (median rate 5.4%), and between 2025 and 2030 will fall in the range of 4.28% to 5.5% (median rate 4.95%). **【The research reviewed includes: (Bai & Zhang, 2016; Bank of China "Research Team on the New Model of China's Economic Development," 2016; F. Cai, 2017; Lian, Zhou, Tang, & Liu, 2018; Li, Lou, & Wang, 2017; S. Liu, 2018; Sheng & Zheng, 2017; X. Wang & Zhou, 2017; Xiao & Wang, 2018; C. Zhang & Zheng, 2018)】**

Figure 2 Projection of population (blue) and GDP growth rate (orange) (2020-2050)



Development indicators: By 2030, China's per capita income level, human development index, and major modernization indicators will reach the level of mid and high-income countries. By 2040, major social and economic development indices will approach or reach the level of moderately developed countries (Hu & Zhang, 2017). The middle-income population will surge to over 60% of the total population (R. Zhang, 2019).

II. China has achieved multiple targets under its NDC ahead of schedule

China has made good progress in fulfilling most of the indicators under its first NDC, laying a solid foundation for achieving its 2030 targets. This report reviews progress in 15 quantitative indicators in China's 2015 NDC.

Nine targets for 2020 have been fulfilled ahead of schedule, including: CO₂ emissions per unit of GDP (carbon intensity) in 2019 dropped 48.1% from the 2005 level, and the target of reducing carbon intensity by up to 40% to 45% was fulfilled ahead of schedule. In 2019, China's photovoltaic solar (PV) installed capacity reached 204 million kilowatts, exceeding the 2020 goal. In addition, the installed capacity of wind power, the proportion of non-fossil energy in primary energy and the proportion of green buildings in new urban buildings in 2019 exceeded the 2020 goal. During the 13th Five-Year Plan period, the Transit Metropolis Demonstration Program has promoted public transit development, meaning that public transit will make up over 60% of transit in urban motorized travel in large and medium-sized cities by 2020.

The work to meet two of the key indicators is also on track. The share of natural gas in primary energy consumption and the share of strategic emerging industries in GDP are in line with planning expectations. The 2017 and 2018 data on coal bed gas production and annual geothermal use, however, reveal a gap with the 2020 goals.

Due to a lack of public data, it is not possible to estimate progress in meeting the emission reduction target for two HFCs and the gap with the 2020 goals.



Photo Credit: Diego Montero

Figure 3 Performance of key policy targets of China's NDC

Policy Targets	Performance of Key Policy Targets of NDC							
	2016	2017	2018	2019	Target 2020	Target 2020	Target 2030	Target Type in Domestic planning
CO ₂ emissions per unit of GDP fell compared to 2005	46%		48%		40%-45%		60%—65%	Mandatory
The share of non-fossil fuels in primary energy consumption	13.0%	13.6%	14.5%	15.3%	15%		20%	Mandatory
Forest stocks increased by 2005 (100 million cubic meters)	Achieved 2020 target in 2013				13	53	45	Mandatory
Average coal consumption of newly-built coal-fired generating units (g standard coal/kWh)			<300		300			Mandatory
The share of natural gas in primary energy consumption		7.6%	8.1%		10% or more			Predictive
Coalbed methane production (100 million cubic meters)		183.6			300			Predictive
Wind power installed (100 million kilowatts)	1.5	1.64	1.84	2.1	2			Predictive
Photovoltaic installation (100 million kilowatts)		1.3	1.74	2.04	Around 1			Predictive
The annual utilization scale of geothermal energy (10,000 tons of standard coal)		1900			5000			Predictive
The added value of strategic emerging industries accounts for the proportion of GDP		8.90%			15%	>17%		Predictive
Reduce the production and consumption of HCFC-22 for controlled use from the 2010 level					35%	67.5%		Mandatory
Control HFC-23 emissions					Effective control			Mandatory
Fertilizer and pesticide utilization		Zero growth			Zero growth			Predictive
The share of green buildings in newly built buildings			40%	65%	50%			Predictive
The share of public transport in motorized modes in large and medium cities					30%			Predictive

Sources: Documents and press statements from National Bureau of Statistics, Ministry of Ecology and Environment, Ministry of Housing and Urban-Rural Development and China Electricity Council; National White Paper on Climate Change, Statistical Yearbook and special planning including 13th Five-Year Electricity Plan, 13th Five-Year Energy Development Plan, etc.

Note: Target type is from China's economic and social development plans and sector-specific plans.

	Beyond expectation	On track	Below expectation	Unclear
--	--------------------	----------	-------------------	---------

III. Climate Goals of the 14th Five-Year Plan and the Long-Range Objectives Through the Year 2035

In the latest "14th Five-Year Plan", issued in 2021, and the "Outline of the Long-Range Objectives Through the Year 2035" (hereinafter referred to as the "Outline"), the implementation of the dual carbon goals and the response to climate change have already been fully laid out, providing a strong anchor for the carbon neutrality goal.

In the "Outline", it is proposed to "implement the 2030 NDC goal to combat climate change, formulate an action plan for achieving the carbon emission peak before 2030", "implement a system with carbon intensity control as the main factor and supplemented by total carbon emission control, and support qualified localities, key industries and key enterprises to take the lead in reaching the peak of carbon emissions", and "anchor efforts to achieve carbon neutrality by 2060 and adopt more powerful policies and measures". At the same time, specific targets and a series of emission reduction measures have been set (see table below).

Climate change targets		Reduce carbon dioxide emissions per unit of GDP by 18% by 2025
Cross-sector policies		<ul style="list-style-type: none"> • Increase the control of methane, hydrofluorocarbons, perfluorocarbons and other greenhouse gases. • Promote market-based mechanisms, including pollutant emission trading, energy use trading, water use trading and carbon emission trading.
Sector-specific policies	Energy	<ul style="list-style-type: none"> • Increase the proportion of non-fossil energy in total energy consumption to about 20%. • Upgrade the scale of wind power and photovoltaic power generation, develop offshore wind power and promote nuclear power construction. • Control fossil energy consumption, the scale and pace of development of coal-fired power construction, and promote the replacing of coal with electricity. • Plan the layout of future industries including hydrogen energy and energy storage.
	Industry	Accelerate the formulation and revision of mandatory national standards for energy consumption limits and energy efficiency of products and equipment.
	Transportation	Give priority to the development of urban public transportation, build non-motorized transport systems such as bicycle lanes and walking lanes, and transport long-distance goods by rail and waterways. Promote the electrification of urban public transport and logistics distribution vehicles.
	Building	Develop smart buildings, promote green building materials, prefabricated buildings and steel structure houses, and carry out the demonstration of near-zero energy consumption building projects.
	Agriculture and forestry	<ul style="list-style-type: none"> • The forest coverage rate should reach 24.1% in 2025. Improve the carbon sink capacity of ecosystems. • Develop water-saving agriculture and dry farming, implement pesticide and chemical fertilizer reduction actions, control agricultural film pollution, improve the agricultural film recycling rate, and promote the utilization of resources such as straw and manure.
	Waste	Promote the central incineration of sludge, to achieve an urban sludge disposal rate of 90%.

IV. Mid- and long-term goals in key sectors become increasingly clear

China's sectoral plans and policies during the 13th and 14th Five-Year plan periods are the concrete measures being taken to achieve carbon peaking around 2030 and the basis for China to update its NDC. Various ministries and departments have issued departmental plans, and successively updated or put forward more detailed, stronger and longer-term energy-saving and carbon reduction targets, policies, measures, and even medium-and long-term strategic plans for 2025 and 2030. Figures 4 and 5 outline the key post-2020 mid- and long-term targets and strategic action plans, major goals and policy measures.

Figure 4 Key strategies and plans that include post-2020 targets and actions



Figure 5 Key post-2020 sector-specific targets and policy progress

Energy and Electricity	2020	2025	2030	2035	2040	2045	2050
Total energy consumption control (100 million tons of equivalent coal)	49.8		Below 60				Stable
Share of non-fossil fuel in primary energy consumption (%)	> 15.30%		20%				More than 50%
Share of natural gas in primary energy consumption (%)	> 8.1%		Around 15%				
Energy consumption per unit of GDP (ton of equivalent coal/ 10,000 yuan, 2005)	-		Current World Average				
Share of coal-fired power units with ultra-low pollutant emissions	-		Above 80%				
Total coal consumption (100 million tons of equivalent coal)	28.3		29.4 ¹⁰				
Important policy progress			<ul style="list-style-type: none"> • Total control of energy consumption and total control of coal consumption – “13th Five-Year Plan for Energy Development” and “The coal industry’s 14th Five-Year Plan on high-quality development guidance” • National carbon trade market for electricity industry – “National Carbon Emission Trading Market Construction Plan (Electricity Generation Sector)” • Renewable energy quota system for electricity consumption- “Notice of the National Energy Administration of the National Development and Reform Commission on the Implementation of Renewable Energy Electricity Quota System (Draft)” issued in November 2018, “The Absorption of Clean Energy Action Plan (2018-2020),” “Notice on Promoting Subsidy-free Grid Parity for Wind Power and Photovoltaic Power Generation,” “Notice on Announcing the First Group of Grid Parity Projects for Wind Power and Photovoltaic Power Generation in 2019” • Establish quota responsibility system for total electricity generation from renewable energy in provincial administrative regions- “Notice of the National Energy Administration of the National Development and Reform Commission on the Establishment of a Guarantee Mechanism for Electricity Consumption of Renewable Energy” • More stringent standards for energy conservation and ultra-low emission of coal-fired power plants- “Plan for Fully Implementing Ultra-low Emission and Energy Conservation Transformation of Coal-fired Power Plants” • Financial incentives for the development and utilization of coalbed methane, etc.- “Notice on Subsidy Standards for the Development and Utilization of Coalbed Methane (Gas) during the 13th Five-Year Plan” • Increase the proportion of non-fossil energy in primary energy- President Xi Jinping during an important speech at the Climate Ambition Summit in December 2020 				

¹⁰ The coal industry’s “14th Five-Year Plan on high-quality development guidance” proposed that the national coal consumption will limit to about 4.2 billion tons by the end of the 14th Five-Year Plan period. We use 0.7 as a conversion factor to convert 4.2 billion tons of coal to 2.94 billion tons of standard coal.

Industry	2020	2025	2030	2035	2040	2045	2050
Carbon emissions per unit of industrial added value decrease by (%) compared with 2015	-	40%					Stable
Energy consumption per unit of added value of enterprise above designated size decreases by (%) compared	-	34%					More than 50%
HFCs production and consumption control compared with the baseline*	-	Freeze at the baseline level (2024)	Decrease 10% (2029)	Decrease 30%	Decrease 50%	Decrease 80%	
Important policy progress	<ul style="list-style-type: none"> Energy efficiency top runner system for energy-intensive industries- <i>Notice on publishing "Detailed Rules for the Implementation of the "Leader" System for Energy Efficiency in Energy-intensive Industries"</i> Industrial adjustment and upgrading, managing excessive capacity- "<i>Made in China 2025</i>," "<i>Industrial Green Development Plan (2016-2020)</i>" Transition to ultra-low emission in energy-intensive industries- "<i>Industrial Green Development Plan (2016-2020)</i>" Implementing mandatory standards for the quota of the energy consumption and energy efficiency quota- <i>Notice on publishing "Industrial Energy Conservation and Green Standardization Action Plan (2017-2019)"</i> The control of HFCs production and consumption- "<i>Kigali Amendment</i>" 						
Buildings	2020	2025	2030	2035	2040	2045	2050
Enhancement of cooling energy efficiency in large-scale public buildings	-		30%				
Enhancement of cooling energy efficiency in general	-		25%				
Market share of green and efficient cooling products increases by (%)	-	Above 20% (2022)	40%				
Improvement of energy efficiency level of cooling products such as household air-conditioners, multi-split air-conditioning and VRV air-conditioning system	-	Above 30% (2022)					
The rate of clean heating in northern China	-	70% (2021)					

What to Expect in China's Second Nationally Determined Contribution

Towards a Carbon Neutral Global Future 2021 Edition

Important policy progress	<ul style="list-style-type: none"> • Improve energy-saving design standards for new buildings, the proportion of green buildings and renewable energy buildings- <i>Notice on Issuing the "13th Five-Year Plan for Building Energy Conservation and Green Building Development"</i> • Requirements for Improving the Performance of Green Buildings- "<i>Green Building Assessment Criteria</i>" (GB/T50378-2019) • Promote prefabricated buildings- <i>Notice on publishing the "13th Five-Year Plan of Action for prefabricated buildings"</i>, "<i>Regulation of Prefabricated Buildings for Pilot Cities</i>", "<i>Regulation of Prefabricated Buildings for Industrial Bases</i>" • Promote clean heating in Beijing- "<i>Guidelines on Promoting Clean Heating in Northern Heating Areas</i>" • Fasten the reform of the energy conservation for existing buildings and extend building life-cycle- <i>Notice on the "Utilization and Retrofit of Existing Buildings in Cities"</i> • Financial incentives to encourage the consumption of green and high efficiency cooling products, etc.- <i>Notice on publishing the "Action Plan for Green and High Efficiency Cooling Plan"</i> 						
Transport	2020	2025	2030	2035	2040	2045	2050
Average fuel consumption of new vehicles (liter/100 km)	-	4					
Proportion of new energy vehicles in automobile production and sales (%)	-	Above 20%					
Specific energy of power battery system (watt-hour/kg)	-	350					
Important policy progress	<ul style="list-style-type: none"> • Improve fuel economy for automobiles- "<i>Parallel Management of Average Fuel Consumption of Passenger Vehicle Enterprises and New Energy Vehicles Rewards</i>", "<i>Limiting the Value of Fuel Consumption for Heavy Commercial Vehicles (GB30510-2018), (GB19578-2021)</i>", "<i>Limiting Value of Fuel Consumption for Passenger Vehicles</i>" which is scheduled to be implemented in 2021 • Enhance the promotion of ethanol gasoline as vehicle fuel- <i>Notification of the Establishment of a Monthly Report System for Expanding Production and Promotion of Bio-fuel Ethanol and for Encouraging Using Ethanol Gasoline as Vehicle Fuel</i>" • Increase the proportion of production and sales of new energy vehicles- <i>Notice on publishing the "Medium and Long-term Development Plan for Automobile Industry"; Notice on Printing and Distributing the Development Plan of the New Energy Automobile Industry (2021-2035)</i> • Increase the proportion of urban public transport and green commuting- <i>Notice on Publishing "Green Travel Action Plan (2019-2022)"</i> 						

Agriculture, Forestry and Waste	2020	2025	2030	2035	2040	2045	2050
Forest coverage rate (%)	23.2%	24.1%	>24%				
Important policy progress	<ul style="list-style-type: none"> • Improving forest coverage - <i>Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Long-term Goal for 2035; National Forest Management Plan (2016-2050)</i> • Large-scale land greening action- "<i>Opinion about Actively Promoting Mass Land Greening Action</i>" • Promote the resource utilization of wastes from livestock and poultry- "<i>Opinion about Accelerating the Resource Utilization of Wastes from Livestock and Poultry</i>" • Promote the integrated and centralized disposal of sludge- <i>Notice on Publishing the "13th Five-Year Plan for the Construction of National Urban Sewage Disposal and Recycling Facilities"</i> • Accelerate the establishment and promotion of domestic waste classification model- "<i>Implementation Plan of Domestic Waste Classification System</i>" 						

Sources: Websites of government departments such as Ministry of Ecology and Environment, Ministry of Housing and Urban-Rural Development, National Development and Reform Commission, Ministry of Transport and Ministry of Agriculture;
 “-” indicates unknown



V. Research foundation for the long-term emission pathway by 2050 is getting stronger

In recent years, domestic and foreign research organizations have jointly conducted multiple model and scenario analyses of long-term green and low-carbon development in China, providing a technical foundation for China's policymakers to strengthen long-term GHG emission control goals (see Table 1). The Institute of Climate Change and Sustainable Development, Tsinghua University (ICCS) and the Energy Foundation jointly launched a project titled Research on China's Low-Carbon Development Transition Strategy and Pathway in 2018. This research consists of 18 sub-topics and convenes the top research bodies in China to systematically analyze the pathways for mid- and long-term sustainable development and low-carbon transition, technological breakthroughs needed, and potential costs. The goal is to provide a scientific foundation for mid- and long-term GHG emission control targets and policies in light of new domestic and global conditions (Energy Foundation China, 2019).

Table 1 Research on China's long-term energy and low-carbon development strategies after 2015

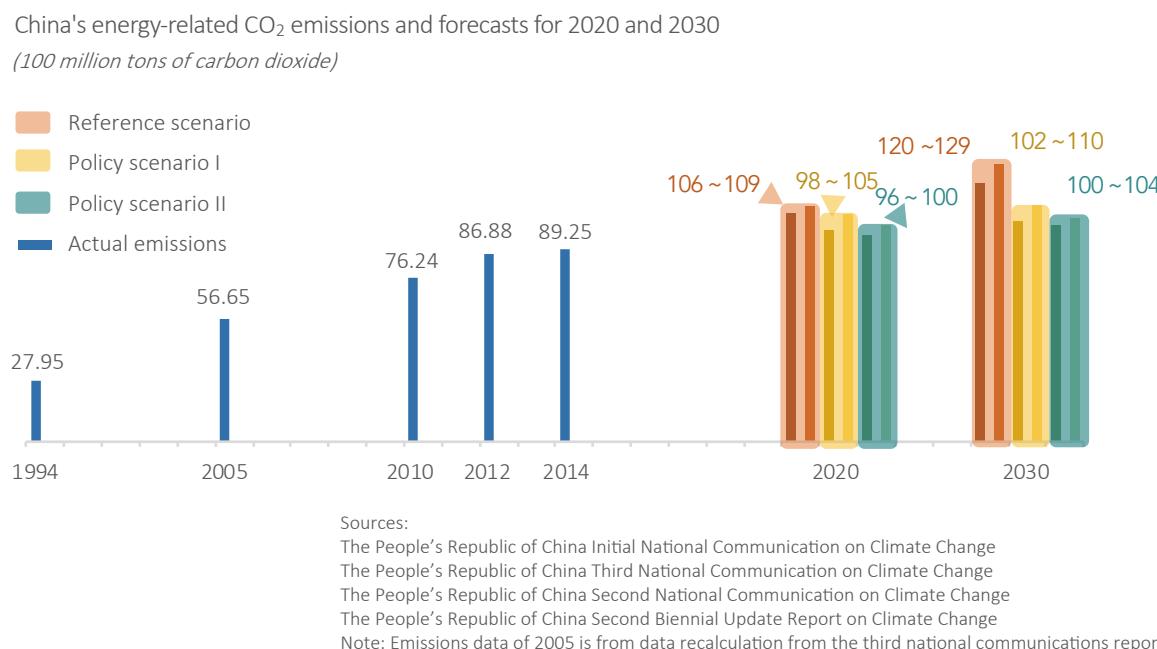
Institutions	Projects	Year of Publication
Institute for Climate Change and Sustainable Development of Tsinghua University Energy Foundation	China's Low-carbon Development Transformation Strategies and Pathways Research	2020
World Resources Institute	Vision 2050 Project	Ongoing
Rocky Mountain Institute	China 2050: A Fully Developed Rich Zero-Carbon Economy	2019
International Energy Agency	World Energy Outlook 2018	2018
National Center for Climate Change Strategy and International Cooperation Energy Research Institute Energy Innovation	China's Climate Change Policies and Actions	2017
China Council for International Cooperation on Environment and Development Green Transition Research Group	China's Green Transition Prospects 2020-2050	2017
National Center for Climate Change Strategy and International Cooperation Energy Research Institute The State Information Center	Macro-strategy of China's Low-carbon Development	2016
Energy Research Institute Rocky Mountain Institute Lawrence Berkeley National Laboratory Energy Foundation	Restructuring Energy: A Roadmap for China's Revolutionary Energy Consumption and Production Pathway to 2050	2016
China Academy of Engineering	China Energy Strategy Research	2016
Energy Research Institute Energy Foundation et al.	China 2050 High Renewable Energy Penetration Scenario and Roadmap	2015

Source: Compiled by iGDP

Most existing research agrees on what China's emission trajectory will be up to 2030. With full implementation of current emission reduction policies, China is very likely to meet carbon peak and carbon intensity goals by 2030 (den Elzen et al., 2019; Gallagher, Zhang, Orvis, Rissman, & Liu, 2019; Ge, Liu, Wang, & Zheng, 2018; Q. Liu, Gu, Teng, Song, & Chen, 2017). But in order to meet the 2°C goal, China will need to cut emissions more quickly after 2030 (Fu, Zou, & Liu, 2015). Model analysis from Tsinghua University's "Research on China's Long-term Low-Carbon Development Strategy and Transformation Path" shows that under a 2°C scenario, the total carbon dioxide emissions of primary energy consumption will reach 9.42 billion tons of CO₂e in 2030 and will be reduced to 2.92 billion tons of CO₂e in 2050, with improvements in the electrification level of the end-use energy sector and adopting carbon capture and storage technology playing an important role (He et al., 2020).

In the People's Republic of China Third National Communication on Climate Change submitted in June 2019, China devotes a chapter to future CO₂ emission trends, setting three future emission scenarios based on domestic and foreign studies (see Figure 6). Policy Scenario I and Policy Scenario II consider both policies driving economic upgrading and transition, and strong carbon emission curbing policies. Under these two policy scenarios, China will see a slow increase in, and then peaking of, energy-related CO₂ emissions between 2020 and 2030.

Figure 6 China's energy-related CO₂ emissions and projections for 2020 and 2030



Box 2 Analysis of China's emission scenarios by IEA World Energy Outlook 2018

The World Energy Outlook 2018 published by the International Energy Agency (IEA) modeled a new policy scenario (the scenario under which all NDC measures and actions are implemented) and SDG scenario (the scenario required to achieve the UN 2030 SDGs) based on the global context since the adoption of the Paris Agreement and analysis of carbon emissions in various countries (IEA, 2019).

Under the new policy scenario, if China implements stricter energy conservation and emission reduction standards on top of achieving strategic plan goals for 2020, and substantially increases the proportion of clean energy consumption and dissemination of low-carbon technologies, expands the sectoral coverage of national carbon trading scheme, enhances the co-benefits of air pollution control and carbon emission reduction, it will peak carbon emissions by 2030 and the peaking level will be lower than the carbon intensity target level in China's NDC (see Table below).

Under the SDG scenario, if China aims to achieve the 2030 UN Sustainable Development Goals, its carbon emissions will peak around 2025 and drop quickly thereafter.

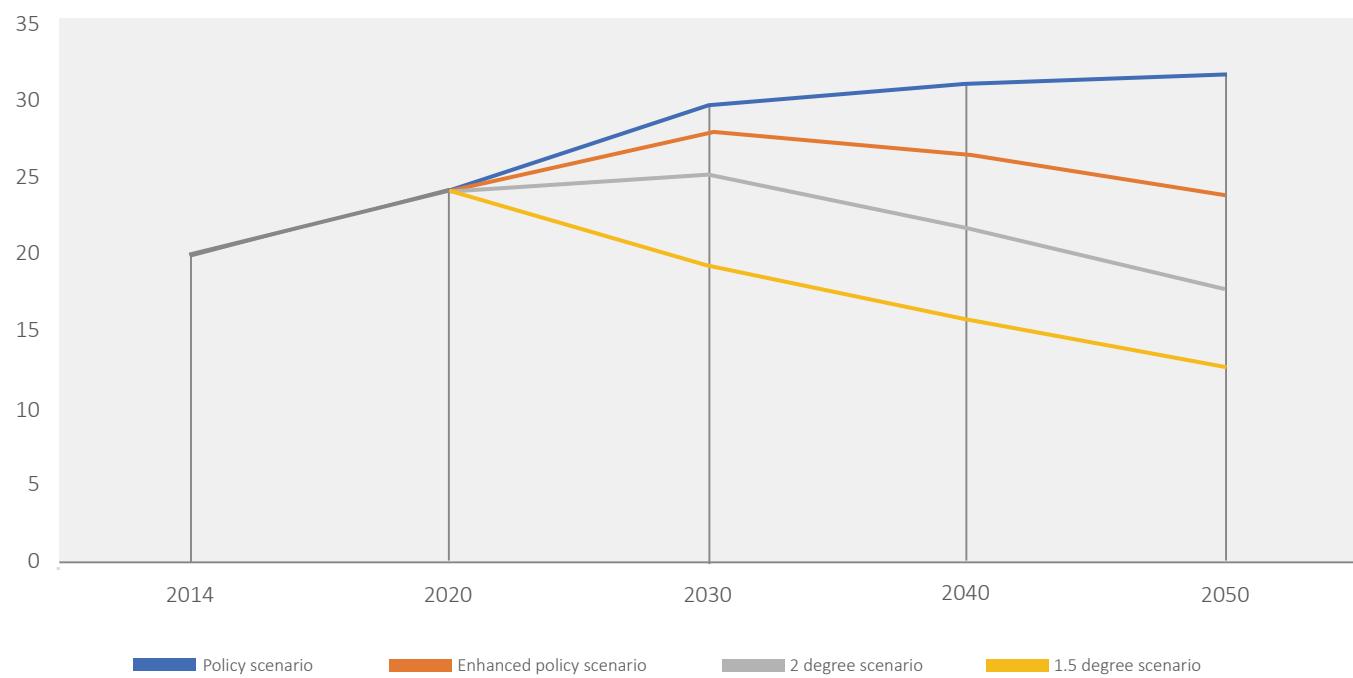
Scenario	2020	2025	2030	2040
Emissions based on NDC 2020 and 2030 intensity targets				
NDC_40%+60% intensity target	116		128	
NDC_45%+65% intensity target	107		117	
Emissions projections based on IEA scenario analysis				
IEA_New policy scenario		97	96	91
IEA_SDG scenario		84	98	32

Note: Emission levels are estimated based on NDC intensity targets, GDP growth rate of 2019 and 2020 was set at 6.3% and 6.1% respectively. GDP growth rate of 2021-2025 and 2026-2030 was set at 5.5% and 5.0%, which are based on median values of emission estimations from different relevant studies.

In addition, many research organizations have conducted analysis of non-CO₂ GHG emission trends and emission reduction actions, and have estimated potential emission reductions under stronger regulation. Tsinghua University's "Research on China's Long-term Low Carbon Development Strategy and Transformation Path" shows that under China's current NDC objectives and existing policies, non-CO₂ GHG emissions will continue to rise, reaching 3.17 billion tons of CO₂e by 2050. In contrast, under a scenario of cost-effective emission reduction measures, non-CO₂ GHG can peak before 2030 or around 2025, and emissions will drop to 1.761 billion tons of CO₂e in 2050 (in the 2°C temperature control target scenario) (He et al., 2020). The World Resources Institute also analyzed China's non-CO₂ emission trends under different policies (Figure 7). Under a Reference Scenario (China only implements relevant policies announced at the end of 2015), between 2012 and 2030, emissions from industrial processes may triple and emissions from other sectors will remain stable or flatten out. Under an Existing Policy Scenario (based on existing policies through the end of 2018), by 2030 non-CO₂ emissions will decrease by 383 million tons of CO₂e compared to the Reference Scenario. Under an Intensification Scenario (based on emission cutting solutions exceeding the existing policy scenario), if strong measures are taken, non-CO₂ emissions will be kept at the 2012 level by 2030 (Song, 2019). A scenario analysis by the Chinese Academy of Sciences shows that with weak non-CO₂ GHG emission control, the peaking time of CO₂ does not necessarily coincide with that of total GHG emissions (Q. Liu et al., 2017). According to research by the Lawrence Berkeley National Laboratory (LBNL), China is likely to peak GHG emissions by 2023 with intensified control policies (Lin, Khanna, & Liu, 2018).

In some research on non-CO₂ emissions, different scenario analyses are used to predict methane emission reduction potential in landfills. With 2012 as the baseline year, it is predicted that by 2030, with stronger emission control, methane emissions will drop by 970,000 tons, or 53.89% from the baseline scenario (equivalent to 20.37 million tons of CO₂e) (Cai et al., 2018). Research conducted by the National Center for Climate Change Strategy and International Cooperation (NCSC) and the American Energy Innovation Council (AEIC) (Q. Liu et al., 2016) shows that industrial HFC emission reduction has some of the largest emission reduction potential. Under a scenario of intensified HFC emission control (emissions will be frozen at the baseline level as of 2024), China will peak HFC emissions in 2030 and the peaking level will be at one billion to 1.2 billion tons (Fang et al., 2016). Without any control over HFC consumption, HFC emissions will continue to rise through 2050, and the cumulative emissions between 2018 and 2050 will reach about 19.6 billion tons of CO₂e. If China implements the Kigali Amendment, it will gain huge climate benefits shortly after the peaking of HFC emissions (College of Environmental Sciences and Engineering of Peking University, 2018). Some research organizations have studied specific HFCs, including HFC-134a. According to the emission reduction research on the car refrigerant with low global warming potential replacing HFC-134, if China controls the use of HFC-134a according to the timeframe under the Kigali Amendment, then between 2040 and 2050, China will cut 41 million tons of CO₂e on average every year (College of Environmental Sciences and Engineering of Peking University, 2019). The series of studies provided feasibility research for setting additional non-CO₂ GHG emission reduction targets.

Figure 7 Non-CO₂ GHG emissions projection under different scenarios (Mt CO₂e)



Source: (He et al, 2020)



PROSPECTS FOR CLIMATE ACTION

The global call for enhanced climate action is getting louder. As a major emitter, China has stated that it will honor its obligations and “guide international cooperation on climate change, and become an important participant, contributor and leader of global ecological progress”, as mentioned in the report of the 19th CPC National Congress. China has fulfilled many commitments under the Paris Agreement ahead of schedule, and is also working to peak carbon emissions around 2030.

A review of overall policy trends, analytical models, and the specific low-carbon strategies and policies of key sectors over the past five years shows that the following aspects of the second NDC will be of central importance:

1. Prospects: Raising the ambition of the long-term GHG emission reduction vision toward 2050
2. Targets: Setting additional total carbon control targets and intensifying non-CO₂ GHG control targets by 2025
3. Actions: Updating and intensifying specific emission reduction measures according to the latest sectoral strategic measures.

I. Prospects: Establishing a long-term GHG emission reduction roadmap

The Paris Agreement called for parties to submit NDCs by 2020, control the global temperature rise below 2°C by 2050, strive to achieve the goal of 1.5°C by 2050, and voluntarily submit long-term low greenhouse gas emission development strategies (LT-LEDS). As of February 2021, 29 countries and regions have officially notified the Convention Secretariat of their long-term low-emission strategies and put forward greenhouse gas emission reduction targets and paths toward 2050. France has updated its low-carbon strategy and a number of countries are in the final stage of formulating long-term low-emission strategies for submission this year.

Figure 8 Countries that have already submitted long-term low-emissions strategies (Data accessed by 2021/2)

Country	Latest Submission Date	Long-term Target	Domestic Legal Force
Canada	2016-11-17	By 2050, economy-wide GHG emissions are reduced by 80% compared to 2005	/
Mexico	2016-11-16	By 2050, economy-wide GHG emissions are reduced by 50% compared to 2000	Climate Change Act 2012
United States	2016-11-16	By 2050, economy-wide GHG emissions are reduced by 80% compared to 2005	/
Benin	2016-12-12	No target set for 2025 or 2050	/
Germany	2017-04-05	Achieve carbon neutrality by 2050, economy-wide GHG emissions are reduced by 80-95% compared to 1990, and break down targets by sectors	Approved the Climate Protection Plan 2050 and set the climate cabinet

France	2017-04-18	By 2050, economy-wide greenhouse gas emissions are reduced by 75% compared to 1990, and break down targets by industry	Set a 2050 carbon-neutral target in the Energy and Climate Act
Czech Republic	2018-01-15	Strive for an economy-wide GHG emission of 39 million tons of CO ₂ eq by 2050 (equivalent to an 80% reduction from 1990)	Climate Protection Policy
United Kingdom	2018-04-17	By 2050, economy-wide GHG emissions are reduced by 80% compared to 1990	The UK Climate Change Act
Ukraine	2018-07-30	By 2050, economy-wide GHG emissions are reduced by 31-34% compared to 1990	/
Marshall Islands	2018-09-25	An economy-wide goal of net-zero GHG emissions and 100% renewable energy by 2050	/
Fiji	2019-02-25	Economy-wide net-zero GHG emissions by 2050	To be included into the ongoing Climate Change Act
Japan	2019-06-26	By 2050, economy-wide GHG emissions are reduced by 80% compared to 1990	Plan for Global Warming Countermeasures released in 2016
Portugal	2019-09-20	Achieve carbon neutrality by the end of 2050, and decrease greenhouse gas emissions in the whole economy by 50-60% compared to 1990	/
Costa Rica	2019-12-12	Achieve net-zero greenhouse gas emissions throughout the country and within its territory by 2050	/
European Union	2020-03-06	Achieve climate neutrality by 2050	European Green Deal, European Climate Law, Regulation on the Governance of Energy Union and Climate Action
Slovakia	2020-03-30	Strive to achieve climate neutrality by 2050	Proposes to establish the "European Green Deal and Low Carbon Transition Committee" to the Government of the Slovak Republic

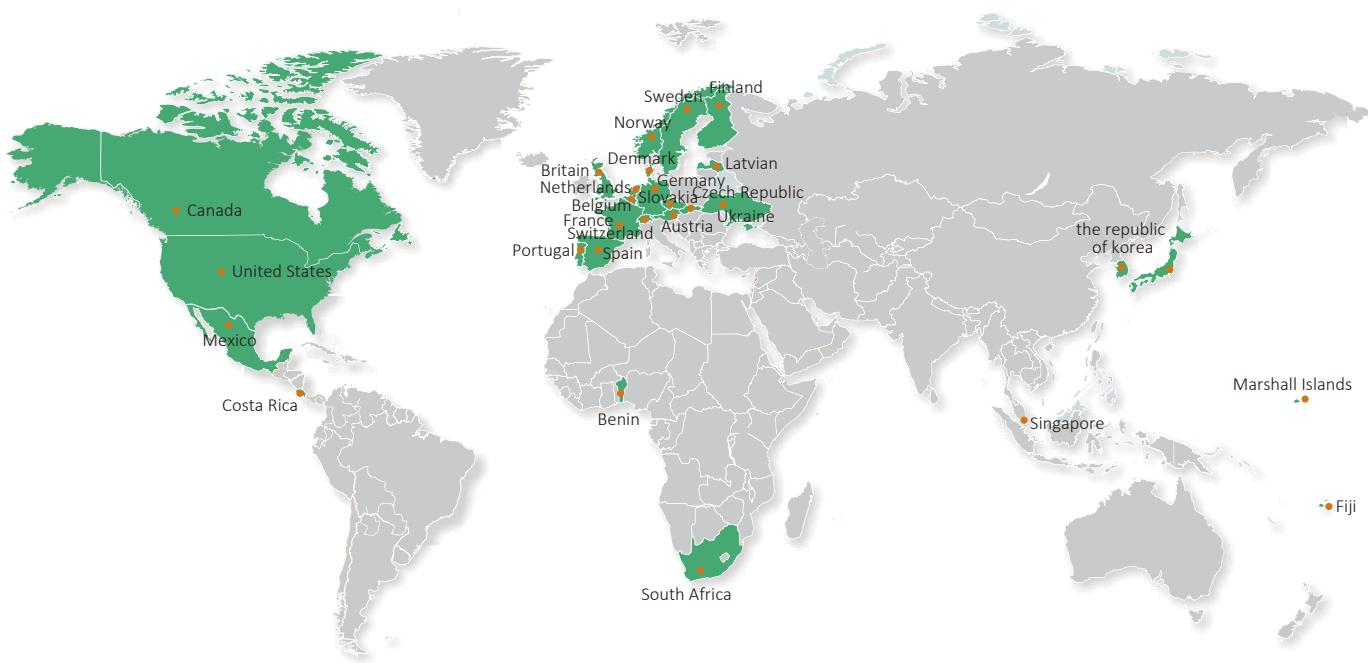
What to Expect in China's Second Nationally Determined Contribution

Towards a Carbon Neutral Global Future 2021 Edition

Country	Date	Target Description	Policy Framework
Singapore	2020-03-31	Reduced emissions to 33 MtCO ₂ e and achieve net-zero emissions by the second half of this century	/
South Africa	2020-09-23	Achieve the goal of net-zero economy in 2050	Climate Change Act (coming soon)
Finland	2020-10-06	Achieve carbon neutrality by 2035 and reduce greenhouse gas emissions by at least 80% compared with 1990	Set up a ministerial working group on climate and energy
Norway	2020-11-25	By 2050, reduce greenhouse gas emissions in the whole economy by 80-95% compared with 1990	Climate Change Act
Latvia	2020-12-09	Achieve climate neutrality by 2050	/
Belgium	2020-12-10	Has no overall emission reduction targets, only regional emission reduction targets. The Walloon region requires carbon neutrality to be achieved by 2050, and greenhouse gas emissions to have dropped by 95% compared with 1990; Flanders requires climate neutrality by 2050; Brussels-Capital Region requires carbon neutrality by 2050	/
Spain	2020-12-10	Achieve carbon neutrality by 2050	Climate Change and Energy Transformation Act
Sweden	2020-12-11	Achieve the goal of net-zero greenhouse gases emission in 2045, and emissions should be reduced by at least 85% compared with 1990	Climate Law, establish a climate policy committee
Netherlands	2020-12-11	Reduce greenhouse gas emissions by 95% by 2050 compared with 1990	Climate Change Act
Austria	2020-12-11	Achieve climate neutrality by 2015 and no use of nuclear power	Climate Change Act
Republic of Korea	2020-12-30	Achieve carbon neutrality by 2050	/
Denmark	2020-12-30	Achieve climate neutrality by 2050	Danish Climate Act

Switzerland	2021-01-28	Achieve net-zero greenhouse gases emissions by 2050	Carbon Dioxide Act
France	2021-02-08	Achieve carbon neutrality by 2050, greenhouse gas emissions in the whole economy should decrease by 75% compared with 1990, and there are sector-specific goals	Energy and Climate Bill

Figure 8 Countries that have already submitted long-term low-emissions strategies
(Data accessed by 2021/2)



China recently announced targets to peak carbon emissions by 2030 and achieve carbon neutrality by 2060. Observers are now closely watching to see the specific policies and measures that are developed in service of these medium and long-term goals and how they will shape China's second NDC. Following the principle of common but differentiated responsibility, and drawing upon other countries' existing national strategic plans, the new national roadmap will lead to the setting of specific emission reduction measures and mechanisms, with periodic evaluation and adjustment, en route to achieving the carbon neutrality goal. Specific targets and their periodic adjustments will be decided based on a foundation of low-carbon development research and China's developmental conditions. These actions will be incorporated into future mid- and long-term national economic and social development plans, and brought into alignment with the mid- and long-term plans of various sectors to provide a stable and consistent institutional guarantee for estimating and intensifying GHG control goals, actions and policies.

II. Targets: Setting additional total carbon control targets and intensifying non-CO₂ GHG control targets

1. Total energy-related CO₂ emission control targets

Setting total energy-related CO₂ emission control targets by 2025 and 2030 (hereafter referred to as total carbon control) will be necessary to peak CO₂ emissions around 2030 and may lead to achievement of an earlier peak, as well as generate positive impacts for controlling long-term GHG emission trends. The quantifying of a total carbon control target, and not just a year, will be decided according to the *People's Republic of China Third National Communication on Climate Change*, which predicts China's energy-related CO₂ emission trend between 2020 and 2030. The total carbon control target will not necessarily contribute to extra GHG emission reduction beyond existing NDCs. However, under China's environment and climate change regulation regime, setting total carbon control targets will greatly stimulate policy implementation. For that reason it is one of China's most anticipated GHG emission reduction actions.

Total carbon control is not a new policy. Instead, it is formulated based on a host of binding and anticipatory policies including CO₂ peaking target, carbon intensity reduction target, total coal target and total energy target. Although China did not specify a peak emission target when proposing its peaking year, to peak CO₂ emissions around 2030 China has outlined a reasonably clear economic and social development pathway. Taking into consideration the GDP growth target and carbon intensity reduction target during the 13th and 14th Five-Year Plan periods, estimating a target range is straightforward. The NDRC and NEA's *Energy Production and Consumption Revolution Strategy (2016 to 2030)*, issued in 2016, raised the following strategic targets: between 2021 and 2030, the use of renewable energy, natural gas and nuclear power should keep increasing and the use of high-carbon fossil energy should drop substantially. Total energy consumption should be limited to below 6 billion tons of standard coal, and non-fossil energy and natural gas should account for about 20% and 15% of total energy consumption, respectively. This document also points to future trends for energy-related CO₂ emissions.

Total carbon control would be a breakthrough policy measure. It would be conducive to long-term energy transition, green development, and policy implementation. Compared to total coal and energy control, total carbon control would give local governments a more flexible mechanism and strike a balance between coal control and non-fossil fuel development without imposing a single solution. It would also incentivize local governments to try their best to increase the share of non-fossil fuel in energy consumption and expand the economic development space. This would stimulate the restructuring of both the energy mix and green industry. In terms of institutionalization and mechanisms, the function of responding to climate change has shifted to the newly-created Ministry of Ecology and Environment, which is a major institutional restructuring of the CPC Central Committee and the State Council. This restructuring will better align China's climate change response with environmental pollution control. The existing environmental regulation mechanism in China, especially on air and water, mainly works through the system of control, planning, standards, licensing, monitoring and law enforcement. Setting a total carbon control target is an important step to promote institutional integration. The future climate change response work, from monitoring to the setting of targets, policies and plans, and to supervision and implementation, is likely to better synergize with pollution control and environmental protection.

Local governments have tried to set absolute total control indicators and targets for energy-related CO₂ emissions. As early as during the 12th Five-Year Plan period, Beijing's Municipal People's Conference passed the legislation of the *Decision on Launching Pilot Carbon Trading Scheme with the Precondition of Strictly Controlling Total Carbon Control*, and implemented a dual control and dual reduction mechanism to control total energy consumption and intensity, and total carbon emissions and intensity. Shanghai incorporated mid and long-term carbon emission reduction targets into its five-year plan for national economic and social development and overall urban development master plan. During the 13th Five-Year Plan period, Shanghai set the total carbon control targets by 2020 and annually, and broke them down to key sectors of industry and transport. Wuhan published the *Wuhan Carbon Emission Peaking Action Plan (2017 to 2022)*, which sets the peaking year and total emission level and adopts accountability system for various districts and key sectors. These pilot programs will provide first-hand experience and a foundation for policymaking at the national level.

Box 3 Recommendations on setting total carbon control targets

Background

During the 12th Five-Year Plan period, against the backdrop of an average GDP growth rate of 7.8%, CO₂ emissions per ten thousand yuan of GDP dropped by 21.8%, exceeding by 1.8% the target under the 12th Five-Year Plan, and CO₂ emissions per unit of GDP decreased by 5%. During the 13th Five-Year Plan period, the reduction target of CO₂ emission per unit of GDP is 18%, equal to an annual decline rate of 3.9%. In reality, China's GDP growth has slowed down. In 2016, 2017 and 2018, the GDP growth rate was 6.7%, 7.1% and 6.3%, respectively. CO₂ emissions per unit of GDP declined by 5.1% and 4% in 2017 and 2018, respectively. Although future domestic and global political and economic trends are impossible to accurately predict, it is very likely that China's economic growth will shift from high-speed growth to medium-high speed and high-quality growth. Under the SDG scenario, if China aims to achieve the 2030 UN Sustainable Development Goals, its carbon emissions will peak around 2025 and drop quickly thereafter.

Setting total control targets

When setting absolute total carbon control targets, China needs to comprehensively consider its current capacity and institutional foundation, as well as its potential carbon emission trajectory. Setting the targets should draw upon energy-related CO₂ emission forecasts between 2020 and 2030 under the *People's Republic of China Third National Communication on Climate Change*. Based on the carbon intensity reduction achieved during the 11th, 12th and 13ths Five-Year Plan periods and the carbon intensity reduction commitment by 2030, a combination of carbon emission growth in the past years, and energy-related GHG emission scenario analysis based on the consensus of social and economic development trend prediction, it is possible to estimate an objective range of total GHG control targets in a certain region or sector. For a total target, it is possible to take a quantitative modeling and scenario analysis covering carbon emission prediction in all economic sectors, supported by carbon emission prediction models reflecting macro social, economic, energy and environmental changes, and decide the feasible range for total control targets.

Breakdown of total carbon emissions

We can combine top-down and bottom-up methods to formulate a solution through consultations between the central and local governments. We can combine total carbon increase control and total carbon emission reduction control in different regions based on regional economic development. For the specific methods taken by various regions and industries, we need to make gradual changes according to trends in economic development, structural adjustment, technological upgrading, energy replacement potential, air quality and total air pollution control. For regions and sectors that have entered a post-industry stage that are taking the lead in peaking carbon emissions around 2020, achieving negative total coal consumption growth, and are required to impose special limits on air pollutant discharge, priority can be given to total carbon emission reduction control. These regions and sectors include priority development areas within the Beijing-Tianjin-Hebei Region, Yangtze River Delta, Pearl River Delta, and steel, cement and other industries. For less developed regions in central and western China and sectors not able to peak carbon emissions during the 14th Five-Year Plan period, total emissions will continue to rise and total carbon emission increase control can be adopted. The total emission control or total emission increase control will be incorporated into the five-year and annual plans of social and economic development. Evaluation will be conducted in line with the five-year national plan period, and fulfillment of indicators in the interval years will be more flexible. Allocation between the years is allowed to reduce the impact of real GDP growth higher or lower than expected.

Combining the evaluation of progress in meeting total carbon control targets and the existing pollution emission reduction evaluation system

Evaluation of progress in meeting total carbon control targets can take into account market and legal measures designed

to promote the transformation of government functions. First, we must make basic emission statistics more comprehensive, and intensify the reporting and verification system supported by the existing carbon intensity and total air pollution control evaluation system. In addition, we need to strengthen legal constraints and strictly implement energy-saving laws, regulations and standards. Activities that violate industry binding energy consumption standards or failure to report carbon data exactly will be punished more severely in accordance with the law. In this way, an evaluation system on total carbon control targets will be created, based on initial and final-stage administrative evaluation, strengthened legal supervision and long-acting market regulatory measures.

Combining total carbon emission control targets with the total quota in the national carbon trading market

The national carbon trading market now decides total emission quotas in market sectors in a bottom-up approach, and then allocates them to emission sources sector by sector. Total carbon control targets, on the other hand, are allocated by the national government to local governments in a top-down approach, and the goals are set according to regional carbon intensity targets and GDP growth rate. These two approaches could be combined effectively so that industrial and regional targets are integrated and form dual constraints, reflecting the principle of "emitter pays."

Box 4 Case study of local carbon cap: Absolute carbon cap under long-term carbon emission reduction targets in Shanghai

Shanghai is the first city in China that set the mid and long-term targets of absolute total energy-related CO₂ emission control. The *Master Plan of Urban Development in Shanghai* (2017 to 2035) issued in January 2018 states:

- Total carbon emissions and per capita carbon emissions will peak by 2025
- By 2035, total carbon emissions will drop by 5% compared to the peak level and the energy consumption per ten thousand yuan of GDP will be limited to below 0.22 tons of standard coal

The Comprehensive Work Program for Energy Conservation and Emission Reduction and GHG Emission Control during the 13th Five-Year Plan Period in Shanghai issued in April 2018 for the first time set a target of limiting CO₂ emissions to below 250 million tons by 2020.

Setting mid and long-term energy-related CO₂ absolute total emission control targets was a gradual process. The targets took shape at the end of the 12th Five-Year Plan period. Since 2015, Shanghai has raised its annual CO₂ emission control target in the annually-published *Key Work Arrangement on Energy Conservation and Climate Change*. Between 2016 and 2019, the city has allocated an increase in CO₂ emission of up to 26.40 million tons.

Cap on increased carbon emission during the 13th FYP in Shanghai (2015-2019)

2015	Keep it under 8.7million tons, strive to keep it around 7.8 million tons.
2016	Keep it under 6.5 million tons, strive to keep it in 6 million tons.
2017	Keep it under 5.8 million tons.
2018	Keep it under 5.15 million tons.
2019	Keep it under 9 million tons.

During the 12th and 13th Five-Year Plan periods, using sophisticated energy conservation indicators, Shanghai set reduction targets for CO₂ emissions per unit of GDP, broke them down by district and evaluated their progress. Compared to energy conservation indicators, however, Shanghai's carbon indicators are not sufficiently binding for local governments, key sectors and industries. Shanghai has taken the approach of "inter-agency interaction and horizontal-vertical combination" and allocated energy reduction tasks to relevant sectors, districts and prefectures. Carbon intensity indicators are only imposed on districts and broken down by sector, and total carbon control indicators are imposed on only two key sectors of industry and transport. For example, Shanghai will limit municipal urban emission increase to below 9 million tons in 2019, and the control targets for industry and transport are 350 tons and 250 tons respectively, accounting for 78% of total municipal emissions.

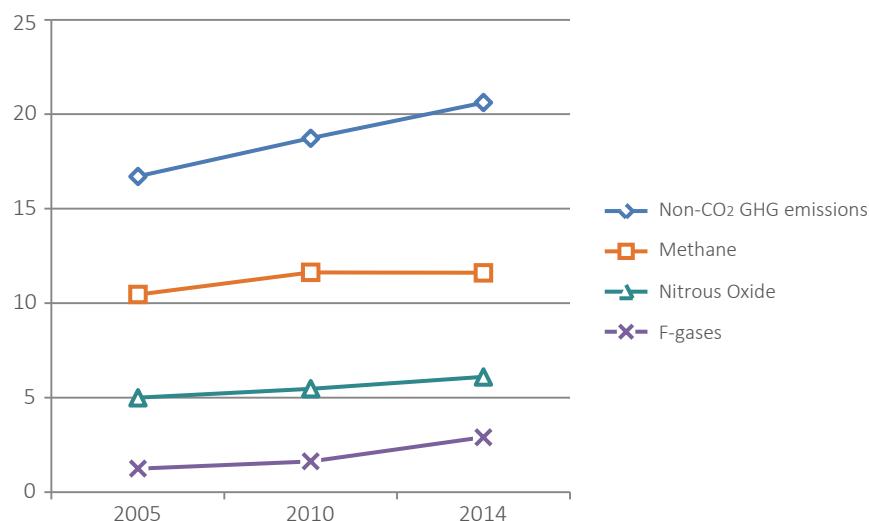
Setting absolute total carbon control targets is the starting point for Shanghai to build an institutional system on total carbon control. Prioritizing carbon emission control in Shanghai's social and economic growth target system requires stronger institutional support, including building a legal system to enforce total carbon control, and a statistical, testing, evaluation and management structure to evaluate carbon indicators.

Source: Compiled by iGDP

2. Non-CO₂ GHG Emissions Reduction Targets

Setting targets for non-CO₂ GHG emissions, which account for 18% of China's total GHG emissions, could also strengthen China's commitment to climate change action. China's commitment to achieve CO₂ GHG emissions peaking around 2030 is limited to energy-related carbon emissions. While China has adopted a series of policy measures to reduce non-CO₂ GHG emissions, it did not propose an overall target. Developing emission reduction targets and enhancing policy strength for non-CO₂ GHG emissions in the new NDC could be an additional contribution to addressing climate change. It could also help China propose an economy-wide reduction target for 2050 long-term low emissions strategies. Looking to international conventions and post-2015 domestic policy actions, as well as the latest research results, it is clear there are different policy options for non-CO₂ GHG emissions reduction target setting, including a non-CO₂ emissions peaking target, a total HFCs emission reduction target, and sector-specific methane emissions reduction targets.

Figure 9 China's Non-CO₂ GHG Emissions (2005, 2010, 2014)



Source: (Ministry of Ecology and Environment, 2019a, 2019b)

Non-CO₂ emissions peaking target: China's overall non-CO₂ GHG emissions have been steadily rising, among which methane, nitrous oxide and F-gases (mainly HFCs) account for 56%, 30% and 14%, respectively. According to China's Third National Communication on Climate Change and research analysis from the World Resources (WRI), methane emissions are close to flat; nitrous oxide emissions should peak soon given the requirements of the 2015 NDC;¹¹ and F-gases are a major contributor for the overall growth of non-CO₂ GHG emissions. In the 2016 Kigali Amendment, China is obliged to freeze the production and consumption of HFCs at the baseline level in 2024, and gradually begin to reduce the production and consumption of HFCs, which basically locks in China's F-gases emissions. Aside from this, WRI's latest research shows that under the current policy scenario, China's non-CO₂ GHG emissions will "grow modestly between 2020 and 2030, and will remain flat between 2030 and 2040." It also suggests "an ambitious non-CO₂ GHG target should stabilize emissions starting in 2020. Those emissions will begin to decline as early in the decade as possible."

Total HFCs emission reduction target: HFCs emission reduction has the largest potential for non-CO₂ GHG emissions reduction in China in the future. The emission reduction targets can be estimated based on the emission reduction roadmap in the Kigali Amendment. With the average of 2020, 2021 and 2022 as the baseline, China will freeze the production and consumption of HFCs at baseline starting in 2024, and reduce the production and consumption of HFCs by 10%, 30%, 50% and 80% from baseline levels in 2029, 2035, 2040 and 2045 (UNEP, 2017). Following China's formal ratification of the Kigali Amendment, many relevant industry policies are starting to be developed. For instance, the newly-issued "Green High-Efficiency Cooling Action Plan" proposes to "guide enterprises to accelerate the adoption of air-conditioning production lines using low-GWP [global warming potential] refrigerants and to limit the use of HFCs."

Sector-specific methane emissions reduction targets: Sector-specific methane emission reduction targets could focus on energy-related or municipal solid waste (MSW)-related emissions reduction. Methane emissions reduction from coal mining and post-mining activities has the second largest potential for non-CO₂ GHG emissions control, and is also one of the most important non-CO₂ GHG emissions reduction measures in the energy sector. "13th Five-Year Plan for the development and utilization of coalbed methane (coal mine gas)" proposes a series of industry development goals, and points out that by 2020, the utilization rate of coalbed methane and coal mine gas will increase by 3.6% and 14.7% respectively compared with 2015. The implementation of these goals and actions will reduce methane emissions from coal mining. Methane emissions from municipal solid waste, while accounting for less than 12% of China's methane emissions, can be reduced in cost-effective ways. The solid waste management measures based on the "Work Plan for Zero Waste City Pilot Construction" and the establishment of a waste classification system in the new "Solid Waste Law" will be a new driving force for further reducing MSW-related methane emission, which cannot be ignored.

Box 5 Contribution of China's "Green High Efficiency Cooling Plan" to GHG emissions reduction

Cooling technology gives people the ability to live in a suitable space during the hot season, to maintain food quality for a long time, and is also an indispensable part of healthcare service. However, the power required for cooling technology may come from fossil energy, resulting in a large amount of carbon emissions. Many refrigerants that have been used in cooling systems also have relatively high global warming potential (GWP). Developing and promoting green and high-efficient cooling technologies will contribute to addressing climate change and achieving sustainable development goals.

In October 2016, the Kigali Amendment was agreed to by the parties to the Montreal Protocol, requiring countries to phase down the production and usage of HFCs. The move is considered "to avoid global warming of 0.5°C by the end of the century, and to provide strong support for the Paris Agreement's goal of controlling global temperature rise to within 2°C by the end of the century." Combined with replacing with lower GWP refrigerants and improving energy efficiency, these actions will double the pace of emissions reduction.

China is the world's largest producer, consumer and exporter of cooling technology. As an important contributor to the

¹¹ 2015 NDC set a target on zero growth for the use of fertilizers and pesticide.

Paris Agreement and the Kigali Amendment, China's efforts on green and high-efficient cooling development will also make great contributions to addressing climate change. In June 2019, the National Development and Reform Commission of China promulgated the "Green High-Efficiency Cooling Action Plan." The plan is divided into four parts: major significance, general requirements, main tasks and complementary measures. It proposes the main tasks and a series of policy objectives and measures to strengthen standards, improve product supply, promote green and efficient cooling consumption, promote energy-saving renovation, and deepen international cooperation. These actions should be an important part of China's contribution to further strengthening efforts to deal with climate change.

The plan proposes that "by 2022, the energy efficiency of household air conditioners, multi-zone cooling products will increase by more than 30%, the market share of green efficient cooling products will increase by 20%, and the annual energy saving will be about 100 billion kWh. By 2030, the energy efficiency of large-scale public buildings will increase by 30%, the overall energy efficiency of overall cooling will increase by more than 25%, the market share of green high-efficiency cooling products is increased by more than 40%, and the annual energy saving is about 400 billion kWh." The plan calls for the development or revision of mandatory minimum energy efficiency standards for more than ten cooling products and technologies in the future, and for the energy-saving transformation of a series of cooling systems. The plan also requires "strictly implementing the Ozone Depleting Substances Management Regulations and the Montreal Protocol, guiding enterprises to accelerate the conversion to air-conditioning production lines using low-GWP refrigerants, accelerate the phase-out of HCFCs refrigerants, and limit the use of HFCs."

Green and efficient cooling is an important new emission reduction field across industries, construction, transportation and other industries. With people's quality of life constantly improving and a growing middle class, cooling will become a large contributor to emissions out of China. Therefore, including green and efficient cooling in China's NDC updates will be important for its efforts to address climate change. Some analyses have shown that the successful implementation of the "Green High-Efficiency Cooling Action Plan" would reduce at least 200 million tons of carbon dioxide equivalent in 2030 compared with existing policies.

Box 6 Contribution of China's new waste sorting policy to GHG emissions reduction

In 2017, the Ministry of Housing and Urban-Rural Development issued the "Notice on Accelerating the Classification of Municipal Solid Waste (MSW) in Some Key Cities" and the "Implementation Plan for the MSW Classification System" to implement mandatory MSW sorting in 46 cities, ushering China into a new era of waste sorting. In January 2019, the State Council issued the "Work Plan for the 'Zero Waste City' Pilot Construction", aiming to facilitate source reduction, resource utilization and harmless disposal. The implementation of these policies will further promote GHG emissions reduction, especially in controlling non-CO₂ GHG emissions like methane.

As indicated in China's Second Biennial Update Report on Climate Change, methane emissions from waste management in 2014 reached 80.68 million tons of CO₂ equivalent, mainly from emissions of perishable waste (food waste and kitchen waste). A large number of perishable waste products have not been separately classified. They have been directly mixed with other wastes for treatment, including landfill and incineration. It is estimated that perishable waste accounts for about 60% of MSW. Treatment and disposal without classification releases into the environment a large amount of methane that could be recycled. The challenge is that, one the one hand, the collection and utilization of landfill gas is difficult in mixed waste landfills. On the other hand, due to the high moisture content of perishable wastes, mixed waste can also affect incineration, thus increasing GHG emissions.

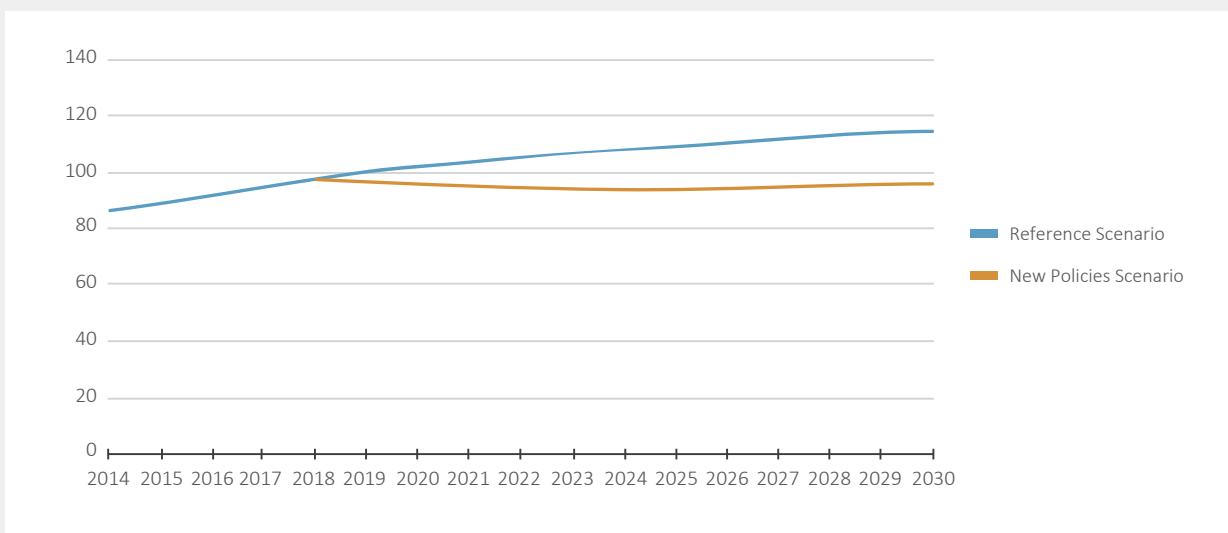
Under the implementation of these new policies, 46 cities have successively formulated implementation plans of waste classification, gradually establishing a four-type classification system. Different from the "three-type classification" (i.e.,

hazardous waste, recyclable waste and other waste) used in the past, perishable garbage has been added to a new “four-type classification system.” With separate collection and disposal of perishable waste, China can significantly reduce its emissions from the waste sector.

First, under the new waste sorting rules, by effectively classifying and disposing of perishable waste, the total amount of mixed waste that will eventually need to be landfilled and incinerated will be reduced.

Second, the classified perishable waste can be transported to special food/kitchen waste treatment plants and converted into biogas through anaerobic digestion and other technologies. After a purification process, biogas can be upgraded to natural gas to generate electricity or enter of the city's natural gas pipeline. The biogas residue can be used for land use, and the biogas slurry is returned to sewage treatment plants for treatment.

Against this backdrop, iGDP calculated the emission reduction potential that the waste classification policy will bring. A reference scenario examines GHG emissions from MSW in the absence of a mandatory waste classification. A new policy scenario takes into account the waste sorting policy and its future implementation from 46 cities to 294 prefecture-level cities. The growth rate of MSW is calculated based on GDP and the ratio of incineration and landfill is based on the “13th Five-Year Plan for the Construction of Urban MSW Harmless Treatment Facilities” and the newly introduced “Medium and long-term special plan for incineration power generation from MSW.” As shown below, with the implementation of the new regulations, by 2030 the new policies on waste classification can reduce annual emissions by 10.85 million tons of CO₂e. Between 2020-2030, the cumulative emission reduction brought about by the compulsory waste classification policy will reach 80.82 million tons of CO₂e, which is close to the total methane emission from the waste sector in 2014.



Source: Compiled and calculated by iGDP (MtCO₂e)

III. Actions: Enhance emission reduction actions based on the latest departmental strategic measures

China has formulated a series of departmental strategic plans for the implementation of the social and economic development goals set out in the 13th and 14th Five-Year plans, the construction of an ecological civilization, and the deepening of the structural upgrading and transformation of the economy. Some of these departmental strategic plans propose newer, more detailed, more robust and longer-term energy-saving carbon reduction targets and policy measures that will have a direct impact on China's future greenhouse gas emissions trends, and are an important foundation for China's new round of NDC content updates. This report sorts out these strategic plans, industry policies, and action plans, and compares the content of the different chapters of the 2015 NDC. It proposes ideas for how to incorporate these goals and measures into the second NDC.

1. The contribution of new policies since 2016 to strengthening China's response to climate change

Since 2016, various government departments in China have issued strategic plans or action programs. Some of these plans go beyond 2020 and provide actions for 2025, 2030 or further. As with the current NDC, these documents will provide a policy basis for China to strengthen its NDC. As indicated in Table 2, China has set up corresponding action targets for strengthening its response to climate change under its 2016 NDC, formulated cross-sectoral industry policies, and developed sectoral policies by industry. A series of new sectoral climate change-related policies introduced by China during the 13th and 14th Five-Year plan periods may become new policy options that China can consider when submitting its next NDC.

In October 2018, global leaders officially launched the Global Commission on Adaptation in The Hague, Netherlands, with China's Minister of Ecology and Environment, Li Ganjie, serving as a member. China has issued such policy documents as "Guiding Opinions on Promoting the Construction of a Green Belt and Road," the "One Belt and One Road Ecological Environmental Protection Cooperation Plan" and others to encourage enterprises to increase research and development and promote the application of climate change-related technologies. China has also proposed the establishment of a multi-faceted cooperation platform involving governments, enterprises, think tanks, social organizations and the public called the "One Belt, One Road Green Development International Alliance." Against this backdrop, government and non-government agencies from China and abroad have launched actions such as the One Belt and One Road Green Efficient Refrigeration Initiative and the Belt and Road Green Lighting Initiative to promote green and low-carbon cooperation in Belt and Road countries. In 2019, China took the lead in the field of Nature-based Solutions (NBS), co-leading the NBS Coalition at that year's United Nations Climate Action Summit and jointly issuing the NBS for Climate Manifesto.

China's development of the national carbon market can also inform its second NDC. In 2017, China released the "National Carbon Emissions Trading Market Construction Plan (Power Generation Industry)", creating a national emissions trading market in the power generation industry. The national market will gradually expand to other major emitting industries in the future. In 2021, China implemented a series of policies to support the construction of the national carbon market, including the "Measures for the Administration of Carbon Emission Trading (trial)", "Rules for the Administration of Carbon Emission Registration (trial)", and "Rules for the Administration of Carbon Emission Settlement (trial)", and call for public comments on the "Provisional Regulations on the Management of Carbon Emissions Trading (revised draft)".

Energy use: During the 13th Five-Year Plan period, China has issued or started formulating a series of energy development documents including, "Revolutionary Strategy for Energy Production and Consumption (2016-2030)," "Notice on Implementing Renewable Energy Power Quota System Draft (Request for Comments)," "Coal-bed Methane Development and Utilization 13th Five-Year Plan," and "Notice on Establishing and Improving the Safeguard Mechanism for Renewable Energy Power Consumption." China has proposed that by 2030: total energy consumption will be controlled to within 6 billion tons of standard coal, the average coal consumption of coal-fired power plants to be further reduced, ultra-low pollutant discharge coal-fired generating units will account for more than 80% of coal-fired generating units, the proportion of natural gas will reach about 15%, non-fossil energy generation will account for 50% of total power generation, and new energy demand will be mainly

met by clean energy. To accomplish these goals, policy measures will further strengthen coal-fired energy-saving and ultra-low-emissions, improve the renewable energy power quota system, increase the total quantity of renewable energy power consumption, increase subsidy standards for coal-bed methane exploitation and utilization, and accelerate the adjustment of the energy supply structure. During the 14th Five-Year Plan period, in the proposal of the Energy Bureau asking for comments on the target setting of its renewable portfolio standard in 2021 and the expected target in 2022-2030, it is proposed that increasing the national renewable portfolio standard to 40% of electricity consumption in 2030, of which the share of non-hydropower power consumption is 25.9%.

Industry: The policy document "Industrial Manufacturing 2025" proposes a 20% reduction in CO₂ emissions per unit of industrial value added by 2025 compared to 2015, and a 34% reduction in energy consumption per unit of industrial added value. China has also issued "Opinions on Doing a Good Job in Resolving the Excessive Production Capacity of the Iron and Steel Industry in 2017 to Realize the Development of the Depleted Capacity" and the "Notice on Doing a Good Job in Resolving Excess Capacity in 2018 Key Areas," as it deepens supply-side structural reforms. During the 13th Five-Year Plan period, in order to advance the green transformation of the manufacturing industry, the industrial sector will upgrade high-energy-consuming industries such as steel, building materials and cement by implementing more stringent mandatory energy consumption limit standards and equipment energy efficiency standards, promoting ultra-low emissions, and fostering energy efficiency leadership. During the 14th Five-Year Plan period, green transformation and intelligent manufacturing of industries with high energy consumption will be accelerated. According to the "14th Five-Year Plan for Intelligent Manufacturing Development" (Draft for comments) issued by the Ministry of Industry and Information Technology, by 2025, manufacturing enterprises above a designated size have to increase digitalization, and key enterprises in key industries must undergo the initial phase of the transformation toward incorporating intelligent systems. By 2035, the digitalization of manufacturing enterprises above a designated size should be fully implemented, and backbone enterprises should achieve a basic level of transformation toward incorporating intelligent systems.

In 2016, China and nearly 200 other countries worked together to adopt the Kigali Amendment of the Montreal Protocol to include greenhouse gas HFCs, which will come into force in 2019. With the average of 2020, 2021 and 2022 levels as the baseline, China will gradually reduce the production and consumption of HFCs from 2024. In 2020, the General Office of the Ministry of Ecology and Environment published the "Regulations on the Management of Ozone Depleting Substances and Hydrofluorocarbons (revised draft for comments)", bringing HFCs into the scope of control. China has also issued industry standards QB/T 4975-2016 "Safety Technical Specifications for the Production of Household and Similar-Use Room Air Conditioners Using Flammable Refrigerants," and QB/T 4976-2016 "Special Use for the Transport of Flammable Refrigerant Room Air Conditioner Products," which regulate operation and management of flammable refrigerants with low GWP values. In addition, China has a new car air conditioning standard that will apply the new low GWP refrigerant HFO-1234yf standard for the first time.

Transportation: The "Long-term Development Plan for the Automotive Industry" released in 2017 proposes that by 2025, the average fuel consumption of new passenger cars will drop to the target of 4 liters/100 kilometers, new energy vehicles will account for 20% of automobile production and sales, and battery systems will have a specific energy of 350 watt-hours/kg. According to the "New Energy Vehicle Industry Development Plan (2021-2035)" issued in 2021, by 2025, the average power consumption of pure electric passenger cars will be reduced to 12.0 kWh/100 km. At the same time, it is proposed in the plan that from 2021, the proportion of new energy vehicles in public areas such as public transportation, rental, logistics and distribution will not be less than 80%. In addition, China has continued to promote the use of ethanol gasoline for vehicles and established a monthly reporting system. Other recently issued policies include "Parallel Management Measures for Average Fuel Consumption and New Energy Vehicle Points for Passenger Vehicle Enterprises," GB 30510-2018 "Limits for Fuel Consumption of Heavy Commercial Vehicles", and GB19578 "Passenger Vehicle Fuel Consumption Limits (Draft for Comment)."

Buildings: In 2019, the Ministry of Housing and Urban-Rural Development promulgated a new "Green Building Evaluation Standard" to further improve building energy efficiency design standards. In 2017, the National Development and Reform Commission released the "Northern Clean Winter Heating Plan (2017-2021)," which proposes that by 2019 and 2021, the clean heating rate in the northern regions will reach 50% and 70% respectively, of which the "2+26" cities will be the focus. The According to "Action Plan for Green Buildings" released in 2020, the proportion of green buildings in newly-built urban heating rate in urban areas will reach over 90% in 2019.

buildings should reach 70% by 2022. In 2019, the National Development and Reform Commission, the Ministry of Industry and Information Technology, and the Ministry of Housing and Urban-Rural Development jointly released the "Green Efficient Refrigeration Action Plan," which is a comprehensive work plan across multiple fields of architecture, industry, and transportation. By 2030, the efficiency of refrigeration in large public buildings will increase by 30%, and the overall energy efficiency of refrigeration will increase by 25%.

Agriculture: In 2017, China issued the "Opinions of the General Office of the State Council on Accelerating the Utilization of Livestock and Poultry Waste Resources" and the "National Livestock and Poultry Resource Utilization County Promotion Project (2018-2020)," which propose that by 2020, the comprehensive utilization rate of livestock and poultry manure in the country will reach more than 75%, the equipment matching rate for manure treatment facilities in large-scale farms will reach over 95%, and eventually 100%. At the same time, a central government pilot project on the utilization of livestock and poultry manure resources was launched to provide financial support for the utilization of livestock and poultry manure resources in animal husbandry. Between 2018 and 2020, more than 200 animal husbandry counties will be selected to carry out the construction of livestock and poultry manure treatment and resource utilization facilities, with emphasis on infrastructure construction for livestock manure collection, storage, treatment and utilization.

Forestry: The National Land Planning Outline (2016-2020) issued by the State Council in 2017 proposes a forest coverage rate goal of greater than 24% by 2030. In 2018, the National Greening Committee and the State Forestry and Grassland Bureau's Opinions on Actively Promoting Large-Scale Land Greening Actions proposed that by 2020, the overall environment will be improved and an ecological security barrier will be developed, the forest coverage rate will reach 23.04%, and the forest stock volume will reach 16.5 billion cubic meters. By 2035, the national ecological safety frame will be basically completed, and ecological service functions and ecological carrying capacity will be significantly improved. The National Forestry and Grass Bureau has established the basic objectives of ecological construction in the "14th Five-Year Plan". By 2025, the national forest coverage rate should reach 24.1%, the forest volume should reach 19 billion cubic meters, the comprehensive vegetation coverage of grassland should reach 57%, the wetland protection rate should reach 55%, and 60% of the treatable desertification land should be treated.

Waste management: During the 13th Five-Year Plan period, the National Development and Reform Commission issued the "Circular Development Leading Action" to promote the establishment of a green recycling low-carbon industrial system and improve the utilization level of typical urban waste resources. In 2017, the Ministry of Housing and Urban-Rural Development issued the "Notice on Accelerating the Classification of Domestic Waste in Some Key Cities" and the "Implementation Plan for the Domestic Waste Classification System." These documents propose that at the end of 2020, the relevant laws, regulations and standards for waste separation will be basically established, classification of domestic waste will be well promoted, and in cities where domestic garbage use is mandatory, the utilization rate of domestic garbage should be more than 35%. In January 2019, the State Council issued the "Pilot Work Plan for the Construction of No Waste Cities" and a technical guide. In 2021, China passed the "Anti-Food Waste Law", which will provide legal support for the promulgation of a series of standards for food waste, and at the same time help to reduce the production of perishable organic waste. The goal is to reduce methane emissions associated with solid waste in cities.

Climate change adaptation: China has taken many measures to address water resources management, marine environmental protection and early warning of climate disasters, as well as pilot projects such as sponge cities and pilot cities for climate change adaptation. China has successively issued the "13th Five-Year Plan for Water Consumption and Intensity Dual Control Action Plan" and the "City Adaptation Climate Change Action Plan" to promote dual-control actions on total water consumption and intensity. At the same time, cities are required to incorporate climate change-related indicators into urban and rural planning systems, and reduce urban development and construction's impact on the ecological environment in.

2. Policy Options for the NDC Update (See Table 2)

IV Subnational and non-state climate actions

With the setting of “dual carbon” goals, different regions, industries and companies are actively developing carbon peaking action plans and exploring carbon neutrality research based on their own circumstances. The following table provides a brief overview of this.

Regions	By April 2021, 19 provinces and municipalities have explicitly proposed to prepare carbon-peaking and carbon-neutrality action plans (China’s CDM, 2021). For example, Hebei Province has proposed to develop and implement a medium- and long-term plan to achieve carbon peaking and carbon neutrality, Shaanxi Province has launched a study on carbon peaking and carbon neutrality, and Hainan Province has proposed to comprehensively promote the construction of a clean energy island and study the energy implementation pathways to achieve carbon peaking and carbon neutrality. In June 2021, Zhejiang Province also released its Action Plan for Science and Technology Innovation of Carbon Peaking and Carbon Neutrality.
Companies	Many companies have responded to the “dual carbon” goals by proposing carbon neutrality strategies. For example, Tongwei Group, Huaneng, Tencent, BYD, National Energy Group, and JD Logistics have started carbon neutrality studies (Jiang, 2021). 17 petroleum and chemical companies, chemical parks, and the China Petroleum and Chemical Industry Association have jointly released the "Declaration of China's Petroleum and Chemical Industry on Carbon Peaking and Carbon Neutrality", declaring their commitment and action plans for carbon peaking and carbon neutrality. In addition, 33 Chinese companies have joined the Science Based Carbon Target Initiative (SBTi), an international initiative focusing on setting climate targets for corporate emissions reductions.
Financial organizations	In February 2021, six companies, including Southern Power Grid, State Power Investment Group, issued the first batch of carbon neutrality bonds (Duan, 2021). Subsequently, Tianfeng Securities, Securities Times and the International Institute of Green Finance of the Central University of Finance and Economics jointly released the first Initiative to Promote "Carbon Neutrality" in the securities and futures industry (Hu, 2021).
Industry associations	Steel and non-ferrous metal industry associations have made preliminary considerations for promoting carbon peaking and reduction, and several industry associations are promoting research on initiatives in carbon peaking (Sun & Kou, 2021).



Photo Credit: Diego Montero

Table 2 Policy Options for the NDC Update

2015 NDC	Policies from 2015 NDC	Policy Options for the NDC Update	Sources of Policy Options
International Cooperation	Establish the South-South Cooperation Fund for Climate Change	Build the International Coalition for Green Development on the Belt and Road	The Belt and Road Ecological and Environmental Cooperation Plan, Policy Proposition on Nature-based Solutions (NBS for Climate Manifesto)
Mitigation Targets	By 2020, the carbon dioxide emissions per unit of GDP will fall by 40%-45% compared with 2005, and the share of non-fossil fuel will account for about 15% of primary energy consumption.	Set an energy-related CO ₂ emissions cap	
		Set non-CO ₂ GHG emissions reduction targets	
Cross-sectoral Policy	Gradually establish a carbon emission trading system	Under the premise of stable operation of the carbon market in the power generation industry, the market coverage will be gradually expanded to include new trading varieties and trading methods.	National Carbon Emissions Trading Market Construction Plan (Power Generation Industry), Measures for the Administration of Carbon Emissions Trading (Trial)
Sector-specific Policies	Energy	Control total coal consumption, strengthen the clean utilization of coal, increase the proportion of coal centralized and efficient power generation, and reduce the average coal consumption of new coal-fired generating units to about 300 grams standard coal per kWh.	In 2030, total energy consumption is controlled to within 6 billion tons of standard coal. By 2030, the average coal consumption of coal-fired power plants will be further reduced, and ultra-low pollutant discharge coal-fired generating units will account for more than 80% of the fleet.
		Expand the scale of natural gas utilization. By 2020, natural gas will account for more than 10% of primary energy consumption, and coalbed methane production will strive to reach 30 billion cubic meters.	In 2030, non-fossil fuel accounts for about 20% of total energy consumption, and natural gas accounts for about 15%. In 2030, increasing the national renewable energy portfolio standard to 40% of electricity consumption, of which the share of non-hydropower power consumption is 25.9%.
	Industry	Increase the share of value added of strategic emerging industries to 15% of the total GDP by 2020.	By 2025, the value added of industrial enterprises above the designated size will be 34% lower than that of 2015, and the carbon emissions per unit of industrial added value will be 40% lower than that of 2015.

What to Expect in China's Second Nationally Determined Contribution

Towards a Carbon Neutral Global Future 2021 Edition

		Gradually reduce the production and use of controlled use of difluorochloromethane (HCFC-22), by 35% from baseline (2010 production) in 2020, and by 67.5% in 2025, HFC- 23 Emissions will be effectively controlled by 2020.	Taking the average HFC consumption levels for 2020, 2021 and 2022 as the baseline, freeze production and consumption of HFCs at baseline levels from 2024, and cut production and consumption of HFCs by 10% at baseline by 2029.	The Kigali Amendment
Industry		Formulate carbon emission control targets and action plans for key industries, and study and formulate GHG emissions standards for key industries.	Implement measures such as “energy-saving subsidies” and “replace old home appliance with green ones”, and use subsidies and incentives to support residents to purchase green and efficient cooling products.	Green and High-Efficiency Cooling Action Plan
		Strengthen carbon emission management of new projects and actively control GHG emissions from industrial production processes.	Improve production process of adipic acid and nitric acid.	Industrial Green Development Plan (2016-2020)
		Build a green low-carbon transportation system, optimize transportation methods, and prioritize the development of public transportation.	By 2025, the average fuel consumption of new cars will drop to 4.0 liters/100 kilometers. From 2021 onwards, the proportion of new energy vehicles in public areas such as public transportation, rental, logistics and distribution should not be less than 80%.	Mid- and Long-Term Development Plan for the Automobile Industry, Development Plan of New Energy Automobile Industry (2021-2035)
Transport		Encourage the development and use of low-carbon environmentally friendly transportation such as new energy vehicles and ships.	By 2025, new energy vehicles account for more than 20% of automobile production and sales. By 2025, the average power consumption of pure electric passenger cars should be reduced to 12.0 kWh/100 km.	Mid- and Long-Term Development Plan for the Automobile Industry, Development Plan of New Energy Automobile Industry (2021-2035)
		By 2020, the proportion of green buildings in newly built buildings will reach 50%.	Implement new green building standards. By 2022, the proportion of green building area in new urban buildings should reach 70%.	
Buildings		Improve building energy efficiency.	By 2030, cooling efficiency in large public buildings will increase by 30%.	Green and High-Efficiency Cooling Action Plan, Action Plan for Green Buildings
		The forest area has increased by 40 million hectares compared with 2005, and the forest stock volume has increased by 1.3 billion cubic meters compared with 2005.	By 2030, forest coverage is greater than 24%. The forest volume will increase by 6 billion cubic meters compared with 2005.	National Land Planning Outline (2016-2020), President Xi Jinping's speech at the Climate Ambition Summit

	Cooling		Develop sector-specific cooling policies. By 2030, the overall energy efficiency of major cooling products will increase by 30%.	<i>Green and High-Efficiency Cooling Action Plan</i>
	Waste	Strengthen the collection and utilization of methane in landfills.	Establish laws, regulations and standards related to waste sorting. Promote source reduction and resource utilization of municipal solid waste.	<i>Notice on Accelerating the Classification of Municipal Solid Waste in Some Key Cities & Work Plan for Zero Waste City Pilot Construction</i>
		Promote the comprehensive utilization of straw, the utilization of agricultural and forestry waste resources and the comprehensive resource utilization of livestock and poultry manure.	Establish the pilot program for financing the resource utilization of livestock and poultry manure.	<i>Opinions of the General Office of the State Council on Accelerating the Resource Utilization of Livestock and Poultry Waste 13th Five-Year Plan for Urban Wastewater Treatment and Recycling Facilities Construction</i>
Climate Adaptation		Improve the safe management of water resources, transportation, energy and other infrastructure under climate change.	Minimize the impact of urban development and construction on the ecological environment, and 70% of the rainfall will be absorbed and utilized locally. By 2030, more than 80% of the urban built-up areas will meet the target.	<i>Guiding Opinions on Promoting the Construction of Sponge Cities</i>
		Implement stringent water management system. Strengthen the development and utilization of non-traditional water sources such as reclaimed water, desalinated seawater and rainwater.	Promote the implementation of dual-control actions on the total amount and intensity of water consumption	<i>13th Five-Year Action Plan for Dual Control on Total Amount and Intensity of Water Resources Consumption</i>
		Strengthen capacity building in marine disaster prevention and comprehensive management of coastal zones.	Further strengthen marine environmental protection measures and launch the "Bay Chief System" pilot.	<i>Guiding Opinions on Launching the Pilot Work of the Bay Chief System</i>
		Properly layout urban functional areas and coordinate infrastructure construction.	Generally integrate climate change-related indicators into urban and rural planning systems, construction standards and industrial development plans, and build 30 pilot cities for climate change adaptation.	<i>Urban Climate Change Adaptation Plan</i>
		Improve the national climate change monitoring and early warning information release system, and improve the emergency response mechanism for extreme weather and climate events.	By 2035, the capacity and level of meteorological disaster monitoring, forecasting and early warning will jump sharply, and the level of legalization, standardization and modernization of disaster prevention, mitigation and relief work will be significantly improved.	<i>Opinions on Strengthening Meteorological Disaster Prevention, Disaster Mitigation and Disaster Relief Work</i>

References

- Bai, C., & Zhang, Q. (2016). Research on China's economic growth potential. *New Finance Review*, (5), 4.
- Bank of China "Research team on the New Model of China's Economic Development." (2016). Estimation and Prediction of the Potential Growth Rate of China's Economy. *Financial Regulation Research*, 8, 41–66.
- China CDM Fund. (2021). Nineteen provinces (cities) clearly proposed to prepare carbon peaking and carbon neutral action plans. China CDM Fund. <http://www.cdmfund.org/28323.html>
- Cai, F. (2017). Two "L"-type trajectories- the medium-term and long-term outlook for China's economic growth. *Financial Minds*, 2(2), 5–16.
- Cai, Q., Zheng, X., Zhao, X., & Xu, H. (2016). Suggestions on CO₂ emission control targets for major departments and key industries during the "13th Five-Year Plan." Retrieved from National Center for Climate Change Strategy and International Cooperation website: <http://www.ncsc.org.cn/yjcg/fxgc/201801/P020180920510030806443.pdf>
- College of Environmental Sciences and Engineering of Peking University. (2018). Summary and analysis report on the baseline and the Kigali Amendment scenarios, and the energy demand of cooling. Beijing, China: Peking University.
- College of Environmental Sciences and Engineering of Peking University. (2019). Greenbook of HFCs Refrigerant Reduction of China Automotive Air Conditioning. Beijing, China: Peking University.
- Den Elzen, M., Kuramochi, T., Höhne, N., Cantzler, J., Esmeijer, K., Fekete, H., ... Sha, F. (2019). Are the G20 economies making enough progress to meet their NDC targets? *Energy Policy*, 126, 238–250.
- Duan, S. (2021). First batch of carbon neutral bonds issued, six companies including Southern Power Grid participated. China Business Network. <https://www.yicai.com/news/100948021.html>
- Energy Foundation China. (2019). Energy Foundation China Quarterly Newsletter (2019 Q2). Retrieved from Energy Foundation China website: <http://www.efchina.org/Attachments/Publication%28%E5%88%8A%E7%89%A9%29/publication-efchina-20190820/%E8%83%BD%E6%BA%90%E5%9F%BA%E9%87%91%E4%BC%9A%E5%B7%A5%E4%BD%9C%E7%AE%80%E6%8A%A5-2019-Q2.pdf>
- Fu, S., Zou, J., & Liu, L. (2015). Comments on China's NDC. Retrieved from National Center for Climate Change Strategy and International Cooperation website: <http://www.ncsc.org.cn/yjcg/zlyj/201506/W020180920484693490826.pdf>
- Fang, X., Velders, G. J., Ravishankara, A. R., Molina, M. J., Hu, J., & Prinn, R. G. (2016). Hydrofluorocarbon (HFC) emissions in China: an inventory for 2005–2013 and projections to 2050. *Environmental Science & Technology*, 50(4), 2027–2034.
- Gallagher, K. S., Zhang, F., Orvis, R., Rissman, J., & Liu, Q. (2019). Assessing the Policy gaps for achieving China's climate targets in the Paris Agreement. *Nature Communications*, 10(1), 1256.
- Ge, Q., Liu, Y., Wang, F., & Zheng, J. (2018). Simulated CO₂ emissions from 2016–2060 with comparison to INDCs for EU, US, China and India. *Acta Geographica Sinica*, 73(1), 3–12.
- He, J., Li, Z., Zhang, X., Wang, H., Dong, W., Chang, S., Ou, X., Guo, S., Tian, Z., & Gu, A. (2020). Comprehensive report on China's Long-Term Low-Carbon Development Strategies and Pathways. *Chinese Journal of Population, Resources and Environment*, 30(11), 1–25.
- Hu, A., & Zhang, X. (2017, October 11). Hu Angang: The primary stage of socialism enters a new era. Reference News. Retrieved from <http://opinion.jrj.com.cn/2017/10/11150323215731.shtml>
- IEA. (2019). World Energy Outlook 2018. Paris, France: International Energy Agency.
- Jiang, X. (2021). The latest progress of carbon neutrality in some regions and enterprises. China 5e Network. <https://www.china5e.com/news/news-1110397-1.html>
- Josh Gabbatiss. (2021). Analysis: Which countries met the UN's 2020 deadline to raise "climate ambition"? Carbon Brief. <https://www.carbonbrief.org/analysis-which-countries-met-the-uns-2020-deadline-to-raise-climate-ambition>
- Levin, K., Fransen, T., & Ge, M. (2015). 5 Things You Need to Know About the UN Emissions Gap Report. Retrieved from <https://www.wri.org/blog/2018/11/5-things-you-need-know-about-un-emissions-gap-report>
- Lian, P., Zhou, K., Tang, ianwei, & Liu, X. (2018). Prospects for China's Economic Development in the New Era. *Scientific Development*, (1), 14–20.
- Lin, J., Khanna, N., & Liu, X. (2018). China's Non-CO₂ Greenhouse Gas Emissions: Future Trajectories, and Mitigation Options and Potential. Berkeley, CA: Lawrence Berkeley National Laboratory.
- Li, P., Lou, F., & Wang, H. (2017). Analysis and Forecast of China's Total Economy and Its Structure from 2016–2035. *Strategic Study of Chinese Academy of Engineering*, 19(1), 13–20.

- Liu, Q., Gu, A., Teng, F., Song, R., & Chen, Y. (2017). Peaking China's CO₂ emissions: Trends to 2030 and mitigation potential. *Energies*, 10(2), 209.
- Liu, Q., Tian, C., Zheng, X., Jiang, K., He, C., Harvey, H., ... Kennan, H. (2016). China Climate and Energy Policy Program: Quantitative Analysis and Policy Recommendations during the 13th Five-Year Plan Period. Beijing, China: National Center for Climate Change Strategy and International Cooperation.
- Liu, S. (2018). A Ten-Year Outlook of China's Economic Growth (2013-2022): Looking for new power and balance. Beijing, China: CITIC Press Group.
- Ministry of Ecology and Environment. (2019a). The People's Republic of China Second Biennial Update Report on Climate Change. Retrieved from Ministry of Ecology and Environment website: <http://qhs.mee.gov.cn/kzsqtppf/201907/P020190701765971866571.pdf>
- Ministry of Ecology and Environment. (2019b). The people's Republic of China Third National Communication on Climate Change. Retrieved from Ministry of Ecology and Environment website: <http://qhs.mee.gov.cn/kzsqtppf/201907/P020190701762678052438.pdf>
- National Bureau of Statistics. (2021). Statistical Bulletin on National Economic and Social Development in 2020. Retrieved from National Bureau of Statistics website: http://www.gov.cn/xinwen/2021-02/28/content_5589283.htm
- Sheng, L., & Zheng, X. (2017). What growth rate is needed to achieve the second "100-year" goal? *Management World*, (10), 1–7.
- Simon Evans, & Josh Gabbatiss. (2020). Coronavirus: Tracking how the world's "green recovery" plans aim to cut emissions. Carbon Brief. <https://www.carbonbrief.org/coronavirus-tracking-how-the-worlds-green-recovery-plans-aim-to-cut-emissions>
- Song, R. (2019). Opportunities to Advance Mitigation Ambition in China: Non-CO₂ Greenhouse Gas Emissions. Retrieved from World Resources Institute website: https://wriorg.s3.amazonaws.com/s3fs-public/opportunities-advance-mitigation-ambition-china_0.pdf
- Sun, X., & Kou, J. (2021). Fight the hard battle to achieve carbon peaking and carbon neutrality. *People's Daily Online*. <http://politics.people.com.cn/n1/2021/0604/c1001-32121957.html>
- Su, M., Li, X., & Xu, H. (2016). Recommendations for the non-CO₂ GHG emissions control for the 13th Five-Year Plan. Retrieved from National Center for Climate Change Strategy and International Cooperation website: <http://www.ncsc.org.cn/yjcg/fxgc/201801/P020180920510029092762.pdf>
- Tian, D. (2019, April 1). Accelerate the establishment of a national carbon cap system. *China Environment News*. Retrieved from http://www.qstheory.cn/zoology/2019-04/01/c_1124311631.htm
- United Nations. (2019). World Population Prospects 2019 Highlights. Retrieved from United Nations website: https://population.un.org/wpp/Publications/Files/WPP2019_HIGHLIGHTS.pdf
- Wang, jinnan, Cai, B., Cao, D., Zhou, Y., & Liu, L. (2011). Study on Regional Decomposition Plan of Total CO₂ Emission Control in China. *Journal of Environmental Sciences*, 31(4), 680–685.
- Wang, X., & Zhou, Y. (2017). China's economic growth forecast 2020-2030. In China's New Sources of Economic Growth (Vol. 1): Reform, Resource, Energy and Climate Change (pp. 58–77). Retrieved from <http://press-files.anu.edu.au/downloads/press/n4153/pdf/ch04.pdf>
- Xiao, H., & Wang, T. (2018). Forecast of China's potential economic growth rate under the "two-stage" strategic goal of the new era. *Price:Theory Practice*, (9), 1.
- Xiong, X., Kang, Y., Feng, S., & Zhao, M. (2015). Study on Decomposition of Total Carbon Emission Control Target. *China Energy*, (11), 15–19.
- Yang, L. (2015). A brief analysis on China's INDC. Retrieved from Innovative Green Development Program website: <http://www.igdp.cn/igdp%E6%95%B0%E8%AF%B4%E3%80%81%E5%9B%BE%E8%AF%B4%E5%92%8C%E5%81%87%E8%AF%B4%E4%B8%AD%E5%9B%BDindc/>
- Zhang, C., & Zheng, Z. (2018). Paths and policies to promote high-speed economic growth. Beijing, China: Social Sciences Academic Press.
- Zhang, R. (2019, September 6). Liu Shijin: Double the size of middle-income group, make low-income group the new impetus for China's economy. *The Paper*. Retrieved from https://www.thepaper.cn/newsDetail_forward_4357345
- Zhu, Y. (2019, March 29). Wang Yi, Vice President of the Institute of Science and Development of Chinese Academy of Sciences: The 14th Five-Year Plan should establish a total carbon emission control system. *China Energy News*. Retrieved from https://www.cenews.com.cn/company/201903/t20190329_896319.html

iGDP

Address: 7-1-51, JIANGUOMENWAI DIPLOMATIC RESIDENCE COMPOUND, NO.1 XIUSHUI
STREET, CHAOYANG DISTRICT, BEIJING, 100600, PEOPLE'S REPUBLIC OF CHINA, 100600
TEL: 86-10-8532-3096
FAX: 86-10-8532-2632
EMAIL: igdpoffice@igdp.cn
WEBSITE: www.igdp.cn