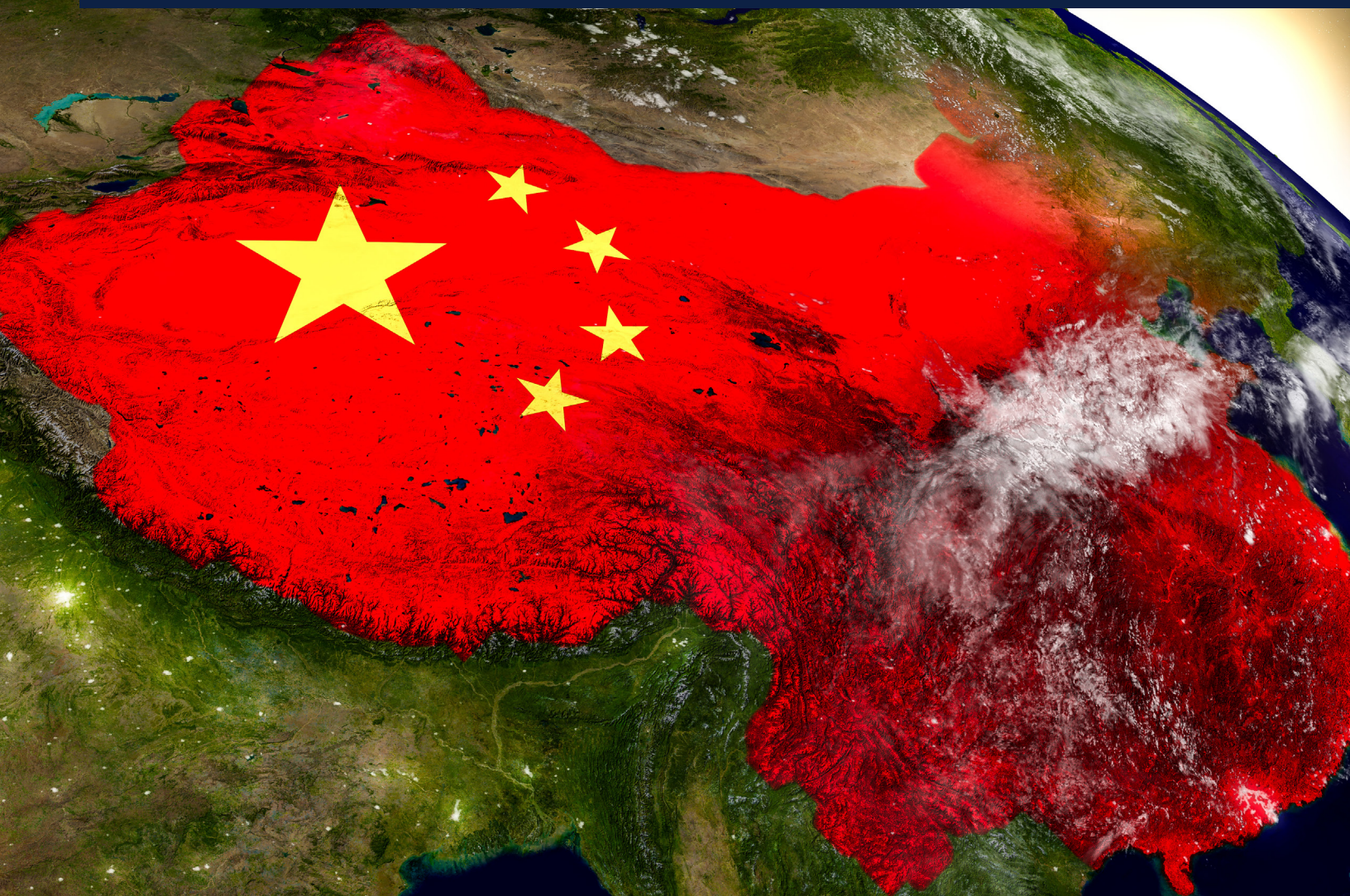


GUIDE TO CHINESE CLIMATE POLICY 2022

DAVID SANDALOW, MICHAL MEIDAN,
PHILIP ANDREWS-SPEED, ANDERS HOVE,
SALLY YUE QIU AND EDMUND DOWNIE





THE OXFORD
INSTITUTE
FOR ENERGY
STUDIES

GUIDE TO CHINESE CLIMATE POLICY 2022

**DAVID SANDALOW, MICHAL MEIDAN,
PHILIP ANDREWS-SPEED, ANDERS HOVE,
SALLY YUE QIU AND EDMUND DOWNIE**

57 Woodstock Road
Oxford
OX2 6FA
United Kingdom

chineseclimatepolicy.oxfordenergy.org



  @oxfordenergy

TABLE OF CONTENTS

PREFACE	3
INTRODUCTION	6
PART I - BACKGROUND	9
1. CHINESE EMISSIONS OF HEAT-TRAPPING GASES	11
A. Carbon Dioxide	11
i. Emissions Metrics	12
ii. Emissions Growth	16
iii. Emissions by Sector and Source	18
iv. Land Use Change and Forestry	19
B. Other Gases	19
C. Uncertainties in Emissions Estimates	20
D. Estimates by Leading Research Organizations	22
E. Chinese Emissions and the Carbon Budget	25
2. IMPACTS OF CLIMATE CHANGE IN CHINA	26
A. China's Vulnerability to Climate Change	26
B. Recent Extreme Weather Events	28
3. SHORT HISTORY OF CHINESE CLIMATE POLICY	32
PART II - DOMESTIC POLICIES	39
4. CLIMATE GOALS	40
5. COAL	45
6. RENEWABLE POWER	58
A. Hydropower	62
B. Wind Power	64
C. Solar Power	67
7. NUCLEAR POWER	71
8. POWER SECTOR REFORM	77
9. ENERGY EFFICIENCY	87
10. EMISSIONS TRADING	92
11. MANUFACTURING SECTOR	102

12. NATURAL GAS	118
13. HYDROGEN	126
14. COAL-BASED OIL, GAS AND CHEMICALS	134
15. CARBON CAPTURE, UTILIZATION AND STORAGE	140
16. VEHICLES	149
A. Chinese Vehicle Stock	149
B. Vehicle Fuel Efficiency	150
C. Electric Vehicles	153
17. URBAN AIR POLLUTION	162
18. URBANIZATION	171
19. HFCS	177
20. GREEN FINANCE	182
21. CLEAN ENERGY R&D	187
22. FOOD SYSTEM	192
23. FORESTRY	199
24. ADAPTATION	209
PART III - FOREIGN POLICIES	213
25. UNFCCC	214
26. BELT AND ROAD INITIATIVE	217
A. Background	217
B. Green Development Policies	220
C. Energy Sector Projects	223
D. Financial Institutions	230
E. Climate Impacts	237
CONCLUSION	241
APPENDICES	253
APPENDIX A: GOVERNMENT STRUCTURE	254
APPENDIX B: KEY PLAYERS	256
ACKNOWLEDGMENTS	260
ABOUT THE AUTHORS	261
PRAISE FOR <i>GUIDE TO CHINESE CLIMATE POLICY 2022</i>	263

PREFACE TO 2022 EDITION

During the summer of 2022, record heat swept across China. On June 25, the temperature in the northeast province of Hebei reached 44.2°C (111.6°F)—breaking an all-time record there. On July 13, the temperature in Shanghai reached 40.9°C (105.6°F)—the highest temperature ever recorded in the famous coastal city. In mid-August, dozens of heat records were broken daily across much of central China. One meteorologist called the heat wave—which lasted from mid-June through the end of August—“the worst ever seen worldwide.”¹

Extreme heat struck elsewhere too. On July 19, weather stations in the United Kingdom recorded temperatures above 40°C (104°F) for the first time in history. In the United States, at least 43 locations broke or tied their records for the hottest July ever. On August 9, the temperature in western Iran reached 53.6°C (128.5°F)—the highest August temperature ever recorded in Asia.²

These heat waves—and similar ones in recent summers—are just one of the impacts scientists predict from the growing accumulation of heat-trapping gases in the atmosphere. More severe and frequent storms, droughts and floods are also ahead, and seas are rising.³

China’s leaders have declared that “climate change is a severe threat to all mankind”⁴ and set ambitious long-term climate goals. The Chinese government has invested vast sums promoting low-carbon technologies. Yet climate goals often appear to be subordinate to other goals in the short term and implementation of climate policies sometimes lags.

Every year since 2006, China has led the world in emissions of heat-trapping gases. Last year, more than 30% of heat-trapping gases emitted globally came from China. China’s cumulative emissions since the beginning of the Industrial Revolution are 15% of the global total (second only to the United States) and growing fast.⁵

There is no solution to climate change without China.

The most recent version of the *Guide to Chinese Climate Policy* was released in 2019. My goal was to provide a reliable and authoritative resource on China’s response to climate change.

Much has changed in the world since 2019. Perhaps most significant, the COVID-19 pandemic has cost millions of lives and disrupted the global economy.

1 See Chapter 2 at notes 12–20.

2 “[A Milestone in UK Climate History](#),” UK Met Office (July 22, 2022); Jacob Knutson, Andrew Freedman and Erin Davis, “[July heat records shattered across the U.S.](#),” Axios (August 3, 2022); @extremetemps, [Extreme Temperatures Around the World](#), *Twitter* (August 14, 2022).

3 Intergovernmental Panel on Climate Change, [Working Group II Sixth Assessment Report: Impacts, Adaptation and Vulnerability](#) (2022).

4 People’s Republic of China, [China’s Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy](#) (October 2021) at p.3.

5 See Chapter 1(A).

Much has changed in Chinese climate policies since 2019 as well. Perhaps most significant, in September 2020 President Xi Jinping announced an ambitious new goal—that China would aim to achieve carbon neutrality by 2060. This goal implies dramatic changes in China’s economy and energy infrastructure in the decades ahead. In the past two years, the Chinese government has announced many policies that help achieve this long-term goal. Chinese leaders have also made clear that carbon neutrality should be pursued in harmony with other important goals, including economic growth and energy security.⁶

On the ground, trends in China’s response to climate change in the past three years have been mixed.

On the one hand:

- In each of the past three years, China led the world in new solar power, wind power and hydro power projects. China leads the world in renewable power deployment by far, with more than three times as much capacity as any other nation.⁷
- In each of the past three years, China led the world in production and sales of electric vehicles. Roughly 45% of the electric cars and 95% of the electric buses in the world today are in China.⁸
- In each of the past three years, China led the world in deployment of new nuclear power plants. Roughly 19 GW of new nuclear power capacity is under construction in China—about a third of the nuclear power capacity under construction in the world.⁹

On the other hand:

- In each of the past three years, China’s carbon dioxide (CO₂) emissions have continued to climb (despite a brief drop in the first half of 2020 due to the COVID-19 pandemic). In 2021, China’s CO₂ emissions grew 5-6%—the largest annual increase in 10 years.¹⁰
- In each of the past three years, significant new coal power plant capacity has been approved and come on line in China. In 2021, two-thirds of new coal power plant capacity added globally was in China.¹¹

The 2022 edition of the *Guide to Chinese Climate Policy* covers these topics and more. All chapters in the 2019 edition have been comprehensively updated. The 2022 edition also includes eight new chapters on topics discussed briefly, if at all, in previous editions. The new chapters are on Power Market Reform (Chapter 9); the Manufacturing Sector (Chapter 11); Hydrogen (Chapter 13); Coal-Based Oil, Gas and Chemicals (Chapter 15); Carbon

6 See Chapter 4.

7 See Chapter 6.

8 See Chapter 16 at note 25.

9 See Chapter 7.

10 See Chapter 1(A).

11 See Chapter 5.

Capture, Utilization and Storage (Chapter 16); Clean Energy R&D (Chapter 20); Urbanization (Chapter 21) and the Food System (Chapter 22).

For this edition of the *Guide to Chinese Climate Policy*, it has been my enormous privilege and pleasure to work with five extraordinary co-authors: Michal Meidan, Philip Andrews-Speed, Anders Hove, Sally Qiu and Edmund Downie. Each brings deep expertise and experience to the topics in this book. Each brought commitment, dedication and good humor to the project. I hope they've enjoyed our collaboration and learned as much from it as I have.

Each chapter in this book was drafted by one co-author and edited by another. Each chapter was then read by at least one and often several external reviewers (not among our team of co-authors). We're hugely grateful to the 38 external reviewers who read our draft texts, providing invaluable comments and insights. (Their names are in the Acknowledgments section.) Any mistakes are of course our own.

This *Guide* provides an updated resource for anyone interested in China's climate change policies. We hope you find it useful.

David Sandalow

INTRODUCTION

In 2021, China was the world's leading emitter of heat-trapping gases by a wide margin. Its policies for limiting emissions will have a significant impact on the global climate for decades to come.

From a historical perspective, China's status as the world's leading emitter is relatively recent. During most of the 19th and 20th centuries, Chinese emissions were modest. Then, in the early part of this century, as the Chinese economy boomed, Chinese emissions began to skyrocket, overtaking those from the United States around 2006. China's cumulative emissions of carbon dioxide since the beginning of the Industrial Revolution are roughly half those from the United States or Europe. (Carbon dioxide, the leading heat-trapping gas, stays in the atmosphere for many years once emitted.)

China's leaders have declared that climate change is “a grim challenge facing all mankind” and that China is “one of the countries most adversely affected by climate change.”¹ The Chinese government has set goals for limiting emissions of heat-trapping gases, including pledges to peak carbon emissions by 2030 and achieve carbon neutrality by 2060, and adopted wide-ranging policies that contribute to meeting these goals. The policies are shaped in part by other objectives, including growing the economy, enhancing energy security, cutting local air pollution and promoting strategic industries.

This *Guide* examines Chinese climate change policies. It starts with a review of Chinese emissions. It then explores the impacts of climate change in China and provides a short history of the country's climate policies. The bulk of the *Guide* discusses China's principal climate policies, explaining the policy tools the Chinese government uses to address climate change and related topics. Appendices provide background on institutions that shape climate policy in China.

What are “climate policies”? Monetary and fiscal policies affect emissions and could therefore qualify, as could policies on many other topics. This *Guide* does not catalog all policies that could affect emissions or the climate but instead focuses on policies most directly related to climate change, including those on energy, transportation, urbanization, forestry, climate adaptation and climate diplomacy.

In choosing policies to focus on, we are guided in part by international convention and in part by governments' extensive reporting on this topic. The Nationally Determined Contributions submitted by more than 160 nations to the UN Framework Convention on Climate Change show a broad international consensus that policies on energy, transportation, urbanization and forestry, among others, are considered “climate policies.”² The Chinese government's official documents on climate change show the same.

1 People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021) at p.1; People's Republic of China, [China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy](#) (October 2021) at p.4.

2 See “[INDCs as communicated by Parties](#),” UN Framework Convention on Climate Change.

The Chinese government's climate change policies are set forth in a wide range of official documents. These include:

- the *14th Five-Year Plan for a Modern Energy System*, released by the National Development and Reform Commission (NDRC) and National Energy Administration in March 2022;³
- the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality*, released by the State Council in October 2021;⁴
- the *Action Plan for Carbon Dioxide Peaking Before 2030*, released by NDRC in October 2021;⁵
- China's updated *Nationally Determined Contributions*, submitted to the UN Framework Convention on Climate Change in October 2021;⁶
- China's *Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy*, released in October 2021;⁷
- the *Guiding Opinions on Coordinating and Strengthening Work Related to Addressing Climate Change and Environmental Protection*, released by the Ministry of Ecology and Environment in January 2021;⁸
- China's *Second Biennial Update Report on Climate Change*, submitted to the UN Framework Convention on Climate Change in December 2018;⁹ and
- detailed reports on China's policies and actions for addressing climate change published each year by the State Council or NDRC;¹⁰

In October 2021, President Xi Jinping announced that China would adopt a "1+N" policy framework for climate change. The "1" refers to a long-term approach to combating climate

3 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022).

4 State Council, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full And Faithful Implementation of the New Development Philosophy](#) (October 24, 2021).

5 NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021).

6 People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021).

7 People's Republic of China, [China's Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy](#) (October 2021).

8 Ministry of Ecology and Environment, [Guiding Opinions on Coordinating and Strengthening Work Related to Addressing Climate Change and Ecological Environmental Protection](#) (January 2021). See Liu Daizong and Zhang Daiyang, "Climate Change will be a Higher Priority in the 14th FYP: Latest Signal from MEE Marks Increased National Efforts," World Resources Institute (March 2, 2021)

9 People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018).

10 See State Council Information Office, [Responding to Climate Change: China's Policies and Actions](#) (October 2021); NDRC, [China's Policies and Actions for Addressing Climate Change](#) (June 2021), NDRC, [China's Policies and Actions for Addressing Climate Change](#) (November 2019); NDRC, [China's Policies and Actions for Addressing Climate Change](#) (November 2018); NDRC, [China's Policies and Actions for Addressing Climate Change](#) (in Chinese) (October 2017); NDRC, [China's Policies and Actions for Addressing Climate Change](#) (October 2016); Dimitri De Boer and Fan Danting, ["How is Progress in China's 1+N Policy Framework?"](#) CCICED (March 11, 2022).

change, as set forth in the State Council's *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality*. The “N” refers to specific plans to peak carbon dioxide emissions by 2030, such as NDRC's *Action Plan for Carbon Dioxide Peaking Before 2030*.¹¹

Several themes run throughout the Chinese government's climate change policy documents, including promoting low-carbon development, scaling up clean energy sources, investing in industries of the future, balancing low-carbon development with other goals, including energy security, and participating actively in climate diplomacy.

Implementation is fundamental to any policy. This is especially true in China, where policy implementation can be a considerable challenge. Key ministries may fail to coordinate. Resources for enforcement may be lacking. Policies designed to achieve different objectives may conflict. The priorities of provincial leaders may not align with policies from Beijing. For these reasons and more, stated policies—while important—are just part of the picture when it comes to understanding China's response to climate change.

The organization of this *Guide* reflects that. Most chapters start with a section of background facts. This background provides context and can help in forming judgments on the impacts of policies to date and potential impacts of policies in the years ahead. Where implementation has been especially challenging or successful, that is highlighted.

This *Guide* can be read in parts or as a whole. Individual chapters are designed to stand alone and provide readers with information on discrete topics. The *Guide* as a whole is designed to provide an understanding of China's response to climate change and the implications of that response for China and the world.

The *Guide* can be accessed in two ways:

1. by purchasing it as a book on Amazon.com, and
2. by visiting the *Guide to Chinese Climate Policy* website at chineseclimatepolicy.oxfordenergy.org, where you can navigate to each chapter and download the entire manuscript for free.

This is a “living document.” Many of the facts and policies it describes will change in the months and years ahead. As that happens, this *Guide* will be updated. New editions of the *Guide* will be released in the years ahead.

We welcome comments on and updates to the material in this *Guide*. Please send comments and updates to chineseclimatepolicy@oxfordenergy.org.

¹¹ State Council, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full And Faithful Implementation of the New Development Philosophy](#) (October 24, 2021); NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021); Embassy of the People's Republic of China in the US, [“China's 1+N Policy Framework”](#) (November 17, 2021); Dimitri De Boer and Fan Danting, [“How is Progress in China's 1+N Policy Framework?”](#) CCICED (March 11, 2022)., 2022

PART I - BACKGROUND

TERMINOLOGY

Gt—gigatonne. One billion metric tonnes.

CO₂—carbon dioxide.

CO₂e—carbon dioxide equivalent, a measure used to compare heat-trapping gases based on their warming potential. The CO₂e value of carbon dioxide is 1.

Heat-trapping gases—also commonly referred to as “greenhouse gases.” The term “heat-trapping gas” more clearly captures the impact of these gases in the atmosphere and will be used throughout this Guide.

HEAT-TRAPPING GASES

The principal heat-trapping gases emitted by human activities are carbon dioxide (CO₂), methane (CH₄), nitrous oxide (NO_x) and fluorinated gases (such as HFCs and SF₆). Of these, carbon dioxide is by far the most important, with roughly 75% of the total warming impact of these gases globally. Methane is the second most important, with roughly 18% of the warming impact, followed by nitrous oxides with 4% and fluorinated gases with 2%.¹

Carbon dioxide emissions are caused mainly by burning coal, oil and gas. Some industrial processes, including cement production, also release carbon dioxide, as does deforestation. Methane and nitrous oxide emissions come

from agriculture, the energy sector and elsewhere. The fluorinated gases are used mostly in air conditioning and refrigeration.

The unit “CO₂ equivalent” (CO₂e) is a measure used to compare heat-trapping gases based on their warming potential. One molecule of methane traps roughly 80 times more heat than a carbon dioxide molecule over a 20-year period, for example. Methane is therefore often assigned a CO₂e value of roughly 80. One molecule of nitrous oxide traps roughly 273 times more heat than a carbon dioxide molecule over a 20-year period. Nitrous oxide is therefore often assigned a CO₂e value of roughly 273. The leading fluorinated gases have CO₂e values in the hundreds and thousands.²

1 Intergovernmental Panel on Climate Change (IPCC) Working Group III, [Climate Change 2022: Mitigation of Climate Change—Summary for Policymakers \(Sixth Assessment Report\)](#) at p.11 (Figure SPM.1).

2 IPCC Working Group I, [Climate Change 2021: The Physical Science Basis](#) at p.1017 (Table 7.15).

CHAPTER 1 - CHINESE EMISSIONS OF HEAT-TRAPPING GASES

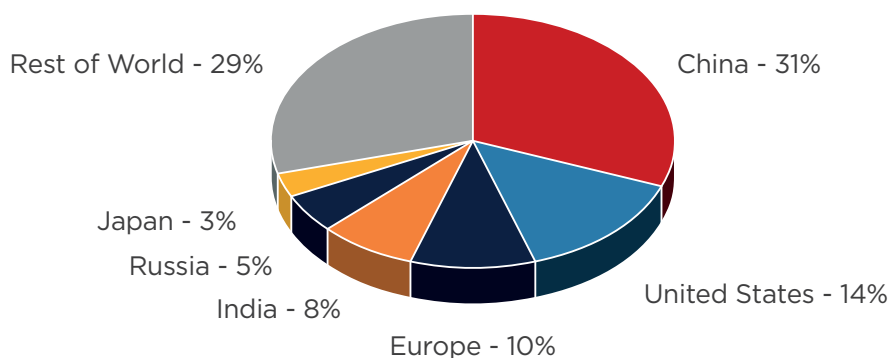
China leads the world in annual emissions of heat-trapping gases. In 2021, China's emissions of roughly 14.1 Gt CO₂e were approximately 28% of the global total.¹

This chapter starts by examining China's emissions of carbon dioxide (CO₂) and other heat-trapping gases. The chapter then discusses uncertainties in estimates of Chinese emissions, compares leading research organizations' estimates of Chinese emissions for each of the past 10 years, and considers implications of China's emissions for the global carbon budget.

A. Carbon Dioxide

In 2021, China's CO₂ emissions were roughly 11.3 Gt—almost one-third of the global total. Roughly 10.5 Gt were from the combustion of fossil fuels (coal, oil and gas). Most of the rest were from cement manufacturing. China's CO₂ emissions exceeded those from the United States, European Union and Japan combined.²

Figure 1-1: CO₂ Emissions from Fossil Fuel (2021)



Source: BP Statistical Review of World Energy 2022³

1 [Climate Action Tracker-China](#) (May 2022 update) (China's 2021 emissions = 14.1 GtCO₂e); [Climate Action Tracker-Global Temperatures](#) (November 2021 update) (global 2021 emissions = 50-51 GtCO₂e). See also Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.33 (China's 2020 emissions = 14.3 GtCO₂e).

2 [BP Statistical Review of World Energy](#), (June 2022) at p.12 (China 2021 fossil CO₂ emissions = 10.52 Gt; world 2021 fossil CO₂ emissions = 33.88 Gt); Shiming Liao et al., ["China's provincial process CO₂ emissions from cement production during 1993-2019,"](#) Scientific Data (2022) (China 2019 cement process CO₂ emissions = 818 Mt - more than 50% of global cement process CO₂ emissions); Statista, ["Production of cement in China from January 2012 to December 2021,"](#) (accessed August 13, 2022) (Chinese 2019 cement production roughly equal to Chinese 2021 cement production). See also RB Jackson et al., ["Global fossil carbon emissions rebound near pre-COVID-19 levels,"](#) Environmental Research Letters (March 2022) (China 2021 fossil CO₂ emissions = 10.9 Gt; World 2021 fossil CO₂ emissions = 36.2 Gt).

3 [BP Statistical Review of World Energy](#), (June 2022) at p.12.

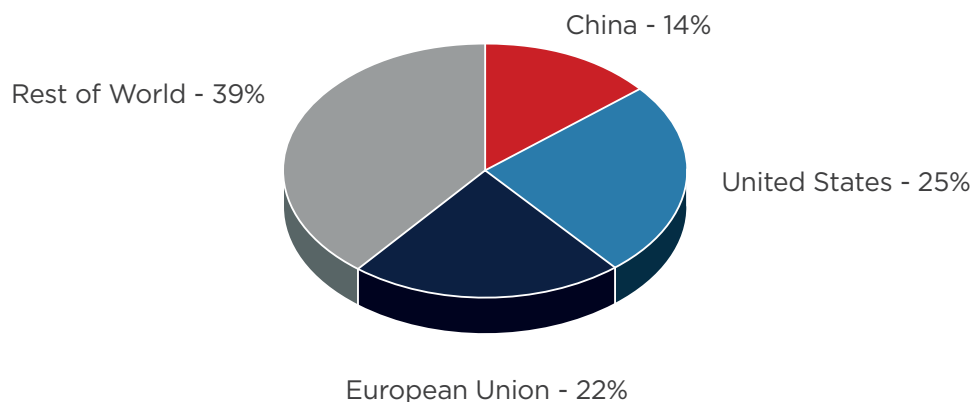
i. Emissions Metrics

Total annual emissions from a country's territory are not the only way to measure contributions to global warming. Other common metrics include (a) cumulative emissions over many years, (b) per capita emissions, (c) emissions per unit of GDP (often referred to as “carbon intensity”), and (d) consumption-based emissions.

- a. **Cumulative CO₂ emissions.** Once emitted, CO₂ remains in the atmosphere for many years. According to the IPCC, more than two-thirds of a pulse of CO₂ remains in the atmosphere for several decades, and 15%–40% remains in the atmosphere for more than 1000 years. Cumulative emissions over long periods are an important measure of a country's contribution to current global warming.⁴

One common metric is cumulative emissions since the beginning of the Industrial Revolution in the mid-18th century. Roughly 14% of the CO₂ emitted globally between 1751 and 2020 came from China. Roughly 25% came from the United States and roughly 22% from the EU (28).⁵

Figure 1-2: Cumulative CO₂ Emissions (1751–2021)



Source: *Our World in Data* based on CDIAC and Global Carbon Project⁶

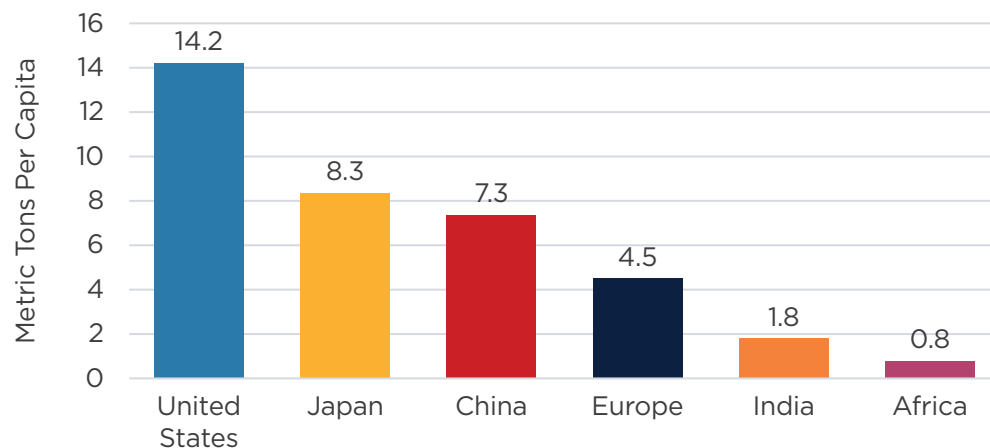
4 Intergovernmental Panel on Climate Change, [Climate Change 2013: The Physical Science Basis](#) at p.472 (Chapter 6, Box 6.1).

5 Hannah Ritchie and Max Roser, “[CO₂ emissions -- Cumulative CO₂ emissions](#),” *Our World in Data*, based on data published by the [Global Carbon Project](#) (accessed August 13, 2022) (fossil fuel and cement emissions).

6 Hannah Ritchie and Max Roser, “[CO₂ and Greenhouse Gas Emissions](#),” *Our World in Data*, based on data published by the [Global Carbon Project](#) (accessed August 4, 2022) (fossil fuel and cement emissions).

- b. **CO₂ emissions per capita.** In 2021, Chinese CO₂ emissions were roughly 7.4 tonnes per person—much less than the United States (14.1 tonnes per person) and less than Japan (8.4 tonnes per person). China emits more CO₂ per capita than Europe (5.0 tonnes per person) and much more than India (1.8 tonnes person) and Africa (0.9 tonne per person).⁷

Figure 1-3: Per Capita CO₂ Emissions from Fossil Fuels (2021)



Sources: BP Statistical Review of World Energy (June 2022); UN Department of Economic and Social Affairs - Population)⁸

Within China, there are significant regional variations in per capita emissions.

- The highest per capita emissions come from northern provinces, including Inner Mongolia, Ningxia and Shanxi. These provinces have many energy-intensive heavy industries and rely heavily on coal for heat and power. Some export electricity to other provinces.⁹
- The lowest emissions come from southern and western provinces, including Sichuan and Yunnan. Light industry plays a significant role in the industrial structure, heating demand is modest and hydro provides a large share of the

⁷ BP Statistical Review of World Energy, (June 2022) at p.12; United Nations Department of Economic and Social Affairs, [Population/Total Population/Annual Total Population at Mid-Year](#) (accessed August 13, 2022). See also Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.32 (greenhouse gas emissions per capita for G20 countries); Jiang Xiaoqian, “[6 pictures to understand China’s per capita carbon emissions](#),” World Resources Institute (in Chinese) (July 19, 2021)

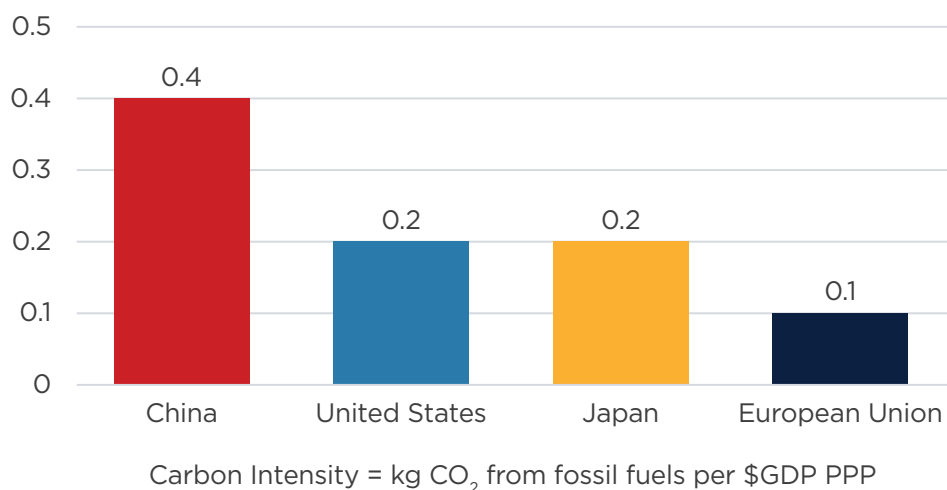
⁸ BP Statistical Review of World Energy, (June 2022) at p.12; United Nations Department of Economic and Social Affairs, [Population/Total Population/Annual Total Population at Mid-Year](#) (accessed August 13, 2022).

⁹ Jiang Xiaoqian, “[6 pictures to understand China’s per capita carbon emissions](#),” World Resources Institute (in Chinese) (July 19, 2021); Zhu Liu, [China’s Carbon Emissions Report 2016](#), Belfer Center, Harvard Kennedy School (October 2016) at pp.5-10.

power supply in these provinces.¹⁰

- c. **CO₂ emissions per unit of GDP (carbon intensity).** In 2021, China emitted roughly 0.39 kg of CO₂ from fossil fuels per dollar of GDP. The carbon intensity of China's economy has been steadily improving for the past 15 years due to structural shifts in the Chinese economy (from manufacturing to services), policies encouraging the phaseout of inefficient industrial facilities, energy efficiency standards and other factors. However China's carbon intensity remains high in comparison with other major economies, including the United States (0.20), Japan (0.19) and the European Union (0.13).¹¹

Figure 1-4: Carbon Intensity (kg CO₂ Emissions from Fossil Fuels per \$GDP PPP) (2021)



Source: BP Statistical Review of World Energy 2022; IMF Data Mapper-GDP Current Prices¹²

- d. **Consumption-based emissions.** Consumption-based emissions accounting allocates emissions from production of a good to the place that good is consumed. Thus, if a good is produced in Country A but consumed in Country B, emissions associated with producing that good are allocated to Country B. This contrasts with traditional territorial or production-based emissions accounting, which assigns all emissions that occur within a country to that country.

China is the world's leading net exporter of goods. Many of the goods China

¹⁰ Jiang Xiaoqian, "6 pictures to understand China's per capita carbon emissions," World Resources Institute (in Chinese) (July 19, 2021); Zhu Liu, [China's Carbon Emissions Report 2016](#), Belfer Center, Harvard Kennedy School (October 2016) at pp.5-10.

¹¹ [BP Statistical Review of World Energy](#) (June 2022) at p.12; International Monetary Fund, [IMF Data Mapper-GDP Current Prices](#) (accessed August 13, 2022).

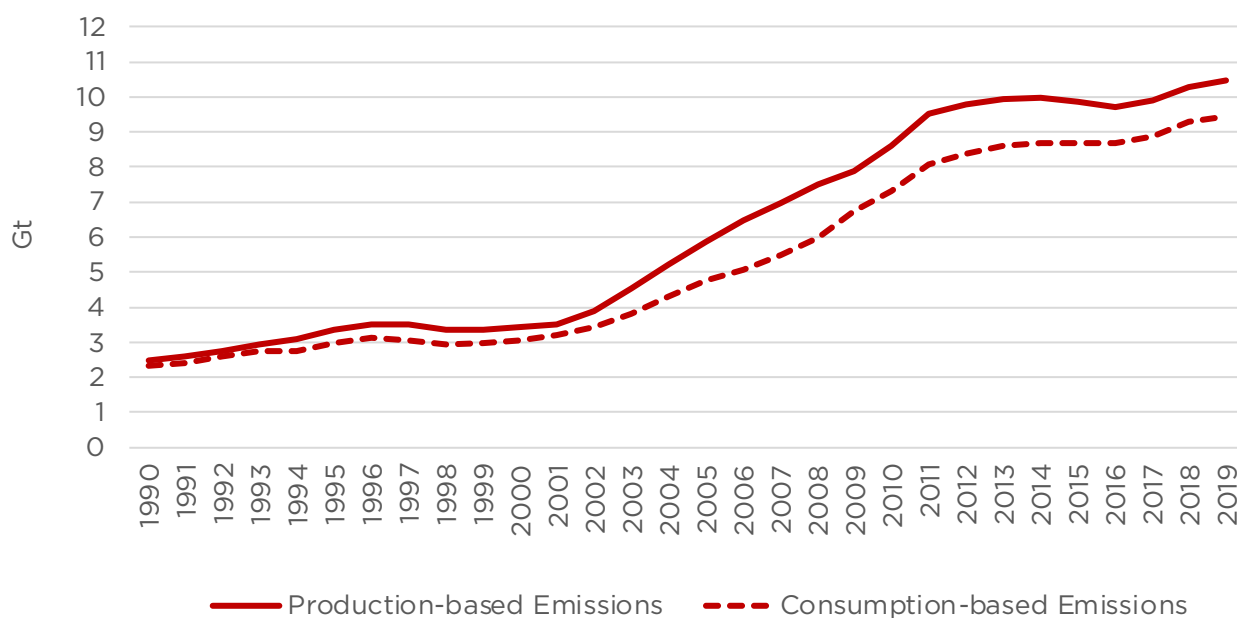
¹² [BP Statistical Review of World Energy](#) (June 2022) at p.12; International Monetary Fund, [IMF Data Mapper-GDP Current Prices](#) (accessed August 13, 2022).

exports are produced in carbon-intensive processes. As a result, a consumption-based emissions accounting system reduces China's CO₂ emissions as compared to traditional territorial emissions accounting.

In 2019, China's share of global CO₂ emissions using consumption-based emissions accounting was roughly 27%. This is four percentage points less than China's 31% share of global CO₂ emissions using a traditional territorial emissions accounting system.¹³

China remains the world's largest CO₂ emitter when using consumption-based accounting, but by a somewhat smaller margin than when using traditional territorial accounting. (Using consumption-based accounting, the world's second largest CO₂ emitter—the United States—was responsible for 16% of global CO₂ emissions in 2019, as compared to 14% with traditional territorial accounting.)¹⁴

Figure 1-5: Production- and Consumption-Based CO₂ Emissions - China (1990–2019)



Source: *Our World in Data*¹⁵

¹³ Hannah Ritchie and Max Roser, [China: CO₂ Country Profile—Consumption-Based Accounting \(Table\)](#) (accessed August 13, 2022)

¹⁴ Hannah Ritchie and Max Roser, [United States: CO₂ Country Profile—Consumption-Based Accounting \(Table\)](#) (accessed August 13, 2022)

¹⁵ Hannah Ritchie and Max Roser, [China: CO₂ Country Profile—Consumption-Based Accounting \(Table\)](#) (accessed August 13, 2022)

ii. Emissions Growth

China's CO₂ emissions have been rising for most of the past 40 years.¹⁶

- In 1980, China's CO₂ emissions were less than 1.5 Gt. Per capita emissions were less than North Korea's per capita emissions today.¹⁷
- Between 1980 and 2000, China's CO₂ emissions grew at roughly 4% per year, as the Chinese government's "Reform and Opening Up" policies produced steady economic growth.
- Between 2000 and 2012, China's CO₂ emissions shot up roughly 9.5% per year, reflecting the country's extraordinary economic growth during this period. Chinese CO₂ emissions nearly tripled in 12 years. This period included the largest decadal CO₂ emissions growth of any country in history, by far.
- Between 2013 and 2016, China's CO₂ emissions held roughly steady. In several years during this period, according to some estimates, China's CO₂ emissions declined. The plateau in China's CO₂ emissions from 2013 to 2016 was the result of a number of factors, including (i) a structural shift in the economy away from heavy manufacturing, (ii) a cyclical downturn in some energy-intensive industries, (iii) slower overall economic growth, (iv) coal-to-gas switching, (v) increases in solar and wind power, and (vi) greater hydropower generation due to significant rainfall in several years.¹⁸
- From 2017 to 2019, China's CO₂ emissions began climbing again. Estimates vary, but an average of leading estimates suggests that CO₂ emissions rose by roughly 2% in 2017, 3% in 2018 and 2.5% in 2019. Causes included a cyclical rebound in some energy-intensive industries and (in 2018) greater demand for heating and cooling due to an unusually large number of hot and cold days.¹⁹
- From January to April 2020, the COVID-19 pandemic led to widespread lockdowns and disruptions of economic activity in China. CO₂ emissions fell sharply. One analysis found that CO₂ emissions in the weeks around Chinese New Year 2020 were 25% less than CO₂ emissions in the weeks around Chinese New Year 2019.²⁰ Other analyses found that CO₂ emissions during the first quarter of 2020 fell in the range of 10–20% year-over-year.²¹

16 For historical data on China's emissions, see [Climate Watch-China](#) (CAIT and PIK datasets).

17 [Climate Watch-China](#) (CAIT dataset); [Climate Watch-North Korea](#) (CAIT dataset).

18 See Table 1-10 below; Jan Korsbakken and Glen Peters, "[A Closer Look at China's Stalled Carbon Emissions](#)," CarbonBrief (March 1, 2017).

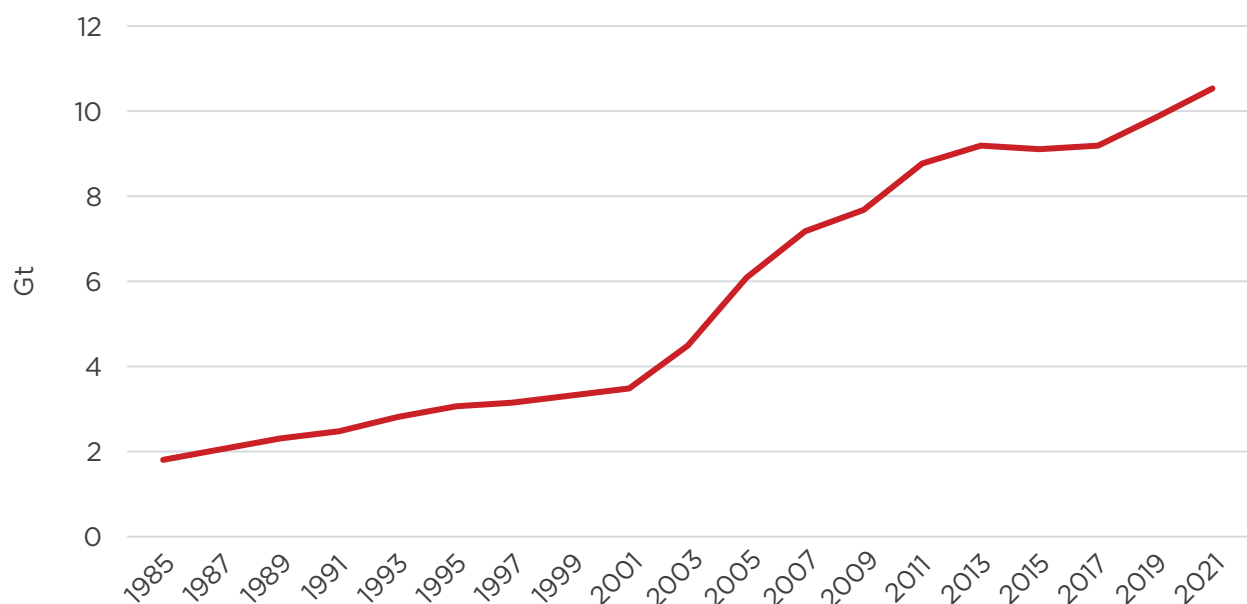
19 See Table 1-10 below; [BP Statistical Review of World Energy 2019](#) (June 2019) at pp.3-4.

20 Laura Myllyvirta, "[Coronavirus temporarily reduced China's CO₂ emissions by a quarter](#)," CarbonBrief (February 19, 2020).

21 Bo Zheng et al., "[Satellite-based estimates of decline and rebound in China's CO₂ emissions during COVID-19 pandemic](#)," *Science Advances* (December 2, 2020); Qingqing Wang et al., "[Coronavirus pandemic reduced China's CO₂ emissions in short-term, while stimulus packages may lead to emissions growth in medium- and long-term](#)," *Appl Energy*, (November 15, 2020).

- In the second quarter of 2020, COVID lockdowns were steadily relaxed. During the second half of 2020, CO₂ emissions were above pre-pandemic levels, in part because economic recovery measures focused on heavy, carbon-intensive industries. For 2020 as a whole, CO₂ emissions increased roughly 1.5%.²²
- In 2021, CO₂ emissions rebounded dramatically, increasing 5–6%. Greater electricity demand, most of which was supplied by coal-fired power plants, was the main reason.²³
- During the first half of 2022, CO₂ emissions in China fell sharply. According to preliminary estimates, Chinese CO₂ emissions declined 1.5% year-over-year from January-March 2022 and 8% year-over-year from April-June 2022. COVID lockdowns, the ongoing real estate slump (leading to less cement and steel production) and strong growth in renewables output were among the reasons.²⁴

Figure 1-6: China's CO₂ Emissions from Fossil Fuels (Gt) (1985–2021)



Source: BP Statistical Review of World Energy 2022²⁵

22 See Figure 1-9 below; Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.33.

23 IEA, [Global CO₂ emissions rebounded to their highest level in history in 2021](#) (March 8, 2022); IEA, [Global Energy Review: CO₂ Emissions in 2021](#); Zhu Liu et al., "Monitoring global carbon emissions in 2021," *Nature Reviews Earth & Environment* (March 21, 2022); [BP Statistical Review of World Energy](#) (June 2022) at p.12.

24 Lauri Myllyvirta, "[China's CO₂ emissions see longest sustained drop in a decade](#)," *CarbonBrief* (May 30, 2022); Lauri Myllyvirta, "[China's CO₂ emissions fall by record 8% in second quarter of 2022](#)," *CarbonBrief* (September 1, 2022).

25 [BP Statistical Review of World Energy](#) (June 2022) at p.12.; IEA, [CO₂ Emissions from Fossil Fuel Combustion](#) (2017) at pp. 80-81.

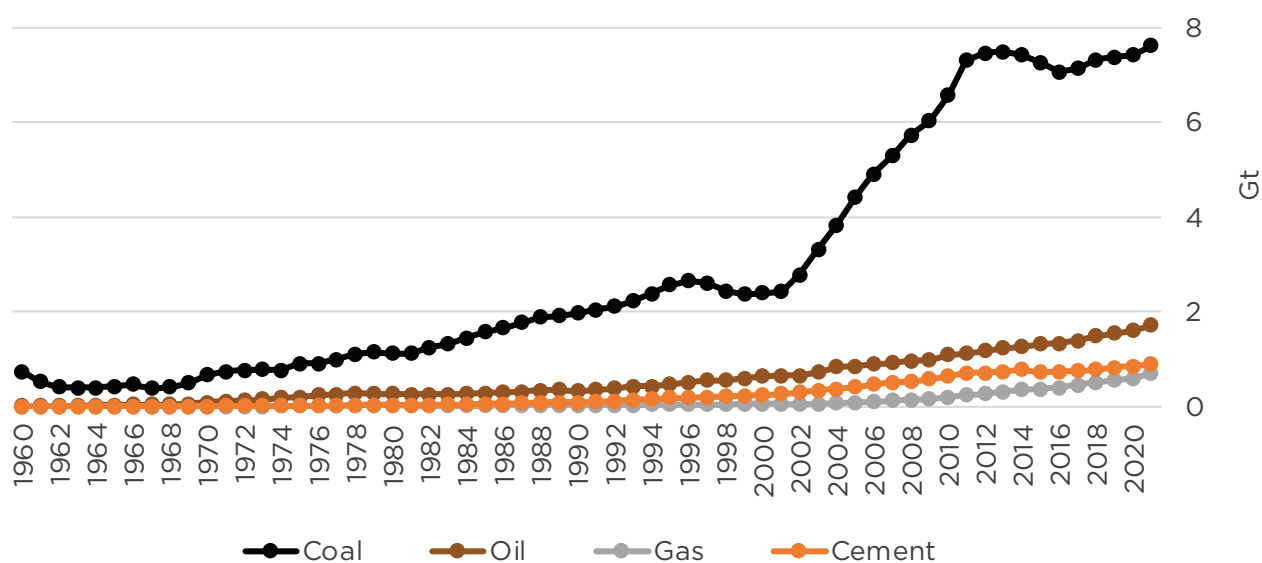
iii. CO₂ Emissions by Sector and Source

Roughly 45% of China's CO₂ emissions come from electricity generation, 35% come from manufacturing and 8% come from transport. (Almost half the electricity generated in China is used for manufacturing. If emissions from that electricity are allocated to manufacturing, manufacturing's share of total CO₂ emissions jumps to 60%.)²⁶

This sectoral composition of emissions is very different than in most developed countries. In the United States, for example, roughly 25% of emissions of heat-trapping gases come from electric power, 27% from industry and 27% from transportation.²⁷

Coal combustion is by far the leading source of heat-trapping gas emissions in China, with roughly 7.6 Gt in 2021.²⁸

Figure 1-7: China's CO₂ Emissions by Fuel Type (1960–2020)



Source: *The Global Carbon Project's fossil CO₂ emissions dataset*²⁹

26 Different sources have different estimates, in part due to different definitions and categories. Percentages vary from year to year. See M. Crippa et al., [GHG emissions of all the world countries 2021 Report-Downloads](#) (accessed August 17, 2022) (in 2020, 4794 Gt power industry/11,680 Gt China total = 41%); [Carbon Emissions Accounts and Datasets](#) (CEADs) project—IPCC Sectoral Emissions database (accessed August 17, 2022) (in 2019, 4642 Gt “production and supply of electricity, steam and hot water”/9795 China Gt total = 47%); Ian Teseo, [“Energy-related CO₂ emissions breakdown in China 2020, by sector,”](#) Statista (June 9, 2022) (in 2020, electricity production and supply = 48%). See also Chapters 9, 12 and 17 of this Guide.

27 US EPA, [“Sources of Greenhouse Gas Emissions,”](#) (accessed August 17, 2022) (2020 data).

28 Global Carbon Project, [Global Carbon Budget 2021-Presentation](#) (November 2021) at Slide 28.

29 [Global Carbon Budget 2021](#) at slide 28; Robbie Andrew et al., [The Global Carbon Project's fossil CO₂ emissions dataset,](#) (October 14, 2021).

iv. Land Use Change and Forestry

Land use change and forestry in China are net sinks (meaning they absorb more CO₂ than they release). Climate Watch, an online data platform managed by World Resources Institute, estimates that roughly 710 Mt CO₂ were sequestered by land use change and forestry in China each year from 2011 to 2015 and 650 Mt CO₂ were sequestered each year from 2016 to 2019. The most recent official estimates are from the Biennial Update Reports submitted by the Chinese government to the UN Framework Convention on Climate Change. The Chinese government estimates that land use change and forestry in China sequestered 576 Mt CO₂ in 2012 and 1150 Mt CO₂ in 2014. The reasons for the difference between the two figures are not clear.³⁰

B. Other Gases

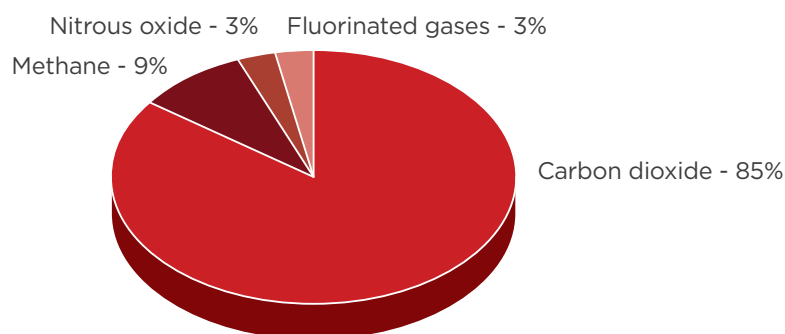
The leading heat-trapping gases other than CO₂ are methane, nitrous oxide and fluorinated gases. In 2020, emissions of these gases from China were roughly 2 Gt CO₂e—about 13% of the global total. (China's share of global emissions of heat-trapping gases other than CO₂ is much smaller than its share of global emissions of CO₂).³¹

After CO₂, the most significant heat-trapping gas is methane. In 2020, Chinese methane emissions were roughly 1.2 Gt CO₂e—about 8% of China's total emissions of heat-trapping gases. Uncertainties with respect to methane measurement are especially large. Methane emissions in China come from coal mining, rice farming, waste disposal, livestock production and leakage during the production and distribution of natural gas, among other sources.³²

30 [Climate Watch-China \(Data Source CAIT\)](#) (accessed August 17, 2022); People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.16; People's Republic of China, [First Biennial Update Report on Climate Change](#) (December 2016) at p.22. See Chapter 23 of this Guide.

31 Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at pp.47-49.

32 Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.47; Jiang Lin et al., "[China's Non-CO₂ Greenhouse Gas Emissions: Future Trajectories and Mitigation Options and Potential](#)," Scientific Reports (November 2019).

Figure 1-8: China's Heat-Trapping Emissions by Gas (CO₂e) (2020)

Source: PBL Netherlands Environmental Assessment Agency (April 2022)³³

Nitrous oxide is another important heat-trapping gas. Emissions are mainly from the agriculture sector. In 2020, Chinese nitrous oxide emissions were roughly 430 Gt CO₂e—about 3% of China's total emissions.³⁴

China is a major producer and consumer of HFCs, a pollutant used in refrigeration and air-conditioning with a global warming potential more than 10,000 times greater per molecule than CO₂. In 2020, emissions of HFCs and other fluorinated gases were approximately 315 Mt CO₂e (roughly 2% of Chinese emissions). The Chinese government's Second Biennial Update Report to the UNFCCC estimated HFC emissions of 214 Mt CO₂e (roughly 1.5% of Chinese emissions) in China in 2014.³⁵

C. Uncertainties in Emissions Estimates

There are significant uncertainties with regard to estimates of Chinese emissions of heat-trapping gases. Although China's data collection systems have improved enormously in recent years, those systems are not as developed or transparent as similar systems in many industrialized countries. In addition, some Chinese data may have systematic reporting biases. Some provincial economic and energy data may be overstated, for example, because promotion criteria for provincial officials have traditionally emphasized hitting GDP targets. China's National Bureau of Statistics has revised its estimates of coal consumption and other energy

³³ Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at pp.46-49.

³⁴ Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.48. See Chapter 22 of this Guide.

³⁵ Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.49 (Chinese F-gas emissions in 2020 = 448 Mt) and p. 34 (70% of China's F-gas emissions are HFCs); People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.16. See Chapter 18 of this Guide.

data several times in the past 20 years, with significant implications for emissions estimates.³⁶

Analysis of Chinese emissions data in the peer-reviewed literature has grown in recent years.

- In 2012, a *Nature* paper found a 1.4 Gt gap between China's CO₂ emissions when calculated based on two different sets of official statistics (national and provincial). As the authors note, 1.4 Gt is roughly equal to annual CO₂ emissions from Japan.³⁷
- In 2015, a *Nature* paper concluded that previous estimates of Chinese carbon dioxide emissions may have been overstated by roughly 10%, mainly due to errors estimating emissions factors for Chinese coal.³⁸
- In 2016, a *Nature* paper raised questions about previous estimates of a drop in Chinese coal use and related reductions in emissions.³⁹
- A 2017 *Climate Policy* paper examined uncertainties in estimates of China's emissions of non-CO₂ heat-trapping gases.⁴⁰
- In 2018, a *Nature* article found uncertainties in China's 2015 emissions estimates of -15% to 25% at a 97.5% confidence level.⁴¹
- In 2018, an *Energy Policy* paper explored how modifications in China's energy statistics create uncertainty with respect to China's ability to meet its carbon peaking targets.⁴²
- In 2020, a *Scientific Data* paper found uncertainties in China's energy-related emissions estimates of -15% to 30% at a 97.5% confidence level.⁴³
- In 2022, a *China Economic Review* paper analyzed revisions in China's energy statistics following the Third National Census in 2013 and causes of the discrepancies between China's national and provincial energy data.⁴⁴

36 See Jan Ivar Korsbakken, Robbie Andrew and Glen Peters, "[China's CO₂ emissions grew slower than expected 2018](#)," CarbonBrief (May 3, 2019) (discussing 2018 data challenges); People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.22; Derek Scissors, "[China's Economic Statistics Mean Everything and Nothing](#)," Newsweek (May 24, 2016).

37 Dabo Guan et al., "[The Gigatonne Gap in China's Carbon Dioxide Inventories](#)," *Nature Climate Change* (2012) pp.672-675.

38 Zhu Liu et al., "[Reduced carbon emission estimates from fossil fuel combustion and cement production in China](#)," *Nature* (August 20, 2015) at p.2.

39 Jan Ivar Korsbakken et al., "[Uncertainties around reductions in China's coal use and CO₂ emissions](#)," (February 16, 2016) at p.1.

40 Xin Wang et al., "[Challenges to addressing non-CO₂ greenhouse gases in China's long-term climate strategy](#)," *Climate Policy* (December 2017).

41 Yuli Shan et al., "[China CO₂ emission accounts 1997-2015](#)," *Nature* (2018). See also Teng Fei, "[Carbon: resolve ambiguities in China's emissions](#)," *Nature* (2015); Teng Fei and Zhu Songli, "[Which estimation is more accurate? A technical comments on Nature Paper by Liu et al on overestimation of China's emission](#)," *Sci. Technol. Rev.* (2015) at pp.112-116.

42 Heran Zheng et al., "[How modifications of China's energy data affect carbon mitigation targets](#)," *Energy Policy* (May 2019).

43 Yuli Shan et al., "[China CO₂ emission accounts 2016-2017](#)," *Scientific Data* (February 2020).

44 Ben Ma et al., "[Improved statistical consistency: The effect of data revisions on the energy use gap between China and its provinces](#)," *China Economic Review* (June 2022).

Improving emissions data is a goal of the Chinese government. In 2014, the National Bureau of Statistics and National Development and Reform Commissions (NDRC) established a 23-member Leading Group on Climate Statistics and launched “climate change statistical practice pilots” in 15 provinces. In 2016, the State Council’s Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan directed provinces and municipalities to “strengthen statistical work on climate change,” “improve the greenhouse gas emission measurement and monitoring system” and “promote greenhouse gas emissions data disclosure.” In 2021, NDRC’s Action Plan for Carbon Dioxide Peaking Before 2030 said:

“We will improve our capacity for the statistics and accounting of carbon emissions, work for better accounting methods and accelerate the establishment of a unified and standardized carbon emissions measuring and counting system. We will support industries and businesses in conducting methodology research on carbon emissions accounting based on their own characteristics and set up a sound measuring system for that purpose.”⁴⁵

In August 2021, a Working Group on Carbon Emission Statistics and Accounting was established under the National Leading Group for Carbon Peaking and Carbon Neutrality. Co-led by NDRC and the National Bureau of Statistics (NBS), the Working Group coordinates carbon emission statistics and accounting procedures among ministries, provinces and companies.⁴⁶ In August 2022, NDRC, NBS and the Ministry of Ecology and Environment announced an Implementation Plan on Accelerating the Establishment of a Unified and Standardized Carbon Emission Statistics and Accounting System. The Plan says that

“by 2025, the unified and standardized carbon emission statistics and accounting system will be further improved, the data quality will be improved in an all-round way, and comprehensive, scientific and reliable data support will be provided for carbon peaking and carbon neutralization.”⁴⁷

D. Estimates by Leading Research Organizations

Many organizations publish data on Chinese emissions of heat-trapping gases.

- The Chinese government provides official emissions estimates for all heat-trapping gases in its Biennial Update Reports to the UN Framework Convention on Climate Change. The most recent biennial update was submitted in 2018, reporting 2014 data.⁴⁸

45 State Council, [“Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan,”](#) (in Chinese) (October 27, 2016); NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021).

46 “Carbon Peak Carbon Neutrality Leading Group Office established a carbon emission statistics and accounting working group,” NDRC (August 31, 2021)

47 “China’s carbon emissions statistics and accounting system to accelerate the improvement” People’s Daily Overseas Edition (August 22, 2022)

48 People’s Republic of China, [First Biennial Update Report on Climate Change](#) (in Chinese) (December 2016); People’s Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018).

- Chinese government agencies, including the National Bureau of Statistics, publish estimates of fossil fuel use, electricity consumption and other economic activity, in some cases as often as monthly. The China Electricity Council publishes estimates on these topics as well. English translations of this material are often provided on China Energy Portal. These data and other information are used by experts around the world to estimate Chinese emissions.⁴⁹
- Among the organizations that publish information on Chinese emissions are the Chinese government, International Energy Agency, European Commission, PBL Netherlands Environmental Assessment Agency, Carbon Dioxide Information Analysis Center, Carbon Emissions Accounts and Datasets, Global Carbon Project, World Resources Institute and BP. Estimates from these organizations vary in coverage and scope. (See Figure 1-9 below.)

E. Chinese Emissions and the Carbon Budget

In the Paris Agreement, more than 190 nations agreed to “hold the increase in the global average temperature to well below 2°C (3.6°F) above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C (2.7°F) above pre-industrial levels” According to the Intergovernmental Panel on Climate Change, cumulative global CO₂ emissions from the beginning of 2020 must be less than (i) 900 Gt, to have an 83% chance of meeting the 2°C (3.6°F) goal, and (ii) 300 Gt, to have an 83% chance of meeting the 1.5°C (2.7°F) goal.⁵⁰

China’s emissions will have a significant impact on the world’s ability to achieve these goals. For example, if China were to keep emitting CO₂ at its current pace of 10–11 Gt per year, it alone will use up one-third of the global 2°C carbon budget by 2050 and one-third of the global 1.5°C carbon budget by 2032.⁵¹ If China’s CO₂ emissions increase during the 2020s, these goals become even harder to reach.

Of course, industrialized countries emitted far more CO₂ than China during the past century. (CO₂ stays in the atmosphere for many years once emitted.) Industrialized countries are responsible for most of the human-caused CO₂ currently in the atmosphere and, in part for that reason, have agreed to take the lead in cutting emissions in the decades ahead. But however much other countries limit emissions in the decades ahead, China’s emissions will have a significant impact on the world’s ability to meet the agreed climate goals.

49 See National Bureau of Statistics, [Statistical Communiqué](#) (February 28, 2022); [China Electricity Council—Data and Publications](#); [China Energy Portal](#).

50 [Paris Agreement](#) Article 2.1.a; Intergovernmental Panel on Climate Change, [Climate Change 2021: The Physical Science Basis—Summary for Policymakers](#) at p.29 Table SPM.2.

51 (i) 10.5 Gt/year x 28 years (between now and 2050) = 294 Gt = roughly one-third of the 900 Gt global carbon budget to stay below 2°C. (ii) 10.5 Gt x 10 years (between now and 2032) = 105 Gt = roughly one-third of the 300 Gt global carbon budget to stay below 1.5°C.

Figure 1-9: China's Annual Emissions of Heat-Trapping Gases (2012-2021) (Gt)

Data Source	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
All Gases (CO₂e)										
PRC, Biennial Update Reports ⁵¹	11.9	--	12.3	--	--	--	--	--	--	--
Climate Watch-CAIT ⁵²	11.4	11.9	11.9	11.8	11.8	12.0	12.5	12.7	--	--
PRIMAP ⁵³	12.4	12.7	12.8	12.7	12.6	12.8	13.0	13.4	--	--
Climate Action Tracker ⁵⁴ (based upon PRIMAP)	12.4	12.7	12.8	12.7	12.6	12.8	13.0	13.4	13.6	14.1
EDGAR ⁵⁶	12.9	13.2	13.3	13.2	13.2	13.4	13.7	---	---	--
PBL Netherlands ⁵⁶ (based upon EDGAR)	13.0	13.3	13.3	13.3	13.2	13.4	13.8	14.1	14.3	--
CO₂ from Fossil Fuels and Industrial Processes										
CEADs-IPCC Sectoral Emissions ⁵⁷	9.1	9.5	9.5	9.3	9.3	9.4	9.6	9.8	--	--
CDIAC-FF ⁵⁸	9.6	9.8	9.8	9.7	9.6	9.7	10.1	--	--	--
Global Carbon Project ⁵⁹ (based upon CDIAC-FF)	9.8	10.0	10.0	9.8	9.7	9.9	10.3	10.5	10.7	--
CEADs-Apparent Emissions ⁶⁰	9.9	10.1	10.0	9.8	9.6	9.8	10.0	10.4	--	--
IEA ⁶¹	9.9	10.4	10.4	10.3	10.3	10.5	11.0	11.2	11.4	11.9
EDGAR ⁶²	10.5	10.7	10.8	10.7	10.7	10.9	11.3	11.5	11.7	--
CO₂ from Fossil Fuels										
BP ⁶³	9.0	9.2	9.3	9.2	9.2	9.4	9.7	9.9	10.0	10.5
CO₂ Removal Land Use Change and Forestry										
PRC, Biennial Update Reports ⁶⁴	(0.6)	--	(1.1)	--	--	--	--	--	--	--
Climate Watch-CAIT ⁶⁵	(0.7)	(0.7)	(0.7)	(0.7)	(0.6)	(0.6)	(0.6)	(0.6)	--	--

- 52 People's Republic of China, [First Biennial Update Report on Climate Change](#) (in Chinese) (December 2016) at p.22; People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.16.
- 53 [Climate Watch-China \(Data Source CAIT\)](#) (accessed August 13, 2022).
- 54 J. Gütschow, A. Gunther, M. Pflüger, [PRIMAP-hist national historical emissions time series \(1750-2019\) v2.3.1](#) (September 22, 2021).
- 55 [Climate Action Tracker-China](#) (May 2022 update) (Data Download) (accessed August 13, 2022). This data source uses PRIMAP data through 2019 and extrapolates for 2020-21.
- 56 M. Crippa et al., [GHG emissions of all the world countries 2021 Report-Downloads](#) (accessed August 17, 2022).
- 57 Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.45. This data source uses EDGAR data through 2018 (adding Hong Kong and Macau emissions as well as CH₄ & N₂O emissions from savannah burning) and extrapolates for 2019-20.
- 58 Yuru Guan et al., "[Assessment to China's Recent Emission Pattern Shifts](#)," *Earth's Future* 9, No. 11 (October 21, 2021): e2021EF002241; Yuli Shan et al., "[China CO₂ Emission Accounts 2016-2017](#)," *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., "[China CO₂ Emission Accounts 1997-2015](#)," *Scientific Data* 5, No. 1 (January 16, 2018): 170201. Data is available at [Carbon Emissions Accounts and Datasets-Nation](#) (accessed August 16, 2022).
- 59 Gilfillan D; Marland G; Boden T; Andres R (2021): [Global, Regional, and National Fossil-Fuel CO₂ Emissions: 1751-2018](#) CDIAC-FF, Research Institute for Environment, Energy, and Economics, Appalachian State University.
- 60 P. Friedlingstein et al. [Global Carbon Budget 2021](#), *Earth Systems Science Data* (April 26, 2022). GCP's data adds process emissions of CO₂ from lime production to CDIAC-FF estimates. See Robbie Andrew and Glen P. Peters, "[The Global Carbon Project's fossil CO₂ emissions dataset](#)," CICERO Center for International Climate Research, section 2.2.3.
- 61 Yuru Guan et al., "[Assessment to China's Recent Emission Pattern Shifts](#)," *Earth's Future* 9, No. 11 (2021): e2021EF002241; Yuli Shan et al., "[China CO₂ Emission Accounts 2016-2017](#)," *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., "[China CO₂ Emission Accounts 1997-2015](#)," *Scientific Data* 5, No. 1 (January 16, 2018): 170201. Data is available at [Carbon Emissions Accounts and Datasets-Nation](#) (accessed August 16, 2022).
- 62 International Energy Agency, [Global Energy Review: CO₂ Emissions in 2021](#) (April 2022) at p.9 Figure 5 and (accessed August 20, 2022).
- 63 M. Crippa et al., [GHG emissions of all the world countries 2021 Report-Downloads](#) (accessed August 17, 2022).
- 64 [BP Statistical Review of World Energy](#) (June 2022) at p.12.
- 65 People's Republic of China, [First Biennial Update Report on Climate Change](#) (in Chinese) (December 2016) at p.22; People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.16.
- 66 FAO 2022, FAOSTAT Emissions Database. Accessed via [Climate Watch-China \(Data Source CAIT\)](#) (accessed August 13, 2022).

CHAPTER 2 - IMPACTS OF CLIMATE CHANGE IN CHINA

“China is among the countries most severely affected by climate change. Climate change has exerted persistent impacts on China’s ecological environment and socio-economic development, and already brought serious threats to its food, water, ecology, energy, and urban operation security, as well as people’s safety and property.”

— *China’s Nationally Determined Contributions (October 2021)*.¹

A. China’s Vulnerability to Climate Change

China is acutely vulnerable to climate change.

In 2015, China’s Ministry of Science and Technology, the China Meteorological Administration, the Chinese Academy of Sciences and the Chinese Academy of Engineering released China’s *Third National Assessment Report on Climate Change*—a 900-page document based on the work of more than 500 Chinese experts. The report found that China faces many risks from climate change including sea level rise, more intense heat waves and more severe and frequent storms, droughts and floods. The report offered a number of conclusions, including:

- average annual temperature increases in China since 1909 have been higher than the global average, rising 0.9°–1.5°C (1.6°–2.7°F) per century;
- from 1970 to 2000, glaciers in China shrunk roughly 10%; and
- by 2100, temperatures in China could increase 1.3–5.0°C (2.7–9.0°F).²

Work on a *Fourth National Assessment Report on Climate Change* is underway.³ In addition, each year the Chinese Meteorological Administration publishes the *China Blue Book on Climate Change*, which provides information on temperatures, rainfall, sea levels and other topics. The 2022 edition of the *Blue Book* found that:

- average annual temperature increases since 1951 have been higher than the global average, rising 0.26°C (0.47°F) per decade;
- extreme heat waves and storms are becoming more frequent in China; and

¹ People’s Republic of China, [China’s Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021) at p.1.

² Wang Jing, [“China’s Third National Assessment on Climate Change Released,”](#) ScienceNet.cn (in Chinese) (November 22, 2015); Bing Wang et al., [“Comprehensive analysis on China’s National Climate Change Assessment Reports: Action and emphasis,”](#) Other studies have reached similar results, see e.g. Shaohong Wu et al., [“Integrate Risk From Climate Change in China Under Global Warming of 1.5 and 2.0 °C,”](#) Earth’s Future (November 9, 2019); Lulu Liu, [“Warming of 0.5°C may cause double the economic loss and increase the population affected by floods in China,”](#) Natural Hazards and Earth Systems Sciences (May 10, 2022); Bing Wang et al., [“Comprehensive analysis on China’s National Climate Change Assessment Reports: Action and emphasis,”](#) Frontiers of Engineering Management (July 12, 2019).

³ [“Ministry of Science and Technology Organized the third meeting of the Expert Committee on the Fourth National Assessment Report on Climate Change,”](#) Tanjiaoyi (in Chinese) (September 10, 2020).

- in 2021, glacier retreat in China was almost at record levels, with the west end of the Urumqi Heyuan 1 glacier retreating 8.5 meters in one year.⁴

China's vulnerability to sea level rise is especially acute. More than 650 million people live in China's coastal provinces—one of the most densely populated regions on Earth. More than 150 million people in China live in low-elevation coastal areas.⁵ The *Third National Assessment Report* found that:

- sea levels off eastern China rose 93 millimeters (3.5 inches) between 1980 and 2012;
- sea levels in China could rise 40–60 centimeters (16–24 inches) above 20th century average levels by the end of this century; and
- an increase of one centimeter (0.4 inches) could cause the coastline to recede by more than 10 meters (33 feet) in parts of China.⁶

The *Third National Assessment Report* found that rising seas would significantly increase risks of flooding and storm damage along China's coasts. Several recent studies have reached similar results. A 2018 study found that China would incur far more costs from flooding due to sea level rise than any other nation. A 2021 study found trillions of dollars of economic activity along China's coastline at risk from climate change, including almost \$1 trillion at risk in Shanghai alone.⁷

China is also vulnerable to heat waves, storms, floods and droughts. The *Third National Assessment Report* found that climate change would increase all four. The report found that climate change could extend growing seasons for some crops in northern China but warned that climate change would bring less reliable rains, the spread of dangerous pests and shorter growing seasons for many crops. It found that changing rainfall patterns would strain reservoirs and create dam safety challenges, including at the Three Gorges Dam.⁸

4 [“China's Blue Book on Climate Change \(2022\) released the global warming trend continues,”](#) People's Daily Online (in Chinese) (August 3, 2022); [“Annual Blue Book highlights increasing climate impacts on China,”](#) China Dialogue (August 4, 2022); Li Hongyang, [“Climate change making China's summer hotter,”](#) China Daily (August 4, 2022). See also Chinese Meteorological Administration, *China Blue Book on Climate Change 2019*, as reported in Zhang Tianchi and Qiu Haifeng, [“China's surface temperature shows a clear upward trend,”](#) People's Daily (in Chinese) (April 11, 2019).

5 Statista, [Population in China in 2020, by province or region](#); Asia Development Bank, [Climate Risk Country Profile: China](#) (2021) at p.18 (estimating 11.4% of China's population lives in low-elevation coastal areas).

6 Bing Wang et al., [“Comprehensive analysis on China's National Climate Change Assessment Reports: Action and emphasis,”](#) *Frontiers of Engineering Management* (July 12, 2019).

7 Jevrejeva et al., [“Flood damage costs under the sea level rise with warming of 1.5°C and 2°C,”](#) *Environmental Research Letters* (July 4, 2018) (flood costs from sea level rise in China in 2100 an order of magnitude greater than in the US and Japan); [“China's sea-level rise raises threat to economic hubs to extreme,”](#) *Financial Times* (June 12, 2021); Yan Zhang et al., [“Coastal vulnerability to climate change in China's Bohai Economic Rim,”](#) *Environment International* (February 2021); Li You, [“Rising Seas Threaten China's Long, Low, and Crowded Coast,”](#) *Sixth Tone* (December 31, 2020); Hu Yiwei, [“Why Sea Level Rise is a Big Deal for China,”](#) CGTN (June 8, 2019); Ying Qu et al., [“Coastal Sea level rise around the China Seas,”](#) *Global and Planetary Change* (January 2019); Chris Buckley, [“Chinese Report on Climate Change Depicts Somber Scenarios,”](#) *New York Times* (November 29, 2015).

8 Bing Wang et al., [“Comprehensive analysis on China's National Climate Change Assessment Reports: Action and emphasis,”](#) *Frontiers of Engineering Management* (July 12, 2019); Chris Buckley, [“The Findings of China's Climate Change Report,”](#) *New York Times* (November 30, 2015); Chris Buckley, [“Chinese Report on Climate Change Depicts Somber Scenarios,”](#) *New York Times* (November 29, 2015).

The Intergovernmental Panel on Climate Change found that extreme agricultural droughts in western China would be at least twice as likely with a 1.5°C (2.7°F) increase over pre-industrial temperatures globally and 150–200% more likely with 2°C (3.6°F) of warming.⁹

Droughts create significant risks for China’s power grid. Lack of water is a particular problem in China’s southern provinces, many of which are reliant on hydropower.¹⁰

Melting glaciers will also create challenges for China. More than 80% of China’s glaciers are in retreat. The *Third National Assessment Report* found potential geopolitical risks from disputes with South Asian neighbors over transboundary water resources and smaller river flows caused by shrinking glaciers.¹¹

B. Recent Extreme Weather Events

Record Heatwave

Summer 2022 was the hottest summer in China ever. Hundreds and perhaps thousands of temperature records were broken in a heat wave that lasted more than nine weeks from June through August. One meteorologist called the heat wave “the worst ever seen worldwide.” Another meteorologist said the heat wave was “unimaginable” both in intensity and longevity.¹²

- Between June and mid-July, 71 weather stations recorded their highest temperatures ever.¹³
- On July 13, the temperature in Shanghai reached 40.9°C (105.6°F)—equaling the temperature record for Shanghai set in 2017.¹⁴
- July 2022 was the hottest month ever recorded in Hong Kong.¹⁵
- In July, the temperature in Fuzhou exceeded 41°C (almost 106°F) for three days in a row for the first time ever.¹⁶
- On August 14, 81 heat records were broken across China. In Quxian, Sichuan, the temperature reached 43.4°C (110.1°F)—the highest temperature ever recorded in

9 Intergovernmental Panel on Climate Change, [Climate Change 2022: Impacts, Adaptation and Vulnerability](#) at p.556.

10 [“Historic droughts trigger power shortages in the Yangtze basin,”](#) China Dialogue (August 18, 2022); Emily Feng, [“Shanghai’s skyline will be dark for 2 days due to power shortages caused by heat wave,”](#) National Public Radio (August 23, 2022).

11 Asia Development Bank, [Climate Risk Country Profile–China](#) (2021) at p.18; Yongping Shen et al., [Melting Earth: Glacier Retreat and its Impacts in China’s Cryosphere](#) (December, 2018); Chris Buckley, [“Chinese Report on Climate Change Depicts Somber Scenarios,”](#) New York Times (November 29, 2015).

12 Michael LePage, [“Heatwave in China is the most severe ever recorded in the world,”](#) New Scientist (August 23, 2022); @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 20, 2022); @ScottDuncanWX, [Scott Duncan](#), Twitter (August 20, 2022).

13 Vivian Wang, [“Hotter, Longer and More Widespread Heat Waves Scorch China,”](#) New York Times (July 26, 2022).

14 [“Temperature in Shanghai hits record high,”](#) Xinhua (July 13, 2022).

15 Almond Li, [“July was Hong Kong’s hottest month ever, breaking 11 weather records,”](#) Hong Kong Free Press (August 1, 2022).

16 Vivian Wang, [“Hotter, Longer and More Widespread Heat Waves Scorch China,”](#) New York Times (July 26, 2022).

Sichuan Province.¹⁷

- On August 18, the temperature in Chongqing reached 45°C (113°F)—the highest temperature ever recorded in China outside Xinjiang. On August 19, the temperature reached 45°C (113°F) again in Chongqing.¹⁸
- On August 19, the overnight low in Chongqing was 34.9°C (94.8°F) – the highest night-time temperature ever recorded in China.¹⁹
- On August 21, 82 heat records were broken across China. Many stations recorded their hottest 20–30 day period in 70 years.²⁰

Record-breaking heat waves are becoming common in China. For example:

- In 2013, several southern and eastern provinces had the most severe heat wave in at least 140 years. Chinese authorities declared the heat a “level 2” weather emergency—a designation previously used only for typhoons and flooding. The China Meteorological Association found that human activities increased the likelihood of this heat wave by 60 times.²¹
- On July 24, 2015, the temperature reached 50.3°C (122.5°F) near Ayding Lake in Xinjiang Province. This was the highest temperature ever recorded in China.²²
- In July 2018, 24 weather stations across China recorded their highest temperatures ever.²³

A leading Chinese scientist calls heat waves the “new normal” for China.²⁴

Heavy Rain and Floods

Heavy rains are also becoming a new normal in China. These rains—in combination with loss of wetlands and more land area being paved for roads and parking—have led to enormously damaging flooding.

- In July 2007, the worst rainstorms in 115 years hit Chongqing, causing dozens of deaths and extensive property damage.²⁵

17 @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 15, 2022).

18 @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 19, 2022); @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 20, 2022).

19 @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 20, 2022).

20 @extremetemps, [Extreme Temperatures Around the World](#), Twitter (August 22, 2022).

21 [“China endures worst heat wave in 140 years,” USA Today](#) (August 1, 2013); [“China’s surface temperature shows a clear upward trend,” People’s Daily](#) (in Chinese) (April 11, 2019).

22 [“50.3°C 新疆吐鲁番市艾丁湖刷新 “中国热极” 记录 \[50.3°C Xinjiang Turpan Ayding Lake sets China temperature record\],” Asia Heart Network](#) (in Chinese) (July 29, 2015).

23 Hou Liqiang, [“July sees records in temperatures,” China Daily](#) (August 3, 2019).

24 Matthew Walsh and Du Caicai, [“Deadly Heat Waves Could Be China’s ‘New Normal,’ Scientist Warns,” Caixin](#) (August 7, 2019).

25 [“Rainstorms kill 32 in Chongqing,” China Daily](#) (July 18, 2007).

- In July 2012, the heaviest rainfall in 60 years hit Beijing, leaving 37 people dead.²⁶
- A 2016 study found that rainfall in southern China in 2015 was 50% greater than the 1971–2000 average and that “rain fell in a series of heavy storms, causing severe flooding in many cities with impacts that included loss of life.”²⁷
- In August and September 2018, record rains fell in parts of Guangdong, requiring the evacuation of more than 200,000 people and causing RMB 2.76 billion (roughly \$400 million) in damages.²⁸
- In June 2020, rain in the Yangtze River Valley broke records. At least 78 people died and direct economic losses exceeded RMB 25 billion (roughly \$3.6 billion).²⁹
- In July 2021, almost a year’s worth of rain fell in three days in the central Chinese city of Zhengzhou, breaking records. Record rains also fell in Henan province. More than 69 people were killed and 50,000 houses were destroyed.³⁰
- In summer 2022, heavy rains led to flooding in the Pearl River Basin and western province of Qinghai.³¹

Droughts

Record droughts have also plagued China in recent years. (More droughts and heavy rains are both more likely as a result of a warming atmosphere, according to climate scientists.)³²

- In 2007, a severe drought struck parts of southern China. Reservoirs shrank and parts of the Yangtze River dropped to the lowest levels since records were first kept in the 19th century (probably due not just to drought but to withdrawals).³³
- In 2017, parts of Inner Mongolia experienced the worst drought on record.³⁴
- In August 2022, China suffered its worst drought ever. Parts of the Yangtze River were

26 [“Beijing chaos after record floods in Chinese capital,”](#) BBC (July 23, 2012).

27 Stephanie C. Herring et al., [“Explaining Extreme Events of 2015 From a Climate Perspective,”](#) Special Supplement to the Bulletin of the American Meteorological Society (December 2016).

28 Li You, [“Fall Semester Delayed at 120 Schools in Flood-Ravaged City,”](#) Sixth Tone (September 5, 2018).

29 Science China Press, [“A combined influence of three oceans on record-breaking rainfall over China in June 2020,”](#) (April 8, 2021).

30 Yuan Ye, [“Global warming of 2C could ‘double’ flooding costs in China compared to 1.5C,”](#) CarbonBrief (July 26, 2022); Steven Lee Myers et al., [“As China Boomed, It Didn’t Take Climate Change Into Account. Now It Must,”](#) New York Times (July 26, 2021).

31 Steven Lee Myers et al., [“As China Boomed, It Didn’t Take Climate Change Into Account. Now It Must,”](#) New York Times (July 26, 2021); Karina Tsui and Ian Livingston, [“China hit by drought, floods, as Yangtze River runs dry,”](#) Washington Post (August 18, 2022).

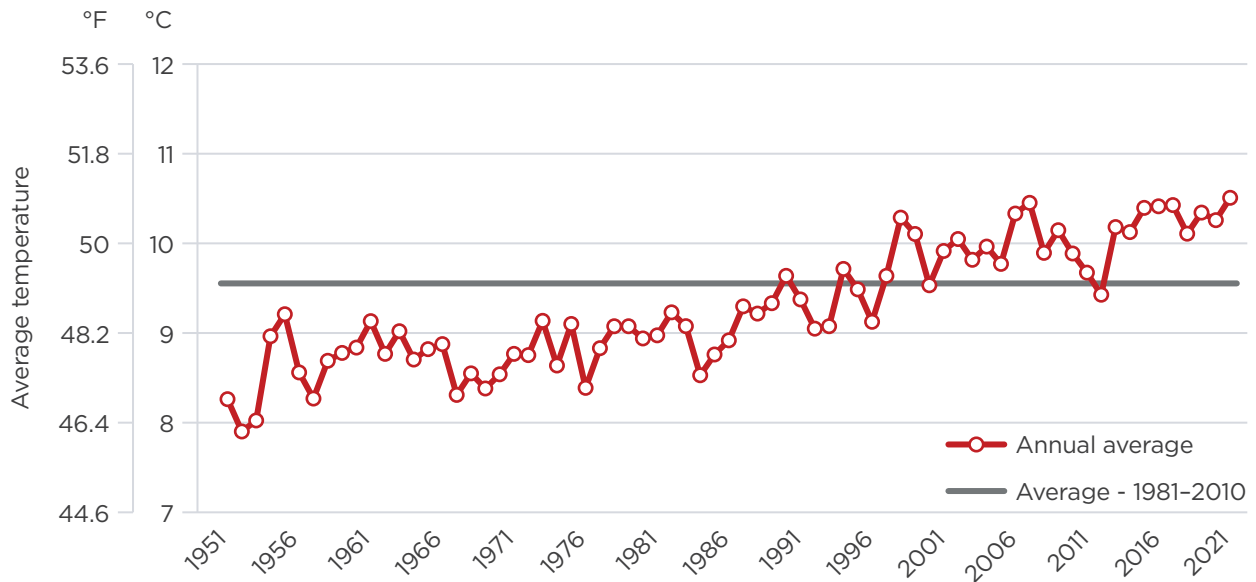
32 John Schwartz, [“More Floods and More Droughts: Climate Change Delivers Both,”](#) New York Times (December 12, 2018).

33 China Meteorological Administration, [“Global warming has changed rainfall patterns of China,”](#) (February 17, 2017); “Droughts in China,” Facts and Details (March 29, 2010).

34 Edward Wong, [“Northern China suffering from worst drought on record, officials say,”](#) Today China and India (July 1, 2017).

at the lowest levels ever recorded. In Sichuan Province, which relies on hydropower, factories were ordered to shut down to preserve electricity for households.³⁵

Figure 2-1: Average Annual Temperatures in China (1951–2021)



Source: China Meteorological Administration³⁶

35 Karina Tsui and Ian Livingston, [“China hit by drought, floods, as Yangtze River runs dry,”](#) Washington Post (August 18, 2022); Echo Xie, [“Yangtze River, lakes at record low levels as heatwaves, drought hit southern China,”](#) South China Morning Post (August 15, 2022); China Dialogue, [“Historic droughts trigger power shortages in the Yangtze basin,”](#) (August 18, 2022).

36 China Meteorological Administration, [China Climate Bulletin](#), 中国气候公报 (in Chinese) (2017).

CHAPTER 3 - SHORT HISTORY OF CHINESE CLIMATE POLICY

Climate change first emerged as a public policy issue in the 1980s, with growing evidence from scientists and calls for action from prominent politicians, including UK Prime Minister Margaret Thatcher and US Senator Al Gore. During this period, the Chinese government was beginning to implement market-based reforms. Early attention to climate change in China was focused mostly on scientific issues and led by the State Science and Technology Commission. In 1990, the National Climate Change Coordinating Group was established to coordinate work on climate change by government ministries. Members included the State Meteorological Administration (which housed and administered the group), the Ministry of Science and Technology, the Ministry of Energy, the Ministry of Foreign Affairs and others.¹

In the early 1990s, China participated in global negotiations to establish a UN Framework Convention on Climate Change (UNFCCC). In the negotiations, China gave high priority to “common but differentiated responsibilities”—the principle that all countries are responsible for taking action to prevent climate change but that responsibilities vary based on a country’s level of development.

In 1992, Premier Li Peng attended the Rio Earth Summit and signed the UN Framework Convention on Climate Change. The principle of common but differentiated responsibilities was included in the agreement. In his remarks at Rio, Premier Li highlighted several principles, including:

- economic development must be coordinated with environmental protection;
- protecting the environment is the common task of all mankind, but developed countries have greater responsibility; and
- international cooperation on the environment should be based on respect for national sovereignty.²

In 1997, China joined more than 100 other nations in adopting the Kyoto Protocol, which imposed emissions limits on industrialized countries but not on China or other developing countries.

In 1998, the National Climate Change Coordinating Group was moved from the State Meteorological Administration to the State Planning and Development Commission (the predecessor to NDRC) as part of a broader governmental reorganization. The move to the State Planning and Development Commission reflected the far-reaching implications of climate change as an issue.

The 10th Five-Year Plan (2001–2005) was the first to mention climate change, affirming

1 See Ye Qi and Tong Wu, “[The Politics of Climate Change in China](#),” WIREs Climate Change (June 14, 2013) at p.307; Iselin Stensdal, “[Chinese Climate-Change Policy 1988–2013: Moving On Up](#),” Asian Perspective (January–March 2014) at p.120.

2 [Premier Li Peng’s speech at the Rio Earth Summit](#), China State Council Bulletin (July 15, 1992) (in Chinese).

the Chinese government's commitment to addressing climate change and other global environmental issues. The plan contained several environmental targets (including for forest cover and air pollutants) but none for climate change or energy efficiency. The Chinese economy grew rapidly during this period with a massive wave of industrialization but scant attention to energy efficiency, which worsened during the period of the 10th Five-Year Plan (2001–2005).³

In 2002, China ratified the Kyoto Protocol. In the years that followed, Chinese entities began actively participating in the Clean Development Mechanism (CDM). At the same time, air pollution became an increasingly significant problem in many Chinese cities. Some Chinese planners identified renewable energy as an industry with significant growth potential globally. In 2005, the National People's Congress passed the Renewable Energy Law, which set national renewable energy targets and established feed-in tariffs for renewable energy.⁴

The 11th Five-Year Plan (2006–2010) was the first to include a binding target for energy efficiency. The target—a 20% improvement—was implemented in part by assigning energy efficiency targets to each province, with provincial and local leaders accountable for achieving them. Although GDP and other economic targets remained most important to these provincial and local leaders with respect to promotion opportunities, failure to achieve energy efficiency and environmental targets became a potential barrier to promotion for the first time. Evidence emerged that some provincial and local leaders were manipulating energy and environmental data in order to be seen as hitting their targets.⁵

During the 11th Five-Year Plan (2006–2010), climate change rose rapidly on the agenda of Chinese leaders. Important developments included:

- In 2006, the Chinese government released its first “National Assessment Report on Climate Change,” based on work by more than 20 ministries and government agencies. The report found that climate change posed serious threats to China.⁶
- In 2007, the Intergovernmental Panel on Climate Change (IPCC) released its Fourth Assessment Report, which found that “warming of the climate system is unequivocal” and that most of the recent increase in global average temperatures was probably due to human activities. Chinese experts participated in the IPCC

3 National People's Congress, [“Tenth Five-Year Plan,”](#) (March 15, 2001) (in Chinese); Ye Qi and Tong Wu, [“The Politics of Climate Change in China,”](#) WIREs Climate Change (June 14, 2013) at p.307.

4 Iselin Stensdal, [“Chinese Climate-Change Policy 1988–2013: Moving On Up,”](#) Asian Perspective (January–March 2014) at p.120; Joanna Lewis, [“China's Strategic Priorities in International Climate Change,”](#) Washington Quarterly (November 2007); Feng Wang, Haitao Yin and Shoude Li, [“China's Renewable Energy Policy: Commitments and Challenges,”](#) Energy Policy (2010).

5 Ye Qi and Tong Wu, [“The Politics of Climate Change in China,”](#) WIREs Climate Change (June 14, 2013) at pp.307, 311; Da Zhang, Valerie Karplus, Cyril Cassisa and Xiliang Zhang, [“Emissions trading in China: Progress and prospects,”](#) Energy Policy (2014) at p.10; Yana Jin, Henrik Andersson and Shiqui Zhang, [“Air Pollution Control Policies in China: A Retrospective and Prospects,”](#) International Journal of Environmental Research and Public Health (December 2016).

6 Ding Yihui et al., [“China's National Assessment Report on Climate Change \(I\): Climate change in China and the future trend,”](#) (November 2007); E. Lin et al., [“China's National Assessment Report on Climate Change \(II\): Climate change impacts and adaptation,”](#) (December 2006); He Jiankun et al., [“China's National Assessment Report on Climate Change \(III\): Integrated evaluation on policies of China responding to climate change,”](#) (December 2006).

process as Core Writing Team members and reviewers.⁷

- In 2007, news reports around the world indicated that in 2006 China had become the world's leading greenhouse gas emitter.⁸
- In 2007, the National Climate Change Coordinating Group was elevated to become the National Leading Group on Addressing Climate Change (a higher level in the bureaucracy). Some provinces also established Leading Groups on Climate Change.
- In 2007, the Chinese government issued the National Climate Change Program, a 60-page report on Chinese climate policies.
- In 2008, NDRC released its first white paper on climate change—*China's Policies and Actions for Addressing Climate Change*.⁹

In late 2008, the global financial crisis struck. Within months, the Chinese government launched an RMB 4 trillion (roughly \$600 billion) economic stimulus plan. Some elements, including support for solar power manufacturing, fit well with the growing attention to low-carbon development. However, other elements underscored the far greater priority the leadership attached to sustaining economic growth in the face of a global recession and unprecedented instability in financial markets. The stimulus package included vast energy-intensive construction projects and support for industries heavily dependent on fossil fuels. Environmental regulations were sometimes suspended to facilitate rapid spending. The stimulus package led to emissions increases and slowed progress on energy efficiency across the economy.¹⁰

The 2009 Copenhagen Conference of the Parties (COP) to the UNFCCC received enormous global attention. Just before the conference, China announced its first-ever goal concerning carbon dioxide emissions: to lower “carbon intensity” by 40%–45% from 2005 levels by 2020. (“Carbon intensity” is the ratio of carbon dioxide emissions to GDP.) Premier Wen Jiabao traveled to Copenhagen where he met with US President Barack Obama and other world leaders. The negotiations were chaotic, and the Copenhagen conference was widely considered to be a failure. China and other leading emitters received considerable criticism in the global media for the failure to reach a more ambitious agreement.¹¹

In February 2010, in the wake of the Copenhagen conference, top leaders from the Chinese central government and provinces convened for a week-long meeting on low-carbon development. President Hu Jintao, Premier Wen Jiabao and members of the Politburo participated. Later that year, NDRC announced that five provinces and eight municipalities

7 Intergovernmental Panel on Climate Change, [Climate Change 2007 – Synthesis Report, Annex I](#) (2008) at pp.92–95.

8 See e.g., [“China overtakes US as world’s biggest CO₂ emitter,”](#) Guardian (June 19, 2007).

9 NDRC, [China’s Policies and Actions for Addressing Climate Change](#) (October 2008) (in Chinese).

10 Yana Jin, Henrik Andersson and Shiqui Zhang, [“Air Pollution Control Policies in China: A Retrospective and Prospects,”](#) International Journal of Environmental Research and Public Health (December 2016); Ye Qi and Tong Wu, [“The politics of climate change in China,”](#) WIREs Climate Change (June 14, 2013)

11 Malcolm Moore, [“China announces carbon target for Copenhagen,”](#) Telegraph (November 2009); [“Why did Copenhagen fail to deliver a climate deal?”](#) BBC News (December 22, 2009); Mark Lynas, [“How do I know China wrecked the Copenhagen deal? I was in the room,”](#) The Guardian (December 22, 2009).

had been chosen for low-carbon development pilot projects.¹²

During 2010, officials in many provinces realized they were at risk of failing to achieve the energy efficiency targets in the 11th Five-Year Plan. To achieve the targets, many officials ordered short-term shutdowns of factories and power plants. The shutdowns provided evidence of how seriously many officials treated the targets.¹³

In October 2010, the Chinese government announced plans to promote seven “strategic emerging industries,” including alternative energy, new energy vehicles, and environmental and energy-saving technologies. The government offered financial incentives for investments in these industries and set quantitative targets for each industry’s contribution to GDP. Related to this, Chinese policy makers gave increasing attention to promoting the innovative capabilities of the Chinese economy more broadly, focusing on educational and institutional reforms that could promote innovation. In the years that followed, low-carbon development was increasingly seen as part of a strategy for investing in industries of the future and enhancing China’s capacities for innovation.¹⁴

The 12th Five-Year Plan (2011–2015) was the first with an explicit climate change target. The plan included a chapter on climate change and called for a 17% cut in carbon emissions per unit of GDP (as well as a 16% cut in energy consumption per unit of GDP). To help achieve this target, the State Council released a *Work Plan for Controlling Greenhouse Gas Emissions* during the 12th Five-Year Plan period.¹⁵ Significant developments during this period included the following:

- At the end of 2011, the Chinese government chose seven provinces for pilot carbon dioxide emissions trading projects. The projects were launched and implemented in the years that followed, eventually covering more than 10,000 businesses and roughly 6% of China’s CO₂ emissions.¹⁶
- In 2012, low-carbon development, the “green economy” and “ecological civilization” were all heralded by the Chinese leadership at its 18th Party Congress.¹⁷
- In 2013, the Chinese government released its first *National Climate Change Adaptation Plan*.¹⁸

12 Ye Qi and Tong Wu, [“The Politics of Climate Change in China,”](#) WIREs Climate Change (June 14, 2013) at p.305.

13 Da Zhang, Valerie Karplus, Cyril Cassisa and Xiliang Zhang, [“Emissions trading in China: Progress and prospects,”](#) Energy Policy (2014) at p.10; Kevin Lo and Mark Y. Wang, [“Energy conservation in China’s Twelfth Five-Year Plan period: Continuation or Paradigm Shift?”](#) Renewable and Sustainable Energy Reviews (2013) at p.501; Isabel Hilton, [China’s Green Revolution: Energy, Environment and the 12th Five-Year Plan](#) at p.5.

14 Simon Rabinovitch, [“China Outlines Strategic Industries,”](#) Financial Times (August 4, 2011); US-China Business Council, [“China’s Strategic Emerging Industries,”](#) (March 2013).

15 [“China: 12th Five-Year Plan \(2011–2015\) for National Economic and Social Development,”](#); State Council, [“Work Plan for Greenhouse Gas Emission Control during the 12th Five-Year Plan Period,”](#) (2011); Lisa Williams, [“China’s Climate Change Policies—Actor and Drivers,”](#) Lowy Institute (July 2014) at p.13; Isabel Hilton, [China’s Green Revolution: Energy, Environment and the 12th Five-Year Plan](#).

16 Da Zhang, Valerie Karplus, Cyril Cassisa and Xiliang Zhang, [“Emissions trading in China: Progress and prospects,”](#) Energy Policy (2014) at p.12.

17 Ye Qi and Tong Wu, [“The Politics of Climate Change in China,”](#) WIREs Climate Change (June 14, 2013) at pp.302, 307.

18 National Development and Reform Commission et al., [National Strategy for Climate Change Adaptation](#) (November 18, 2013) (in Chinese);

- In September 2014, NDRC released the *National Plan on Climate Change (2014–2020)*. The plan identified key principles, policies and targets for fighting climate change.¹⁹
- In November 2014, China and the United States jointly announced steps each country would take to combat climate change during a summit meeting between President Xi Jinping and President Barack Obama. As part of the announcement, China pledged to peak carbon dioxide emissions around 2030 and to make best efforts to peak early. The agreement made headlines around the world (and was widely seen as a catalyst to reaching agreement at the Paris climate conference the following year).²⁰
- In June 2015, China submitted its Intended Nationally-Determined Contribution (INDC) to the Secretariat of the UN Framework Convention on Climate Change. In its INDC, China pledged to achieve the peaking of carbon dioxide emissions around 2030, making best efforts to peak early. It also pledged that by 2030, it would (1) lower carbon dioxide emissions per unit of GDP by 60%–65% from the 2005 level, (2) increase the share of nonfossil fuels in primary energy consumption to around 20% and (3) increase the forest stock volume by around 4.5 billion cubic meters from the 2005 level.²¹

China was an active participant in the Paris climate conference in December 2015. At the opening ceremony, President Xi Jinping declared climate change “a shared mission of all mankind” and joined other world leaders in announcing a commitment to double funding for research and development on clean energy. The Paris Agreement reflected work by the Chinese delegation, led by chief negotiator Minister Xie Zhenhua, to find common ground on challenging issues, including the principle of “common but differentiated responsibilities.” Official Chinese news sources reported that China worked closely with other countries during the conference “to ensure the agreement was adopted.”²²

The Chinese government has been unwavering in its support for the Paris Agreement.

- In January 2017, President Xi Jinping described the Paris Agreement as a “hard-won achievement...in keeping with the underlying trend of global development” and a “milestone in the history of climate governance” that “we must ensure is not derailed.”²³
- In October 2017, in his high-profile remarks to the 19th Party Congress, President Xi said, “Taking the driving seat in international cooperation to respond to climate change, China has become an important participant, contributor, and torchbearer in the global endeavor for ecological civilization.”²⁴

19 NDRC, [China–National Plan for Climate Change \(2014–2020\)](#)

20 NDRC, [China’s Policies and Actions on Climate Change \(2014\)](#) (November 2014); White House, [“U.S.-China Joint Announcement on Climate Change,”](#) White House (November 2014).

21 NDRC, [Enhanced Actions On Climate Change: China’s Intended Nationally Determined Contributions](#) (June 30, 2015), pp.2–16.

22 [“President Xi’s speech at opening ceremony of Paris climate summit,”](#) China Daily (December 1, 2015); [“China Voice: China takes leading role in global climate deal,”](#) Xinhua (December 14, 2015) (in Chinese); Shannon Tiezzi, [“China Celebrates Paris Climate Change Deal,”](#) (December 15, 2015).

23 Xi Jinping, [“Speech at U.N. Office in Geneva,”](#) (January 18, 2017).

24 [“Xi Jinping’s Speech to 19th CPC National Congress,”](#) (November 3, 2017) (in Chinese); Michael Swaine, [“Chinese Attitudes Toward The U.S. Withdrawal from the Paris Climate Accords,”](#) China Leadership Monitor (September 11, 2017).

In July 2019, Premier Li Keqiang reiterated the Chinese government's support for the Paris Agreement and commitment to cutting emissions in a meeting of the National Leading Group on Climate Change, Energy Conservation and Emissions Reduction.²⁵

In a September 2020 speech to the UN General Assembly, President Xi Jinping announced that China would aim to achieve carbon neutrality before 2060. The announcement received considerable media attention around the world. In the same speech, President Xi also announced that China would aim to peak carbon dioxide emissions “before” 2030, a slight strengthening of his previous pledge that China would achieve peak emissions “around 2030, making best efforts to peak early.”²⁶

In July 2021, the Chinese government officially launched a national emissions trading program for carbon dioxide. The program covers the power sector and is scheduled to expand to other major-emitting sectors in the years ahead.²⁷

On several occasions during 2021 and the first half of 2022, Chinese leaders emphasized that climate change goals must be pursued in an “orderly manner” consistent with other important goals including energy security and economic growth. In July 2021, for example, the Politburo of the Chinese Communist Party warned against “campaign-style” carbon reduction policies. In a January 2022 speech, President Xi emphasized that low-carbon development must be pursued in ways that help achieve energy security goals. In an Environment Day speech in June 2022, Vice Premier Han Zheng said: “We will promote carbon neutrality in an orderly manner and reduce carbon emissions while ensuring energy security, industrial chain supply chain security and food security.”²⁸

25 [“Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction,”](#) Chinese Government Network (July 11, 2019) (in Chinese); [“China to continue efforts to tackle climate change: Premier Li,”](#) Xinhua (July 12, 2019).

26 For President Xi's remarks, see [“Statement by Xi Jinping at General Debate of 75th UNGA,”](#) Xinhua (September 23, 2020). For news articles, see, e.g., Matt McGrath, [“Climate change: China aims for ‘carbon neutrality by 2060’,”](#) BBC News (September 22, 2020); Stephen Lee Myers, [“China's Pledge to Be Carbon Neutral by 2060: What It Means,”](#) New York Times (September 23, 2020).

27 [“China's national carbon market to start trading in July,”](#) Xinhuanet (July 14, 2021); [“Trading Begins Under China's National ETS”](#) SDG Knowledge Hub (July 19, 2021).

28 Xiaoying You, [“China issues new ‘single-game’ instructions to guide its climate action,”](#) CarbonBrief (August 4, 2021); [“China's Xi Says Climate Targets Can't Compromise Energy Security,”](#) Bloomberg (January 25, 2022); [“China's Xi says country's low carbon push must guarantee energy, food security,”](#) Reuters (January 25, 2022); [“Xi Jinping sent a letter to congratulate the national home event of the June 5th Environment Day in 2022,”](#) Ministry of Ecology and Environment (June 5, 2022) (in Chinese); [“Xi Jinping sent a letter to congratulate the national home event of the June 5th Environment Day in 2022,”](#) Teller Report (June 5, 2022).

PART II - DOMESTIC POLICIES

CHAPTER 4 - CLIMATE GOALS

The Chinese government has two headline climate goals: to peak carbon dioxide (CO₂) emissions before 2030 and achieve carbon neutrality before 2060. The two goals are often referred to as the “30-60” goals.

The first of these goals—to peak CO₂ emissions before 2030—has its origins in an announcement by President Xi Jinping at a November 2014 summit with US President Barack Obama. At that summit, President Xi said that “China intends to achieve the peaking of CO₂ emissions around 2030, making best efforts to peak early.”¹ The pledge made headlines around the world. President Xi strengthened the pledge slightly in a September 2020 speech to the UN General Assembly, saying that China would “aim to have CO₂ emissions peak before 2030.”² There is now considerable literature on China’s prospects for meeting the 2030 peaking goal, with many analysts projecting that China is likely to peak CO₂ emissions several years before 2030.^{3,4}

The second of these goals—to achieve carbon neutrality by 2060—was first announced by President Xi in his September 2020 speech to the UN General Assembly.⁵ This pledge also made headlines around the world. In 2021, Minister Xie Zhenhua, China’s Special Climate Envoy, explained that the 2060 goal:

“includes emission of greenhouse gases across the economy, which is different from the 2030 target. Not only carbon dioxide, but also non-carbon dioxide greenhouse gases such as methane and hydrofluorocarbons.”⁶

President Xi’s 2060 goal implies a dramatic transformation in China’s energy systems, which are overwhelmingly dependent on fossil fuels. There is growing literature on pathways for China to achieve the 2060 carbon neutrality goal.⁷

1 See [U.S.-China Joint Announcement on Climate Change](#) (November 12, 2014).

2 [Statement by President Xi Jinping at 75th UNGA](#), *China Daily* (September 22, 2020).

3 See e.g. Jiandong Chen et al., “[Carbon peak and its mitigation implications for China in the post-pandemic era](#),” *Nature* (March 2022) (carbon peak likely before 2026); Swithin Liu, “[Why China is set to significantly overachieve its 2030 climate goals](#),” *CarbonBrief* (May 19, 2022) (carbon peak likely by 2025); Ye Qi et al., [China’s Peaking Emissions and the Future of Global Climate Policy](#), Brookings (September 2018); Dabo Guan et al., “[Structural decline in China’s CO₂ emissions through transitions in industry and energy systems](#),” *Nature Geoscience* (July 2018); Feng Hao and Tang Damin, “[China could peak carbon emissions in 2023](#),” *China Dialogue* (November 23, 2017).

4 Some US politicians have said that China’s 2030 peaking goal means China has committed “to do nothing at all” until 2030. This is incorrect for at least two reasons. First, the Chinese government has supplemented its 2030 peaking goal with many energy and emissions goals for the years before 2030. These include goals to deploy renewable and nuclear energy, improve energy efficiency and cut CO₂ emissions per unit of GDP. Second, the Chinese government intends to keep growing its economy in the years after 2030. Significant changes will be needed to ensure that the Chinese economy can keep growing in the 2030s without increasing emissions. See Frank Jotzo, “[Fact Check: does the new climate deal let China do nothing for 16 years?](#),” *The Conversation* (November 16, 2014); Bob Sussman, “[The US-China Climate Deal: Not a Free Ride for the Chinese](#),” Brookings (November 25, 2014).

5 [Statement by Xi Jinping at General Debate of 75th UNGA](#), *China Daily* (September 23, 2020).

6 Eduardo Baptista, “[China’s 2060 carbon neutral goal covers other greenhouse gases](#),” *South China Morning Post* (July 28, 2021); “[2060 neutrality pledge includes all greenhouses gases](#),” *China Dialogue* (July 29, 2021).

7 See e.g. [An energy sector roadmap to carbon neutrality in China](#) IEA (September 2021); “[How China could be carbon neutral by mid-century](#),” *Nature* (October 19, 2020); [How China Can Achieve Carbon Neutrality by 2060](#) BCG (December 14, 2020); [Five strategies to achieve China’s 2060 carbon neutrality goal](#) Energy Foundation (September 29, 2020).

In speeches during 2021 and 2022, China's leaders emphasized that the carbon peaking and carbon neutrality goals should be pursued in harmony with other important goals. In a June 2022 speech, for example, Vice Premier Han Zheng said:

“We will promote carbon neutrality in a steady and orderly manner, reducing carbon emissions while ensuring energy security, industrial chain supply chain security, food security and normal life for the masses.”⁸

This echoed a January 2022 speech by President Xi Jinping to China's Politburo that used similar language. Following a July 2021 meeting chaired by President Xi, China's Politburo issued instructions to “carry out the carbon-peaking and carbon neutrality work in a coordinated and orderly manner” and “rectify campaign-style carbon reduction.” The latter phrase has been interpreted to mean local officials should avoid sudden, overzealous steps in meeting carbon reduction goals.⁹

In addition to the carbon peaking and carbon neutrality goals, the Chinese government has highlighted four other principal climate change goals, all to be achieved by 2030:

- to lower CO₂ emissions per unit of GDP by over 65% from the 2005 level;
- to increase the share of non-fossil fuels in primary energy consumption to around 25%;
- to increase the forest stock volume by 6 billion cubic meters from the 2005 level; and
- to bring its total installed capacity of wind and solar power to over 1200 gigawatts.

These goals were first announced by President Xi at the Climate Ambition Summit in December 2020 and are set forth in the Nationally Determined Contribution China submitted to the UN Framework Convention on Climate Change in October 2021.¹⁰

Each of these goals is a stronger version of previous goals announced by the Chinese government.

- The Chinese government's first goal with respect to CO₂ emissions per unit of GDP (often called “carbon intensity”) was announced by Premier Wen Jiabao just before the Copenhagen climate conference in 2009. The goal was to reduce CO₂ emissions by 40%–45% from the 2005 level by 2020. In 2015, in its first Nationally Determined Contribution, the Chinese government pledged to reduce CO₂ emissions by 60%–

8 [“Xi Jinping sent a letter to congratulate the national home event on June 5th Environment Day in 2022.”](#) Ministry of Ecology and Environment (June 5, 2022).

9 [“China's Briefing, 27 January 2022: Surge in offshore wind, Xi's new speech; IEA's report.”](#) CarbonBrief (January 27, 2022); [“China's Xi Says Climate Targets Can't Compromise Energy Security.”](#) Bloomberg (January 26, 2022); Xiaoying You, [“China issues new ‘single-game’ instructions to guide its climate action.”](#) CarbonBrief (August 4, 2021); Dongmei Chen and Mari Luomi, [Balancing China's Energy Security and Its Transition to Carbon Neutrality](#), KAPSARC (April 10, 2022). See also [“Li Keqiang Attends the Opening Ceremony of the Taiyuan Energy Low Carbon Development Forum 2021 and Delivers A Keynote Speech.”](#) Embassy of the PRC in Ireland (September 3, 2021).

10 [Remarks by Xi Jinping at the Climate Ambition Summit.](#) Xinhuanet (in Chinese) (December 12, 2020); People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) at p.2.

65% from the 2005 level by 2030. In December 2020, President Xi pledged that, by 2030, China would reduce CO₂ emissions per unit of GDP by over 65% from the 2005 level by 2030.¹¹

- In November 2014, President Xi pledged that China would increase the share of non-fossil fuels in primary energy to around 20% by 2030. In December 2020, President Xi strengthened this pledge, announcing that China would increase the share of non-fossil fuels in primary energy to around 25% by 2030.¹²
- In November 2009, Premier Wen pledged that China would increase its forest stock volume by 1.3 billion cubic meters from 2005 levels by 2020. In 2015, in its first Nationally Determined Contribution, the Chinese government pledged to increase the forest stock volume by around 4.5 billion cubic meters from 2005 levels by 2030. (In July 2019, Premier Li Keqiang announced that China had met this goal—11 years ahead of schedule.) In December 2020, President Xi pledged that China would increase its forest stock volume by 6 billion cubic meters from the 2005 level.¹³
- The Chinese government has announced wind and solar power deployment goals in each of its recent Five-Year Plans. The 13th Five-Year Plan, for example, included goals of 210 GW of grid-connected wind power and 153 GW of solar capacity in China by 2020.¹⁴ President Xi's remarks at the December 2020 Climate Ambition Summit was the first time the Chinese government had announced a 2030 goal for wind and solar power deployment.

11 Jonathan Watts, "[China sets first targets to curb world's largest carbon footprint.](#)" Guardian (November 26, 2009); NDRC, [China's Policies and Actions for Addressing Climate Change \(November 2018\)](#) at p.1; [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) at p.2.

12 See Fu Sha, Zou Ji and Liu Linwei, "[An Analysis of China's INDC](#)" (2015) at p.5; Jian-KunHe, "[China's INDC and non-fossil energy development.](#)" Advances in Climate Change Research (September–December 2015); NDRC, [China's Policies and Actions for Addressing Climate Change \(November 2018\)](#) at p.1.

13 "[Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction.](#)" Chinese Government Network (in Chinese) (July 11, 2019); Taryn Fransen, Ranping Song, Fred Stolle and Geoffrey Henderson, "[A Closer Look at China's New Climate Plan \(INDC\).](#)" WRI (July 2, 2015).

14 NEA, "[国家能源局关于可再生能源发展“十三五”规划实施的指导意见](#)" [[Guiding opinions on the implementation of the "13th FYP" for renewable energy development.](#)] (July 29, 2017); NDRC, "[可再生能源发展“十三五”规划](#)" [Renewable Energy 13rd Five-Year Plan] (December 2016).

The State Council Information Office, Ministry of Ecology and Environment, National Development and Reform Commission (NDRC) and National Bureau of Statistics all report on progress toward meeting these goals.¹⁵ The following table shows recent data on that progress.

Goal	Recent Data
Lower CO ₂ emissions per unit of GDP by over 65% from the 2005 level	In 2020, CO ₂ emissions per unit of GDP were 48% lower than in 2005. ¹⁶
Increase the share of non-fossil fuels in primary energy consumption to around 25%	In 2020, the share of non-fossil fuels in primary energy consumption was roughly 16%. ¹⁷
Increase the forest stock volume by 6 billion cubic meters from the 2005 level	As of December 31, 2020, the forest stock volume was 4.5 billion cubic meters above the 2005 level. ¹⁸
Bring total installed capacity of wind and solar power to over 1200 GW	As of December 31, 2021, total installed capacity of wind and solar power was 635 GW. ¹⁹

In October 2021, President Xi Jinping announced that China would adopt a “1+N” policy framework for climate change. The “1” refers to a long-term approach to achieving carbon neutrality and the “N” refers to specific plans to peak carbon dioxide emissions by 2030. The Chinese government’s “1+N” policy documents reiterate the headline goals discussed above and contain dozens of additional climate-related goals. Examples of such additional goals include:

- No less than 50% of electricity transmitted via newly-constructed power lines will be generated from renewable resources.²⁰
- Approximately 40 gigawatts of hydro power capacity will be installed during the 14th Five-Year Plan (2021–2025) and an additional 40 gigawatts of hydro power capacity will be installed during the 15th Five-Year Plan (2026–2030).²¹
- By 2030, no less than 70% of travel in cities with permanent populations of one million or more will be conducted through environmentally friendly means.²²

The “1+N” policies are set forth in the State Council’s *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality*, NDRC’s *Action Plan for Carbon Dioxide Peaking Before 2030*,

15 See, e.g., State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021); Ministry of Ecology and Environment, [China’s Policies and Actions for Addressing Climate Change](#) (2019); NDRC, [China’s Policies and Actions for Addressing Climate Change](#) (November 2018); National Bureau of Statistics, [Statistical Communiqué](#) (February 28, 2022).

16 State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at III(1).

17 State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at III(2).

18 Kou Jiangze “China’s forest carbon reserve hits 9.2 billion tonnes,” *People’s Daily* (January 21, 2021).

19 National Bureau of Statistics, [Statistical Communiqué](#) (February 28, 2022) at Section 3.

20 NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021) at 1(a).

21 NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021) at 1(c).

22 NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021) at 5(b).

implementation plans for carbon peaking from a range of sectors and other documents.²³

All of the Chinese government's climate-related goals are implemented through a policy infrastructure that includes regulations, guidance documents and financial support. One common tool is to allocate targets to provinces.

Many Chinese provinces and localities have committed to climate goals as well. At least 23 provinces and cities have committed to peak CO₂ emissions before 2030.²⁴

23 State Council, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full And Faithful Implementation of the New Development Philosophy](#) (October 24, 2021); NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021); Embassy of the People's Republic of China in the US, "[China's 1+N Policy Framework](#)," (November 17, 2021); Dimitri De Boer and FAN Danting, "[How is Progress in China's 1+N Policy Framework?](#)" CCICED (March 11, 2022).

24 "[Summary of Carbon Peak Action policies in 23 provinces across the country](#)," H₂O-China (in Chinese) (April 15, 2021).

CHAPTER 5 - COAL

China is the world's largest consumer and producer of coal. In 2021, its coal consumption and production accounted for more than half the world's total. Each year for the past decade, more than 20% of global CO₂ emissions from fossil fuels have come from coal combustion in China.¹

Chinese policy makers have plans to “strictly control” coal use during the 14th Five-Year Plan period (2021–2025) and start phasing down coal use during the 15th Five-Year Plan period (2026–2030).² However, new coal mines and coal-fired power plants continue to be built in China on a significant scale. Concerns about energy security and power sector reliability, as well as promotion criteria for provincial officials, are among the reasons.

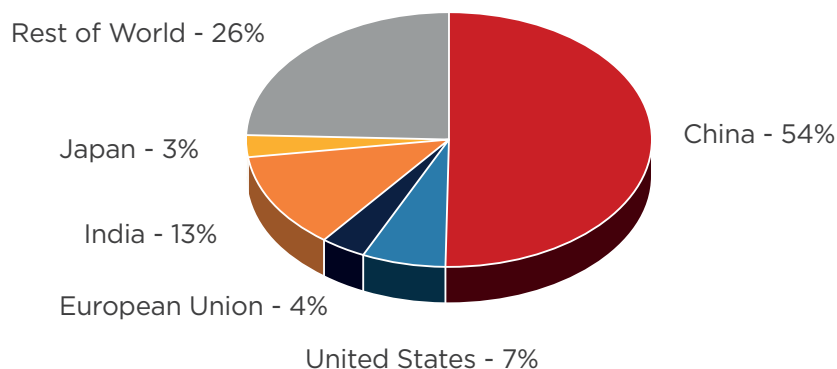
This chapter provides background on China's coal consumption, production and policies.

Background

Coal Consumption

China uses more coal than the rest of the world combined, with roughly 54% of global consumption in 2021.³

Figure 5-1: World Coal Consumption (2021)



Source: BP⁴

1 [BP Statistical Review of World Energy](#) (June 2022) at pp.38, 39; Global Carbon Project, [Global Carbon Budget 2021](#) (November 2021) at Slide 11 (36.4 Gt global CO₂ emissions from fossil fuels in 2021), Slide 28 (7.6 Gt CO₂ from coal in China in 2021); Robbie Andrew, “[Figures from the Global Carbon Budget 2020](#),” at Slide 12 data files (showing global CO₂ emissions from fossil fuels from 1990 to 2020) and China Emissions slide data files (showing Chinese CO₂ emissions from coal 2000–2020) (accessed July 5, 2022).

2 NDRC and NEA, [十四五现代能源体系规划 \[14th Five-Year Plan for a Modern Energy System\]](#) (in Chinese) (March 2022).

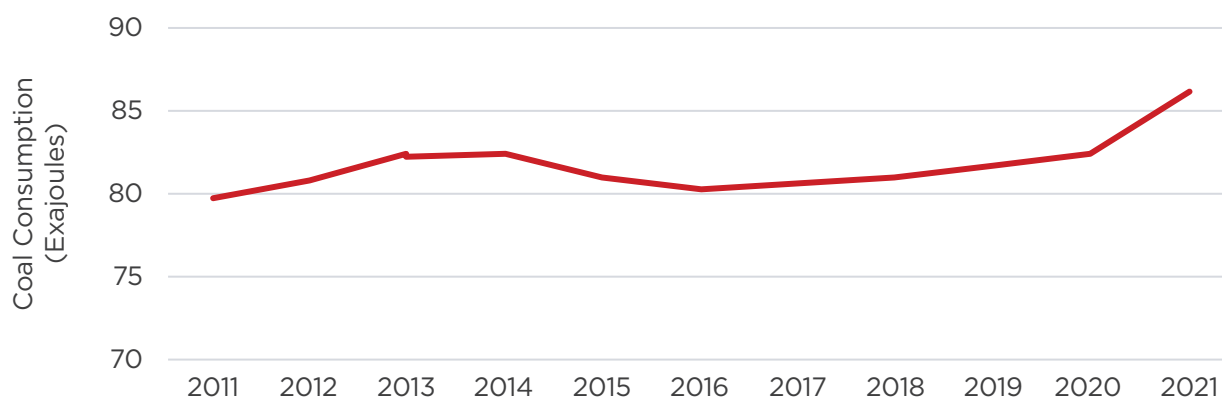
3 [BP Statistical Review of World Energy](#) (June 2022) at p.39.

4 [BP Statistical Review of World Energy](#) (June 2022) at p.39.

From 2013 to 2020, coal use in China was roughly flat due to slowing economic growth and government policies to limit coal consumption. Since then, coal consumption has increased and then decreased sharply.

- In 2021, coal consumption in China grew by almost 5% as energy-intensive industries led the economic recovery, and some previous policies to limit coal use were relaxed. Chinese coal consumption reached its highest level ever, exceeding the previous peak set in 2013–2014.⁵
- In the first half of 2022, coal consumption decreased roughly 2-3% year-over-year according to preliminary estimates. China's economic growth during this period slowed due to COVID lockdowns and other factors.⁶

Figure 5-2: Chinese Coal Consumption (2011-2021)



Source: BP⁷

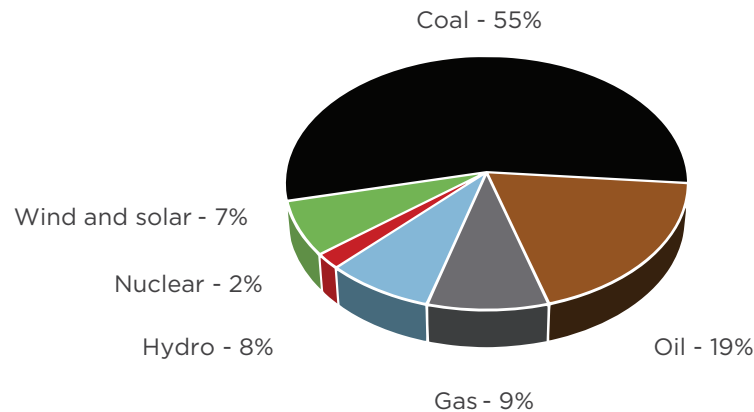
In 2021, 56% of primary energy consumption in China was from coal, according to official statistics. In 2020, coal's share was 57%; in 2015, it was 64%. Coal's share of primary energy was more than 70% in the mid-2000s and has fallen steadily since.⁸

5 See [BP Statistical Review of World Energy](#) (June 2022) at p.39 (2021 coal consumption = 86.17 exajoules, as compared to previous high of 82.48 exajoules in 2014); National Bureau of Statistics, [Statistical Communiqué of the People's Republic of China on the 2021 National Economic and Social Development](#) (February 28, 2022) at Section 12 (2021 total energy consumption = 5.24 billion tonnes coal equivalent (btce), with coal accounting for 56%, or 2.9 btce); National Bureau of Statistics, [China Statistical Yearbook 2019](#) (In 2013, total energy consumption = 4.17 btce, with coal accounting for 67.4% or 2.8 btce).

6 See Lauri Myllyvirta, "[China's CO₂ emissions fall by record 8% in second quarter of 2022.](#)" CarbonBrief (September 1, 2022); Lauri Myllyvirta, "[China's CO₂ emissions see longest sustained drop in a decade.](#)" CarbonBrief (May 30, 2022); Guosen Securities, [The investment strategies for coal in 2022](#) (July 2022) at p. 2

7 [BP Statistical Review of World Energy](#) (June 2022) at p.39.

8 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022) at p.4; National Bureau of Statistics, [Statistical Communiqué of the People's Republic of China on the 2021 National Economic and Social Development](#) at Section XII. The [BP Statistical Review of World Energy](#) (June 2022) has slightly lower figures for coal's share of primary energy—54.7% in 2021 and 55.8% for 2020 (p.9). See also Xiaoying You, "[Analysis: What does China's coal push mean for its climate goals?](#)" Carbon Brief (March 29, 2022).

Figure 5-3: China's Primary Energy Sources by Fuel (2021)

Source: BP⁹

China's coal consumption is closely linked to the country's industrialization. Between 2002 and 2013, coal accounted for 77% of the increase in primary energy demand, driven mainly by coal consumption in the cement, chemical and steel sectors (including both direct coal use and power from coal-fired power plants used in these sectors).¹⁰

Coal is widely used in China for generating electricity, producing heat and as an industrial feedstock. In 2020, 60% of coal was used for electricity and heat generation. Industry accounted for an additional one-third of demand, with buildings, agriculture and non-energy use representing another 7%.¹¹

Coal-Fired Power Plants

In 2021, 62.6% of China's power generation came from coal. This was a slight decrease from 2020 when the figure was 63.3%.¹²

At the end of 2021, China had 1100 GW of installed coal-fired power capacity—more than half the world's total.¹³

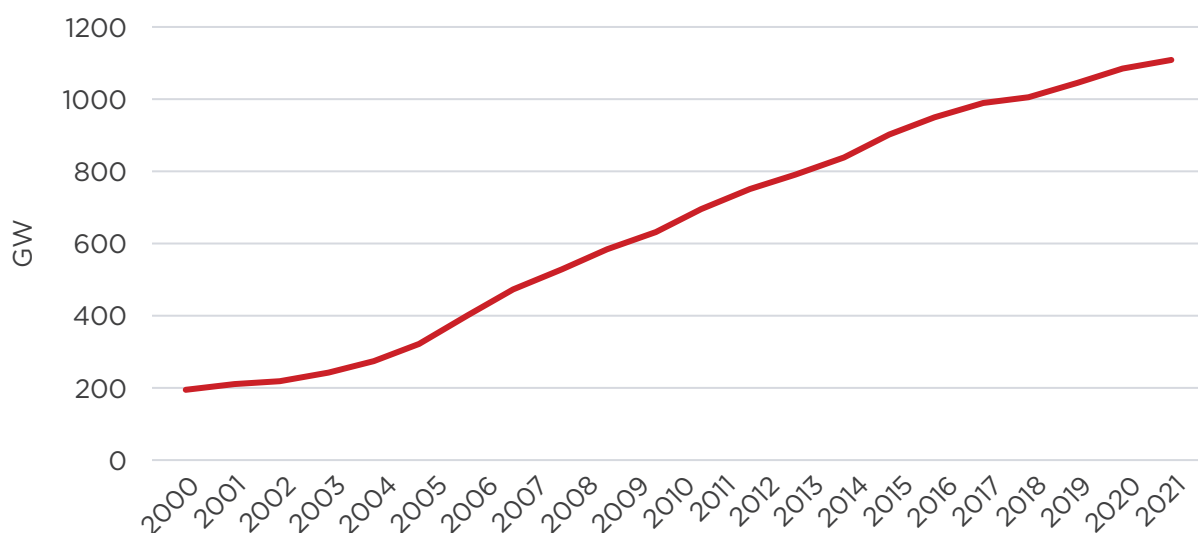
⁹ BP [Statistical Review of World Energy](#) (June 2022) at p.9

¹⁰ IEA, [An Energy Sector Roadmap to Carbon Neutrality in China](#) (September 2021), p.22.

¹¹ IEA, [An Energy Sector Roadmap to Carbon Neutrality in China](#) (September 2021), p.23.

¹² BP [Statistical Review of World Energy](#) (June 2022) at p. 51.

¹³ China Electricity Council, [2021-2022 National Electricity Supply and Demand Situation Analysis and Forecast Report](#), (in Chinese) (January 27, 2022); [Boom and Bust Coal 2022](#), at p.1 (2100 GW of global capacity).

Figure 5-4: Chinese Coal Power Plant Capacity (2000-2021)

Source: Carbon Brief; China Energy Portal, Global Energy Monitor¹⁴

More than 25 GW of new coal-fired plant capacity was added in China in 2021—56% of the new capacity worldwide. At the same time, retirements slowed down, dropping to an estimated 2.1 GW—the lowest in more than a decade.¹⁵ Construction also started on 33 GW of new coal-fired plants—the most since 2016.

In the first quarter of 2022, the Chinese government approved the construction of 8.6 GW of coal-fired capacity, according to Greenpeace.¹⁶ Meanwhile, China installed 7.3 MW of coal-fired power plants in the first half of 2022.¹⁷

Construction of coal-fired power plants continues in China for a number of reasons:

- First, electricity demand is projected to rise in the years ahead, propelled by ongoing urbanization, economic growth, the expansion of energy-consuming industries such as data centers, and electrification of vehicles and space heating.
- Second, energy security concerns are prompting the government to prioritize

¹⁴ Carbon Brief Infographics: [Global Coal Power](#) (accessed October 2022); “2019 electricity and other energy statistics.” [China Energy Portal](#) (January 2021); [Global Energy Monitor, New Coal- Fired Capacity by Country](#) (January 2022)

¹⁵ [Boom and Bust Coal 2022](#), at p.6.

¹⁶ [“China coal plant approvals surge as energy security trumps climate - Greenpeace.”](#) Reuters, (July 20, 2022).

¹⁷ [China Electricity Council, 2022年1-6月份电力工业运行简况](#). The power sector operation overview from January to June 2022 (20 July, 2022) at paragraph 5: newly installed capacity

domestic resources, in particular coal.¹⁸

- Third, grid planners need a way to balance variable renewable power. Natural gas serves this function in much of the world, but China's domestic natural gas supplies are limited and increasing import dependence is not attractive, especially with global gas prices surging in 2021 and 2022.
- Fourth, the coal industry is at the heart of local economic growth and job creation for some provinces. In 2021, the coal sector supported more than 2.7 million jobs in China.¹⁹
- Fifth, promotion criteria for local and provincial officials often emphasize short-term GDP growth, which can be strengthened with construction projects even if the capacity is not needed in the long-term.²⁰
- Sixth, provincial leaders are often reluctant to share electricity across provincial lines (sometimes called a "Provincial fortresses"), leading to construction in one province even if electricity-generating capacity is available next door.²¹
- Seventh, China's steel, cement and chemicals industries rely on coal as a feedstock as well as on cheap coal-fired electricity and therefore have an interest in maintaining coal production in China.
- Finally, some policymakers are concerned that the switch from coal to other fuels could raise energy costs, thereby exacerbating inflationary pressures and leading to unemployment.²²

While China continues to add capacity, coal-fired power plants operated an average of 4448 hours in 2021 and 4216 hours in 2020, or roughly half the 8760-hour theoretical maximum.²³ (Overcapacity is widespread throughout Chinese industry, not just in the power sector.) In provinces where hydropower dominates, such as Sichuan, Yunnan and Guangxi, coal is often used for power generation only during the dry season or in response to peak load. Annual utilization for coal plants in these provinces has been around 2000 hours for a long time. Nevertheless, local authorities keep the plants online in order to maintain system reliability.²⁴

18 National Energy Administration, [“国家能源局关于印发《2022年能源工作指导意见》的通知 \[Guiding Opinions on Energy Work in 2022\].”](#) (in Chinese) (March 17, 2022).

19 Alex Clark, Weirong Zhang, [“Estimating the Employment and Fiscal Consequences of Thermal Coal Phase-Out in China.”](#) *Energies* 2022, (January 2022).

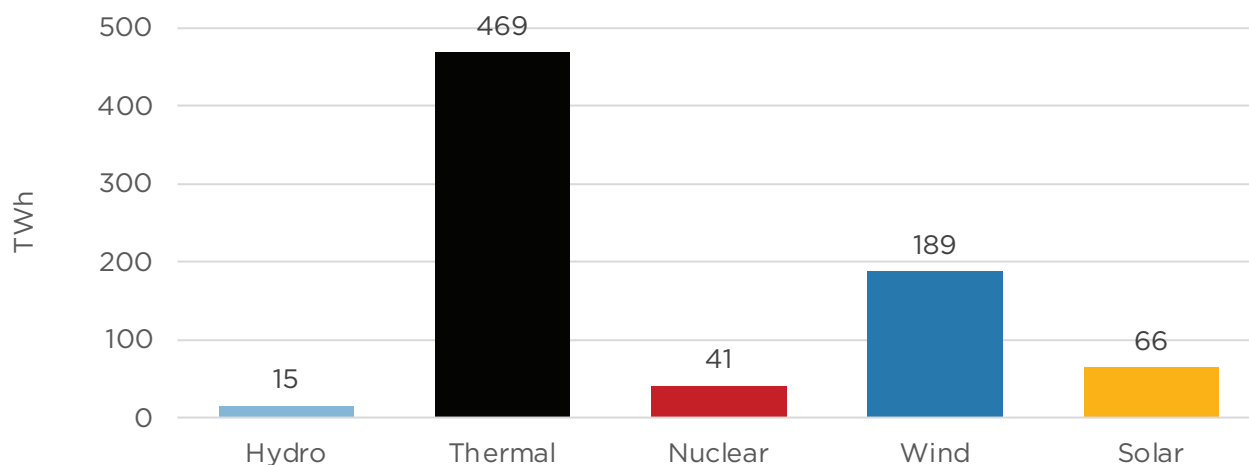
20 Bas Heerma van Voss, Ryan Rafaty, [“Sensitive intervention points in China's coal phaseout.”](#) *Energy Policy*, Volume 163 (April 2022).

21 See Chapter 9—Power Market Reforms.

22 Bas Heerma van Voss, Ryan Rafaty. [“Sensitive intervention points in China's coal phaseout.”](#) *Energy Policy*, Volume 163 (April 2022).

23 National Energy Administration, 国家能源局发布2021年全国电力工业统计数据, [Statistical data of the national power industry in 2021](#)] (in Chinese) (January 26, 2022); National Energy Administration, 国家能源局发布2020年全国电力工业统计数据, [Statistical data of the national power industry in 2020](#)] (in Chinese) (January 20, 2021). See also Lauri Myllyvirta, Shuwei Zhang, Xinyi Shen, [“Analysis: Will China build hundreds of new coal plants in the 2020s?”](#) Carbon Brief, (March 24, 2020).

24 See Gao Baiyu, [“Does coal still have a role in China's decarbonising power market?”](#) *China Dialogue* (January 8, 2021).

Figure 5-5: Annual Increase in Electricity Production in China (TWh) (2021)

Source: China Electricity Council²⁵

The extent of overcapacity in China's coal-fired power plants stems in part from a 2014 central government decision to transfer approval authority for plants to the provincial level. Many provincial governments propped up demand for local coal, in order to make regional employment and production targets. Local governments collectively approved 169 GW in less than a year as they sought to prop up demand for local coal to reach these targets.²⁶

This surge of new projects came as demand for coal-fired electricity declined from 2013 to 2015. As a result of overcapacity, bankruptcies surged in the coal-fired electricity sector, leading the government to focus on keeping the sector afloat through mergers. The National Energy Administration introduced a traffic light system in 2017 to prevent provinces with overcapacity from permitting new projects. The central government then moved to curtail approvals and suspend projects that had already been permitted.²⁷

But in 2019, as economic activity recovered strongly and trade tensions with the US grew, the Chinese government became increasingly focused on beefing up domestic coal supplies and prioritized employment and production. Approvals of new plants increased as the traffic light

²⁵ China Electricity Council, [Electric Power Industry Statistical Index](#) (2021) (in Chinese).

²⁶ Global Energy Monitor, [Out of Step: China Is Driving the Continued Growth of the Global Coal Fleet](#) (2019).

²⁷ NEA “[国家能源局关于发布2020年煤电规划建设风险预警的通知 \[Notice on 2020 Coal Planning and Construction Risk Warning\]](#),” (in Chinese) (April 2017); State-owned Assets Supervision and Administration Commission of the State Council (SASAC), [中央企业煤电资源区域整合试点方案 \[Pilot Plan for the Regional Integration of Coal and Power Resources of Central Enterprises\]](#), (in Chinese) (November 2019).

system was loosened.²⁸

- In 2018, six provinces were given a green light for coal power plant construction and three provinces were awarded an orange light.²⁹
- In 2019, 15 provinces were given a green light and two were given an orange light.³⁰
- In 2020, 19 provinces were given a green light.³¹

Then in early 2021, the central government announced that it would strictly control “high emissions” projects, so permitting of new coal power projects was essentially frozen. The power crunch that hit over 20 provinces and municipalities in the second half of 2021 led to a reversal of that policy.³²

In 2021, the China Electricity Council estimated that the median age of China’s coal-fired power fleet was 12 years, with only 1% of the current fleet more than three decades old (the typical lifespan of a coal-fired unit).³³ Over the past decade, most of the new coal-fired power plants in China have been supercritical and ultra-supercritical.³⁴ Although the share of more efficient supercritical and ultra-supercritical plants has increased significantly since 2005, subcritical and less-efficient high-pressure and circulating fluidized bed (CFB) plants still represent almost half of China’s operational coal-fired power fleet.³⁵

China has not yet deployed CCUS at coal power plants on a large scale. (See Chapter 15 of this Guide.)

28 The traffic light system introduced is essentially a risk management mechanism for provinces based on the profitability of their coal-fired generation, their existing coal capacity and local resource constraints, including water availability and air quality. Based on these three factors, each province was assigned a color to signify the viability of their coal pipeline. Red means no new coal projects should be permitted. Orange indicates local governments and coal companies should tread carefully and green indicates space for new coal.

29 National Energy Administration, “[国家能源局关于发布2022年煤电规划建设风险预警的通知 国能发电力 \(2019\)](#) [Circular on 2022 risk and early warning for coal power planning and construction],” (in Chinese) (May 14, 2018).

30 National Energy Administration, “[国家能源局关于发布2022年煤电规划建设风险预警的通知 国能发电力 \(2019\)](#) [Circular on 2022 risk and early warning for coal power planning and construction],” (in Chinese) (March 27, 2019).

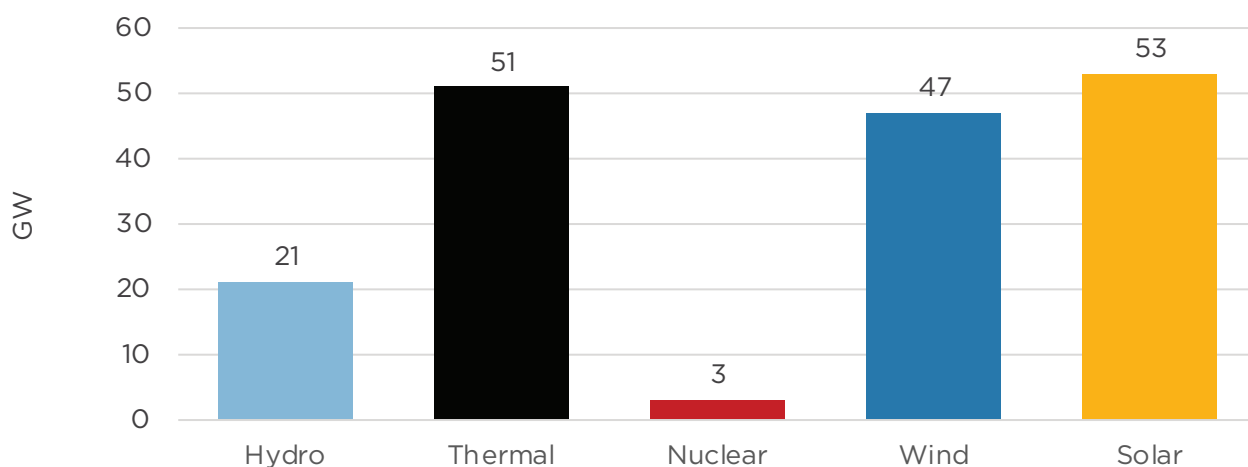
31 National Energy Administration, “[国家能源局关于发布2023年煤电规划建设风险预警的通知 \[Circular on 2023 risk and early warning for coal power planning and construction\]](#),” (in Chinese) (February 26, 2020).

32 Michal Meidan, Philip Andrews-Speed (eds), [Oxford Energy Forum – The 2021 energy crisis: Implications for China’s energy market and policies](#) Oxford Institute for Energy Studies, (March 2022).

33 China Electricity Council, [煤电机组灵活性运行与延寿运行研究 \[Research on the flexible operation and life extension of coal-fired power generating units\]](#) (5 January 2021)

34 [China’s Long Term Low Carbon Development Strategies and Pathways](#), Institute of Climate Change and Sustainable Development of Tsinghua University et al, p. 297.

35 IEA, “[The Role of China’s ETS in Power Sector Decarbonisation](#),” (April 2021), p.25

Figure 5-6: Annual Increase in Generating Capacity in China (GW) (2021)

Source: China Electricity Council³⁶

Coal Production

China produces more coal than the rest of the world combined, with roughly 51% of global production in 2021. According to official statistics, in 2021 Chinese coal production increased 5.7% to reach 4.13 billion tonnes. In the first half of 2022, it surged by 11% y/y³⁷. During the 13th Five-Year Plan (2016–2020), coal production in China increased by an average of 2.5% per year.³⁸

In 2020, China's proved coal reserves were estimated at 143 billion tonnes—35 years of production at current rates. China has the world's fourth-largest coal reserves—after the United States, Russia and Australia—with roughly 13% of the global total.³⁹

In recent years, China has imported approximately 8–10% of the coal it uses, although net imports (the difference between total imports and exports) account for a smaller share of around 6–7%. In 2020, Chinese coal imports reached a record 304 million tonnes, only to rise again in 2021 to 323 million tonnes. China's import requirements have been driven by factors including surging electricity demand, domestic transportation bottlenecks, economic factors (as imported coal can be cheaper than domestic coal in some coastal provinces), environmental and safety considerations, and concerns about depleting coking coal reserves.

³⁶ China Electricity Council, [Electric Power Industry Statistical Index \(2021\)](#) (in Chinese).

³⁷ National Bureau of Statistics, [Energy Production Overview of June 2022](#) (15 July 2022)

³⁸ [BP Statistical Review of World Energy](#) (June 2022) at p.38; National Bureau of Statistics, [Statistical Communiqué of the People's Republic of China on the 2021 National Economic and Social Development](#) (February 28, 2022) at Table 3; NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022) at p.5.

³⁹ [BP Statistical Review of World Energy](#) (June 2021) at p.46.

Chinese coal imports are roughly one-fifth of total global coal imports.⁴⁰

Coal Data Uncertainties

There are considerable uncertainties with respect to Chinese coal data.

- Chinese government agencies have revised their estimates of domestic coal production and consumption on several occasions. Some of these revisions have been substantial. Official estimates of coal production in 2000 are now 39% higher than the original number released by the National Bureau of Statistics. In 2015, official estimates of Chinese coal consumption for the prior decade were revised upward by 17%.⁴¹
- Aggregate data from provincial authorities generally exceed national figures from the central government, sometimes by as much as 20%. Reasons may include double-counting of coal traded among provinces and inflated figures from provincial officials (whose promotion often depends on hitting GDP targets that have historically been correlated with coal consumption).⁴²
- Some Chinese coal consumption statistics are based on tonnage while others are based on thermal content. Trends with respect to each can vary, causing confusion. Estimates of the thermal content of Chinese coal sometimes differ, which can compound the confusion.⁴³

Policies

The Chinese government's coal policies attempt to strike a balance between the goal of dramatically reducing coal use in the long-term and the economy's continued dependence on coal in the short- and medium-term. While policies to reduce coal consumption often had the highest priority in the 2010s, in the past several years Chinese policymakers, while seeking to limit the share of coal in the energy mix, have also emphasized the important role they see coal playing in the Chinese economy.

40 [BP Statistical Review of World Energy](#) (June 2022) at pp.39, 40; [BP Statistical Review of World Energy](#) (June 2021) at p.42; National Bureau of Statistics, [Statistical Communiqué of the People's Republic of China on the 2021 National Economic and Social Development](#) (February 28, 2022) at Table 11; National Bureau of Statistics, [Statistical Communiqué \(in Chinese\)](#) (February 28, 2021) at Table 11.

41 Ye Qi and Tong Wu, "[Putting China's Coal Consumption into Context](#)," Brookings (November 30, 2015); Ayaka Jones, "[Recent statistical revisions suggest higher historical coal consumption in China](#)," Today in Energy, US Energy Information Administration (September 16, 2015); Chris Buckley, "[China Burns Much More Coal Than Reported, Complicating Climate Talks](#)," New York Times (November 3, 2015); Robert Wilson, "[Can Chinese coal data be trusted?](#)" Carbon Counter (June 9, 2015); Kevin Tu, [Industrial Organization Of The Chinese Coal Industry](#), Stanford Program on Energy and Sustainable Development (July 2011).

42 Xinyu Chen et al., "[Changing carbon content of Chinese coal and implications for emissions of CO₂](#)," Journal of Cleaner Production (May 20, 2018); Dabo Guan et al., "[The Gigatonne Gap in China's Carbon Dioxide Inventories](#)," Nature Climate Change (2012) pp.672-675.

43 See generally Zhu Liu et al., "[Reduced carbon emission estimates from fossil fuel combustion and cement production in China](#)," Nature (August 20, 2015); Jan Ivar Korsbakken et al., "[Uncertainties around reductions in China's coal use and CO₂ emissions](#)," Nature Climate Change (February 16, 2016); Michael Lelyveld, "[China's Coal Consumption Clouded in Mystery](#)," Radio Free Asia (May 21, 2018).

During the 13th Five-Year Plan (2016–2020), China’s leaders introduced many policies aimed at reducing coal’s share of the energy mix, including capping coal use, removing dispersed coal from urban areas, switching from coal to natural gas heating across much of northern China, closing inefficient coal-fired boilers, tightening CO₂ emissions standards and strengthening efficiency standards in power plants.⁴⁴ These policies principally targeted local air pollution.⁴⁵

One particular area of focus was “dispersed” coal (散煤), which includes coal used for home heating and cooking. Dispersed coal is effectively raw coal that has not been processed and washed according to strict standards. It combusts inefficiently and its emissions are not filtered before being discharged. Therefore, even though dispersed coal accounts for only 2% of China’s total coal consumption, it results in 5 to 10 times more air pollution per unit of energy than industrial coal. Dispersed coal is an important source of air pollution during the winter in northern China and became a focal point of government policies between 2014 and 2020.⁴⁶

In 2020, President Xi Jinping’s pledge to reach carbon neutrality by 2060 elevated decarbonization as a policy goal and sent a strong message about coal’s long-term future in China. In 2021, the Chinese government released its *Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy*, which includes a goal of 80% non-fossil fuels in the energy mix.⁴⁷ While there are still questions about the potential role of coal with carbon capture, utilization and storage (CCUS) in meeting these goals, the direction of travel has clearly been set.

This is reflected in the 14th Five-Year Plan (2021–2025), which reiterates President Xi Jinping’s announcement at the 2021 Leaders’ Summit on Climate that China will “strictly control” coal consumption in the next five years, although the Plan does not set a limit on coal-fired power plant capacity in China or call for a halt to new construction. The 14th Five-Year Plan reiterates President Xi’s pledges to stop building coal-fired power projects abroad and gradually “phase down” domestic coal use in the next five-year plan period (2026–2030). These pledges are also discussed in China’s 1+N papers.⁴⁸

The pledge to “phase down” coal consumption was also included in the US–China joint

44 See Nathaniel Taplin, “[The Real ‘War on Coal’ is in China](#),” Wall Street Journal (November 14, 2017); Sylvie Cornot-Gandolphe, [China’s Coal Market: Can Beijing Tame ‘King Coal’?](#), Oxford Energy Institute (December 2014) at pp.3, 11.

45 Air pollution from coal causes significant health problems and large economic costs in China. See Chapter 5; American Chemical Society, “[Residential coal use in China results in many premature deaths, models indicate](#),” Science Daily, (May 12, 2021); Lindsay Maizland, “[China’s Fight Against Climate Change and Environmental Degradation](#),” Council on Foreign Relations (May 19, 2021); Robert Finkelman, Linwei Tian, “[The health impacts of coal use in China](#),” International Geology Review 60(4):1-11, DOI: 10.1080/00206814.2017.1335624, (June 2017).

46 Ping Qin et al., “[Coal taxation reform in China and its distributional effects on residential consumers](#),” Energy Policy 139, (2020), pp.1-2.

47 People’s Republic of China, [China’s Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy](#) (October 2021); Siwen Wang et al., “[Natural gas shortages during the “coal-to-gas” transition in China have caused a large redistribution of air pollution in winter 2017](#),” PNAS, (November 2020).

48 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) at p.19; “[Full Text: Remarks by Chinese President Xi Jinping at Leaders Summit on Climate](#),” Xinhua, (April 22, 2021); NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021); State Council, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full And Faithful Implementation of the New Development Philosophy](#) (October 24, 2021).

declaration signed at COP26 and in the Glasgow Climate Pact.⁴⁹ These documents were the first international pledges ever made by the Chinese government to phase down coal consumption or coal power.

While these statements are significant, the 14th Five-Year Plan sets no limits for domestic coal production, consumption or power generation capacity but rather talks of “strengthening coal’s role as energy security guarantee...” and “the regulating role of coal power in the power system”. Instead, the 14th FYP says that coal power plants will be built or retrofitted as flexible rather than baseload power sources. The aim is to help regulate the fluctuations of renewables. By 2025, around 24% of all power generation capacity (3000 GW) will be “flexible power sources”, and at least 200 GW of existing coal power will undergo flexibility retrofits.⁵⁰ Unlike the 13th FYP, the 14th FYP does not include controls on the efficiency of coal power generation. (This may be because using coal power plants as flexible resources reduces their efficiency.)⁵¹

The Chinese government’s renewed emphasis on coal dates back to at least October 2019, when Premier Li Keqiang, at a conference on China’s “new energy security strategy”, highlighted the role of coal more strongly than renewable energy.⁵² In recent years, China’s leaders have reiterated the need to “give full play to coal’s role” in meeting the nation’s “basic energy needs”, to promote the use of coal in producing chemicals as a means of limiting reliance on imported oil; and that “clean and efficient” use of coal was “an important means” to achieving the country’s 2030 and 2060 goals.⁵³

The 14th Five-Year Plan also emphasizes coal production as a means of ensuring supply security. Although the Plan does not mandate output targets, it includes a goal for the country’s “comprehensive energy production capacity” to exceed 4.6 billion tonne of standard coal equivalent.⁵⁴ Setting a target for capacity rather than actual production points to a greater emphasis on ensuring there are reserves for times of need. The Plan also discusses the need to optimize the layout of coal supplies by focusing on five large-scale and modern coal mines in Shanxi, Inner Mongolia, Shaanxi and Xinjiang. These will become China’s major coal supply bases as outdated, unsafe and inefficient coal mines are shuttered. In addition to the emphasis on energy production capacity, the government is looking to ensure a long-term “coal supply guarantee mechanism” which also includes reserve facilities.

49 [U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s](#) US Department of State, (November 10, 2021).

50 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) at p.15-16

51 The target was set at around 39%, compared with an estimate by the China Electricity Council of 34.6% in 2021, in China Electricity Council, 2021-2022年度全国电力供需形势分析预测报告 [2021-2022 National Electricity Supply and Demand Situation Analysis and Forecast Report] (in Chinese) (January 27, 2022)

52 [李克强主持召开国家能源委员会会议](#), [Li Keqiang presides over a meeting of the National Energy Commission], (in Chinese) (October 11, 2019)

53 See e.g. [“Han Zheng emphasized the need to strengthen planning, ensure safe supplies and promote efficient utilization at a conference on clean and efficient use of coal.”](#) (in Chinese) Xinhua (March 22, 2022).

54 The “comprehensive energy production capacity” refers to primary energy including coal, oil, gas and non-fossil energy, according to a previous NDRC document: [“20 Main indicators in the 14th Five Year Plan Outline: Comprehensive energy production capacity.”](#) (in Chinese) (December 25, 2021). The NDRC also estimated China’s total energy consumption would reach 5.45-5.5 bn tce in 2025 and that domestic energy production would be above 4.6 bn tce, suggesting a self-sufficiency rate of 84%. None of those figures appears in the final 14FYP for energy.

So while China's 2030 and 2060 carbon pledges clearly define a declining role for coal in the energy mix, the near-term trajectory for coal is complicated by the desire to use coal for supply security and concerns about the intermittency of renewable sources.

In 2015, large power generation companies were prohibited from emitting more than 650 grams of CO₂ per kWh on average across all their plants. The 13th Five-Year Plan included a target of 550 grams of CO₂ emissions per kWh by 2020 for these large power generators.⁵⁵ These standards required Chinese power companies to improve the efficiency of coal production, invest in low-carbon generation or both.⁵⁶ The 14th Five-Year Plan does not include a target for CO₂ emissions per kWh.

NDRC sets targets for coal use per kWh in electricity generation and has steadily made those targets more stringent. In 2005, the target was 370 grams of coal per kWh; in 2020, it was 305.5 grams of coal per kWh; in 2021, NDRC set a target of 300 grams of coal per kWh by 2025.⁵⁷

Coal production in China is subject to a tax of 2%–10%, with the exact rate set by individual provinces.⁵⁸

China's CO₂ Emissions Trading System also encourages greater efficiencies in the coal-fired power fleet. (See Chapter 11).

Climate Change Impacts

China's coal sector plays a significant role in global climate change.

- Coal produces more CO₂ per unit of energy than any other fuel.⁵⁹
- China produces and consumes more coal than any country in the world, by far.⁶⁰
- Each year for the past decade, more than 20% of global CO₂ emissions from fossil fuels came from coal combustion in China (as noted in the first paragraph of this chapter).⁶¹

55 State Council, "[Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan](#)," (in Chinese) (October 27, 2016).

56 State Council, "[Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan](#)," (in Chinese) (October 27, 2016); "[National Plan for Addressing Climate Change \(2014–2020\)](#)," (in Chinese) (November 25, 2014) at p.3; Alvin Lin, "[China's New Plans Deepen Action on Climate Change](#)," (December 19, 2016).

57 NDRC, "[国家发展改革委 国家能源局关于开展 全国煤电机组改造升级的通知 \[Notice on transformation and upgrading of national coal fired power plants\]](#)," (October 29, 2021).

58 "[China Imposes a New Coal Production Tax](#)," (January 13, 2015); Ping Qin et al., "[Coal taxation reform in China and its distributional effects on residential consumers](#)," Energy Policy 139, (2020), pp.1–2.

59 [Carbon Dioxide Emissions Coefficients](#), U.S. Energy Information Administration (November 18, 2021).

60 [BP Statistical Review of World Energy](#) (June 2022) at pp.38, 39.

61 Global Carbon Project, [Global Carbon Budget 2021](#) (November 2021) at Slide 11 (36.4 Gt global CO₂ emissions from fossil fuels in 2021), Slide 28 (7.6 Gt CO₂ from coal in China in 2021); Robbie Andrew, "[Figures from the Global Carbon Budget 2020](#)," at Slide 12 data files (showing global CO₂ emissions from fossil fuels from 1990 to 2020) and China Emissions slide data files (showing Chinese CO₂ emissions from coal 2000–2020) (accessed July 5, 2022).

- In 2020, Chinese coal-fired power stations were responsible for more than 15% of global CO₂ emissions.⁶²
- Chinese coal production also produces methane emissions.

The Chinese government has ambitious plans to reduce coal consumption in the decades ahead. The pace at which it does so will have a significant impact on the world's ability to meet its climate goals.

62 IEA, [An Energy Sector Roadmap to Carbon Neutrality in China](#) (September 2021), p.18.

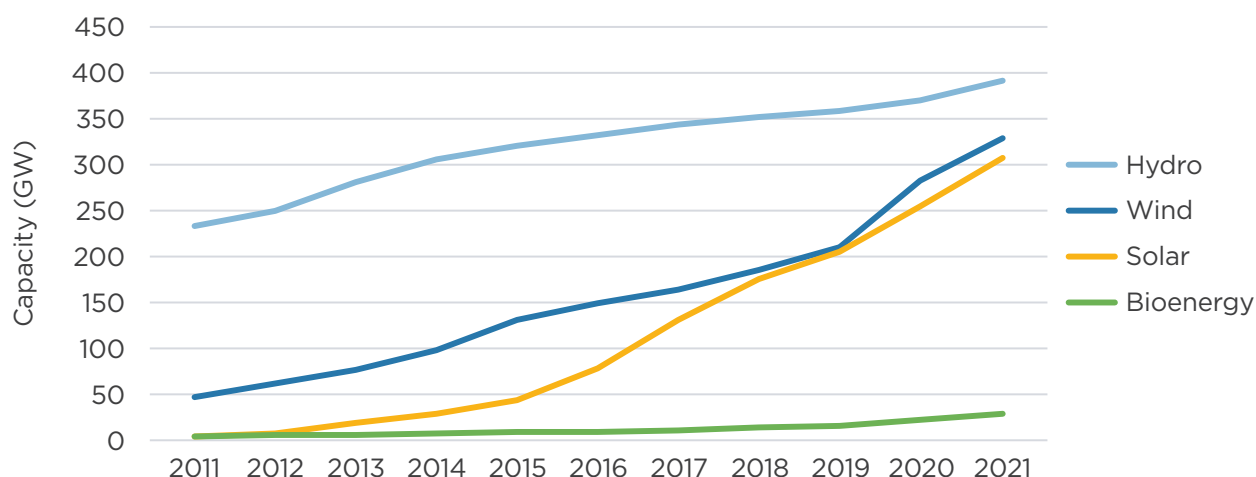
CHAPTER 6 - RENEWABLE POWER

China leads the world in deployment of renewable power, with more than three times as much capacity as any other nation. In 2021, 43% of the renewable power capacity added globally was in China.¹ These statistics reflect the Chinese government's longstanding commitment to renewable power, as well as China's enormous population.

On a per capita basis, China's global rankings with respect to renewable power are generally less high. In 2020, China ranked roughly 30th in the world in renewable energy consumption per capita.²

Hydropower has been a significant electricity source in China for decades. Wind and solar power have grown dramatically in the past 10 years. In 2021, renewables provided roughly 30% of the electricity generated in China—16% from hydropower, 8% from wind, 4% from solar and 2% from biomass.³

Figure 6-1: China's Renewable Power Capacity (2011-2021)



Source: IRENA, [Renewable Capacity Statistics 2022](#)⁴

1 REN21, [Renewables 2022 Global Status Report](#) (2022) at p.46; IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.2.

2 Our World in Data, [Per Capita Energy Consumption from Renewables 2021](#) at TABLE tab (accessed July 6, 2022).

3 NEA, “[国家能源局举行新闻发布会 发布2021年可再生能源并网运行情况等并答问](#) [NEA news conference issues 2021 renewable energy integration and operational situation and Q&A],” (in Chinese) (January 29, 2022); China Electricity Council, [2021 China National Electricity Industry Statistical Report](#) (in Chinese) (2022).

4 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022).

This chapter starts with a discussion of cross-cutting renewable power policies (that is, those that apply to more than one type of renewable power). The following sections discuss hydropower, wind power and solar power.

Cross-cutting Renewable Power Policies

The Chinese government's support for renewable power dates back to at least the 9th Five-Year Plan (1996–2000), which set targets for “new and renewable energy.”⁵ In 2005, the Renewable Energy Law set national renewable energy targets, provided financial support and required grid operators to connect to renewable electricity projects.⁶

The *13th Five-Year Plan on Renewable Energy*, issued by NDRC in December 2016, set targets of 15% non-fossil energy in primary energy consumption, 675 MW of renewable power capacity by 2020, and 20% non-fossil energy in primary energy consumption by 2030.⁷ The Plan was implemented with generous feed-in tariffs, access to capital from government policy banks, and other policies and measures. By 2020, the share of non-fossil energy in primary energy consumption in China reached 15.9%, exceeding the target, and renewable power capacity rose to over 930 GW, vastly exceeding the target.⁸

Prior to the release of the 14th Five-Year Plan, President Xi Jinping announced China's commitment to install at least 1,200 GW of wind and solar power capacity, a target that was eventually incorporated into the country's Nationally Determined Contribution and its Five-Year Plans.⁹ China's focus on establishing remote clean energy bases connected to the cities via large, high-voltage power lines was underlined at the National People's Congress in 2022, when National Development and Reform Commission (NDRC) Minister He Lifeng said that China would build 450 GW of wind and solar capacity in the Gobi Desert.¹⁰

The *14th Five-Year Plan Outline* was released by NDRC in March 2021. The Plan calls for increasing the share of non-fossil energy in primary energy consumption to 20% by 2025 (five years earlier than called for in the 13th Five-Year Plan), changing the wording around wind and solar from “continuing momentum” to “extensive expansion,” building a number of mega-size clean energy bases that integrate different power sources, and expanding pumped hydro storage and other energy storage capacity.

In 2021, China's State-owned Assets Supervision and Administration Commission of the

5 In China, renewable energy includes hydropower, solar PV, solar thermal, concentrating solar, wind energy, bioenergy, geothermal, and tidal or marine energy. In the power sector, China generally distinguishes between hydropower and non-hydro renewable energy, which typically equates to “new energy.”

6 State Planning Commission, “[新能源和可再生能源发展纲要 \[Outline to Develop New Energy and Renewable Energy\]](#),” (in Chinese) (January 5, 1995); Lisa Williams, “[China's Climate Change Policies—Actor and Drivers](#),” Lowy Institute for International Policy (July 2014) at p.2; Feng Wang, Haitao Yin and Shoude Li, “[China's Renewable Energy Policy: Commitments and Challenges](#),” *Energy Policy* (2010). A “feed-in-tariff” guarantees electricity generators a set price for delivery of power, typically at levels high enough to encourage investment.

7 NDRC, “[13th Five-Year Plan for Renewable Energy](#),” (December 2016) at Table 2.

8 NEA, “[百年能源薪火相传](#),” (in Chinese) (June 11, 2021).

9 Xinhua, “[Full Text: Remarks by Chinese President Xi Jinping at Climate Ambition Summit](#),” (12 December 2020).

10 National Development and Reform Commission, “[两会 | 首场“部长通道”：国家发展改革委主要负责同志回应热点问题](#),” (in Chinese) (March 5, 2022).

State Council (SASAC), which manages state-owned enterprises (SOEs), announced a new requirement that central SOE power companies have at least 50% renewable energy capacity by 2025. In 2020, the share of renewable energy capacity at China's Big Five power generators was under 40%.¹¹

In March 2022, NDRC issued the *14th Five-Year Plan for a Modern Energy System*. In addition to the targets already included in the broader Five-Year Plan, the plan includes a target for the non-fossil share of electricity to rise by 5.8% to 39%, approximately in line with the recent trend.¹²

Under the *14th Five-Year Plan for a Modern Energy System*, China's planners will no longer set individual five-year capacity targets for wind, solar, and other new energy sources, but rather emphasize meeting high-level targets for non-fossil energy and removing barriers to clean energy integration. The Plan mentions removing barriers to market trading of distributed energy, including within distribution grids, creating spot markets among multiple provinces (which would help smooth variable renewable energy and thereby resolve integration issues), promoting green power trading by the private sector and emphasizing the construction of hybrid renewable energy bases in tandem with storage.¹³

The Plan lists numerous technologies and applications for continued R&D focus and demonstration, such as agrivoltaics,¹⁴ building-integrated photovoltaics, low-speed wind and deep-water offshore wind. The Plan emphasizes construction of large-scale clean energy bases in remote regions and states that those bases should be connected to high-voltage lines carrying at least 50% renewables. It also calls for eastern provinces to focus on distributed renewables and deploy renewables to enhance energy security, promote technology development and boost green energy employment.¹⁵

In June 2022, the National Energy Administration issued the *14th Five-Year Plan for Renewable Energy*. The Plan sets targets for non-hydro renewables (wind, solar, biomass and geothermal) to reach an 18% combined share of electricity output in 2025, for all renewables to reach a 33% share and for renewable energy to account for over 50% of incremental energy consumption—implying that coal and other fossil fuels will continue to increase output over the period. The Plan also included five areas that would be targeted for “simultaneous development”: centralized and distributed energy (particularly for solar), onshore and offshore energy, local consumption of renewables and interprovincial transmission, single versus hybrid renewable plants and single versus comprehensive planning of assets.¹⁶

11 Beijixing News, “[国资委：到2025年央企可再生能源装机比重达到50%以上 \[SASAC announces that central SOEs must reach 50% renewable capacity by 2025\].](#)” (in Chinese) (December 30, 2021); State-owned Assets Supervision and Administration Commission of the State Council (SASAC), “[国务院国资委印发指导意见扎实推进央企碳达峰碳中和 \[SASAC publishes guiding opinion advancing central SOE carbon neutrality\].](#)” (in Chinese) (December 30, 2021); for further information on the share of the Big Five, see [Yan Qin](#), Refinitiv.

12 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) (in Chinese).

13 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) (in Chinese).

14 Agrivoltaics in China include combining PV with crops, pasture or fisheries.

15 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) (in Chinese).

16 NDRC, [14th Five-Year Plan for Renewable Energy](#) (June 2022) (in Chinese).

The Chinese government is gradually phasing out feed-in tariffs, which have been central to the Chinese wind and solar industries for the past decade. Starting in 2021, feed-in tariffs were phased out nationally for most PV and onshore wind projects.¹⁷ Feed-in tariffs remain for narrow categories such as offshore wind and concentrating solar power, with the feed-in tariffs for these two categories set and paid for by provincial authorities.¹⁸ Residential rooftops and poverty-alleviation village projects continue to receive national feed-in price premiums, but the budget and quotas available have been cut substantially.¹⁹ In addition, under a policy introduced in 2021, older wind and solar plants receiving feed-in tariffs will have their payments reduced for energy produced beyond a specified number of operating hours per year.²⁰

Feed-in tariffs are being replaced with a range of policies and market mechanisms, including the following:²¹

- i. auctions in which wind and solar power developers who bid prices less than or equal to the prevailing coal tariff (“grid parity”) will receive contracts that guarantee purchase of all power from their projects at fixed prices for at least 20 years;
- ii. renewable electricity consumption obligations (sometimes compared to renewable portfolio standards in the U.S.) requiring grid companies, large electricity users and others to purchase minimum percentages of renewable electricity set for each province by the National Energy Administration;
- iii. minimum operating hours obligations for each type of renewable energy depending on local conditions;
- iv. green power trading, employing green certificates issued to wind and solar plants; and
- v. electricity trading via mid- to long-term contracts, and eventually with spot market trading, including via interprovincial markets.

Renewable auctions and renewable consumption quotas were introduced in a series of notices during 2018 and 2019. Under these policies, provinces hold auctions and establish quotas for wind and solar projects. Auction winners receive 20-year power contracts.²²

17 NDRC, [“Circular on improving the Feed-in Tariff mechanism for PV power generation,”](#) (April 28, 2019); NDRC, “关于完善陆上风电光伏发电上网标杆电价政策的通知 [Notice on Improving the Pricing Policy for Onshore Wind Power and On-Grid Solar Photovoltaic Power Prices],” (December 2016).

18 National Development and Reform Commission, [“关于2021年新能源上网电价政策有关事项的通知 \[2021 new energy feed-in tariff policy notice\],”](#) (in Chinese) (June 7, 2021).

19 Andries Wantenaar, [“China’s NDRC proposes 40% cut to solar FiT for its last year,”](#) Rethink Research (April 15, 2021).

20 National Development and Reform Commission, [“国家发改委发布2021年新能源上网电价政策有关事项通知\(征求意见稿\) \[NDRC publishes 2021 new energy grid price draft for comments\],”](#) (in Chinese) (April 2021).

21 For more detail, see Chapter 8 of this Guide.

22 NDRC and NEA, [“Notice on the first batch of 2019 of non-subsidized wind and PV power generation projects \(grid-parity projects\),”](#) (May 20, 2019); NDRC and NEA, [“Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption,”](#) (in Chinese) (May 10, 2019); NDRC and NEA, [“Notice on actively promoting the non-subsidized generation of wind and PV power,”](#) (January 7, 2019); NDRC, Ministry of Finance and NEA, [“Notice on matters relevant to PV power generation in 2018,”](#) (May 31, 2018).

The main reasons for these changes include the high cost of feed-in tariffs, challenges administering the feed-in tariff program and falling costs for wind and solar power, which will make those technologies increasingly competitive in the years ahead. Most utility-scale wind and solar projects in recent years have been approved via grid parity tenders, which refers to auctions where the tariff is fixed at below the prevailing provincial grid tariff.²³ With the phase-out of national feed-in tariffs, provinces are responsible for determining grid parity project terms and managing any auctions or quotas for such projects.²⁴

Power sector reforms underway in China could help promote deployment of renewables, as described in detail in Chapter 8 (Power Sector Reform). Historically, most coal plant operators in China received preferential access to the grid through contracts that guaranteed a minimum number of hours of dispatch per year. The power sector reforms underway scale back those guarantees. They also include incentives for interprovincial trading of electricity and pilot programs for dispatching electricity on the basis of the lowest marginal cost, both of which benefit renewables. In November 2021, China's largest grid company, State Grid, published a new trial policy on cross-provincial power trading that would enable renewable energy to compete in cross-provincial spot markets.²⁵

In recent years, China has moved towards incorporating energy storage with wind and solar plants, and around half of Chinese provinces have adopted policies requiring or encouraging storage with newly-added utility-scale wind or solar projects. No additional compensation is presently available to meet the extra costs for generation-sited storage.²⁶

Discussions of the hydro, wind and solar power sectors are below.

A. Hydropower

Background

China leads the world in deployment of hydropower, with roughly 29% of global hydropower capacity. In 2021, approximately 80% of new hydropower capacity added globally was in China.²⁷

In 2021, China installed 20 GW of new hydropower capacity to reach 391 GW of total hydropower capacity by year end. In 2021, hydropower accounted for roughly 16% of China's

23 National Development and Reform Commission, “关于公布2019年第一批风电、光伏发电平价上网项目的通知 [First round of 2019 wind and solar grid parity projects notice],” (in Chinese) (May 20, 2019); National Development and Reform Commission, “关于公布2020年风电、光伏发电平价上网项目的通知 [2020 wind and solar grid parity project notice],” (in Chinese) (July 31, 2020).

24 National Energy Administration, “对十三届全国人大四次会议第1727号建议的答复 [NEA replies to Fourth Session of 13th People's Congress Questions],” (in Chinese) (July 14, 2021).

25 State Grid Corporation of China, “省间电力现货交易(试行)印发 [Cross-Provincial Spot Market Trading Trial Policy Published],” (November 24, 2021).

26 International Energy Net, “新能源强制配储: 人大代表不建议! 但7省已于 [New energy mandates for energy storage: National People's Congress members don't recommend it, but seven provinces have already adopted],” International Energy Net (in Chinese) (March 9, 2021).

27 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at pp.5-7; REN21, [Renewables 2022 Global Status Report](#) (2022) at pp.119-120.

installed power capacity and 16% of China's electricity generation.²⁸

The Three Gorges Dam, which became fully operational in 2012, is the world's largest dam with an installed capacity of 22.5 GW.²⁹ Most Chinese hydropower development is in the western and southern parts of the country. Northern China has very little hydropower development.

Policies

The Chinese government has a longstanding commitment to expanding the nation's hydropower capacity. Planning for the Three Gorges Dam began in the 1980s, as part of a broader program to use China's hydro resources for development and flood control. Chinese hydropower capacity grew throughout the 1990s and began to accelerate rapidly in the early part of the last decade. The 12th Five-Year Plan (2011–2015) called for a 30% growth in hydropower capacity in five years. This target was exceeded with China reaching 319 GW of hydropower capacity in 2015.³⁰

The Chinese government continues to support hydropower development, but capacity additions have slowed during the past 10 years.

- The 13th Five-Year Plan set a target of 380 GW of hydropower capacity by 2020 and 470 GW of hydropower capacity by 2025 (including pumped hydro). The 2020 targets were missed by 9-10 GW.³¹
- The *14th Five-Year Plan for Renewable Energy* calls for hydropower to provide 17.4% of China's electricity generation in 2025 (up from 16% in 2021) and “scientific and orderly” development of hydropower resources.³²

The 14th Five-Year Plan gives more attention to solar and wind power than hydropower.

Pumped hydropower is seeing more rapid expansion, because the technology offers the potential to help meet peak loads and improve integration of wind and solar power into electric grids. In 2021, the NEA issued a *Medium and Long-term Development Plan for Pumped Storage (2021–2035)* that calls for China to more than double its pumped hydro capacity to 62 GW by 2025 and reach 120 GW by 2030.³³

28 NEA, “国家能源局举行新闻发布会 发布2021年可再生能源并网运行情况等并答问 [NEA news conference issues 2021 renewable energy integration and operational situation and Q&A],” (in Chinese) (January 29, 2022); China Energy Portal, *2021 electricity & other energy statistics* (2022); China Electricity Council, *2021 China National Electricity Industry Statistical Report* (in Chinese) (2022).

29 “Three Gorges Dam,” Encyclopedia Britannica (accessed June 23, 2019).

30 NEA, *China's Hydropower 13th FYP (2016–2020)* (in Chinese) at p.2.

31 NEA, *China's Hydropower 13th FYP (2016–2020)* (in Chinese) at p.7; NDRC, *14th Five-Year Renewable Energy Development Plan* (June 2022) (in Chinese) at Box 1 and Section 3(3).

32 NDRC, *14th Five-Year Renewable Energy Development Plan* (June 2022) (in Chinese) at Box 1 and Section 3(3).

33 NEA, “抽水蓄能中长期发展规划 (2021–2035 年) [Medium and Long-term Development Plan for Pumped Storage (2021–2035)],” (in Chinese) (August 2021); China had 30 GW of pumped hydro in 2021; see Emiliano Bellini, “State Grid of China switches on world's largest pumped-hydro station,” PV Magazine (January 4, 2022).

B. Wind Power

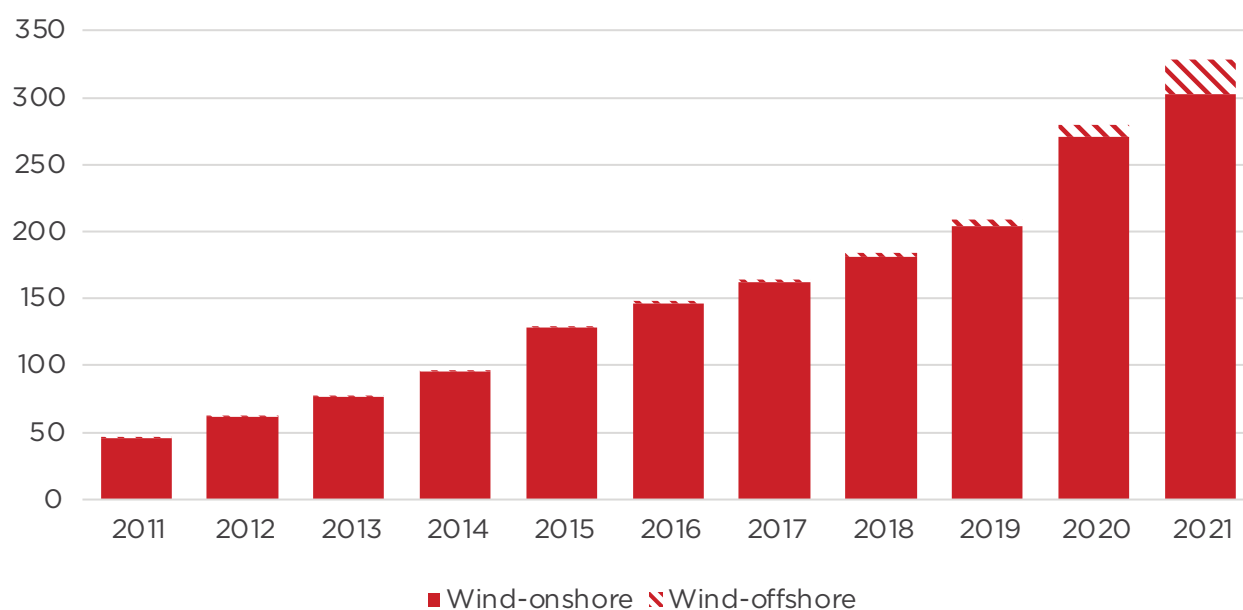
Background

China leads the world in deployment of wind power, with more than one-third of global capacity. China has led the world in new wind power additions every year for the past decade.³⁴

In 2021, roughly 48 GW of wind power capacity were added to the grid in China. Total wind power capacity reached 329 GW. This figure includes 26 GW of offshore wind, most of which was added in 2021. In 2021, wind power accounted for roughly 13% of China's installed power capacity and 8% of China's electricity generation.³⁵

In the first half of 2022, roughly 13 GW of wind power was added to the grid in China.³⁶

Figure 6-2: China's Wind Power Capacity (2010-2021)



Source: GIZ 2022 and NEA³⁷

34 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.13.

35 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.13 and 19; NEA, “[国家能源局举行新闻发布会 发布2021年可再生能源并网运行情况等并答问 \[NEA news conference issues 2021 renewable energy integration and operational situation and Q&A\]](#),” (in Chinese) (January 29, 2022).

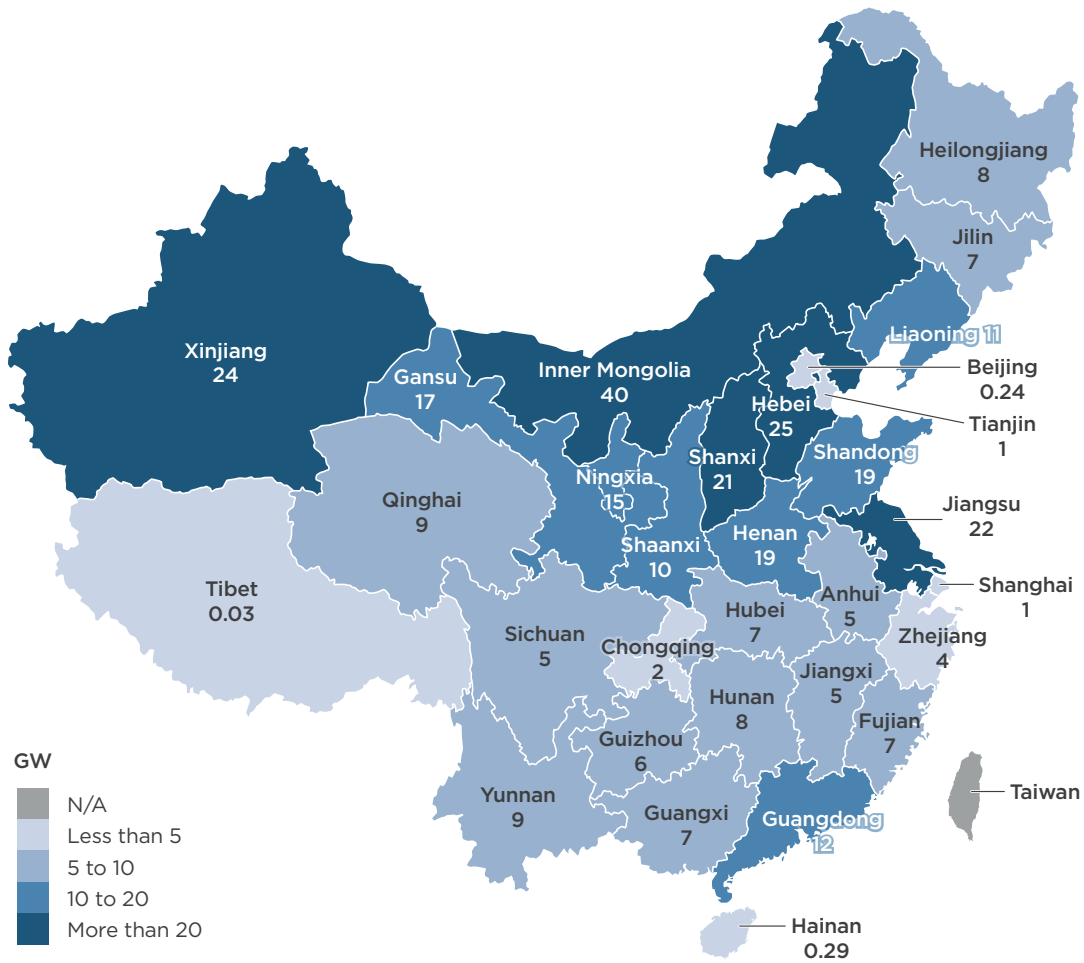
36 National Energy Administration, “[Transcript of the online press conference of the National Energy Administration in the third quarter of 2022](#)” (August 02, 2022) (in Chinese).

37 National Energy Administration, “[国家能源局2021年一季度网上新闻发布会文字实录 \[China NEA 1st Quarter 2021 News Conference Transcript\]](#),” (in Chinese) (January 30, 2021); National Energy Administration, “[我国风力发电正在“走向深海” \[China wind power is heading to the deep water\]](#),” (in Chinese) (January 21, 2022).

China’s domestic firms dominate the Chinese wind turbine market. Vestas is the only international company in China’s top 10. Chinese companies are not major players in most wind power markets outside of China, in contrast to solar PV where China dominates the global supply chain.³⁸

China has significant wind power resources, especially in Inner Mongolia, Xinjiang and other northern and western provinces.

Figure 6-3: China’s Wind Power Installed Capacity by Province (GW) (Year-End 2021)



Source: GIZ, based on NEA data³⁹

38 Shashi Barla, “Global Wind Turbine Market: State of Play,” Wood Mackenzie (April 14, 2021); Yuki, “China’s Wind Turbine OEMs Top Ten in 2019,” Iceberg Energy (February 26, 2020).

39 Map from GIZ, 2022, based on data from China New Energy Monitoring Center, “2021年各省风光装机、发电量及消纳数据 [2021 provincial wind and solar capacity, generation, and consumption statistics],” (March 18, 2022).

Initially, most wind power was located in China's northern provinces, but in recent years new development has tended to shift towards the more populous eastern provinces.

Curtailment of electricity produced by wind posed a significant challenge in past years, but the situation has been largely resolved at a national level since reaching a peak curtailment rate of 17% in 2016. In 2020, China's wind power curtailment rate was roughly 3.5% nationally, with rates of 10% in Xinjiang, 7% in Tibet, 6.4% in Gansu and 5.5% in Hunan.⁴⁰

Policy

The 13th Five-Year Plan established a goal of 210 GW of grid-connected wind power by 2020, including 5 GW of offshore wind. Provinces were given specific deployment goals, including 27 GW for Inner Mongolia, 18 GW for Xinjiang and 18 GW for Hebei. The plan also established a goal of 420 TWh of electricity generation from wind.⁴¹

A National Energy Administration draft notice on clean energy industry development issued in 2021 set a goal for solar and wind to provide 16.5% of China's total electricity generation in 2025.⁴²

China's feed-in tariff for wind power dates to 2009. Rates vary by region and are declining slowly. In early 2019, the Chinese government announced major changes to the feed-in tariff policies for wind and held auctions for wind projects to sign long-term contracts at below local coal tariffs.⁴³ Feed-in tariff subsidies remain for offshore wind power, which can help explain the strong growth experienced in this field since 2020.

Under the feed-in tariff regime, starting in 2016 the central government intervened to slow the provincial construction of wind or solar to prevent curtailment, issuing regular investment monitoring reports. In March 2019, the National Energy Administration's investment monitor halted wind power projects in Xinjiang and Gansu (including those that had already been approved) and banned approvals of new wind power projects in Inner Mongolia and parts of Shanxi, Shaanxi and Hebei.⁴⁴ In 2020, the NEA halted new wind projects in Tibet, Tianjin, Hebei, Sichuan, Yunnan, part of Shaanxi, part of Gansu, Qinghai, Ningxia and Xinjiang.⁴⁵ With curtailment largely at low levels and feed-in tariff subsidies phased out, these interventions may be dropped.

40 China 5e, “[西藏弃光超25%，全国风电、光伏消纳情况 \[Tibet solar curtailment tops 25%; national wind and solar integration situation update\]](#),” (in Chinese) (February 7, 2021).

41 NEA, “[国家能源局关于可再生能源发展“十三五”规划实施的指导意见 \[Guiding opinions on the implementation of the “13th FYP” for renewable energy development\]](#),” (in Chinese) (July 29, 2017); NEA, “[风电发展“十三五”规划 \[13th FYP development plan for wind power\]](#),” (November 2016).

42 National Energy Administration, “[国家能源局综合司关于对《关于2021年风电、光伏发电开发建设有关事项的通知（征求意见稿）》公开征求意见的公告 \[NEA Comprehensive Reform Department Issues 2021 Wind and Solar PV Development and Construction Notice Draft for Comments\]](#),” (in Chinese) (April 19, 2021).

43 NDRC and NEA, “[Notice on the first batch of 2019 of non-subsidized wind and PV power generation projects \(grid-parity projects\)](#),” (May 20, 2019); NDRC and NEA, “[Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption](#),” (in Chinese) (May 10, 2019); NDRC and NEA, “[Notice on actively promoting the non-subsidized generation of wind and PV power](#),” (January 7, 2019); Angel Hang, “[Is China Ready for Subsidy-Free Renewables?](#),” Greentech Media (May 31, 2019).

44 NEA, “[Circular on 2019 wind power investment monitoring and early warning results](#),” (May 4, 2019).

45 National Energy Administration, “[国家能源局关于发布《2020年度风电投资监测预警结果》和《2019年度光伏发电市场环境监测评价结果》的通知 \[NEA issues 2020 wind investment monitor early warning result and 2019 solar PV market environmental evaluation result\]](#),” (in Chinese) (March 30, 2020).

C. Solar Power

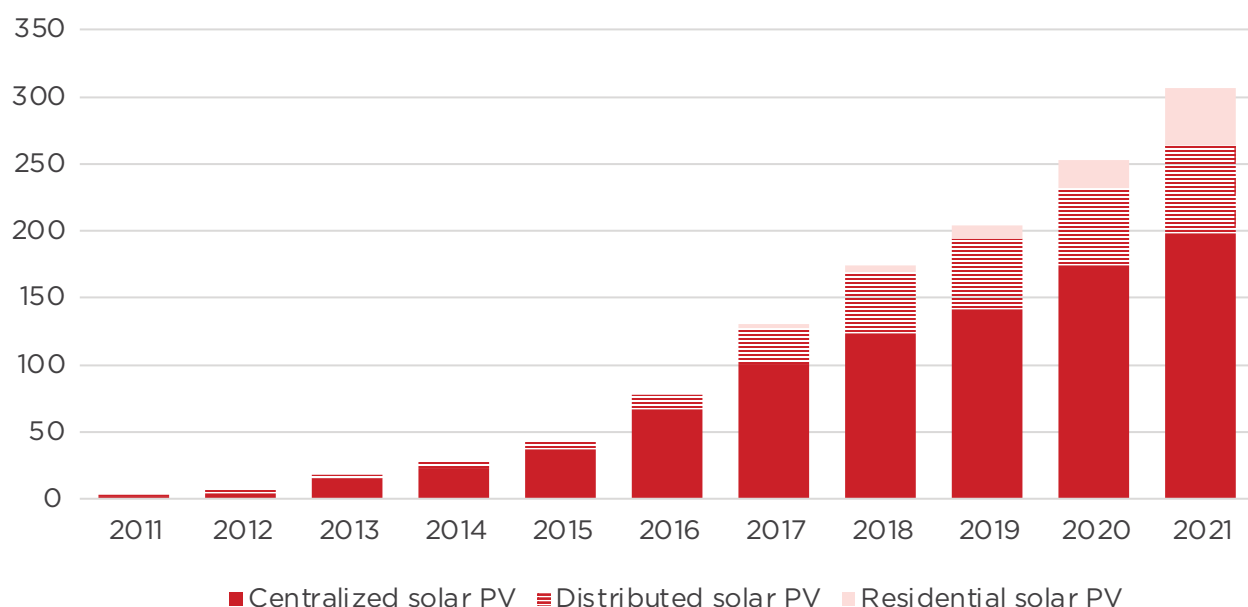
Background

China leads the world in deployment of solar power, with more than one-third of global capacity. China has led the world in solar power deployment every year since 2015.⁴⁶

In 2021, 53 GW of solar power capacity was added in China—40% of the global total.⁴⁷ At year end, total solar power capacity reached 307 GW.⁴⁸

In the first half of 2022, roughly 31 GW of solar power were added to the grid in China.⁴⁹

Figure 6-4: China Solar PV Installed Capacity (2010-2021)



Source: GIZ 2022, NEA data⁵⁰

China also leads the world in solar manufacturing, as it has for many years. In 2020, 67% of solar PV modules globally were made in China.⁵¹ China accounts for a similarly large share of

46 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.20.

47 IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.20.

48 NEA, “[国家能源局举行新闻发布会 发布2021年可再生能源并网运行情况等并答问 \[NEA news conference issues 2021 renewable energy integration and operational situation and Q&A\]](#),” (in Chinese) (January 29, 2022).

49 National Energy Administration, “[Transcript of the online press conference of the National Energy Administration in the third quarter of 2022](#)” (August 02, 2022) (in Chinese)

50 National Energy Administration, “[国家能源局2021年一季度网上新闻发布会文字实录 \[China NEA 1st Quarter 2021 News Conference Transcript\]](#),” (in Chinese) (January 30, 2021); National Energy Administration, “[户用光伏项目信息 \[Residential rooftop solar PV project info\]](#),” (in Chinese) (January 19, 2022).

51 Fraunhofer Institute for Solar Energy Systems, [Photovoltaics Report](#) (February 24, 2022).

global PV cell and polysilicon production.⁵²

In 2021, solar power was 13% of China's power capacity and produced roughly 4% of China's electricity.⁵³

In December 2018, a 500 MW solar project in Qinghai became the first in China to sell electricity for less than the benchmark price for electricity from coal.⁵⁴ As a result of the dramatic scale-up in manufacturing, solar PV in China now costs less than coal-fired power at the wholesale level in most Chinese provinces, and less than retail tariffs for distributed solar in most major Chinese cities.⁵⁵

Curtailement is a challenge for the Chinese solar power industry, although the situation has improved in the past few years. In 2020, solar power curtailment was roughly 2% nationally, unchanged from the prior year, with rates of 25.4% in Tibet, 8.0% in Qinghai, 4.6% in Xinjiang and 3.6% in Inner Mongolia.⁵⁶

While China initially focused on utility-scale solar PV in remote regions, distributed solar PV has become a growing trend. (State Grid defines distributed solar as systems near consumers, mainly for self-consumption, that connect to transmission and distribution systems at 35 kV or below.⁵⁷ Hence, distributed systems may be either ground-mounted multi-MW systems or smaller rooftop systems.) In 2021, over half of new PV installations were classified as distributed, of which 21 GW were residential rooftop solar installations eligible for fiscal subsidies. Hebei, Shandong and Hunan provinces accounted for over half of such installations, many of which focus on rural villages.⁵⁸

Photovoltaic (PV) technologies dominate China's solar industry, with roughly 99% of China's solar power capacity. Chinese PV manufacturing accounts for the vast majority of global PV production. In 2020, China accounted for 76% of global polysilicon production, 96% of PV wafer production, 78% of PV cell production and 70% of global PV panel production.⁵⁹ China exported 100 GW of PV modules in 2021⁶⁰ and total Chinese module capacity could reach 500 GW in 2022, far higher than annual PV installations globally.⁶¹

52 Bloomberg New Energy Finance, *Solar PV Trade and Manufacturing: A Deep Dive* (February 2021).

53 China Energy Portal, [2021 electricity & other energy statistics](#) (2022); China Electricity Council, [2021 China National Electricity Industry Statistical Report](#) (in Chinese) (2022).

54 "Two solar power bases launched in northwestern China," Xinhua (December 29, 2018).

55 Jinyue Yan et al., "[City-level analysis of subsidy-free solar photovoltaic electricity price, profits and grid parity in China](#)," Nature Energy 4 (August 12, 2019); Gang He et al., "[Rapid cost decrease of renewable energy and storage offers an opportunity to accelerate the decarbonization of China's power system](#)" Energy Analysis and Environmental Impacts Division Lawrence Berkeley National Laboratory (March 2020).

56 China 5e, "[西藏弃光超25%。全国风电、光伏消纳情况！ \[Tibet solar curtailment tops 25%; national wind and solar integration situation update\]](#)," (in Chinese) (February 7, 2021).

57 Hanfang Li et al., "[Research on the policy route of China's distributed photovoltaic power generation](#)," *Energy Reports* (November 2020)

58 National Energy Administration, "[户用光伏项目信息（2021年12月） \[Residential PV project information\]](#)," (in Chinese) (January 19, 2022); "[2021年，风电、光伏新增装机100.54GW，完成90GW目标！ \[In 2021 wind and PV added 100.54 GW and completed 90 GW target\]](#)," (in Chinese) PV Perspective (January 25, 2022).

59 Congressional Research Service, [U.S. Solar Photovoltaic Manufacturing](#) (May 5, 2022).

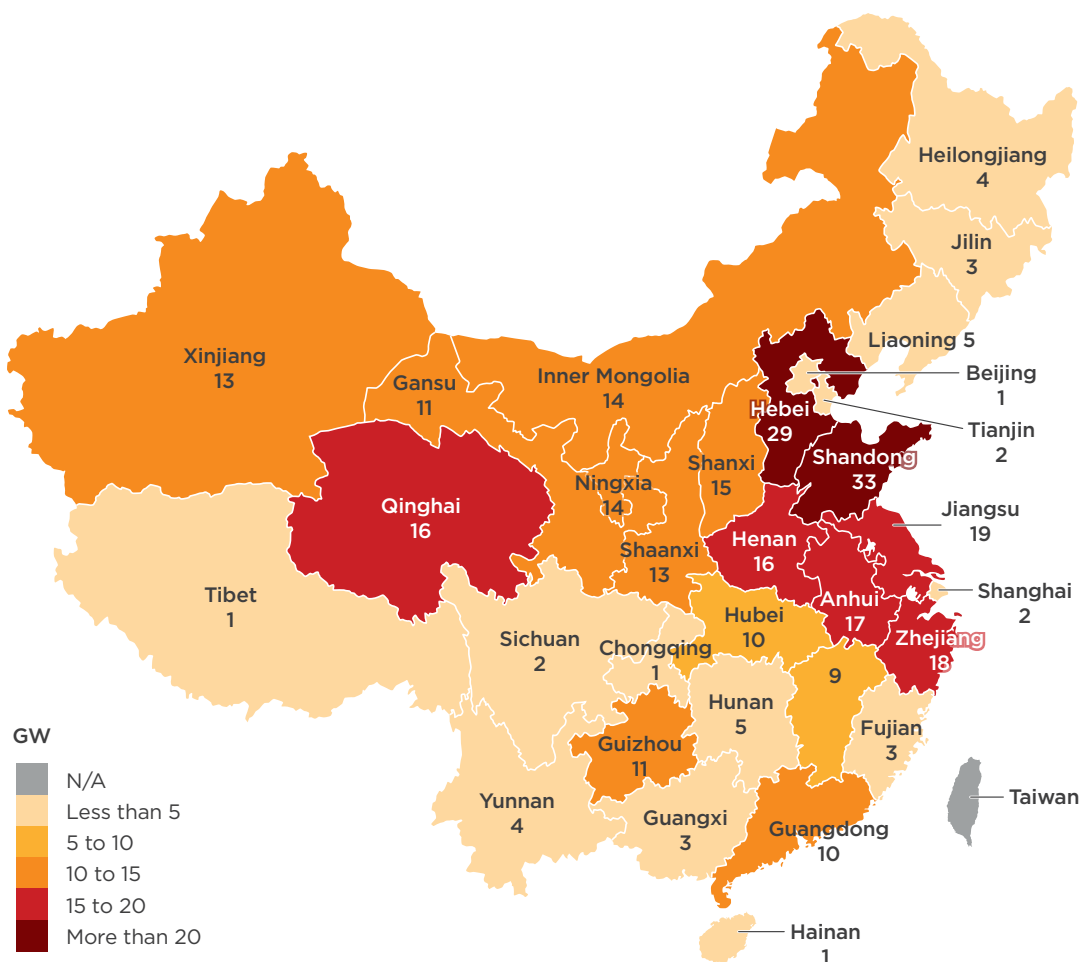
60 Frank Haugwitz, "[China's PV Industry Reaches New Heights](#)," PV Magazine (May 28, 2022).

61 Emiliano Bellini, "[Chinese solar industry may reach 500 GW module capacity by year end](#)," PV Magazine (January 21, 2022).

China is also promoting other solar technologies. In 2020, China added 200 MW of concentrating solar power—the only country worldwide to add new CSP capacity—building upon its year-end 2019 capacity of 400 MW.⁶² With less than 1 GW of CSP installed, China fell short of a target set in the 13th Five-Year Plan for CSP capacity of 5 GW by 2020.⁶³ However, several projects are in various stages of the development pipeline and the field remains a policy priority.⁶⁴

China has excellent solar resources, especially in the western part of the country.

Figure 6-5: Cumulative Solar PV Installed Capacity by Province (GW) (Year-End 2021)



Source: GIZ 2022, based on data from NEA⁶⁵

62 International Energy Agency, [Concentrating Solar Power \(CSP\) – Tracking Report](#) (2021); Xin Zhang et al., “[Study of China’s Optimal Concentrating Solar Power Development](#),” *Front. Energy Res.* (November 16, 2021).

63 National Energy Administration, [The 13th Five-Year Plan in China’s Solar Energy Development](#) (in Chinese) (2016).

64 “[Concentrating Solar Power Projects in China](#),” National Renewable Energy Lab (accessed August 22, 2019);

“[China concentrated solar power pilot projects’ development](#),” HeliosCSP (accessed August 22, 2019).

65 Map from GIZ, 2022, based on data from [China New Energy Monitoring Center](#), “2021年各省风光装机、发电量及消纳数据 [2021 provincial wind and solar capacity, generation, and consumption statistics],” (March 18, 2022).

While China's solar resources are best in the northern and western regions, in recent years more solar has been installed in the populous eastern areas of the country. This is reflected in the top five provinces in installed solar capacity: Shandong, Hebei, Jiangsu, Zhejiang and Anhui.

Air pollution may significantly reduce output from solar panels in some parts of China. One study using 2015 data estimated a reduction of 14% versus unpolluted conditions, though air quality has improved significantly since then.⁶⁶

Policy

China supported solar power with subsidized grid feed-in tariffs for many years, but these tariffs have been largely phased out.⁶⁷ The feed-in tariff phase-out began with a 2018 announcement that reduced the tariffs and directed local governments to shift most solar procurements to competitive auctions. The changes were seen as an effort to control the cost of solar subsidies (over \$15 billion in 2017) and address overcapacity in power markets.⁶⁸

The *13th Five-Year Plan for Energy Development* set a goal of 110 GW of solar capacity in China by 2020, which China far surpassed.⁶⁹

China's *13th Five-Year Plan for Solar Energy Development* contained specific goals for solar technology innovation, including commercialized monocrystalline silicon cells with an efficiency of at least 23% and commercialized multi-crystalline silicon cells with an efficiency of at least 20%. The Chinese government spends heavily on research and development for solar power to help meet these and other goals. Much of this funding comes through the Ministry of Science and Technology (MOST).⁷⁰

66 Bart Sweerts et al., "[Estimation of losses in solar energy production from air pollution in China since 1960 using surface radiation data](#)," *Nature Energy* (July 8, 2019).

67 NDRC, "[Circular on improving the Feed-in Tariff mechanism for PV power generation](#)," (April 28, 2019); NDRC, "关于完善陆上风电光伏发电上网标杆电价政策的通知 [Notice on Improving the Pricing Policy for Onshore Wind Power and On-Grid Solar Photovoltaic Power Prices]," (December 2016); NEA, "[国家发展改革委关于完善太阳能光伏发电上网电价政策的通知 \[Notice on Improving the Pricing Policy for On-Grid Solar Photovoltaic Power Prices\]](#)," (in Chinese) (August 2011).

68 NDRC, Ministry of Finance and NEA, "[Notice on matters relevant to PV power generation in 2018](#)," (May 31, 2018); REN21, "[Renewables 2019 Global Status Report](#)," Chapter 3 Market and Industry Trends, Solar Photovoltaics at notes 25–28; NDRC and NEA, "[关于促进新时代新能源高质量发展实施方案的通知 \[Implementation Plan for Promoting Quality Development of New Energy in the New Era\]](#)," (in Chinese) (May 2022).

69 National Energy Administration, [13th Five-Year Plan for Energy Development](#) (2016); IRENA, [Renewable Capacity Statistics 2022](#) (April 2022) at p.20.

70 Jeffrey Ball, Dan Reicher, Xiaojing Sun and Caitlin Pollock, [The New Solar System](#), Stanford Steyer-Taylor Center (March 2017), pp.96–99.

CHAPTER 7 - NUCLEAR POWER

China has the third largest nuclear power fleet in the world, behind only the United States and France. As of September 2022, China's 54 operating nuclear power units had roughly 52 GW of capacity.¹

Much of the growth of the global nuclear power industry is in China.

- During 2021 and the first 9 months of 2022, 10 nuclear power plants were connected to the grid globally. Five of these were in China.
- During the first nine months of 2022, construction began on 7 nuclear power plants globally. Five of these were in China.
- As of September 2022, about one-third of the nuclear power capacity under construction globally was in China.²

In 2021, nuclear power provided roughly 4.8% of China's electricity. Two commercial reactors and one demonstration reactor were connected to the grid. In October 2021, the State Council reiterated that nuclear power will play an important role in peaking carbon emissions before 2030.³

Background

Construction on the first civilian nuclear reactor in China began in 1985. The program grew slowly with three reactors in operation by 1994. During the *10th Five-Year Plan* (2001–2005), the Chinese government launched an ambitious expansion of its nuclear power program, calling for the construction of eight more nuclear plants. That trend continued in the *11th Five-Year Plan* (2006–2010), which called for further expansion of the nuclear power program and a focus on Generation III technologies.⁴

The Fukushima accident on March 11, 2011, brought the rapid expansion of China's nuclear program to a halt. China's State Council ordered an immediate safety review at plants under construction and suspended approvals for new plants, pending a major safety review. In October 2012, a new safety plan was approved and approvals resumed.⁵

Between 2011 and 2020, China connected 37 nuclear reactors to the grid. These reactors had

1 [World Nuclear Association – Reactor Database](#) (accessed September 24, 2022). See also China Nuclear Energy Association, “China's nuclear energy development in the past decade,” (September 15, 2022) (China has 53 operational nuclear power plants with 55.6 GW of capacity).

2 [World Nuclear Association – Reactor Database](#) (accessed September 24, 2022) (23 GW under construction in China, 62 GW under construction globally). See also IAEA, [Nuclear Power Reactors in the World \(2021\)](#).

3 National Bureau of Statistics, [“Statistical Communiqué”](#) (February 28, 2022) at Table 3; Zheng Xin, [“Shidaowan gives China edge in nuclear power tech”](#), China Daily (December 21, 2021); State Council, [“Action Plan for Carbon Dioxide Peaking Before 2030”](#) (October 27, 2021).

4 World Nuclear Association, [“Nuclear Power in China”](#) (September 2022 update). “Gen III” reactors are safer, more fuel efficient and have longer lifespans than earlier reactors. See World Nuclear Association, [“Advanced Nuclear Power Reactors”](#) (April 2021).

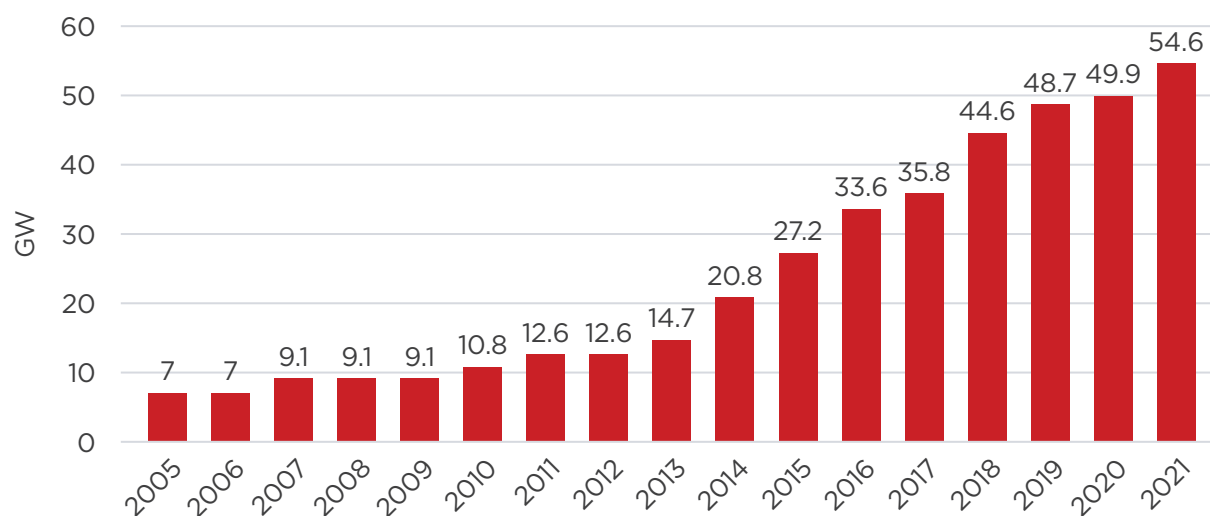
5 World Nuclear Association, [“Nuclear Power in China”](#) (September 2022 update).

approximately 36 GW of capacity, which was roughly 60% of the nuclear power capacity added globally during this period.⁶ The growth of China's nuclear power industry between 2011 and 2020 is one of the fastest additions of nuclear power capacity in history, behind only the US and France between 1979 and 1989 (US: 50 GW, France: 45 GW).⁷

In the past decade, at least two nuclear projects in China have been canceled due to strong public opposition. These include a proposed uranium processing plant in Guangdong (canceled in 2013) and proposed nuclear fuel reprocessing facility in Jiangsu (canceled in 2016).⁸

All of China's operating nuclear power plants are in coastal provinces. All nuclear power plants under construction in China are in coastal provinces as well. However three planned nuclear reactors and many proposed nuclear reactors are inland.⁹

Figure 7-1: Nuclear Power Capacity in China (2005-2021)



Source: World Nuclear Association (September 2022)¹⁰

6 IAEA, [Power Reactor Information System-Country Statistics-China](#); IAEA, [Nuclear Power Reactors in the World](#) (2021) at p.18 (59.3 GW nuclear power connected to electric grids globally from 2011 to 2020).

7 US Energy Information Administration, ["Nuclear explained - U.S. nuclear industry"](#) (updated April 18, 2022); World Nuclear Association, ["Nuclear Power in France"](#) (September 2022 update).

8 Li Jing, ["Nuclear fuel plant on hold in eastern China after thousands protest"](#) South China Morning Post (August 10, 2016); Minnie Chan and He Hui Feng, ["Jiangmen uranium plant is scrapped after thousands take part in protests"](#) South China Morning Post (July 13, 2013).

9 World Nuclear Association, ["Nuclear Power in China"](#) (September 2022 update).

10 World Nuclear Association, ["Nuclear Power in China"](#) (September 2022 update).

Policies

The Chinese government has regularly set ambitious goals for expanding nuclear power. The *13th Five-Year Plan* (2016–2020) called for 58 GW of installed nuclear power capacity and an additional 30 GW under construction by 2020.¹¹ Although this goal for installed capacity was missed, the *14th Five-Year Plan* (2021–2025) set a goal of 70 GW of installed capacity by 2025.¹²

The Chinese government supports the development of nuclear power with a number of policy tools:

- First, nuclear power plants often receive favorable prices and allocations of operating hours for electricity sales. While power market reforms have the potential to undermine this favorable treatment, the recent focus of energy security has led to its continuation.¹³
- Second, through policy banks such as China Development Bank, the government provides cheap debt capital to the large state-owned enterprises that dominate China’s nuclear power sector (including China National Nuclear Corporation, China General Nuclear Power Group and State Power Investment Corporation).
- Finally, central and provincial authorities help assemble land and arrange for transmission connections at new nuclear power plant sites.¹⁴

In building its nuclear power fleet, China has imported technology from the United States (AP1000), Canada (CANDU), Russia (VVER) and France (M310 and EPR). The Chinese government aims to localize these technologies and become self-sufficient in reactor design and construction.

Chinese policy now mandates using Generation III or more advanced technologies. The *14th Five-Year Plan* explicitly identified the new China nuclear technologies to be deployed:

- Hualong One – indigenous design, one in operation, six under construction in China. Two overseas Hualong One reactors are operational in Pakistan.
- Guohe One (CAP 1400) – based on Westinghouse AP1000, one reactor under construction.
- High-temperature gas-cooled reactors – one demonstration plant with two reactors in operation in Shandong Province. These are China’s first Generation IV reactors.

The *14th Five-Year Plan* also encourages the development of small modular reactors and

11 NDRC, [Energy Development Strategy Action Plan 2014–2020](#) (June 7, 2014) (in Chinese).

12 National People’s Congress, 14th Five-Year Plan (2021–2025), [CSET Original Translation: China’s 14th Five-Year Plan \(georgetown.edu\)](#) (accessed March 8, 2022).

13 Authors’ discussion with NDRC’s Energy Research Institute (April 27, 2022).

14 See Mark Hibbs, [The Future of Nuclear Power in China](#) (Carnegie Endowment for International Peace 2018) at p.65.

floating offshore nuclear power plants.¹⁵

In April 2022, Westinghouse Electric Company announced that China's State Council had approved construction of four new AP1000 reactors (two in Sanmen, Zhejiang Province and two in Haiyang, Shandong Province).¹⁶

Nuclear waste in China is stored on-site at nuclear power plants and in temporary storage facilities. In part due to the country's dependence on imported uranium, the government is planning a closed fuel cycle. Testing started at a pilot reprocessing plant in Gansu Province in 2010. A larger demonstration project is under construction at the same site and projected to begin operating by 2025. The possibility of developing a coastal site is also being assessed.¹⁷

Central players in the development of China's nuclear policies include the State Council, National Development and Reform Commission (NDRC), National Energy Administration (NEA), National Nuclear Safety Administration (NNSA), Chinese Atomic Energy Authority (CAEA),¹⁸ Bureau of Science, Technology and Industry for National Defense, and all the major nuclear power companies.

The key laws governing nuclear power include:

- the *2015 National Security Law* which mentions the protection of nuclear materials and the need for capacity to respond to nuclear threats and attacks;¹⁹ and
- the *Nuclear Safety Law*, effective from January 1, 2018.²⁰

China has no law on nuclear liability. Two "Replies" from the State Council, in 1986 and 2007, provide guidance on this topic.²¹ A draft Atomic Energy Law was first proposed in 1984 but never enacted. It was circulated for consultation in 2018 and is tentatively scheduled for deliberation by the Standing Committee of the National People's Congress in 2022.²²

Regulations directed explicitly at the nuclear industry include:

- 1987 *Regulation on the Management of Nuclear Material*;
- 1990 *Regulation on the Control of Nuclear Material*;

15 National People's Congress, 14th Five-Year Plan (2021–2025), [CSET Original Translation: China's 14th Five-Year Plan \(georgetown.edu\)](#) (accessed March 8, 2022).

16 Businesswire, "[Four Additional Westinghouse AP1000® Reactors to be Built in China](#)", (April 26, 2022).

17 World Nuclear Association, China's Nuclear Fuel Cycle, updated August 2021, [China's Nuclear Fuel Cycle - World Nuclear Association \(world-nuclear.org\)](#) (accessed March 8, 2022); Hui Zhang, "[Pinpointing China's New Plutonium Reprocessing Plant](#)", *Bulletin of the Atomic Scientists*, May 5, 2020 (accessed March 8, 2022).

18 Mark Hibbs, [The Future of Nuclear Power in China](#) (Carnegie Endowment for International Peace 2018) at p.15.

19 National Security Law of the People's Republic of China (adopted July 1, 2015 and entered into force July 1, 2015) (People's Republic of China).

20 Nuclear Safety Law of the People's Republic of China (adopted September 1, 2017 and entered into force January 1, 2018) (People's Republic of China).

21 Xianfeng Cai, "China's Legislative Perfection in the Field of the Compensation for Nuclear Damage", (2017) (2) *Journal of China University of Geosciences (Social Sciences Edition)* (in Chinese).

22 NPC Observer, "[Atomic Energy Law of the People's Republic of China](#)", (accessed March 8, 2022).

- 1993 *Regulation on Emergency Measures for Nuclear Accidents at Nuclear Power Plants*;
- 2005 *Regulation on the Safety Supervision and Administration of Civil Nuclear Facilities*.

One key question with respect to the future of nuclear power in China is the siting of nuclear power plants in inland provinces. Safety concerns and public opposition have stalled approvals at inland reactor sites ever since the Fukushima nuclear accident in 2011. Due to land constraints in coastal regions, expansion into inland provinces will be needed for significant growth in the Chinese nuclear power sector.

Impact on CO₂ Emissions

The Chinese government identifies its nuclear power policies as part of its strategy to fight climate change.²³

China's nuclear power fleet helps reduce emissions of heat-trapping gases.

- Coal plants and nuclear power plants play similar roles on electric grids, as baseload power.²⁴
- A nuclear plant emits 95–97% less CO₂ per MWh on a lifecycle basis than a coal-fired power plant,²⁵ which means that a 1 GW nuclear power plant replacing coal-fired power avoids roughly 7 million tonnes of CO₂ per year.²⁶
- If each nuclear plant in China displaces a coal-fired power plant that might have been built in its place, then avoided emissions from China's nuclear fleet in 2022 (based on roughly 55.8 GW of capacity) would be roughly 390 million tonnes of CO₂ per year—approximately 3.5% of China's CO₂ emissions and almost 1% of global CO₂ emissions.
- The NDRC's Energy Research Institute estimates that China's nuclear power fleet contributed a reduction of 274 million tonnes of CO₂ in 2020.²⁷ The difference between this estimate and the one above will reflect the lower installed capacity in

23 State Council, "[Action Plan for Carbon Dioxide Peaking Before 2030](#)", October 27, 2021); People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021).

24 This is not always the case in China. In the mid-2010s, new nuclear capacity was coming online at a time of slowing demand. As a consequence, the nuclear power fleet was operating well below full capacity, with an aggregate curtailment rate of 19% in 2016. Chunting Lin, "Nuclear Energy Curtailment Caused About 20 billion RMB of Losses to Power Plants", March 11, 2017, [去年弃核电量致企业损失近200亿元 核企呼吁要保障核电消纳 \(yicai.com\)](#) (accessed September 18, 2018) (in Chinese).

25 NREL, "[Life Cycle Greenhouse Gas Emissions from Electricity Generation](#)" (January 2013) (5%); World Nuclear Association, "[Greenhouse gas emissions avoided through use of nuclear energy](#)" (accessed July 13, 2019) (approximately 3%).

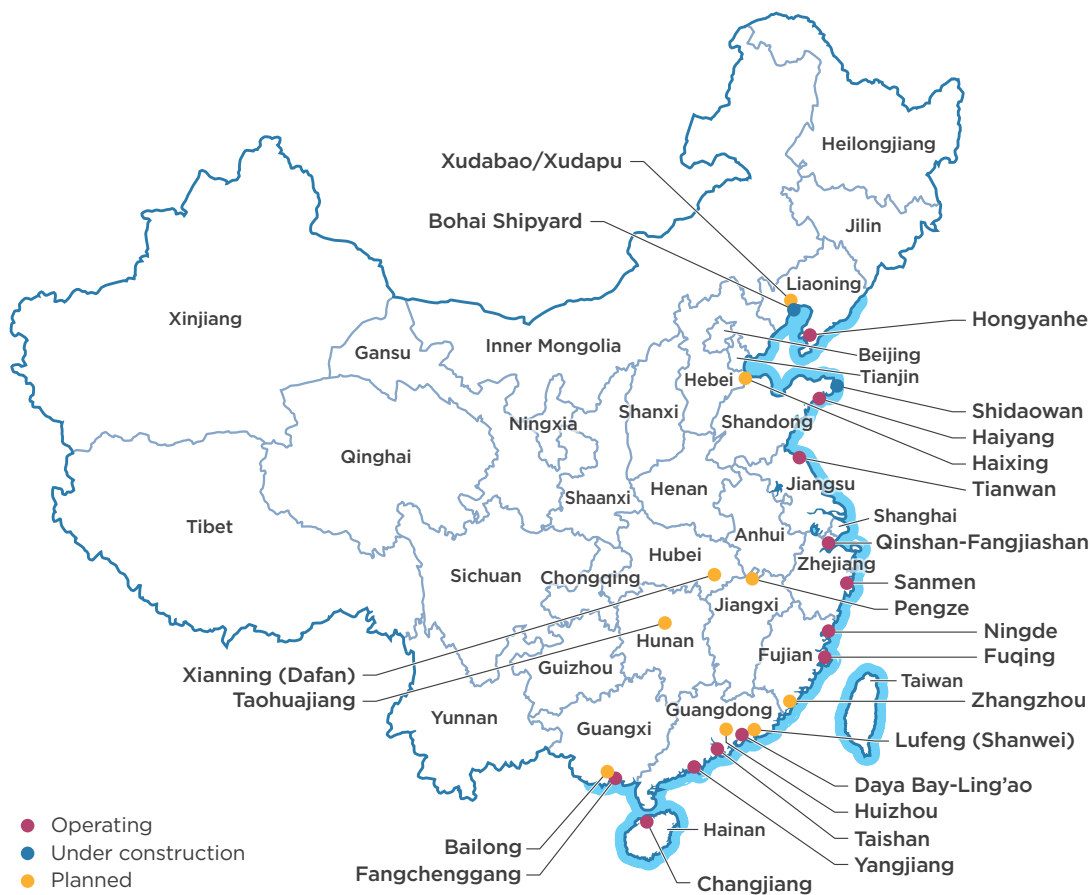
26 Based on coal plant emissions of 890 tonnes CO₂/GWh (see Alvin Lin, "[China's New Plans Deepen Action on Climate Change](#)," NRDC Expert Blog [December 19, 2016]) and nuclear plant operating at 90% capacity. This may be an underestimate. See K. Feng et al., "[The energy and water nexus in Chinese electricity production](#)," *Renewable and Sustainable Energy Reviews* (2014) at p.23 (life cycle CO₂ emissions of coal plants in China = 1230 tonnes/GWh).

27 Authors' discussion with NDRC's Energy Research Institute (April 27, 2022).

2020 as well as possible assumptions concerning coal power plant emissions, nuclear plant operating hours or other factors.

- The China Nuclear Energy Association estimated that the supply of nuclear power during the period January to March 2022 prevented 70.9 million tonnes of CO₂ emissions compared to the equivalent amount of coal-fired power.²⁸

Figure 7-2: China Nuclear Power Plants



Source: World Nuclear Association (February 2022)²⁹

28 China Nuclear Energy Association, [National Nuclear Power Operation](#) (January–March 2022), (May 6, 2022).

29 World Nuclear Association, [“Nuclear Power in China”](#) (September 2022 update).

CHAPTER 8 - POWER SECTOR REFORM

The structure and functioning of China's power sector will play a significant role in the Chinese government's ability to meet its climate goals. Chinese policy makers have highlighted the importance of power market reform to meeting these goals, including in the 14th Five-Year Plan for a Modern Energy System, which highlights power market reform as an element of a modern energy system that can enable carbon peaking and carbon neutrality.¹

Background

The electric power sector accounts for roughly 45% of China's carbon dioxide (CO₂) emissions.² In 2021, coal provided 67% of China's electric power, hydropower provided 16%, wind power 8%, nuclear power 5% and solar power 4%. Coal's share of electric power production has fallen during the past decade, from 77% in 2010 to 67% in 2021.³

Electric power in China is delivered predominantly by two state-owned utilities: China State Grid and China Southern Grid. China State Grid—the world's largest electric utility by far—supplies electricity to more than 1.1 billion people in 26 Chinese provinces.⁴ China Southern Grid serves more than 250 million people in Guangdong, Guangxi, Yunnan, Guizhou, Hainan, Hong Kong and Macao.⁵

Historically, electricity was dispatched in China based on province-by-province administrative allocations. At the end of each year, provincial dispatching centers would forecast total power demand for the following year and then allocate power generation quotas to each generator within their province. Generators within the same category (such as coal-fired power plants) would be allocated roughly the same number of annual operating hours. Coal-fired power plants typically received priority, with guarantees of a minimum number of annual operating hours, even if other sources (such as renewable power) were available.⁶

This system—known as “fair dispatch”—differs significantly from electric dispatch systems in most advanced economies. In the United States, Europe and Japan, for example, most electricity is dispatched based on the marginal cost of the electric generator. Electric utilities start by purchasing the electricity with the lowest marginal cost, then purchase electricity with next lowest marginal cost, and repeat this process until all demand for electricity in a service area is met. This system is known as “economic dispatch.”⁷

1 National Development and Reform Commission and National Energy Administration, [14th Five-Year Plan for a Modern Energy System \(十四五 现代能源体系规划\)](#) (March 2022) at p.6 (in Chinese).

2 Estimates vary. See M. Crippa et al., [GHG emissions of all the world countries-2021 Report](#) (EDGAR databased) (accessed August 17, 2022)(in 2020, 4794 Gt power industry/11,680 Gt total = 41%); [Carbon Emissions Accounts and Datasets-Nation](#) (accessed August 17, 2022) (in 2020, 4642 Gt “production and supply of power, steam and hot water”/9795 Gt total = 47%)

3 China Electricity Council, [“2021 electricity & other energy statistics \(preliminary\),”](#) (January 27, 2022).

4 [Global Sustainable Electricity Partnership - China State Grid](#) (accessed June 12, 2022).

5 [China Southern Power Grid](#), bnamericas (accessed September 10, 2022).

6 See IEA, [China Power System Transformation](#) (February 2019) at pp. 14, 28–30.

7 See generally, Seth Blumsack, [“Economic Dispatch”](#) in Introduction to Electricity Markets (Penn State, 2020).

China's historic system of electricity dispatch created several problems with respect to the government's climate and clean energy goals.

- First, administrative allocations to coal power plants resulted in significant curtailment of wind and solar power. Although China has led the world in wind and solar power capacity for many years, until recently much of that capacity was underutilized because coal power plants received priority in dispatching to the electric grid. Wind and solar power did not necessarily receive priority, even though they typically have zero marginal cost.⁸
- Second, province-by-province electricity planning also slowed the growth in wind and solar power. Provincial governments tend to design power market policies to favor generation from within their province, leading to a phenomenon known as “provincial fortresses” in which excess renewable power cannot reach nearby provinces where it may be needed despite ample transmission capacity.⁹

Electric power market reforms are underway in China to help reduce prices, improve efficiency, cut coal power capacity and promote climate change goals.¹⁰ These reforms are described below.

Policies

During the latter part of the 20th century, all parts of China's electric power system were run by a single state-owned enterprise—the State Power Corporation. In 2002, the State Council published *Document #5*, breaking up the State Electricity Department into two grid companies (China State Grid and China Southern Grid) and five power generation companies. An independent regulator—the State Electricity Regulatory Commission—was established (and later folded into the National Energy Administration).¹¹

Reform of the electricity market returned to the national energy policy agenda in 2015 with the publication of *Document #9 on Deepening Reform of the Power Sector*.¹² The

8 For more on the causes of renewable energy curtailment, see Ye Qi et al., [Fixing Wind Curtailment with Electric Power System Reform in China](#) Brookings Institution (March 1, 2018); Michael R. Davidson, [Market Solutions to China's Wind Integration Problem: Are Current Reforms Sufficient?](#) MIT (August 2017); and Michael R. Davidson, [Regulatory and technical barriers to wind energy integration in northeast China](#) MIT (2014).

9 Michael Davidson, “Technology Integration in China's Electricity System: Central Targets and Local Challenges,” in Loren Brandt and Thomas G Rawski eds., *Policy, Regulation and Innovation in China's Electricity and Telecom Industries*, Cambridge University Press, 2019, pages 150–151; Energy Storage China, [“什么是省间壁垒，谁在跨省交易中扮演重要角色？”](#) (February 10, 2020); Hao Zhang, [“Prioritizing Access of Renewable Energy to the Grid in China: Regulatory Mechanisms and Challenges for Implementation,”](#) Chinese Journal of Environmental Law (December 3, 2019).

10 The central government issued major policies on reducing coal overcapacity in 2009, 2013, 2016, 2017, 2018 and 2019. For further information, see Delu Wang et al., [“Coal overcapacity in China: Multiscale analysis and prediction,”](#) Energy Economics (February 2018), and Delu Wang et al., [“Overcapacity Risk of China's Coal Power Industry: A Comprehensive Assessment and Driving Factors,”](#) Sustainability (January 29, 2021).

11 See China State Council, [国务院关于印发电力体制改革方案的通知](#) (February 10, 2002) (in Chinese); [Electricity Regulation in China: An Overview](#), Thomson Reuters, (March 2021); Chun-ming Tsai, [The Paradox of Regulatory Development in China: The Case of the Electricity Industry](#), University of California Berkeley (2010).

12 Central Committee of the Communist Party of China and China State Council, [Opinions on Deepening Reform of the Electricity System](#) (March 15, 2015).

document laid out a broad agenda for reforms, including changing the revenue model for grid companies, direct retail access to power markets, retail competition, promotion of demand-side management, improved generator dispatch, improved renewable integration and removal of barriers to distributed generation.¹³ The document's call for wholesale markets to determine dispatch and investment decisions aligned with the philosophy of the high-profile Third Plenum of the 18th Party Congress in November 2013 to allow markets to play a central role in guiding investment in environmental and energy resources.¹⁴

Power market reforms in recent years include measures in the following areas:

1. Direct power purchases. In 2016, NDRC announced a transition from fixed operating hour contracts between generators and provincial grid companies to a wholesale market involving bilateral contracts between generators and large industrial consumers.¹⁵ Thousands of retail marketing companies (often subsidiaries of grid companies) sprang up to offer such contracts to end users, typically on a monthly or annual basis.¹⁶ In 2021, these mid-to-long-term (MLT) contracts accounted for 37% of total electricity consumption (up from 33% in 2020).¹⁷ After pricing-related power outages in late 2021, the central government announced that all industrial and commercial consumers would be encouraged to move to the bilateral contract market.¹⁸

13 See Max Dupuy and Frederick Weston, "[A New Framework for China's Power Sector](#)," Regulator Assistance Project (March 23, 2015).

14 Central Government of the People's Republic of China, [中共中央关于全面深化改革若干重大问题的决定](#) (November 2013) (in Chinese).

15 National Development and Reform Commission and National Energy Administration, [电力中长期交易基本规则](#) (December 29, 2016) (in Chinese).

16 China5e, "[新规实施后的售电市场前景展望](#)" (January 6, 2022) (in Chinese).

17 China Electricity Council, [2021-2022 National Electricity Supply-Demand Situation Analysis Report](#) (January 27, 2022) (in Chinese).

18 National Development and Reform Commission, [Notice on Further Deepening the Market Reform of On-grid Electricity Price for Coal-fired Power Generation](#) (October 12, 2021) (in Chinese).

Figure 8-1: Factors Contributing to Power Shortages in China (Fall 2021)



Source: Lantau Group 2021¹⁹

19 Lantau Group, [“Factors contributing to power shortages by province in China”](#) (February 2022).

2. Spot markets. In 2017, the National Energy Administration introduced spot market pilots covering eight regions and provinces.²⁰ Trade began with trial operations, then proceeded to more continuous operation in certain provinces.²¹ In designing these pilots, several provinces worked with international organizations such as Nordpool in Europe and the PJM Interconnection in the United States.²² In 2021, six additional provinces were added to the list of eight original pilots. A 2021 NDRC policy document encouraged commercial and industrial consumers to purchase electricity from the spot market, promoted the full inclusion of renewable energy in spot markets, and discussed the need to integrate provincial and regional spot market designs.²³
3. Interprovincial power trading. In recent years, numerous policies have promoted greater interprovincial and cross-regional power trading. In 2021, for example, an interprovincial spot market pilot was established between Inner Mongolia and nearby provinces.²⁴ In 2022, China's NEA and NDRC issued a guiding opinion calling for a unified national power market framework—targeting an initial design by 2025 and basic implementation by 2030.²⁵ The unified market would incorporate uniform rules for provinces as well as a national trading center, breaking down the provincial barriers that have hindered market designs in the past, and would harmonize spot markets, MLT trading and ancillary services markets.²⁶ (However, provincial officials have responded to recent power shortages by increasing investment in within-province power generation rather than by increasing interprovincial power trading.²⁷)
4. Ancillary services. Ancillary services, such as frequency regulation, voltage control and black start, help maintain the secure and stable operation of the electric grid. Ancillary services markets are especially important as variable renewable power grows in importance on electric grids. In China, ancillary services often refers to ramping plant output up or down to follow load, sometimes called peak regulation. Previously, China's power system provided only limited funds for ancillary services, and effectively required coal plants to pay one another for such services. Since 2018, reforms have established ancillary service market pilots, starting with Northeast

20 Spot markets are short-term markets, typically with intervals of an hour or shorter, in which electricity is traded near the time when it is used, such as on an hour-ahead or day-ahead basis. National Energy Administration, [八地区成为电力现货市场首批试点](#) (September 6, 2017) (in Chinese).

21 For the example of Guangdong, which is often considered the most advanced spot market pilot province, see Yang Liu et al., [“Assessing China’s provincial electricity spot market pilot operations: Lessons from Guangdong province.”](#) Energy Policy (2022).

22 Yuyan Cao et al., [Tracking China’s Provincial Spot Market Designs](#) Rocky Mountain Institute (December 2019).

23 National Development and Reform Commission, [“Notice on Improving the Pilot Work of Developing the Electricity Spot Market.”](#) (May 8, 2021).

24 State Grid Corporation of China, [“省间电力现货交易\(试行\)印发.”](#) (November 24, 2021).

25 National Development and Reform Commission, [“国家发展改革委 国家能源局关于加快建设全国统一电力市场体系的指导意见.”](#) (January 18, 2022) (in Chinese).

26 [“Power market reform; ‘Energy-conserving’ 14FYP scheme; Xi’s trip to coal province.”](#) Carbon Brief, (February 3, 2022).

27 Ye Ruolin and Yuan Ye, [“Untangling the Crossed Wires of China’s ‘Super Grid.’](#) Sixth Tone (March 9, 2021).

- China, focused on peak regulation.²⁸ China's ancillary services markets initially limited participation to coal-fired generators, but more recent policies call for opening up ancillary services markets to renewable energy, batteries and the demand side.²⁹
5. Transmission and distribution (T&D) pricing. New policies transition the revenue model of China's grid companies to a cost-plus-reasonable profit model, based on estimates of costs for building and maintaining transmission and distribution grid infrastructure.³⁰ Prior to T&D reforms, grid company profits depended on the price difference between the cost of generation (purchased by the grid companies under a single-buyer model) and retail electricity prices set administratively. For large transmission projects, revenues were based on the volume of electricity transferred as well as the distance—providing an incentive for grid companies to focus on long-distance, ultra-high voltage (UHV) lines.³¹ In late 2014, five provinces were designated as T&D reform pilots. This was expanded to a further 12 provinces and cities in early 2016, and then to all remaining provinces in late 2016.³² Initial reforms focused on setting revenues for existing grid assets within provinces. Subsequent reforms starting in 2017 created a process for setting revenues for newly-added transmission and distribution grids, as well as for cross-provincial transmission projects.³³
 6. Retail pricing for commercial and industrial customers. Retail prices for commercial and industrial customers have traditionally been set administratively by the National Development and Reform Commission (NDRC), and responsibility delegated to local DRC electricity offices. This has gradually changed with the introduction of bilateral power contracts, which began with the largest power consumers, and gradually expanded to include small customers via intermediate power marketing firms. After October 2021, the central government announced the cancellation of all administrative price schedules for industrial and commercial customers, which must now participate in the power market either via bilateral contracts or by accepting a default tariff offered by the grid company.³⁴

28 National Energy Administration, “完善电力辅助服务补偿(市场)机制工作方案。” (November 15, 2017) (in Chinese). North China Energy Regulation Bureau, “华北电力辅助服务市场建设方案(征求意见稿) [Establishment Plan of the North China Power Ancillary Services Market (Draft for Public Comment)].” (March 20, 2018) (in Chinese).

29 Liu Xiying and Kong Lingcheng, [A New Chapter in China's Electricity Market Reform](#) Energy Studies Institute (March 21, 2016).

30 Liu Xiying and Kong Lingcheng, [A New Chapter in China's Electricity Market Reform](#) Energy Studies Institute (March 21, 2016).

31 Michael Davidson and Ignacio Perez-Arriaga, “Avoiding Pitfalls in China's Electricity Sector Reforms.” *The Energy Journal* (2020).

32 For a summary, see BJX, “一文看懂全国输配电价核定情况 [One Article to Understand T&D Pricing Situation].” (August 15, 2019) (in Chinese).

33 National Development and Reform Commission, “区域电网输电价格定价办法 [Trial Pricing Measures for the Power Transmission of Regional Power Grids].” (December 29, 2017) (in Chinese); National Development and Reform Commission, “跨省跨区专项工程电价定价办法 [Trial Pricing Measures for the Power Transmission of Specific Inter-Provincial and Inter-Regional Power Transmission Projects].” (December 29, 2017) (in Chinese); National Development and Reform Commission, “关于制定地方电网和增量配电网配电价格的指导意见 [Guiding Opinion on Provincial Distribution Pricing and Pricing for Incrementally-added Distribution].” (December 29, 2017) (in Chinese).

34 National Development and Reform Commission, [Notice on Further Deepening the Market Reform of On-grid Electricity Price for Coal-fired Power Generation](#) (October 12, 2021) (in Chinese).

7. Retail prices for residential customers. In 2011, NDRC adopted a policy for residential customers aimed at encouraging electricity conservation. The policy required each household to have one power meter and created an electricity price premium for households consuming more electricity than the district average. The pricing policy, known as ladder pricing, keeps prices unchanged for 80% of customers, but creates a 2nd and 3rd tier of residential customers in the 80–95% percentiles and 95–100% percentiles of local district monthly average household power consumption, charging higher retail prices for these tiers.³⁵
8. Time-of-use pricing. Most regions in China offer time-of-use (TOU) power price schedules for commercial and industrial customers. In recent years, in line with policies to encourage more demand-side participation in power markets, the government has promoted provincial adoption of TOU prices and encouraged increasing the price differential between peak and trough times. A July 2021 policy targeted a ratio of 4:1 between peak to valley prices.³⁶ This policy remains in effect despite the cancellation of administrative price schedules for industrial and commercial customers in late 2021.
9. Renewable obligation. Starting in 2018, NEA adopted provincial quotas for renewable energy consumption that apply to provincial grid companies and large industries (which often own their own power supplies).³⁷ These provincial quotas were short-term administrative measures mandating renewable energy consumption over one to two years, with the goal of integrating existing renewable capacity into power grids. In early 2021, NEA issued a new draft renewable obligation that set out provincial requirements to 2030, showing how non-hydro renewable energy can reach 25% of total generation by that time.³⁸ NEA subsequently indicated that renewable consumption targets will continue to be published on an annual basis and long-term targets will remain advisory.³⁹ (Similar policies in the United States—known as renewable portfolio standards—and the United Kingdom—known as the renewable obligation—typically have binding targets for 10–20 years to help guide investment.)

35 National Development and Reform Commission, [关于居民生活用电试行阶梯电价的指导意见](#) (2011) (in Chinese).

36 National Development and Reform Commission, [“国家发展改革委关于进一步完善分时电价机制的通知”](#) (July 26, 2021) (in Chinese).

37 National Energy Administration, [“可再生能源电力配额及考核办法\(征求意见稿\) \[Renewable Electricity Obligation and Compliance Mechanisms \(Draft for Public Comment\)\]”](#) (March 23, 2018) (in Chinese); NEA, [“可再生能源电力配额及考核办法\(第二次征求意见稿\) \[Renewable Electricity Obligation Compliance Mechanism \(Second Draft for Public Comment\)\]”](#) China National Energy Administration],” (September 13, 2018) (in Chinese); NEA, [“关于实行可再生能源电力配额制的通知\(征求意见稿\) \[Notice on Implementing Renewable Electricity Obligation \(Draft for Public Comment\)\]”](#) (November 15, 2018) (in Chinese); NDRC and NEA, [“关于建立健全可再生能源电力消纳保障机制的通知, 发改能源〔2019〕807号 \[Notice on Building a Renewable Electricity Guaranteed Consumption System, NDRC Energy\(2019\) No. 807\]”](#) (May 10, 2019) (in Chinese).

38 NEA, [“定调未来10年可再生能源发展 协调消纳责任权重 \[Setting 10-Year Renewable Development and Harmonizing Renewable Obligation\]”](#) (February 18, 2021) (in Chinese).

39 NDRC and NEA, [“关于2021年可再生能源电力消纳责任权重及有关事项的通知 \[Notice on 2021 Renewable Obligation and Related Projects\]”](#) (May 21, 2021) (in Chinese).

10. In 2017, the Chinese government launched a voluntary market for green certificates and identified green power trading as a potential path for phasing out subsidies and fixed feed-in tariffs.⁴⁰ To receive a green certificate under this program, a company must relinquish any feed-in-tariff subsidy. As a result of this design, purchase volumes have been low.⁴¹ More recently, green power trading has started to grow, though only for monthly and annual contracts and only for renewable production hours beyond the hours already guaranteed for purchase by grid companies.⁴² In 2021, the central government also announced a set of green power trading pilots that would involve interprovincial trading.⁴³ Several provinces have now participated in an interprovincial green power trading platform organized for contracts of one year or longer. The government plans to eventually link the green certificate and renewable obligation policies.

Relationship to Climate Goals

Power market reforms are widely considered important to achieving carbon neutrality because of their potential to promote energy efficiency and low-carbon energy sources.

Barriers to interprovincial trading of electricity have been an obstacle to wind and solar power generation, since variable renewable energy can be more easily managed when smoothed over larger geographical areas.⁴⁴ Several studies have shown that more flexible trading of electricity across provincial boundaries offers the lowest cost solution for improving system flexibility and increasing renewable integration.⁴⁵

Spot markets are also often considered essential for integrating large amounts of renewable power into electric grids. Spot markets tend to favor plants with lower marginal cost of production such as wind and solar power (which have zero fuel costs). Spot markets are also

40 NDRC, Ministry of Finance, NEA, “关于试行可再生能源绿色电力证书核发及自愿认购交易制度的通知. 发改能源 [2017] 132号 [Notice Regarding Trial Implementation of Renewable Energy Green Electricity Certificates and Voluntary Procurement and Trading Institutions, NDRC Energy (2017) No. 132],” (February 6, 2017) (in Chinese).

41 Ye Ze, “我国可再生能源绿色证书自愿认购交易规则评价与建议 [National Renewable Energy Green Certificate Voluntary Purchase and Trading Rules: An Assessment and Suggestions],” China Power, (June 30, 2017) (in Chinese); Anders Hove and Daniel Wetzel, “China is planning provincial quotas for clean energy,” China Dialogue (April 23, 2018) (in Chinese).

42 NDRC, “绿色低碳转型体制机制和政策措施的意见” (January 30, 2022) (in Chinese).

43 National Development and Reform Commission, “锚定双碳目标, 绿色电力交易方案蓄势出台: 绿色电力交易试点工作方案解读 [To reach carbon neutrality, green power trading plan issued: understanding the green power trading pilot work plan],” (September 28, 2021) (in Chinese); Tao Jinnan, “绿电开市! 首批交易电量近80亿千瓦时,” China Energy Reports (September 7, 2021) (in Chinese).

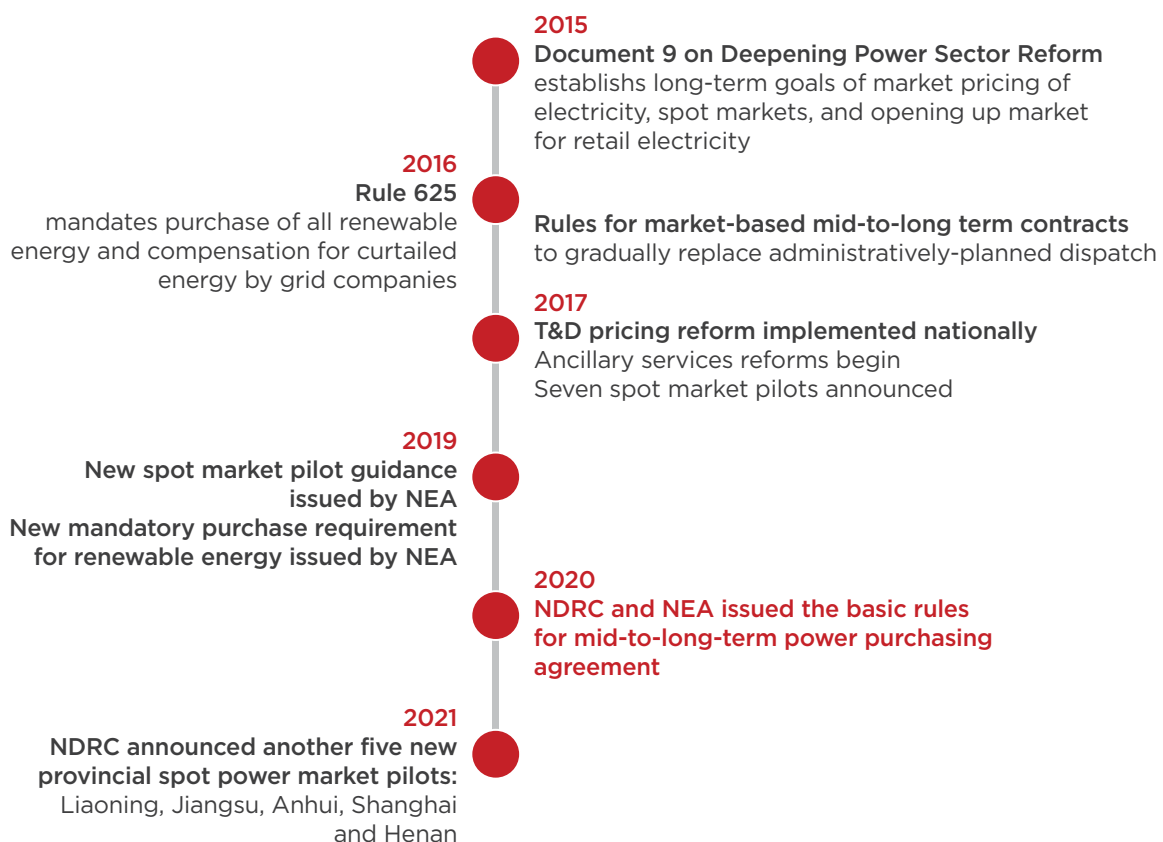
44 Michael Davidson, “Technology Integration in China’s Electricity System: Central Targets and Local Challenges,” in Loren Brandt and Thomas G Rawski eds., Policy, Regulation and Innovation in China’s Electricity and Telecom Industries, Cambridge University Press, 2019, pages 150–151; Energy Storage China, “什么是省间壁垒, 谁在跨省交易中扮演重要角色?” (February 10, 2020) (in Chinese); Hao Zhang, “Prioritizing Access of Renewable Energy to the Grid in China: Regulatory Mechanisms and Challenges for Implementation,” Chinese Journal of Environmental Law (December 3, 2019).

45 Jiang Lin et al., “Large balancing areas and dispersed renewable investment enhance grid flexibility in a renewable-dominant power system in China,” iScience (2022); Shiyu Liu et al., “Curtailed of renewable energy in Northwest China and market-based solutions,” Energy Policy (2018); Max Dupuy, “Unwinding Finance for Coal Power in China: The Role of Power Sector Reform,” Regulatory Assistance Project (July 20, 2021); Zheng Yanan et al., “Quantifying power sector flexibility in Germany and China’s Jing-Jin-Ji region, for better integration of renewables” National Development and Reform Commission Energy Research Institute (December 2020).

key to ensuring that carbon prices fully incentivize consumers to prioritize energy efficiency and lower-carbon generation (although China's current carbon markets are based on carbon intensity benchmarks, and the price of carbon emissions allowances does not increase the price of electricity for end consumers or directly affect the dispatch order of power plants).⁴⁶

A 2022 analysis by the International Energy Agency found that moving from administratively determined dispatch to economic dispatch would strengthen China's Emissions Trading System by allowing markets to reflect carbon prices in electricity generation costs.⁴⁷ Several studies have found that power market reform in China is likely to reduce the cost of low-carbon energy sources and steps toward carbon neutrality.⁴⁸

Figure 8-2: Power Sector Reform Timeline



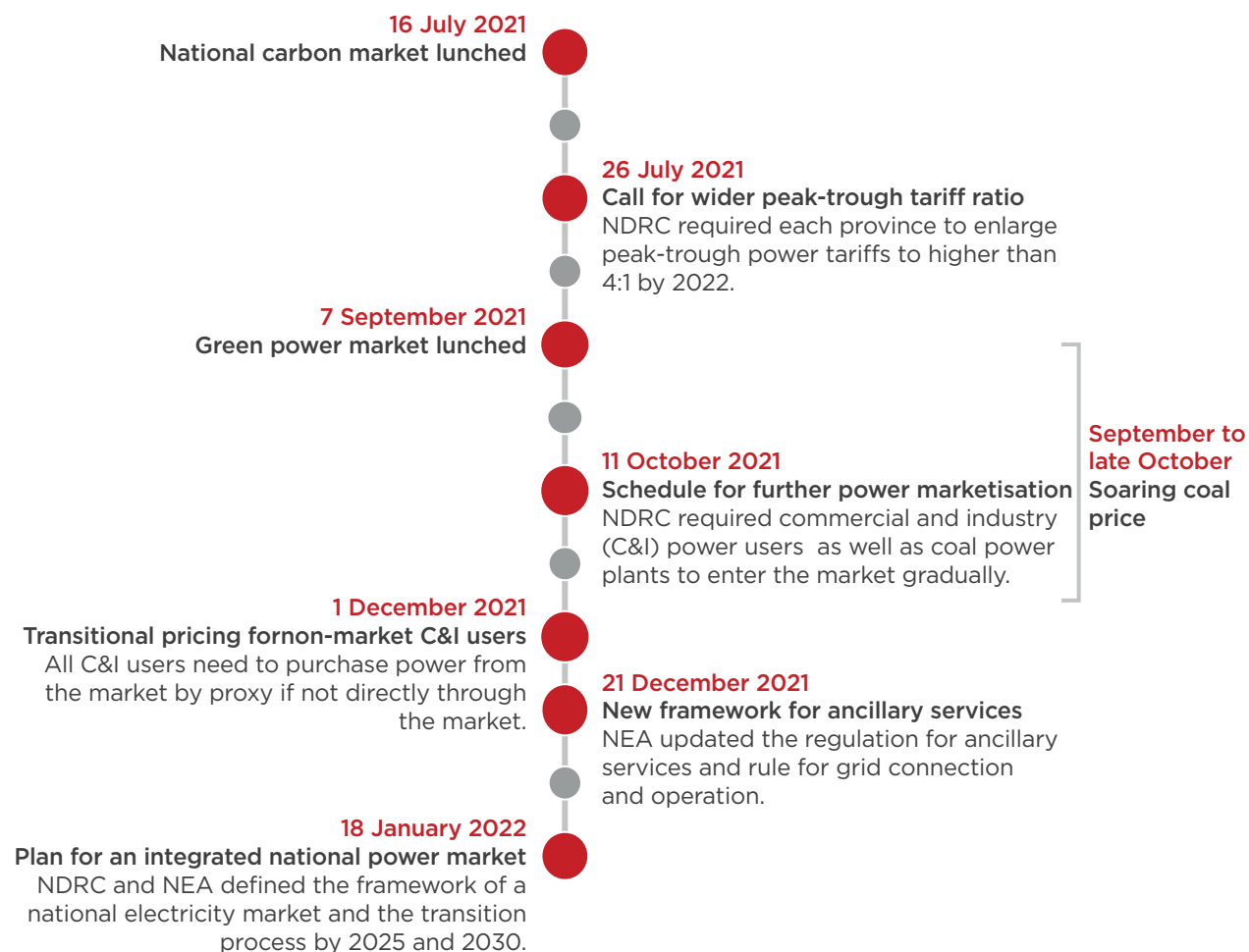
continued on next page

46 Max Dupuy et al., [Designing Power Markets to Maximize the Effectiveness of Carbon Pricing](#) Regulatory Assistance Project (May 2020).

47 International Energy Agency, [Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector](#) (May 2022).

48 International Energy Agency, [China Power System Transformation](#) (February 2019); Ruosida (Star) Lin and Dan Wetzel, [Implications of Energy Spot Markets in China: Finding the Right Market Mechanisms to Address the Technical, Economic, and Political Impacts of China's Market Reform](#) RMI China (2019).

continued from previous page



Source: GIZ (2022)⁴⁹

49 Sino-German Energy Transition Project, GIZ, 2022.

CHAPTER 9 - ENERGY EFFICIENCY

“China’s progress in implementing mandatory energy efficiency policies over the past decade has made it the world’s energy efficiency heavyweight.”

— IEA, *Energy Efficiency in China* (February 2021)¹

Background

China’s economy is energy-intensive. In 2021, only seven countries in the world used more energy per unit of GDP than China. The energy intensity of China’s economy is due to several factors, including the high share of heavy manufacturing in China’s economy and lack of market signals to motivate energy efficiency in some sectors.²

The energy intensity of the Chinese economy has improved dramatically in the past several decades. Between 1990 and 2020, energy use per unit of GDP in China fell by roughly 75%.³

The steady improvement in China’s energy intensity has been caused by structural changes in the economy as services and light industry grow, as well as regulation-induced energy efficiency improvements. The industrial sector has had the greatest energy savings, mainly in response to government mandates. Energy appliance standards and labeling have played an important role, as have energy service companies (ESCOs). The deployment of smart meters to drive demand response is only recent but growing rapidly. The central government has continued to introduce measures to improve the energy efficiency of buildings.⁴

China’s energy efficiency gains have had an enormous impact on energy use and emissions of heat-trapping gases. The International Energy Agency estimates that (i) energy efficiency improvements since 2010 have cut energy consumption by 20%; (ii) energy efficiency improvements between 2000 and 2017 reduced China’s 2017 emissions by nearly 1.2 Gt CO₂e (roughly equal to Japan’s 2017 emissions).⁵

Policies

In 2018, more than 60% of China’s energy use was covered by mandatory energy efficiency policies—more than any other nation in the world.⁶

1 International Energy Agency, [Energy Efficiency in China](#) (February 12, 2021).

2 Enerdata, [Energy intensity of GDP | Global Energy Intensity Data | Enerdata](#) (accessed August 23, 2022). On energy efficiency in China generally, see IEA, [Energy Efficiency 2021](#) at pp. 22 and 41; IEA, [Energy Efficiency 2018](#) at pp.145-149; Lynn Price et al., [Reinventing Fire: China—the Role of Energy Efficiency in China’s Roadmap to 2050](#) (2017).

3 Enerdata, [Energy intensity of GDP | Global Energy Intensity Data | Enerdata](#) (accessed August 23, 2022).

4 IEA [An energy sector roadmap to carbon neutrality in China](#) (September 2021); IEA, [Energy Efficiency in China](#) (February 2021); IEA, [Energy Efficiency 2021](#) (November 2021) at pp.17, 29, 89.

5 IEA, [Energy Efficiency 2018](#); IEA, [Energy Efficiency in China](#) (February 12, 2021).

6 IEA, [Energy Efficiency 2018](#) at p.37.

Improving energy efficiency is a long-standing goal of the Chinese government. Most Five-Year Plans since the 1980s have included energy intensity goals for the Chinese economy. The *11th Five-Year Plan* (2006–2010) contained especially strong provisions, with a mandatory national target to reduce energy intensity 20% below 2005 levels by 2010. The *12th Five-Year Plan* (2011–2015) contained a mandatory national target to reduce energy intensity 16% below 2010 levels by 2015. Both these targets were met or almost met.⁷

The *13th Five-Year Plan* (2016–2020) contained a mandatory national target to reduce energy intensity 15% below 2015 levels by 2020. This target was missed when energy intensity improved only 13.2%, due in part to the focus on energy-intensive industries in post-COVID economic recovery programs.⁸

The *13th Five-Year Plan* also introduced the Dual Control policy, which set caps for total energy consumption and energy intensity for provinces, municipalities and autonomous regions. These sub-national governments would then set annual Dual Control targets and establish mechanisms to achieve those targets, focusing on energy-intensive industries. In August 2021, the National Development and Reform Commission (NDRC) identified ten provinces that were not on track to meet one or both of their annual Dual Control targets for 2021.⁹

The *14th Five-Year Plan* (2021–2025) contains a mandatory national target to reduce energy intensity 13.5% below 2020 levels by 2025.¹⁰

As the energy intensity of an economy improves, easier ways of saving energy are implemented and more challenging ways remain. If energy intensity improves by 15% in one five-year period, a 15% improvement in the next five-year period would require more effort than in the first. As a result, the successive energy intensity improvement targets in recent Five-Year Plans—from 20% to 16% to 15% to 13.5%—do not represent diminished ambition on the part of Chinese energy planners. Instead, those targets represent roughly constant ambition in improving energy intensity over time.

The State Council highlighted the importance of energy efficiency in several policy documents published in late 2021 and early 2022. It drew attention to the need for energy efficiency improvements in sectors including heavy industry, building materials, coal, transport, appliances and urban design. The State Council also highlighted the need to continue with the Dual Control mechanism.¹¹

7 People's Republic of China, [Third National Communication on Climate Change](#) (December 2018) at pp.107–121; Ye Qi and Tong Wu, "[The Politics of Climate Change in China](#)," WIREs Climate Change, at n.3; Lisa Williams, [China's Climate Change Policies—Actor and Drivers](#), Lowy Institute (2014) at p.2; State Council, [12th Five-Year Plan for Energy Conservation and Emission Reduction](#) (in Chinese) (August 2012).

8 S&P Global, "[China's energy intensity caps poorly timed amid ongoing fuel shortages](#)," (September 29, 2021).

9 HCA Consulting China, [China Dual-Control Impact Summary](#) (September 29, 2021); S&P Global, "[China's energy intensity caps poorly timed amid ongoing fuel shortages](#)," (September 29, 2021).

10 NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021).

11 State Council, [Action Plan for Carbon Dioxide Peaking Before 2030](#), (October 2021); State Council, [14th Five-Year Plan Comprehensive Work Plan for Energy Conservation and Emissions Reduction](#), (in Chinese) (January 2022).

NDRC's *14th Five-Year Plan for a Modern Energy System* repeats the energy intensity target in the overarching 14th Five-Year Plan published in March 2021. It sets no cap on total energy consumption, but mentions the need to improve the Dual Control mechanism.¹²

These energy intensity targets in Five-Year Plans are implemented through four main policy tools: (1) annual goals, (2) provincial targets, (3) government spending and (4) regulations and standards.

1. Annual goals. In the past, Five-Year Plan targets for energy intensity were supplemented with specific annual goals. Such annual targets have not been set in the 14th Five-Year Plan.¹³
2. Provincial targets. As part of the process for implementing China's Five-Year Plans, each province is required to meet specific energy intensity targets. Under the 13th Five-Year Plan, these targets varied from a 17% improvement (for eight provinces, including Beijing, Shanghai and Guangdong) to 10% (for Xinjiang, Tibet and Qinghai).¹⁴ Such provincial targets for energy intensity reduction and total energy consumption are part of the Dual Control mechanism.

In September 2021, NDRC issued proposals to improve the Dual Control mechanism through the more careful setting of targets and their decomposition, greater flexibility in implementation in certain cases, improved energy consumption management systems and better early warning mechanisms. Under the new scheme, NDRC continues to set energy consumption and energy intensity targets for provinces which, in turn, delegate targets to subordinate levels of government. Lower levels of government are allowed flexibility to set their annual goals.¹⁵

3. Central government spending. The central government spent more than \$35 billion on energy efficiency programs during the 12th Five-Year Plan (2011–2015). Provincial governments spent at least \$7 billion. These funds were spent on projects to demonstrate energy efficient equipment, upgrade coal-fired boilers, recover waste heat, implement energy management systems and more. Financial tools used in these projects included direct funding, subsidized loans and credit guarantees. The IEA estimates that Chinese government funding leveraged over \$211 billion of private spending on energy efficiency.¹⁶
4. Regulations and standards. The Chinese central government has issued dozens of regulations standards to promote energy efficiency across a range of sectors.

12 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022).

13 See L. Wang, "[China targets 3.4 pct cut in energy intensity in 2017](#)," CCTV (March 5, 2017); Bloomberg News, "[China Avoids 2022 Energy Intensity Target Amid Commodity Tumult](#)," (March 4, 2022).

14 For breakdown of provincial targets, see "['13th Five-Year' energy consumption control indicators](#)," 21st Century Business Herald (in Chinese) (January 12, 2017). See also NDRC, [China's Policies and Actions for Addressing Climate Change](#) (October 2016) at pp.10-11.

15 State Council, [Plan for Improving the Dual Control System for Energy Consumption Intensity and Total Consumption](#) (in Chinese) (September 2021).

16 IEA, [Energy Efficiency Market Report 2016](#) at pp.51-52; [China Energy Efficiency Report](#), ABB (February 2013).

NDRC, the Ministry of Industry and Information Technology (MIIT), the Ministry of Housing and Urban-Rural Development (MOHURD), the Ministry of Commerce (MOFCOM), and other ministries all have roles. Among the most important are:

- a. Efficiency standards for coal-fired power plants. All new coal plants must use supercritical or ultra-supercritical technology. There are long-standing programs to retire small and low-efficiency coal boilers.¹⁷
- b. Benchmarks for energy-intensive industries. In October 2021, NDRC identified the need to tighten energy efficiency benchmarking for energy-intensive industries such as steel, aluminum, flat glass, cement, oil refining, chemicals and data centers. The new benchmarks were published one month later. In February 2022, NDRC followed up by declaring that steel, cement, coal-to-chemicals and aluminum smelting plants must all meet minimum standards by 2025 or be phased out, and that some portions of other industries should meet new benchmark standards by 2025.¹⁸
- c. Appliance standards and labels. The Chinese government's appliance energy efficiency standards and labeling programs date back many years. NDRC and MIIT each publish catalogs of recommended energy-saving products and promote their use through public education. NDRC runs an Energy Efficiency Leaders program to recognize top products in different categories. The most recent catalog was published in April 2020. In it, NDRC stated that the 14 previous rounds of catalog published since March 2005 covered 37 types of products and more than 1.9 million product models, resulting in more than 500 billion TWh of electricity savings. Recognizing the growing importance of air conditioning and other uses of cooling, the government issued a *Green and Efficient Cooling Action Plan* in 2019. This plan covered a wide range of settings including buildings and data centers and addressed both energy efficiency and the coolants used.¹⁹
- d. Building standards. All new urban residential and public buildings must meet energy-saving design standards established by MOHURD. MOHURD has also developed a *Green Building Action Plan*, with green building evaluation standards and a labeling program. These standards were updated in 2019. MOHURD issued further codes for energy efficiency and renewable energy for buildings in 2021. MOHURD issued its *14th Five-Year Plan for Building Energy*

17 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022).

18 NDRC, [Several Opinions on Strict Energy Efficiency Constraints to Promote Energy Conservation and Carbon Reduction in Key Areas](#) (in Chinese) (October 18, 2021); Yujie Xue, "China sets efficiency benchmarks for power-hungry industries to meet net-zero goals, hitting shares of steel and aluminium producers," South China Morning Post (November 16, 2021); Eric Ng, [China's new five-year energy efficiency targets to drive heavy industry consolidation, analysts say](#)," South China Morning Post (February 14, 2022).

19 NDRC, [Product Catalogue for Energy Efficiency Labelling \(15th edition\) and Related Implementation Rules](#) (in Chinese) (April 27, 2020); Institute for Governance and Sustainable Development, [China's Green and High-Efficiency Cooling Action Plan](#) (June 13, 2019); NDRC, [China's Policies and Actions for Addressing Climate Change](#) (2016) at p.10-11; Hermann Aemecke et al., [Buildings Energy Efficiency in China, Germany, and the United States](#) (Climate Policy Initiative, April 2013).

Conservation and Green Building Development in March 2021, effective in April 2022. This sets targets relating to the energy consumption of new buildings, the renovation of existing buildings, the proportion of prefabricated buildings, renewable energy and construction methods, among others.²⁰

20 MOHURD, [Assessment Standard for Green Building](#), (May 30, 2019); MOHURD, [General Code for Building Energy Conservation and Renewable Energy Utilization](#) (October 13, 2021); MOHURD, [14th Five-Year Plan for Building Energy Conservation and Green Building Development](#) (in Chinese) (March 1, 2022); Wei Feng et al., *The Evolution of Building Energy Codes and Standards in China*, Lawrence Berkeley National Laboratory (2017).

CHAPTER 10 - EMISSIONS TRADING

China's national emissions trading system (ETS), launched in 2017, officially came into operation in 2021. The ETS covers the power sector (electricity and heat generation), which emits almost 5 Gt of CO₂ annually (roughly 45% of China's and 15% of global CO₂ emissions).¹ It is the world's largest emissions trading program in terms of CO₂ emissions covered. The Chinese government has announced that the ETS will be expanded to include other sectors in the years ahead.²

The ETS introduced a carbon price in China and has the potential to play an important role in China's transition to carbon neutrality. To date, however, the ETS has had little if any impact on CO₂ emissions. The reasons include a generous supply of allowances, lack of a hard cap on emissions and limited trading liquidity. At present, regulators appear to be more focused on improving data collection and familiarizing regulated entities with details of the system than on reducing emissions. In the years ahead, the ETS could become an important factor in reducing Chinese CO₂ emissions, depending on design and implementation decisions.³

Background

An ETS is a way to put a price on emissions. Under an ETS, companies acquire rights to release a certain amount of a pollutant, known as allowances, which can be traded. At the end of a compliance cycle, usually every year, these companies are required to surrender allowances to match their verified emissions. The companies may sell surplus allowances and buy allowances to cover any shortfall. Companies that fail to surrender sufficient allowances are subject to penalties.

The Chinese government's interest in emissions trading dates to at least the late 1990s, when the State Environmental Protection Agency (led by Administrator Xie Zhenhua) explored the feasibility of emissions trading for sulfur dioxide. In 2005, the NDRC authorized Chinese companies to participate in the Clean Development Mechanism (CDM), an international emissions trading program for CO₂ and other heat-trapping gases run by the UN Framework Convention on Climate Change. China soon became the world's biggest supplier of CDM

1 Estimates vary. See M. Crippa et al., [GHG emissions of all world countries 2021 Report](#), EDGAR database-Downloads (accessed August 17, 2022) (in 2020, 4794 Gt CO₂ from the power industry/11,680 Gt CO₂ China total = 41%); [Carbon Emission Accounts and Datasets \(CEADs\)](#) project, IPCC Sectoral Emissions database (accessed August 17, 2022) (in 2019, 4642 Gt CO₂ from the production and supply of electric power, steam and hot water/9795 Gt CO₂ China total CO₂ = 47.4%). Total CO₂ emissions in China grew roughly 5% in 2021, largely due to increases in coal-fired power generation. See IEA, ["Global CO₂ emissions rebounded to their highest level in history in 2021."](#) (March 8, 2022); IEA, [Global Energy Review: CO₂ Emissions in 2021](#) (March 2022) at p.8. See also IEA, ["Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector,"](#) (May 2022) at p. 27 (ETS covered around 4.5 Gt of CO₂ emissions in 2020).

2 IEA, [China's Emissions Trading Scheme](#), June 2020, p. 65; Jane Nakano, Scott Kennedy, ["China's New National Carbon Trading Market: Between Promise and Pessimism,"](#) CSIS Critical Questions, (July 23, 2021); [China national ETS delays sector expansion, how to solve carbon data issues?](#) (in Chinese) (May 2022).

3 See generally Noah Kaufman and Jonathan Elkind, ["Can China's CO₂ Trading System Avoid the Pitfalls of Other Emissions Trading Schemes?"](#) Columbia Center on Global Energy Policy (February 2018); Frank Jotzo et al., ["China's emissions trading takes steps towards big ambitions,"](#) Nature Climate Change (April 3, 2018); Robert Stavins, ["What Should We Make of China's Announcement of a National CO₂ Trading System?"](#) (January 7, 2018).

credits, with more than half the world's CDM projects.⁴

In 2011, the Chinese government announced plans to develop a domestic CO₂ emissions trading market. Over the next several years, pilot programs were launched in eight cities and provinces—Beijing, Shanghai, Chongqing, Shenzhen, Hubei, Tianjin, Guangdong and Fujian.⁵ The design of the pilot emissions trading programs—that were intended to inform a national scheme—drew on experiences in California, the European Union and other jurisdictions.

In 2014, the NDRC released its *Interim Measures for Managing Carbon Emissions Trading Rights* to start the process of developing standards for a national carbon trading market.⁶ The launch of the ETS was, however, repeatedly delayed. It was initially planned to be issued within the 12th Five-Year Plan period (2011–2015),⁷ but was postponed. In September 2015, President Xi Jinping announced that the Chinese government would launch a national CO₂ emissions trading program by the end of 2017.⁸

In December 2017, NDRC released its *National Carbon Market Development Plan (Power Generation Sector)*.⁹ The document set forth a three-phase plan:

- Phase 1 (“Basic Infrastructure Establishment”): “Build unified national systems for emissions data reporting, registration and allowance trading.”
- Phase 2 (“Simulated Operation”): “Conduct mock trading of allowances in the power generation sector.”
- Phase 3: (“Deepening and perfecting”): “Conduct spot trading of allowances among participants from the power generation sector...Once the carbon market for the power generation sector is successfully established, the market shall gradually expand to cover other sectors, trading products and trading types.”

The challenge of collecting reliable emissions data, a government reshuffle (with the Ministry

4 The environmental additionality of some of China's CDM projects sparked controversy. See Mark Shapiro, [“‘Perverse’ Carbon Payments Send Flood of Money to China,”](#) Yale Environment 360 (December 13, 2010); [“Kyoto Protocol ‘loophole’ has cost \\$6 billion,”](#) New Scientist (February 9, 2007). With respect to early interest in SO₂ emissions trading, see Wang Jinnan et al., [SO₂ Emissions Trading Program: A Feasibility Study for China](#) (December 2001). The IEA has argued that the ETS could take a central role in driving the energy transition in China, IEA, [China's Emissions Trading Scheme](#), (June 2020), while others have argued that although it is a significant tool, it is unlikely to play a leading role in signalling long term investment pathways, see Anders Hove, Michal Meidan and Philip Andrews-Speed, [Software versus hardware: how China's institutional setting helps and hinders the clean energy transition](#), OIES Paper, CE3, (December 2021), p. 40.

5 See generally Yande Dai, Yanbing Kang and Xiaoping Xiong, Carbon Trading System Research, Energy Research Institute, NDRC (May 2014); Da Zhang, Valerie J. Karplus, Cyril Cassisa and Xiliang Zhang, [“Emissions trading in China: Progress and prospects,”](#) Energy Policy (2014).

6 NDRC, [“碳排放权交易管理暂行办法” \[Interim Measures for Managing the Carbon Emission Trading Rights\]](#) (in Chinese) (December 10, 2014).

7 National Energy Administration, [“China is expected to establish an emissions trading system during the 12th Five Year Plan period,”](#) 中国有望在“十二五”期间建立碳排放交易系统, (in Chinese) (December 9, 2011).

8 Julie Hirschfeld Davis and Coral Davenport, [“China to Announce Cap-and-Trade Program to Limit Emissions,”](#) New York Times (September 2015).

9 NDRC, [“Program for the establishment of a national carbon emissions trading market \(power generation industry\),”](#) 国家发展改革委关于印发《全国碳排放权交易市场建设方案（发电行业）》的通知 (in Chinese) (December 18, 2017).

of Ecology and Environment (MEE) replacing the Ministry of Environmental Protection in an effort to elevate the importance of environmental protection) and other factors led to a delay in the rollout of the ETS.¹⁰

In April 2021, President Xi mentioned the ETS in a high-profile speech at the Leaders Summit on Climate Change, tying it to his carbon peaking and carbon neutrality goals.¹¹

ETS design and first implementation cycle

At the end of 2020, the MEE published its allocation plan for the power sector. The first annual implementation cycle started on January 1, 2021, with the MEE publishing the *Interim Rules for Carbon Emissions Trading Management* that same month. The Rules came into effect in February 2021¹² clarifying the inclusion criteria of key emission entities, how allowances would be set and allocated, verification methods, reporting and information disclosure, supervision and penalties for breach.

The initial compliance cycle included 2225 participating entities from the power sector¹³ with compliance obligations covering their 2019 and 2020 emissions.^{14,15}

- The emissions allowances—each representing the right to emit one tonne of CO₂—were determined based on actual output levels of coal- and gas-fired power plants (total kWh of electricity generated), using CO₂ emission intensity benchmarks in tonnes of CO₂/kWh for electricity and tonnes of CO₂/GJ for heat generation.¹⁶
- The threshold for inclusion in the ETS was set at 26,000 tonnes of CO₂ per year per entity. This is roughly equivalent to the annual emissions of a small five-megawatt (MW) coal-fired power plant.¹⁷
- The initial 2225 participants—described as “key emission entities”—were selected based on their greenhouse gas emissions in 2013–2018, as collected, verified and

10 Honqiao Liu, [“In-depth Q&A: Will China’s emissions trading scheme help tackle climate change?”](#) CarbonBrief, (June 26, 2021).

11 Xinhua, [“Full Text: Remarks by Chinese President Xi Jinping at Leaders Summit on Climate.”](#) (April 22, 2021).

12 Ministry of Environment and Ecology, [Interim rules for carbon emissions trading management](#), 碳排放权交易管理办法（试行）, (in Chinese) (January 2021).

13 Ministry of Environment and Ecology, List, 纳入 2019-2020 年全国碳排放权交易配额管理的重点排放单位名单, (December 2020).

14 Ministry of Environment and Ecology, 2019-2020 年全国碳排放权交易配额总量设定与分配实施方案（发电行业） [\[2019-2020 Implementation Plan for National Carbon Emissions Trading Total Allowances Setting and Allocation \(Power Sector\)\]](#), (December 30, 2020).

15 Yan Qin, “The long-awaited national carbon market: big news, limited near term impact”, in Michal Meidan, Philip Andrews-Speed, Yan Qin, [“Key issues for China’s 14th Five Year Plan.”](#) (March 2021), p.10.

16 Ministry of Environment and Ecology, “List of entities covered by 2019–2020 National Carbon Emissions Trading Allowance Management,” 2019-2020 年全国碳排放权交易配额总量设定与分配实施方案（发电行业） [\[2019-2020 Implementation Plan for National Carbon Emissions Trading Total Allowances Setting and Allocation \(Power Sector\)\]](#), (in Chinese) (December 30, 2021).

17 Honqiao Liu, [“In-depth Q&A: Will China’s emissions trading scheme help tackle climate change?”](#) CarbonBrief, (June 26, 2021).

compiled by MEE's provincial subsidiaries.¹⁸ The vast majority of the entities covered in the first cycle are coal-fired power plants with a small number of gas-fired plants, reflecting the structure of China's power fleet.

- Although the ETS only covers the power sector, the inclusion of captive power plants in the participating entities impacts other sectors too. Captive power plants are built to provide stable power supplies with lower energy costs for the private use of industrial or commercial sites. Captive power plants account for roughly one-third of the entities regulated by the ETS in its first implementation cycle.¹⁹ Nearly half of these captive plants serve the chemical industry, with others covering pulp and paper as well as metals, among others. Since these captive plants are usually smaller and less efficient (circulating fluidized bed, CFB or subcritical plants) than large and new coal power plants (ultra-supercritical plants), the ETS would therefore lead to a more rapid phase out of these plants.²⁰

Permit allocation

- Permits were allocated to the different entities based on emissions intensity “benchmarks,” and were allocated for free in the first compliance cycle.
- Coal power plants were divided into three benchmark categories and gas-fired power plants followed one unified benchmark.
- Gas-fired power plants do not have a compliance obligation, so do not need to purchase allowances when they have a deficit.²¹ This is an indirect subsidy on gas plants in order to encourage coal-to-gas switching.
- CFB plants received 30% more allowances than large conventional coal plants and 192% more than gas-fired power plants. CFB plants use low-grade coal which makes their emission intensity higher than other coal technologies.
- As the ETS covers only coal- and gas-fired power plants, generation from non-fossil energy sources, such as renewables and nuclear power plants, does not receive any allowances and cannot act as a source of supply to the market.²²
- Entities are also allowed to use Chinese Certified Emissions Reduction (CCER) offset

18 [List of entities covered by 2019-2020 National Carbon Emissions Trading Allowance Management](#), 纳入 2019-2020 年全国碳排放权交易配额管理的重点排放单位名单, (in Chinese) (December 2020); Ministry of Environment and Ecology, 2019-2020 年全国碳排放权交易配额总量设定与分配实施方案（发电行业） [[2019-2020 Implementation Plan for National Carbon Emissions Trading Total Allowances Setting and Allocation \(Power Sector\)](#)], (in Chinese) (December 30, 2020).

19 Honqiao Liu, “In-depth Q&A: Will China’s emissions trading scheme help tackle climate change?,” CarbonBrief, (June 26, 2021).

20 IEA, [China’s Emissions Trading Scheme](#), (June 2020), p.12.

21 Ministry of Environment and Ecology, 2019-2020 年全国碳排放权交易配额总量设定与分配实施方案（发电行业） [[2019-2020 Implementation Plan for National Carbon Emissions Trading Total Allowances Setting and Allocation \(Power Sector\)](#)], (in Chinese) (December 2020). (January, 2021)

22 IEA, [Enhancing China’s ETS for Carbon Neutrality: Focus on Power Sector](#), (May 2022), p 27.

credits to meet compliance obligations for up to 5% of verified emissions.²³

In March 2020, the 2225 regulated power generation sites received their preliminary allocation of emission permits for 2019 and 2020, and opened a trading account in the Shanghai Environment and Energy Exchange.²⁴

Figure 10-1: Benchmark Design for Electricity Generation for 2019 and 2020

Benchmark category	Technology	CO ₂ emissions benchmark for electricity generation (t CO ₂ /kWh)
Unconventional coal-fired units	Technology type	1146
Conventional coal-fired units at and below 300 MW	Circulating fluidized bed (CFB)	979
Conventional coal-fired units above 300 MW	High pressure Subcritical ≤300 MW Supercritical ≤300 MW	877
Gas-fired units	Gas	392

Source: International Energy Agency²⁵

The initial allowances covered an estimated 4.5 Gt of CO₂,²⁶ making China's ETS the largest emissions trading system globally.

Yet China's ETS is currently designed using intensity-based targets, thus limiting its effectiveness for emissions reductions: Compliance obligations are measured in emissions per unit of production (or per unit of electricity generated) so the ETS does not set a cap on total emissions, unlike the EU ETS and California's Cap-and-Trade Program which hold participating entities accountable for their absolute emissions and set the overall emissions cap several years into the future. The aim of the first compliance cycle was therefore to encourage participation and allow the regulator to collect historical data and test the system.

Moreover, the benchmarks for the first compliance period were higher than the average CO₂ emissions factor of the coal fleet. As a result, most of the power plants had sufficient allowances to cover their compliance needs in the first cycle.²⁷ The ETS effectively incentivizes an improvement to the overall efficiency of coal-fired plants and helps reduce their CO₂

23 Ministry of Environment and Ecology, [Interim Rules for Carbon Emissions Trading Management](#), 碳排放权交易管理办法（试行）(in Chinese).

24 Honqiao Liu, "In-depth Q&A: Will China's emissions trading scheme help tackle climate change?," CarbonBrief, (June 26, 2021).

25 IEA, [Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector](#), (May 2022), p. 27.

26 IEA, [Enhancing China's ETS for Carbon Neutrality: Focus on Power Sector](#), (May 2022) p. 26.

27 Yan Qin, "China's ETS: Performance, Impact, and Evolution," Oxford Energy Forum No. 132, (June 2022).

emission intensity²⁸ by penalizing aging and inefficient thermal plants if their emission intensity is above the benchmark. But more efficient thermal plants have surplus allowances through which they can generate revenue (as they can sell this on the allowance market). Gas-fired power plants are also a case in point.

This output-based allocation provides flexibility given that China's energy demand is still growing and industrial capacity is expanding. This approach is consistent with China's climate intensity target in the 14th Five-Year Plan (2021-2025).²⁹

Going forward, more sectors will be added to the ETS (by 2025), the allocation will likely be tightened and an absolute cap could be introduced to replace the intensity target, although the latter is more likely after 2025.

Reporting and verification

- All regulated entities in the initial phase are subject to monitoring, reporting and verification (MRV) of their emissions in 2019 and 2020.
- MRV for emissions in 2020 is also required from sites whose annual emissions are above the 26,000t CO₂ threshold in sectors that were named for future inclusion in the ETS (petrochemicals, chemicals, building materials, steel, non-ferrous, pulp and paper, and aviation).
- Between April and June 2021, power generators included in the compliance cycle reported their emissions in 2020 to MEE, which subsequently confirmed the ETS coverage and the list of sites included in the first compliance cycle.
- Between September and December, the additional sectors that were originally nominated for inclusion within the ETS also completed reporting their 2020 emissions to the MEE.

MRV is a critical element of the ETS. In March 2022, the MEE discovered problems with emissions data submitted by power plants, following an inspection campaign that ran through the fourth quarter of 2021.³⁰

Data and enforcement challenges

- Since emissions are calculated based on the amount of coal burned and quality of the fuel, companies can buy small amounts of high-quality coal and submit this for examination but then use mostly cheaper, low-quality coal.³¹
- The provincial MEEs are sent to inspect but some have inadequate personnel and technical ability. They also face a conflict of interest as many of the biggest emitters

28 Yan Qin, "[China's ETS: Performance, Impact, and Evolution](#)," Oxford Energy Forum No. 132, (June 2022).

29 Yan Qin, "[China's ETS: Performance, Impact, and Evolution](#)," Oxford Energy Forum No. 132, (June 2022).

30 Reuters, "[China slams firms for falsifying carbon data](#)," (March 15, 2022).

31 Bloomberg, "[China's Weak Carbon Market Hits a New Roadblock -- Data Fraud](#)," (April 18, 2022).

are state-owned companies that are critical for local growth, development and the security of energy supplies.³²

- For power plants, penalties are not a deterrent as violations are only subject to an administrative penalty of up to 30,000 yuan. This is related to the fact that ETS regulations are ministerial level, thus capping the permissible fine. If and when compliance moves under the purview of the State Council, which ranks above the MEE, ETS implementation will be more robust as penalties will be higher.³³

Trading

- Following the reporting process, participating entities received their allowance for the first compliance period. Provincial environment bureaus allocated allowances to enterprises covered in their jurisdictions.
- Allowances were then issued in the national ETS registry hosted on the China Hubei Carbon Emissions Exchange, which serves as the registry of transactions and holdings until an official national ETS registry is established. The trading platform is based at the Shanghai Environment and Energy Exchange.³⁴
- Only compliance entities are currently allowed to trade in China's national ETS and only spot trading is allowed. There are currently no financial derivatives available.
- Transactions are referred to as either listed trades or over-the-counter (OTC) bulk trades (bilateral OTC trades that cleared on exchange at the end of each session). They have a daily price fluctuation limit of 10% and 30%, respectively.³⁵
- China's ETS pilots continued operations in parallel but, for the most part, saw trade volumes drop as power sector emitters turned to the national ETS.
- Emitting companies in sectors other than power generation are still regulated by the respective regional markets, though some captive power plants in Beijing and Guangdong have shifted to the national ETS. The pilots' role will likely decrease as the national ETS develops.³⁶
- There was also some trading activity in 2021 on the Beijing Green Exchange and China Hubei Carbon Emissions Exchange.

32 Bloomberg, "[China's Weak Carbon Market Hits a New Roadblock -- Data Fraud.](#)" (April 18, 2022).

33 Yan Qin, "The long-awaited national carbon market: big news, limited near term impact", in Michal Meidan, Philip Andrews-Speed, Yan Qin, [Key issues for China's 14th Five Year Plan](#), (March 2021), p.10.

34 Shanghai Environment and [Energy Exchange Carbon Emission Trading Rules](#), 上海环境能源交易所碳排放交易规则, (January 2021),

35 "[The Shanghai Environment and Energy Exchange issued the notice on matters related to the national carbon emissions trading system.](#)" 上海环境能源交易所正式发布《关于全国碳排放权交易相关事项的公告》, (in Chinese) China Securities Journal (June 22, 2021)

36 Tan Luyue, "[The first year of China's national carbon market, reviewed.](#)" China Dialogue, (February 2022).

The first compliance cycle

The first compliance cycle was heralded as a success by the MEE given the high compliance rate, estimated at 99.5%.³⁷ The China Emission Allowance (CEA) traded between RMB 40 and RMB 60 per tonne of CO₂ during most sessions and remained near RMB 60 per tonne of CO₂ in May 2022. While these prices are just a fraction of the EU ETS price, Chinese policymakers were not prioritizing high prices during the first compliance cycle. Indeed other emissions trading systems, including the European ETS, went through several years of low prices and limited liquidity after initial launch.

Trading volumes of CEAs was very thin—below 100 thousand tonnes in most sessions. Volumes increased in late November 2021 when the end-of-year deadline for surrendering allowances for compliance drew near. Entering 2022, trading activities almost dried up with many sessions seeing only trivial amounts of tonnes changing hands. (A slow start is not uncommon for emissions trading systems. In 2005—its first year—the EU ETS saw 321 million allowances traded. In 2021, the number of allowances traded reached 12 billion.)³⁸

Figure 10-2: Allowance Trades in China’s Carbon Market (2021)

	Trade volume (million tonnes)	Value (million \$)
National ETS	178.79	1,301.23
Regional pilots	63.58	371.05
CCERs	169.68	N/A
Total	412.05*	1,672.83

Source: China Dialogue

Note: Total volume includes allowances transacted in pilot ETS, national ETS and CCER transactions. Value includes only allowance units (as CCERs are mainly traded over-the-counter, there is no publicly available source for prices). Transactions of local offset units in the separate pilots are small, and not included in this assessment.³⁹

The first compliance cycle had, at most, a negligible impact on CO₂ emissions. That is because:

- Power plants have sufficient allowances to cover their compliance needs. One study estimated final verified emissions for 2020–2021 at 8.68 billion tonnes, against a known total allocation of 9.01 billion allowances.⁴⁰
- The use of offsets further loosened the supply-demand balance. Roughly 30 million

37 China Ministry of Ecology and Environment, “[Completion of first compliance cycle of national ETS.](#)” 全国碳市场第一个履约周期顺利结束, (December 2021).

38 Tan Luyue, “[The first year of China’s national carbon market, reviewed.](#)”, China Dialogue (February 2022).

39 Tan Luyue, “[The first year of China’s national carbon market, reviewed.](#)”, China Dialogue, (17 February, 2022).

40 Yan Qin, “[China’s ETS: Performance, Impact, and Evolution.](#)” Oxford Energy Forum No. 132, (June 2022).

offsets were used. In combination, the excess allowances plus offsets left a surplus of 360 million allowances going forward into the new compliance period.⁴¹

- The low allowance price also partly reflected the low cost of improving efficiencies in many Chinese coal plants. (Much higher carbon prices would be required to incentivize fuel switching from coal to natural gas or renewables.)

The second compliance cycle and beyond

The ETS's second compliance period started in 2022 with the covered entities unchanged. The new cycle is expected to cover 2021–2022.

In October 2021, the NDRC issued new guidelines on coal-fired plants' retrofitting and upgrading, seeking to reduce thermal plants' average coal consumption to 300 grams standard coal/kWh in 2025, down from the current level of 305 grams standard coal/kWh.⁴² The national ETS's benchmarks for the power sector are closely linked with this coal consumption indicator. A lower ETS benchmark would reflect improvements in the efficiency of the coal fleet and counteract excess allowances in the first compliance period.

A number of questions remain:

- Use of offsets: In the first compliance period, as discussed above, enterprises were allowed to use CCER for up to 5% of their yearly compliance obligation.⁴³ This led to a rise in CCER prices, although CCER prices have remained lower than the ETS allowance price, at RMB 20 to RMB 30/tCO₂. The CCER offsets therefore offer covered entities a way to lower their compliance costs under the ETS. Allowing offset use also helps achieve other objectives, such as redirecting carbon finance for mitigation actions to sectors not under the ETS. But offsets can be regarded as cheaper substitutes for compliance, reducing the net allowance demand of entities and resulting in an allowance surplus. Going forward, the government will need to make decisions regarding the role of offsets when setting allowance allocation benchmark levels.⁴⁴
- Expansion of the ETS beyond the power sector. The regulator aims to include more industry sectors by 2025, allowing the ETS to cover 60–70% of China's emissions. The aluminum and cement sectors may be the first new sectors to enter the ETS. Other candidates include petrochemicals, building materials, iron and steel, non-ferrous metals, and pulp and paper.
- Impact of the EU carbon border adjustment mechanism (CBAM), which could

41 Yan Qin, "[China's ETS: Performance, Impact, and Evolution](#)," Oxford Energy Forum No. 132, (June 2022); Tan Luyue, "[The first year of China's national carbon market, reviewed](#)," China Dialogue, (February 17, 2022).

42 NDRC, "[Notice on the Transformation and Upgrading of National Coal-fired power plants](#)," 关于开展全国煤电机组改造升级的通知, (in Chinese) (October 29, 2021).

43 Ministry of Ecology and Environment, "[Interim Rules for Carbon Emissions Trading Management](#)," 碳排放权交易管理办法（试行） (in Chinese) (December 31, 2020).

44 Yan Qin, "[China's ETS: Performance, Impact, and Evolution](#)," Oxford Energy Forum No. 132, (June 2022).

prompt the Chinese government to speed up the inclusion of the iron and steel sector in the ETS. However the complexities associated with emissions data collection and benchmark calculation could delay the process.⁴⁵

Climate Impacts

The ETS has improved emissions data collection, built capacity in covered entities and raised awareness of the cost of carbon emissions. To date, however, the ETS has had at most a marginal impact on emissions.

The extent to which the ETS will play a role in meeting China's carbon peaking and carbon neutrality goals depends on a number of factors, including:

- the levels at which benchmarks are set;
- how rapidly the ETS moves from an intensity-based system to absolute emissions caps;
- the extent to which allowance prices are allowed to rise;
- whether free allocations are replaced with auctions;
- the speed with which other sectors are included;
- when ETS regulations are elevated to State Council level; and
- the capacity of regulated entities and local officials.

Other emissions trading systems around the world took a number of years to move from experimental stages to maturity. The pace at which China's ETS does so could have a significant impact on global CO₂ emissions.

⁴⁵ IEA, [China's Emissions Trading Scheme](#), June 2020, p. 65; Jane Nakano, Scott Kennedy, "[China's New National Carbon Trading Market: Between Promise and Pessimism](#)," CSIS Critical Questions, (July 23, 2021); [China national ETS delays sector expansion, how to solve carbon data issues?](#) (in Chinese) (May 2022), Caijing Magazine.

CHAPTER 11 - MANUFACTURING SECTOR

China is one of the world's manufacturing powerhouses. It produces more than half the world's steel, aluminum and cement, and is the world's largest producer of plastics and ammonia. China generates around 30% of manufacturing value added globally, as compared with roughly 16–17% each from the United States and European Union.¹

Manufacturing is the largest source of heat-trapping emissions in China. In 2019, roughly 35% of China's heat-trapping emissions came from manufacturing. When indirect emissions from electricity generated for manufacturing are included, the figure is 60%. The steel and cement sectors are the largest sources. Chemicals, refineries and smelters of non-ferrous metals, such as aluminum, are also significant contributors.²

NOTE ON TERMINOLOGY

*The terms “**manufacturing**” and “**industry**” have overlapping definitions in Chinese policy. In official Chinese statistics, “**manufacturing**” refers to light and heavy industry, including large emissions sources such as cement, steel, non-ferrous metals smelting and chemicals, as well as many sectors with more modest heat-trapping footprints such as textiles, papermaking and equipment manufacturing.³ “**Industry**” is a broader term that includes manufacturing as well as coal mining, oil and gas extraction, and the production and supply of electric power. These two terms are used in this way in this chapter. (In many Chinese policy documents, the term “industry” refers mostly or exclusively to the manufacturing sector, even though the definition in official statistical documents is broader.)*

Scope 1 emissions are the emissions a company or facility produces from assets directly under its control, through combustion of fossil fuels for process heat, for instance, or through industrial processes that generate greenhouse gases as a byproduct.

Scope 2 emissions are emissions a company or facility produces indirectly from the energy carriers it procures—for example, through its purchase of electricity or heat produced with fossil fuels.

1 World Bank, [Manufacturing, value added \(Current \\$\)](#), indicator code NV.IND.MANF.CD, World Development Indicators (updated July 20, 2022) (accessed August 14, 2022). For more information on comparability between World Bank and Chinese domestic statistics on the manufacturing sector, see footnote 5.

2 Emissions figures for the manufacturing sector in this chapter are calculated based upon sectoral emissions estimates from the China Emissions Datasets and Accounts Series (CEADs) project, available at [CEADs](#); Yuru Guan et al., “[Assessment to China's Recent Emission Pattern Shifts](#),” *Earth's Future*, 9, No. 11 (2021): e2021EF002241; Yuli Shan et al., “[China CO₂ Emission Accounts 2016–2017](#),” *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., “[China CO₂ Emission Accounts 1997–2015](#),” *Scientific Data* 5, No. 1 (January 16, 2018): 170201. For details on the sectors included under manufacturing, see the table of contents for General Administration of Quality Supervision, Inspection and Quarantine and Standardization Administration of China, “[P.R.C. National Standard GB/T 4754-2017 国民经济行业分类 \[Industrial Classification for National Economic Activities\]](#),” (in Chinese) (October 1, 2017).

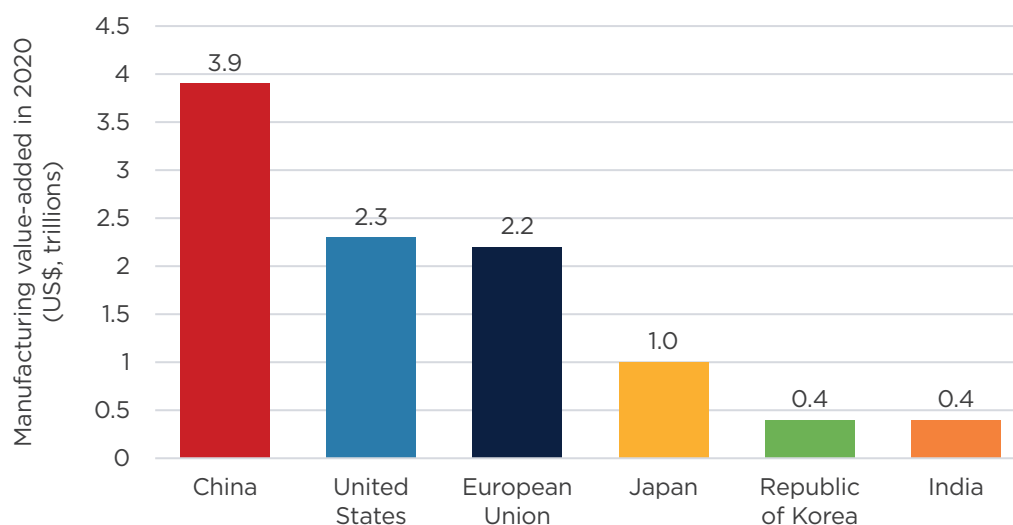
3 For the full list of sectors under “manufacturing,” see footnote 2.

China’s major climate policy statements over the past fifteen years have often included some treatment of the manufacturing sector’s carbon footprint. Mitigation work has historically centered on boosting energy efficiency and reining in overcapacity—priorities that align well with national industrial policies and energy security goals. These priorities remain central to China’s plans to achieve a manufacturing emissions peak and drive broader industrial upgrading to support “high-quality development”. Research, development and demonstration projects are focused on technological breakthroughs for deep decarbonization as a long-term priority.

A. Overview of China’s Manufacturing Sector

In 2021, the gross value added from China’s manufacturing sector was RMB 31.7 trillion (roughly \$4.5 trillion), accounting for 27.4% of the nation’s GDP.⁴ China led the world in manufacturing value added, with 29.8% of the global total.⁵

Figure 11-1: Manufacturing Value-Added in 2020 (\$, trillions)



Source: World Bank⁶

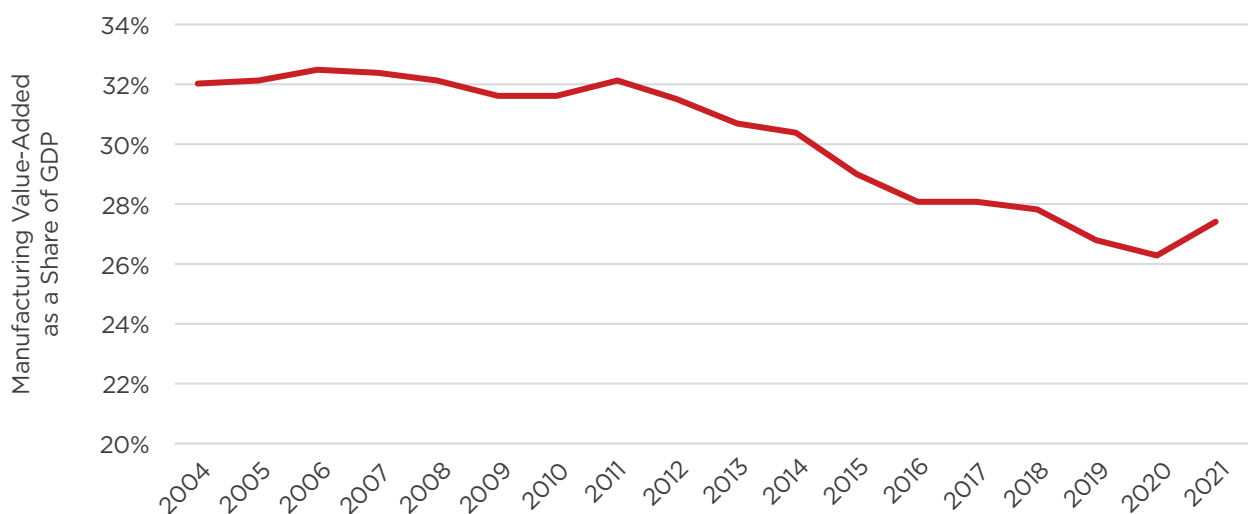
4 People’s Daily, “[我国制造业增加值连续12年世界第一 \(National Manufacturing Industry Value-Added Is the World’s Largest for 12 Years Running\)](#),” (in Chinese) (March 10, 2022).

5 World Bank, [Manufacturing, value added \(Current US\\$\)](#), indicator code NV.IND.MANF.CD, World Development Indicators (updated July 20, 2022) (accessed August 14, 2022). The World Bank’s manufacturing statistics include all economic activity under categories 15–37 under the United Nations International Standard Industrial Classification of All Economic Activities, Revision 3. These categories generally match with the definition of “manufacturing” under Chinese industrial classifications, referenced in footnote 2.

6 World Bank, [Manufacturing, value added \(Current \\$\)](#), indicator code NV.IND.MANF.CD, World Development Indicators (updated July 20, 2022) (accessed August 14, 2022)

The manufacturing sector accounts for the highest value added share of GDP among any major sectors in Chinese statistical accounting. The next largest are wholesale and retail trade (9.7%), finance (8.0%), construction (7.6%) and housing (6.8%).⁷ This sector has grown 7% on average over the past decade and yet its value added share of GDP has been declining steadily over the past decade, from 32.1% in 2011 to 27.4% today (Figure 11-2).⁸

Figure 11-2: Chinese Manufacturing Value-Added as a Share of GDP 2004-2021



Source: World Bank⁹

China is the world's largest manufacturer of a number of important products. It accounts for 50–60% of global output of crude steel, primary aluminum, cement and methanol.¹⁰ It is also the world's largest producer of other products such as ammonia, plastics, refined copper and

7 National Bureau of Statistics, [indicator 分行业增加值 “Value-Added by Sector” \(under 年度数据 Annual Data / 国民经济核算 National Economic Accounts\)](#), (accessed August 14, 2022). (For manufacturing sector value added, see footnote 4.)

8 World Bank, [Manufacturing, value added \(Current \\$\)](#), indicator code NV.IND.MANF.CD, World Development Indicators (updated July 20, 2022) (accessed August 14, 2022); World Bank, [Manufacturing, value added \(% of GDP\)](#), World Development Indicators, indicator code NV.IND.MANF.ZS (updated July 20, 2022) (accessed August 14, 2022).

9 World Bank, [Manufacturing, value added \(% of GDP\)](#), indicator code NV.IND.MANF.ZS, World Development Indicators (updated July 20, 2022) (accessed August 14, 2022)

10 World Cement Association, [“World Wide Cement Production 2018 & Forecast 2030.”](#) (accessed April 21, 2021); World Steel Association, [“World Steel in Figures 2022.”](#) (accessed August 4, 2022); International Aluminium Institute, [“Primary Aluminium Production.”](#) (July 20, 2022); International Energy Agency, [“An Energy Sector Roadmap to Carbon Neutrality in China.”](#) (September 2021), 104.

textiles, with around 30–40% shares in each.¹¹ A number of these products involve carbon-intensive or energy-intensive production processes, as discussed further below.

B. Energy Use

Manufacturing is China's largest energy consumer. In 2020, manufacturing sector activities were responsible for roughly 56% of total energy consumption in China.¹² This share fell fairly steadily during the 2010s after peaking in 2007 at around 62%.

These trends track overall shifts in the structure of the Chinese economy (from manufacturing to services). They also reflect a significant decline in the energy intensity of Chinese manufacturing, which fell threefold between the mid-2000s and the mid-2010s (Figure 11-3).

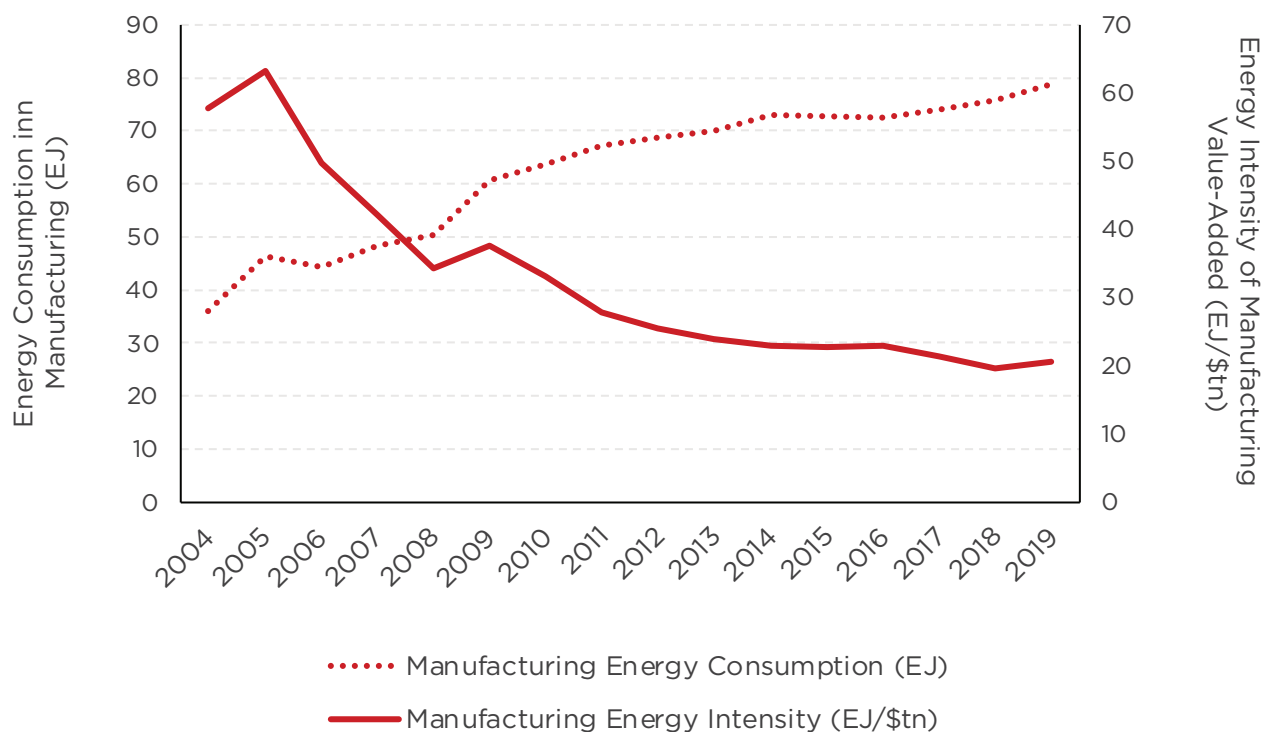
Energy efficiency gains have been an important driver of these savings. The cement sector, for instance, boosted production volumes by 133% between 2005 and 2014 while increasing coal consumption by only 46%. Between 2000 and 2015, the energy intensity of Chinese steel production fell around 30%.¹³ These gains are partly due to turnover in production facilities as inefficient small-scale units have been replaced by larger, more advanced facilities. As of 2020, for instance, the average ages of major energy-consuming assets in China's steel, cement and chemicals sectors are around 7 to 15 years old, as against 40-year expected lifetimes.¹⁴ But the increasing penetration of such efficient units has also meant less room for new gains, leading to a slower pace of improvements in recent years.

11 For copper, see United States Geological Survey, "[Copper](#)," in Mineral Commodities Summaries, Scientific Investigations Report, 2021; International Copper Study Group, "[The World Copper Factbook 2021](#)," 2021, 20, 25. For textiles, see Shweta Punj and MG Arun, "[Losing The Thread](#)," India Today (July 4, 2020); Astrid Pepermans, "[China as a Textile Giant Preserving Its Leading Position in the World, and What It Means for the EU](#)," 政治科學論叢 (Collected Papers in Political Science), No. 80 (June 1, 2019): 76. For ammonia, see International Energy Agency, "[Ammonia Technology Roadmap: Towards More Sustainable Nitrogen Fertiliser Production](#)" (OECD, 2021), 24. For plastics, see Plastics Europe and European Association of Plastics Recycling and Recovery Organisations, "[Plastics - the Facts, 2021](#)" (Brussels, Belgium, 2021), 13.

12 Calculated based upon National Bureau of Statistics, [indicator 分行业能源消费总量 "Total Energy Consumption by Sector" \(under 年度数据 Annual Data / 能源 Energy\)](#), (accessed August 14, 2022). For a list of sectors included under manufacturing, see footnote 2.

13 Edmund Downie, "[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges](#)," Columbia University SIPA Center on Global Energy Policy (August 25, 2021), 21.

14 Laszlo Varro and An Fengquan, "[China's Net-Zero Ambitions: The Next Five-Year Plan Will Be Critical for an Accelerated Energy Transition](#)," International Energy Agency (October 29, 2020).

Figure 11-3: Energy Use in Chinese Manufacturing, 2004-19

Source: World Bank, National Bureau of Statistics¹⁵

Within manufacturing, several sectors stand out as particularly energy-intensive. Top of this list is the smelting and pressing of ferrous metals--iron, steel and other iron-based alloys, which accounted for around 13% of national energy consumption in 2019. Other top energy-intensive manufacturing activities include manufacturing of raw chemical materials and chemical products; manufacturing of non-metallic mineral products (e.g. cement, glass and limestone); processing of petroleum, coal and other fuels; and smelting and pressing of non-ferrous metals (e.g. aluminum, copper and zinc) (Figure 11-4).¹⁶ These five sectors combined comprise over 40% of Chinese energy consumption.

¹⁵ World Bank, [Manufacturing, value added \(Current \\$\)](#), indicator code [NV.IND.MANF.CD](#), World Development Indicators (updated July 20, 2022) (accessed August 14, 2022); National Bureau of Statistics, [indicator 分行业能源消费总量 “Total Energy Consumption by Sector” \(under 年度数据 Annual Data / 能源 Energy\)](#), (accessed August 14, 2022)

¹⁶ National Bureau of Statistics, [indicator 分行业能源消费总量 “Total Energy Consumption by Sector” \(under 年度数据 Annual Data / 能源 Energy\)](#), (accessed August 14, 2022).

Figure 11-4: Energy-Intensive and Carbon-Intensive Industries in China (2019)

Sector	Examples of Products	Energy Use (EJ)	% of Chinese Total Energy Consumption	Scope 1 + 2 CO ₂ Emissions (mt)	% of Chinese Total CO ₂ Emissions
Smelting and Pressing of Ferrous Metals	Iron, steel, iron-based alloys	19.2	13.4%	2,227	22.8%
Raw Chemical Materials and Chemical Products	Fertilizers, industrial-use chemicals, synthetic materials	15.6	10.9%	639	6.5%
Nonmetal Mineral Products	Cement, glass, limestone	9.8	6.8%	1,318	13.5%
Petroleum Processing and Coking	Gasoline/petrol, kerosene, coke	9.5	6.7%	316	3.2%
Smelting and Pressing of Nonferrous Metals	Aluminum, copper, zinc, nickel	7.2	5.0%	453	4.6%
Subtotal		61.3	42.9%	4,953	50.6%

Source: National Bureau of Statistics; Guan et al. (2021); Shan et al. (2020); Shan et al. (2018)¹⁷

C. Emissions of Heat-Trapping Gases

Emissions of heat-trapping gases from China's manufacturing sector include the following:

- Scope 1 emissions of CO₂ from fuel combustion for heat (for instance, emissions from the combustion of fossil fuels to create heat for producing ammonia).
- Scope 1 emissions of CO₂, nitrous oxide (N₂O) and fluorinated gases (F-gases). Some industrial processes – such as cement production – involve chemical or physical transformations that emit heat-trapping gases as byproducts.
- Scope 2 emissions of CO₂ from electricity consumption (for instance, emissions from fossil fuel combustion to generate electricity that powers the grinding of raw materials in cement production).

¹⁷ National Bureau of Statistics, [indicator 分行业能源消费总量 “Total Energy Consumption by Sector”](#) (under [年度数据 Annual Data / 能源 Energy](#)), (accessed August 14, 2022); Yuru Guan et al., “[Assessment to China's Recent Emission Pattern Shifts](#),” *Earth's Future*, 9, No. 11 (2021): e2021EF002241; Yuli Shan et al., “[China CO₂ Emission Accounts 2016–2017](#),” *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., “[China CO₂ Emission Accounts 1997–2015](#),” *Scientific Data* 5, No. 1 (January 16, 2018): 170201. Conversions of energy consumption volumes from tons of standard coal equivalent (tce), as used in Chinese data, to joules uses a conversion factor of 29.31 GJ/tce. National Research Council, Chinese Academy of Sciences and Chinese Academy of Engineering, [Cooperation in the Energy Futures of China and the United States](#), National Academies Press (2000), 92.

The diversity of sources and types of manufacturing emissions make a comprehensive sectoral inventory challenging. Data from China's most recent national greenhouse gas inventory, for 2014, indicated that Chinese Scope 1 emissions from energy usage in manufacturing and construction and from industrial processes were a combined 5.2 Gt CO₂e, just under half (46.6%) of total national emissions. Around 4.8 Gt CO₂e (42.5%) came from CO₂, with the balance split between N₂O and F-gases.¹⁸

These estimates, notably, do not reflect the Chinese manufacturing sector's Scope 2 emissions--and the manufacturing sector's sizable share of national electricity consumption means that these are also important to consider. Tsinghua University's Carbon Emissions Accounts and Datasets (CEADs) project includes sectoral emissions estimates covering the largest manufacturing sources--CO₂ emissions from fossil fuel and electricity consumption and from cement production processes.¹⁹ Per their data, Scope 2 emissions have consistently accounted for around 40% of the manufacturing sector's emissions footprint in recent years. They estimate around 6.0 Gt of combined Scope 1 and 2 CO₂ emissions from the manufacturing sector in 2019, comprising 61.6% of national emissions.

Around half of national emissions came from the same five sectors that dominate manufacturing energy use (Figure 11-4). More than a third came from two sectors: non-metallic mineral products (largely cement) and smelting and pressing of ferrous metals (iron and steel). High emissions in these sectors reflect process emissions from cement production as well as the carbon intensity of China's steel industry, which relies largely upon blast furnaces consuming large volumes of coking coal.²⁰ (Carbon intensity is the carbon emissions per unit of output.)

Manufacturing emissions have grown substantially over the past three decades--a threefold increase since the late 1990s, per CEADs data. Yet that increase took place entirely between the early 2000s and the early 2010s (Figure 11-5). Between 2014 and 2017, manufacturing emissions declined around 5%. In 2018, manufacturing emissions started a modest rebound.

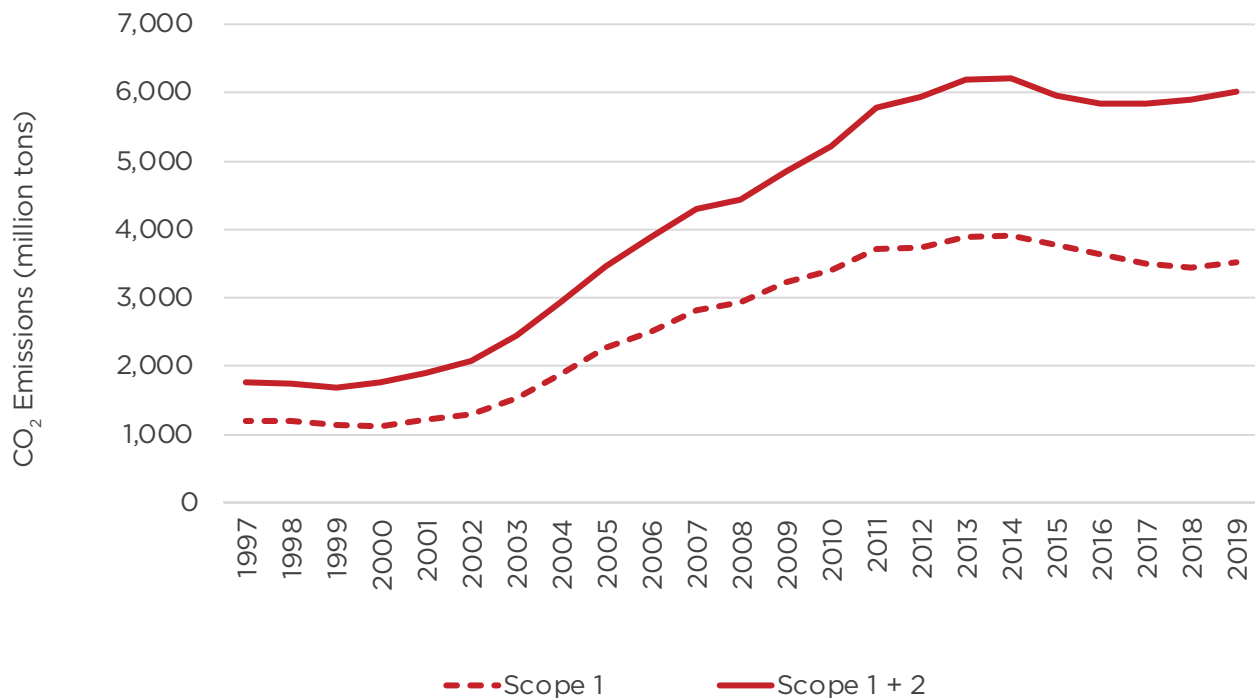
18 This figure is calculated based on data in [The People's Republic of China, The People's Republic of China Second Biennial Update Report on Climate Change](#) (December 2018), 16-20. It uses as its baseline the reported total of 11,186mt CO₂e (including emissions from land use changes). It adds reported CO₂e figures for all GHGs from industrial processes to CO₂e figures from energy usage in manufacturing and construction that are calculated by applying the inventory's global warming potential factors to reported CO₂, CH₄ and N₂O emissions volumes. Note that all F-gas emissions in this inventory are attributed to industrial processes, although some of these emissions often occur in the use of these products (as in leaks of F-gases used in air conditioning and refrigeration equipment). [Industrial Processes and Product Use](#) in 2006 IPCC Guidelines for National Greenhouse Gas Inventories, vol. 3, sec. 1.1 (accessed August 14, 2022).

19 Guan et al., "[Assessment to China's Recent Emission Pattern Shifts](#)," (October 21, 2021); Shan et al., "[China CO₂-Emission Accounts 1997-2015](#)," *Scientific Data* 5 (January 16, 2018); Shan et al., "[China CO₂ Emission Accounts 2016-2017](#)," *Scientific Data* 7 (February 13, 2020). Data is available at [CEADs](#). Note that the CEADs inventory for 2014 appears to trail the 2014 national GHG inventory by around 10%. The national inventory records 4.39 Gt of Scope 1 CO₂ emissions from energy use in manufacturing and construction as well as industrial processes in the "minerals" sector (i.e., cement production). The CEADs inventory records 3.95 Gt. (For national inventory data and calculation methods, see footnote 14.)

20 Edmund Downie, "[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges](#)," Columbia University SIPA Center of Global Energy Policy (August 25, 2021) 11-12; Ali Hasanbeigi and Cecilia Springer, "[How Clean Is the U.S. Steel Industry?](#)," *Global Efficiency Intelligence* (November 2019), 20.

These trends follow output patterns in major carbon-intensive industrial products such as cement and steel. Production of both items fell amidst slowing economic growth in the mid-2010s, but steel rebounded in the late 2010s amidst renewed infrastructure spending.²¹

Figure 11-5: Chinese CO₂ Emissions from Major Industrial Sources (1997-2019)



Source: Guan et al. (2021); Shan et al. (2020); Shan et al. (2018)²²

Manufacturing emissions' share of national emissions likewise grew from the early 2000s but flattened out from the late 2000s and began declining around the early 2010s (Figure 11-6). This trend reflects energy efficiency gains as well as structural shifts in the Chinese economy towards consumption-driven sectors such as services and household use.²³ Service-sector

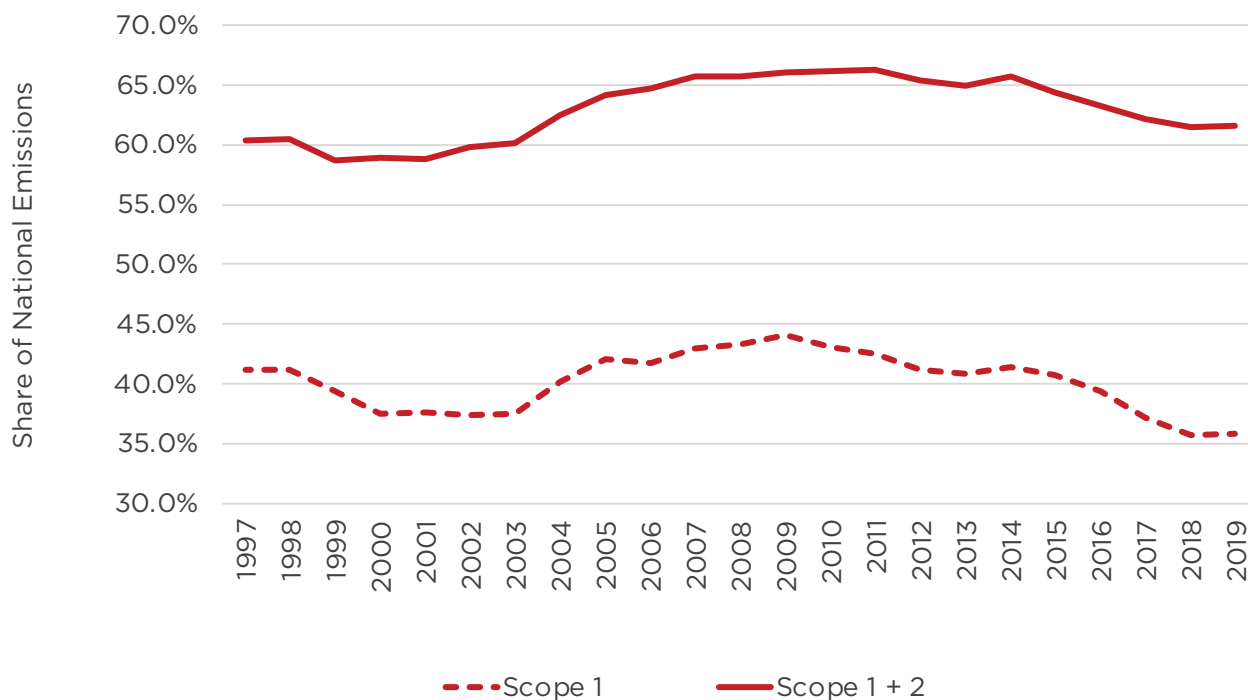
21 Edmund Downie, "[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges.](#)" Columbia University SIPA Center of Global Energy Policy (August 25, 2021) 38-39. The trends in CEADs data in 2014-19 align with those from the Climate Watch (CAIT) dataset, which records China's Scope 1 emissions from energy use in manufacturing and construction and industrial processes. CAIT records a 2014 peak in CO₂ emissions in these sectors at 3.86 Gt, with a decline through 2017 and a modest rebound in 2018-19 to 3.60 Gt. World Resources Institute, [Historical GHG Emissions](#), Climate Analysis Indicators data set, Climate Watch platform (2021).

22 Yuru Guan et al., "[Assessment to China's Recent Emission Pattern Shifts.](#)" *Earth's Future*, 9, No. 11 (2021): e2021EF002241; Yuli Shan et al., "[China CO₂ Emission Accounts 2016-2017.](#)" *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., "[China CO₂ Emission Accounts 1997-2015.](#)" *Scientific Data* 5, No. 1 (January 16, 2018): 170201.

23 International Energy Agency, "[E4 Country Profile: Energy Efficiency in China.](#)" IEA (February 12, 2021).

emissions (Scope 1 and Scope 2) in 2019 were just 16.3% of national emissions, a quarter of the manufacturing sector. But service-sector emissions growth has exceeded the manufacturing sector every year from 2010 to 2019, the most recent year in the CEADs inventory.

Figure 11-6: Chinese CO₂ Emissions from Major Industrial Sources as a Share of National Emissions (1997-2019)



Source: Guan et al. (2021); Shan et al. (2020); Shan et al. (2018)²⁴

Economic policy in the COVID era has driven some of China's largest emissions swings in the past decade. Analysis from the Center for Research on Clean Air and Energy finds year-on-year drops in quarterly national emissions up to 5% during early 2020 and 2022. Between these declines, however, was a surge in emissions, reaching as high as a 15% year-on-year increase in Q1 2021 emissions. These swings largely tracked industrial output. COVID lockdowns in early 2020 and 2022 curtailed manufacturing activity, while tightening policy in the real estate and steel sectors reduced cement and steel production. The 2021 spike,

24 Yuru Guan et al., "Assessment to China's Recent Emission Pattern Shifts," *Earth's Future*, 9, No. 11 (2021): e2021EF002241; Yuli Shan et al., "China CO₂ Emission Accounts 2016-2017," *Scientific Data* 7, No. 1 (February 13, 2020): 54; Yuli Shan et al., "China CO₂ Emission Accounts 1997-2015," *Scientific Data* 5, No. 1 (January 16, 2018): 170201.

meanwhile, reflected a post-COVID infrastructure stimulus.²⁵

China has been the world's largest source of manufacturing emissions for several decades now. Estimates for 2019 by the World Resources Institute suggest that China accounts for 43% of global Scope 1 emissions from industrial processes and from energy usage in manufacturing and construction. Chinese emissions from these sources have exceeded any other country since at least 1990, when their estimates begin. But the gap between China and the rest of the world has grown enormously since then. Chinese emissions exceeded US emissions from these sources by around 10% in 1990; in 2019, they were around six times those of the US and 5.5 times those of India.²⁶

D. Policy

China's major policy statements around emissions of greenhouse gases over the past fifteen years have often included some treatment of the manufacturing sector's carbon footprint. These plans have linked carbon emissions reduction to other policy priorities including energy efficiency, local air pollution and industrial upgrading, with a supporting role for low-carbon technology development and the control of emissions of non-CO₂ heat-trapping gases such as N₂O and F-gases.²⁷ These priorities have been captured in a succession of targets for reducing the energy intensity and carbon intensity of industrial value added, issued often in more general plans for the sector. For instance, the *Made in China 2025* plan, issued by the State Council in May 2015, targeted a 40% reduction in the carbon intensity of industrial value added by 2025 compared to 2005 levels.²⁸

Policy documents released in 2021–22 outline China's updated manufacturing emissions policy priorities since Xi Jinping's pledge in 2020 to achieve an emissions peak by 2030 and carbon neutrality by 2060. China's updated Nationally Determined Contribution (NDC), submitted in October 2021, included "a green and low-carbon transformation of the industrial sector" as one of the new measures to implement its 30–60 goals. At a high level, it called for the implementation of peaking plans in high-emitting sectors including iron and steel, non-

25 Lauri Myllyvirta, "[Analysis: Surge in China's Steel Production Helps to Fuel Record-High CO₂ Emissions](#)," CarbonBrief (December 3, 2020); Lauri Myllyvirta, "[Analysis: China's Post-Lockdown Emissions Surge Shows Signs of Cooling](#)," CarbonBrief (August 13, 2021); Lauri Myllyvirta, "[Analysis: China's CO₂ Emissions See First Quarterly Fall since Post-Lockdown Surge](#)," CarbonBrief (November 25, 2021); Lauri Myllyvirta, "[Analysis: China's CO₂ Emissions See Longest Sustained Drop in a Decade](#)," CarbonBrief (May 30, 2022).

26 World Resources Institute, [Historical GHG Emissions](#), Climate Analysis Indicators data set, Climate Watch platform (2021).

27 See e.g., Ministry of Ecology and Environment, "[China's Policies and Actions for Addressing Climate Change \(2019\)](#)," (November 2019), 3,8; The People's Republic of China, "[Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions](#)," (in Chinese) (September 3, 2016), 8–9; Ministry of Industry and Information Technology et al., "[工业领域应对气候变化行动方案（2012年-2020年） \[Action Plan for Confronting Climate Change in Industry \(2012-20\)\]](#)," (in Chinese) (December 31, 2012); National Development and Reform Commission, "[国家应对气候变化规划（2014-2020年） \[National Plan for Confronting Climate Change \(2012-2020\)\]](#)," (in Chinese) (September 2014). See also Edmund Downie, "[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations are Responding to National Decarbonization Pledges](#)," Columbia University SIPA Center on Global Energy Policy (August 25, 2021) 19–24.

28 State Council, "[国务院关于印发《中国制造2025》的通知 \[Notification from the State Council on the Publication of 'Made in China 2025'\]](#)," (in Chinese) (May 8, 2015). The People's Republic of China, "China's Achievements, New Goals and New Measures for Nationally Determined Contributions," (June 2022), 35.

ferrous metals, petrochemicals and chemicals, and building materials, as well as industrial restructuring targets “guided by the principle of energy conservation and carbon reduction.” More specific themes discussed included overcapacity control, expanded “clean and low-carbon energy” use, and adoption of circular economy and low-carbon technologies.²⁹

The NDC, as an outward-facing commitment, reflects policy priorities developed through China’s domestic-facing policy apparatus. An important summary of these priorities, at least in the short term, is the *Implementation Plan for Carbon Peaking in Industry*, released in summer 2022 by the Ministry of Industry and Information Technology (MIIT), the National Development and Reform Commission (NDRC), and the Ministry of Ecology and Environment (MEE).³⁰ This plan, which covers the manufacturing sector, is one of a series of emissions peaking action plans already released or under development for different sectors and regions.³¹ As with many Chinese policy plans, it covers a sprawling range of topics. Key priorities and targets include:

- **Priorities:** the Plan indicates that energy efficiency and industrial upgrading remain the key focus areas for peaking, with technological innovation more important for post-peaking emissions reductions.
 - Priority areas for industrial upgrading include controlling capacity additions and eliminating inefficient excess capacity growth (“resolutely restricting the blind development of energy-intensive, emissions-intensive, low-quality projects”). These are long-standing priorities in heavy industry but have been challenging. Installed steel capacity as of 2019–20, for instance, exceeded policy targets by roughly 20% (200mt).³²
 - Other action items include (i) promoting electrification, (ii) aligning industrial siting with the needs of low-carbon production, and (iii) advancing research, deployment and demonstration projects on low-carbon technologies.³³

29 The People’s Republic of China, “[China’s Achievements, New Goals and New Measures for Nationally Determined Contributions](#),” (June 2022), 35.

30 Ministry of Industry and Information Technology, National Development and Reform Commission, and Ministry of Ecology and Environment, “[三部委关于印发工业领域碳达峰实施方案的通知 \(Notification from Three Ministries Regarding Publication of Implementation Plan for Carbon Peaking in Industry\)](#),” (in Chinese) (July 7, 2022).

31 Fan Danting and Dimitri De Boer, “[How Is Progress in China’s 1+N Policy Framework?](#),” China Council for International Cooperation on Environment and Development (March 11, 2022).

32 Edmund Downie, “[Getting to 30-60: How China’s Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges](#),” Columbia University SIPA Center on Global Energy Policy (August 25, 2021), 40; Lauri Myllyvirta, “[Analysis: Surge in China’s Steel Production Helps to Fuel Record-High CO₂ Emissions](#),” CarbonBrief (December 3, 2020). On overcapacity in other sectors, see International Energy Agency, “[An Energy Sector Roadmap to Carbon Neutrality in China](#),” (September 2021) 103; Bruce Wang, Jie Gong and Haipeng Li, “[Can Cement Industry ‘Cooperation’ Ensure Long-Term Stability?](#),” Hong Kong: Huatai Research (August 15, 2019), 25–28.

33 Ministry of Industry and Information Technology, National Development and Reform Commission, and Ministry of Ecology and Environment, “[三部委关于印发工业领域碳达峰实施方案的通知 \(Notification from Three Ministries Regarding Publication of Implementation Plan for Carbon Peaking in Industry\)](#),” 3–5.

- **Targets:**

- Peaking emissions in the industrial sector by 2030.
- Reducing the energy intensity of industrial value added by 13.5%, equal to the national goal for reducing energy intensity of GDP.
- Securing a decline in carbon emissions intensity of industrial value beyond the national decline in emissions intensity, targeted at 18% for the same period.³⁴

The Chinese government uses Five-Year Plans (FYPs) to indicate economic priorities at national, regional and sectoral levels. The current planning cycle (2021–25) features several plans relevant to industrial emissions.

The *14th Five-Year Plan Outline*, covering 2021–25, is China’s most important economic policy document, presenting the country’s overall priorities and targets for the period. It is drafted by the State Council, China’s top administrative authority, under guidance from top leadership in the CCP Central Committee.³⁵ It specifies broad priorities for the manufacturing sector, emphasizing industrial upgrading in service of the long-standing national goal of becoming a “strong manufacturing nation”.³⁶ Measures towards this end include controlling inefficient excess production and strengthening energy efficiency and other environmental performance indicators in coal use.³⁷ It also calls out hydrogen, a key input for industrial decarbonization, as one of seven “areas for cutting-edge technological and industrial transformations.” The other areas listed—including artificial intelligence and deep-sea and space exploration—underscore hydrogen’s standing in national innovation agendas.³⁸

Sectoral or issue-specific FYPs provide targets and more detailed priorities for the manufacturing sector. The *14th Five-Year Plan for Raw Materials*, released by the Ministry of Industry and Information Technology, the Ministry of Science and Technology, and the Ministry of Natural Resources, specifically covers iron and steel, building materials, petrochemicals and

34 Ministry of Industry and Information Technology, National Development and Reform Commission, and Ministry of Ecology and Environment, “[三部委关于印发工业领域碳达峰实施方案的通知 \(Notification from Three Ministries Regarding Publication of Implementation Plan for Carbon Peaking in Industry\)](#),” 3. National targets are taken from People’s Republic of China, “[Outline of 14th Five-Year Plan and Long-Term 2035 Goals for the Economic and Social Development of the People’s Republic of China](#)” (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要) (March 12, 2021) (accessed May 11, 2021), 10.

35 Xinhua, “[China Focus: China’s Five-Year Plan: A Democratic Perspective](#),” (March 11, 2021).

36 The “strong manufacturing nation” played a prominent role in the Made in China 2025 plan for industrial upgrading released in May 2015, though it was in use before then. State Council, “[国务院关于印发《中国制造2025》的通知 \[Notification from the State Council on the Publication of “Made in China 2025”\]](#)”; Ministry of Industry and Information Technology, “[制造强国战略揭开新篇章 \[Revealing a New Chapter in the Strategy for a Strong Manufacturing Nation\]](#),” (in Chinese) (February 3, 2015).

37 People’s Republic of China, “[Outline of 14th Five-Year Plan and Long-Term 2035 Goals for the Economic and Social Development of the People’s Republic of China](#),” (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要) (in Chinese) (March 12, 2021) (accessed May 11, 2021) 95.

38 People’s Republic of China, “[Outline of 14th Five-Year Plan and Long-Term 2035 Goals for the Economic and Social Development of the People’s Republic of China](#)” (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要) (in Chinese) (March 12, 2021) (accessed May 11, 2021) 24.

chemicals, and non-ferrous metals--the most carbon-intensive sectors in manufacturing.³⁹ Another relevant plan is the MIIT's *14th Five-Year Plan for Green Development in Industry*.⁴⁰ Both were released in late 2021.

- **Priorities:** many of the relevant issues discussed in other plans reviewed above-- industrial upgrading, overcapacity, energy efficiency, technology development--are discussed in greater detail in these plans.
 - On industrial clustering, for instance, the Raw Materials plan discusses “advancing” a range of specific aims: shifting aluminum facilities to locations with plentiful hydropower or wind resources, siting electric arc furnaces near cities to access scrap steel, and better integrating chemicals manufacturing with green hydrogen production.⁴¹
 - On low-carbon manufacturing technology, the plans call out a wide range of technologies for R&D, pilot projects or further promotion. These include pre-commercial hydrogen applications in steel and cement and carbon capture and utilization in cement and chemicals, as well as mature technologies such as waste-derived fuel in cement kilns.⁴²
- **Targets:** major targets include:
 - Declines in energy intensity of 2% in cement and 3.7% in steel by 2025. (The plan reports a 4.7% decline in steel energy intensity among large and medium-sized firms in 2016–20.)⁴³
 - A 5% decline in carbon emissions from electrolytic aluminum by 2025, the biggest energy-consuming sector within non-ferrous metals.⁴⁴
 - An increase in recycled steel usage in iron supply from 260mt in 2020 to 320mt by 2025, as well as an increase in recycled metals in non-ferrous metals supply from 14.3mt to 20mt (Green Development plan); a 30% share for recycled steel

39 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” (December 29, 2021).

40 Ministry of Industry and Information Technology, “工业和信息化部关于印发《‘十四五’ 工业绿色发展规划》的通知 [Notification from the Ministry of Industry and Information Technology on the Publication of the 14th Five-Year Plan for Green Development in Industry],” (in Chinese) (November 15, 2021).

41 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 13–14.

42 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 16–17; Ministry of Industry and Information Technology, “工业和信息化部关于印发《‘十四五’ 工业绿色发展规划》的通知 [Notification from the Ministry of Industry and Information Technology on the Publication of the 14th Five-Year Plan for Green Development in Industry],” 5–6.

43 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 2, 5–6.

44 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 5–6.

supply in total steel output and a 35% share for recycled copper, up from 25% and 32.5% today (Raw Materials plan).⁴⁵ (The absolute volume targets were initially announced by the NDRC's 14th Five-Year Plan on Circular Economy Development in summer 2021.⁴⁶)

The 14th FYP Outline supports industries “with the right conditions” to pursue emissions peaking earlier than the pre-2030 national target.⁴⁷ As of mid-2022, official government plans for the high-emitting industrial sectors discussed in this paper did not include any such early-peaking targets, though no specific peaking plans have been released beyond the industry action plan cited above.⁴⁸ That said, the absence of stricter targets does not preclude early peaking, especially in sectors such as cement and steel with slowing output growth.⁴⁹ Indeed, some industrial associations tied to these sectors have suggested earlier targets. The building materials association in early 2021 announced a goal of sector-wide peaking by 2025 and cement peaking by 2023, while the association for the coking coal industry--a carbon-intensive input for the production of steel and other industrial products--has announced a

45 Targets are taken from the Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 22-23; Ministry of Industry and Information Technology, “工业和信息化部关于印发《‘十四五’ 工业绿色发展规划》的通知 [Notification from the Ministry of Industry and Information Technology on the Publication of the 14th Five-Year Plan for Green Development in Industry],” 12. The Raw Materials plan also targets a 20% share of recycled aluminum, but China has already achieved this share as of 2020. Baseline absolute volumes are calculated based upon 2020 crude steel (粗钢), refined copper (精炼铜), and primary aluminum (原铝 (电解铝)) output from the National Bureau of Statistics. National Bureau of Statistics, [indicator 工业产品总量 “Industrial Product Output” \(under 年度数据 Annual Data / 工业 Industry\)](#), (accessed August 24, 2022). Baseline shares are taken from the NDRC's 14th Five-Year Plan for Circular Economy Development. National Development and Reform Commission, “关于印发 ‘十四五’ 循环经济发展规划的通知 [Notification Regarding the Publication of the 14th Five-Year Plan for Circular Economy Development],” (in Chinese) (July 1, 2021) 1-2.

46 National Development and Reform Commission, “关于印发 ‘十四五’ 循环经济发展规划的通知 [Notification Regarding the Publication of the 14th Five-Year Plan for Circular Economy Development],” 4-5.

47 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五” 原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 16; People's Republic of China, “[Outline of 14th Five-Year Plan and Long-Term 2035 Goals for the Economic and Social Development of the People's Republic of China](#)” (中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要) (in Chinese) (March 12, 2021) (accessed May 11, 2021) 93.

48 For steel, media reports suggest that a draft Action Plan for Peaking and Reducing Emissions in the Iron and Steel Industry had been prepared as of April 2021, with targets of peaking by 2025 and reducing emissions 30% from peak levels by 2030. A final plan had not been released as of August 2022, and its status is unclear from public documents. A high-level document on overall development in steel, the Guiding Opinions on Accelerating the High-Quality Development of the Iron and Steel Sector, spoke of ensuring that the sector peaked emissions by 2030. But China Coking Coal Industry's Action Plan for the Coking Coal Industry on Carbon Peaking and Carbon Neutrality explicitly cites the steel industry's action plan as targeting a 2025 peak. Liang Qian (梁倩), “[钢铁行业碳达峰及降碳行动方案成型 \[Steel Industry Carbon Emissions Peaking and Reduction Action Plan Takes Shape\]](#),” Economic Information Daily (经济参考报) (in Chinese) (March 30, 2021) (accessed August 14, 2022); Ministry of Industry and Information Technology, National Development and Reform Commission, and Ministry of Ecology and Environment, “[三部委关于促进钢铁工业高质量发展的指导意见 \(Guiding Opinions from Three Ministries on Accelerating the High-Quality Development of the Iron and Steel Industry\)](#),” (in Chinese) (January 20, 2022); China Coking Coal Industry Association, “[焦化行业碳达峰碳中和行动方案 \[Action Plan for the Coking Coal Industry on Carbon Peaking and Carbon Neutrality\]](#),” (in Chinese) (August 3, 2022) 5.

49 “China Cement Association Vice Chair Li Shen told reporters in January 2021 that ‘clinker production volume is the biggest factor influencing the cement industry’s carbon emissions’ and projected that the production peak expected during the 14th FYP would secure an emissions peak.” Edmund Downie, “[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges](#),” Columbia University SIPA Center on Global Energy Policy (August 25, 2021), 38-40.

2025 peaking target.⁵⁰ Companies have been generally more hesitant to issue targets, though the steel sector's largest three state-owned enterprises, with capacity equal to 21% of 2022 production, have announced peaking targets for 2022–25.⁵¹

Emissions control in these sectors can also benefit from other trends that reduce the carbon intensity of output. For instance:

- **Steel:** capacity restriction policies in steel seek to incentivize installations of electric arc furnaces (EAFs) and other plant types that help reduce air pollution and carbon emissions footprints. Data from the Center for Research on Clean Air and Energy finds that the share of EAFs in capacity additions grew from 12.9% in 2019 to 38.9% in 2021.⁵² *The Guiding Opinions on the High-Quality Development of the Iron and Steel Industry*, released in early 2022 by the MIIT, NDRC and MEE, targets by 2025 a 15%+ production share in crude steel for EAFs. (EAFs produced 10.6% of national output in 2021.⁵³)
- **Aluminum:** the *Implementation Plan for Coordinating Increases in Efficiency to Reduce Pollution and Carbon Emissions*, released by the MEE, NDRC, MIIT and four other ministries, targets a 30% share in 2025 for renewables in power usage by electrolytic aluminum smelters. These smelters account for 6% of national power consumption. The 2021 renewables share in their power mix was 22%, up from just 12% in 2018. These gains largely reflected the relocation of smelters in northern China with captive coal power plants to parts of southwest China with plentiful hydropower.⁵⁴
 - The NDRC has also introduced pricing surcharges for less efficient smelters.⁵⁵ (China's aluminum smelters are already more efficient than global averages, and even smelters with 4% higher efficiency above the world average will be

50 China Building Materials Federation, “[推进建筑材料行业碳达峰、碳中和行动倡议书 \[Action Declaration for Advancing Carbon Peaking and Carbon Neutrality in Building Materials\]](#),” (in Chinese) (accessed August 13, 2022); China Coking Coal Industry Association, “[焦化行业碳达峰碳中和行动方案 \[Action Plan for the Coking Coal Industry on Carbon Peaking and Carbon Neutrality\]](#),” 5.

51 For cement and steel company targets, see Edmund Downie, “[Getting to 30-60: How China's Biggest Coal Power, Cement, and Steel Corporations Are Responding to National Decarbonization Pledges](#),” Columbia University SIPA Center on Global Energy Policy (August 25, 2021) 27-28. The three largest SOEs by production as of 2021 were Baowu (119.95mt), Ansteel (55.65mt) and HBIS (41.64mt); total Chinese production was 1032.8mt. See World Steel Association, “[World Steel in Figures 2022](#),” 7.

52 Center for Research on Energy and Clean Air, “[Most Coal Power Plants since 2016 Entered Construction in China in 2021, Investment in Coal-Based Steelmaking Accelerated](#),” (February 2022), 11.

53 World Steel Association, “[World Steel in Figures 2022](#),” 10.

54 Electrolytic aluminum's share of 2020 power consumption is estimated based upon national power consumption by Chinese primary aluminum smelters reported by the International Aluminum Institute (520TWh) as against China's 2020 national power consumption of around 7500TWh; National Bureau of Statistics, [indicator 分行业能源消费总量 “Total Energy Consumption by Sector” \(under 年度数据 Annual Data / 能源 Energy\)](#), (accessed August 14, 2022). For plant relocations, see e.g. “[China Hongqiao to Move Aluminium Smelting Capacity to Yunnan Province](#),” Reuters, (December 28, 2021), Zheng Xin and Li Yingqing, “[Weiqiao's Relocated Aluminum Smelter Starts Operations in Yunnan Province](#),” China Daily (accessed August 24, 2022).

55 National Development and Reform Commission, “[国家发展改革委关于完善电解铝行业阶梯电价政策的通知 \[NDRC Notification on Improving Tiered Pricing Policies in the Electrolytic Aluminum Industry\]](#),” (in Chinese) (August 26, 2021).

penalized under this policy.⁵⁶) These measures are part of a series of mechanisms in power pricing reforms since 2021 that expose coal-intensive industries to higher electricity prices.⁵⁷

On the other hand, ministries have cautioned against overly aggressive application of carbon and energy efficiency targets. The NDRC, MIIT, MEE and two other agencies in October 2021 released *Certain Opinions on Rigorously Enforcing Energy Efficiency Restrictions and Advancing Energy Conservation and Carbon Reduction in Major Industries* clarifying the import of the 30–60 goals for industrial energy efficiency work. This directive included a warning against economic and social disruptions from “one-size-fits-all” management and “campaign-style carbon reduction.”⁵⁸

Carbon neutrality in manufacturing will require the introduction of technologies with limited deployment today, including hydrogen-based iron reduction in steel manufacturing, carbon capture in the cement industry, and CO₂ capture and utilization in methanol production. Chinese firms have announced or completed a range of demonstration projects in these areas.⁵⁹ But policymakers have publicly recognized the challenges in reaching carbon neutrality in manufacturing. The 14th FYP on Raw Materials speaks frankly on “hard tasks of carbon peaking and neutrality” among factors that make “green and safe development increasingly urgent.” Its treatment of bottlenecks and weaknesses in these sectors cites deficits in technological and resource self-sufficiency (among other concerns) and notes that, “for green and low-carbon development, the task is heavy and the road is long.”⁶⁰ Progress globally on this road requires progress in China.

56 China’s policy applies surcharges for units with efficiency of 13,650kWh/t or higher. The world average efficiency for aluminum smelters in 2021 was 14,114kWh/t. National Development and Reform Commission, “国家发展改革委关于完善电解铝行业阶梯电价政策的通知 [NDRC Notification on Improving Tiered Pricing Policies in the Electrolytic Aluminum Industry]”; International Aluminium Institute, “[Primary Aluminium Smelting Energy Intensity](#),” (August 9, 2022).

57 National Development and Reform Commission, “[关于进一步深化燃煤发电上网电价市场化改革的通知\(发改价格〔2021〕1439号\)](#) [Notification on Further Deepening Marketization Reforms in On-Grid Pricing on Coal Power (NDRC Pricing No. 1439 (2021))],” (in Chinese) (October 11, 2021).

58 National Development and Reform Commission et al., “[关于严格能效约束推动重点领域节能降碳的若干意见\(发改产业〔2021〕1464号\)](#) [Certain Opinions on Rigorously Enforcing Energy Efficiency Restrictions and Advancing Energy Conservation and Carbon Reduction in Major Industries (NDRC Industry 2021, No. 1464)],” (in Chinese) (October 18, 2021).

59 International Energy Agency, “[An Energy Sector Roadmap to Carbon Neutrality in China](#),” (September 2021) 105–6.

60 Ministry of Industry and Information Technology, Ministry of Science and Technology, and Ministry of Natural Resources, ““十四五”原材料工业发展规划 (14th Five-Year Plan for the Development of the Raw Materials Industry),” 2–3.

CHAPTER 12 - NATURAL GAS

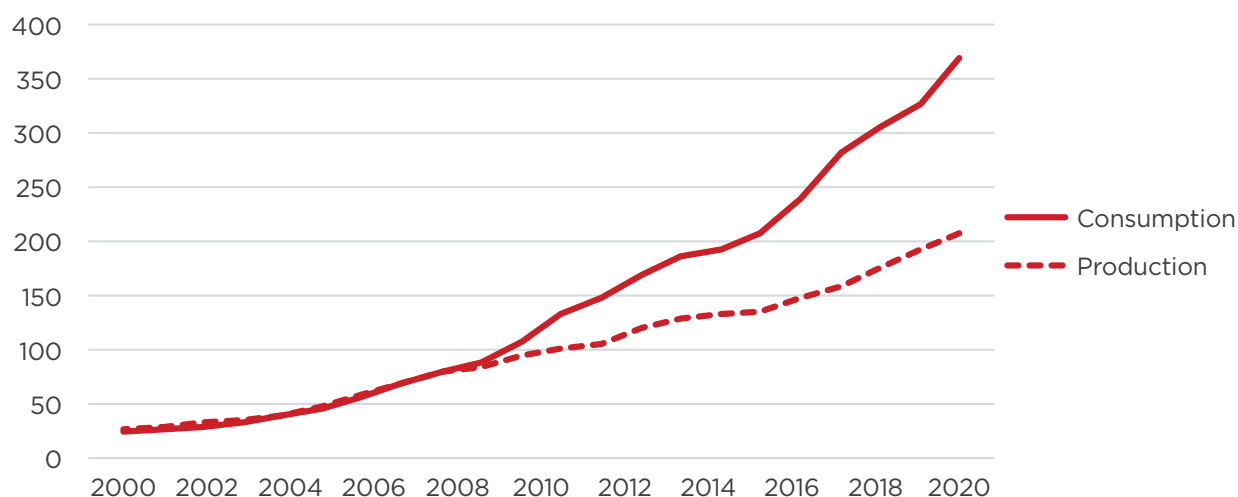
In 2021, China was the world's third largest consumer of natural gas, behind the United States and Russia. Natural gas accounted for 8.6% of China's primary energy use—a much smaller share than the global average of almost 25%. Approximately 6.5% of China's energy-related CO₂ emissions came from natural gas.¹

China's central government and its state-owned oil and gas companies support the development of China's domestic natural gas resources.² The conversion of coal heating to natural gas is an important part of the government's strategy for reducing local air pollution in northern China. Natural gas has potential climate benefits if it substitutes for coal and methane emissions are controlled.

Background

Natural gas use in China has grown significantly in recent years. During the 13th Five-Year Plan (FYP) (2015–2020), China's natural gas use grew by 70%. In 2020, despite the COVID-19 pandemic, natural gas consumption in China grew by 6.9% (three times GDP growth) to reach 328 bcm.³ In 2021, gas use grew by 12.6% (almost double GDP growth) to reach 372.6 bcm.⁴

Figure 12-1: China's Gas Consumption and Production (2000-2020)



Source: National Bureau of Statistics⁵

1 [BP Statistical Review of World Energy](#) (June 2022) at pp.9, 31; [Global Carbon Project, Global Carbon Budget 2021-Presentation](#) (November 2021) at Slide 28. See also NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) 十四五现代能源体系规划, (March 2022) (in Chinese) at p. 5, Box 1 (natural gas = 8.4% of Chinese primary energy consumption in 2020).

2 See NDRC, [Action Plan for Carbon Dioxide Peaking Before 2030](#) (October 27, 2021) at III(1)(e).

3 NEA, [China's Natural Gas Development Report 2021](#), 中国天然气发展报告 2021 at p. 5.

4 NDRC, [“2021 Natural Gas Profile”](#) (February 10, 2021). According to the [Natural Gas Development Report 2022](#) (中国天然气发展报告 2022), demand in 2021 reached 369 bcm, p.3.

5 [National Bureau of Statistics](#)

Natural gas is used for many purposes in China. In 2020, the principal uses were for industry (46-47% of total consumption), city gas including residential and transport use (37-38%) and power generation (16%).⁶

The Chinese government promotes natural gas consumption as a means of displacing dispersed coal in industrial, commercial and residential use.⁷ But the availability and cost of gas have been limiting factors. In 2017-2018, when the government-mandated coal-to-gas switch in northern China led to price spikes and supply shortfalls,⁸ the government amended the policy guidance to allow switching from dispersed coal to coal-powered electric stoves. Coal-to-electricity was also permitted, provided that this eliminated small industrial coal-fired steam boilers. The main policy priority was to reduce pollution from fine particulate matter (PM2.5), not carbon emissions.⁹

Gas plays a small role in China's power sector, accounting for roughly 6% of installed capacity.¹⁰ This is a much smaller share than in the EU or the US, where gas represents over a third of gas in power, but a 72% increase since 2015.¹¹ While expensive imported gas, costly turbine technology and the lack of fully competitive electricity and carbon markets in China have limited the role of gas in China's power sector, its use is set to increase in the coming years due to the growing need for power system flexibility and government's aim to limit the use of coal in the power sector.

China's natural gas comes from three sources: domestic production, pipeline imports and imports of liquefied natural gas (LNG).

6 NEA, [China's Natural Gas Development Report](#) 2021, 中国天然气发展报告 2021, p. 5.

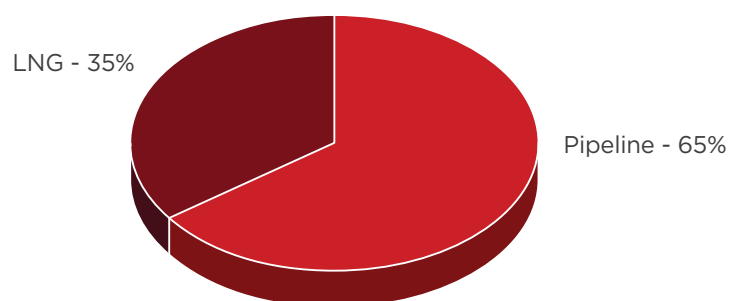
7 "Dispersed coal" (散煤) refers to raw coal burned in non-centralized combustion facilities. These facilities typically lack end-of-pipe air pollutant treatment and have high ash residue.

8 [BP Statistical Review of World Energy](#) (June 2019) at p.32; IEA, [The Role of Gas in Today's Energy Transitions](#) (2019) at p.14; NDRC, [Natural Gas 13th Five-Year Development Plan](#) (December 2016) at p.3 (in Chinese); Lucy Hornby and Archie Zhang, ["China hit by gas shortages as it moves away from coal,"](#) Financial Times (December 3, 2017); IEA and Tsinghua University, [District Energy Systems in China](#) (2017).

9 See Akira Miyamoto, Chikako Ishiguro, [The Outlook for Natural Gas and LNG in China in the War against Air Pollution](#), OIES Paper NG 139, December 2018.

10 Yan Qin, [Natural gas in China's power sector: Challenges and the road ahead](#), OIES Energy Insight 80, December 2020.

11 NEA, China's [Natural Gas Development Report](#) 2021, 中国天然气发展报告 2021, p. 10.

Figure 12-2: China's Gas Imports by Category (2021)

Source: General Administration of Customs¹²

- Historically, most of China's natural gas has come from domestic production, mainly from conventional wells. In 2020, domestic production reached 192.5 bcm, just shy of the 13th Five-Year Plan target of 207 bcm.¹³ At the end of 2021, according to China's National Bureau of Statistics, domestic output grew further to reach 205 bcm, rising year over year by 8.2%.¹⁴ In the 13th FYP, domestic output rose by close to 60 bcm, from 135 bcm. In the 14th FYP, China is aiming for a more modest increase in domestic production, reaching 230 bcm by 2025.
 - China has substantial proven reserves of shale gas but much of it is very deep, in mountainous areas and challenging to produce. Shale gas production in 2020 reached 20 bcm, a large 32% year-over-year increase, and a sharp rise from the 4.5 bcm produced in 2015,¹⁵ although this was still short of the government's targeted 30 bcm by 2020.¹⁶
 - At the same time, China produced 6.7 bcm of coal-bed methane¹⁷ in 2020, falling short of the 13th FYP target of 10 bcm, and 4.7 bcm of synthetic gas (syngas). While the production of gas from coal seams helps China in its quest to produce more gas domestically and mitigate its reliance on imported sources, coal-bed methane and syngas create environmental challenges, with syngas in particular

¹² General Administration of Customs, [Table of major imported commodities in December 2021](#) (RMB value) 2021年12月进口主要商品量值表 (人民币值) (January 2022).

¹³ NDRC and NEA, [13th Five Year Plan for Natural Gas Development](#) (2016) at p. 11.

¹⁴ [China's energy production situation in December 2021](#) (January 17, 2022), National Bureau of Statistics, (in Chinese)

¹⁵ Oceana Zhou, Cindy Liang, "[Analysis: China to miss 2020 shale gas production targets amid tough upstream conditions.](#)" S&P Global, (April 30, 2019).

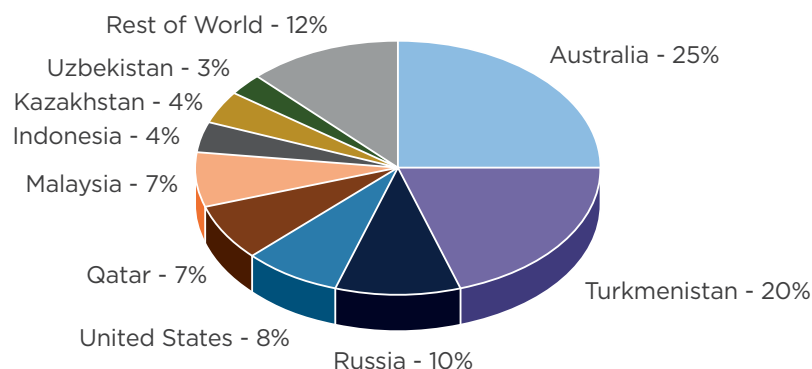
¹⁶ NDRC and NEA, [13th Five Year Plan for Natural Gas Development](#) (2016) at p. 13.

¹⁷ Coal-bed methane is regarded as an unconventional source of gas as the methane is held within a low porosity rock formation. Wells are drilled into the coal seam; the gas is then collected on the surface and can be combusted to generate electricity or processed for injection into the main gas grid. CBM production typically requires more wells than conventional gas fields.

increasing CO₂ emissions.¹⁸

- China currently imports natural gas through three pipeline systems: the Central Asia gas pipeline system (from Turkmenistan, Kazakhstan and Uzbekistan), with a capacity of 55 bcm and the China-Myanmar pipeline, which has 12 bcm capacity. In December 2019, the Power of Siberia pipeline from Russia began operating. The pipeline is designed to deliver 38 bcm to China and is expected to reach full capacity in 2024–2025 as the infrastructure to expand deliveries within China is being added and Russia increases production at the fields supplying the pipeline. Total pipeline imports in 2020 reached 47.7 bcm,¹⁹ representing a 15.7 bcm increase over the course of the 13th FYP, from 32 bcm in 2015. In 2021, however, pipeline imports reached 59 bcm and with higher volumes expected through the Power of Siberia, they may temper the growth in LNG imports.
- In 2020, Chinese LNG imports reached 89 bcm, surging from 25 bcm in 2015. Much of the demand increase was due to coal-to-gas switching. The strong growth in demand, combined with efforts to liberalize the market and allow more non-state players to import gas, led to a large increase in LNG import terminals. In 2021, China had an estimated 90 Mtpa of LNG import terminal capacity. The country more than doubled its LNG terminal capacity over the course of the 13th FYP²⁰ and is set to add as much as 100 Mtpa by 2025.²¹ China also continues to add domestic pipeline capacity.

Figure 12-3: China's 2021 Natural Gas Imports by Country



Source: General Administration of Customs accessed via Argus

¹⁸ Yue Qin et al., "[Air quality, health, and climate implications of China's synthetic natural gas development](#)," PNAS, Vol. 114, No. 19, (April 24, 2017).

¹⁹ NEA, [China's Natural Gas Development Report 2021](#), 中国天然气发展报告 2021, p. 4.

²⁰ NEA, [China's Natural Gas Development Report 2021](#), 中国天然气发展报告 2021, p. 9.

²¹ Michal Meidan, "After the energy crisis, a dash for gas?," [Oxford Energy Forum 131, The 2021 energy crisis: Implications for China's energy market and policies](#), March 2022.

Production and Consumption Goals

Government policy documents focus on ensuring supply security and operational flexibility in the domestic gas markets.

- The *14th FYP* includes a target for domestic production to reach 230 bcm and, more broadly, highlights efforts to increase domestic reserves and output of both conventional and unconventional gas sources.
- The *14th FYP* also aims for gas storage to reach 55–60 bcm, or 13% of total consumption (suggesting an implicit demand guidance of 430–460 bcm in 2025). The storage additions are ambitious given that in 2020 China held 14 bcm of underground storage capacity.
- The *14th FYP* discusses the need to develop the pipeline infrastructure as well as the digitization and technological upgrade of the energy sector, including the oil and gas sector.
- These operational improvements are also aimed at encouraging third-party access to the gas both upstream and downstream as the government continues to pursue market reforms.

The 14th FYP does not, however, specifically address the role of natural gas in the energy mix or in the dual carbon targets. It does not include an explicit goal for the share of gas in the energy mix, nor does it include a target for the share of gas in installed power capacity. It does, however, clearly envisage a role for gas in the power sector to help manage intermittency.²²

China's National Energy Administration's (NEA) *Natural Gas Development Report* in 2021 estimates that gas consumption will reach 550–600 bcm in 2030²³, in line with Tsinghua's University's estimates of demand reaching 580 bcm that year, or 13% of the energy mix. By 2040, however, views diverge with Tsinghua's forecast of demand falling to 340 bcm, while the State Grid's energy research unit expects 600 bcm of demand. Meanwhile, China's largest natural gas producers, the China National Petroleum Corporation (CNPC) and Sinopec, forecast that gas demand will peak in 2040 at 650 bcm and 620 bcm respectively.²⁴

Market Reforms

Historically, the National Development and Reform Commission (NDRC) set natural gas prices by adding production costs, transmission costs and fixed margins. Gas prices have been kept high for industrial users to help cover the costs of subsidizing residential gas use. In recent years, a growing percentage of Chinese nonresidential natural gas sales have been priced

²² NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) 十四五现代能源体系规划 (March 2022).

²³ NEA, [China's Natural Gas Development Report 2021](#), 中国天然气发展报告 2021, p. 19. The 2022 report does not offer a projection to 2030 and discusses only the 2022 outlook (the [Natural Gas Development Report 2022](#) (中国天然气发展报告 2022)).

²⁴ ["Unpacking CNPC's net-zero road map for China,"](#) S&P Global, (February 8, 2022); ["China's oil consumption seen peaking around 2026, Sinopec exec says,"](#) Reuters, (September 17, 2021).

based on market value. Citygate tariffs for residential users are being deregulated as well. These price reforms are intended in part to bring down the cost of natural gas for industrial users, encouraging the switch from coal to natural gas.²⁵ Given the price volatility in global markets in late 2021 and early 2022, further liberalization of prices may be stalled.

Structural changes are also underway in China's natural gas pipeline network. Historically, CNPC and Sinopec controlled most of China's long-distance natural gas pipeline network. But the creation of the China Oil & Gas Piping Network Corporation (PipeChina) in December 2019, stripped the state-owned majors of their interprovincial pipelines as well as some of their LNG receiving terminals. The creation of PipeChina, a state-owned company, was intended to provide fair and open access to pipelines, LNG import terminals and storage facilities, given the state-owned majors' reluctance to grant third-party access to the infrastructure. Ultimately, Beijing hopes that the new midstream company will further support the liberalization of both the upstream and midstream.²⁶

Investors in the upstream had struggled to market their production in the large consumer areas given the transport constraints, while private LNG suppliers could not use the country's LNG terminals. If PipeChina manages to increase transparency and optimize gas supplies in China, it could spur demand. But from a climate change perspective, as discussed above, a higher share of gas in the energy mix is conducive to China's carbon footprint only if it displaces coal and/or if the carbon is sequestered.

Environmental Standards

China does not have regulations addressing methane leaks from natural gas production, transport or use. China is a Partner Country in the Global Methane Initiative, "an international public-private partnership focused on reducing barriers to the recovery and use of methane as a clean energy source." CNPC is a member of the Oil and Gas Climate Initiative, a voluntary industry initiative working to reduce methane emissions.²⁷

In May 2021, China's Oil and Gas Methane Alliance was inaugurated. The Alliance includes seven members: the three large state-owned oil and gas companies (CNPC, Sinopec and the China National Offshore Oil Corporation (CNOOC)), as well as PipeChina, Beijing Gas, CR Gas and ENN Energy. The founding members pledged to control methane emissions across the entire industry chain. Member companies have further pledged to "strive to reduce the average methane intensity in natural gas production to below 0.25% by 2025 [...] and work to reach world-class level by 2035".²⁸

China did not sign the Global Methane Pledge, which was released in connection with COP26

25 IEA, [The Role of Gas in Today's Energy Transitions](#) (2019) at p.89; Anders Hove and David Sandalow, [Understanding China's Growing Natural Gas Sector](#), Paulson Institute (September 14, 2017).

26 Erica Downs, Sheng Yan, "[Reform Is in the Pipelines: PipeChina and the Restructuring of China's Natural Gas Market](#)," Columbia SIPA, (September 2020).

27 [Global Methane Initiative website](#) (accessed September 11, 2022); [Oil and Gas Climate Initiative website](#) (accessed September 11, 2022).

28 "[China Oil and Gas Methane Alliance was inaugurated](#)," CNPC, (May 19, 2021).

in November 2021 and has now been signed by more than 100 countries. At COP26, the Chinese government announced it would produce a national action plan to control methane emissions prior to COP27 in November 2022. The 14th FYP also seeks to “strengthen the recovery and utilization of methane in oil and gas fields”. In the US-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s, published in November 2021, the US and China committed to work together to bolster monitoring, management and research of methane emissions over the next ten years.

Climate Change Impacts

The climate change impacts of natural gas use are complicated and controversial.

- On the one hand, burning methane (the principal component of natural gas) produces roughly half the CO₂ emissions per unit of energy as burning coal. Conversion of China’s vast coal-based heating and power infrastructure to natural gas could significantly reduce Chinese CO₂ emissions.²⁹
- On the other hand, each molecule of methane has roughly 84 times the warming impact of a molecule of CO₂ over a 20-year period and roughly 28 times the warming impact of a molecule of CO₂ over a 100-year period. As a rough rule of thumb, if more than 3%–8% of natural gas leaks during production, transport or consumption that would cancel the climate change benefits of switching from coal to natural gas. There are very little data on the extent of methane leakage in China.³⁰
- In addition, new natural gas infrastructure such as pipelines and receiving terminals will likely last for decades, creating carbon lock-in and potentially slowing a move away from natural gas and toward renewables or other solutions in hard-to-abate sectors.³¹

The climate change impacts of natural gas use in China are uncertain. Natural gas in China often displaces coal, reducing CO₂ emissions as a result. (The 13th Five-Year Plan for Gas Development stated that when natural gas use in China reached 360 bcm—a level attained in 2021—CO₂ emissions from that natural gas would be 710 million tonnes fewer than CO₂ emissions from coal of the same calorific value).³² However there is little data with respect to methane leakage in China. Such leakage could partially or completely offset any climate change benefits from lower CO₂ emissions.

29 IEA, [The Role of Gas in Today’s Energy Transitions](#) (2019) at p.89.

30 Sophie Szopa and Vaishal Naik [Short-lived Climate Forcers](#), Intergovernmental Panel on Climate Change; Shindell et al., (2012). “[Simultaneously Mitigating Near-Term Climate Change and Improving Human Health and Food Security](#),” *Science*, 335, 183-189; International Energy Agency, [World Energy Outlook 2017](#) (November 2017).

31 See IEA, [The Role of Gas in Today’s Energy Transitions](#) (2019); Dave Roberts, “[More natural gas isn’t a “middle ground”—it’s a climate disaster.](#)” *Vox* (May 30, 2019); Tim Gould, “[The Environmental Case for Natural Gas.](#)” International Energy Agency (October 23, 2017).

32 NDRC and NEA, [13th Five Year Plan for Natural Gas Development](#) (2016) at p.25.

Figure 12-4: China Infrastructure Map



Source: OIES³³

33 OIES research based on IEA, “The Asian Quest for LNG in a Globalising Market”, (November 2014), p.100; Shell International and The Development Research Center, Mallika Ishwaran, William King, Martin Haigh, Taoliang Lee & Shangyou Nie “China’s Current Natural Gas Market Mechanisms and Regulatory System”, (November 2017), Argus, Company Reports,

CHAPTER 13 - HYDROGEN

China is the world's largest producer and consumer of hydrogen. Most of this hydrogen is used as a chemical feedstock. Almost all hydrogen in China today is made from coal or natural gas, releasing carbon dioxide (CO₂) to the atmosphere in the process.¹

In March 2022, the Chinese government published its first plan for long-term development of the hydrogen industry. The plan calls for greater use of hydrogen fuels and more production of low-carbon hydrogen.² More use of hydrogen fuels in China will increase CO₂ emissions unless the hydrogen comes from low-carbon sources.

Background

Hydrogen is the most abundant element in the universe. However, with rare exceptions, hydrogen occurs in nature only when bound with other elements into molecules such as CH₄ (methane) or H₂O (water). The process of separating hydrogen from those molecules can result in substantial CO₂ emissions (such as when hydrogen is stripped from coal or natural gas). The process of separating hydrogen can also result in almost no CO₂ emissions (such as when hydrogen is released from water using electricity made with renewable or nuclear power).³

Hydrogen is not a heat-trapping gas. As a result, hydrogen can play an important role in helping fight climate change.

- Hydrogen burns at high temperatures, which makes it potentially valuable as a replacement for fossil fuels in industrial processes that require high-grade heat (such as in the iron and steel, cement and chemical sectors).⁴
- Hydrogen can serve as a fuel or as a feedstock for low-carbon fuels.
- Hydrogen can store energy from electricity over long periods, helping tackle issues related to variable wind and solar power.

Yet even though hydrogen is not a heat-trapping gas, it has climate change impacts. First, the process of producing hydrogen can and usually does result in CO₂ emissions. Second, when hydrogen is released into the atmosphere, it contributes to the formation of methane and other heat-trapping gases and lengthens the residence time of those heat-trapping gases in the atmosphere.⁵

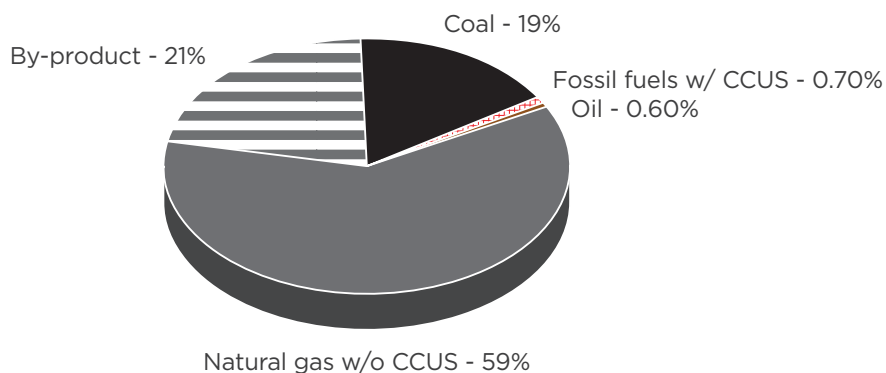
1 NDRC, 氢能产业发展中长期规划（2021-2035 年） [Medium and Long-term plan for the development of a hydrogen industry](#) (2021-2035), (March 2022).

2 NDRC, 氢能产业发展中长期规划（2021-2035 年） [Medium and Long-term plan for the development of a hydrogen industry](#) (2021-2035), (March 2022).

3 See US Department of Energy, [Hydrogen Production](#) (accessed July 22, 2022); William Lee Jolly, [Production and applications of hydrogen](#) *Britannica* (accessed July 22, 2022).

4 See David Sandalow et al., [ICEF Industrial Heat Decarbonization Roadmap](#) (2019).

5 Ilissa Ocko and Steven Hamburg, ["Climate consequences of hydrogen leakage,"](#) *Atmospheric Chemistry and Physics* (February 18, 2022).

Figure 13-1: Energy Sources for Hydrogen Production Worldwide

Source: IEA, *Global Hydrogen Review (2021)*⁶

THE HYDROGEN RAINBOW

In describing different ways of producing hydrogen, the following terms are commonly used:

- *Black or brown hydrogen—hydrogen made from coal*
- *Gray hydrogen—hydrogen made from natural gas*
- *Blue hydrogen—hydrogen made from coal or natural gas, with carbon capture and storage*
- *Green hydrogen—hydrogen made from electrolysis of water with renewable energy*
- *Pink or yellow hydrogen—hydrogen made from electrolysis of water with nuclear energy*
- *Turquoise hydrogen—hydrogen made from natural gas using pyrolysis or photocatalysis*

The hydrogen produced from all these methods is identical (a molecule with two hydrogen atoms—H₂). The only difference is in the production method.

These different production methods have very different climate change implications.

- *Black or brown hydrogen results in significant CO₂ emissions.*

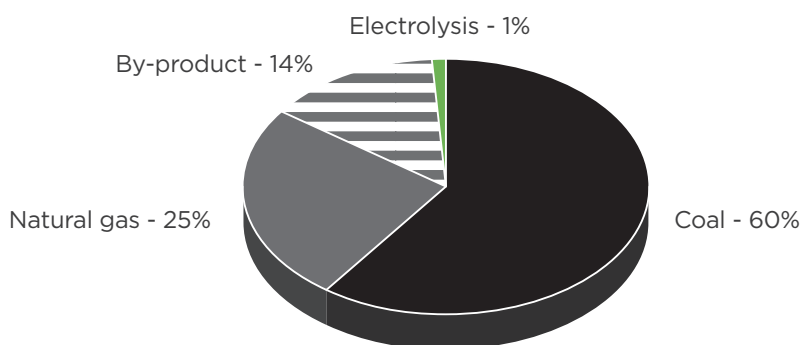
⁶ IEA, [Global Hydrogen Review 2021](#) (October 2021)

- Gray hydrogen results in significant CO₂ emissions, though less than black or brown hydrogen.
- CO₂ emissions from other kinds of hydrogen can be (but aren't always) very modest. The amount of emissions from blue hydrogen depends on factors such as the percentage of CO₂ captured and stored, for example. The amount of emissions from green hydrogen depends on factors such as the percentage of electricity that comes from renewable sources.⁷

Hydrogen can also be made from biomass feedstocks. The carbon footprint of bio-hydrogen can vary dramatically based upon feedstocks and other factors.

China is the world's largest producer of hydrogen, with an annual output estimated at 33 million tonnes (Mt)⁸. Black or brown hydrogen (from coal gasification) predominates, unlike in most other countries where gray hydrogen (from steam reformation of methane) is most common. Roughly 60% of China's hydrogen comes from coal and 25% comes from methane. Most of the remaining hydrogen is a byproduct of petrochemical industry processes. A very small percentage of China's hydrogen comes from electrolysis.⁹

Figure 13-2: Energy Sources for Hydrogen Production in China



Source: CSIS (February 2022); NDRC (March 2022)¹⁰

7 Emeka Ochu et al., [Hydrogen Fact Sheet: Production of Low-Carbon Hydrogen](#), Center on Global Energy Policy, Columbia University (June 17, 2021).

8 NDRC, 氢能产业发展中长期规划 (2021-2035 年) [Medium and Long-term plan for the development of a hydrogen industry \(2021-2035\)](#), (March 2022).

9 IEA, [Global Hydrogen Review 2021](#), (October 2021) at p.188; Kevin Tianjun Tu, "[Prospects of a hydrogen economy with Chinese characteristics](#)," Etudes de l'Ifri, IFRI, (October 2020); [Hydrogen Factsheet - China](#), International PtX Hub (60% coal, 20% natural gas).

10 Jane Nakano, "[China's Hydrogen Industrial Strategy](#)", CSIS Commentary (February 3, 2022); [National Development and Reform Commissions, "Medium- and Long-Term Plan for the Development of Hydrogen Energy Industry \(2021-2035\)"](#), 氢能产业发展中长期规划 (2021-2035 年) (March 23, 2022)

In China, hydrogen is used principally for ammonia synthesis, methanol production and petroleum refining. (In 2020, 11 Mt of hydrogen was used for ammonia synthesis, 9 Mt for methanol production and 8 Mt for petroleum refining.) Hydrogen is also used in metal smelting, electronics, pharmaceuticals and other sectors.¹¹

According to the IEA, the use of hydrogen-based fuels could avoid cumulative emissions of close to 16 Gt CO₂ in China by 2060, with the biggest reductions coming from industry, followed by shipping, aviation and road transport.¹² However for hydrogen to help mitigate climate change and contribute to decarbonization, it must be produced with low-carbon processes and leaks must be controlled.

Policies

Historical policies

Chinese hydrogen policies date to the *10th Five-Year Plan* (2001–2005), which included attention to hydrogen in the transport sector. Hydrogen fuels were seen as a potential way of reducing China’s growing oil import dependence—a source of significant strategy vulnerability due to China’s rapidly growing vehicle fleet. Hydrogen fuels were also seen as potentially helpful in curbing urban air pollution.¹³

In 2015, the Chinese government published the *Made in China 2025* initiative—a ten-year plan to upgrade China’s manufacturing industry—citing hydrogen as a key technology to develop in the energy vehicle market.¹⁴ The following year, the first *Hydrogen Fuel Cell Vehicle (FCV) Technology Roadmap* was released aiming for mass application of hydrogen in the transport sector by 2030.¹⁵

The *Hydrogen FCV Roadmap* included interim targets to have 5,000 FCVs in demonstration, alongside 100 hydrogen refueling stations by 2020, focusing on industrial clusters and demonstration-application areas in the Beijing-Tianjin-Hebei area, as well as the country’s manufacturing and export powerhouses in the Yangtze River Delta, Pearl River Delta, Shandong Peninsula and the central region.¹⁶ At the end of 2021, 10,700 FCVs (mostly buses

11 NDRC, 氢能产业发展中长期规划 (2021–2035 年) [Medium and Long-term plan for the development of a hydrogen industry](#) (2021–2035), (March 2022).

12 IEA, “[An energy sector roadmap to carbon neutrality in China](#),” (September 2021), p.175.

13 Michal Meidan, “[China’s emerging hydrogen strategy and the 2060 net zero commitment](#),” Oxford Energy Forum issue 127 (May 2021).

14 “[国务院关于印发《中国制造2025》的通知](#),” [“[Made in China 2025](#),”] (in Chinese) (May 8, 2015), in Chapter 3, section 6, point 6.

15 节能与新能源汽车技术路线图 [Energy Saving and New Energy Vehicle Technology Roadmap],” cited in China Automotive Technology Research Center, “[中国燃料电池汽车发展路线图](#),” [China’s fuel cell vehicle development roadmap],” (in Chinese) (September 2017), p.6.

16 节能与新能源汽车技术路线图 [Energy Saving and New Energy Vehicle Technology Roadmap],” cited in China Automotive Technology Research Center, “[中国燃料电池汽车发展路线图](#),” [China’s fuel cell vehicle development roadmap],” (in Chinese) (September 2017), p.6.

and trucks) were deployed in China, with 194 hydrogen fueling stations in operation.¹⁷

Similarly, the *National Innovation-Driven Development Strategy and Action Plan for Innovation in the Energy Technology Revolution (2016–2030)*¹⁸ list hydrogen and fuel cell technology as central components of China’s future energy system. The *13th Five-Year Plan for Strategic Development in Emerging Industries*¹⁹ suggests systematically encouraging research and industrial development in the FCV area and promoting hydrogen storage systems.²⁰

The National Alliance of Hydrogen and Fuel Cells (or China Hydrogen Alliance) was launched in 2018. In an April 2021 report, the Alliance predicted that hydrogen production from renewable energy in China would reach 100 Mt by 2060, with total hydrogen use reaching 130 Mt and accounting for 20% of China’s final energy consumption. According to the Alliance, around 60% of hydrogen demand will come from industry, with most of the rest coming from transport.²¹

The transport sector has remained a focal point for government hydrogen policy. In 2020, China’s Ministry of Finance (MOF), Ministry of Industry and Information Technology (MIIT), Ministry of Science and Technology (MOST), and National Development and Reform Commission (NDRC) jointly released *A Notice on Optimizing Fiscal Subsidies for Promoting New Energy Vehicles*²² as part of the government’s annual review of subsidy policies. In the Notice, “new energy vehicles” refer to battery electric vehicles, plug-in hybrid vehicles and fuel cell vehicles (FCVs). The 2020 Notice set out measures to replace vehicle purchase subsidies with a four-year pilot program in which cities were selected to carry out research, development and demonstrations of FCVs. The scheme rewards clusters of cities based on a series of parameters, including the deployment of more than 1000 FCVs that meet certain technical standards, achieving a delivered hydrogen price at a maximum of RMB 35.00/kg (\$ 5.00/kg) and providing at least 15 operational HRSs.

The base subsidy for fuel cell electric passenger cars is a linear function of the rated power of the fuel cell system (RMB 4,800/kW) and capped at RMB 160,000 per car. For light-duty fuel cell electric commercial vehicles—i.e. buses, coaches, trucks and vocational vehicles—the base subsidy is RMB 240,000 per vehicle. For medium to heavy-duty commercial vehicles, the base subsidy is RMB 400,000 per vehicle.

In 2020, the four ministries further issued *A Notice on Launching Demonstration Applications*

17 IEA. [Global Hydrogen Review 2021](#), (October 2021) at p.188; “8198辆! 1.63亿公里! 632.59万小时! 五大示范城市群进展如何? [8,198 vehicles! 163 million km! 6,3259 million hours! How are the five pilot city clusters progressing?],” (in Chinese) (June 1, 2022); “2025年我国加氢站数量预测 [Forecast of the number of hydrogen refueling stations in China in 2025],” 21st Century Business Herald, (in Chinese) (April 2, 2022).

18 “中共中央 国务院印发《国家创新驱动发展战略纲要 [National Innovation-Driven Development Strategy and the Action Plan for Innovation in the Energy Technology Revolution (2016-2030)].” (in Chinese) (May 2016), in chapter 4, section 1, point 10.

19 “国务院关于印发 十三五 国家战略性新兴产业发展规划的通知 [13th Five-Year Plan for Strategic Development in Emerging Industries],” (November 2016), Chapter 5, Section 1.

20 GIZ, [China Energy Transition Status Report](#), p.73.

21 “专家预测：在碳中和情景下 氢能在我国终端能源消费中占比将达20%左右 [Experts predict: For China’s net zero pledge, hydrogen will account for around 20% of China’s final energy consumption],” CNR, (in Chinese) (April 22, 2021).

22 “关于完善新能源汽车推广应用财政补贴政策的通知 [Notice on optimizing fiscal subsidies for promoting new energy vehicles],” (in Chinese) (April 2020).

of *Fuel Cell Vehicles*²³ offering additional details on the four-year subsidy program for FCVs which aims to support the entire value chain from vehicle production and infrastructure development. Cities can apply to be included in the pilot program with funding attributed according to a point system.²⁴ Following the Notice, several provincial governments issued their own subsidy programs,²⁵ in addition to central government support.

In 2020, China accounted for 8% of the global stock of electrolyzers and 35% of the global manufacturing capacity of electrolyzer equipment and components.²⁶ The China Hydrogen Alliance estimates China could add 100 GW of electrolyzer capacity by 2030 to produce green hydrogen.²⁷

Current policies

In March 2022, NDRC published its *Medium- and Long-Term Plan for the Development of the Hydrogen Energy Industry (2021-2035)*²⁸—the first official document to lay out a long-term vision for China’s hydrogen economy. The Plan consolidates hydrogen policy initiatives into a single document and reiterates some goals set out in previous plans, including the deployment of 50,000 fuel cell vehicles by 2025.²⁹

NDRC’s Hydrogen Plan emphasizes that provinces should choose their hydrogen production routes according to local conditions (including resource endowments and industrial structure), giving them considerable leeway in hydrogen production. This could promote innovation, as the provinces experiment with different approaches for scaling up hydrogen infrastructure. It could also lead to overcapacity, as provinces build production capacity independently.

NDRC’s Hydrogen Plan calls for establishing hydrogen markets close to current production sites, including where hydrogen is recovered as an industrial byproduct from alkaline production, propane dehydrogenation (PDH) plants and renewable electrolysis power-to-gas. The Plan also calls on the industry to pilot more advanced technologies including seawater electrolysis, nuclear hydrogen production and others. The Plan reiterates the importance of hydrogen fuels for transport in the near term but emphasizes that, going forward, hydrogen application needs to be developed in energy storage, power generation, industry and other sectors.

NDRC’s Hydrogen Plan also calls for production of 100,000–200,000 tonnes of green hydrogen per year by 2025 (roughly 0.3% to 0.6% of current hydrogen production). According to NDRC,

23 [“财政部 工业和信息化部 科技部 发展改革委 国家能源局关于开展燃料电池汽车示范应用的通知 \[Notice on Launching Demonstration Applications of Fuel Cell Vehicles\].”](#) (in Chinese) (September 2020).

24 Hongyang Cui, Hui He, [“China announced 2020–2022 subsidies for new energy vehicles.”](#) ICCT Policy update, (July 13, 2020).

25 For a brief overview of Shanghai’s subsidies, [“上海：对燃料电池汽车产业给予补贴 \[Shanghai: subsidies for fuel cell vehicle industry\].”](#) China Association of Automobile Manufacturers, (in Chinese) (November 4, 2021).

26 Jane Nakano, [“China’s Hydrogen Industrial Strategy.”](#) CSIS Commentary, (February 3, 2022).

27 [“专家预测：在碳中和情景下 氢能在我国终端能源消费中占比将达20%左右 \[Experts predict: For China’s net zero pledge, hydrogen will account for around 20% of China’s final energy consumption\].”](#) CNR, (in Chinese) (April 22, 2021).

28 National Development and Reform Commission, [“氢能产业发展中长期规划（2021-2035年）\[Medium- and Long-Term Plan for the Development of Hydrogen Energy Industry \(2021-2035\)\].”](#)(in Chinese) (March 23, 2022).

29 The Hydrogen Plan does not set a target for HRSs, although the New Energy Vehicle Industry Development Plan includes a target for HRSs to grow from 72 units in mid-2020 to 2000 units by 2035.

this will lead to CO₂ emissions reductions of 1–2 Mt per year by 2025. These targets are widely seen as easily achievable. By 2035, Beijing is aiming for a complete and diversified ecosystem of green hydrogen applications, covering transportation, energy storage and industry.

The Plan is informed by a number of earlier policy documents:

- In March 2020, the National Development and Reform Commission and the Ministry of Justice issued *Opinions on Accelerating the Establishment of Green Production and Consumption Laws and Policies*,³⁰ stating that the promotion of clean energy development requires the study and formulation of standards and supporting policies for new technologies, such as hydrogen and ocean energy.
- The draft *Energy Law*, issued in April 2020, re-classified hydrogen as a secondary energy source, rather than a hazardous material. When regarded as a hazardous material, its production, transportation, refueling and storage has been strictly regulated, entailing lengthy approval processes. For example, production is restricted to chemical industry zones, hindering the development of on-site HRS. In road transport, the working pressure of tube trailers for hydrogen transportation is limited, resulting in low transportation efficiency and high costs.³¹ At the time of writing, the draft Energy Law has yet to be finalized, and so hydrogen remains a hazardous material.
- In 2020 and 2021, several policy documents were released outlining technical requirements for hydrogen pipelines, storage systems and refueling stations. The documents included guidance for universities and other educational institutions,³² stressing the need for research on the hydrogen economy, including on fuel cells, and hydrogen storage.³³
- The State Council's *White Paper on China's Energy Development in the New Era*,³⁴ published in December 2020, includes a broad ambition to develop green hydrogen production, storage, transportation and application, and promote the development of the hydrogen energy fuel cell technology chain and hydrogen fuel cell vehicle industry chain.
- The National Development and Reform Commission's *Catalogue of Encouraged Industries in the Western Region*, issued in January 2021, includes hydrogen processing and manufacturing, hydrogen energy fuel cell manufacturing, hydrogen

30 NDRC, Ministry of Justice, “[国家发展改革委 司法部印发《关于加快建立绿色生产和消费法规政策体系的意见》的通知 \[Notice on Accelerating the Establishment of a Green Production and Consumption Regulatory System\]](#),” (in Chinese) (March 2020).

31 Michal Meidan, “[China's emerging hydrogen strategy and the 2060 net zero commitment](#),” Oxford Energy Forum issue 127, (May 2021); “[《能源法》拟将氢能列入能源范畴，业界已畅想“行业大爆发” \[The Energy Law is set to include hydrogen in the energy category, the industry is anticipating a big bang\]](#),” Yicai, (in Chinese) (April 11, 2020).

32 Vera Zhang, [Hydrogen Law, Regulations & Strategy in China](#), (November 2021).

33 “[关于加快建立绿色生产和消费法规政策体系的意见 \[Notice on Accelerating the Establishment of a Green Production and Consumption Regulatory System\]](#),” (in Chinese) March 2020); Vera Zhang, [Hydrogen Law, Regulations & Strategy in China](#), (November 2021).

34 State Council, “[《新时代的中国能源发展》白皮书 \[White Paper on China's Energy Development in the New Era\]](#),” (in Chinese) (December 2020).

transmission pipeline and hydrogenation station construction.³⁵

- The State Council's "*Guiding Opinions on Accelerating the Establishment and Improvement of the Green and Low-carbon Circular Development Economic Systems*"³⁶ discusses the need to promote the green and low-carbon transformation of the energy system and to develop hydrogen energy.
- In March 2021, the "*14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 for the People's Republic of China*,"³⁷ also identified hydrogen as one of the six industries that China should focus on.
- The *14th Five-Year Plan for a Modern Energy System*,³⁸ issued in March 2022, reiterates the importance of hydrogen production, innovation and deployment.

All these documents include discussions of hydrogen, highlighting the growing importance of hydrogen both as an industry and a low-carbon solution for China's decarbonization plans, they offer few concrete targets and details.

In addition to the central government level guidance, 28 provinces have included the development of hydrogen energy in their provincial *14th Five-Year Plan for National Economic and Social Development and the Outline of Long-Term Goals for 2035*. Ten provinces, including Guangdong and Shanxi, have included development of hydrogen energy in their Government Work Reports in recent years. Shandong, Hebei and Zhejiang have released development plans for their hydrogen energy industries. Many other provinces have adopted policies to promote hydrogen energy, including policies related to the construction of hydrogen energy infrastructure and the manufacturing of key components.³⁹

Climate Change Implications

The relationship between the Chinese government's hydrogen policies and its climate goals is unclear. Today, almost all hydrogen in China is made from fossil fuels, releasing heat-trapping gases into the atmosphere in the process. The expansion of this industry as called for in central government planning documents could significantly increase emissions. The planning documents also call for increased production of low-carbon hydrogen, but in small amounts. If demand for hydrogen grows faster than the supply of low-carbon hydrogen, that would increase CO₂ emissions, making it more difficult to achieve China's carbon peaking and carbon neutrality goals.

35 NDRC, "[西部地区鼓励类产业目录 \(2020年本\) \[Catalogue of Encouraged Industries in the Western Region\]](#)," (in Chinese) (January 18, 2021).

36 State Council, "[国务院关于加强建立健全绿色低碳循环发展经济体系的指导意见 \[Guiding Opinions on Accelerating the Establishment and Improvement of the Green and Low-carbon Circular Development Economic Systems\]](#)," (in Chinese) (February 2, 2021).

37 "[中华人民共和国国民经济和社会发展第十四个五年规划和2035年远景目标纲要 \[14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035 for the People's Republic of China\]](#)," (in Chinese) (March 13, 2021).

38 "[“十四五”现代能源体系规划 \[14th Five Year Plan for a Modern Energy System\]](#)," (in Chinese) (March 22, 2022).

39 Vera Zhang, [Hydrogen Law, Regulations & Strategy in China](#).

CHAPTER 14 - COAL-BASED OIL, GAS AND CHEMICALS

China's abundant coal resources can be used to produce oil, natural gas and many chemicals, reducing China's dependence on imports of these products. However coal conversion processes typically have high financial and environmental costs. Emissions of carbon dioxide (CO₂) and local air pollutants from such processes can be especially significant.

Policy support for coal-based oil, natural gas and chemicals in China has varied over the years. As energy security concerns have become an especially prominent priority for Chinese leaders in the past several years, attention to coal-based products in Chinese policy documents has grown. Several 14th Five-Year Plan documents call for technological innovation with respect to these products and planning of coal-to-oil and coal-to-gas strategic bases.¹

Background

Industrial processes for coal conversion date back to at least the early 20th century. However such processes are expensive and rarely commercially viable except in times of high oil or natural gas prices.

In addition, the environmental impacts of coal conversion can be significant. Lifecycle CO₂ emissions of coal-based oil and coal-based natural gas can be several times higher than lifecycle CO₂ emissions of conventional oil and natural gas. If coal is converted to natural gas and that gas is then burned in a combined cycle turbine to generate power, the resulting CO₂ emissions are higher on a lifecycle basis than burning coal directly in an ultra-supercritical power station.²

Coal conversion also consumes large quantities of water. This is a particular challenge in China, where some of the most abundant coal resources are in the arid and semi-arid northern regions. Water recycling is an option, but the treatment of wastewater from these plants remains a technical challenge.³

The coal chemical industry in China uses coal both as a feedstock and as an energy source.

Coal-to-oil

China's use of coal liquefaction technology dates back to the 1930s. It grew after World War Two due to the country's shortage of oil reserves, however the discovery of the Daqing oil

1 See Current Policies section below.

2 Ian Reid, [Non-energy uses of coal](#), CCC/291, International Centre for Sustainable Carbon (November 29, 2018); Richard Liu, Zhou Yang and Xinzhou Qian, ["China's risky gamble on coal conversion,"](#) China Environment Forum, Choke Point, (January 9, 2020); Yue Qin, Fabian Wagner et al., ["Air quality, health and climate implications of China's synthetic natural gas development,"](#) Proceedings of the National Academy of Sciences, 114 (19) (2017), 4887-4892.

3 Ziyao Xu, Jijian Lian, Jinliang Zhang and Lingling Bin, ["Investigating and optimizing the water footprint in a typical coal energy and chemical base in China,"](#) *Science of the Total Environment*, 7272 (2020), 138781; Dongyan Zhao, Weijie Lun and Junjie Wei, ["Discussion on Wastewater Treatment Process of Coal Chemical Industry,"](#) IOP Conference Series: Earth and Environment Science 100 (2017), 012067; Peizhe Cui, Yu Qian and Siyu Yang, ["New Water Treatment Index System Toward Zero Liquid Discharge for Sustainable Coal Chemical Processes,"](#) ACS Sustainable Chemistry & Engineering 6 (1) (2018), 1370-1378.

field in 1959 brought a temporary end to the priority assigned to this technology. The oil crises of the 1970s triggered a renewed interest not just in the established, indirect liquefaction process (Fischer-Tropsch) but also in developing direct liquefaction technologies.⁴ Momentum increased after China became a net oil importer in 1993. By 2006, the government was envisaging annual production of liquid fuels from coal of 30 million tonnes.⁵

China's capacity to liquefy coal expanded rapidly in the early 2000s as coal-rich areas of the country took advantage of rising oil prices and favorable government policies.⁶ The industry's products were used for transport and petrochemicals.⁷ However, the Chinese government started to restrict such coal-to-oil projects due to their environmental impacts and, by 2008, only Shenhua's liquefaction plants were allowed to proceed.⁸

A new Shenhua coal-to-oil plant came onstream in 2016 at a cost of about RMB 55 billion and with an annual capacity of four million tonnes of oil products.⁹ The output of oil products from this and other newer plants in China reached about five million tonnes in 2019¹⁰—less than 1% of China's annual oil consumption.

The liquefaction process to produce transport fuels is only commercially viable when oil prices are high. The process also has a high energy cost.¹¹

Coal-to-gas

The need to reduce urban air pollution has spurred the production of synthetic natural gas from coal. China's first two synthetic natural gas (SNG) plants started commercial production in December 2013, in Xinjiang and Inner Mongolia. Environmental concerns led to a temporary suspension of project approvals in 2015. The following year saw three new projects approved, in Xinjiang, Inner Mongolia and Shaanxi. The government had originally set annual production targets for SNG of 15–18 bcm by 2015 and 32 bcm by 2017 and hoped for 55 bcm by 2020.¹² In 2021, SNG accounted for about 6 billion cubic meters or 3% of domestic gas production.¹³

SNG could reduce the level of air pollution in the urban areas of northern China such as the

4 Fang Rong and David G. Victor, "[Coal liquefaction policy in China: explaining the policy reversal since 2006.](#)" Energy Policy 39 (2011), 8175–8184.

5 Han Hao, Zongwei Liu et al., "[Coal-derived alternative fuels for vehicle use in China: a review.](#)" Journal of Cleaner Energy Production 141 (2017), 774–790.

6 Zhou Yang and Xinzhou Qian, [Risky Business. Growth of Water-Intensive Coal Conversion Projects in Western China](#), Washington D.C.: Wilson Center, China Environment Forum, (November 2019).

7 Minchener, A.J.(2011) [Coal-to-oil, gas and chemicals in China. International Energy Agency](#), Clean Coal Centre, CCC/181.

8 Zhou Yang and Xinzhou Qian, [Risky Business. Growth of Water-Intensive Coal Conversion Projects in Western China](#), Washington D.C.: Wilson Center, China Environment Forum, (November 2019).

9 Xinhua News Agency (2016), [Significant coal-to-liquid project in production in Ningxia](#) (accessed 18 November 2020).

10 US Energy Information Administration (2020), [Country Analysis Executive Summary: China](#) (30 September 2020) (accessed 8 November 2020).

11 Zhaoyang Kong, Xiucheng Dong and Qingzhe Jiang, [The net energy impact of substituting oil with coal-to-liquid in China](#), Journal of Cleaner Production 198 (2018), 80–90.

12 Yue Qin, Fabian Wagner et al., "[Air quality, health and climate implications of China's synthetic natural gas development.](#)" Proceedings of the National Academy of Sciences, 114 (19) (2017), 4887–4892.

13 US Energy Information Administration, "[China increased both natural gas imports and domestic production in 2021.](#)" (April 22, 2022).

Beijing–Tianjin–Hebei region, especially if allocated to the residential sector rather than to industry and power generation.¹⁴ However, SNG appears to be less efficient in the use of coal than advanced coal-fired plants.¹⁵ It yields a lower energy return on investment than imported gas¹⁶ and bears significant commercial risk.¹⁷

Coal-to-chemicals

China's demand for petrochemical products is likely to continue rising for the foreseeable future, even as demand for oil in the transport sector steadies due to electrification. As a result, the focus of investment in liquefaction has switched from coal-to-oil to coal-to-chemicals. There was a surge in the number of planned projects in 2017, including 15 coal-to-ethanol plants.¹⁸ The production of petrochemicals involves the gasification of coal to produce methanol which can then be converted to olefins such as ethylene and propylene. These in turn form the basis for making plastics and many other materials used in daily life. Another product is ethylene glycol which can be used as an intermediate to manufacture polyester for clothes and other fabrics.¹⁹

By 2018, coal was the source material for 16% of China's petrochemicals, up from 3% in 2010. Although coal-to-olefins is the most profitable of the various coal conversion processes, its commercial viability still depends heavily on the prevailing price of oil. Meanwhile, the commercial viability of coal-to-gas and coal-to-ethylene glycol has been questionable, as evidenced by the slow growth of coal-to-gas capacity and low utilization rate of coal-to-ethylene glycol plants. As a result, the industry has been supported by billions of RMB per year through direct and indirect subsidies.²⁰

Policies

Historical policies

Coal conversion grew in China in the early 2000s. Starting in 2008, the central government began issuing a number of policies to manage the coal conversion industry more tightly.

14 Yue Qin, Fabian Wagner et al., "[Air quality, health and climate implications of China's synthetic natural gas development.](#)" Proceedings of the National Academy of Sciences, 114 (19) (2017), 4887–4892.

15 Man, Yi, Yulin Han, Yusha Hu, Sheng Yang, and Siyu Yang, "[Synthetic Natural Gas as an Alternative to Coal for Power Generation in China: Life Cycle Analysis of Haze Pollution, Greenhouse Gas Emission, and Resource Consumption.](#)" Journal of Cleaner Production 172 (2018), 2503–2512.

16 Zhaoyang Kong, Xiucheng Dong, and Guixian Liu, "[Coal-Based Synthetic Natural Gas vs. Imported Natural Gas in China: A Net Energy Perspective.](#)" Journal of Cleaner Production 131 (2016), 690–701.

17 Yang Liu, Yu Qian, Honghua Xiao, and Siyu Yang, "[Techno-Economic and Environmental Analysis of Coal-Based Synthetic Natural Gas Process in China.](#)" Journal of Cleaner Production 166 (2107), 417–424.

18 John Richardson, "[China aims to end petrochemical imports. Independent Commodity Intelligence Services.](#)" (April 29, 2018) (accessed 6 November 2020).

19 Ian Reid, "[Non-energy uses of coal. International Energy Agency.](#)" Clean Coal Centre, CCC/291 (2018).

20 Callum O'Reilly, "[CTO and MTO projects in China may decelerate. Hydrocarbon Engineering.](#)" (May 2, 2019); Richard Liu, Zhou Yang and Xinzhou Qian, "[China's risky gamble on coal conversion.](#)" China Environment Forum, Choke Point, (January 9, 2020). Yiming Li and Changqing Li, "[Fossil energy subsidies in China's modern coal chemical industry.](#)" Energy Policy. 135 (2019), 111015.

These included:²¹

- 2009, NDRC Notice on restricting overcapacity and guiding healthy development of the coal chemical industry.
- 2011, NDRC Notice on regulating the development of the coal chemical industry.
- 2014, NEA Notice on regulating the development of coal-to-liquids and coal-to-gas industries.
- 2014, NEA Guidance on promoting safe, green development and clean, efficient utilization of coal.
- 2015, NEA Guiding opinions on steadily promoting the construction of coal-to-oil demonstration projects.

These documents sought to balance the desire to promote the modern coal chemical industry with the need to protect the environment and manage water resources.

In 2015, the NEA issued an Action Plan for Clean and Efficient Use of Coal (2015–2020).²² This spelled out in some detail the need for the “moderate” development of the coal chemical industry, including coal gasification, along with strong directives on protecting the environment and managing water resources effectively. In the same year, the Ministry of Environmental Protection issued its Environmental Entry Conditions for Modern Coal Conversion Construction Projects (Trial).²³ This emphasized the need for all projects to maximize energy efficiency, minimize pollution and water use, ensure that discharged water meets national standards and manage solid waste effectively.

The 13th Five-Year Plan for Energy Development (2016–2020) identified the need to develop large-scale plants for coal-to-oil and coal-to gas and bring the national annual capacity to 13 million tonnes and 17 billion cubic meters respectively by 2020. It also mentioned coal-to-chemicals, the construction of pipelines to transport coal-based natural gas and further development of technology for indirect liquefaction.²⁴ The 13th Five-Year Plan for Natural Gas Development reiterated the need to produce more coal-based natural gas, though it omitted the 17 billion cubic meter target.²⁵ These plans were supported with substantial subsidies.²⁶

21 Han Hao, Zongwei Liu et al., “[Coal-derived alternative fuels for vehicle use in China: a review](#),” *Journal of Cleaner Energy Production* 141 (2017), 774-790; Hou Jianchao, Wang Zhiwei and Pingkuo Liu, “[Current practice and future projection for coal-to-SNG in China](#),” *Resources Policy* 75 (2022), 102376.

22 National Energy Administration, [Action Plan for Clean and Efficient Use of Coal \(2015-2020\)](#), (in Chinese) (April 27, 2015).

23 Ministry of Environmental Protection, [Environmental Entry Conditions for Modern Coal Conversion Construction Projects \(Trial\)](#), (in Chinese) (December 2015).

24 National Energy Administration, [13th Five-Year Plan for Energy Development \(2016-2020\)](#), (in Chinese) (December 2016).

25 National Development and Reform Commission, [13th Five-Year Plan for Natural Gas Development](#), (in Chinese) (June 7, 2017).

26 Yiming Li and Changqing Li, “[Fossil energy subsidies in China’s modern coal chemical industry](#),” *Energy Policy*. 135 (2019), 111015.

Current policies

Coal conversion receives attention in several 14th Five-Year Plan documents.

- NDRC's overarching 14th Five-Year Plan calls for planning coal-to-oil and coal-to-gas strategic bases.²⁷
- The 14th Five-Year Plan for a Modern Energy System issued by NDRC and the National Energy Administration calls for technological innovation and demonstration projects for all three types of coal synthesis (oil, gas and chemicals).²⁸
- The Ministry of Industry and Information Technology, along with five other central government agencies, issued Guiding Opinions on the 14th Five-Year Plan to Promote the High-Quality Development of the Petrochemical Industry. This reiterated the need to continue improving the industries and technologies for coal-to-chemicals, coal-to-oil and coal-to-gas, involving higher efficiencies, better environmental practices and the development of strategic bases.²⁹
- The 14th Five-Year Plan for Scientific and Technological Innovation in the Energy Sector also calls for innovation in these fields.³⁰
- According to the State Council's Comprehensive Work Plan on Energy Conservation and Emissions Mitigation in the 14th Five-Year Plan Period, coal that is used as a feedstock will be exempted from the assessment of both energy intensity and energy consumption targets. This is expected to boost coal chemical development in China.³¹
- The Guidelines for Developing the Modern Coal Chemical Industry in the 14th Five-Year Plan, issued by the China National Coal Association, call for the establishment of a national coal chemical strategic reserve capacity and set targets for the 14th Five-Year Plan period.³²

Taken together, these documents signal renewed interest from Chinese policymakers in coal-based oil, natural gas and chemicals. The development of these industries would make it more difficult to achieve the Chinese government's 2030 carbon peaking and 2060 carbon neutrality goals.

27 NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021).

28 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022) at Chapter 3 p.9 and Chapter 6 p.26.

29 Ministry of Industry and Information Technology, [Guiding Opinions on the "14th Five-Year Plan" to Promote the High-Quality Development of the Petrochemical Industry](#), (in Chinese) (April 7, 2022).

30 National Energy Administration and Ministry of Science and Technology, [14th Five-Year Plan for Scientific and Technological Innovation in the Energy Sector](#) (April 2022), 34.

31 Xiaonan Fang, ["China refines dual-control scheme: Tilting the balance towards economic growth,"](#) IHSMarkit (January 2022).

32 China National Coal Association, [Guidelines for Developing the Modern Coal Chemical Industry in the 14th Five-Year Plan Period](#) (in Chinese) (2021).

NOTE ON TERMINOLOGY

The language used to describe coal conversion processes can be confusing.

First, the terms “coal-to-gas” and “coal-to-gas conversion” are often used to describe the process of converting coal to natural gas (as in this chapter). However the same terms are also used to describe a completely different process: converting boilers and furnaces from the use of coal to the use of natural gas. This latter process—converting boilers and furnaces—is central to the Chinese government’s strategy for fighting local air pollution in northern China. It has large benefits not only with respect to local air pollution but also with respect to carbon dioxide emissions. It is a completely different process than converting coal itself to natural gas, although the same terms are sometimes used to describe both.

Second, the term “coal gasification” is sometimes used in discussing this topic. Although “coal gasification” may sound like it refers to the process of converting coal to natural gas, it often refers to a broad set of processes including the conversion of coal to chemicals and other products. Natural gas is just one possible product of “coal gasification”.

CHAPTER 15 - CARBON CAPTURE, UTILIZATION AND STORAGE

Carbon capture, utilization and storage (CCUS) starts with the capture of carbon dioxide (CO₂) emitted from power plants, factories or other industrial facilities. Once captured, the CO₂ is either (i) used in products, or (ii) pumped underground for long-term storage.¹

Deployment of CCUS technology in China has been modest to date, but is growing. In April 2022, a report commissioned by China's Ministry of Science and Technology (MOST), the Chinese Academy of Sciences and others found that CCUS can “promote China's smooth transition from a fossil energy-based energy structure to a low-carbon multi-energy supply system and ensure China's energy security while reducing emissions.”²

Background

At the end of 2021, roughly 16 CCUS projects with just over 2 million tonnes per year of CO₂ capture capacity were operating in China. (See Figure 15-1). At least 11 more projects with roughly 10 million tonnes per year of CO₂ storage capacity were under development. (See Figure 15-2.)

In comparison, CCUS projects in the US had roughly 20 million tonnes per year of CO₂ capture capacity in 2021. Brazilian projects had roughly 4.6 million tonnes per year and Canada and Australia each had about 4 million tonnes per year.³

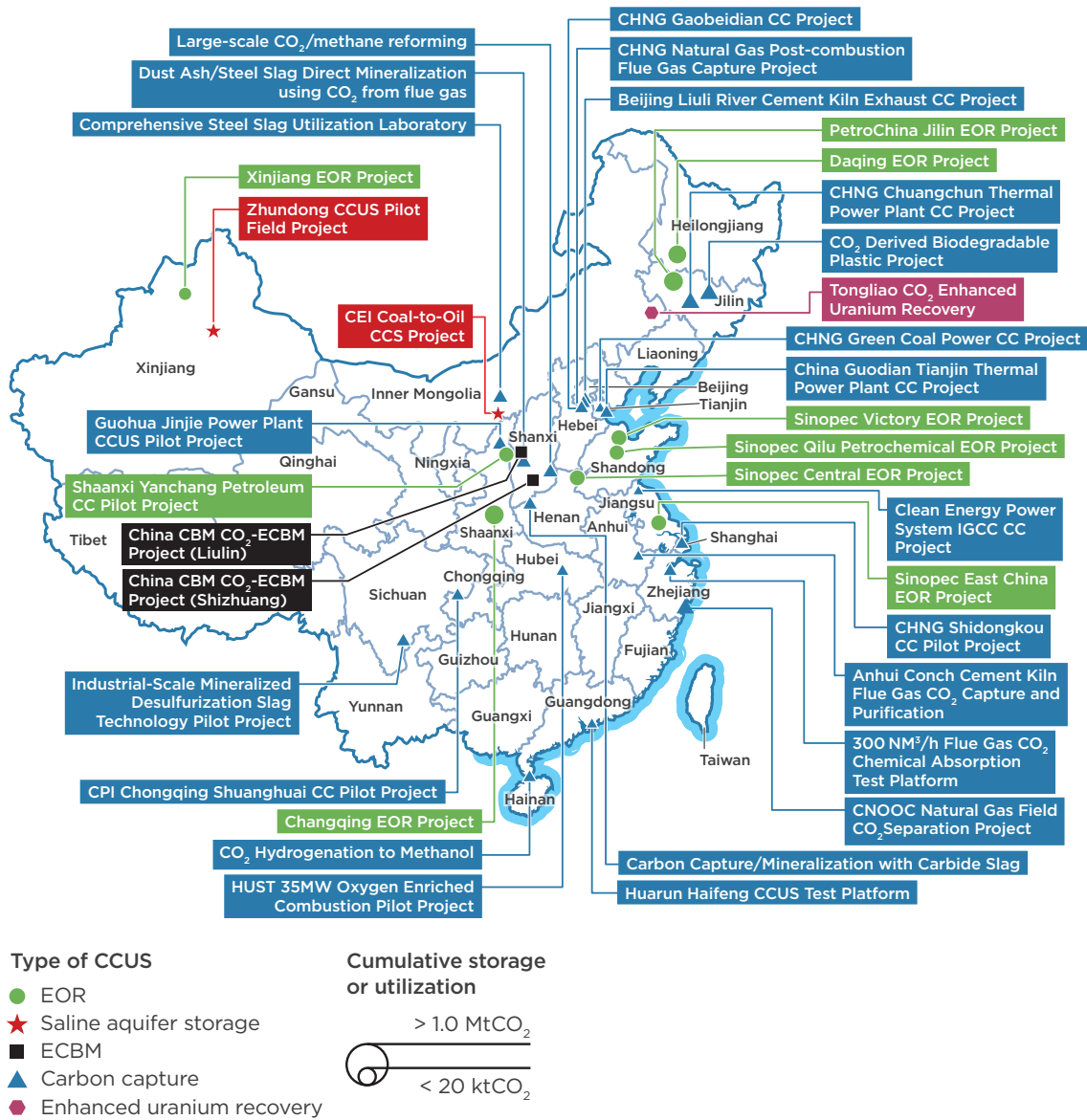
China's CCUS projects are spread across much of the country, with most in northern or eastern provinces. (See Figure 15-1.)

1 See International Energy Agency, [Carbon capture, utilisation and storage](#) (accessed September 6, 2022); Global CCS Institute, [Carbon Capture and Storage 101](#) (2022); Ministry of Economy, Trade and Industry, Japan, [What is CCUS Technology?](#) (accessed September 6, 2022).

2 Ministry of Science and Technology, [First special report of the Fourth National Assessment Report on Climate Change--China Carbon Capture Utilization and Storage Technology Assessment Report](#) (in Chinese) (April 22, 2022).

3 Global CCS Institute, [Global Status of CCS 2021](#).

Figure 15-1: CCUS Projects in China (2021)



Source: Kevin Tu and Sally Qiu based on China CCUS Annual Report 2021⁴

4 Prepared by Kevin Tu and Sally Qiu based on Cai Bofeng et al., China CCUS Annual Report 2021 (中国二氧化碳捕集利用与封存(CCUS) 年度报告(2021)——中国 CCUS 路径研究) Institute of Environmental Planning, Ministry of Ecology and Environment, Wuhan Institute of Rock and Soil Mechanics, Chinese Academy of Sciences and China Agenda 21 Administration Center (2021).

The principal technologies for capturing CO₂ are post-combustion chemical absorption and physical separation. Pre-combustion technologies, including integrated gasification combined cycle and industrial separation, are also used. Other technologies such as oxyfuel combustion, membrane separation and chemical looping are at early stages of development.⁵

Carbon capture has been used in a variety of industrial processes in China including power generation, natural gas processing, cement and chemical production, and coal liquefaction (Figure 15-1). Notable CCUS projects under development include coal liquefaction plants in Ningxia Province and integrated gasification combined cycle power plant in Tianjin. One project is linked to a steel plant with an annual capacity of 90,000 tonnes (Figure 15-2).

China's largest CCUS project entered into operation on August 29, 2022. The Sinopec Qilu Petrochemical Company will capture the CO₂ and transport it to Sinopec Shengli Oilfield for enhanced oil recovery (EOR). Sinopec estimates that the project can cut CO₂ emissions by 1 million tonnes per year.⁶

The principal use of captured carbon dioxide in China is for EOR, although a few projects are operating which use the carbon dioxide for other purposes, such as the production of chemicals or cement or in the food and beverage industry. The China National Petroleum Corporation (CNPC) applied EOR successfully to the Daqing oilfield in the 1960s. From the 1990s onwards, a growing number of other oilfields followed suit as well productivity started to decline. The effectiveness of many of these projects was limited by the low reservoir permeability and the practice of using carbon dioxide in a gaseous or liquid phase rather than in a supercritical form.⁷

Projects to demonstrate the application of EOR to CCUS came onstream in different oilfields between 2006 and 2008.⁸ There are now at least nine such projects, of which three are in commercial operation (Figure 15-1). At least four additional projects with a total annual capacity of 2.3 million tonnes per year are under development and due to be commissioned during the 2020s (Figure 15-2).

China possesses large sedimentary basins with saline aquifers that can be used for the storage of CO₂ both onshore and offshore. The CO₂ storage potential of these basins is enormous. One study found that China has more than 2300 Gt of deep geologic storage capacity dispersed throughout the country in onshore basins. (This is roughly 230 years of current CO₂ emissions in China.)⁹

5 International Energy Agency, [An Energy Sector Roadmap to Carbon Neutrality in China](#) (2021); Bofeng Cai and Qi Li, [China Status of CO₂ Capture, Utilization and Storage \(CCUS\) 2019](#), Chinese Academy for Environmental Planning (March 2020).

6 ["China's largest CCUS project set to cut annual CO₂ emissions by 1m tonnes."](#) Global Times (August 29, 2022).

7 Hill et al., ["CO₂-EOR in China: A comparative review."](#) International Journal of Greenhouse Gas Control (December 2020).

8 Hill et al., ["CO₂-EOR in China: A comparative review."](#) International Journal of Greenhouse Gas Control (December 2020).

9 RT Dahowski et al., [Regional Opportunities for Carbon Dioxide Capture and Storage in China](#) Pacific Northwest National Laboratory (2009). See also J. Kearns et al., ["Developing a Consistent Database for Regional Geologic CO₂ Storage Capacity Worldwide."](#) Energy Procedia (2017).

As of late 2021, two carbon capture projects in China are dedicated purely to the long-term storage of CO₂. Both are small in scale (Figure 15-1). However, three large-scale projects are due to be commissioned during the 2020s with a planned aggregate annual capacity of 5.0 million tonnes (Figure 15-2).

Most transport of CO₂ in China is by truck and, in a small number of cases, by barge. The only pipeline transport of CO₂ in China is in the Jilin oilfield (for 53 km) and from Sinopec's Qilu petrochemical plant in Shandong Province to the Shengli oilfield. The lack of CO₂ pipeline infrastructure is a significant constraint on the growth of CCUS in China.¹⁰

Policies

Historical Policies

Discussion of CCUS in Chinese policymaking dates to at least the 11th Five-Year Plan (2006–2010), which mentioned the need to develop CCUS technologies but provided no details. In the 12th Five-Year Plan (2011–2015), CCUS was identified as a critical technology in various plans, including those for scientific research and development. During this period, the amount of scientific research into CCUS increased markedly, as shown by a dramatic increase in the number of scientific publications on the topic from Chinese institutions. The number of international collaborations in this field also rose. At the same time, banking institutions began to recognize CCUS as being qualified for green credits and green bonds.¹¹

In 2011, the MOST issued a technology roadmap for CCUS spanning the period 2011–2030. This covered technologies for capture, storage and use, as well as the need to develop plans and standards for the long-distance transport of carbon dioxide. Specific aims to be achieved by 2020 included the establishment of projects with annual capacities of one million tonnes for capture, two million tonnes for utilization (specifically, enhanced oil recovery) and one million tonnes for storage. By 2030, supply chains for these technologies were to be fully developed and commercialized, each being allocated specific cost targets.¹²

MOST followed up in 2013 with a more detailed CCUS plan for the period to 2015. In the same year, the National Development and Reform Commission issued a document promoting CCUS pilot and demonstration projects that included the need to support research, develop economic incentives, establish standards and build human capacity. Two years later the Ministry for Environmental Protection issued draft guidelines for assessing the environmental risk related to CCUS.¹³

The level of direct support for CCUS rose significantly during the 13th Five-Year Plan period

¹⁰ International Energy Agency, [An Energy Sector Roadmap to Carbon Neutrality in China](#) (2021); [“China's largest CCUS project set to cut annual CO₂ emissions by 1m tonnes,”](#) Global Times (August 29, 2022).

¹¹ Kai Jiang et al. (2020), [“China's carbon capture, utilization and storage \(CCUS\) policy: A critical review,”](#) Renewable and Sustainable Energy Reviews (November 2019).

¹² Zhang et al. (2013), [“Technology roadmap study on carbon capture, utilization and storage in China,”](#) Energy Policy (2013) at pp.536–50.

¹³ Hao Zhang (2021), [“Regulations for carbon capture, utilization and storage: Comparative analysis of development in Europe, China and the Middle East,”](#) Resources, Conservation & Recycling 173, 105722 (October 2021).

(2016–2020). The technology was mentioned in several national and subnational plans relating to energy, technology and climate change mitigation. An explicit aim was to invest RMB 37.5 billion in CCUS in order to reduce emissions by 390 million tonnes per year.¹⁴

In 2019, MOST published a new CCUS Roadmap that envisaged the country having an operating CCUS capacity of 100 million tonnes by 2035 and 300 million tonnes by 2040. This would abate about 4% of current thermal coal consumption¹⁵ and require reducing the cost of CO₂ capture by 10–15% in 2030 and 40–50% in 2040.¹⁶ One analysis reported a cost of capture, transport and storage in 2015 of RMB 350/tonne of CO₂ and a target cost for the year 2030 of RMB 240/tonne. The capture process accounts for the largest share of this cost at RMB 210/tonne and RMB 140/tonne in 2015 and 2030 respectively.¹⁷ This compares to an IEA estimate for non-Chinese projects in 2019 of just over \$60/tonne (around RMB 400/tonne).¹⁸

Current Policies

Recent policy documents from the Chinese government mention CCUS, calling for research and development as well as demonstration projects in the years ahead.

- In October 2021, the State Council released its *Action Plan for Carbon Dioxide Peaking before 2030*. The *Action Plan* mentions CCUS five times, focusing on basic and applied research, development and deployment. The *Action Plan* also highlights the need for international cooperation on CCUS.¹⁹
- In November 2021, the National Energy Administration and Ministry of Science and Technology (MOST) released the *14th Five-Year Plan for Scientific and Technological Innovation in the Energy Sector*. CCUS has a brief mention as one of 37 tasks under the heading “green and efficient fossil energy development and utilization technology.”²⁰

In March 2022, NDRC published the *14th Five-Year Plan for a Modern Energy System*. The Plan mentions CCUS five times in the context of technology demonstration projects, encouraging the deployment, suitable financial instruments and international cooperation.²¹

14 Kai Jiang et al. (2020), “[China’s carbon capture, utilization and storage \(CCUS\) policy: A critical review](#),” Renewable and Sustainable Energy Reviews (November 2019).

15 Wan (2019), “[Carbon capture and storage in China](#),” CRU, (July 30, 2019).

16 IEA, [Energy Technology Perspectives 2020: Special Report on Carbon Capture Utilisation and Storage – CCUS in clean energy transitions](#) (accessed on 14 October 2021).

17 Kai Jiang et al. (2020), “[China’s carbon capture, utilization and storage \(CCUS\) policy: A critical review](#),” Renewable and Sustainable Energy Reviews (November 2019).

18 IEA, [Energy Technology Perspectives 2020: Special Report on Carbon Capture Utilisation and Storage – CCUS in clean energy transitions](#) (accessed on 14 October 2021).

19 National Development and Reform Commission, [Action Plan for Carbon Dioxide Peaking before 2030](#) (October 27, 2021).

20 NEA and MOST, [14th Five-Year Plan for Scientific and Technological Innovation in the Energy Sector](#) (in Chinese) (November 2021).

21 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022).

Climate Impacts

At present, CCUS facilities in China have only a negligible impact on CO₂ emissions. The aggregate capacity of the CCUS plants in operation in late 2021 was about 2 million tonnes per year (Figure 15-1)—0.02% of the country’s carbon emissions. The capacity of projects under construction at that time was 11.3 million tonnes (Figure 15-2)—0.1% of total emissions.

However CCUS has the potential to grow significantly in China, with major climate benefits.

- China has significant emissions from hard-to-abate industrial sectors such as steel and cement manufacturing. CCUS is an important decarbonization option in these sectors.²²
- China has the world’s largest fleet of coal-fired power plants. A large percentage of these facilities are located within several hundred kilometers of a CO₂ storage site. CCUS is an important decarbonization option at these facilities.²³
- China has significant internal markets for goods that can be produced with captured CO₂, including in particular cement.
- Chinese geologic formations have the capacity to store vast quantities of CO₂ underground.²⁴
- CCUS—perhaps on a large scale—may be needed to meet the Chinese government’s carbon neutrality goal.²⁵

In addition, CCUS technology could become a significant export market for China. CCUS facilities may be needed in many countries as an important tool for meeting net zero pledges.

The extent to which CCUS contributes to meeting China’s carbon neutrality goals will depend on a number of factors, including the cost of CCUS, progress in other decarbonization technologies and public acceptance.

22 With respect to industrial emissions generally, see Chapter 11 of this Guide.

23 Simon Bennett et al., [“Ready for CCS retrofit: The potential for equipping China’s existing coal fleet with carbon capture and storage in China.”](#) International Energy Agency (May 25, 2016). However if these coal-fired power plants mainly provide peak shaving and operate at very low-capacity factors in the 2040s and 2050s, as some Chinese energy planners project, that would limit the cost-effectiveness of CCUS at these facilities.

24 RT Dahowski et al., [Regional Opportunities for Carbon Dioxide Capture and Storage in China](#) Pacific Northwest National Laboratory (December 2009). See also J. Kearns et al., [“Developing a Consistent Database for Regional Geologic CO₂ Storage Capacity Worldwide.”](#) Energy Procedia (2017).

25 Raimund Malischek and Samantha McCulloch, [“The world has vast capacity to store CO₂: net zero means we’ll need it.”](#) International Energy Agency (April 1, 2021).

Figure 15-2: Operating CCUS Projects in China (late 2021)²⁶

Project	Year of Operation	Capture/use/storage	Type	Capture capacity (Mt/year)	Status	Industry
Sinopec Zhongyuan Carbon Capture Utilization and Storage Pilot Project	2006	EOR	Commercial	0.12	Operational	Chemical Production
Huaneng Gaobeidian Power Plant Carbon Capture Pilot Project	2008	Food	Pilot	0.003	Completed	Power Generation
Jilin Oil Field EOR Demonstration Project	2008	EOR	Demonstration	0.10-0.35	Operational	Natural Gas Processing
Sinopec Shengli Oilfield Carbon Capture Utilization and Storage Pilot Project	2008	EOR	Pilot	0.04	Operational	Natural Gas Processing
Shanghai Shidongkou 2nd Power Plant Carbon Capture Demonstration Project	2009	Beverage	Demonstration	0.10-0.12	Operational	Power Generation
Chongqing Hechuan Shuanghuai Power Plant CO ₂ Capture Industrial Demonstration Project	2010	Chemicals	Demonstration	0.10	Operational	Power Generation
Sinopec Shengli Oilfield Carbon Capture Utilization and Storage Pilot Project (2)	2010	EOR	Pilot	0.03-0.04	Operational	Power Generation
Shenhua Group Ordos Carbon Capture and Storage (CCS) Demonstration Project	2011	Storage	Demonstration	0.1	Completed	Coal-to-liquids

26 Global CCS Institute, [Global Status of CCS 2021](#); Kai Jiang et al. (2020), [“China’s carbon capture, utilization and storage \(CCUS\) policy: A critical review.”](#) Renewable and Sustainable Energy Reviews (November 2019); Congbin Xu et al., [“Carbon capture and storage as a strategic reserve against China’s CO₂ emissions.”](#) Environmental Development (March 2021).

ITRI Calcium Looping Pilot	2013	Capture	Pilot	1 tonne/hour	Operational	Cement
Daqing Oil Field EOR Demonstration Project	2014	EOR	Demonstration	0.20	Operational	Chemical Production
Karamay Dunhua Oil Technology CCUS EOR Project	2015	EOR	Commercial	0.10	Operational	Chemical Production
PetroChina Changqing Oil Field EOR CCUS	2017	EOR	Demonstration	0.05-0.10	Operational	Coal-to-liquids
Beijing Shuangang LanzaTech New Energy Technology	2018	Ethanol	Commercial	0.09	Operational	Steel Production
CNPC Jilin Oil Field CO ₂ -EOR (2)	2018	EOR	Commercial	0.60	Operational	Natural Gas Processing
Haifeng Carbon Capture Test Platform	2018	Capture		0.03	Operational	Power Generation
Guohua Jinjie CCS Full Chain Demonstration	2021	Storage		0.15	Operational	Power Generation

Figure 15-3: CCUS Projects Under Construction 2021²⁷

Project	Year of Operation	Capture/use/storage	Type	Capture capacity (Mt/year)	Status	Industry
Sinopec Qilu Petrochemical CCS	2021	EOR		1.0	In construction	Chemical Production
Yanchang Integrated CCUS Demonstration	2020-2021	EOR		0.41	In construction	Chemical Production
Chinese-European Emission Reducing Solutions (CHEERS)	2022	Capture	Pilot and demo	-	Advanced Dvlpmt	Oil refining
Australia-China Post-Combustion Feasibility Study Project	-		Capture	Pilot and demo	1.00	Advanced Dvlpmt

27 Global CCS Institute, [Global Status of CCS 2021](#); Kai Jiang et al. (2020), [“China’s carbon capture, utilization and storage \(CCUS\) policy: A critical review.”](#) Renewable and Sustainable Energy Reviews (November 2019); Congbin Xu et al., [“Carbon capture and storage as a strategic reserve against China’s CO₂ emissions.”](#) Environmental Development (March 2021).

Guodian Taizhou Power Station Carbon Capture	2020s	EOR		0.3	In construction	Power generation
China Resources Power (Haifeng) Integrated CCS Demonstration	2020s	Storage		1.00	Early	Oil refining
Huaneng GreenGen IGCC Large-scale System (Phase 3)	2020s	Storage		2.00	Early	Oil refining
Huazhong University of Science and Technology Oxy-fuel project	2020s	Capture	Pilot and demo	0.10	In construction	Power generation
Shanxi International Energy group CCUS	2020s	Not defined	Large-Scale CCS	2.00	Early Dvlpmt	Power generation
Shenhua Ningxia Coal-to-liquids Project	2020s	Storage	Large-Scale	2.00	Early Dvlpmt	Power generation
Sinopec Eastern China CCS	2020s	EOR	Large-Scale	0.50	Early Dvlpmt	Power generation
Development	Fertilizer Production	Not defined	Large-Scale CCS	2.00	Early Dvlpmt	Power generation

CHAPTER 16 - VEHICLES

Vehicles produce roughly 8% of the heat-trapping gases emitted in China each year.¹ This percentage will increase in the years ahead as the Chinese vehicle stock grows and heavy manufacturing declines as a percentage of the overall economy.

The Chinese government's principal policies with respect to vehicle emissions include fuel efficiency standards and support for "new energy vehicles." (The Chinese government uses the term "new energy vehicle," or "NEV," to describe vehicles powered by fuels other than petroleum.) Almost all NEVs in China today are plug-in electric vehicles with batteries, although fuel cell electric vehicles are receiving growing attention from policy makers.

This chapter discusses China's vehicle stock, fuel efficiency standards and new energy vehicle programs.

A. China's Vehicle Stock

China's vehicle stock has grown at an extraordinary pace in the past three decades, along with the nation's GDP. In 1990, China had just 5.5 million registered motor vehicles. At the end of 2021, this figure had risen to over 395 million.²

In 2021, 21 million new motor vehicles were sold in China, down from a high of 24 million in 2017,³ making it the world's largest vehicle market by far. (The United States was second, with roughly 17 million vehicles sold in 2019, and under 15 million annually in 2020–2021.⁴) China's 2021 sales represented the first year of positive overall growth since 2018.⁵ Vehicle sales peaked in 2018 at over 28 million. Passenger vehicles accounted for 21 million, showing growth in 2021 but also still below the peak in 2019.⁶ SUVs and crossovers have shown strong growth in market share reaching 46% in 2021 despite fuel economy regulations.⁷

China's vehicle stock is projected to grow significantly in the years ahead.⁸ At present, there is roughly one motor vehicle for every four people in China, compared with more than one motor vehicle for every two people in the European Union and almost one motor vehicle for

1 See China State Council, 国务院关于建设现代综合交通运输体系有关工作情况进行专题询问 (June 2021) (comments of Deputy Director Hu Zucai at 15:46:29) (in Chinese); IEA, "[CO₂ Emissions from Fuel Combustion 2018](#)," at pp.15, 81 (in 2016, China's transport emissions = 0.8 Gt CO₂ and China's total CO₂ emissions from fossil fuel combustion = 9.1 Gt); World Bank, "[World Development Indicators](#)," (accessed September 10, 2022) (in 2014, transport = 8.6% of China's CO₂ emissions); "[People's Republic of China, Second Biennial Update Report on Climate Change](#)," (December 2018) at pp.16, 19 (in 2014, transport emissions = 9.0% CO₂ emissions and CO₂ emissions = 81.6% of total greenhouse gas emissions).

2 National Bureau of Statistics of China, "[National Data](#)," (5.5 million vehicles in 1990); Chinese Association of Automobile Manufacturers, "[截至2021年底, 全国新能源汽车保有量达784万辆, 其中纯电动汽车保有量640万辆](#)," (January 13, 2021) (in Chinese).

3 Bart Demandt, "[China Car Sales Analysis 2021](#)," Car Sales Base (January 2022).

4 Good Car Bad Car, "[U.S. Auto Industry Sales Analysis](#)," (accessed June 9, 2022).

5 China Association of Automobile Manufacturers, "[2021年12月汽车工业产销综述 \[December 2021 Automotive Industry Production and Consumption Summary\]](#)," (January 13, 2022) (in Chinese).

6 Bart Demandt, "[China Car Sales Analysis 2021](#)," Car Sales Base (January 2022).

7 Bart Demandt, "[China Car Sales Analysis 2021](#)," Car Sales Base (January 2022).

8 See e.g., Yang Li et al., "[Exploration of Sustainable Urban Transportation Development in China through the Forecast of Private Vehicle Ownership](#)," Sustainability (August 2019).

every person in the US.⁹

China has more than 100 vehicle manufacturers.¹⁰ Many of these vehicle manufacturers are owned or heavily supported by provincial and local governments.

Traffic congestion is a major problem in many Chinese cities. Beijing, Chongqing, Changchun, Guiyang and Shanghai were rated the worst cities for traffic congestion in 2021.¹¹

B. Vehicle Fuel Efficiency

Background

Estimates of Chinese vehicle fuel efficiency vary. The Ministry of Industry and Information Technology (MIIT) estimates that the average fuel economy of new passenger cars sold in China in 2020 was about 5.6 liters per 100 kilometers (L/100 km)—equivalent to approximately 42 miles per gallon.¹² The IEA estimates that the average fuel economy of light-duty vehicles in China in 2019 was 7.2 L/100 km—equivalent to roughly 33 miles per gallon.¹³

The Chinese government uses a fuel economy test procedure that has been phased out elsewhere due to its frequent failure to reflect real-world vehicle fuel consumption. Tests by the International Council on Clean Transportation found that the real-world fuel consumption of Chinese vehicles is on average 37% higher than suggested by this test procedure.¹⁴ The Chinese government is in the process of transitioning to a new fuel economy test procedure.

9 US Bureau of Transportation Statistics, [Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances](#) (accessed June 3, 2020) (276 million registered highway vehicles in the United States in 2020). European Automobile Manufacturers Association, [Vehicles in Use – Europe](#) (January 2021) at p.9 (278 million motor vehicles in the EU in 2019); [World Bank Data](#) (accessed June 3, 2022) (in 2020, China population = 1.4 billion, US population = 332 million); [Eurostat News Release](#) (July 10, 2019) (513 million people in the EU in 2019).

10 Ministry of Industry and Information Technology, [“2020年度中国乘用车企业平均燃料消耗量与新能源汽车积分情况公告 \[2020 China Passenger Car Industry Average Fuel Consumption and NEV Points Report\],”](#) (July 15, 2021) (in Chinese).

11 Beijing Transport Institute, [2021 China Urban Transportation Report](#) (2021) (in Chinese).

12 Ministry of Industry and Information Technology, [“2020年度中国乘用车企业平均燃料消耗量与新能源汽车积分情况公告 \[2020 China Passenger Car Industry Average Fuel Consumption and NEV Points Report\],”](#) (July 15, 2021) (in Chinese).

13 IEA, [Fuel Economy in China](#) (December 13, 2021).

14 Ruoxi Wu et al., [“Evaluation of real-world fuel consumption of light-duty vehicles in China: A 2021 update,”](#) International Council on Clean Transportation (October 2021).

NOTE ON UNITS

In China and most of the world, the standard measure of vehicle fuel efficiency is liters per 100 kilometers (L/100 km). In the United States, the standard measure is miles per gallon (mpg).

- *When using liters per 100 kilometers (fuel per unit of distance), lower numbers indicate better performance.*
- *When using miles per gallon (distance per unit of fuel), higher numbers indicate better performance.*

Several websites offer conversion tables, including [CalculateMe.com](https://www.calculateme.com) and [Calculator Site](https://www.calculator.net).

Policies

The Chinese government requires all new passenger vehicles to meet fuel efficiency standards. The Ministry of Industry and Information Technology (MIIT) issues these standards. According to the State Council, the purpose of China's fuel efficiency standards is "to ease fuel supply and demand contradictions, reduce emissions, improve the atmospheric environment, and promote the automotive industry and technological progress."¹⁵

The Chinese government's fuel efficiency standards have two main parts.

- First, each vehicle must meet a fuel efficiency standard based on its weight. These standards were first issued in 2004 and have been tightened every few years since.¹⁶
- Second, each vehicle manufacturer must meet Corporate Average Fuel Consumption (CAFC) limits. The most recent CAFC policy was adopted in February 2021. These limits apply to each manufacturer's new vehicle fleet as a whole on an annual basis. The standard for 2020 is 5 L/100 km. This will tighten to 4 L/100 km in 2025 and 3.2 L/100 km in 2030.¹⁷

Manufacturers are offered several flexibility schemes to help meet the CAFC standards.

- First, manufacturers may use "NEV credits" to help meet the standards. These credits

¹⁵ State Council, "[Notice on the issuance of energy-saving and new energy automotive industry development plan \(2012–2020\)](#)," (June 28, 2012) (in Chinese); See Innovation Center for Energy and Transportation, [China Passenger Vehicle Fuel Consumption Development Annual Report 2017](#) (September 2017).

¹⁶ TransportationPolicy.net, "[China: Light Duty: Fuel Consumption](#)" (accessed September 10, 2022); Innovation Center for Energy and Transportation (ICET), [China Passenger Vehicle Fuel Consumption Development Annual Report 2016](#) (September 2016) at p.2.

¹⁷ "[《乘用车燃料消耗量限值》强制性国家标准发布](#)," Ministry of Industry and Information Technology of the People's Republic of China, (February 23, 2021) (in Chinese); International Energy Agency, [Fuel Economy in China](#) (December 13, 2021); TransportationPolicy.net, "[China: Light Duty: Fuel Consumption](#)," (accessed September 10, 2022).

include a multiplier for various characteristics, such as electric drive trains. Pure EVs were initially allowed a multiplier of five, but this declined to two in 2020 and will decline to one (that is, the multiplier will disappear) by 2025. NEV credits can be (i) earned by manufacturing electric vehicles or (ii) purchased from electric vehicle manufacturers.¹⁸

- Second, manufacturers may average performance over several years, using overperformance in one year to compensate for underperformance in other years.¹⁹

In 2020, the majority of China's largest auto manufacturers exceeded their CAFC limits. Under MIIT's regulations, manufacturers must come into CAFC compliance by applying NEV credits or using other flexibility tools.²⁰

Chinese taxes on the manufacture and import of passenger cars vary by size, with larger cars paying more. This promotes fuel efficiency. There is also a 10% tax on "super-luxury vehicles" (priced above RMB 1.3 million, equal to roughly \$190,000). The Finance Ministry says this tax is aimed at encouraging "rational consumption" and promoting energy conservation.²¹

18 TransportationPolicy.net, "[China: Light Duty: Fuel Consumption](#)" (accessed September 10, 2022).

19 TransportationPolicy.net, "[China: Light Duty: Fuel Consumption](#)" (accessed September 10, 2022).

20 Ministry of Industry and Information Technology, "[2020年度中国乘用车企业平均燃料消耗量与新能源汽车积分情况公告 \[2020 China Passenger Car Industry Average Fuel Consumption and NEV Points Report\]](#)," (July 15, 2021) (in Chinese).

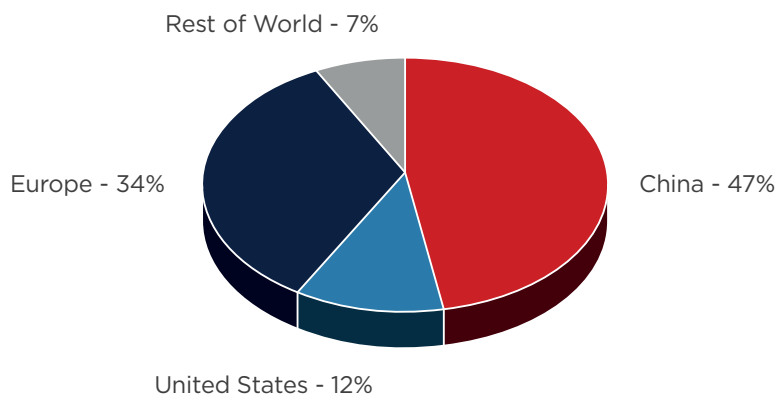
21 Xiang Lele, "[New Standard for Luxury Car Tax 2021](#)," PC Auto.com (accessed June 3, 2022) (in Chinese); Ministry of Finance, "[Notice about Additional Taxation on Luxury Vehicles](#)," (in Chinese).

C. Electric Vehicles

Background

China leads the world in deployment of electric vehicles. At the end of 2021, almost half the electric cars and 95% of electric buses and trucks in the world were in China. China also dominates global markets for electric two- and three-wheelers.²²

Figure 16-1: World Electric Car Stock



Source: IEA, *Global EV Outlook 2022* at p.16²³

In 2021, 3.5 million electric vehicles were sold in China, of which 3.3 million were passenger cars. Electric car sales were 16% of total car sales. As of the end of 2021, roughly 7.8 million electric vehicles were on the roads in China, accounting for roughly 2.6% of total vehicles.²⁴

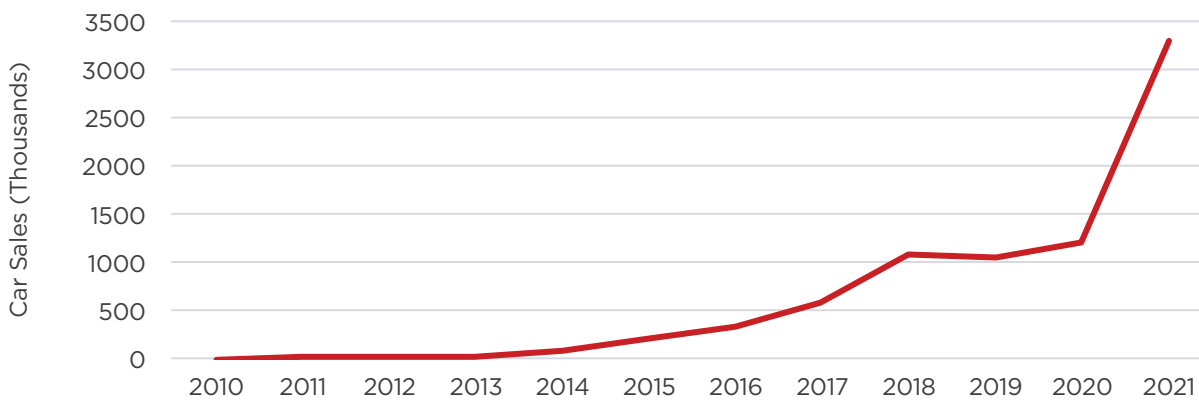
The growth in electric vehicle sales continued during the first half of 2022. From January through June 2022, 2.6 million electric vehicles were sold – a 120% year-over-year increase. Electric car sales reached 24% of total car sales.²⁵

22 IEA, [Global EV Outlook 2022](#) at pp. 14, 29, 36.

23 IEA, [Global EV Outlook 2022](#) at p.16

24 IEA, [Global EV Outlook 2022](#) at p.16; China Association of Automobile Manufacturers, “[2021年12月汽车工业产销综述 \[December 2021 Automotive Industry Production and Consumption Summary\]](#),” (January 13, 2022); China Association of Automobile Manufacturers, “[截至2021年底，全国新能源汽车保有量达784万辆，其中纯电动汽车保有量640万辆](#),” (January 13, 2021) (in Chinese).

25 Phate Zhang, “[China’s NEV sales reach record 596,000 units in June, CAAM data show](#),” CnEVPost (July 11, 2022)

Figure 16-2: Electric Car Sales in China (2010-2021)

Source: IEA, *Global EV Outlook 2022*²⁶

The foregoing figures do not include either electric bicycles or low-speed electric vehicles.

- Electric bicycles are omnipresent in China today. More than 325 million electric two-wheel scooters and motorcycles are on the roads, with roughly 47 million new units sold each year.²⁷ Most use lead-acid batteries, but lithium-ion batteries have steadily gained market share.
- As of year-end 2021, roughly 10 million low-speed electric vehicles (LSEVs) were in use in China. (These have approximately the size and performance of electric golf carts.) In recent years, sales have averaged roughly 2 million per year: Hebei, Shandong and Henan have seen the most sales of LSEVs.²⁸ These LSEVs generally have top speeds of no more than 70 kilometers (40 miles) per hour, short ranges and lead-acid batteries, and are not counted in tallies of NEV sales. Due to the wider variety of low-cost mini-EVs in smaller cities, LSEV sales may peak and decline in the coming years.

The number of EV charging stations in China is growing rapidly. In January 2022, the Chinese Electric Vehicle Charging Infrastructure Promotion Agency (EVCIPA) reported 2.6 million EV charging posts in China (a 47% increase in one year). Of these, roughly 1.1 million were public chargers, of which 470,000 were DC fast chargers. Charging station numbers are much larger in the wealthy coastal provinces where EV mandates and incentives have been strongest: Of the more than 74,000 total public charging stations, over half were located in the five provinces or municipalities of Guangdong, Jiangsu, Zhejiang, Shanghai and Beijing. The top

²⁶ IEA, [Global EV Outlook 2022](#) at p.16

²⁷ iResearch, [“2021年中国两轮电动车智能化白皮书 \[2021 China Two-wheeled EV Smart Energy White Paper\]”](#) (2021) (in Chinese).

²⁸ China Car Reports, [“2021年12月数据: 低速电动车已形成庞大产业 \[December 2021 statistics: LSEVs have become a huge industry\].”](#) (December 9, 2021) (in Chinese).

three charging station operators accounting for over half of public charging stations were TELD, State Grid and Star Charge.²⁹

Battery swapping stations are also rising rapidly, led by NIO which now uses battery swapping in a number of its vehicles. At the end of 2021, there were 1,298 battery swap stations in China. Nearly a quarter of these stations were in Beijing, with many in Guangdong Province as well. Almost all battery swap stations are owned by NIO (with 789 stations), Aulton (with 402) and Hangzhou First Technology.

Prices for public charging or battery swapping are regulated, typically using the industrial electricity price plus a maximum service fee with time-of-use price differentials. Each province sets its own public charging price. Prices range from RMB 0.4/kWh to RMB 2/kWh, with RMB 1.5/kWh (\$0.23/kWh) as a typical mid-price. Home charging in China generally employs the residential electricity price.³⁰

There are dozens of EV manufacturers in China and, according to some reports, the quality of Chinese EVs was initially uneven and Chinese EVs often had low driving range.³¹ The Chinese industry has grown and evolved rapidly in the past four years, and today there are a number of long-range luxury Chinese EVs on the market. This includes battery-swap pioneer NIO, Xpeng, Polestar (a subsidiary of Geely-owned Volvo) and MG (a British brand now owned by SAIC) that manufacture mid- to high-end EVs at volume for both the domestic and export markets. China's EV market has been described as having a barbell pattern, with large numbers of vehicles at the high- and low-ends, and fewer vehicles competing for ordinary, middle-priced vehicles.

Foreign automakers have also participated in China's EV market. Tesla opened its Shanghai factory in 2018 and now manufactures almost as many vehicles in China as in the US (The Tesla Model 3 is China's #2 top-selling EV, after the Hongguang mini-EV.) At the time of Tesla's Shanghai launch, China removed its joint-venture requirements for foreign automakers. China's top-selling EV, the Hongguang mini-EV, is a product of the joint venture between GM, SAIC and Wuling.

Fuel cell electric vehicles

In 2021, 1586 fuel cell electric vehicles were sold in China, bringing the country's total fuel cell electric vehicle fleet sales since production started in 2015 to 8938.³²

Most FCVs are buses or trucks. China dominates the market for fuel cell buses worldwide, accounting for a total of 3,300 fuel cell buses as of 2021, or two-thirds of the cumulative worldwide sales. China has also scaled up its deployment of hydrogen vehicle charging

29 ["China has 2.617 million EV charging piles by end of 2021,"](#) Gasgoo (January 12, 2022).

30 ["各地电动汽车充电服务费收费标准汇总 \[Local EV charging service fee list\],"](#) Auto Home (December 2, 2020) (in Chinese); State Grid, ["国家电网高速公路快充网络服务指南 \[State Grid Highway Charging Service Guide\],"](#) (2018) (in Chinese); ["新能源汽车充电价格表 \[NEV charging table\],"](#) Shangyici (October 23, 2021) (in Chinese).

31 Adam Minter, ["Electric Car Fires in China Should Set Off Alarms,"](#) Bloomberg Opinions (March 19, 2019)

32 ["2021年全国燃料电池汽车产销1777辆/1586辆 \[In 2021 China fuel cell vehicle production and sales were 1777 and 1586\],"](#) OFweek (January 13, 2022) (in Chinese).

infrastructure, adding 100 new stations in 2021 for a total of 218 hydrogen fueling stations.³³

Several cities have established pilot programs for fuel cell vehicles and hydrogen fueling infrastructure—and most policies aimed at hydrogen specifically focus on fuel cell vehicles. Beijing and Zhangjiakou included fuel cell buses and fueling infrastructure in the 2022 Winter Olympics plan, and Beijing plans to have over 10,000 fuel cell buses and 74 hydrogen fueling stations by 2025.³⁴ Many other cities have adopted hydrogen development programs that focus on fuel cell vehicles. Stand-outs include Chengdu, which plans to have at least 3,000 fuel cell vehicles and 30 hydrogen fueling stations by 2025,³⁵ and Datong, which has a target of 6,300 fuel cell vehicles and 50 hydrogen fueling stations by 2025 followed by 57,000 fuel cell vehicles by 2030.³⁶

Policies

“Developing new energy vehicles is essential for China’s transformation from a big automobile country to a powerful automobile country. We should increase research and development, seriously analyze the market, adjust existing policy and develop new products to meet the needs of different customers. This can make a strong contribution to economic growth.”

—President Xi Jinping (May 2014, visiting an electric vehicle factory in Shanghai).³⁷

The Chinese government strongly supports electric vehicles. Central government policies include:

- a target of 5 million electric vehicles on China’s roads by 2020 (a target missed, albeit barely, with 4.92 million NEVs registered by year-end 2020);³⁸
- a target of 20% NEV sales share by 2025;³⁹
- EV quotas for vehicle manufacturers and importers;
- manufacturing subsidies;

33 Harry Morgan, “[Buses and trucks accelerate as Chinese FCEV vehicles hit overdrive.](#)” ReThink Research (January 22, 2022).

34 Harry Morgan, “[Buses and trucks accelerate as Chinese FCEV vehicles hit overdrive.](#)” ReThink Research (January 22, 2022).

35 Chengdu City Government, “[成都市实施清洁能源替代攻坚加快能源消费结构调整工作方案2021—2025年征求意见稿 \[Chengdu City’s Implementation of Clean Energy Alternatives to Accelerate the Adjustment of Energy Consumption Structure Work Plan \(2021-2025\) \(Draft for Comment\)\]](#),” (August 18, 2021) (in Chinese).

36 Datong City Government, “[大同市氢能产业发展规划（2020-2030年） \[Datong City Hydrogen Industry Development Plan 2020-2030\]](#),” (Sept. 2020) (in Chinese).

37 “[Local governments claim jurisdiction over e-vehicle charging industry.](#)” *Lexology* (October 24, 2016).

38 “[公安部：2020年全国新能源汽车保有量达492万辆 \[Public Safety Bureau: In 2020 NEV stock reached 4.92 million\]](#),” Number 1 EV (January 11, 2021) (in Chinese).

39 China State Council, “[国务院办公厅关于印发新能源汽车产业发展规划（2021—2035年）的通知 \[State Council publishes New Energy Vehicle Industry Development Plan 2021-2035\]](#),” (October 20, 2020) (in Chinese).

- tax exemptions;
- government procurement;
- support for the construction of electric vehicle charging stations.

Many provincial governments also support electric vehicles, with preferential access to license plates and other incentives.

The goals of these policies include: cleaning the air in China's cities, reducing China's oil imports, positioning China for global leadership in a strategic industry and helping to meet President Xi's carbon neutrality goal.⁴⁰

The Chinese central government's principal policies to promote electric vehicles include the following.

1. New emissions vehicle mandate. Starting in 2019, each Chinese passenger vehicle manufacturer and importer was required to make or import at least 3.8% electric vehicles to meet the 10% NEV credit requirement, assuming a corporate average electric range of 200 km. The credit required increased to 12% in 2020 and, with a more stringent conversion rate, increased to 14% in 2021, 16% in 2022 and 18% in 2023, though vehicles with long ranges can qualify for extra credit. These regulations apply to any company that manufactures or imports more than 30,000 passenger vehicles in China. Companies that fail to achieve the required percentages may purchase credits from companies that over-comply. The target for 2025 is for 20% NEV sales. (This target was achieved in the first half of 2022.)⁴¹
2. Subsidies. The Chinese government provides subsidies to manufacturers of electric vehicles.
 - All-electric plug-in cars with a range over 400 km are eligible for subsidies of RMB 12,600 (approximately \$2000).
 - All-electric plug-in cars with a range of 300–400 km are eligible for subsidies of RMB 9100 (approximately \$1400).
 - Plug-in hybrid cars are now eligible for subsidies of RMB 4800

40 See State Council, “[国务院办公厅关于印发新能源汽车产业发展规划（2021—2035年）的通知 \[State Council publishes New Energy Vehicle Industry Development Plan 2021-2035\].](#)” (October 20, 2020) (in Chinese); Anders Hove, “[These four lessons will help China win the electric vehicle market.](#)” (May 9, 2017).

41 International Council On Clean Transportation, China's New Energy Vehicle Mandate Policy (Final Rule) (accessed June 9, 2022); TransportationPolicy.net, “[China: Light Duty: Fuel Consumption.](#)” (accessed September 10, 2022); 新能源乘用车车型积分计算方法 [NEV passenger car model point calculation methodology], in Wang Wuyou, “工信部修订“双积分”管理办法 明确2021-2023年新能源汽车积分比例 [MIIT revises dual credit management, clarifies 2021-2023 NEV point proportions],” Number 1 EV (June 22, 2020) (in Chinese); Craig Hart, Zhu Jiayan and Ying Jiahui, Mapping China's Climate and Energy Policies (December 2018) at p. 104; International Council On Clean Transportation, China's New Energy Vehicle Mandate Policy (Final Rule) (January 2018).

(approximately \$750).⁴²

All-electric plug-in cars with a range of less than 250 km are no longer eligible for subsidies.

All subsidies for the manufacture of plug-in electric cars were scheduled to be eliminated in 2021, though this was extended to the end of 2022.⁴³ Subsidies for plug-in electric buses are being reduced as well.⁴⁴

3. Tax exemptions. The Chinese government exempts electric vehicles from consumption and sales taxes, which can save purchasers tens of thousands of RMB (equivalent to thousands of dollars).⁴⁵
4. Procurement. The Chinese government also uses its procurement power to promote electric vehicles. A May 2016 order requires that half of new vehicles purchased by China's central government be new energy vehicles within five years.⁴⁶
5. New auto factory requirements. Chinese regulations strongly discourage the construction of factories for manufacturing internal combustion engine vehicles only. Subject to exceptions that are difficult to satisfy, any new vehicle factory is required to include capacity for the construction of electric vehicles.⁴⁷
6. Support for charging infrastructure. The Chinese central government promotes the development of EV charging infrastructure as a matter of national policy. It sets targets (120,000 EV charging stations and 4.8 million EV charging posts by 2020), provides funding and mandates standards. In 2022, the government also required all new communities and workplaces to have EV charging installed.⁴⁸ In addition, many provincial and municipal governments promote EV charging infrastructure with financial incentives and requirements that building owners provide EV charging. China State Grid and China Southern Grid, China's two state-owned

42 Ministry of Finance, [“关于2022年新能源汽车推广应用财政补贴政策的通知 \[2022 New Energy Vehicle Incentive Policy Finance Notice\].”](#) (December 31, 2021) (in Chinese).

43 Ministry of Finance, [“关于2022年新能源汽车推广应用财政补贴政策的通知 \[2022 New Energy Vehicle Incentive Policy Finance Notice\].”](#) (December 31, 2021) (in Chinese).

44 NDRC, MOST and Ministry of Finance, [“Notice on Further Improving the Financial Subsidy Policy for the Promotion and Application of New Energy Vehicles.”](#) (March 26, 2019) (in Chinese); Nikki Sun, [“EV subsidy cuts give Chinese automakers more reason to fret.”](#) Nikkei Asian Review (April 8, 2019); Tamara Sheldon and Rubal Dua, [“Impact of China's Plug-In Electric Vehicle Subsidy Reduction.”](#) KAPSARC (July 7, 2019).

45 “Ministry of Finance, [“关于新能源汽车免征车辆购置税有关政策的公告 \[NEV tax exemption policy\].”](#) (April 16, 2020) (in Chinese).

46 Zolzaya Erdenebileg, [“Shifting Gears: Investing in China's Electric Vehicles Market.”](#) China Briefing (May 11, 2016); See also Shiqi Ou et al., [A Study of China's Explosive Growth in the Plug-In Electric Market](#) (January 2017); Trefor Moss, [“China, With Methodical Discipline, Conjures a Market for Electric Cars.”](#) Wall Street Journal (October 2, 2017).

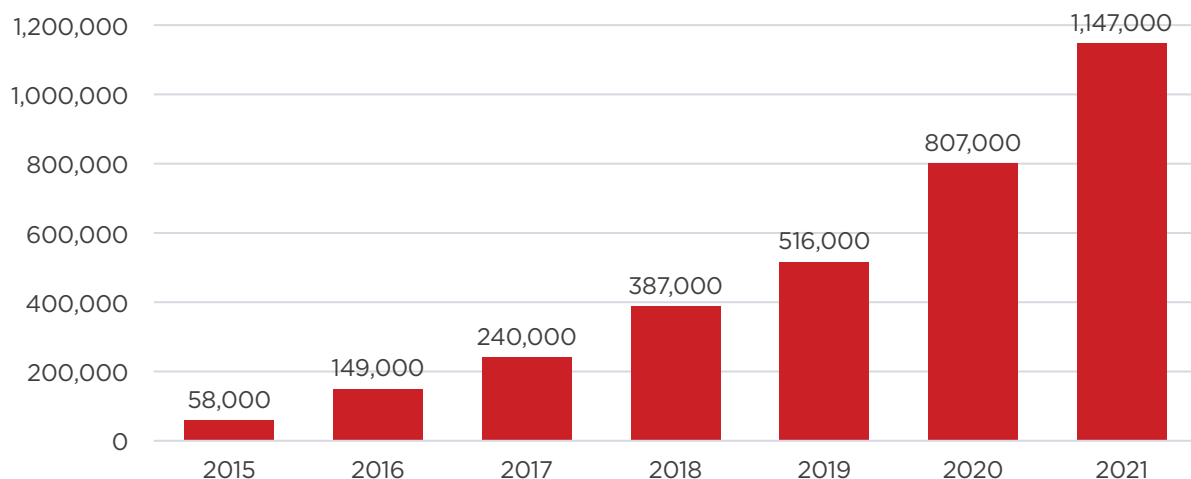
47 Echo Huang, [“China's making it super hard to build car factories that don't make electric vehicles.”](#) Quartz (December 19, 2018); NDRC, [“汽车产业投资管理规定” \[Administrative Provisions for Investment in the Automobile Industry\]](#) (December 2018).

48 National Development and Reform Commission, [“国家发展改革委等部门关于进一步提升电动汽车充电基础设施服务保障能力的实施意见 \[NDRC Restructuring Department publishes opinion on further raising EV charging infrastructure service\].”](#) (January 10, 2022) (in Chinese).

electric utilities, both have programs to promote the development of electric vehicle charging infrastructure.⁴⁹

7. Support for fuel cell electric vehicles. In 2018, the Chinese government began offering a subsidy of up to RMB 200,000 (roughly \$29,000) for fuel cell electric cars and RMB 500,000 (roughly \$72,500) for fuel cell electric trucks and buses.⁵⁰ These subsidies have now ended and been replaced by demonstration programs in pilot cities to be selected by the central government.⁵¹ As noted, several cities have their own fuel cell vehicle programs.

Figure 16-3: Number of Public Charging Stations in China (2015-2021)



Source: China Electric Vehicle Charging Infrastructure Promotion Alliance⁵²

Many Chinese provincial and local governments are very active in promoting electric vehicles as well.

- Many municipalities provide license plates for electric vehicles much faster and cheaper than for conventional vehicles. (In Beijing, for example, plates for electric

49 Anders Hove and David Sandalow, [Electric Vehicle Charging in China and the United States](#), Center on Global Energy Policy (February 2019); NDRC, NEA, MIIT and others, [“Action plan for enhancing the charging capacity for electric vehicles.”](#) (November 9, 2018) (in Chinese).

50 Ayako Matsumoto, [Development Potential of Hydrogen Fuel Cell Electric Vehicles in China](#) (March 2019); Jimmy Li, [Hydrogen Energy Country Overview](#) (September 11-12, 2018); Aaron Cole, [“The Godfather of EVs in China has turned his attention to hydrogen cars.”](#) Green Car Reports (June 20, 2019); Henry Sanderson, [“Hydrogen power: China backs fuel cell technology.”](#) Financial Times (January 1, 2019); Zheng Xin, [“Hydrogen vehicles on their way.”](#) China Daily (April 11, 2019); [“Project launched to develop hydrogen fuel cells in E China.”](#) Xinhua (August 30, 2018).

51 Ministry of Finance, [“关于开展燃料电池汽车示范应用的通知 \[Notice on developing fuel cell vehicle pilots\]”](#) (October 23, 2020) (in Chinese).

52 [China Electric Vehicle Charging Infrastructure Promotion Alliance](#)

vehicles can be obtained in months, while plates for conventional vehicles can take years. In Shanghai, plates for electric vehicles are free, while plates for conventional vehicles cost more than \$12,000.)

- Free and preferential parking spaces for electric vehicles are common.
- Many large Chinese cities restrict passenger cars from driving on certain days based on their license plate number but exempt electric cars from such restrictions.
- Some municipalities pay local manufacturers subsidies for electric vehicles.
- Shenzhen's entire taxi fleet is all-electric.
- In March 2019, Hainan provincial officials announced that the sale of fossil fuel cars would be banned in the province starting in 2030.⁵³

The provincial and municipal government policies play an important role in the development of China's electric vehicle market.

Chinese government policies with respect to electric vehicles are set forth in a number of documents, including the *New Energy Vehicle Industry Development Plan 2021-2035* (October 2020).⁵⁴

Impact on CO₂ Emissions

What impact do electric vehicles have on China's CO₂ emissions? Though the majority of China's electricity comes from coal, carbon emissions from EVs are generally lower on a life-cycle basis than internal combustion vehicles due to the greater efficiency of electric vehicles.

- The IEA estimated that electric vehicles in China avoided 30 MT of CO₂ emissions in 2018.
- The ICCT in 2021 estimated that in 2020 EVs would have life-cycle emissions 37-45% lower than internal combustion vehicles in China, whereas for 2030 EVs would offer life-cycle emissions 48-64% lower than ICE vehicles.⁵⁵
- In 2021, the China Automotive Technology & Research Center (CATARC) estimated per km life-cycle emissions of 2020 hybrid passenger vehicles as 18% lower, plug-in

53 See Anders Hove and David Sandalow, [Electric Vehicle Charging in China and the United States](#) (February 2019); Juma Feiteng, "[Summary of new energy policies in November 2018.](#)" (December 3, 2018) (in Chinese); Ayako Matsumoto, [Development Potential of Hydrogen Fuel Cell Electric Vehicles in China](#) (March 2019); "[Shenzhen taxis will be 100% pure electric, with energy consumption of only 20 cents per kilometer.](#)" Sohu (January 7, 2019); Liu Yukun, "[Hainan launches plan to stop selling fossil-fuel cars by 2030.](#)" China Daily (March 12, 2019); Shiqi Ou et al., [A Study of China's Explosive Growth in the Plug-In Electric Market](#) (January 2017) at pp.39-40.

54 China State Council, "[国务院办公厅关于印发新能源汽车产业发展规划（2021—2035年）的通知](#) [State Council publishes *New Energy Vehicle Industry Development Plan 2021-2035*]." (October 20, 2020) (in Chinese).

55 George Bieker, [A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars](#) International Council on Clean Transportation" (July 2021).

hybrids as 12% lower and pure EVs as 39% lower than ICE vehicles.⁵⁶ The CATARC study notes that the emissions reduction and water-saving benefits of EVs will rise steadily towards 2060.

The CO₂ impacts of electric vehicles likely vary within China depending on where and when the vehicles are charged. China's electric generation is more carbon intensive in the north than in the south, for example, and renewable output varies by time. A 2022 study of EV smart charging in China showed that timing charging could enable a 20% reduction in well-to-wheel heat-trapping gas emissions while also reducing the need for new charging infrastructure.⁵⁷

Electric vehicles have the potential to significantly reduce CO₂ emissions from the Chinese vehicle fleet as the carbon intensity of China's power sector declines in the decades ahead. In the medium- to long-term, vehicle electrification will be important to meeting the Chinese government's goals for a low-carbon economy.

56 China Automotive Technology & Research Center (CATARC), [中国汽车低碳行动计划研究报告2021 \[China Automotive Low-Carbon Program 2021 Research Report\]](#) (2021) (in Chinese).

57 Jiahui Chen et al., "[Emission mitigation potential from coordinated charging schemes for future private electric vehicles.](#)" *Applied Energy* (February 15, 2022).

CHAPTER 17 - URBAN AIR POLLUTION

Air pollution chokes many Chinese cities. Soot and haze levels exceed national and international health standards, often greatly, although air quality has improved in many Chinese cities in recent years.¹

Most Chinese policies to help fight urban air pollution also help fight climate change. This chapter provides background on urban air pollution in China, summarizes the principal policies to address it and considers the impact of those policies on climate change.

Background

The primary air pollutant in China's urban areas is particulate matter. Fine particulates known as PM_{2.5} (particles smaller than 2.5 microns in diameter) are a significant problem. PM_{2.5} has a negative impact on human health due to its ability to penetrate lung tissue, enter the bloodstream and accumulate in the central nervous system. It can cause acute health problems on high pollution days as well as chronic cardiovascular and neurological diseases that can develop years after exposure to polluted conditions.²

PM_{2.5} comes from many sources, especially heavy industry, coal burning for heating, vehicle emissions, power plant smokestack emissions, crop burning and fertilizers. A large fraction of China's PM_{2.5} comes from secondary formation of particulates from precursor pollutants such as nitrates, sulfates, volatile organic compounds, ammonia and elemental carbon (dust). During haze events (extended periods of high ambient PM_{2.5} covering vast regions), stagnant air and air inversion conditions in the North China Plain can lead to rapid increases in secondary PM_{2.5} formation from these precursor chemicals.³

Regional transport of air pollutants is a significant factor in air pollution in many Chinese cities. During periods of severe haze, regional transport often accounts for a large fraction of ambient PM_{2.5}. As a result, preventing haze requires regional coordination, not just local emissions reductions.⁴

1 Xi Lu et al., "[Progress of Air Pollution Control in China and Its Challenges and Opportunities in the Ecological Civilization Era](#)," *Engineering*, Vol. 6, Issue 12 (December 2020), pp. 1425-1431; World Economic Forum, [How China is tackling air pollution with big data](#), (February 10, 2021); New York Times, [Blue skies in China, no longer just for the Olympics](#)

2 You Jun Kang et al., "[An Air Particulate Pollutant Induces Neuroinflammation and Neurodegeneration in Human Brain Models](#)," *Advanced Science* (November 2021); Lilian Calderón-Garcidueñas et al., "[Long-term air pollution exposure is associated with neuroinflammation, an altered innate immune response, disruption of the blood-brain barrier, ultrafine particulate deposition, and accumulation of amyloid beta-42 and alpha-synuclein in children and young adults](#)," *Toxicol. Pathol.* (February 2008); Yun-Chul Hong et al., "[Air pollution: a new risk factor in ischemic stroke mortality](#)," *Stroke* (February 2002); Elissa H. Wilker et al., "[Long-term exposure to fine particulate matter, residential proximity to major roads and measures of brain structure](#)," *Stroke* (2015).

3 Zhisheng An et al., "[Severe haze in northern China: A synergy of anthropogenic emissions and atmospheric processes](#)," *Proceedings of the National Academy of Sciences* (April 15, 2019); Rujin Huang et al., "[High secondary aerosol contribution to particulate pollution during haze events in China](#)," *Nature* (October 9, 2014); X. J. Zhao et al., "[Analysis of a winter regional haze event and its formation mechanism in the North China Plain](#)," *Atmos. Chem. Phys.* (June 13, 2013).

4 Yang Hua et al., "[Investigating the impact of regional transport on PM_{2.5} formation using vertical observation during APEC 2014 Summit in Beijing](#)," *Atmos. Chem. Phys.* (2016); Wei Wen et al., "[Understanding the Regional Transport Contributions of Primary and Secondary PM_{2.5} Components over Beijing during a Severe Pollution Episodes](#)," *Aerosol and air quality research* (July 2018); J. G. Zheng et al., "[Exploring the severe winter haze in Beijing: the impact of synoptic weather, regional transport and heterogeneous reactions](#)," *Atmos. Chem. Phys.* (March 17, 2015).

Urban air pollution worsened significantly in many parts of China during the first part of this century. From 2001 to 2007, areas with 92% of China's population experienced sharply negative air quality trends. According to satellite data, very few urban areas met national air quality standards. A long period of especially severe air pollution in the winter of 2013 gained widespread attention and became known as the Airpocalypse.⁵

These trends reversed in 2013/2014. Since then, almost 80% of China has experienced air quality improvement. The proportion of cities achieving national air quality standards for PM_{2.5} has increased notably, particularly in eastern and southern regions.⁶ PM_{2.5} concentrations decreased from 66 micrograms/m³ in 2013 in the Beijing–Tianjin–Hebei region to 41 micrograms/m³ in 2018. A similar improvement took place in the Sichuan Basin and Shanghai Yangtze River Delta regions. On a national average basis, PM_{2.5} concentrations fell from 55 micrograms/m³ in 2013 to 31 micrograms/m³ in 2018.⁷

In 2019, researchers at Tsinghua University found that meteorological conditions were responsible for only 16% of the improvement in air quality in the Beijing–Tianjin–Hebei region and played no role in improvements in other air quality control regions. Policies to control air pollution were a more significant factor. Of the policy actions taken, the most important were those that addressed industrial emissions, including the enforcement of stricter emissions standards and closure of inefficient industrial boilers. Changes to residential heating or vehicle emissions were minor factors.⁸

Researchers at Tsinghua and the Beijing Environmental Bureau found that, between 2013 and 2017, local emissions reductions accounted for 65% of improved air quality and regional reductions accounted for 22%. Coal boiler controls, cleaner residential heating, closure of local emissions-intensive industry and vehicle emissions controls contributed to local emissions reductions (in that order).⁹ Other researchers have found that favorable weather accounted for 14% of the improvement in air quality in Beijing and up to 27% in Sichuan from 2013 to 2018.¹⁰

Air quality policies have focused on the largest emitting sectors, particularly coal combustion in heavy industry and electricity generation. Sulfur emissions have seen the strongest reductions, which led to a decrease in severe haze events caused by formation of secondary

5 In Chinese: “空气末日.” Qingqing He et al., [“Satellite-derived 1-km estimates and long-term trends of PM_{2.5} concentrations in China from 2000 to 2018.”](#) Environment International (November 2021).

6 Qingqing He et al., [“Satellite-derived 1-km estimates and long-term trends of PM_{2.5} concentrations in China from 2000 to 2018.”](#) Environment International (November 2021).

7 Jing Wei et al., [“Reconstructing 1-km-resolution high-quality PM_{2.5} data records from 2000 to 2018 in China: spatiotemporal variations and policy implications.”](#) Remote Sensing Environment (January 2021).

8 Qiang Zhang et al., [“Drivers of improved PM_{2.5} air quality in China from 2013 to 2017.”](#) Proceedings of the National Academies of Science (December 3, 2019).

9 Jing Cheng et al., [“Dominant role of emission reduction in PM_{2.5} air quality improvement in Beijing during 2013–2017: a model-based decomposition analysis.”](#) Atmos. Chem. Phys. Discuss. (May 9, 2019).

10 Shixian Zhai et al., [“Fine particulate matter \(PM_{2.5}\) trends in China, 2013–2018: separating contributions from anthropogenic emissions and meteorology.”](#) Atmos. Chem. Phys. (August 29, 2019).

PM2.5 during periods of high humidity.¹¹ Nitrogen and ammonia have seen smaller emissions reductions. As coal power and industrial emissions have fallen, the contribution of coal heating, vehicle tailpipe emissions (particularly diesel trucks) and agriculture has grown.¹²

During the first months of the COVID-19 pandemic in early 2020, nationwide transportation restrictions and work closures resulted in significant improvements in China's air quality—although a few weather-related haze events took place during this period.¹³ NO₂ emissions, which are mainly associated with heavy industry, fell 36% from the prior year during the lockdown period. However, NO₂ emissions levels returned back to normal levels by the end of March 2020.¹⁴

The health consequences of China's air pollution are significant. Studies have found that:

- air pollution contributes to 1.6 million premature deaths per year in China;¹⁵
- roughly 500 million residents of northern China have lost more than 2.5 billion years of life expectancy due to air pollution from coal burning;¹⁶
- almost 100 million people in China suffer from chronic obstructive pulmonary disease, and air pollution is one of the main causes;¹⁷
- deaths from cardiovascular and pulmonary disease in 272 Chinese cities are closely related to PM2.5 levels in those cities;¹⁸ and
- PM2.5 and ozone emissions from six sectors in China cause roughly 1.1 million premature deaths and cost approximately RMB 267 billion (roughly \$38 billion) per year.¹⁹

11 Haiyue Li et al., "[Rapid transition in winter aerosol composition in Beijing from 2014 to 2017: response to clean air actions.](#)" *Atmos. Chem. Phys.* (September 12, 2019).

12 Deng Qi et al., "[北京PM2.5来源机动车等移动源成最大头 \[Beijing PM2.5 sources and vehicles becoming leading factor\].](#)" (in Chinese) *Beijing News* (May 14, 2018).

13 Xin Huang, "[Enhanced secondary pollution offset reduction of primary emissions during COVID-19 lockdown in China.](#)" *National Science Review* (June 18, 2020).

14 Lauri Myllyvirta, "[Analysis: Coronavirus temporarily reduced China's CO₂ emissions by a quarter.](#)" *Carbon Brief* (February 19, 2020 and updated March 30, 2020).

15 Robert A. Rohde and Richard A. Muller, "[Air Pollution in China: Mapping of Concentrations and Sources.](#)" *PLOS ONE* (August 2015).

16 Yuyu Chen, Avraham Ebenstein, Michael Greenstone and Hongbin Li, "[Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy.](#)" *Proceedings of the National Academy of Sciences of the United States* (August 2013).

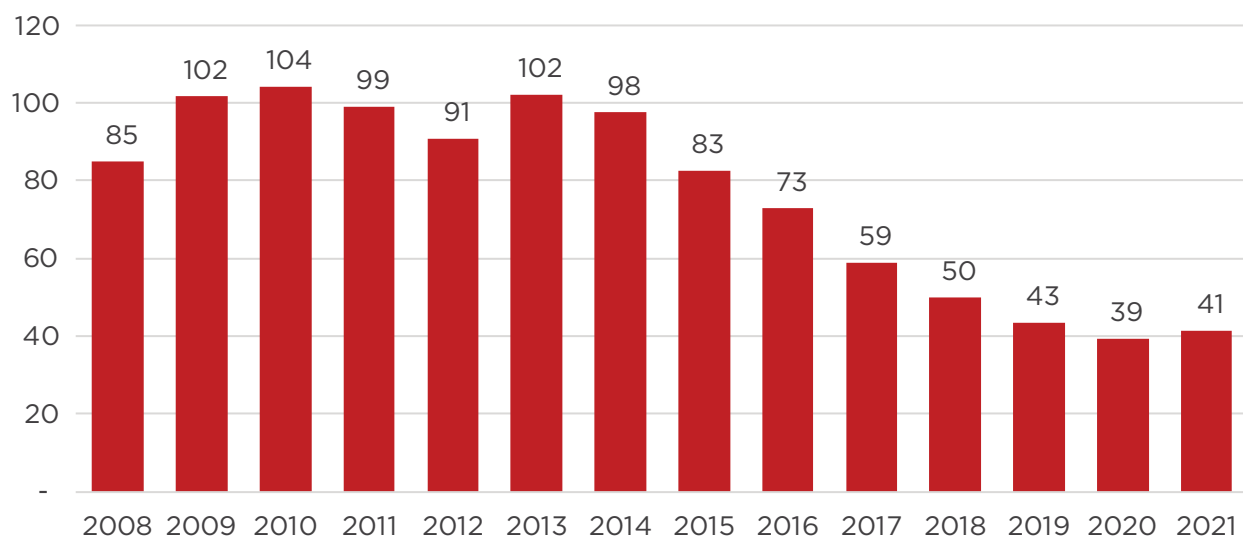
17 Liwen Fang et al., "[Chronic Obstructive Pulmonary Disease in China: a Nationwide Prevalence Study.](#)" *Lancet Respiratory Medicine* (June 2018).

18 American Thoracic Society, "Chinese Air Pollution Linked to Respiratory and Cardiovascular Deaths," *ScienceDaily* (February 10, 2017); Yaohua Tian et al., "[Fine Particulate Air Pollution and Hospital Visits for Asthma in Beijing, China.](#)" *Environmental Pollution* (November 2017); Lei Zhao et al., "[Association Between Air Pollution and Cardiovascular Mortality in China: a systematic review and meta-analysis.](#)" *Oncotarget* (September 12, 2017).

19 Yefy Gu et al., "[Impacts of sectoral emissions in China and the implications: Air quality, public health, crop production and economic costs.](#)" *Environmental Research Letters* (July 2018).

In recent decades, air pollution has been a top concern of many Chinese citizens. In a 2016 survey of Beijing residents, 96% said that poor air quality had negatively affected their health. In a 2015 national survey, 76% of respondents said that air pollution was a “big problem” and 35% of respondents said it was a “very big problem”. The air pollution documentary *Under the Dome* was viewed more than 300 million times in China before it was removed from Internet platforms four days after its 2015 release.²⁰

Figure 17-1: Beijing Hourly PM2.5 Readings - Annual Averages (2008-2021)



Source: U.S. Embassy, Beijing²¹

20 Zhang, X, “[The Reemerging Concern over Air Pollution in China: the Smog of the State’s Efforts to Guide Public Opinion](#),” *Journal of Chinese Political Science* (2018) at pp. 519-536; George Gao, “[As Smog Hangs Over Beijing, Chinese Cite Air Pollution As Major Concern](#),” Pew Research Center (December 2015). See also: Cunningham, Edward, Tony Saich and Jessie Turiel, “[Understanding CCP Resilience: Surveying Chinese Public Opinion Through Time](#),” Ash Center for Democratic Governance and Innovation (2020); Li, X., & Tilt, B, “[Public engagements with smog in urban China: Knowledge, trust, and action](#),” *Environmental Science & Policy* (2019) at pp.220-227; Associated Press, “[As Incomes Rise in China, So Does Concern About Pollution](#),” (October 2016); Richard Wike and Bridget Parker, “[Corruption, Pollution, Inequality Are Top Concerns in China](#),” Pew Research Center (September 2015).

21 U.S. Embassy, Beijing, data available for [download](#).

Policies

Cutting air pollution is a long-standing goal of Chinese leaders. President Xi Jinping announced a Blue Skies Initiative shortly after coming into office in 2013 and spoke about the war against pollution in several high-profile settings in the 2010s, as did Premier Li Keqiang.²² In recent years, President Xi and Premier Li have spoken less about air pollution, in part because the air pollution problem is not as dire as it was in 2013/2014 and in part because other issues including COVID, energy security, the economy and carbon neutrality have risen on the agenda.

China's first air pollution law dates to 1987. In the decades that followed, China's air pollution laws were mostly ineffective due to sporadic enforcement, low penalties and weak monitoring. Perhaps most important, local officials generally lacked incentives to make clean air a priority. Starting around 2007, the Chinese government developed and implemented serious measures to control air pollution in connection with the 2008 Beijing Summer Olympics. However, these measures affected only the Beijing area and were mostly short-term, such as shutting down factories before and during the Olympics. By 2009, air pollution in the Beijing area returned to its earlier high levels.²³

In September 2013, the Chinese government announced the *Action Plan on Prevention and Control of Air Pollution*, following the horrific air pollution events of the previous winter. The action plan called for a 10% cut in PM10 concentrations by 2017 in cities across China, with more stringent PM2.5 reduction targets in three key regions: a 25% reduction by 2017 for Beijing–Tianjin–Hebei, 20% reduction for the Yangtze River Delta and 15% reduction for the Pearl River Delta, with Beijing establishing a specific target to reduce average annual PM 2.5 concentrations to 60 ug/m³. It described 10 tasks for cleaning the air, including tightened enforcement, changes to the industrial and energy supply structure in key regions, strengthening enforcement, establishing regional coordination and setting up a public early warning system for pollution episodes.²⁴

Measures to control coal burning were a top priority. They included a ban on new coal-fired power capacity, improved SO₂ and NO_x controls at coal-fired power plants and policies to promote alternatives to coal (including natural gas, hydropower, wind power, solar power and nuclear power). Stricter vehicle fuel efficiency and emissions standards have also been adopted. The Chinese government has led campaigns against the use of fireworks during Spring Festival, a long-standing Chinese tradition, for air quality reasons.

Other changes include greater incentives for local officials to prioritize air quality, better air

22 President Xi spoke about air pollution at the 19th Party Congress in October 2017 and 13th National People's Congress in March 2018). For remarks by Premier Li, see China Daily, "[李克强对话夏季达沃斯论坛中外企业家代表 \[Premier Li Keqiang's Dialogues with Chinese and Foreign Entrepreneurs in Summer Davos Forum\]](#)," (in Chinese) (September 2013); ABC News, "[China's Premier Li Keqiang Vows to Tackle Chronic Air Pollution](#)," (March 2017); Ministry of Foreign Affairs, "[Transcript of Premier Li Keqiang's Meeting with the Press at the Fifth Session of the 12th National People's Congress](#)" (in Chinese) (March 2017).

23 Yana Jin, Henrik Andersson and Shiqiu Zhang, "[Air Pollution Control Policies in China: A Retrospective and Prospect](#)," *International Journal of Environment Research and Public Health* (December 2016); Rob Schmitz, "[China's Fight for Cleaner Air](#)," *Marketplace* (July 2014); Colgate University, "[The History of Air Pollution in China](#)."

24 China's State Council, "[National Action Plan on Prevention and Control of Air Pollution](#)" (in Chinese) (2013).

pollution monitoring, larger penalties and stricter enforcement. In 2014, Chinese authorities brought roughly 2000 criminal cases for environmental violations—double the number for the past 10 years combined. In November 2016, more than 1100 Chinese officials were held accountable for violations of air pollution laws.²⁵ In 2021, authorities issued 133,000 fines totaling RMB 11.6 billion, arrested 3397 people, closed 1093 polluting facilities and reported nearly 9000 property or asset seizures related to environmental enforcement.²⁶

China's 13th Five-Year Plan (2016–2020) prioritized fighting air pollution. In addition to limits on coal consumption, the plan set quantitative goals for air pollution reduction and air quality, including a 15% cut in SO₂ and NO_x levels and a requirement that all cities meet air quality standards at least 80% of the time. Monitoring capabilities were enhanced dramatically, and each province was required to share air quality information regularly.²⁷ Figures published by the Ministry of Ecological Environment show that China met or exceeded the 13th Five-Year Plan targets. Between 2013 and 2017, the average concentration of PM2.5 fell 39.6% in Beijing–Tianjin–Hebei, 34.3% in the Yangtze River Delta and 27.7% in the Pearl River Delta.²⁸

During 2017, strict policies on coal burning, industrial activities and traffic were announced for the Beijing–Tianjin–Hebei area. These helped produce record cuts in pollution levels during the fall and winter of 2017–2018. However, natural gas supplies to replace coal in the region lagged, leading to shortages and inadequate heating during parts of the winter.²⁹

In June 2018, the State Council issued its *Three-Year Action Plan for Blue Sky Defense*. The Action Plan called for significantly reducing fine particulates and other air pollution with measures to control the production capacity of highly-polluting industries, promote clean heating and cut pollution from vehicles (including in particular heavy trucks).³⁰ It covered the greater Beijing–Tianjin–Hebei region (including Shandong and parts of Shanxi province), Yangtze River Delta and neighboring provinces, and the Fenwei Plain covering parts of Shanxi, Shaanxi and Henan provinces. The Action Plan set targets for reducing coal use, including a

25 Yana Jin, Henrik Andersson and Shiqiu Zhang, “Air Pollution Control Policies in China” (December 2016); China News, “[环保部：2014年8458名环境案件犯罪嫌疑人被抓捕 \[Ministry of Environmental Protection: 8458 Suspects Arrested in Environmental Criminal Actions in 2014\]](#),” (in Chinese) (June 2015); Christopher Beam, “China Tries a New Tactic to Combat Pollution: Transparency,” *The New Yorker* (February 2015).

26 Ministry of Ecological Environment, “[生态环境部通报2021年1-12月环境行政处罚案件与《环境保护法》配套办法执行情况 \[Ministry of Ecological Environment 2021 Environmental Enforcement and Fines and ‘Environmental Protection Law’ Administrative Update\]](#),” (in Chinese) (January 24, 2022).

27 NDRC, “13th Five Year Plan for Economic and Social Development of the People’s Republic of China” (2016) at pp.19 and 127; China’s State Council, “[“十三五”生态环境保护规划》主要内容 \[Key Components of the Five-Year Plan for Nationwide Ecological Protection\]](#),” (2016); Barbara Finamore, “[Tackling Pollution in China’s 13th Five Year Plan: Emphasis on Enforcement](#),” NRDC (March 2016); Beth Gardiner, “[China’s Surprising Solutions to Clear Killer Air](#),” *National Geographic* (May 5, 2017); “[Environmental Damages: 1,140 Chinese Officials Held Accountable](#),” *China Daily* (November 2017).

28 Ministry of Ecology and Environment, “Circular on the Final Assessment of the Implementation Plan of the Air Pollution Prevention Action Plan” (May 17, 2018); Chloe Wong, “[Air Pollution in China: Are China’s Policies Working?](#),” *Earth.org* (December 23, 2021).

29 Damien Sharkov, “[China Issues First National Smog Red Alert](#),” *Newsweek* (2017).

30 State Council, “[打赢蓝天保卫战三年行动计划 \[Three-Year Action Plan to Win the Blue Sky Defense War\]](#),” (in Chinese) (June 27, 2018); “[The State Council rolls out a three-year action plan for clean air](#),” Ministry of Ecology and Environment (July 13, 2018).

10% reduction from 2015 levels by 2020 for Beijing, Tianjin, Hebei, Shandong and Henan, and a 5% reduction from 2015 levels by 2020 for the Yangtze River Delta. In 2021, the Action Plan was declared a success in all of its major goals.³¹

To replace it, the government has announced a broader Three Landmark Campaign Program, covering air, water and soil quality. On air quality, the policy continues to emphasize the greater Beijing–Tianjin–Hebei and Fenwei Plain regions. Specific targets include reducing severe pollution days to below 1% of days by 2025, reducing NO₂ and volatile organic compound emissions by 10% while reversing the growth trend of ground-level ozone, reducing diesel truck emissions by retiring old vehicles and shifting freight to railways and waterways, strictly preventing agricultural straw-burning and reducing ammonia emissions by 5%.³² Individual cities also continue to adopt air quality plans and targets. For example, Shanghai has set a targets of an average PM2.5 concentration below 32 micrograms/m³ and more than 87% clear sky days in 2022.³³

In June 2022, five Chinese ministries, NDRC and the National Energy Administration issued the “Implementation Plan for Pollution and Carbon Reduction Coordinated Effectiveness,” emphasizing the importance of cross-ministry and cross-sector efforts to reduce air pollution and cut carbon dioxide emissions.³⁴ The Plan includes targets for reducing local air pollutants and carbon dioxide emissions, including increasing the share of steel produced with electric arc furnaces to 15% by 2025 and 20% by 2030, the share of renewable energy used in aluminum production to 30% by 2030, and the share of new energy vehicles in total sales for key air pollution regions to 50% by 2030.

Relationship to Climate Change

Most measures to fight urban air pollution in China also help fight climate change. Policies that promote solar, wind, hydro and nuclear power as alternatives to coal reduce both local air pollutants and heat-trapping gasses—as do policies that promote energy efficiency. Policies that promote energy efficiency and electrification (particularly from non-fossil sources) in Chinese industry, vehicles and buildings all have dual benefits, helping fight both local air pollution and climate change.³⁵

Policies that promote natural gas as an alternative to coal help reduce local air pollution by 90% or more, depending on the pollutant. The impact of those policies on climate change is more complicated.

31 Ministry of Ecological Environment, [“生态环境部召开2月例行新闻发布会 \[MEE holds February News Conference\].”](#) (February 25, 2021).

32 China State Council, [“中共中央 国务院关于深入打好污染防治攻坚战的意见 \[China Central Government and State Council Issue Opinions on Deepening Pollution Control and Enforcement Fight\].”](#) (in Chinese) (November 7, 2021).

33 Shanghai Bureau of Ecological Environment, [“上海市2022年 大气环境与应对气候变化工作计划 \[Shanghai 2022 Air Quality and Climate Change Work Plan\].”](#) (in Chinese) (March 3, 2022).

34 Ministry of Ecology and Environment and six other ministries, [“关于印发《减污降碳协同增效实施方案》的通知 \[Implementation Plan for Pollution and Carbon Reduction Coordinated Effectiveness\].”](#) (in Chinese) (June 10, 2022).

35 See Mark Dworzan, [“Tackling Air Pollution in China.”](#) MIT News (May 2017).

- Natural gas produces roughly half the carbon dioxide (CO₂) emissions of coal per unit of energy. Converting China's vast coal-based heating and power infrastructure to natural gas would significantly reduce Chinese CO₂ emissions.³⁶
- However, leaks during the production, distribution or consumption of natural gas could significantly reduce the climate change benefits of using natural gas to replace coal. Methane—the principal component of natural gas—is itself a powerful heat-trapping gas. As a rough rule of thumb, if more than 3–8% of the natural gas consumed as an energy source leaks, it cancels the climate change benefits of switching from coal to natural gas.³⁷ A 2021 study of China's natural gas sources showed that the highest emissions sources (long-distance LNG) offered CO₂ emissions intensities comparable to coal, with upstream and transportation emissions varying by a factor of six depending on the source.³⁸
- In addition, new natural gas infrastructure, such as pipelines and receiving terminals, will likely last for decades. This infrastructure could slow the transition to even cleaner energy sources. There may be a trade-off between the CO₂ emissions reductions natural gas can deliver by displacing coal today and the CO₂ emissions reductions natural gas could delay by slowing the deployment of renewables and nuclear power in future years.³⁹

China's policies to promote electric vehicles provide significant local air pollution benefits, since electric vehicles do not have tailpipe emissions and the power to recharge them is usually generated outside urban centers. Electric vehicles in China also emit less CO₂ on a lifecycle basis than similar vehicles with internal combustion engines. (Electric motors are far more efficient than internal combustion engines, offsetting the impact China's coal-heavy electricity sector and upstream battery manufacturing emissions.) Continued improvements in EV efficiency and battery energy density, together with a growing share of low-carbon power in the electricity mix, are projected to increase the climate benefits of China's EVs relative to conventional vehicles, even as the latter improve in fuel economy. Trends towards smart charging and aggregation of EV charging will also help reduce lifecycle CO₂ emissions from electric vehicles, by shifting EV charging to off-peak times when carbon emissions are lower.⁴⁰

36 Yue Qin, Ryan Edwards, Fan Tong and Denise L. Mauzerall, "[Can Switching from Coal to Shale Gas Bring Net Carbon Reductions to China?](#)," ACS Publications (February 2017).

37 Methane breaks down more quickly than carbon dioxide in the atmosphere. Experts consider methane to be roughly 84 times more powerful than carbon dioxide as a heat-trapping gas over a 20-year period and 28 times more powerful over a 100-year period. See Intergovernmental Panel on Climate Change, [Climate Change 2014: Synthesis, Fifth Assessment Report](#) (2014) at p.87; Daniel Raimi, "The Fracking Debate," Columbia University Press (2017) at p.111.

38 Yu Gan et al., "[Carbon footprint of global natural gas supplies to China](#)," Nature Communications (2020).

39 See Dave Roberts, "[More natural gas isn't a 'middle ground'—it's a climate disaster](#)," Vox (May 30, 2019)

40 China Automotive Technology & Research Center (CATARC), "[中国汽车低碳行动计划研究报告2021 \[China Automotive Low-Carbon Program 2021 Research Report\]](#)," (in Chinese) (2021); George Bieker, [A global comparison of the life-cycle greenhouse gas emissions of combustion engine and electric passenger cars](#)," [International Council on Clean Transportation](#) (July 2021); Jiahui Chen et al., "[Emission mitigation potential from coordinated charging schemes for future private electric vehicles](#)," Applied Energy (February 15, 2022). See Chapter 16 of this Guide.

Finally, some technologies for controlling local air pollution are counterproductive when it comes to global warming. Scrubbers on coal plants have important local air pollution benefits, but increase CO₂ emissions slightly since scrubbers require energy to operate. More significantly, synthetic natural gas can help reduce local air pollution by moving coal combustion from urban to rural areas but it significantly increases CO₂ emissions. Policies to promote synthetic natural gas are counterproductive when it comes to China's climate goals.⁴¹

41 Haijun Zhao, Weichun Ma, Hongjia Dong and Ping Jiang, [“Analysis of Co-Effects on Air Pollutants and CO₂ Emissions Generated by End-of-Pipe Measures of Pollution Control in China's Coal-Fired Power Plants.”](#) Sustainability (2017). See discussion in Chapter 14 of this Guide.

CHAPTER 18 - URBANIZATION

In recent decades, hundreds of millions of people have moved from rural to urban areas in China. The percentage of Chinese people living in cities has grown from roughly 18% in 1978 to just under 65% today.¹

Urbanization often results in higher carbon dioxide (CO₂) emissions due to demand for steel and cement as well as rising consumption levels. However beyond a certain level of per capita income, urbanization may reduce CO₂ emissions as people move into denser urban spaces. The relationship between urbanization and CO₂ emissions remains the topic of substantial research.²

The Chinese government has a range of policies to promote low-carbon urban development. This chapter provides background on urbanization in China and summarizes those policies.

Background

During the last decade, more than 235 million people moved from rural to urban areas in China. In 2021, seven Chinese cities (Shanghai, Beijing, Shenzhen, Chongqing, Guangzhou, Chengdu and Tianjin) had populations of more than 10 million people and 14 cities had populations between 5 million to 10 million. By 2030, roughly 75% of China's population—more than 1 billion people—are expected to live in urban areas.³

China's current stage of urbanization—with widespread and rapid construction of buildings, roads and other infrastructure—is energy intensive and produces significant carbon dioxide (CO₂) emissions. In addition, Chinese urban residents typically emit more CO₂ per capita than rural residents. Studies have found that:

- Cities contribute roughly 85% of China's CO₂ emissions.⁴
- Chinese urban residents emit roughly 1.4 times more energy-related CO₂ on average than Chinese rural residents.⁵
- One hundred million people moving from the countryside to cities in China increases CO₂ emissions an average of 200 million tonnes per year over five years.⁶

1 Yang Wang et al., [“Calibrations of Urbanization Level in China.”](#) China CDC Weekly (February 11, 2022) at p.111; The State Council–The People's Republic of China, [“China's urbanization rate hits 64.72% in 2021,”](#) Xinhua (February 2, 2022).

2 Qichang Xie and Junxian Liu, [“Combined nonlinear effects of economic growth and urbanization on CO₂ emissions in China: Evidence from a panel data partially linear additive model.”](#) Energy (November 1, 2019); Qian Lv et al., [“Effects of urbanization on freight transport carbon emissions in China: Common characteristics and regional disparity,”](#) Journal of Cleaner Production, (February 20, 2019); Jian Chen et al., [“Research on the impact of multi-dimensional urbanization on China's carbon emissions under the background of COP21,”](#) Journal of Environmental Management (November 1, 2020).

3 The World Bank, [China Urban Population Data \(2020\)](#); The State Council of the People's Republic of China, [“China's urbanization rate hits 64.72% in 2021,”](#) (February 22, 2020); John Liu et al., [“Urbanization Could Help Solve China's Shrinking Workforce,”](#) (July 19, 2021).

4 Zhu Liu and Bofeng Cai, [High-resolution Carbon Emissions Data for Chinese Cities](#) (June 2018) at p.1.

5 Stephanie Ohshita et al., [The Role of Chinese Cities in Greenhouse Gas Emission Reduction](#), Stockholm Environment Institute (September 2015) at p.4.

6 Kuishuang Feng et al., [“Carbon implications of China's urbanization,”](#) Energy, Ecology and Environment (February 25, 2016).

- The wealthiest 5.3% of the Chinese population, almost all of whom live in cities, have carbon footprints nearly four times greater than the Chinese average.⁷
- Urban agglomerations formed by megacities currently contribute roughly 78% of China's GDP and 72% of China's carbon emissions, which will be further increased to 90% and 83% respectively by 2030.⁸
- In 2019, the city with the highest carbon emissions (458 million tonnes) is Yulin in Shaanxi Province. The city with the lowest carbon emissions (1.49 million tonnes) is Ganzi in Sichuan province.⁹

Studies suggest that per capita CO₂ emissions in Chinese cities peak at approximately \$21,000 per capital GDP (2011 PPP). Above that level, as Chinese cities get wealthier, per capita emissions tend to decline.¹⁰ There is evidence of a statistically significant negative relationship between population density and per capita emissions, even after controlling for income, economic structure and proxies for environmental policy.¹¹

Meanwhile, urbanization also has implications for carbon sinks. As forests are cleared to build cities, carbon stored in trees, other plants and soil is released into the atmosphere. However at least one study has found that urbanization in China can lead to long-term growth in carbon stocks as (i) urban tree planting and greening increases carbon stocks in cities after an initial loss, and (ii) carbon stocks increase in rural areas with less dense populations.¹²

Policy

The Chinese government promotes urbanization as a matter of policy. The *14th Five-Year Plan* sets a target for the urbanization rate to reach 65% at the end of 2025 (a goal that has almost already been achieved).



7 Dominik Wiedenhofer et al., "[Unequal household carbon footprints in China.](#)" *Nature Climate Change* (December 19, 2016).

8 Energy Foundation and World Wildlife Fund, [Carbon Emission Peaking Path of China's City Clusters: Exploring the Opportunities](#) (in Chinese) (August 4, 2019).

9 Carbon Emission Accounts & Datasets, [File: The Emission Inventories for 290 Chinese Cities from 1997 to 2019](#) (January 2022).

10 Haikun Wang et al., "[China's CO₂ peak before 2030 implied from characteristics and growth of cities.](#)" *Nature Sustainability* (July 29, 2019). This is an example of the "[The Environmental Kuznets Curve](#)".

11 Yonhee Kim et al., "[Denser cities could help China reconcile economic and climate goals.](#)" *Brookings* (December 9, 2021).

12 Xiaoxin Zhang et al, "[A large but transient carbon sink from urbanization and rural depopulation in China.](#)" *Nature Sustainability*, Volume 5, (February 7, 2022).

At the same time, in light of President Xi's commitment to peak carbon emissions by 2030 and reach carbon neutrality by 2060, greening the urbanization process has become an integral part of policy planning. The *14th Five-Year Plan* includes the following goals for 2025:

- The percentage of days with good air quality in cities should rise to 87.5%.¹³
- Implement recycling transformation in industrial pilot parks.¹⁴
- Build 100 “zero-waste” cities and promote zero-waste development in each province.¹⁵
- Apply green building standards, including low-energy consumption and net-zero emission, to all new buildings.¹⁶
- Construct 50 million m² of new buildings with low-energy consumption and net-zero emissions. Renovate 350 million m² in existing buildings by adopting energy-saving designs.¹⁷

In June 2022, the State Council approved a new urbanization plan for the 14th Five-Year Plan period (2021–25) submitted by the National Development and Reform Commission (NDRC). According to the State Council Information Office, the plan should “promote healthy, livable and safe urban development” and focus on “high-quality urbanization.”¹⁸

In 2021, the State Council released the *Opinions on Promoting the Green Development of Urban and Rural regions*¹⁹ which sets the overall goals for 2025 and 2035. It lays out in broad terms an ambition to formalize a green development mechanism and policy system for urban and rural development in order to reduce pollution in cities by 2025. The Opinions aims for a comprehensive urban and rural green development system in each province and for carbon emission reductions to further accelerate by 2035.²⁰

Meanwhile, the *Plan to Peak Emissions in Rural and Urban Construction*,²¹ issued in 2022, outlined more detailed targets. The Plan includes an ambition to build ecological corridors,

13 The Government of the People's Republic of China, “[Urban Air Quality is Included in the Indicators of Economic and Social Development in the 14th Five-Year Plan.](#)” (in Chinese) (August 7, 2021).

14 NDRC, [Supporting High-quality Development of Industrial Transformation and Upgrading of Old Industrial Cities and Resource-based Cities Plan during the 14th Five-Year Plan Period](#) (in Chinese) (November 19, 2021).

15 The CPC Central Committee and the State Council, “[The Circular on the Nationwide Battle to Prevent and Control Pollution.](#)” (in Chinese) (November 8, 2021).

16 State Council, “[Notice on Issuing the Work Plan for the Energy Conservation and Emission Reduction during the 14th Five-Year Plan.](#)” (in Chinese) (December 28, 2021).

17 Ministry of Housing and Urban-Rural Development, [14th Five-Year Plan for Building Energy Efficiency and Green Building Development](#) (in Chinese) (March 17, 2022); People's Daily, “[Green Buildings – Making Cities Better Places to Live.](#)” (in Chinese) (June 8, 2022).

18 State Council Information Office, “[New urbanization implementation plan approved.](#)” (June 7, 2022).

19 State Council, “[关于推动城乡建设绿色发展的意见 \[Opinions on Promoting the Green Development of Urban and Rural regions\].](#)” (in Chinese) (October 2021).

20 State Council, “[关于推动城乡建设绿色发展的意见 \[Opinions on Promoting the Green Development of Urban and Rural regions\].](#)” (October 2021).

21 This plan is part of the 1+N policy papers and includes targets through to 2035. NDRC, Ministry of Housing and Urban-Rural Development, “[住房和城乡建设部 国家发展改革委关于印发城乡建设领域碳达峰实施方案的通知 \[Plan to peak emissions in rural and urban construction\].](#)” (in Chinese) (June 2022).

improve urban transportation and commuting, save energy by speeding up the renovation of existing buildings and promote the use of renewable energy in buildings. Specifically, the *Plan* calls for:

- Covering 50% of new-build public buildings and factories in towns and cities with solar panels by 2025. This complements a policy to install solar PV on existing buildings issued in June 2021.²²
- Retrofitting public buildings so that they are 10% more energy efficient than current levels by 2030.

The *Plan to Peak Emissions in Rural and Urban Construction* also addresses land and water usage and includes a goal for urbanized areas across the country to achieve an average of 45% permeable land by 2030, a measure to protect against flooding. Cities are also instructed to maintain green land, which should reach 38.9% of urban land by 2030.

If implemented, these plans could significantly impact China's energy consumption and emissions profile. For instance, demolished buildings in China are on average 25–30 years old, despite a designed service life of 50–100 years. Tsinghua's Institute of Climate Change and Sustainable Development estimates that the massive demolition and construction of new buildings leads to as much as 40 to 50 Mt of steel and 220 to 260 Mt of cement every year.²³ When taking into account the energy consumed in the construction process, this results in an additional 120 mtce of energy consumed every year, or 5% of global energy consumption. In response to these challenges, targets for prefabricated buildings (40%) and construction waste were specified in the *Plan to Peak Emissions in Rural and Urban Construction*.²⁴

Meanwhile, as part of China's afforestation strategy linked to urbanization, billions of new trees have been planted while the move into dense urban areas has left large tracts of land behind. In addition, the Chinese government's ecological civilization policy has mandated percentages of urban parks, trees, green roofs and vertical gardens. At the same time, the population decline in rural areas has provided more space to plant new trees in the countryside. One study found that only 6% of urban expansion has come at the expense of forested land. New development has primarily replaced agricultural land (81%) and grasslands (10%)—types of vegetation that have low-carbon storage potential compared to tree cover. Despite cities having made the biggest inroads into agricultural land, China's agricultural area has only shrunk by 3.8% between 2002 and 2019.²⁵

22 See Zhanbg Rui, "[The installation ratio of the roof area of government buildings shall not be less than 50%.](#)" Daily Economic News (in Chinese) (June 24, 2021). See also National Energy Administration, "[国家能源局综合司关于公布整县\(市、区\)屋顶分布式光伏开发试点名单的通知 \[National list of pilot projects for the development of rooftop distributed photovoltaics \(city, district\)\].](#)" (in Chinese) (September 8, 2021).

23 Institute of Climate Change and Sustainable Development of Tsinghua University et al., [China's Long-Term Low-Carbon Development Strategies and Pathways](#) (2022) at p.60

24 NDRC, Ministry of Housing and Urban-Rural Development, "[住房和城乡建设部 国家发展改革委关于印发城乡建设领域碳达峰实施方案的通知 \[Plan to peak emissions in rural and urban construction\].](#)" (in Chinese) (June 2022).

25 Xiaoxin Zhang et al, "[A large but transient carbon sink from urbanization and rural depopulation in China.](#)" Nature Sustainability, Volume 5, (February 7, 2022).

Low-carbon cities

The central government also uses pilot projects to promote low-carbon cities, while cities introduce their own plans to peak and reduce emissions.

In 2022, the Institute of Public and Environmental Affairs and China Research Academy of Environmental Science assessed the emissions of 110 major cities and their efforts to peak emissions. The more economically developed regions such as Beijing–Tianjin–Hebei, the Yangtze River Delta, Guangdong–Hong Kong–Macao Greater Bay Area, which account for 42% of China’s GDP and 34% of heat-trapping gas emissions, were found to be leading the carbon peaking process, with most progress seen in cities that introduced low-carbon pilot projects.²⁶

Another study released in 2022, assessing CO₂ emission inventories of 287 Chinese cities from 2001 to 2019, showed that 38 cities managed to proactively peak their emissions for at least five years and another 21 cities were able to reduce emissions, albeit passively. The 38 cities that proactively peaked emissions managed this through efficiency improvements and structural changes in energy use, while the passive declines in emission were related to economic recession or population loss.²⁷ Maintaining future emissions reductions will therefore require different policy approaches in different cities. In recognition of this, the 14th Five-Year Plan encourages cities to strive to peak emissions before the national goal of 2030.²⁸

Low-carbon development pilot programs have been part of China’s green cities programs for more than a decade:

- In 2010, the NDRC issued the *Notice on Carrying Out Pilots of Low-Carbon Provinces and Cities*, calling for dozens of low-carbon city pilots to be launched around the country.
- In 2016, the *13th Five-Year Plan for Controlling Greenhouse Gas Emissions* highlighted low-carbon urban development as a core part of China’s strategy for controlling emissions. The Plan calls for low-carbon transit systems, energy efficient urban buildings, methane recovery at municipal landfills and more.²⁹
- Also in 2016, the State Council and Communist Party Central Committee released urban development guidelines giving priority to the development of mass transit and

26 Institute of Public and Environmental Affairs and China Research Academy of Environmental Science, [Summary Report on Carbon Peak and Neutrality Index in Chinese Cities](#) (in Chinese) (March 3, 2022); World Resources Institute, [Accelerating the Net-Zero Transition: Strategic Action for China’s 14th Five-Year Plan](#) (in Chinese) (December 1, 2020).

27 Yuli Shan et al., [“City-level emission peak and drivers in China,”](#) *Science Bulletin* (August 24, 2022).

28 China Dialogue, [“Shanghai leads way in China’s carbon transition,”](#) (June 21, 2021).

29 Biliang Hu et al., [“Evaluating China’s low-carbon cities,”](#) *East Asia Forum* (September 6, 2016); State Council, [Notice on Issuing the Work Plan for Greenhouse Gas Emission Control during the 13th Five-Year Plan Period](#) (in Chinese) (October 27, 2016).

calling for “the construction of energy-saving cities”.³⁰

- In 2016, the NDRC launched the *Working Plan for Pilot Programs on Climate-Adaptable Urban Development*. The Plan calls for 30 pilot cities to develop and implement climate adaptation plans.³¹

In September 2020, a senior Ministry of Ecology and Environment official reported that China had developed at least 6 low-carbon provinces, 81 low-carbon cities, 52 low-carbon industrial parks, more than 400 low-carbon communities and 8 low-carbon pilot cities.³²

The Chinese government reports on these pilots in its *Biennial Update Reports* to the UNFCCC and annual *Actions for Addressing Climate Change*, among other places.

- According to China’s *First Biennial Update Report* (December 2016), CO₂ emissions per unit of GDP in these pilots fell 19.4% from 2010 to 2014—faster than the national average.³³
- According to China’s *Second Biennial Update Report* (December 2018), there are now more than 400 provincial pilot low-carbon communities.³⁴
- According to the State Council Information Office’s report *Responding to Climate Change: China’s Policies and Actions* (October 2021), the Chinese government has launched low-carbon pilots in 10 provincial-level units and 77 cities.³⁵

30 CPC Central Committee and State Council, [Urban Development Guidelines](#) (in Chinese) (February 2016); CC Huang, [“Why China’s New Urbanization Guidelines Are A Major Milestone For Urban Sustainability,”](#) Energy Innovation Policy & Technology LLC (March 2, 2016); Stanley CT Yip, [“Planning for eco-cities in China: Visions, approaches and challenges,”](#) in 44th ISOCARO Congress (2008); World Bank, [China: A New Approach for Efficient, Inclusive, Sustainable Urbanization](#) (March 26, 2014).

31 NDRC and MOHURD, [国家发展改革委 住房城乡建设部关于 印发城市适应气候变化行动方案的通知](#) [Action Plan for Urban Adaptation to Climate Change] (in Chinese) (2016).

32 Ministry of Ecology and Environment, [“China has begun to form a comprehensive and multi-level low-carbon pilot system,”](#) (in Chinese) (September 28, 2020).

33 People’s Republic of China, [First Biennial Update Report on Climate Change](#) (in Chinese) (December 2016) at pp.61–62.

34 People’s Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at p.41; NDRC, *China’s Policies and Actions for Addressing Climate Change* (November 2018) at pp. 24–28.

35 State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at II(2).

CHAPTER 19 - HFCs

Background

Hydrofluorocarbons (HFCs) are man-made chemicals used in refrigeration and air-conditioning.¹ They were introduced in the late 1980s to replace chlorofluorocarbons (CFCs) and other chemicals that were damaging the ozone layer. Although HFCs do not damage the ozone layer, they are powerful heat-trapping gases. Some HFCs capture several thousand times more heat than equivalent amounts of carbon dioxide.²

Huge numbers of refrigerators and air conditioners around the world today contain HFCs. Demand for this cooling equipment is increasing rapidly. (The global stock of approximately 2 billion air conditioners is projected roughly to triple by 2050.) As these appliances reach the end of their useful lives, the HFCs they contain will leak into the atmosphere. The climate change impacts are significant.³

Global HFC emissions are growing rapidly. Strategies for reducing HFC emissions focus on finding substitutes that serve similar purposes but trap far less heat when released into the atmosphere. Options include natural refrigerants, hydrofluoroolefins (HFOs) and lower global warming potential HFCs.⁴

HFCs are regulated under the Montreal Protocol on Substances that Deplete the Ozone Layer, a treaty dating to 1987. In 2016, Parties to the Montreal Protocol adopted the Kigali Amendment, which establishes timetables for significant reductions in the production and consumption of HFCs in the decades ahead. The Kigali Amendment—which entered into force January 1, 2019—is projected to avoid 0.44°C (0.8°F) of global warming by 2100. It has been hailed as one of the most significant steps the world has taken to fight global warming.⁵

Chinese HFC Industry

China is the world's largest producer and consumer of HFCs. More than 70% of global HFC production is in China. Roughly half this production is consumed domestically.⁶

China is also the world's largest producer and consumer of appliances that use HFCs. In 2018, Chinese companies manufactured roughly 60% of the world's refrigerators and 80% of the world's residential air conditioners. In 2021, more than 91 million refrigerators and 218 million

1 HFCs are also used in foams, solvents and other products. Most HFC consumption is for refrigeration and air-conditioning.

2 Ezra Clark and Sonja Wagner, [The Kigali Amendment to the Montreal Protocol: HFC Phase-down](#) (UNEP 2016) at p.6.

3 IEA, [Cooling Tracking Report](#) (November 2021); IEA, [The Future of Cooling](#) (May 2018) at p. 59.

4 Durwood Zaelke et al., [Primer on HFCs](#) (Institute for Governance and Sustainable Development, January 2018).

5 See Coral Davenport, [“Nations, Fighting Powerful Refrigerant That Warms Planet, Reach Landmark Deal,”](#) New York Times (October 15, 2016); World Meteorological Organization, [Scientific Assessment of Ozone Depletion: 2018](#).

6 Phil McKenna, [“China Moves to Freeze Production of Climate Super-Pollutants But Lacks a System to Monitor Emissions,”](#) Inside Climate News (January 21, 2022); Liuhanzi Yang et al., [Measures for reducing greenhouse gas emissions from motor air conditioning in China](#) (Working Paper 2022-03), International Council on Clean Transportation (February 2022) at p.10.

air conditioners were made in China. In 2020, 40% of the air conditioners purchased globally were in China.⁷

Capacity utilization in the Chinese HFC industry is less than 50%. In 2020, the Chinese HFC industry had total production capacity of 1.683 million tonnes and actual production of 811,000 tonnes.⁸

China's HFC Policies—International

China participates actively in international negotiations on HFCs under the Montreal Protocol. In 2016, China joined 196 other countries in adopting the Kigali Amendment to the Montreal Protocol. China ratified the Kigali Amendment in June 2021.⁹

The Kigali Amendment sets three timetables for deep reductions in production and consumption of HFCs.

1. Most industrialized countries agreed to reduce production and consumption 10% by 2019, with reductions ultimately reaching 85% by 2036.
2. Most developing countries agreed to peak production and consumption of HFCs by 2024, with reductions ultimately reaching 80% by 2045.
3. Some developing countries in especially hot climates agreed to peak production and consumption of HFCs by 2028, with reductions ultimately reaching 85% by 2045.¹⁰

China is a member of the second group of countries.

HFCs played a high-profile role in China-US diplomacy during the Obama presidency. In 2013, President Xi Jinping and President Barack Obama met for their first full summit in Sunnylands, California. The major announcement at the conclusion of that summit was an agreement by the two countries to work together on HFCs. HFCs received considerable attention at all subsequent Obama-Xi meetings, including President Obama's November 2014 visit to Beijing and President Xi's September 2015 visit to Washington.¹¹

7 NDRC et al., [Green and High-Efficiency Cooling Action Plan](#) (June 13, 2019) (in Chinese) (at p.1) (60% and 80% of global manufacturing); NDRC et al., [China's Green and High-Efficiency Cooling Action Plan](#) (June 13, 2019) at p.2 (60% and 80% of global manufacturing); National Bureau of Statistics, [Statistical Communiqué](#) (February 28, 2022) at Table 3 (218 million and 91 million units); IEA, [Cooling Tracking Report](#) (November 2021) (40% of global a/c purchases). See generally Xiaopu Sun and Tad Ferris, "[The Kigali Amendments and China's Critical Roles in Evolving the Montreal Protocol.](#)" Trends (September/October 2018); China Association of Fluorine and Silicone Industry, [Overview of the Development of Fluorocarbon Chemicals in China](#) (in Chinese) (May 2022).

8 Ministry of Ecology and Environment, [Circular on Strictly Controlling the First Batch of HFC Production Construction Project \(drafts for comments\)](#) (in Chinese) at p.6.

9 [Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer](#), United Nations Treaty Organization; Kevin Rudd, "[China's Commitment on HFCs Sends Key Signal.](#)" China Dialogue (July 28, 2021).

10 Ezra Clark and Sonja Wagner, [The Kigali Amendment to the Montreal Protocol: HFC Phase-down](#) (UNEP 2016).

11 The White House, Office of the Press Secretary, "[United States and China Agree to Work Together on Phase Down of HFCs.](#)" (June 8, 2013); The White House, [US-China Joint Announcement on Climate Change](#) (November 12, 2014).

China's HFC Policies—Domestic

The *14th Five-Year Plan* released in March 2021 states that the Chinese government will increase controls on HFCs as part of climate change mitigation efforts. China's Nationally Determined Contribution submitted to the UN in November 2021 reports that “as of June 2020, cumulative HFC-23 emission reductions of 65,300 tonnes have been achieved with the support of fiscal funds, equivalent to 764 million tonnes of CO₂ emissions.”¹²

Recent measures to address HFC production and consumption include the following:

- On December 28, 2021, the Ministry of Ecology and Environment (MEE), National Development and Reform Commission (NDRC) and Ministry of Industry and Information Technology (MIIT) issued a notice freezing domestic production capacity for five of the most widely-used HFCs. This was two years ahead of the date in which HFC production in China is required to be frozen under the Kigali Amendment.¹³
- In October 2021, MEE, NDRC and MIIT released the amended List of Controlled Ozone-Depleting Substances in China, which now includes HFCs. The List's key regulatory functions include identifying the controlled substances to be phased out in China in accordance with the Montreal Protocol and phasedown timelines for these substances.¹⁴
- Also in October 2021, MEE, the Ministry of Commerce and the General Administration of Customs released the updated *List of Controlled Ozone Depleting Substances for Import or Export in China*.¹⁵ Accordingly, as of November 1, 2021, China commenced implementation of an HFC import and export licensing system consistent with China's obligations under the Kigali Amendment. Enterprises engaged in import and export of HFCs included in this updated List are required, in the following order, to: 1) seek approval from the State Office of Import and Export of Ozone Depleting Substances; 2) apply for an import and export license from the Ministry of Commerce or another agency that the Ministry of Commerce entrusts with such licensing responsibility; and 3) go through required customs clearance procedures for HFC import and export activities.¹⁶

12 NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021) at Article 28, Part 11; People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021) at p.15. See Scott Vaughan, [“A New Plan Ahead.”](#) IISD Knowledge Hub (March 10, 2021).

13 MEE, MIIT and NDRC, [Notice on Strictly Controlling the First Batch of HFC Chemical Production and Construction Projects](#) (in Chinese) (December 28, 2021); Phil McKenna, [“China Moves to Freeze Production of Climate Super-Pollutants But Lacks a System to Monitor Emissions.”](#) Inside Climate News (January 21, 2022).

14 MEE, NDRC and MIIT, [关于发布《中国受控消耗臭氧层物质清单》的公告](#) [[Announcement on Issuing the List of Controlled Ozone-Depleting Substances in China](#)] (in Chinese) (October 8, 2021)

15 MEE, NDRC and MIIT, [关于发布《中国受控消耗臭氧层物质清单》的公告](#) [[Announcement on Issuing the List of Controlled Ozone-Depleting Substances in China](#)] (in Chinese) (October 8, 2021)

16 MEE, Ministry of Commerce and General Administration of Customs, [Announcement on Issuing the List of Controlled Ozone Depleting Substances for Import and Export in China](#) (in Chinese) (October 26, 2021).

- On September 15, 2021, MEE released a circular with a range of measures on HFCs, including requiring the destruction of certain HFCs.¹⁷

During the 13th Five-Year Plan period (2016–2020) there was significant activity on this topic as well.

- The Chinese government took several steps to promote R290 (a low-GWP HFC substitute) for room air conditioners and commercial refrigeration, including completing the upgrade of at least 20 R290 manufacturing lines and three R290 compressor manufacturing lines.¹⁸
- In 2019, seven ministries and agencies jointly released the Green and High-Efficiency Cooling Action Plan, which includes plans for research and development on low-global warming potential (GWP) and high-efficiency refrigerants.¹⁹
- According to the State Council, as of 2019 the Chinese government had paid subsidies worth RMB 1.4 billion for reducing or destroying 65,300 tonnes of HFC-23.²⁰
- NDRC reports that in 2017 it “organized the inspection of the disposal of hydrofluorocarbons (HFCs), published the inspection results of 11 enterprises, ensured the normal operation of HFC-23 destruction devices, and provided quota-based subsidies to enterprises that perform destruction.”²¹
- NDRC reports that in 2016 it “organized the local commissions to report trifluoromethane (HFC-23) disposed by enterprises...arranged for random third-party verification, and together with relevant ministries, implemented the relevant policies that ensure the normal operation of devices to phase out HFC-23.”²²

17 IGSD, [“China Takes Steps to Address HFC-23 Emissions in Advance of International Ozone Day,”](#) (September 15, 2021).

18 Sun and Ferris, “The Kigali Amendments” (September/October 2018). For more information on China’s HFC programs during the 13th Five-Year Plan, see Carolyn Zhong, [“China’s Actions to Promote Low GWP Alternatives,”](#) EIA (April 12, 2016); [“China Backs Natural Refrigerants: The Reaction from Chinese Industry,”](#) CCM Data and Business Intelligence (July 23, 2015).

19 NDRC et al., [Green and High-Efficiency Cooling Action Plan](#) (in Chinese) (June 13, 2019); NDRC et al., [China’s Green and High-Efficiency Cooling Action Plan](#) (June 13, 2019).

20 State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at II(3).

21 NDRC, [China’s Policies and Actions for Addressing Climate Change](#) (November 2018) at p.13.

22 NDRC, [China’s Policies and Actions for Addressing Climate Change](#) (October 2017) (in Chinese) at p.13.

ILLEGAL PRODUCTION OF CFCs

Chlorofluorocarbons (CFCs) are powerful heat-trapping gases, capturing many thousand times more heat than equivalent amounts of carbon dioxide. Production and consumption of CFCs have been banned globally under the Montreal Protocol since 2010.²³

CFC production has been illegal in China for many years. Nevertheless, an atmospheric monitoring study released in 2019 suggested that CFC production was continuing in China. The Chinese authorities stressed their determination to stop this illegal production and strengthened enforcement actions. Recent data suggests these actions have been successful. Two independent studies released in 2021 found that emissions of CFCs in China have dropped dramatically.²⁴

23 Ezra Clark and Sonja Wagner, [The Kigali Amendment to the Montreal Protocol: HFC Phase-down](#) (UNEP 2016) at p.6; [Montreal Protocol on Substances That Deplete the Ozone Layer](#) at Article 2A, “CFCs.”

24 M. Rigby et al., [“Increase in CFC-11 emissions from eastern China based on atmospheric observations,”](#) Nature (May 22, 2019); [“China promises crack down on illegal ODS,”](#) Cooling Post (November 3, 2018); [“Three Arrested in Chinese CFC Raid,”](#) Cooling Post (October 15, 2018); [“Ministry of Ecology and Environment: Resolutely crack down on the illegal production, sale and use of CFC-11 by enterprises,”](#) (in Chinese) People’s Daily (July 26, 2018); Jeff Tollefson, [“Illegal CFC emissions have stopped since scientists raised alarm,”](#) Nature (February 10, 2021).

CHAPTER 20 - GREEN FINANCE

China’s central bank—the People’s Bank of China (“PBoC”)—defines “green finance” as “financial services provided for economic activities that are supportive of environmental improvement, climate change mitigation and more efficient resource utilization.”¹

In 2021, more than \$100 billion of green bonds and \$600 billion of green loans were issued in China.² PBoC removed “clean coal” projects from its Green Bonds Endorsed Projects Catalogue, the Ministry of Ecology and Environment (MEE) issued rules requiring companies to disclose their carbon emissions, and President Xi Jinping and Premier Li Keqiang both spoke about green finance in high-profile settings.³

This chapter discusses China’s green finance policies and their climate impacts.

Background

The capital required to achieve the Chinese government’s climate goals is enormous. The investment bank China International Capital Corporation estimates that China needs \$21 trillion of debt financing in the next four decades to achieve carbon neutrality.⁴ An influential study by the Institute for Climate Change and Sustainable Development (ICCSA) at Tsinghua University found that an investment of RMB 100 trillion (roughly \$15 trillion) is needed for China to be on a path compatible with the 2°C (3.6°F) goal in the Paris Agreement.⁵

In recent years, green finance in China has exceeded trillions of RMB (hundreds of billions of dollars). From 2016 to 2021, green bonds totaling more than RMB 1.5 trillion (\$240 billion) were issued in China.⁶ Overall green finance averaged RMB 2.1 trillion (roughly \$320 billion) per year during 2017/2018.⁷

Green finance in China grew significantly in 2021.

- Green bond issuances more than doubled from 2020 levels.⁸
- China Development Bank issued one of the world’s largest green bonds—an RMB 20 billion (roughly \$3 billion) issuance for carbon reduction projects including wind and

1 People’s Bank of China, [Guidelines for Establishing the Green Financial System](#) (September 2, 2016) at 1(1).

2 Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy–Analysis Report 2021](#) at p.6 (\$109.4 billion of green bonds); [“China’s green loans maintain rapid growth in 2021.”](#) Xinhua (February 1, 2022).

3 People’s Bank of China, National Development and Reform Commission and the China Securities Regulatory Commission, [Notice on Issuing the Green Bond Endorsed Projects Catalogue \(2021 Edition\)](#); [“Xi Focus: China to remain committed to high-quality Belt and Road cooperation.”](#) Xinhua (April 20, 2021); Echo Xie, [“What is green finance, and why is it important to China’s carbon neutral goal?”](#) South China Morning Post (April 2, 2021).

4 Yvonne Lau, [“China needs \\$21 trillion in debt financing to meet its climate goals. Here’s one way to chip away at that sum.”](#) Fortune (July 16, 2021).

5 Lauri Myllyvirta, [“Influential academics reveal how China can achieve its ‘carbon neutrality’ goal.”](#) CarbonBrief (October 14, 2020).

6 Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy–Analysis Report 2021](#) at p.11.

7 June Choi and Thomas Heller, [“The Potential for Scaling Climate Finance in China.”](#) Climate Policy Initiative (February 4, 2021).

8 Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy–Analysis Report 2021](#) at p.6.

solar power.⁹

- The amount of green loans outstanding grew by 33% to reach almost RMB 16 trillion (about \$2.5 trillion), including RMB 10.7 trillion (\$1.7 trillion) for projects with carbon reduction benefits.

In 2021, non-financial corporations issued 46% of China's green bonds. Financial institutions issued 35% of the total.¹⁰

In 2021, several Chinese state-owned banks made commitments to increase green finance. China Development Bank announced that green loans will account for more than 5% of its credit assets by 2025 and 30% of its credit assets by 2030. Bank of China announced it will provide at least RMB 1 trillion in green finance during the 14th Five-Year Plan period and its proportion of green credit will increase each year.¹¹

Policy

Domestic

In 2016, PBoC became the first central bank in the world to issue green finance guidelines. According to PBoC's *Guidelines for Establishing the Green Financial System*:

The establishment of the green financial system requires the internalization of environmental externalities by appropriate incentives and restraints with the support of policies, laws and regulations in the financial, fiscal and environmental areas. It also requires more innovations by financial institutions and financial markets in developing new financial instruments and services, to address the problems of maturity mismatch, asymmetric information and lack of analytical tools for green investment.¹²

PBoC's *Guidelines* remain in effect and continue to play a central role in shaping green finance in China. They call for action in seven areas:

1. green bonds,
2. green lending,
3. green development funds,
4. green insurance,
5. markets for pollution control rights,
6. local government initiatives, and

9 Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy-Analysis Report 2021](#) at p.6.

10 Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy-Analysis Report 2021](#) at p.7.

11 Sun Chi, "[Chinese banks see growth in green credit balance in first 9 months.](#)" China Daily (Dec 21, 2021).

12 People's Bank of China, [Guidelines for Establishing the Green Financial System](#) (September 2, 2016).

7. International cooperation

Green credit has been a particular focus. PBoC's *Guidelines* call for "vigorously develop[ing]" green credit with tools such as central bank relending, guarantee mechanisms and securitization. PBoC includes green finance performance in its macro-prudential assessment system, giving extra points to banks with higher ratios of green credits on their balance sheets and recent records of issuing green bonds.¹³

PBoC's original *Green Bond Endorsed Project Catalogue* included "clean utilization of coal" as an eligible project category. This raised concerns with some stakeholders, in part because international standards for green bond investments do not include coal projects among the eligible categories. In April 2021, PBoC updated its *Green Bond Endorsed Project Catalogue*, removing "clean coal" projects and making a number of other changes that aligned the catalog more closely with international green finance standards.¹⁴

In December 2021, China's Ministry of Ecology and Environment (MEE) updated its rules on corporate environmental disclosures. The updated rules include a new provision requiring companies to disclose their carbon emissions. All listed companies and companies that issue bonds or other debt instruments are subject to the rules. Reports are due annually (by March 15 for the previous calendar year).¹⁵

Many Chinese provincial and local governments have issued green finance guidance documents. At least five pilot green finance zones have been set up, where financial institutions receive a variety of incentives to fund clean and low-carbon industries.¹⁶

In December 2021, the Ministry of Ecology and Environment (MEE) issued a notice launching a *Climate Investment and Financing Pilot Work Plan*. The notice asked cities and provinces to submit applications for pilot investment and financing programs to promote carbon peaking and carbon neutrality. In August 2022, MEE announced 23 pilot regions under this program.¹⁷

International

Since at least 2016, China has played a leading role in the international dialog on green finance.

13 People's Bank of China, [Guidelines for Establishing the Green Financial System](#) (September 2, 2016).

14 People's Bank of China, National Development and Reform Commission and the China Securities Regulatory Commission, [Notice on Issuing the Green Bond Endorsed Projects Catalogue \(2021 Edition\)](#); See also "PBC, NDRC, and CSRC Release Green Bond Endorsed Projects Catalogue," Moody's Analytics (April 27, 2021).

15 Ministry of Ecology and Environment, [Measures for the Administration of Legal Disclosure of Enterprise Environmental Information](#), (in Chinese) (December 21, 2021); See also Song Ziyang, ["How should businesses in China react to new environmental disclosure requirements?"](#) China Dialogue (February 10, 2022).

16 ["China's New Experiment with Climate Finance,"](#) Paulson Institute (March 23, 2022); June Choi and Weiting Li, [The Potential for Scaling Climate Finance in China](#) Climate Policy Initiative (February 2021) at p.11; Climate Bonds Initiative and SynTao Green Finance, [Study of China's Local Government Policy Instruments for Green Bonds](#) (April 2017) at pp.7-8.

17 Ministry of Ecology and Environment, ["气候投融资试点工作方案 \[Climate Investment and Financing Pilot Work Plan\]"](#) (in Chinese) (December 2021); "MEE and Other Government Bodies Publish the Notice of the Pilot Work on Climate Investment and Financing and Attach the Drafted Climate Investment and Financing Pilot Work Scheme," International Climate Initiative (December 30, 2021); Ministry of Ecology and Environment, ["Notice on Announcement of the Pilot List of Climate Investment and Financing,"](#) (in Chinese) (August 10, 2022).

- In 2016, as host of the G20, the Chinese government launched a Green Finance Study Group and included the topic of green finance in a G20 leaders' communique for the first time.¹⁸
- In 2017, PBoC was one of the eight central banks that co-founded the Network for Greening the Financial System (NGFS).¹⁹
- At the Second Belt and Road Forum in April 2019, 28 financial institutions including China Development Bank, China International Capital Corporation, China Construction Bank and the Agricultural Development Bank of China endorsed the Green Investment Principles for the Belt and Road Initiative.²⁰

In a September 2021 speech to the UN General Assembly, President Xi Jinping pledged that China would “no longer build new coal power projects abroad.”²¹

In the past several years, central government ministries have issued several guidelines on green principles and practices in outbound investment, including the 2021 *Green Development Guidelines for Overseas Investment and Cooperation* (“2021 Guidelines”), the 2022 *Guidelines for Ecological and Environmental Protection of Foreign Investment Cooperation and Construction Projects* (“2022 Guidelines”) and *Opinions on Jointly Promoting Green Development of the Belt and Road* (“2022 Opinions”).²² These have shown an evolution toward more stringent standards.²³

China currently co-chairs the G20's Sustainable Finance Working Group.²⁴

The Global Green Finance Leadership Program, co-hosted by the Beijing Institute of Finance

18 [G20 Leaders' Communique–Hangzhou Summit](#) (September 4–5, 2016) at Paragraph 43.

19 [“Joint statement by the Founding Members of the Central Banks and Supervisors Network for Greening the Financial System – One Planet Summit,”](#) Banque de France (December 12, 2017).

20 [“Green Belt and Road principles receive industry backing,”](#) People's Daily (April 26, 2019); [“Green Belt and Road principles receive industry backing,”](#) City of London (April 24, 2019). See Chapter xx of this Guide for more information on the Belt and Road Initiative.

21 Xinhua News Agency, [“习近平在第七十六届联合国大会一般性辩论上的讲话（全文） \[Xi Jinping's Speech at the 76th Session of the United Nations General Assembly \(Full Text\)\],”](#) (in Chinese) (September 22, 2021).

22 Ministry of Commerce and Ministry of Ecology and Environment, [“商务部、生态环境部关于印发《对外投资合作绿色发展工作指引》的通知 \[Notification from the Ministry of Commerce and Ministry of Ecology and Environment Regarding the Publication of 'Guidance for Green Development Work in Outbound Investment and Cooperation'\],”](#) (in Chinese) (July 9, 2021); Ministry of Ecology and Environment and Ministry of Commerce, [“关于印发《对外投资合作建设项目生态环境保护指南》的通知 \[Notification Regarding the Release of 'Guidance on Ecological and Environmental Protection in Outbound Investment and Cooperation Construction Projects'\],”](#) (in Chinese) (January 5, 2022); National Development and Reform Commission et al., [“关于推进共建‘一带一路’绿色发展的意见\(发改开放〔2022〕408号\) \[Opinions on Jointly Advancing the Green Development of the Belt and Road \(NDRC Release No. 408 \(2022\)\)\],”](#) (in Chinese) (March 16, 2022).

23 See Christoph Nedopil, Dimitri De Boer and Fan Danting, [“Understanding China's Latest Guidelines for Greening the Belt and Road,”](#) China Dialogue (February 15, 2022); Christoph Nedopil et al., [“What China's New Guidelines on 'Green Development' Mean for the Belt and Road,”](#) China Dialogue (August 18, 2021); Dimitri De Boer, Christoph Nedopil and Fan Danting, [“Belt and Road Must Align with Paris Agreement – Government Guidance,”](#) China Dialogue (May 3, 2022). Xinhua News Agency, [“习近平在第七十六届联合国大会一般性辩论上的讲话（全文） \[Xi Jinping's Speech at the 76th Session of the United Nations General Assembly \(Full Text\)\],”](#) (in Chinese) (September 22, 2021). See more detailed discussion in Chapter 26 of this Guide.

24 See [G20 Sustainable Finance Working Group](#)

and Sustainability (BIFS), China Council for International Cooperation on Environment and Development (CCICED) and other organizations, provides a platform for knowledge sharing on green and sustainable finance in emerging economies.²⁵

Relationship to Climate Goals

Climate mitigation is a priority within China's green finance policies. PBoC's *Guidelines for Establishing the Green Financial System* and other green finance policy documents specifically highlight the importance of climate mitigation and low-carbon development. China's green finance policies have helped channel hundreds of billions of dollars into renewable energy and low-carbon transport projects in recent years and have the potential to channel trillions more.²⁶

Meeting the climate goals set forth in the Paris Agreement will require trillions of dollars of capital over several decades. China's green finance policies are intended, in part, to help meet that need. These policies will play an important role in the world's response to climate change.

25 See [Global Green Finance Leadership Program](#)

26 People's Bank of China, [Guidelines for Establishing the Green Financial System](#) (September 2, 2016) at 1(1); Climate Bonds Initiative and SynTao Green Finance, [China Green Finance Policy-Analysis Report 2021](#).

CHAPTER 21 - CLEAN ENERGY RESEARCH AND DEVELOPMENT

In recent years, the Chinese government has spent \$4–6 billion annually on clean energy research and development (R&D). The Ministry of Science and Technology (MOST), which leads much of the Chinese government’s work on clean energy R&D, identifies its clean energy priorities as low-carbon power, system integration and optimization, new energy vehicles, nuclear power, energy efficiency and carbon capture, utilization and storage (CCUS).¹

This chapter describes Chinese government spending on clean energy R&D.

Background

Since the Reform and Opening-Up period in the late 1970s, the Chinese government has invested in technology innovation as a core element of its economic development strategy. In the Chinese system, R&D priorities are listed in planning documents issued by central government agencies and implemented mostly by universities, government research institutions and state-owned enterprises. Government funding for demonstration projects, pilot projects and subsidies are loosely coordinated based on technology trends and changing economic priorities.

Energy has held a prominent place in China’s research and development priorities for many years. Energy technology was listed fourth in the 1986 *National High-Tech R&D Program* (known as the 863 Program) and second in the 1997 *National Basic Research Program* (known as the 973 Program). The 2006 *Medium-to-Long-term Program for Science and Technology Development (2006–2020)* placed energy first among over two dozen fields of technology development. The 2006 *Program* called for increasing overall R&D spending from 1.3% to 2.5% of GDP and listed industrial energy efficiency, fossil fuel technology (including coal-to-gas and coal-to-liquids), renewable energy and ultra-high voltage power grids as priorities for energy sector R&D.²

The Chinese government also addresses clean energy R&D in its five-year planning processes. The *11th Five-Year Plan* highlighted R&D on high-powered wind turbines, ultra-high voltage transmission and energy efficiency. The 12th and 13th Five-Year Plans included targets for wind, solar and nuclear power as well as smart grid technologies.

The International Energy Agency (IEA) estimates that overall energy R&D spending by the Chinese government in 2021 was \$8.3 billion—26% of world energy R&D spending. Much of this funding went to conventional energy technologies. China is the world’s largest funder of fossil fuel energy R&D by far. The World Intellectual Property Office (WIPO) ranked China

¹ [Mission Innovation Country Highlights](#) (2020) at p.22; Chad Smith and David Hart, [The 2021 Global Energy Innovation Index: National Contributions to the Global Clean Energy Innovation System](#) Information Technology & Innovation Foundation (October 18, 2021) at pp.5, 18–19; [China-Pathway](#), Mission Innovation website (accessed July 9, 2022).

² See [National High-tech R&D Program \(863 Program\)](#), Embassy of PRC in Norway (2010); [National Basic Research Program of China \(973 Program\)](#), Consulate General of PRC in New York (2016); China State Council, [The National Medium- and Long-Term Program for Science and Technology Development \(2006–2020\)](#) (February 9, 2006).

third in the number of energy patents in 2019.³

China's innovation policies have led to stronger results in some areas than others. Chinese patents—including in the energy sector—tend to be dominated by design- and use-related patents, more than basic technology innovations.⁴ Solar PV and battery manufacturing stand out as areas in which Chinese innovators have especially strong capabilities, as measured by patent citations.⁵

Chinese innovation capabilities have grown significantly in recent years. According to one IEA study, China was responsible for 8% of the world's low-carbon energy intellectual patent families in 2010–2019, with increasing patenting activities over the course of the decade.⁶ Another IEA study found that energy patenting in China has doubled every five years since 2000, with low-carbon energy patents growing rapidly, especially in batteries, electric vehicles and solar.⁷

Chinese businesses invest in R&D, including for clean energy. The private sector has played an especially important role in solar photovoltaic and battery innovations. Clean energy venture capital grew 43% annually in China between 2016 and 2021, with especially strong growth in venture capital funding for deals related to electric vehicles.⁸ Some data suggest that innovation spending by state-owned enterprises is relatively less efficient at generating innovations than the private sector.⁹

The Chinese government has investment funds, known as *guidance* funds, to support private sector innovation, aimed primarily at early- and mid-stage companies rather than startups. Funding has gone to firms working in fields including oil and gas, nuclear equipment and renewable energy.¹⁰

Demonstration projects are a major element of China's innovation system. Several Chinese ministries directly manage and promote demonstrations in various fields. The National Development and Reform Commission oversees the Zhangjiakou Renewable Energy Pilot

3 International Energy Agency, [World Energy Investment 2021](#) (June 2021); James Nurton, "[Patenting trends in renewable energy](#)," WIPO Magazine (March 2020).

4 World Bank and Development Research Center of the State Council, People's Republic of China, [China 2030: Building a modern, harmonious and creative society \(2011\)](#); Xielin Liu and Steven White, "[Comparing innovation systems: a framework and application to China's transitional context](#)," Research Policy 30 (2001).

5 Yawei Wang et al., "[Comparing the Technology Trajectories of Solar PV and Solar Water Heaters in China: Using a Patent Lens](#)," Sustainability, (2018); Yuan Zhou et al., "[Comparing the International Knowledge Flow of China's Wind and Solar Photovoltaic \(PV\) Industries: Patent Analysis and Implications for Sustainable Development](#)," Sustainability (2018); European Patent Office and International Energy Agency, [Innovation in Batteries and Electricity Storage](#) (September 2020); Manuel Bauman et al., "[Comparative patent analysis for the identification of global research trends for the case of battery storage, hydrogen and bioenergy](#)," Technology Forecasting and Social Change (April 2021).

6 International Energy Agency, [Patents and the Energy Transition](#) (April 2021) at p.6.

7 International Energy Agency, [Tracking Clean Energy Innovation-Focus on China](#) (March 2022) at pp.9-10.

8 Chad Smith and David Hart, [The 2021 Global Energy Innovation Index: National Contributions to the Global Clean Energy Innovation System](#) Information Technology & Innovation Foundation (October 18, 2021) at p.19.

9 Henning Kroll and Kou, "[Innovation output and state ownership: empirical evidence from China's listed firms](#)," Industry and Innovation (2018); Mingda Qiu, [A Larger but Not Leaner Fat Tech Dragon: Report Title: China's Uneven High-Tech Drive, Implications for the United States](#) Center for Strategic and International Studies (CSIS) (2020).

10 International Energy Agency, [Tracking Clean Energy Innovation - Focus on China](#) (March 2022).

Zone, which incorporates wind, solar, energy storage and hydrogen technologies. The National Energy Administration supports energy storage demonstration projects and hybrid renewables-storage demonstrations through preferential policies. The Ministry of Science and Technology's National Guiding Fund for the Conversion of Scientific and Technological Achievements funds various demonstration projects aimed at commercializing clean energy technology. The Ministry of Housing and Urban-Rural Development (MOHURD) funds demonstrations in building efficiency, materials and distributed energy. Provincial and local officials also have a major role in launching demonstration projects. Shandong is currently undertaking major hydrogen demonstration projects including hydrogen from wind and solar, hydrogen fueling for trucks and buses, and hydrogen for rural heating. Guangdong province has undertaken a national-level demonstration on fuel cell vehicle technology.¹¹

Policies

The Chinese government's investment in clean energy R&D increased significantly during the 13th Five-Year Plan, almost doubling from 2015 to 2019.¹² Priorities included solar power, wind power and energy storage.

- The *13th Five-Year Plan for Solar Development* listed several solar technology targets, including increasing crystalline silicon PV cell conversion efficiency to 23 per cent and developing thin-film technology.¹³
- In 2016, NDRC set strategic development targets for wind power. NDRC highlighted four areas for innovation: large-scale wind equipment, offshore system construction, wind farm cluster operation based on big data and cloud computation, and recycling of waste equipment.¹⁴
- The National Energy Administration established targets for energy storage, emphasizing development of storage with renewable energy, reductions in the cost of storage and improvements in safety and security.¹⁵
- For nuclear energy, China has demonstration projects for gas-cooled reactors and fast neutron reactors. The first experimental gas-cooled reactor was built near Beijing with Russian technology in 2000, and a commercial-scale gas-cooled reactor in Shandong province connected to the grid in 2021.¹⁶

The *Made in China 2025* initiative, first announced in 2015, targets several clean energy areas. It calls for China to dominate manufacturing of energy-saving and new energy vehicles as

11 International Energy Agency, [Tracking Clean Energy Innovation – Focus on China](#) (March 2022).

12 Chad Smith and David Hart, [The 2021 Global Energy Innovation Index: National Contributions to the Global Clean Energy Innovation System](#) Information Technology & Innovation Foundation (October 18, 2021) at p.18.

13 National Energy Administration, [国家能源局关于印发《太阳能发展“十三五”规划》的通知](#), (in Chinese) (December 2016).

14 Beijixing, [中国大型风电技术创新路线图2016-2030](#), (in Chinese) (June 2, 2016).

15 National Energy Administration, [国家发展改革委 国家能源局关于印发能源发展“十三五”规划的通知](#), (in Chinese) (January 17, 2017).

16 World Nuclear News, [“Chinese fast reactor begins high-power operation,”](#) (February 19, 2021); Sonal Patel, [“China Starts Up First Fourth-Generation Nuclear Reactor,”](#) Power Magazine (February 1, 2022).

well as maintain an 80% share of renewable energy equipment production. These priorities influence R&D investments across the energy sector.¹⁷

In 2016, *China's Energy Supply and Consumption Revolution Strategy* listed four priority areas for technology development: energy efficiency (including waste heat and steam, building energy and new energy vehicles), clean energy (including renewables, nuclear, and efficient coal and oil), smart energy (including high voltage grids) and R&D. R&D priorities specifically mentioned include hydrogen, rare earths, superconductors, solid-state transformers and fast nuclear reactors.¹⁸

In October 2020, the State Council outlined several new energy vehicle technologies as key areas for innovation in the next 15 years. These include battery technology, smart network technology and charging infrastructure improvement.¹⁹

China's *14th Five-Year Plan for Energy Technology Innovation* (2021) notes that China's energy technology innovation system still faces challenges: certain equipment, software and materials still rely on foreign countries; China has developed relatively few of the key energy transition technologies, and mechanisms for technology innovation need improvement. The Plan targets five broad energy fields for innovation:

- renewable energy (including wind, solar, biomass, geothermal, hydro and renewable hydrogen);
- technologies to support a modern electricity system, including two-way interaction between generation and customers, as well as energy storage;
- nuclear technology, including advanced reactor designs, modular reactors and high-temperature gas-cooled reactors;
- fossil energy, including unconventional oil and gas, advanced gas turbines, more efficient mining and the “green, intelligent, and efficient” development and utilization of coal (including ultra-supercritical boilers, carbon capture and storage, and coal-to-liquids);
- digital energy technologies, including in particular those related to the power grid (such as ultra-high voltage lines) and conventional energy.²⁰

Clean energy is one of the first areas for competitive funding under the 14th Five-Year Plan.²¹

17 Jost Wübbeke et al., [Made In China 2025: The making of a high-tech superpower and consequences for industrial countries](#) Mercator Institute for China Studies (December 2016).

18 National Development and Reform Commission and National Energy Administration, [能源生产和消费革命战略 \[Energy Production and Consumption Revolution Strategy\]](#) (in Chinese) (December 2016).

19 China State Council, [国务院办公厅关于印发新能源汽车产业发展规划（2021 - 2035年）的通知](#), (in Chinese) (October 2020).

20 National Energy Administration and Ministry of Science and Technology, [\[十四五\] 能源领域科技创新规划 \[14th Five-Year Plan for Energy Technology Innovation\]](#)” (November 29, 2021).

21 International Energy Agency, [World Energy Investment 2021](#) (June 2021) at p.53.

In addition, the various sectoral five-year plans contain several specific priorities for innovation. The *14th Five-Year Plan for a Modern Energy System* lists the following innovation priorities for R&D and demonstrations: deep offshore wind, high-efficiency PV cells, building-integrated photovoltaics (BIPV), advanced biomass fuels, geothermal energy, battery energy storage, large-scale variable-speed pumped storage and seawater storage, large-scale development and utilization of ocean energy, environmental protection technology and advanced nuclear energy technology. The *14th Five-Year Plan for Hydrogen* calls for research and development in proton exchange membrane (PEM) fuel cells, as well as improved hydrogen storage and transportation technologies and the application of renewable hydrogen in fields outside of transportation.²²

Relationship to Climate Goals

Energy innovation will play an important role in fighting climate change and meeting the goals of the Paris Agreement.²³ Innovation will be especially important in some hard-to-abate sectors, including heavy industry, where China's role in the global economy is strong. More than 22 nations, including China, have joined Mission Innovation—"a global initiative to catalyze action and investment in research, development and demonstration to make clean energy affordable, attractive and accessible to all this decade."²⁴ As the world's leader in clean energy deployment, the second largest economy and largest heat-trapping gas emitter, China's investments in clean energy R&D could have significant implications for climate change in the years and decades ahead.

22 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022); NDRC, [Medium and Long-term plan for the development of a hydrogen industry \(2021-2035\)](#) (in Chinese) (March 2022).

23 See generally, IPCC 2022, Working Group 3 Chapter 16, [Innovation, technology development and transfer](#).

24 [Mission Innovation website](#), (accessed July 9, 2022).

CHAPTER 22 - FOOD SYSTEM

China is the world's largest producer and consumer of food products. In 2019, China's food system produced roughly 1.9 billion tonnes of CO₂eq emissions within China—approximately 13.5% of China's total emissions of heat-trapping gases.¹

The food system spans a vast array of activities, including land clearing, fertilizer manufacturing, crop cultivation, livestock production, fish harvesting, meal preparation and landfill management. It includes food production, transport, processing, packaging, storage, consumption and disposal. Globally, the food system contributes more than 30% of heat-trapping gas emissions each year.²

This chapter provides background on China's food system, emissions of heat-trapping gases and policies related to food system emissions.

Background

Production

China is the world's largest producer of agricultural products. In 2020, China was the world's largest producer of seed cotton (35.5%), rice (28%) and wheat (18%) and the second-largest producer of corn (22%). (In contrast, China produced only 5.5% of the world's soybeans, far behind the United States, Brazil and Argentina.)³

China also leads the world in production of fish and pork. In 2019, 37% of global fish production was in China. In 2020, 38% of global pork production, 13% of global chicken production and 9% of global beef production were in China.⁴

Roughly a quarter of China's employment and 8% of its GDP is in the agriculture sector. Agriculture's share of China's GDP has been gradually declining during the past several decades.⁵

In 2019, agricultural activities were responsible for 1.8% of energy consumption in China, including 0.5% of coal consumption, 2% of gasoline consumption and 10% of diesel oil consumption.⁶

1 2019 is the most recent year for which data are available. See Food and Agriculture Organization, [FAOSTAT database](#) (accessed August 2, 2022). See also Jos Olivier, [Trends in Global CO₂ and Total Greenhouse Gas Emissions](#), PBL Netherlands Environmental Assessment Agency (April 2022) at p.33 (China's total GHG emissions in 2019 = 14.1 Gt CO₂eq); Xinxian Qi et al., "Cutting carbon emissions from China's food system," Research Square (May 2022) (under review) (China food system emissions not including waste disposal = 1.55 Gt CO₂eq in 2018).

2 Franceso Tubiello et al., ["Greenhouse gas emissions from food systems: building the evidence base,"](#) Environmental Research Letters (June 8, 2021); David Sandalow et al., [Food and Climate Change InfoGuide](#), Center on Global Energy Policy, Columbia University (May 2021) at p.1; M. Crippa et al., ["Food Systems Are Responsible for a Third of Global Anthropogenic GHG Emissions,"](#) Nature Food (March 2021) at pp. 1-12. See also Cynthia Rosenzweig et al., ["Climate Change Responses Benefit from a Global Food System Approach,"](#) Nature Food (2020) at pp. 94-97.

3 FAO, [FAOSTAT – Value of Agricultural Production](#) (accessed August 8, 2022); FAO, [FAOSTAT – Crops and livestock products](#) (accessed August 8, 2022).

4 FAO, [FAOSTAT – Food Balances \(2010-\)](#) (accessed August 8, 2022); FAO, [FAOSTAT – Crops and livestock products](#) (accessed August 8, 2022).

5 International Labour Organization, [ILOSTAT Country Profiles](#) (accessed July 31, 2022)(23.6% in 2020); National Bureau of Statistics of China, [National Data](#) (accessed August 9, 2022) (7.6% share of GDP in 2021).

6 Ibid.



Rice terrace in Guilin China



Close up view of rice-plants as a cereal grain

Consumption

The most consumed agricultural products in China include vegetables, cereals, fruits, starchy roots and oil crops.⁷

In 2019, China had roughly 64 kilograms of meat per capita for food supply, approximately half that of the United States and Australia but higher than the world average.⁸ Between 1975 and 2018, China's meat consumption increased 14-fold. (Grain consumption tripled during the same period.)⁹ China is the world's largest consumer of pork.¹⁰

Trade

China is a net food importer and plays a central role in the international agricultural trade.

Between 2017 and 2020, China was the world's largest importer of agricultural products, followed by the United States.¹¹ In 2021, China imported \$219.8 billion of agricultural products, including \$53.5 billion of soybeans, \$32.2 billion of meat products, \$15.2 billion of fruits and nuts and \$14.4 billion of aquatic products.¹²

Between 2015 and 2020, China was the world's fifth largest exporter of agricultural products,

7 FAO, [FAOSTAT- Food Balances \(2010-\)](#) (accessed August 9, 2022).

8 Ibid.

9 China Power Team. "[How is China Feeding its Population of 1.4 Billion?](#)" China Power (January 25, 2017).

10 OECD, [OECD Data - Meat consumption](#) (accessed August 9, 2022).

11 WTO, [WTO STATS](#) (accessed August 9, 2022).

12 General Administration of Customs People's Republic of China, "[\(14\) Major Import Commodities in Quantity and Value,12.2021,](#)" (January 18, 2022).

behind the United States, Netherlands, Brazil and Germany.¹³ In 2021, China exported a total of \$84.4 billion of agricultural goods, including \$21.6 billion of aquatic products, \$12.3 billion of vegetables and \$6.1 billion of fruits and nuts.¹⁴

Emissions of Heat-Trapping Gases

Emissions of heat-trapping gases are generated throughout the food system. The world's leading data source on this topic—the UN Food and Agriculture Organization (FAO)—divides food system emissions into three categories: farm-gate, land use change, and pre- and post-production activities. (The latter category includes fertilizer manufacturing, food household consumption, food packaging, food processing, food retail and food transport.)

According to FAO, in 2019:

- farm-gate emissions in China were roughly 792 Mt CO₂eq total (approximately 6% of total Chinese emissions);
- there were no emissions due to agricultural land use change in China; and
- pre- and post-production activity emissions in China were 1.1 Gt CO₂eq (approximately 8% of total Chinese emissions).¹⁵

These totals included emissions of roughly 469 Mt CO₂eq from household food consumption, 210 Mt CO₂eq from food waste disposal and 131 Mt CO₂eq from fertilizer manufacturing.¹⁶

Emissions Footprint of China's Food System Abroad

China's food imports contribute to emissions of heat-trapping gases abroad. One study found that Chinese soy imports were responsible for 6.5 Mt of CO₂ emissions linked to deforestation in Brazil in 2017.¹⁷ Another study found 12 Mt of CO₂eq emissions in exporting countries from China's import of ruminant products in 2012.¹⁸ In contrast with the industrial sector, where consumption-based emissions accounting reduces China's emissions totals as compared to traditional territorial-based emissions accounting, in the food sector consumption-based emissions accounting increases China's emissions totals.¹⁹

¹³ WTO, [WTO STATS](#) (accessed August 9, 2022).

¹⁴ General Administration of Customs People's Republic of China, "[\(13\) Major Export Commodities in Quantity and Value,1-11,2020.](#)" (December 23, 2020); Trading Economics, [China Exports of Agricultural Products](#) (accessed August 10, 2022).

¹⁵ FAO, [FAOSTAT- Emissions shares](#) (accessed August 7, 2022).

¹⁶ Ibid.

¹⁷ CDP, "[Decoupling China's Soy Imports from Deforestation Driven Carbon Emissions in Brazil.](#)" (December 2019) at p.5.

¹⁸ Du, Y., Ge, Y., Ren, Y. et al., "[A global strategy to mitigate the environmental impact of China's ruminant consumption boom.](#)" Nature Communications (October 8, 2018).

¹⁹ See Chapters 1(A), Chapter 12. On the emissions footprint of China's food system abroad, see also Zhao, H., Chang, J., Havlík, P. et al., "[China's future food demand and its implications for trade and environment.](#)" Nature Sustainability (October 18, 2021); André Vasconcelos, "[Uncovering the Deforestation and Climate Risks of Chinese and EU Soy and Beef Imports from South America.](#)" Wilson Center (January 2022).

Policy

For almost two decades, the first policy document issued by China's State Council each year has been on rural issues. The *No. 1 Central Document* (as it is known) generally focuses on three issues—the rural population, rural areas and agriculture. The most recent *No.1 Central Document*, released in February 2022, calls for:

- stabilizing and increasing agricultural productivity;
- steadily raising farmers' incomes; and
- ensuring stability in rural areas to cope with the COVID-19 pandemic and other changes.

The *No. 1 Central Document* for 2022 focuses in particular on grain security, calling for new measures to ensure that grain production does not fall below 650 billion kilograms.²⁰

The *No.1 Central Document* for 2014 was the first to propose a long-term framework for sustainable agricultural development. The framework focused on water usage, pesticides and chemical fertilizers, among other issues—not directly on climate change.²¹ Similarly, the *National Sustainable Agricultural Development Plan (2015-2030)*, released by the Ministry of Agriculture in May 2015, focused on agricultural productivity, water usage and chemical pollution, without specific goals related to climate change mitigation or adaptation.²² However in the months and years since, Chinese government policy documents have paid growing attention to the relationship between agriculture and climate change.

In June 2015, for example, the Chinese government submitted its *Intended Nationally Determined Contribution (INDC)* to the UN Framework Convention on Climate Change (UNFCCC). The INDC describes plans to:

- promote low-carbon development in agriculture;
- make efforts to achieve zero growth of fertilizer and pesticide utilization by 2020;
- control methane emissions from rice fields and nitrous oxide emissions from farmland;
- construct a recyclable agriculture system by promoting comprehensive utilization of straw, agricultural and forestry wastes, and animal wastes; and

20 National Food and Strategic Reserve Administration, [2022 Central Document No.1](#) (in Chinese) (February 22, 2022); The State Council, ["China's 'No 1 central document' vows promotion of rural vitalization."](#) (February 23, 2022); ["The 19th No.1 Central Document continues to improve rural wellbeing."](#) Beijing Review (February 28, 2022).

21 See Chapter 5. Agricultural policy in China. OECD, ["OECD Food and Agricultural Reviews – Innovation, Agricultural Productivity and Sustainability in China."](#) (October 4, 2018).

22 Ministry of Agriculture, ["National Sustainable Agricultural Development Plan \(2015-2030\) released."](#) (in Chinese) (May 28, 2015); UK-China Sustainable Agriculture Innovation Network, ["National Sustainable Agricultural Development Plan \(2015-2030\)."](#) (accessed August 10, 2022).

- improve greenhouse gas emissions statistics covering areas including agriculture.²³

In December 2016, the Ministry of Agriculture and Ministry of Finance jointly issued the *Plan for Establishing a Green and Ecologically Oriented Agricultural Subsidy System*. The plan promotes the rational use of agricultural resources in accelerating sustainable agricultural development and agricultural modernization. The plan emphasizes that incremental funds should focus on resource-saving and environment-friendly agriculture.²⁴

In December 2018, China released its *Second Biennial Update Report on Climate Change* and the *Third National Communication on Climate Change*. Regarding agriculture, the documents report that China had:

- enhanced energy conservation for agricultural operation and rural buildings;
- implemented the goal for zero growth in the use of chemical fertilizers and pesticides;
- controlled pollution and non-CO₂ greenhouse gas emissions from farming through biogas utilization; and
- increased capacity for climate change adaptation technologies, including water-saving technology and breeding of stress-resistant agricultural varieties.²⁵

In November 2019, the Ministry of Ecology and Environment released its annual report on China's *Policies and Actions for Addressing Climate Change*. The report discussed climate mitigation and adaptation issues related to China's agriculture sector. According to the report:

- demonstrations of chemical fertilizer use reduction had been conducted in 300 counties, reducing the chemical fertilizer use rate of three major crops by 37.8%;
- waste utilization from livestock and poultry had been promoted in 585 counties, resulting in a 70% comprehensive utilization rate of waste resources nationwide;
- localities had been developing water-saving agriculture, promoting drought-resistant and moisture-conserving adaptation technologies, and cultivating high-temperature resistant and drought-resistant crop varieties.²⁶

In August 2020, President Xi Jinping announced the *Clean Plate Campaign* to enhance the public's awareness of food waste.²⁷ (Wasted food results in significant emissions of heat-trapping gases.)²⁸ The campaign highlights the need to maintain a sense of crisis regarding

23 People's Republic of China, [Enhanced Action on Climate Change: China's Intended Nationally Determined Contributions](#) (June 2015).

24 Ministry of Finance, "[The Ministry of Finance and the Ministry of Agriculture vigorously promote the establishment of a green and ecologically oriented agricultural subsidy system reform.](#)" (in Chinese) (December 19, 2016).

25 People's Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at pp.60–61;

People's Republic of China, [Third National Communication on Climate Change](#) (December 2018) at p.93, 96, 115, 133, 135.

26 Ministry of Ecology and Environment, [China's Policies and Actions for Addressing Climate](#) (November 2019) at p.12.

27 "[Xi Focus: Xi stresses stopping wasting food, promoting thrift.](#)" Xinhua News (August 11, 2020).

28 See generally FAO, "[Food waste footprint & Climate Change.](#)" (accessed August 10, 2022); Hannah Ritchie, "[Food waste is responsible for 6% of global greenhouse gas emissions.](#)" Our World in Data (March 18, 2020).

food security during the COVID-19 pandemic and calls for promoting the social custom of thrift. Food distributors have responded with a range of measures, including restaurants offering half-portion options, universities rewarding students with free fruit for finishing their lunch, and catering companies allowing a group of 10 diners to order only nine dishes.²⁹

In March 2021, the China government released its *14th Five-Year Plan for Economic and Social Development and Long-range Objectives through the Year of 2035*. With respect to the food system, the plan calls for:

- modernizing the agricultural sector by 2035;
- accelerating the development of smart agriculture and promoting the digital transformation of agricultural production;
- building a national food security industry belt;
- promoting water-saving renovation; and
- promoting the green transformation of agriculture and strengthening environmental protection of agricultural production areas.³⁰

In April 2021, the National People's Congress passed the *Anti-Food Waste Law*. The law outlines the basic code of conduct for entities including government, enterprises, schools and the food/catering services to improve food procurement, management and preparation processes. Most notably, the law allows restaurants to charge diners an extra fee (if clearly advertised) for leaving excessive amount of food uneaten. Food providers who mislead consumers into making excessive orders could face fines up to RMB 10,000 (roughly \$1500). The law also bans making and distributing binge-eating videos.³¹

In October 2021, the National Development and Reform Commission (NDRC) released the *Action Plan for Carbon Dioxide Peaking Before 2030*, following the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy*. On agriculture, the plans call for:

- developing energy-saving, low-carbon greenhouses for agriculture;
- promoting the use of energy-saving, eco-friendly cookers, agricultural machinery, fishing boats and agricultural vehicles;
- speeding up the application of renewable energy resources, such as biomass energy and solar energy, in agricultural production and daily life in rural areas;
- stepping up efforts to develop green, low-carbon and circular agriculture and

29 Marissa Sheldon, "[China Promotes Clean Plate Campaign to Reduce Food Waste](#)," Hunter College New York City Food Policy Center (October 14, 2020).

30 NDRC, [The Outline of the 14th Five-Year Plan for Economic and Social Development and Long-Range Objectives through the Year 2035 of the People's Republic of China](#) (in Chinese) (March, 2021) at pp.7-8 and 55-56.

31 "[Anti-Food Waste Law of the People's Republic of China](#)," Xinhua News (in Chinese) (April 29, 2021); Liu Caiyu, "[China adopts law against food waste; binge eating, excessive leftovers to face fines](#)," (April 29, 2021).

support low-carbon modes such as agricultural photovoltaics and the combination of offshore wind farms and marine ranches;

- researching applied agricultural technologies that can increase carbon sequestration;
- improving the quality of cropland to protect chernozem soils and to enhance soil organic carbon content; and
- controlling the use of chemical fertilizers, pesticides and agricultural plastic sheeting.³²

In October 2021, the Chinese government submitted its updated *Nationally Determined Contributions* to the UNFCCC. The document discusses China's progress in curbing emissions of heat-trapping gases in the agricultural sector and improvements in the quality of agricultural production.³³

The document includes emissions reduction and efficiency improvement in agriculture among the new measures for implementing the updated NDC goals, citing measures to:

- enhance the reduction and efficiency of chemical fertilizers and pesticides;
- refine the treatment and utilization of livestock and poultry manure;
- adjust planting structure based on the endowment of water resources; and
- select, test and demonstrate energy-saving and emission-reduction technology in agriculture and fishery.³⁴

The document discusses the importance of climate change adaptation for agriculture, calling for strategies to optimize agricultural structure and research on agro-meteorological disaster prevention technologies.³⁵

In June 2022, the Ministry of Agriculture and Rural Affairs and the NDRC jointly issued the *Implementation Plan for Emission Reduction and Carbon Sequestration in Agriculture and Rural Areas*. In alignment with the carbon peaking and carbon neutrality goals, the plan identifies 10 major action areas, including: methane reduction in rice fields, fertilizer reduction and efficiency enhancement, carbon emission reduction from livestock and poultry, sink improvement in fishery, energy conservation in agricultural machinery, sink improvement in farmland, comprehensive utilization of straw, renewable energy replacement, science and technology innovation support, and monitoring system implementation.³⁶

32 NDRC, [Action Plan for Carbon Dioxide Peaking before 2030](#) (October 27, 2021); NDRC, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy](#) (October 24, 2021).

33 People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 28, 2021) at p.24.

34 *Ibid.* at pp.37-37.

35 *Ibid.* at p.15.

36 Ministry of Agriculture and Rural Affairs, [Implementation Plan for Emission Reduction and Carbon Sequestration in Agriculture and Rural Areas](#) (in Chinese) (June, 2022).

CHAPTER 23 - FORESTRY

Almost a quarter of China's land mass is covered by forests, according to official statistics. The Chinese government has ambitious forest conservation programs and highlights growth in forest stock volume as a prominent climate change goal.¹

Most new forest growth in China is in monoculture plantations. The impact of China's timber and food imports on tropical forests abroad may substantially or completely offset the climate change benefits of China's domestic forestry programs.²

Background

Forests cover large parts of southern China, from Fujian Province in the east to Sichuan and Yunnan Provinces in the west. Forests also cover much of China's far northeast. There are fewer forests in the densely populated region between Shanghai and Beijing and almost none in the far western provinces of Xinjiang and Tibet.

Roughly 23% of China's territory is covered with forests, according to the Chinese government and United Nations Food and Agriculture Organization (FAO).³

China's forest cover has expanded in recent decades, according to Chinese government sources.

- China's State Council Information Office reports that 36.3 million hectares of forests were planted from 2016 to 2020.⁴
- NDRC reports that roughly 15 million hectares of forests were planted between 2011 and 2015.⁵
- China's State Forestry Administration reports that China's forest cover grew from roughly 13% in 1981 to more than 20% in 2010.⁶

1 State Council Information Office, [Responding to Climate Change: China's Policies and Actions](#) (October 2021) at Section III-4; NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (March 23, 2021) at pp.90-91; People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021) at p.2.

2 Fangyuan Hua et al., "[Tree plantations displacing native forests: The nature and drivers of apparent forest recovery on former croplands in Southwestern China from 2000 to 2015.](#)" *Biological Conservation* (June 2018); Antje Ahrends et al., "[China's fight to halt tree cover loss.](#)" Royal Society Publishing (October 7, 2017). See section below on Deforestation Abroad.

3 State Council Information Office, [Responding to Climate Change: China's Policies and Actions](#) (October 2021) at Section III-4; U.N. Food and Agriculture Organization, [Global Forest Resources Assessment-China](#) (accessed July 10, 2022). See generally, UN Food and Agriculture Organization, [Global Forest Resources Assessment 2020: Report-China](#), World Resources Institute, [Global Forest Watch—China country summary](#).

4 State Council Information Office, [Responding to Climate Change: China's Policies and Actions](#) (October 2021) at Section III-4.

5 NDRC, [China's Policies and Actions for Addressing Climate Change](#) (October 2016) at p.20.

6 Antje Ahrends, Peter M. Hollingsworth, Philip Beckschäfer, Huafang Chen, Robert J. Zomer, Lubiao Zhang, Mingcheng Wang and Jianchu Xu, "[China's fight to halt tree cover loss.](#)" Royal Society Publishing (October 7, 2017), citing State Forestry Administration China, 2011 China National Progress Report to the UNFF Secretariat on the implementation of NLBI and other relevant resolutions, Beijing, China: State Forestry Administration China (January 2011).

Figure 23-1: China's Forests (2019)



Source: National Forestry and Grasslands Administration⁷

Several academic studies provide similar estimates for the years prior to 2010.

- A 2016 study by scientists at Michigan State University found that between 2000 and 2010, 1.6% of China's territory experienced a significant increase in forest cover

⁷ National Forestry and Grasslands Administration, [Forest Resources in China-The Ninth National Forest Inventory](#) (March 2019) at p.1.

and 0.38% experienced significant forest loss.⁸

- A 2011 study by scientists at Peking University found that forest cover in China increased an average of roughly 0.5% annually between 1980 and 2010.⁹

However, at least one source finds that tree cover has declined in China in the past several decades. Global Forest Watch, an online platform that provides forest data, reports that:

- From 2001 to 2020, China lost 10.9 million hectares of tree cover—a 6.7% decrease—resulting in roughly 4.7 Gt of CO₂ emissions (slightly less than half of China’s CO₂ emissions last year).
- From 2013 to 2021, China lost 3.7 million hectares of natural forest—a 2.7% decrease—resulting in roughly 1.5 Gt of CO₂ emissions.
- From 2002 to 2021, China lost 77,300 hectares of humid primary forest—a 4.5% decrease.¹⁰

The different estimates may in part be due to different definitions. A 2017 study found that:

“If ‘forest’ is defined according to the FAO criteria (including immature and unstocked areas), China’s forest cover gains between 2000 and 2010 were larger than the combined area of Germany, The Netherlands, Belgium and Luxembourg. If forest is defined according to China’s own criteria..., China has gained an area smaller than size of Germany; and if forest is defined according to what non-specialists would view as forest (contiguous blocs of tall (higher than 5 m) and closed (minimum 50%) crown cover), the detectable gains are smaller than the size of The Netherlands.”¹¹

Data quality may also be a problem. Some studies have found systemic over-reporting of tree cover in China, in part because tree cover goals are included in the performance criteria for many local and provincial officials.¹²

Monoculture plantations dominate new forest growth in China. One study found that, although tree cover grew 32% in southwest China between 2000 and 2015, all that growth was due to the conversion of croplands to tree plantations. During the same period, native forests in

8 Andrés Viña, William J. McConnell, Hongbo Yang, Zhenci Xu and Jianguo Liu, [“Effects of conservation policy on China’s forest recovery.”](#) *Science Advances* (March 2016).

9 Lei Shi et al., [“The Changes in China’s Forests: An Analysis Using the Forest Identity,”](#) *PLOS ONE* (June 9, 2011).

10 [Global Forest Watch—China country summary](#), World Resources Institute (accessed July 23, 2022). Global Forest Watch defines “tree cover” as “all vegetation greater than 5 meters in height,” which “may take the form of natural forests or plantations across a range of canopy densities.” [Global Forest Watch—Tree Cover Loss](#), World Resources Institute (accessed July 23, 2022)

11 Antje Ahrends, Peter M. Hollingsworth, Philip Beckschäfer, Huafang Chen, Robert J. Zomer, Lubiao Zhang, Mingcheng Wang and Jianchu Xu, [“China’s fight to halt tree cover loss,”](#) the Royal Society Publishing (October 7, 2017) at p.7. See also Yan Li et al., [Inconsistent estimates of forest cover change in China between 2000 and 2013 from multiple datasets](#), *Scientific Reports* (August 2017).

12 Hong Jiang, [“Taking Down the ‘Great Green Wall’: The Science and Policy Discourse of Desertification and Its Control in China,”](#) *The End of Desertification* (2016) at p.528

southwest China declined by 6.6%. Monoculture tree plantations provide significantly less carbon storage and biodiversity value than natural forests.¹³

Policies

China's Nationally Determined Contribution (NDC) gives high prominence to a forest goal. One of the six principal goals in China's October 2021 NDC is "to increase the forest stock volume by around 6 billion cubic meters from 2005 levels" by 2030. This builds on the forest goal in China's 2015 NDC—to increase the forest stock volume by around 4.5 billion cubic meters from 2005 levels by 2030. (The 2015 NDC forest goal was achieved in 2019, 11 years ahead of schedule.)¹⁴

During the *14th Five-Year Plan* (2021–2025), the Chinese government aims to increase forest cover to 24.1% of the country's total land area. This builds on the forest cover goal in the *13th Five-Year Plan*—to increase forest cover from 21.66% to 23%. The *13th Five-Year Plan* forest goal was met in 2020.¹⁵

The 14th Five-Year Plan sets goals for the protection and restoration of important ecological zones. Six of these goals relate to forestry.¹⁶ (See table below.)

Figure 23-2: 14th Five Year Plan Forest Goals

Area	14th Five-Year Plan Goals
Tibetan Plateau ecological shield zone	Additional 1 million hectares of land will be protected from desertification; additional 3.2 million hectares of grassland will be protected from degradation.
Yellow River ecological zone	800,000 hectares of forest and grass vegetation will be restored; additional 2 million hectares of land will be protected from soil erosion; 800,000 hectares of land will be protected from desertification.
Yangtze River ecological zone	1.1 million hectares of land will be afforested; additional 5 million hectares of land will be protected from soil erosion; 1 million hectares of land will be protected from stony desertification.

13 See Fangyuan Hua et al., "[Tree plantations displacing native forests: The nature and drivers of apparent forest recovery on former croplands in Southwestern China from 2000 to 2015](#)," *Biological Conservation* (June 2018); Antje Ahrends et al., "[China's fight to halt tree cover loss](#)," Royal Society Publishing (October 7, 2017); Simon Lewis et al., "[Restoring natural forests is the best way to remove atmospheric carbon](#)," *Nature* (April 2, 2019).

14 People's Republic of China, [China's Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021) at p.2; People's Republic of China, *Enhanced Action on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.5; [Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction](#), (in Chinese) Chinese Government Network (July 11, 2019). "Forest stock volume" is "the sum of the stem volumes of all the living trees" in an area. See Yang Hu et al., "[Estimating Forest Stock Volume in Hunan Province, China](#)," *Remote Sensing* (January 2020).

15 State Council Information Office, "[China's forest coverage rate to reach 24.1% by 2025](#)" (December 17, 2020); State Council, *Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan* at 3(D); State Council, [Second Biennial Update Report \(December 2018\)](#)

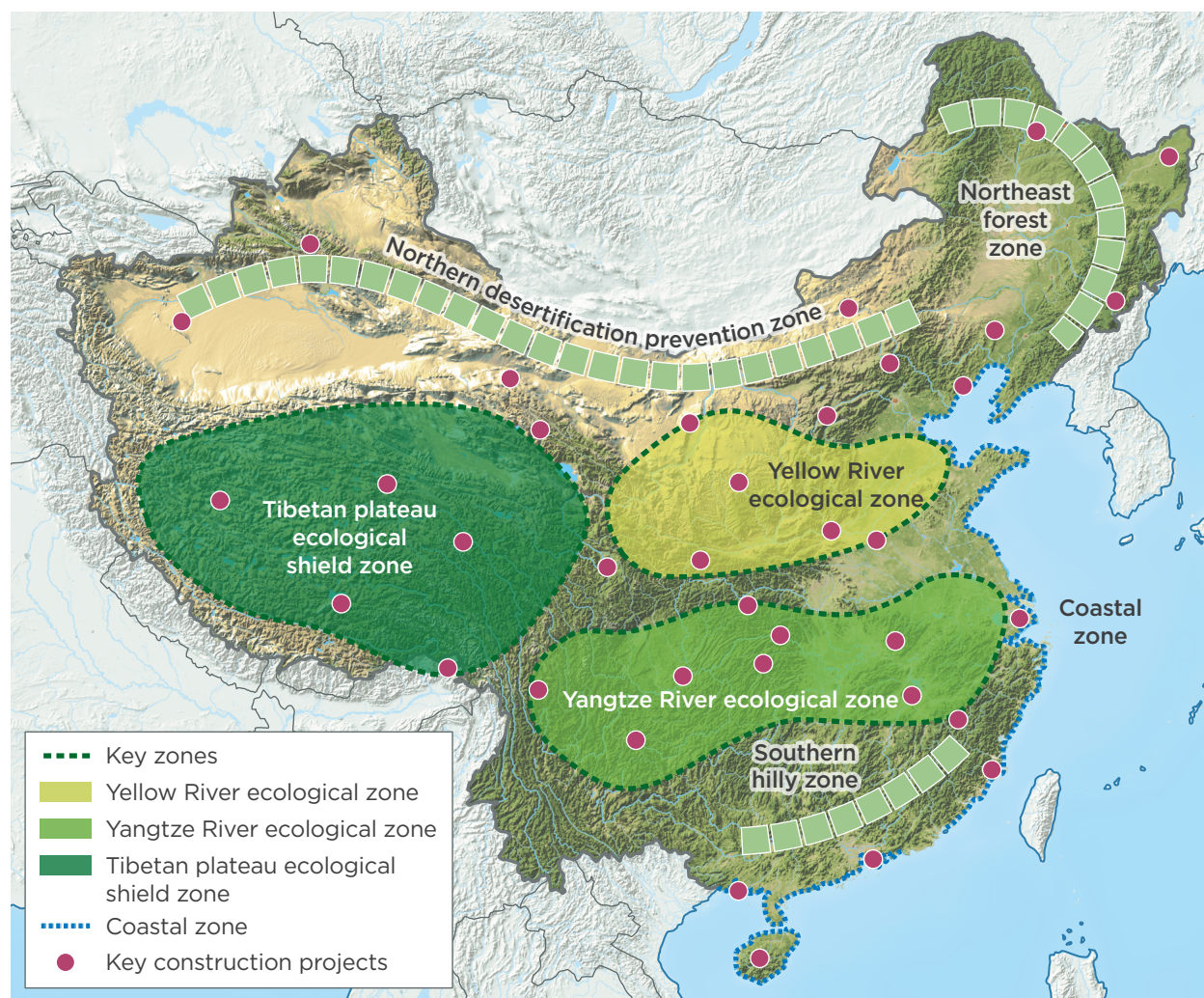
16 NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021) at pp.90–91.

Northeast forest zone	700,000 hectares of land will be cultivated as potential natural forest; 300,000 hectares of degraded grassland will be improved.
Northern desertification prevention zone	2.2 million hectares of land will be afforested; additional 7.5 million hectares land will be protected from desertification; 2.7 million hectares of grassland will be protected from degradation.
Southern hilly zone	90,000 hectares of shelter forest will be built; 300,000 hectares of land will be protected from stony desertification.

Source: NDRC¹⁷

¹⁷ NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021) at pp.90-91.

Figure 23-3: 14th Five-Year Plan: Major Projects for Protection and Restoration of Important Ecosystems



Source: NDRC¹⁸

The Chinese government has extensive domestic forest conservation programs. The largest, known as the Natural Forest Conservation Program, includes large-scale tree-planting, an expansion of forest reserves and a ban on logging in primary forests. From 1998 to 2018, the

¹⁸ NDRC, [14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and Outline of the Vision for 2035](#) (in Chinese) (March 23, 2021) at p.89.

central government spent more than RMB 475 billion (roughly \$72 billion) on the program.¹⁹

Historically, the goal of China's forest conservation programs included preventing floods and fighting desertification. The Three-North Shelterbelt Program, launched in the late 1970s, is a multidecade program to plant a 4,500-kilometer wall of trees through the Gobi Desert to reduce sandstorms. The National Forest Conservation Program was launched in the wake of the catastrophic Yangtze River floods of 1998. In recent years, the goals of China's forest conservation programs have expanded to include fighting local air pollution and climate change as well.²⁰

In December 2019, the National People's Congress revised China's Forest Law for the first time in 10 years. The amendments banned buying, transporting or processing illegal timber and require processing companies to establish a data record of raw materials and products. Environmental advocates praised the amendments, while saying the impacts would depend on how actively the new provisions are enforced. The amendments also strictly control the logging of natural forests and limit annual harvest volumes.²¹

Official documents setting forth China's forest policies include:

1. *National Afforestation and Greening Plan (2016–2020)*²²
2. *National Forest Management Plan (2016–2050)*²³
3. *Action Plan for Climate Change in Forestry in the 13th Five-Year Plan*²⁴
4. *Action Plan for Forestry to Adapt to Climate Change (2016–2020)*²⁵
5. *14th Five-Year Plan for Protection and Development of Forestry and Grassland (2021–2025)*²⁶

The National Forestry and Grassland Administration (NFGA) within the Ministry of Natural Resources has principal responsibility for forest management in China. The NFGA was

19 Hui Wang et al., "[China's Key Forestry Ecological Development Programs](#)," (in Chinese) *Forests* (January 2021); Ahrends et al., "[China's fight to halt tree cover loss](#)," (October 7, 2017); Andrés Viña, William J. McConnell, Hongbo Yang, Zhenci Xu and Jianguo Liu, "[Effects of conservation policy on China's forest recovery](#)," *Science Advances* (March 2016). See also Zihao Ma et al., "[Cost-Benefit Analysis of China's Natural Forest Conservation Program](#)," *Journal for Nature Conservation*, Vol. 55 (June 2020), 125818.

20 Ahrends et al., "[China's fight to halt tree cover loss](#)," (October 7, 2017); Miao-miao Li, An-tian Liu, Chunjing Zou, Wen-duo Xu, Hideyuki Shimizu and Kai-yun Wang, "An overview of the 'Three-North' Shelterbelt project in China," *Forestry Studies in China* (February 2012); Viña et al., "Effects of conservation policy on China's forest recovery" (March 2016); "[Lessons from China on Increasing Forest Cover](#)," *Unravel* (March 3, 2021).

21 Ministry of Ecology and Environment, [Forest Law of the People's Republic of China](#) (December 28, 2019); "[China introduces new law to safeguard forests and improve governance](#)," *Client Earth* (July 8, 2020); Ashoka Mukpo, "[China's revised forest law could boost efforts to fight illegal logging](#)," *Mongabay* (March 19, 2020).

22 State Forestry Administration, [National Afforestation and Greening Plan \(2016–2020\)](#).

23 State Forestry Administration, [National Forest Management Plan \(2016–2050\)](#) (in Chinese).

24 State Forestry Administration, [Action Plan for Climate Change in Forestry in the 13th Five-Year Plan](#) (in Chinese).

25 State Forestry Administration, [Action Plan for Forestry to Adapt to Climate Change \(2016–2020\)](#) (in Chinese).

26 National Forestry and Grassland Administration, NDRC, "[14th Five-Year Plan for Protection and Development of Forestry and Grassland](#)," (in Chinese) (July 2021).

established in 2018 as part of government-wide institutional reforms, assuming the functions and responsibilities of the former State Forestry Administration at that time.²⁷

Several provinces, including Sichuan, Guangdong and Guizhou, have launched pilot carbon sink trading for poverty alleviation programs. Under these programs, poor households can receive compensation for planting and cultivating trees in part for the carbon storage value.²⁸

Sequestration Estimates

China's forest programs sequester significant amounts of carbon.

- A 2020 study estimated that, between 2020 and 2050, forest vegetation in China will absorb roughly 22% of Chinese CO₂ emissions from fossil fuels during the same period.²⁹
- A 2018 study that sampled thousands of plots across China found that each year China's forests sequester carbon equivalent to roughly 5% of the country's CO₂ emissions.³⁰
- A 2016 study estimated that carbon storage in China's forests would reach almost 28 Gt by 2033. (This is equal to roughly nine years of China's CO₂ emissions.)³¹
- A 2015 study estimated that China's forests had absorbed more than 22 Gt of carbon since 1973. (This is equal to roughly seven years of China's CO₂ emissions.)³²

The Chinese government has provided official estimates of the carbon sequestered in land use change and forestry activities combined.

- In its *Second Biennial Update Report* submitted to the UN Framework Convention on Climate Change in December 2018, the Chinese government estimated that 1150 Gt of CO₂ (roughly 11% of China's annual CO₂ emissions) were sequestered by land use change and forestry activities in 2014.³³
- In its *First Biennial Update Report* submitted to the UN Framework Convention on

27 See "[A Brief Account of the National Forestry and Grassland Administration.](#)" National Forestry and Grassland Administration website (accessed September 24, 2022).

28 "[Carbon sink trading sheds new light on China's poverty relief.](#)" XinhuaNet (July 10, 2018).

29 Qiu, Zixuan, Zhongke Feng, Yanni Song, Menglu Li and Panpan Zhang. 2020. "[Carbon Sequestration Potential of Forest Vegetation in China from 2003 to 2050.](#)" Journal of Cleaner Production 252 (April 2020).

30 Jingyun Fang et al., "[Climate change, human impacts, and carbon sequestration in China.](#)" Proceedings of the National Academy of Sciences of the United States, April 17, 2018 (163.4 TgC/year of carbon sequestration for the past decade). 1 Tg = 1 Mt; 1 Mt C = 3.67 Mt CO₂; 163.4 TgC = 598 Mt CO₂.

31 Zhang Xufang, Yang Hongqiang and Zhang Xiaobiao, "[Development level and trend in Chinese forestry carbon pools from 1989 to 2033.](#)" Resources Science (February 2016). 28 Gt C = 103 Gt CO₂.

32 Lu Ni-ni, Wang Xin-jie, Ling Wei, Xu Xue-lei and Zhang Yan, "[Estimation of forest carbon storage in China based on data of National Inventory of Forest Resources.](#)" Journal of Central South University of Forestry & Technology (November 2015). China's 2018 CO₂ emissions = roughly 11 Gt. See Chapter 1-Emissions at note 2. 22 Gt C = 81 Gt CO₂. On C v. CO₂, see Joe Romm, "[The Biggest Source of Mistakes: C. v. CO₂.](#)" Think Progress (March 25, 2008).

33 People's Republic of China, "[Second Biennial Update Report on Climate Change](#)" (December 2018) at p.16.

Climate Change in December 2016, the Chinese government estimated that 576 Gt of CO₂ (roughly 6% of China's annual CO₂ emissions) were sequestered by land use change and forestry activities in 2012.³⁴

A 2020 study examined different methods for estimating forest carbon storage in China, finding that better survey data are needed.³⁵

Deforestation Abroad

China is the world's largest timber importer. In 2019, 56% of logs and sawn wood bought in China were imported.³⁶

China's footprint on tropical forests is especially large.

- In 2018, roughly two-thirds of the world's tropical forest logs were exported to China.³⁷
- China is also the world's largest importer of soy and beef, and the world's second-largest importer of palm oil. Growing global demand for each of these products causes significant tropical deforestation.³⁸

In addition, some Belt and Road Initiative projects are through forested areas, which has led to deforestation.³⁹

From a global perspective, these trends may substantially or completely offset the climate change benefits of China's domestic forest conservation policies. China's impacts on tropical forests around the world are especially important with respect to climate change. Tropical deforestation can lead to significant warming, due to both the release of carbon dioxide from vegetation and biophysical effects such as changing the albedo of the Earth's surface.⁴⁰

34 People's Republic of China, [First Biennial Update Report on Climate Change](#) (December 2016) at p.22.

35 Sun, Wanlong, and Xuehua Liu, "[Review on Carbon Storage Estimation of Forest Ecosystem and Applications in China.](#)" *Forest Ecosystems* (2020)

36 Zhu Chunquan and Jin Zhonghao, [China's Role in Promoting Global Forest Governance and Combating Deforestation](#), World Economic Forum (July 2022) at p.6, 12. See generally Steven Lee Myers, "[China's Voracious Appetite for Timber Stokes Fury in Russia and Beyond.](#)" *New York Times* (April 9, 2019); Bo Li, "[2 Ways for China to Play a Bigger Role in Protecting Global Forests.](#)" World Resources Institute (April 17, 2018); Xiufang Sun, Kerstin Canby and Lijun Liu, [China's Logging Ban in Natural Forests](#), *Forest Trends* (March 2018).

37 Zhu Chunquan and Jin Zhonghao, [China's Role in Promoting Global Forest Governance and Combating Deforestation](#), World Economic Forum (July 2022) at p.6.

38 [Global Green Value Chains](#), China Council for International Cooperation on Environment and Development (September 2020) at p.7; Pietro Bertazzi and Sabrina Zhang, "[Soy: China's deforestation dilemma.](#)" Carbon Disclosure Project (March 21, 2019); "[What Are The Biggest Drivers Of Tropical Deforestation?.](#)" *World Wildlife Fund Magazine* (Summer 2018); "[8 Things To Know About Palm Oil.](#)" World Wildlife Fund website (accessed July 24, 2022).

39 Elizabeth Losos, Alexander Pfaff and Lydia Olander, "[The deforestation risks of China's Belt and Road Initiative.](#)" *Brookings* (January 28, 2019).

40 Deborah Lawrence et al., "[The Unseen Effects of Deforestation: Biophysical Effects on Climate.](#)" *Frontiers in Forests and Global Change* (March 2022). On China's forest conservation policies and global deforestation, see generally Zhu Chunquan and Jin Zhonghao, [China's Role in Promoting Global Forest Governance and Combating Deforestation](#), World Economic Forum (July 2022).

In September 2020, the China Council for International Cooperation on Environment and Development (CCICED), “a high-level international advisory body with the approval of the Government of China,”⁴¹ released a report finding that:

“The Chinese government could strengthen measures to reduce the import of soft commodities that are illegally harvested or produced in their country of origin. This could build upon a provision regarding the legality of timber in the latest revision of the Forest Law.”⁴²

In 2021, the Chinese government signaled attention to deforestation abroad in several international fora.

- At the Second EU–China High-Level Environment and Climate Dialogue in September 2021, China and the EU agreed “to engage collaboratively in support of reducing global deforestation through enhancing cooperation in conservation and sustainable management of forests, making supply chains more sustainable, and combating illegal logging and associated trade.”⁴³
- At the 26th Conference of the Parties to the UN Framework Convention on Climate Change in November 2021 (COP26), China signed the *Glasgow Leaders’ Declaration on Forests and Land Use* together with 140 other countries. The Declaration includes a commitment to “halt and reverse forest loss” by 2030.⁴⁴
- Also at COP26, China and the United States issued the *Joint Glasgow Declaration on Enhancing Climate Action in the 2020s*, pledging to “engage collaboratively in support of eliminating global illegal deforestation through effectively enforcing their respective laws on banning illegal imports.”⁴⁵

41 [China Council for International Cooperation on Environment and Development website - About Us](#) (accessed July 24, 2022).

42 [Global Green Value Chains](#), China Council for International Cooperation on Environment and Development (September 2020) at p.vi;

43 [Joint Press Communiqué following the Second EU–China High Level Environment and Climate Dialogue](#) (October 10, 2021) at Para. 11.

44 [Glasgow Leaders’ Declaration On Forests And Land Use](#) (November 2, 2021).

45 [U.S.–China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s](#) (November 10, 2021) at para.10.

CHAPTER 24 - ADAPTATION

In May 2022, the Ministry of Ecology and Environment (MEE) released its National Climate Change Adaptation Strategy 2035 together with 16 other central government ministries, bureaus and departments.¹ The Strategy updates and strengthens policies laid out in China's first *National Strategy for Climate Change Adaptation*, released in 2013.²

Background

The Intergovernmental Panel on Climate Change (IPCC), in its *Sixth Assessment Report on Impacts, Adaptation and Vulnerability* released in March 2022, found that “there are feasible and effective adaptation options which can reduce risks to people and nature” from climate change. The IPCC identified adaptation strategies with respect to flooding, forests, food systems, energy systems, human health, disaster risk management and other topics.³

The need for adaptation strategies and expenditures in China in the years ahead will be especially high. The IPCC's *Sixth Assessment Report on Impacts, Adaptation and Vulnerability* found, for example, that:

- Without adaptation expenditures, China will suffer the world's biggest economic losses as a result of rising sea levels and the resulting floods.⁴
- Without adaptation expenditures, annual heat-related deaths in 27 major Chinese cities are likely to nearly double, from 32 per million people annually in 1986–2005 to 49–67 per million if global average temperatures rise 1.5°C (2.7°F) from pre-industrial levels. This number is projected to increase to 59–81 deaths per million for 2°C (3.6°F) of warming.⁵

These findings are consistent with findings in official Chinese government reports, including the *China Blue Book on Climate Change* published each year by the Chinese Meteorological Administration. The 2022 edition of the Blue Book states that:

- Average annual temperature increases since 1951 have been higher than the global average, rising 0.26°C (0.47°F) per decade.
- Extreme heat waves and storms are becoming more frequent in China.
- In 2021, glacier retreat in China was almost at record levels, with the west end of the

1 Ministry of Ecology and Environment et al., [国家适应气候变化战略2035 \[National Climate Change Adaptation Strategy 2035\]](#), (in Chinese) (June 7, 2022); Ministry of Ecology and Environment et al., [National Climate Change Adaptation Strategy 2035](#), (English translation) (August 29, 2022).

2 National Development and Reform Commission et al., [国家适应气候变化战略 \[National Strategy for Climate Change Adaptation\]](#) (November 18, 2013).

3 IPCC, [Climate Change 2022: Impacts, Adaptation and Vulnerability—Summary for Policymakers](#) (March 2022) at p. 21–22.

4 IPCC, [Climate Change 2022: Impacts, Adaptation and Vulnerability](#) (March 2022) at p.1500.

5 IPCC, [Climate Change 2022: Impacts, Adaptation and Vulnerability](#) (March 2022) at p.1498.

Urumqi Heyuan 1 glacier retreating 8.5 meters in one year.⁶

One leading study found that every RMB invested in climate adaptation in China could generate RMB 2–RMB 20 in returns over 30 years.⁷

Policies

First National Strategy for Climate Adaptation

The 2013 *National Strategy for Climate Change Adaptation* focused on strengthening monitoring and early warning capabilities, improving public awareness, protection of water resources and prevention of soil erosion, among other topics. It included sectoral adaptation tasks for agriculture and food security and measures to integrate national and regional adaptation strategies. The *Strategy* highlighted the need for greater financial support for science and technologies related to climate adaptation and called for more international cooperation on this topic.⁸

Since the release of the *National Strategy for Climate Change Adaptation* in 2013, the Chinese government has adopted plans that improve climate resilience in a number of sectors including food systems, water resources, forestry, meteorological disaster information systems, urban areas and public health. Some of these plans are described as climate change adaptation plans in official documents, others are not.

- In the agriculture sector, policies have focused on water conservation, water use, reduction in soil erosion and capacity-building for fertilizer conservation.
- In forestry, there have been improvements in pest control, afforestation areas completed and new desertification control areas.
- In marine conservation, several government departments teamed up to address problems such as the destruction of coral reefs, illegal mining of sea sand, illegal dumping of waste and the human occupation of wetlands.
- In water resources, the central government has issued policy documents to strengthen unified management and protection programs. The Yangtze River Protection Law of 2020 strengthened policy and regulatory frameworks for green

6 [“China’s Blue Book on Climate Change \(2022\) released the global warming trend continues,”](#) People’s Daily Online (in Chinese) (August 3, 2022); [“Annual Blue Book highlights increasing climate impacts on China,”](#) China Dialogue (August 4, 2022); Li Hongyang, [“Climate change making China’s summer hotter,”](#) China Daily (August 4, 2022). See also Chinese Meteorological Administration, [China Blue Book on Climate Change 2019 as reported in Zhang Tianchi and Qiu Haifeng, “China’s surface temperature shows a clear upward trend,”](#) (in Chinese) People’s Daily (April 11, 2019). For more information on China’s vulnerability to climate change, see Chapter 2 of this Guide.

7 Helen Ding et al., [Accelerating Climate-Resilient Infrastructure Investment in China](#), World Resources Institute, National Center for Climate Change Strategy and International Cooperation and International Institute of Green Finance (2021).

8 National Development and Reform Commission et al., [国家适应气候变化战略 \(National Strategy for Climate Change Adaptation\)](#) (November 18, 2013); PRC, [First Biennial Update Report on Climate Change](#) (December 2016) at p.119–123; X.J. He, [“Information on Impacts of Climate Change and Adaptation in China,”](#) Journal of Environmental Informatics (June 2017); Sean McLernon, [“China Issues 1st National Climate Change Adaptation Plan,”](#) Law360 (December 10, 2013).

development and ecosystem restoration in the Yangtze River basin.⁹

- In urban infrastructure, there have been considerable investments in the resilience of water supply, drainage pipelines and power systems.¹⁰

In January 2021, Vice Premier Han Zheng spoke at the Climate Adaptation Summit. He called on all nations to formulate and implement climate adaptation plans.¹¹

National Climate Change Adaptation Strategy 2035

The *National Climate Change Adaptation Strategy 2035*, released in May 2022, is a major update of the previous version. The number of ministries participating almost doubled—from 9 to 17. The updated Strategy emphasizes “proactive adaptation”—actively preparing climate impacts, rather than passively responding to them.¹²

The *National Climate Change Adaptation Strategy 2035* highlights that climate change has made China more vulnerable to extreme weather events and that extreme weather poses increasing danger to public health. It calls for strengthening monitoring and assessment of climate risks.

Food security is central to the *National Climate Change Adaptation Strategy 2035*. The Strategy says that, as vegetation belts move north, China needs to take action to optimize its farming and switch to higher-yield and more stress-resistant crops. This builds on regional efforts underway to assess the best adaptation measures by region and crop.¹³

The *Strategy 2035* also notes the importance of climate impacts on supply chains, the financial sector and energy supply. It argues that the risk management capabilities of the industrial, financial and energy sectors have become a key aspect of China’s climate change readiness. The participation of more ministries and administration reflects this as well, with chapters of the Strategy dedicated to more sectors and the health impacts. By doing so, the *Strategy 2035* emphasizes that climate change is a significant non-traditional security threat to China, a statement that was not made in the 2013 version.

The *Strategy* envisages that by 2025, China will improve its institutional mechanisms for monitoring and early warning systems to deal with extreme weather events and have made considerable progress in prevention capabilities. By 2025, China will also have established

9 Lin Fu et al, “[Index for climate change adaptation in China and its application](#),” *Advances in Climate Change Research* (October 2021); Au Shion Yee and Dongmei Guo, “[Yangtze River Protection Law of the People’s Republic of China](#),” *Asia Development Bank Briefs* (October 2021).

10 Lin Fu et al, “[Index for climate change adaptation in China and its application](#),” *Advances in Climate Change Research* (October 2021).

11 “[Chinese vice premier urges joint efforts to tackle global climate change](#),” *Xinhua* (January 26, 2021).

12 Ministry of Ecology and Environment et al., [国家适应气候变化战略2035 \[National Climate Change Adaptation Strategy 2035\]](#), (in Chinese) (June 7, 2022); Ministry of Ecology and Environment et al., *National Climate Change Adaptation Strategy 2035*, (English translation) (August 29, 2022).

13 “[China updates its national strategy for climate adaptation](#),” *China Dialogue* (June 16, 2022); Zhan Tian et al., [Agricultural Adaptation to Climate Change in China](#) (October 2019).

climate-adaptive pilot cities using adaptation technologies.¹⁴

In addition, the *Strategy* states that China will (i) strengthen monitoring at rivers and lakes to boost flood control and improve water supply security, and (ii) reform water prices and impose binding consumption targets in key regions. The Strategy includes a target to cut water intensity—the amount used per unit of economic growth—by 16% over 2021–2025.

The *Strategy* states that by 2035 (i) China will have established a nationwide climate impact and risk assessment system, with improved early warning capabilities, and (ii) all major projects will include climate in environmental impact assessments.

14 Ministry of Ecology and Environment et al., [国家适应气候变化战略2035 \[National Climate Change Adaptation Strategy 2035\]](#), (in Chinese) (June 7, 2022) at pp. 16–17; Ministry of Ecology and Environment et al., [National Climate Change Adaptation Strategy 2035](#), (English translation) (August 29, 2022).

PART III - FOREIGN POLICIES

CHAPTER 25 - UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Rio Earth Summit in 1992. More than 195 countries are Parties. The UNFCCC is the world's principal multilateral agreement on climate change.¹

China ratified the UNFCCC in 1993. It has participated in all annual Conferences of the Parties (COPs) to the UNFCCC and many related meetings, with a steadily growing delegation and role.²

In negotiations under the UNFCCC, China has been a forceful advocate for the principle of “common but differentiated responsibilities.” Under that principle, set forth in Article 3.1 of the Convention, all countries are responsible for contributing to solutions to climate change, but the nature and extent of those responsibilities vary. China has also advocated strongly for:

- flexibility for developing countries on a range of topics, including monitoring, reporting and verification of emissions;
- financial and technical support from developed countries to developing countries to help with emissions reductions and adaptation to climate change; and
- priority attention to the adaptation needs of developing countries.³

In the 1990s, China and other developing countries insisted that they—unlike industrialized countries—should not be subject to binding emissions limits under the UNFCCC. That position was reflected in the structure of the Kyoto Protocol, which was adopted at the third Conference of the Parties (COP 3) in 1997 and entered into force in 2005.

By the time of the Copenhagen climate conference in 2009 (COP 15), China had become the world's largest emitter of heat-trapping gases. Prior to the Copenhagen conference, China pledged to cut CO₂ emissions per unit of GDP 40%–45% from 2005 levels by 2020—its first international pledge to limit CO₂ emissions. China also pledged to increase the share of non-fossil fuels in primary energy consumption to 15% and increase forest cover by 40 million hectares from 2005 levels, both by 2020. Premier Wen Jiabao traveled to Copenhagen, where he met with several heads of state in the final, dramatic hours of the conference. The Copenhagen conference was widely perceived to be a failure, and China, along with many other major emitters, received considerable criticism for the meeting's outcome.⁴

In the years that followed the Copenhagen conference China's leaders increasingly sought common ground on climate change with other countries, including the United States. In 2014, President Xi Jinping and US President Barack Obama made a historic joint announcement on climate change, announcing domestic emissions goals and plans to work together toward a new global climate agreement at the 21st Conference of the Parties to the UNFCCC in Paris

1 UNFCCC, “Parties,” (accessed August 8, 2022).

2 See Yu Jie, “Entering the mainstream: an evolution in China's climate diplomacy,” China Dialogue (December 1, 2015).

3 Craig Hart, Zhu Jiayan and Ying Jiahui, [Mapping China's Climate and Energy Policies](#) (December 2018) at pp. 108-135.

4 Malcolm Moore, “China announces carbon target for Copenhagen,” Telegraph (November 26, 2009); “Why did Copenhagen fail to deliver a climate deal?” BBC News (December 22, 2009); Mark Lynas, “How do I know China wrecked the Copenhagen deal? I was in the room,” Guardian (December 22, 2009).

in December 2015. The joint announcement marked a turning point in the global climate negotiations, with the leaders of the world’s two largest emitters—the largest developing and developed countries—pledging to work together to achieve a global agreement.⁵

In connection with the Paris climate conference (COP 21), Parties to the UNFCCC agreed to submit national action plans for addressing climate change (known as Intended Nationally Determined Contributions, or INDCs). China submitted its INDC in June 2015. In its INDC, China pledged to peak its carbon dioxide emissions around 2030 and make best efforts to peak earlier. It also pledged that, by 2030, it would (1) lower carbon dioxide emissions per unit of GDP 60%–65% from the 2005 level, (2) increase the share of non-fossil fuels in primary energy consumption to around 20% and (3) increase the forest stock volume by around 4.5 billion cubic meters from the 2005 level.⁶

President Xi Jinping joined the opening ceremonies of the Paris climate conference, declaring that “tackling climate change is a shared mission of all mankind.” The Chinese delegation participated actively in shaping the Paris Agreement, which was adopted on December 12, 2015. China ratified the Paris Agreement on September 3, 2016 in a joint ceremony with the United States.⁷

In June 2017, following US President Donald Trump’s announcement that the United States would withdraw from the Paris Agreement, the Chinese government strongly reaffirmed its commitment to the accord. The Chinese government has reiterated that position on many occasions since. In October 2017, in a high-profile report to the 19th Party Congress, President Xi Jinping said that China is “taking the driving seat in international cooperation to respond to climate change.”⁸

The Chinese delegation played a central role in the 24th Conference of the Parties to the UNFCCC (COP 24), held in Katowice, Poland, in December 2018. The principal issue facing negotiators at Katowice were the terms of the “Paris rule book”—a detailed set of requirements on topics including the monitoring, reporting and verification of emissions. Unresolved issues prior to the Katowice conference included the amount of transparency that would be required and the obligations of developing country Parties. In a compromise with the EU and other developed countries, China accepted a common set of standards for all Parties, with some flexibility for developing country Parties in implementation.⁹

In a September 2020 speech to the United Nations General Assembly, President Xi Jinping announced that China would “aim... to achieve carbon neutrality by 2060.” The pledge implied dramatic changes in the Chinese economy in the decades ahead and made headlines around the world.¹⁰

5 [US-China Joint Announcement on Climate Change](#) (November 12, 2014).

6 People’s Republic of China, [Enhanced Action on Climate Change: China’s Intended Nationally Determined Contributions](#) (June 2015).

7 [“President Xi’s speech at opening ceremony of Paris climate summit,”](#) China Daily (December 1, 2015).

8 See [“Xi Jinping’s Speech to 19th CPC National Congress,”](#) (in Chinese) (November 3, 2017); Michael Swaine, [“Chinese Attitudes Toward the U.S. Withdrawal from the Paris Accords,”](#) China Leadership Monitor (September 11, 2017).

9 Lily Hartzell, [“A Shift in Climate Strategy: China at the COP 24,”](#) China-US Focus (January 25, 2019); Kalina Oroschakoff and Paola Tamma, [“UN chief intervenes as climate talks stumble,”](#) Politico (December 12, 2018).

10 [Statement by Xi Jinping at General Debate of 75th UNGA,](#) China Daily (September 22, 2020).

In December 2020, President Xi Jinping participated in the Climate Ambition Summit convened by the United Nations, the United Kingdom and France. President Xi reiterated that China aims “to peak carbon dioxide emissions before 2030 and achieve carbon neutrality before 2060” and announced four new commitments, pledging that by 2030 China will:

- lower its carbon dioxide emissions per unit of GDP by over 65% from the 2005 level;
- increase the share of non-fossil fuels in primary energy consumption to around 25%;
- increase the forest stock volume by 6 billion cubic meters from the 2005 level; and
- bring its total installed capacity of wind and solar power to over 1.2 gigawatts.¹¹

In October 2021, China formally submitted two documents to the UNFCCC pursuant to its commitments under the Paris Agreement.

- In its updated *Nationally Determined Contributions*, the Chinese government reiterated the pledges made by President Xi at the Climate Ambition Summit in December 2020. The document opens by stating that “Climate change is a grim challenge facing all mankind” and emphasizes that “to address climate change is not at others’ request but on China’s own initiative.”¹²
- In its *Mid-Century Strategy*, the Chinese government reiterated its 2030 carbon peaking and 2060 carbon neutrality goals, while discussing strategic priorities including to “foster a green, low-carbon and circular economic system,” “build a clean, low-carbon, safe and efficient energy system,” and “establish a low GHG emission industrial system.”¹³

China was an active participant in the 26th Conference of the Parties to the UNFCCC (COP 26), held in Glasgow in November 2021. China joined the Glasgow Climate Pact, agreeing for the first time to language targeting coal use in a UNFCCC document. (The Chinese delegation insisted that the text call for accelerating efforts to “phase down” instead of “phase out” unabated coal power.) China joined the Glasgow Leaders’ Declaration on Forests and Land Use but did not join the Global Methane Pledge announced by more than 100 countries at the conference. China joined with the United States in announcing the U.S.-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s. In the U.S.-China Joint Glasgow Declaration, the Chinese government pledged “to develop a comprehensive and ambitious National Action Plan on methane” before COP 27 (in November 2022).¹⁴

11 [Remarks by Chinese President Xi Jinping at Climate Ambition Summit](#), Xinhuanet (December 12, 2020).

12 People’s Republic of China, [China’s Achievements, New Goals and New Measures for Nationally Determined Contributions](#) (October 2021). See Chapter 4–Climate Goals.

13 People’s Republic of China, [China’s Mid-Century Long-Term Low Greenhouse Gas Emission Development Strategy](#) (October 2021).

14 See [Glasgow Climate Pact](#) at paragraph 36, [Glasgow Leaders’ Declaration on Forests and Land Use; Global Methane Pledge; US-China Joint Glasgow Declaration on Enhancing Climate Action in the 2020s](#) at section 8(C)(II); Jiang Yifan, [“China at COP26: Coal, 1.5C and short-term actions,”](#) China Dialogue (November 16, 2021).

CHAPTER 26 - BELT AND ROAD INITIATIVE

The Belt and Road Initiative (BRI) is one of China’s signature foreign policy projects in the Xi Jinping era—a sprawling vision for interconnection between China and the rest of the world. Infrastructure investments are a core component of this vision. Chinese banks and companies have signed outbound financing and project contracting deals worth hundreds of billions of dollars since the emergence of the BRI in 2013.¹

Both before and during the BRI era, the energy and mining sectors have been major focus areas for Chinese outbound finance and project contracting. Activity in these and other carbon-intensive sectors—including industry and transport—has been heavily concentrated in the developing world, home to almost all BRI participants.

The BRI has significant climate impacts. Green development and other environmental considerations played little role in BRI activities in its early years. In recent years, such considerations have gained prominence, including in President Xi Jinping’s September 2021 pledge that China would no longer build new coal power plants overseas. (This pledge coincided with a period of retrenchment in China’s outbound financing and contracting activity, which began slowing in the late 2010s and fell sharply during the COVID-19 pandemic.) Analysis from April 2022 reported that 12.8 GW of coal power projects had been “shelved or cancelled” since Xi’s announcement, while the fate of much more coal power capacity in pre-construction stages remained uncertain.

This chapter begins with a review of the BRI’s evolution and structure, as well as its green development policies. The chapter surveys BRI activity in the energy and mining sectors, leading BRI financiers and studies of the BRI’s climate impacts. It concludes with comments on the BRI’s evolving significance for climate.

A. Background

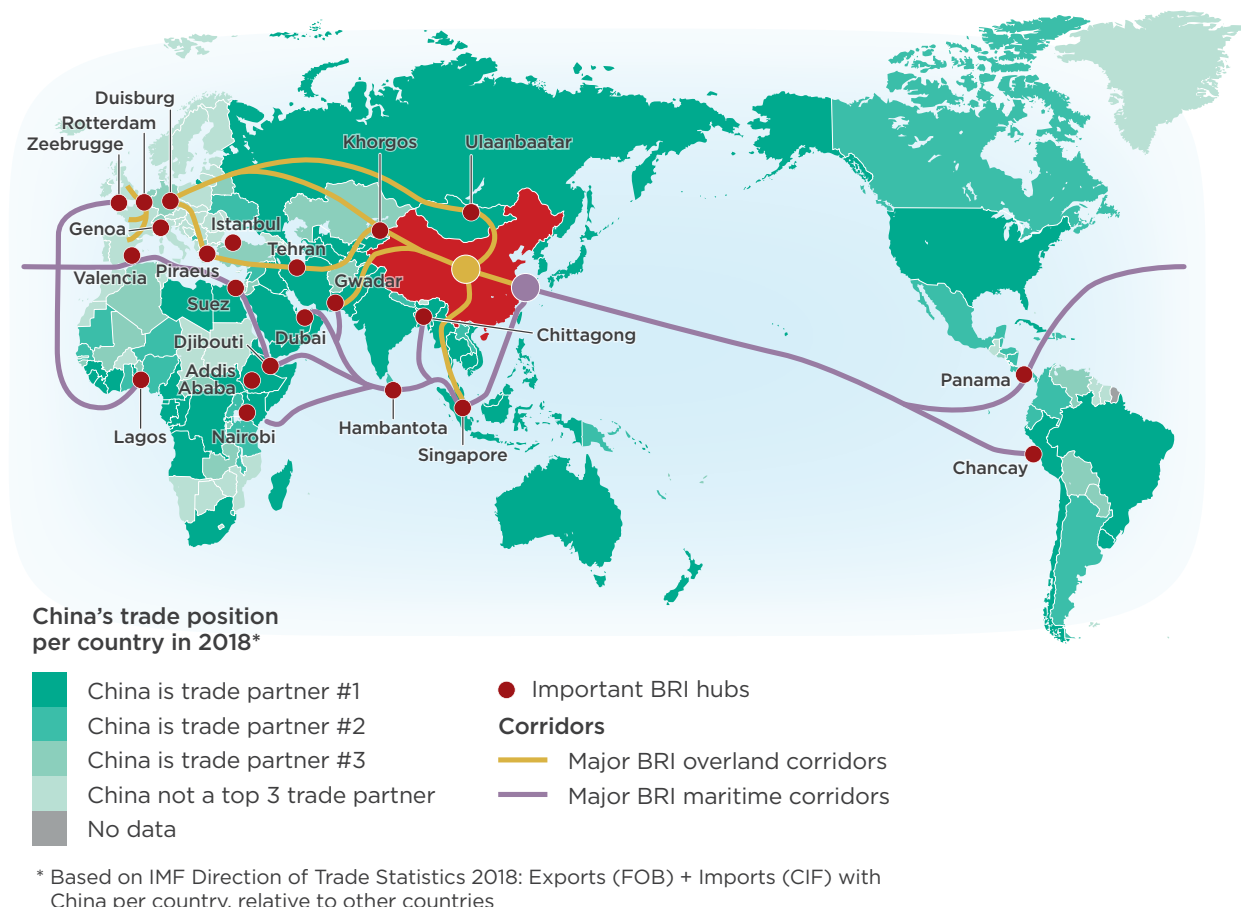
The Belt and Road Initiative emerged from a pair of concepts proposed by Xi Jinping in fall 2013: a “Silk Road Economic Belt” running overland from China via Central Asia to Europe, and a “21st Century Maritime Silk Road” connecting China and Southeast Asia.² These connectivity visions were subsequently yoked together as a broader initiative, the BRI, and developed into a cross-cutting policy framework for Chinese outbound economic engagement, particularly

1 Throughout this chapter, “finance” or “financing” refer to direct investments and lending, as opposed to portfolio finance. “Project contracting” refers to non-financial contracts, including in particular engineering, procurement and construction (EPC) contracts.

2 Ministry of Foreign Affairs, “[习近平在印度尼西亚国会的演讲（全文）](#) [Xi Jinping’s Speech at the Indonesian Parliament (Full Text)],” (in Chinese) (October 3, 2013); Xinhua News Agency, “[习近平在哈萨克斯坦纳扎尔巴耶夫大学的演讲](#) [Xi Jinping’s Speech at Nazarbayev University in Kazakhstan],” (in Chinese) (September 8, 2013).

with the Global South.³ As of late March 2022, the Chinese government reports having signed agreements around BRI cooperation with 149 countries, including 52 from Africa, 38 from Asia, 27 from Europe (mostly in Central and Eastern Europe), 21 from Central and South America and the Caribbean, and 11 from Oceania.⁴

Figure 26-1: Belt and Road Initiative



Source: Belt and Road Research Platform⁵

3 Key official white papers on the BRI include the National Development and Reform Commission, Ministry of Foreign Affairs and Ministry of Commerce, “[推动共建丝绸之路经济带和21世纪海上丝绸之路的远景与行动 \[Vision and Actions on Jointly Building Silk Road Economic Belt and 21st Century Maritime Silk Road\]](#),” State Council (in Chinese) (March 2015); Leading Group for Promoting the Belt and Road Initiative, “[共建‘一带一路’倡议：进展、贡献与展望 \[The Belt and Road Initiative: Progress, Contributions and Prospects\]](#),” (in Chinese) (April 22, 2019). For more high-level overviews of the BRI, see e.g. Nadège Rolland, “[A Concise Guide to the Belt and Road Initiative](#),” National Bureau of Asian Research (accessed June 11, 2022); Yuen Yuen Ang, “[Demystifying Belt and Road](#),” Foreign Affairs, (June 20, 2019).

4 Belt and Road Portal, “[已同中国签订共建‘一带一路’合作文件的国家一览 \[Table of Countries That Have Signed Cooperation Documents with China on Jointly Building the Belt and Road\]](#),” (in Chinese) (March 23, 2022).

5 [Belt and Road Research Platform website](#) (accessed October 9, 2022)

The notion of connectivity invoked in BRI documents is a broad one. Key white papers from 2015 and 2019 discuss “five connectivities” in measuring the BRI’s impact: policy coordination, infrastructure connectivity, trade facilitation, financial integration and people-to-people ties.⁶ Infrastructure projects have been a particularly prominent piece of these efforts, as discussed below.

The BRI enjoys a high-profile formal position within the Chinese Communist Party (CCP) by way of its incorporation into the Party’s Constitution in 2017, alongside a series of other concepts and initiatives associated with Xi Jinping.⁷ President Xi provides periodic guidance on the BRI in a variety of venues, such as annual CCP Congresses and the Belt and Road Forums for International Cooperation (held in 2017 and 2019).⁸ The most senior dedicated body for the BRI is the inter-ministerial Leading Group for Promoting the Belt and Road Initiative, established in 2015.⁹ Its chair is Vice Premier Han Zheng, who is one of seven members of the Politburo Standing Committee, the apex decision-making body in the Chinese party-state. The group’s secretariat is housed in the National Development and Reform Commission, China’s most powerful economic policymaking body.¹⁰

At the same time, a focus on high-level institutions obscures the bottom-up dynamics that drive financing and project contracting decisions under the BRI umbrella.¹¹ Under the BRI, host countries and the Chinese enterprises and financiers with whom they partner have substantial

6 National Development and Reform Commission, Ministry of Foreign Affairs and Ministry of Commerce, “推动共建丝绸之路经济带和21世纪海上丝绸之路的远景与行动 [Vision and Actions on Jointly Building Silk Road Economic Belt and 21st Century Maritime Silk Road],” (in Chinese); Leading Group for Promoting the Belt and Road Initiative, “共建‘一带一路’倡议：进展、贡献与展望 [The Belt and Road Initiative: Progress, Contributions and Prospects],” (in Chinese).

7 Xinhua News Agency, “中国共产党第十九次全国代表大会关于《中国共产党章程（修正案）》的决议 [Decision of the Chinese Communist Party 19th National People’s Congress Regarding ‘The Constitution of the Chinese Communist Party (Revised Version)’],” (in Chinese) (October 24, 2017).

8 Xinhua News Agency, “习近平在推进‘一带一路’建设工作座谈会上发表重要讲话 张高丽主持 [Xi Jinping Gives an Important Speech at the Symposium on Advancing Work on the Construction of the Belt and Road; Zhang Gaoli Chairs the Meeting],” (in Chinese) (August 17, 2016); Xinhua News Agency, “习近平出席推进‘一带一路’建设工作5周年座谈会并发表重要讲话 [Xi Jinping Appears at the Fifth Anniversary Symposium on Advancing Work on the Construction of the Belt and Road and Gives an Important Speech],” (in Chinese) (August 27, 2018); Xinhua News Agency, “习近平出席第三次‘一带一路’建设座谈会并发表重要讲话 [Xi Jinping Appears at the 3rd Symposium on the Construction of the Belt and Road and Gives an Important Speech],” (in Chinese) (November 19, 2021); Xinhua News Agency, “《习近平谈‘一带一路’》主要篇目介绍 [An Introduction to Major Contents of ‘Xi Jinping Discusses the Belt and Road’],” (in Chinese) (December 11, 2018); Rolland, “A Concise Guide to the Belt and Road Initiative”; “Remarks by H.E. Xi Jinping President of the People’s Republic of China At the Press Conference of The Second Belt and Road Forum for International Cooperation,” (April 28, 2019); Xinhua News Agency, “Full Text of President Xi’s Speech at Opening of Belt and Road Forum,” (May 14, 2017). Readers interested in Xi’s remarks on the BRI through 2018 can consult 《习近平谈“一带一路” (Xi Jinping on the Belt and Road), a collection of his speeches. A precis is available at Xinhua News Agency, 《习近平谈“一带一路”》主要篇目介绍 [Introduction to the Main Chapters of Xi Jinping on the Belt and Road] (in Chinese) (December 11, 2018).

9 For more on the role of “leading small groups” in Chinese policy, see Wen-Hsuan Tsai and Wang Zhou, “Integrated Fragmentation and the Role of Leading Small Groups in Chinese Politics,” *The China Journal* 82 (July 2019): 1–22.

10 China Online, “推进‘一带一路’建设工作领导小组 [Leading Group for Promoting the Belt and Road Initiative],” (in Chinese) (April 17, 2019).

11 This section draws upon Thomas Hale, Chuyu Liu and Johannes Urpelainen, “Belt and road decision-making in China and recipient countries: How and to what extent does sustainability matter?” (Initiative for Sustainable Energy Policy and Blavatnik School of Government, April 2020); Dominik Mierzejewski, “The Role of Guangdong and Guangzhou’s Subnational Diplomacy in China’s Belt and Road Initiative,” *China: An International Journal* 18, no. 2 (May 2020): 99–119; Lee Jones and Jinghan Zeng, “Understanding China’s ‘Belt and Road Initiative’: Beyond ‘Grand Strategy’ to a State Transformation Analysis,” *Third World Quarterly* 40, no. 8 (August 3, 2019): 1415–39.

decision-making authority. Central government agencies, including the National Development and Reform Commission (NDRC) and Ministry of Commerce (MOFCOM), as well as provincial governments, determine how high-level guidance is translated into concrete policies and projects. In this way, the BRI is not so much a top-down, tightly-managed plan as a vessel for competing interests across firms, ministries, provinces and host countries.

B. Green Development Policies

The theme of green development has grown in prominence in the BRI since its early days. The Chinese government's first major white paper on the BRI, released in late March 2015, uses the word "green" twice. The *Guidance on Promoting Green Belt and Road*, issued by NDRC, MOFCOM, the Ministry of Environmental Protection and Ministry of Foreign Affairs (MFA) in May 2017, "encourages" companies to use low-carbon and environmentally friendly processes, but includes neither implementation nor enforcement mechanisms.¹² A major government white paper on the BRI issued in 2019 uses "green" thirty-one times and includes a "green road" section that says:

The Belt and Road Initiative pursues the vision of green development and a way of life and work that is green, low-carbon, circular and sustainable. The initiative is committed to strengthening cooperation on environmental protection and defusing environmental risks. It aims to build consensus on green development and increase mutual understanding and mutual support between governments, between enterprises and between peoples of the Belt and Road countries, to fulfill the 2030 Agenda for Sustainable Development.¹³

In the past several years, central government ministries have issued several guidelines on green development in outbound investment, including the 2021 *Green Development Guidelines for Overseas Investment and Cooperation* ("2021 Guidelines"), the 2022 *Guidelines for Ecological and Environmental Protection of Foreign Investment Cooperation and Construction Projects* ("2022 Guidelines") and *Opinions on Jointly Promoting Green Development of the Belt and Road* ("2022 Opinions").¹⁴ These have shown an evolution toward

12 National Development and Reform Commission, Ministry of Commerce, Ministry of Environmental Protection, and Ministry of Foreign Affairs, [Guidance on Promoting Green Belt and Road](#) (May 8, 2017); National Development and Reform Commission, Ministry of Commerce, Ministry of Environmental Protection, and Ministry of Foreign Affairs, [关于推进绿色“一带一路”建设的指导意见](#) [[Guidance on Promoting Green Belt and Road](#)] (April 26, 2017) (in Chinese).

13 Office of the Leading Group for Promoting the Belt and Road Initiative, "[The Belt and Road Initiative: Progress, Contributions and Prospects](#)," (April 22, 2019).

14 Ministry of Commerce and Ministry of Ecology and Environment, "[商务部、生态环境部关于印发《对外投资合作绿色发展工作指引》的通知](#) [[Notification from the Ministry of Commerce and Ministry of Ecology and Environment Regarding the Publication of 'Guidance for Green Development Work in Outbound Investment and Cooperation'](#)]," (in Chinese) (July 9, 2021); Ministry of Ecology and Environment and Ministry of Commerce, "[关于印发《对外投资合作建设项目生态环境保护指南》的通知](#) [[Notification Regarding the Release of 'Guidance on Ecological and Environmental Protection in Outbound Investment and Cooperation Construction Projects'](#)]," (in Chinese) (January 5, 2022); National Development and Reform Commission et al., "[关于推进共建“一带一路”绿色发展的意见\(发改开放〔2022〕408号\)](#) [[Opinions on Jointly Advancing the Green Development of the Belt and Road \(NDRC Release No. 408 \(2022\)\)](#)]," (in Chinese) (March 16, 2022).

more stringent standards.¹⁵ The 2022 *Guidelines* state that:

advancing the promotion of green development in the BRI is an inherent requirement of implementing the concept of green development and advancing the construction of an ecological civilization. It is a major step for confronting climate change and protecting the ecological security of the globe.

The 2022 *Guidelines* “encourage” Chinese companies operating overseas to “use international principles and standards or higher Chinese standards” when “host country standards are absent or too lenient.”¹⁶ (Earlier guidelines only encouraged firms to “follow the environmental protection laws and regulations of host countries.”¹⁷)

The 2022 *Opinions* contain extensive discussion of sector-specific green development issues (for infrastructure, energy, transport, finance and more) and set general targets for green development in the coming decade. By 2025, there will be “solid progress” in “promoting the practical cooperation in fields including inter alia green infrastructure, green energy, green transport, and green finance”; by 2030, “a BRI green development pattern will have basically taken shape.” The 2022 *Guidelines* also state that “China will facilitate the full implementation of the United Nations Framework Convention on Climate Change (UNFCCC) and Paris Agreement among all parties.”

All three guidelines mentioned above are high-level policy documents. They serve as political signals about government priorities, particularly for state-owned entities--financiers, project developers and other contractors--who comprise much of the financing and implementation capacity for Chinese outbound investment in carbon-intensive sectors such as energy and transport. The guidelines are intended to shape the development of more specific regulations around topics such as investment approvals and monitoring, but do not themselves contain enforcement mechanisms.¹⁸

Prior to these guidelines, Chinese companies rarely faced serious consequences in practice for violating host country standards.¹⁹ Whether these new guidelines will lead to more focus on implementation and enforcement remains to be determined.

In a September 2021 speech to the UN General Assembly, President Xi Jinping’s pledged

¹⁵ See e.g. Christoph Nedopil, Dimitri De Boer and Fan Danting, “[Understanding China’s Latest Guidelines for Greening the Belt and Road.](#)” China Dialogue (February 15, 2022); Christoph Nedopil et al., “[What China’s New Guidelines on ‘Green Development’ Mean for the Belt and Road.](#)” China Dialogue (August 18, 2021); Dimitri De Boer, Christoph Nedopil and Fan Danting, “[Belt and Road Must Align with Paris Agreement – Government Guidance.](#)” China Dialogue (May 3, 2022).

¹⁶ Ministry of Ecology and Environment and Ministry of Commerce, “[关于印发《对外投资合作建设项目生态环境保护指南》的通知 \[Notification Regarding the Release of ‘Guidance on Ecological and Environmental Protection in Outbound Investment and Cooperation Construction Projects’\]](#),” (January 5, 2022).

¹⁷ Ministry of Ecology and Environment et al., “[关于推进绿色 ‘一带一路’ 建设的指导意见 \[Guiding Opinions on the Advancing the Construction of a Green Belt and Road\]](#),” (in Chinese) (April 24, 2017).

¹⁸ Kelly Sims Gallagher and Qi Qi, “[Chinese Overseas Investment Policy: Implications for Climate Change.](#)” Global Policy 12, no. 3 (2021): 264.

¹⁹ Gallagher and Qi, “Chinese Overseas Investment Policy,” 264.

that China would “no longer build new coal power projects abroad.”²⁰ The 2022 *Opinions* mentioned above offered an official elaboration:

China will stop building new coal-fired power projects abroad and prudently proceed with existing ones that are under construction. We will push forward the green and low-carbon development of overseas coal-fired power plants that have already been built. Relevant enterprises are encouraged to strengthen clean and efficient coal utilization, adopt advanced technologies such as efficient desulphurization, denitrification, dust removal, as well as carbon capture, utilization and storage, and upgrade energy-saving and environmental protection facilities. We will study and promote international cooperation on green and low-carbon development in steel and other industries. [*Unofficial translation by the BRI International Green Development Coalition*]²¹

Analysts have noted that these comments indicate an end to new projects but leave sizable gray areas such as the expansion of existing projects (see Section C).²²

Several databases collect policy documents and statements related to green BRI issues:

- The China Carbon Neutrality Tracker, developed by Beijing-based consultancy Innovative Green Development Platform (iGDP), includes a database of major national and sub-national policy documents linked to climate issues.²³
- The Climate Policy Databases, developed by the Climate Policy Lab at the Tufts University Fletcher School of Law and Diplomacy, includes databases around Chinese national climate policy as well as Chinese domestic and overseas investment policies.²⁴
- The Green Finance and Development Center at the Fanhai International School of Finance at Fudan University maintains a database on major BRI policies and leadership statements.²⁵

Several Chinese websites compile BRI-related news and analysis as well. These include the official Belt and Road Portal (yidaiyilu.gov.cn), the BRI Environmental Big Data Portal (greenbr.org.cn) and the Chinese Academy of Social Sciences' Belt and Road Database (ydyicn.com).

20 Xinhua News Agency, “[习近平在第七十六届联合国大会一般性辩论上的讲话（全文）](#) [Xi Jinping's Speech at the 76th Session of the United Nations General Assembly (Full Text)],” (in Chinese) (September 22, 2021).

21 National Development and Reform Commission et al., “[Opinions on Jointly Promoting Green Development of the Belt and Road](#),” (April 2, 2022); National Development and Reform Commission et al., “[关于推进共建‘一带一路’绿色发展的意见](#) (发改开放〔2022〕408号) [Opinions on Jointly Advancing the Green Development of the Belt and Road (NDRC Release No. 408 (2022))].”

22 Isabella Suarez, “[China's No Overseas Coal Power Pledge: 15 Projects Cancelled so Far](#),” China Dialogue (May 27, 2022).

23 iGDP, “[China Carbon Neutrality Tracker](#),” (accessed July 8, 2022).

24 Qi Qi, Kelly Sims Gallagher and Fang Zhang, “[Climate Policy Databases](#),” Tufts University Fletcher School Climate Policy Lab, 2021.

25 Green Finance & Development Center, [Belt and Road Initiative \(BRI\) Policies Database](#) (accessed June 24, 2022).

C. Outbound Financing and Project Contracting Activity

Outbound financing and project contracting activity by Chinese firms has grown dramatically since the early 2000s. According to MOFCOM, Chinese firms reported \$2 billion of foreign direct investment in non-financial companies (FDI) in 2003. By 2013, when the BRI was launched, FDI had already reached \$90 billion. FDI peaked at around \$170 billion in 2016 before falling back to \$110 billion in 2019. Figures for new contracted projects abroad show a mostly similar pattern, with Chinese firms reporting \$18 billion in 2003, \$170 billion in 2013 and \$260 billion in 2019.²⁶

Chinese official data report outbound investment and project contracting activity as stable since the start of the COVID pandemic in early 2020. However, some studies suggest a sharp decline. The American Enterprise Institute's China Global Investment Tracker (CGIT) database, for example, recorded a 62% decline in Chinese outbound investments in 2020 and a 40% decline in construction contracting, though activities in BRI countries were slightly more stable.²⁷

The Chinese government does not maintain an official public list of BRI projects. Several public databases provide information on Chinese outbound financing and project contracting in countries with which China has signed BRI cooperation agreements. These include the following:

- **China Global Investment Tracker (CGIT):** this database, compiled by the American Enterprise Institute, catalogs over 3700 Chinese outbound investment and construction contracting projects since 2005 across all sectors.²⁸ CGIT data report around \$790 billion in energy and power investment and contracting projects from 2005 through July 2021, as well as \$400 billion in transport and \$200 billion in metals. These sectors comprise over 60% of recorded deals.²⁹
- **China Overseas Finance Inventory (COFI):** this database, hosted by the World Resources Institute, catalogs 509 power-generation projects in BRI countries that were financed by Chinese corporations and banks and reached financial closure from 2000 to 2021. (COFI aggregates its data from sources including many of the Boston University databases described below.) Total Chinese debt financing recorded is

26 Ministry of Commerce, “《对外直接投资统计制度》相关问题 (50) [Questions Related to ‘System for Outbound Direct Investment Statistics’ (50)].” (in Chinese) (May 2020), question 11; Ministry of Commerce, “对外承包工程统计 [Statistics on Outbound Contracting Projects].” (in Chinese) (April 2022); Ministry of Commerce, “非金融类对外直接投资统计 [Statistics on Non-Financial Foreign Direct Investment].” (in Chinese) (April 2022); MOFCOM reports statistics on investment and contracting in BRI countries since 2014, but covers only 55–60 countries in BRI’s initial Eurasian core. See e.g. “商务部, “2021年我对 ‘一带一路’ 沿线国家投资合作情况.” (in Chinese) (January 24, 2022); 商务部, “2016年对 ‘一带一路’ 沿线国家投资合作情况.” (in Chinese) (January 19, 2017).

27 Derek Scissors, [China Global Investment Tracker](#) (American Enterprise Institute / Heritage Foundation), (accessed June 15, 2022). A report out of the Central University of Finance and Economics' International Institute for Green Finance, combining CGIT data with other sources, finds similar trends: a 54% drop in investments into BRI countries, but a 70% drop in investments into non-BRI countries; Christoph Nedopil, [China's Investments in the Belt and Road Initiative \(BRI\) in 2020](#) (Beijing: Central University of Finance and Economics International Institute for Green Finance, 2021), 5.

28 Derek Scissors, “China Global Investment Tracker.”

29 Derek Scissors, [China's Overseas Investment Starts the Long Climb Back](#) American Enterprise Institute (July 2021), 8.

\$123.4 billion.³⁰

- **Global Chinese Development Finance Database:** this database, developed by the AidData project at the College of William & Mary, catalogs 13,827 Chinese “development finance” projects worth \$843 billion between 2000 and 2017. During the BRI era (2013–17), they report that three-quarters of all such finance (\$323 billion) has gone to projects in industry, mining, construction, energy, transport and storage.³¹
- The Boston University Global Development Policy Center (GDP Center) manages a series of overlapping databases that feed into some of the databases listed above.
 - **China’s Global Energy Finance (CGEF):** catalogs outbound energy-sector lending between 2000 and 2021 from China’s two major policy banks for international projects, China Development Bank (CDB) and the Export-Import Bank of China (China Exim). It records \$75.2 billion in lending since 2016, mostly for oil, gas and coal projects—but no lending in 2021. (Section D below discusses these banks further.)
 - **China’s Global Power Database:** catalogs outbound power generation projects involving Chinese foreign direct investment and policy bank finance since 2000.³² Coverage includes 106 GW of capacity in operation, 43 GW under construction and 37 GW under planning as of its most recent update in 2019.
 - **Chinese Loans to Africa Database:** catalogs loan commitments by Chinese financiers to African governments and state-owned enterprises from 2000 onwards.³³ It records 1188 loan commitments worth \$160 billion, with 65% of financing supporting transport, power or mining projects. But lending has generally fallen since 2013 and was lower in 2020 (\$1.9 billion) than any year since the mid-2000s.³⁴

30 Lihuan Zhou et al., [China Overseas Finance Inventory Database](#) (World Resources Institute) (accessed June 29, 2022); Oyintarelado (Tarela) Moses, [“The Evolving Landscape of Chinese-Financed Power Plants: Updates to the China Overseas Finance Inventory Database.”](#) (July 6, 2022).

31 AidData, [AidData’s Global Chinese Development Finance Dataset, Version 2.0](#) (September 2021); Ammar A. Malik et al., “Banking on the Belt and Road: Insights from a new global dataset of 13,427 Chinese development projects” (AidData, September 2021). AidData treats development finance as “the full range of projects that align with the OECD’s definition of Official Development Assistance (ODA) and Other Official Flows (OOF). Therefore, any project that benefits from financial or in-kind support from any official sector [government and state-owned] institution in China is included, regardless of its purpose, level of financial concessionality, funding source and overseas destination.” AidData, “AidData’s Global Chinese Development Finance Dataset, Version 2.0,” sec. 1.1.

32 Gallagher, Kevin P., Zhongshu Li, Xu Chen and Xinyue Ma. [China’s Global Power Database](#) Boston University Global Development Policy Center, 2019.

33 Boston University Global Development Policy Center, [Chinese Loans to Africa Database](#) (accessed June 29, 2022).

34 Jyhjong Hwang et al., [Chinese Loans to Africa During the COVID-19 Pandemic](#) Boston University Global Development Policy Center (April 2022), 1,10.

- **China-Latin America Finance Databases:** a pair of databases, managed by the GDP Center and the Inter-American Dialogue, that catalog loans by major Chinese policy and commercial banks to Latin American governments and state-owned enterprises. Half of reported loans by commercial banks since 2012 have gone to the energy sector, as has 70% of policy bank financing since 2005.³⁵
- **China’s Overseas Development Finance Database:** catalogs 862 loans by CDB and China Exim to foreign governments, inter-governmental bodies and state-owned entities between 2008 and 2019, with project geolocations included for around 70%.³⁶

The official *Belt and Road Portal* also issues weekly bulletins on Chinese firms’ outbound projects, reporting contract announcements, construction launches and project completions.³⁷

The following sections discuss investments and project contracting for two sectors—energy and mining—in greater detail.

Energy Sector

Within the energy sector, Chinese outbound investment and project contracting over the past several decades has focused on oil, gas and coal. The sectoral balance has changed over time, however, with oil investment volumes falling substantially since the early 2010s. Meanwhile, most investments in low-carbon resources have flowed to hydropower. Wind and solar investments abroad are growing, but slowly—especially in contrast to rapid increases in renewables investments at home (see Chapter 6 of this Guide).

- The CGIT Tracker records \$161 billion of activity in coal, oil and gas by Chinese firms since 2014: \$71 billion in oil, \$55 billion in gas and \$61 billion in coal. This activity was divided roughly equally between investments and construction contracting deals. The vast majority (85%) was in BRI countries.³⁸
- This balance is a shift from the prior decade when oil investments were somewhat more prominent. CGIT records \$87 billion in oil investments from 2005 to 2013, as well as \$43 billion in coal contracting and \$41 billion in hydro contracting. These activities accounted for 95% of recorded energy-sector investments in this period, as opposed to around half since 2014.

35 Kevin P. Gallagher and Margaret Myers, [China-Latin America Finance Database](#),” The Dialogue, 2022; Margaret Myers, [China-Latin America Commercial Loans Tracker](#) The Dialogue, 2021.

36 Rebecca Ray et al., “[Geolocated Dataset of Chinese Overseas Development Finance](#),” *Scientific Data* 8, no. 1 (September 20, 2021): 241. The online version is available at <https://www.bu.edu/gdp/chinas-overseas-development-finance/> (accessed July 29, 2022). This dataset only treats finance from these two banks as development finance. This is a narrower definition than that used by AidData’s Global Chinese Development Finance Database, which includes other entities such as central and local government agencies and state-owned commercial banks.

37 Belt and Road Portal, “[项目周报 \[Weekly Project Reports\]](#),” (in Chinese) (accessed June 30, 2022).

38 Derek Scissors, [China Global Investment Tracker](#).

- Chen and Springer (2021) find Chinese financing or EPC contracting in 1027 overseas coal, gas, wind or solar power plants that entered operation since 2000 or plan to start operations by 2033.³⁹ These power plants have a cumulative capacity of 272 GW. Other studies on currently operating plants identify up to roughly 120 GW of operating coal power overseas built with Chinese financing or contracting services and around 15 GW or more of renewables.
 - The Center for Research on Energy and Clean Air reported in April 2022 that Chinese “private and public entities have provided financial capital or equipment, procurement and construction (EPC) services to approximately 124 gigawatts (GW) of coal plants operating today—12% of the coal generation fleet outside of China.”⁴⁰
 - Regarding financing specifically, the COFI database records 72 GW of coal, 33 GW of hydro, 25 GW of gas, 12 GW of renewables and 4 GW of nuclear financed by Chinese institutions overseas from 2000 to 2020. Aggregate financing for hydropower projects (\$47.7 billion), however, slightly exceeds coal projects (\$40.3 billion).⁴¹
 - Regarding project contracting specifically, Tao et al. (2020) analyze public information for 458 power projects across 15 countries in the BRI’s major regions “in which Chinese engineering contracting companies played a significant role” between 2005 and 2019. Fifty-eight percent of these projects since the BRI’s announcement (45 GW) were coal. Gas accounted for another 20% (18 GW); hydropower was 14% (12 GW), while wind and solar were 10% (8 GW).⁴²
 - A study by Tsinghua University and Greenovation Hub reports 17.1 GW of wind and solar projects developed by Chinese companies in BRI countries from 2014 to 2018, mostly solar. It adds that 15 GW of wind were under construction or “awaiting development” as of mid-2019.

Chinese outbound energy-sector finance has been slower to embrace renewables than domestic investment.

- Lund Larsen and Oehler (2022) find that Chinese enterprises’ outbound energy-sector investments in BRI countries in 2019 focused much more heavily on

39 More than half (150 GW) were coal projects involving Chinese contractors, though planned projects in this dataset may be affected by Xi’s “no new coal” pledge. Han Chen and Cecilia Springer, “[China’s Uneven Regional Energy Investments](#),” *Géopolitique, Réseau, Énergie, Environnement, Nature*, no. 1 (September 2021): 98-107.

40 Center for Research on Energy and Clean Air, [BRIEFING: 12.8 GW of Chinese Overseas Coal Projects Cancelled, but 19 GW Could Still Go Ahead](#) (April 2022), 1. Research from Boston University suggests a similar share for projects operational or under development between 2013 and mid-2019 (13%). Xinyue Ma and Kevin P Gallagher, [Who Funds Overseas Coal Plants?](#) Boston University Global Development Policy Center (July 2021).

41 These figures are minimums, as capacity information for 20 of the 430 projects is not available. Lihuan Zhou et al., [China Overseas Finance Inventory Database: Technical Note](#) (World Resources Institute, 2022), 17-18. The [Global Coal Project Finance Tracker](#) database, developed by Global Energy Monitor, identifies 60.9 GW of overseas coal financed since 2010 by Chinese entities. [Global Coal Project Finance Tracker Global Energy Monitor](#) (accessed June 30, 2022).

42 Yiheng Tao, Haiming Liang and Michael A. Celia, “[Electric Power Development Associated with the Belt and Road Initiative and Its Carbon Emissions Implications](#),” *Applied Energy* 267 (June 1, 2020): 114784.

fossil resources than did their domestic investments. 87% of BRI energy-sector investments in their analysis went to fossil fuel supply or fossil-based power generation, as opposed to 56% of domestic investments. The split was even starker in power generation: 85% of domestic investments were in hydropower or renewables, as opposed to just 34% of outbound investments.⁴³

- Chen and Springer (2021) identify no major changes in the generation mix of Chinese outbound investments in the past decade. They also find that Chinese FDI has supported substantial gas investments—in East Asia, Africa and Southeast Asia, gas FDI exceeds coal, solar and wind combined.⁴⁴

China's financial footprint in outbound fossil-sector lending is large—but not uniquely so. Western and Japanese banks and investors also play a major role in cross-border financial flows for fossil resources. In the coal sector, for instance, a 2021 Boston University study found that, while China is the “largest public financier of overseas coal plants,” more than 80% of coal capacity added or under planning between 2013 and mid-2019 outside of China had no Chinese financial participation. Other major financial sources for these projects include Japanese and Western commercial banks and institutional investors, though data for project-level financing is thin.⁴⁵ Data is also thin on disinvestment (sales of assets), though this certainly takes place. In 2021, for instance, Sinopec sold its oil-producing business in Argentina in a deal reportedly valued at around \$250 mn. This occurred a decade after it had entered the country with a \$2.45 billion purchase of a US oil producer Occidental Petroleum's local assets.⁴⁶

Chinese outbound oil and gas investments and project contracting are showing signs of post-pandemic recovery. A report from Fudan University finds that oil engagements in 2021 (\$6.4 billion) exceeded activity in 2019 (\$3.7 billion), though these are still far lower than volumes seen in the late 2000s and early 2010s.⁴⁷ But the composition of power-sector investment may shift in the coming years. Around 60% of the 53 GW of power capacity in China's Global Power Database with expected commissioning dates of 2022 or later (or with no announced commissioning date) are clean energy projects. These include around 17 GW of hydropower, 8 GW of nuclear and 6.5 GW of wind and solar.

43 Mathias Lund Larsen and Lars Oehler, [“Clean at Home, Polluting Abroad: The Role of the Chinese Financial System's Differential Treatment of State-Owned and Private Enterprises.”](#) *Climate Policy* (March 3, 2022).

44 Chen and Springer, “China's Uneven Regional Energy Investments.”

45 Ma and Gallagher, “Who Funds Overseas Coal Plants?” Comparisons of Chinese, US and Japanese development finance institutions and FDI flows in the power sector indicate that, while more coal financing from these sources comes from China, the US and (especially) Japan support much more gas generation. See Xu Chen et al., [“Financing Carbon Lock-in in Developing Countries: Bilateral Financing for Power Generation Technologies from China, Japan, and the United States.”](#) *Applied Energy* 300 (October 15, 2021): 117318; Xu Chen, Kevin P. Gallagher and Denise L. Mauzerall, [“Chinese Overseas Development Financing of Electric Power Generation: A Comparative Analysis.”](#) *One Earth* 3, no. 4 (October 23, 2020): 491-503; Zhongshu Li, Kevin P. Gallagher and Denise L. Mauzerall, [“China's Global Power: Estimating Chinese Foreign Direct Investment in the Electric Power Sector.”](#) *Energy Policy* 136 (January 1, 2020): 111056.

46 Carolina Millan, [“Billionaire-Owned Driller Buys Sinopec Assets in Argentina”](#) Bloomberg, (June 30, 2021); Charles Newbery, [“CGC Buys Sinopec Assets in Argentina to Increase Its Oil Output.”](#) S&P Global Market Intelligence (June 30, 2021).

47 Christoph Nedopil Wang, [China Belt and Road Initiative \(BRI\) Investment Report 2021](#) (Shanghai: Fanhai International School of Finance Green Finance & Development Center, 2022), 13-14.

Coal's prominence in outbound power-sector investments has been waning in recent years. A study from the Central University of Finance and Economics reported that of the 52 coal-fired power projects outside China with Chinese financial participation announced between mid-2014 and 2020, around half were “shelved”; eight were cancelled and only one had gone into operation as of the end of 2020. Thirty-four projects had been under construction since 2014 and only 19 had gone into operation.⁴⁸

An April 2022 study by the Center for Energy and Clean Air indicates that, while Xi's pledge has accelerated the flight from coal, several types of projects may not be covered under it. Of the “86 GW (81 plants) of Chinese-backed overseas coal ... currently in the construction and pre-construction pipeline,” it reports that:

- Around 12.8 GW (15 plants) have been cancelled since Xi's pledge.
- Around 30 GW (36 plants) are currently under construction and thus would not be expected to count as “new.”
- 19.2 GW (18 plants) “fall into a grey area of China's pledge; 11.2 GW have secured financing and permits to go ahead, and another 8 GW are captive coal projects linked to major BRI industrial parks in Indonesia.” These captive coal projects include two new projects that “secured construction and purchasing agreements from Chinese firms in 2022,” after Xi's pledge.⁴⁹

Mining Sector

Sector-level studies focusing on outbound investments and project contracting are more limited for key sectors in the low-carbon transition beyond energy. One exception is mining. China depends heavily upon raw metals imports to supply its manufacturing base, including key clean-economy manufacturing inputs such as nickel (80%+ imported as of 2016), copper (60%+) and iron ore (60%+).⁵⁰

48 Christoph Nedopil Wang, [Brief: Coal Phase-out in the Belt and Road Initiative \(BRI\): An Analysis of Chinese-Backed Coal Power from 2014–2020](#) Beijing: Green Belt and Road Initiative Center, International Institute of Green Finance, Central University of Finance and Economics (June 16, 2021).

49 Center for Research on Energy and Clean Air, “BRIEFING: 12.8 GW of Chinese Overseas Coal Projects Cancelled, but 19 GW Could Still Go Ahead,” 1. A more recent report from researchers at the Sunrise Project and Inclusive Development International notes another potential loophole for projects with high political priority: “in February 2022, it was reported that China and Pakistan had agreed to prioritise the 300-megawatt Gwadar coal power plant,” a politically important project that had not yet reached financial closure. Danqing Li, Siman Li, and Mark Bo, “[China's Overseas Energy Investments after the 'No Coal' Pledge: An Assessment](#),” Global China Pulse (July 9, 2022), 68. A November 2021 report by Springer and Ma after Xi's pledge identified 50.3 GW of coal-fired capacity under construction or another 50.8 GW under planning that involved either financing or construction arrangements from Chinese entities, representing 594 Mt of emissions. Cecilia Han Springer and Xinyue Ma, [Potential Implications of Xi Jinping's Green Energy and No-Overseas-Coal Announcement](#) Boston University Global Development Policy Center (November 2021).

50 Masuma Farooki, [China's Mineral Sector and the Belt & Road Initiative](#) Strategic Dialogue on Sustainable Raw Materials for Europe, 2018, 4. For more on key raw materials inputs for the global energy transition, see Global Commission on the Geopolitics of Energy Transformation, *A New World: The Geopolitics of the Energy Transformation*, 2019, 59–60.

Most of these resources are purchased from international rather than Chinese suppliers. Ericsson et al. (2020) estimate the total share of global minerals and metals production by value controlled by Chinese companies outside China at 3.5% in 2018. (They estimate Chinese domestic production to be larger, but still just around 15%.)⁵¹ Farooqi (2018) reports that, as of September 2017, 43% of China's 345 total overseas mining assets and projects were "inactive".⁵²

That said, Chinese mining investment has growing importance in certain mining segments and geographies. Chinese annual outbound FDI in mining projects surged in 2017–2019 to roughly \$1.5–2 billion, having never exceeded \$1 billion before. S&P Global analysts report "an increased interest in battery metals, specifically cobalt and lithium, over steelmaking materials, while gold and copper have continued to be central to China's foreign endeavors."⁵³ Chinese companies controlled 23% of global lithium production in 2019 but spent \$4.3 billion in deals for lithium reserves and resources from 2018 through mid-2021, as compared to \$1.4 billion by US companies and \$0.7 billion by Australians.⁵⁴ Myanmar has become a major global producer of an important but niche set of clean-economy metals, heavy rare-earths, because of Chinese miners escaping stricter production controls and environmental regulations at home.⁵⁵ Ericsson et al. estimate large production shares for Chinese companies of key clean-economy minerals in Africa as of 2018, including an 82% share of bauxite output and a 41% share of cobalt.⁵⁶

Iron ore remains an area of interest in these outbound activities as well. The Chinese government's steel industry road map calls for the country to achieve 45%+ self-sufficiency in iron supply for steelmaking by 2025 through tools including expanding Chinese equity holdings in overseas iron ore mines.⁵⁷ A joint Chinese-Australian consortium is currently working to develop the world's largest untapped iron deposit, Simandou in Guinea, whose estimated reserves equal seven years of Chinese iron ore demand.⁵⁸

Recent disputes between Chinese mine operators and host governments underscore the risks that can accompany mining FDI. The government of Guinea suspended the Simandou project

51 Magnus Ericsson, Olof Löff and Anton Löff, "[Chinese Control over African and Global Mining—Past, Present and Future](#)," *Mineral Economics* 33, no. 1 (July 1, 2020): 174.

52 Farooqi, [China's Mineral Sector and the Belt & Road Initiative](#) 10.

53 S&P Global Market Intelligence, [China Outbound Mining Investment](#) (2021).

54 Benchmark Mineral Intelligence, "[China Controls Sway of Electric Vehicle Power through Battery Chemicals, Cathode and Anode Production](#)," (May 6, 2020); Kip Keen and Camille Erickson, "[China Mining, Battery Companies Sweep up Lithium Supplies in Acquisition Blitz](#)," S&P Global Market Intelligence, (November 1, 2021).

55 Beatrice Tanjangco et al., [Pulse 3: Recover, Reform, Restructure: China's Outward Investment Appetite and Implications for Developing Countries](#) London: Overseas Development Institute (June 2021), 52; Li Xuanmin and Xie Jun, "[China, Myanmar Resume Rare-Earth Trade after Border Reopening, to Ease Prices Shortly](#)," *Global Times* (December 2, 2021).

56 Ericsson, Löff and Löff, "Chinese Control over African and Global Mining—Past, Present and Future," 175.

57 Ministry of Industry and Information Technology, "[公开征求对《关于推动钢铁工业高质量发展的指导意见（征求意见稿）》的意见 \[Public Solicitation of Opinions on 'Guiding Opinions Regarding the Advancement of the High-Quality Development of the Iron and Steel Industry \(Draft for Public Consultation\)'\]](#)," (December 31, 2020), 4.

58 Sheridan Prasso, "[China's Quest for Iron Threatens West African Ecosystem](#)," *Bloomberg* (June 23, 2022); Praveen Menon and Helen Reid, "[Rio Tinto Signs Rail, Port JV with China-Backed Consortium for Guinea's Simandou](#)," *Reuters* (July 28, 2022).

in March and July 2022 over disputes around transport infrastructure and equity structure.⁵⁹ A Congolese court in early 2022 announced that it would take away one of the country's largest copper and cobalt mines from Chinese ownership for at least six months while it investigated government accusations that Chinese owners had shirked billions of dollars of royalty payments.⁶⁰ A review of controversies around 22 Chinese outbound mining investments notes that many were “in conflict-affected areas, or countries with poor governance, where social and environmental conflicts linked to mineral resource exploitation are endemic.”⁶¹ At the same time, it found that firms often prioritized “maintaining good relationships with authorities and elites, and avoiding interfering in local power structures...over the concerns of stakeholders about human rights abuses and environmental issues.”⁶² Similar issues have been discussed in hydropower, a market dominated by Chinese companies. Recent assessments suggest that Chinese safeguarding practices are improving as firms' outbound experience has deepened, but that awareness gaps persist on issues such as community engagement and benefit-sharing.⁶³

D. Financial Institutions

China's largest debt financing channels for outbound investment projects are government-owned.⁶⁴ These include two policy banks--China Development Bank (CDB) and the Export-Import Bank of China (China Exim)--as well as other state-owned financial institutions. Many of these institutions have also been important participants in the growth of green finance in China. (See Chapter 20.) China also plays a leading role in multilateral financial institutions including the Asian Infrastructure Investment Bank and New Development Bank.

All of China's largest state-owned financial institutions are among the original 27 signatories of the Green Investment Principles (GIP), announced in 2019 as a set of principles for “greening investment in the Belt and Road.”⁶⁵ The seven principles are high-level commitments around corporate governance, risk assessment, environmental disclosure, green finance, green supply chain management and collective advocacy. There are forty-one signatories today, including major international financial institutions such as BNP Paribas, Swiss RE and Mizuho Bank.⁶⁶

59 Ougna Camara, “[China-Backed Group Can Resume Simandou Operations: Guinea](#),” Bloomberg (March 27, 2022); Menon and Reid, “[Rio Tinto Signs Rail, Port JV with China-Backed Consortium for Guinea's Simandou](#),” Reuters (July 29, 2022).

60 Eric Lipton and Dionne Searcey, “[Chinese Company Removed as Operator of Cobalt Mine in Congo](#),” The New York Times, March 1, 2022.

61 Luis Scungio, “[China's Global Mineral Rush: Learning from Experiences around Controversial Chinese Mining Investments](#),” Amsterdam: Stichting Onderzoek Multinationale Ondernemingen (June 2021), 6.

62 Scungio, “[China's Global Mineral Rush: Learning from Experiences around Controversial Chinese Mining Investments](#),” 61.

63 See e.g. Lila Buckley et al., [What Drives Safeguarding for China's Hydropower Projects in LDCs?](#) (London: International Institute for Environment and Development, January 2022), chap. 4. These issues are not necessarily unique to Chinese companies in this sector, as Buckley's chapter illustrates.

64 For the energy sector, for instance, “Chinese official data on BRI investments confirm that the major players for energy investment are almost exclusively state-owned enterprises through either foreign direct investment or through backing by Chinese policy and commercial bank loans.” Zhou et al., “[China Overseas Finance Inventory Database: Technical Note](#)”.

65 Hong Kong Trade Development Council, “[Twenty-Seven Global Institutions Sign up to Green Investment Principles for the Belt & Road](#),” (April 25, 2019); Green Investment Principles, [What Is GIP?](#) (accessed June 25, 2022).

66 Green Investment Principles, [Membership](#) (accessed June 25, 2022).

The following section profiles the policy banks and multilateral development banks in more detail.

Policy Banks

Within the key sectors for the low-carbon transition, the most important debt financiers of Chinese outbound investment have been two “policy banks”: China Development Bank (CDB) and the Export-Import Bank of China (China Exim).⁶⁷

Background

China Development Bank (CDB) is one of the world’s largest financial institutions. At the end of 2021, its assets were RMB 17.17 trillion (\$2.70 trillion)⁶⁸ and loan balance was RMB 12.79 trillion (\$2.01 trillion).⁶⁹ Were it a commercial bank, it would be the 10th-largest in the world.⁷⁰ Its assets are around four times that of the whole World Bank Group.⁷¹ CDB’s annual report lists as the sixth of its “eight key areas ... the Belt and Road Initiative (BRI)”: “international cooperation in industrial capacity, equipment manufacturing, infrastructure connectivity, energy and resources, and Chinese enterprises ‘going global.’”⁷² (Other areas are domestic-focused, covering spheres such as infrastructure and basic industry, urban-rural integration and “programs essential for national competitiveness” such as industrial upgrading and energy efficiency.)

China Exim is an export credit agency focusing specifically on supporting Chinese trade and outbound investment. Its annual report states its areas of activity as “foreign trade, cross-border investment, the Belt and Road Initiative, international industrial capacity and equipment manufacturing cooperation, the ‘going global’ endeavors of science and technology, cultural industries as well as SMEs, and the building of an open economy.” It had RMB 5.45 trillion (\$0.86 trillion) in total assets and RMB 4.33 trillion (\$0.68 trillion) in loans and advances at the end of 2021.

67 The Boston University Global Development Policy Center, in its work on Chinese outbound finance, defines a policy bank as “a financial institution that is (1) established and guaranteed by the government; (2) has exclusive financial support from the state; (3) bears the responsibility of implementing economic and financial policy.” Junda Jin, Xinyue Ma and Kevin P Gallagher, [“China’s Global Development Finance: A Guidance Note for Global Development Policy Center Databases.”](#) Boston University Global Development Policy Center (July 2018).

68 The author converted to USD using the December 2021 rate of 1USD = 6.3693CNY reported by the Board of Governors of the US Federal Reserve. Board of Governors of the Federal Reserve System (US), [“Chinese Yuan Renminbi to U.S. Dollar Spot Exchange Rate.”](#) FRED, Federal Reserve Bank of St. Louis (FRED, Federal Reserve Bank of St. Louis) (accessed June 24, 2022)

69 China Development Bank, [“Annual Report 2021.”](#) (in Chinese) (December 31, 2021), 55. Only CNY figures are official. “Loans and advances” are taken as the loan balance. The author converted to USD using the December 2021 rate of 1USD = 6.3693CNY reported by the Board of Governors of the US Federal Reserve. Board of Governors of the Federal Reserve System (US), [“Chinese Yuan Renminbi to U.S. Dollar Spot Exchange Rate.”](#) FRED, Federal Reserve Bank of St. Louis (FRED, Federal Reserve Bank of St. Louis) (accessed June 24, 2022)

70 This comparison uses rankings of banks by total assets by S&P Global. Yuzo Yamaguchi, Harry Terris and Rehan Ahmad, [“The World’s 100 Largest Banks, 2022.”](#) (April 11, 2022).

71 World Bank Group, [“Financial Statements.”](#) (accessed June 24, 2022).

72 China Development Bank, [“Annual Report 2021.”](#) (in Chinese) front material.

Both China Development Bank and China Exim were established in 1994.⁷³ They operate under the direct leadership of the State Council, China's chief administrative authority. They are owned solely by the Chinese government and are funded by bond issuances backed by Chinese sovereign credit.⁷⁴ Both institutions have a variety of financial offerings, from loans and loan guarantees to equity investments, but their portfolios differ; CDB's credit portfolio consists mostly of loans, whereas China Exim's is split more evenly between loans and loan guarantees.⁷⁵ China Exim is also allowed to issue loans at concessional (preferential) rates, which CDB cannot do.⁷⁶ For both banks, domestic clean energy lending far exceeds outbound clean energy lending.

CDB is China's largest source of green credit today and has an action plan around green finance and carbon emissions that includes portfolio-wide targets. China Exim has not publicized a low-carbon or climate policy plan, though it has had guidelines on environmental and social impact assessments for outbound loans since 2007. As noted above, both CDB and China Exim signed the Green Investment Principles in 2019. That said, as a general matter, their clean energy lending for domestic projects far exceeds such lending for international projects.⁷⁷

Outbound Footprint

Limited official information is available on CDB and China Exim's outbound lending portfolio. Media reports on CDB's website state that the bank had loaned "more than \$260 billion to projects linked to the [BRI]."⁷⁸ Neither bank provides information on the size of its green credit provisions associated with outbound activity, though bond-level reporting offers some information. For instance, around \$150 mn from CDB's 2017 green bond issuance on international debt markets has been allocated to projects in Pakistan.⁷⁹

Some of the databases noted in Section C collect information on CDB and China Exim outbound lending from public sources. AidData's records suggest that these banks accounted for 75% (\$585 billion) of outbound loan-financed projects and commitments by Chinese government and state-owned institutions between 2000 and 2017.⁸⁰ The WRI COFI dataset finds that these banks have also dominated Chinese outbound lending for coal-fired generation, with an 87% share between 2000 and 2020.⁸¹

73 China Development Bank, "[Annual Report 2021](#)," (in Chinese) front material; The Export-Import Bank of China, "[Annual Report 2021](#)," 2022, 2.

74 China Development Bank, "[Annual Report 2021](#)," (in Chinese) 17; The Export-Import Bank of China, "[Annual Report 2021](#)," 172-73; Gallagher and Qi, "[Chinese Overseas Investment Policy](#)," *Global Policy*, Volume 12, Issue 3, 267.

75 The Export-Import Bank of China, "[Annual Report 2021](#)," 174; China Development Bank, "[Annual Report 2021](#)," 171.

76 Jin, Ma and Gallagher, "China's Global Development Finance: A Guidance Note for Global Development Policy Center Databases."

77 Gallagher and Qi, "[Chinese Overseas Investment Policy](#)," *Global Policy*, Volume 12, Issue 3, 267.

78 China Development Bank, "[China Development Bank Enhances Green Initiatives](#)," (August 24, 2021).

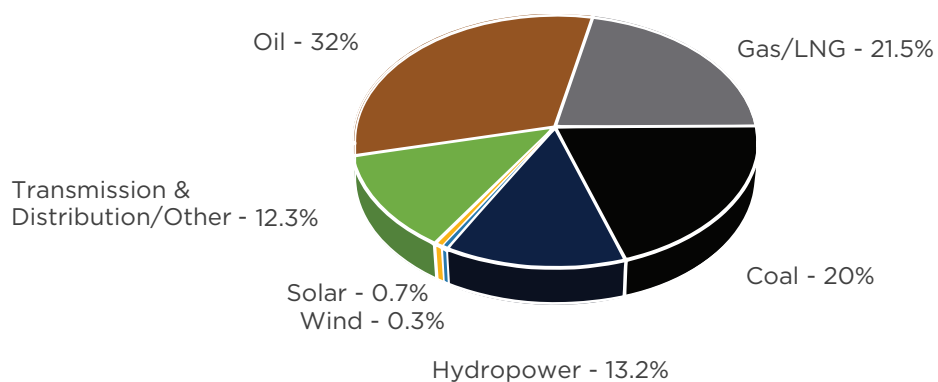
79 The issuance raised \$500 mn and EUR 1 billion; USD:EUR exchange rates at the time (November 2017) were slightly under 1:1. China Development Bank, "[2020 Annual Report on China Development Bank's 2017 Green Bond](#)" (April 2021).

80 Malik et al., "[Banking on the Belt and Road](#)" 124. For AidData's definition of development finance, see footnote 30.

81 Ziyi Ma, "[China Committed to Phase Out Overseas Coal Investment. New Database Tracks Progress](#)," World Resources Institute (February 17, 2022).

The China's Global Energy Finance dataset records \$136 billion in energy-sector lending by CDB and \$83.4 billion by China Exim between 2000 and 2021, in addition to \$14.8 billion in co-financing by the two (Figure 26-1).⁸² Around 70% of recorded CDB loans go to the oil and gas sectors, with Angola and Brazil the leading recipients (Figure 26-2). China Exim's portfolio accounts for most of China's lending in hydropower and renewables, though renewables lending has been quite small thus far. Wind and solar make up just 1% of total lending activity in the past five years and four of the five such projects were announced in 2016-17.

Figure 26-2: China Development Bank and China Exim Energy-Sector Lending by Energy Source, 2016-2021

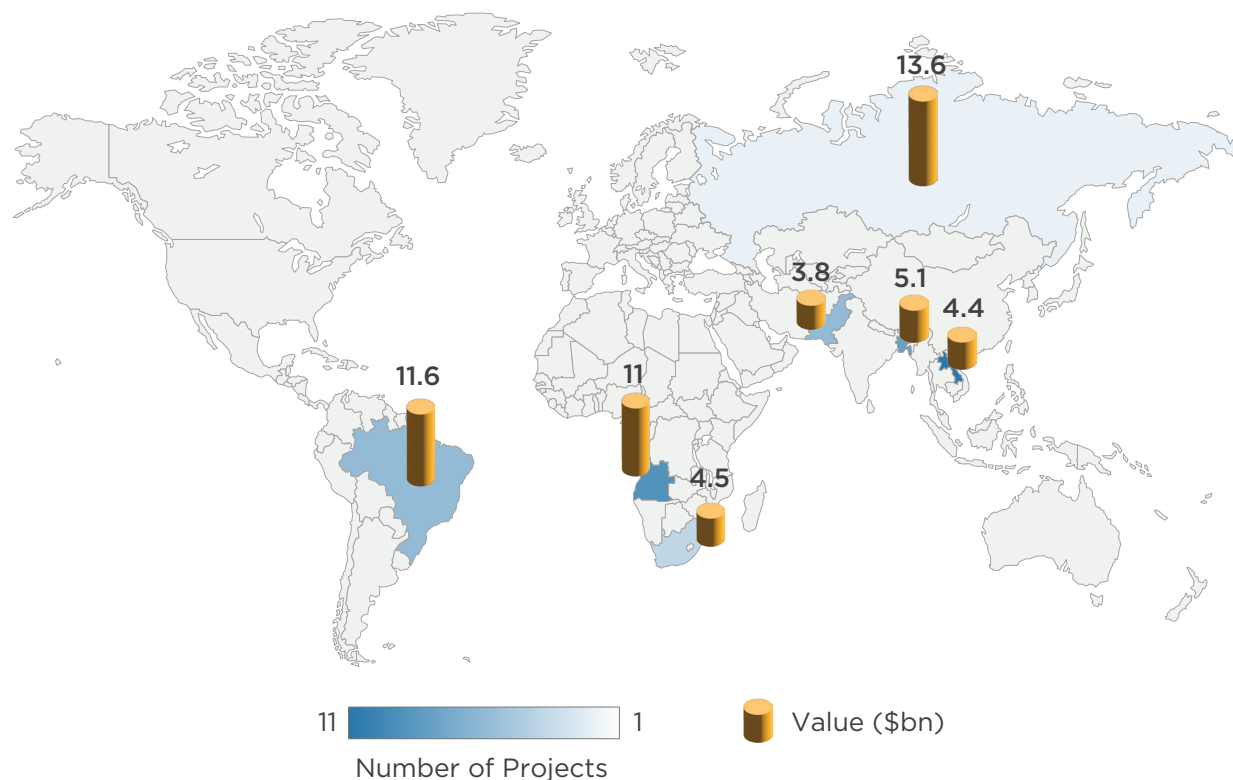


Source: Boston University Global Development Policy Center⁸³

82 The following discussion draws upon Xinyue Ma, Cecilia Han Springer and Honest Shao, "[Outlier or New Normal? Trends in China's Global Energy Finance.](#)" Boston, MA, USA: Boston University Global Development Policy Center, (March 2022); Boston University Global Development Policy Center, "[China's Global Energy Finance.](#)" 2022.

83 Boston University Global Development Policy Center, "[China's Global Energy Finance.](#)" 2022.

Figure 26-3: China Development Bank and China Exim Energy-Sector Lending: Largest Recipients (2016–2021)



Source: Boston University Global Development Policy Center

The CGEF team reports that, since 2016, these two banks' combined lending of \$75.1 billion to "foreign governments and associated entities in the energy sector" is "more energy sector loans provided to public entities than by any other lender in the world."⁸⁴ But more than three-quarters of that activity took place in 2016 and 2017, with outbound lending declining steadily from 2018.⁸⁵ In 2021, the database recorded "no new energy development finance commitments ... to foreign governments."⁸⁶

Multilateral Development Banks

China is an important shareholder in a pair of multilateral development banks established in the past decade, the Asian Infrastructure Investment Bank (AIIB) and the New Development

⁸⁴ Ma, Springer and Shao, "[Outlier or New Normal? Trends in China's Global Energy Finance.](#)" 2.

⁸⁵ Boston University Global Development Policy Center, "[China's Global Energy Finance.](#)"

⁸⁶ Ma, Springer and Shao, "[Outlier or New Normal? Trends in China's Global Energy Finance.](#)" 1.

Bank (NDB). These are not instruments of the Chinese state akin to the policy banks and other state-owned institutions. As multilateral banks, their ownership and voting shares are distributed across all member countries. China is the largest shareholder in the AIIB (30%) and an equal shareholder in the NDB with its four other founding countries.⁸⁷ These banks' assets are also much smaller than the policy banks discussed above. That said, several features make them worthy of discussion here: China was a leader in their establishment, especially the AIIB, and their sectoral focus overlaps with the BRI's emphasis on infrastructure and connectivity.

Asian Infrastructure Investment Bank

The Asian Infrastructure Investment Bank (AIIB) describes its vision as “a prosperous Asia based on sustainable economic development and regional cooperation.”⁸⁸ China first proposed its establishment in 2013 and waged a successful diplomatic campaign over several years to bring countries on board as members. The bank started operations in 2016 with a Beijing headquarters.

As of December 31, 2021, AIIB had assets of \$40.2 billion and \$12.3 billion in loan investments across over 100 member countries.⁸⁹ China is the largest shareholder (30%). It has the biggest voting share (26.6%) in the AIIB's Board of Governors, its highest decision-making body; the next largest shares are India (7.6%) and Russia (6.0%).⁹⁰

The AIIB presents its focus as “financing Infrastructure for Tomorrow”: “green infrastructure with sustainability, innovation and connectivity at its core.”⁹¹ Its Environment and Social Framework, most recently updated in May 2021, includes requirements around project design and implementation “in accordance with the aims of the Paris Agreement, including the Member's nationally determined contributions.”⁹² It also requires ex-ante project heat-trapping gas emissions estimates for projects expected to produce significant emissions.

The AIIB released several new commitments and initiatives around climate issues in 2020–21:

- In 2021, it announced that it would “align its operations with the goals of the Paris Agreement” by July 1, 2023. It also announced a target of a 50% share of financing

87 Rebecca Ray's comparative study of voting structures in multilateral development banks uses several indices of member power based upon potential voting arrangements. Her analysis, using 2017 data, concludes that the AIIB is “largely led by China,” which “holds nearly half of all of the AIIB's coalition-building power.” Rebecca Ray, “[Who Controls Multilateral Development Finance?](#)” *Global Governance: A Review of Multilateralism and International Organizations* 27, no. 1 (February 18, 2021): 135.

88 Asian Infrastructure Investment Bank, [2020 AIIB Annual Report](#) (2021), 1.

89 Asian Infrastructure Investment Bank, “[Members and Prospective Members of the Bank](#),” (July 20, 2022); Asian Infrastructure Investment Bank, [Auditor's Reports and Financial Statements for the Year Ended Dec. 31, 2021](#) (March 23, 2022), 2.

90 Asian Infrastructure Investment Bank, “[Members and Prospective Members of the Bank](#)”; Asian Infrastructure Investment Bank, “[Overview - Governance](#),” (accessed July 30, 2022).

91 Asian Infrastructure Investment Bank, [2020 AIIB Annual Report](#) 1; Asian Infrastructure Investment Bank, “[About AIIB](#),” (accessed June 28, 2022).

92 Asian Infrastructure Investment Bank, [Environmental and Social Framework](#) (May 2021), 54.

approvals for “climate finance” by 2025. (Its share in 2020 was 41%.)⁹³

- In 2020, AIIB president Jin Liqun pledged that the bank was “not going to finance any coal-fired power plants” or “finance any projects that are functionally related to coal—for example roads leading to the plant or transmission lines serving coal power.”⁹⁴

The AIIB launched an update process for its energy sector strategy in December 2021. The draft strategy as of April 2022 incorporates these new commitments and

reflects ... the transitioning environment in the energy sector, and pays particular attention to strengthening its guidance on fossil fuels. Recent years have seen elevated climate change commitments and actions from both governments and the private sector. This necessitates increased action, including new restrictions and conditions on fossil fuel investments.⁹⁵

As of July 2022, AIIB has provided \$5.8 billion in financing across 33 projects in the energy sector since 2016.⁹⁶ Its biggest energy projects in the past three years have included \$500 mn for LNG facility construction in northern China (2019) and several \$300–\$400 mn projects for power grid strengthening in India and Indonesia (2021). It has also financed investments in hydropower, renewables, waste-to-energy and gas power generation capacity. Outside of energy, major projects linked to the low-carbon transition include \$1.3 billion for rapid transit projects in India since 2019.

New Development Bank

The New Development Bank (NDB) was established in 2015 by the five “BRICS” countries—Brazil, Russia, India, China and South Africa.⁹⁷ Its headquarters are in Shanghai. Each member country pledged a capital subscription of \$10 billion, with \$2 billion paid in.⁹⁸ As of December 31, 2021, the NDB reported \$24.8 billion in assets and \$14.0 billion in loans and advances.⁹⁹ Its members include the five founding countries, as well as Bangladesh and the United Arab Emirates who joined in fall 2021.¹⁰⁰ The five founders control equal voting shares.

The New Development Bank describes its purpose as “financing infrastructure and sustainable development projects in BRICS and other emerging economies and developing countries.”¹⁰¹

93 Asian Infrastructure Investment Bank, [“AIIB to Fully Align with Paris Agreement Goals by Mid-2023.”](#) (October 26, 2021).

94 Chloe Farand, [“Asian Multilateral Bank Promises to End Coal-Related Financing.”](#) Climate Home News (September 11, 2020).

95 Asian Infrastructure Investment Bank, [Energy Sector Strategy: Sustainable Energy for Tomorrow \(Draft for Consultation\)](#) (April 8, 2022), 1.

96 Asian Infrastructure Investment Bank, [“Our Projects.”](#) (accessed June 28, 2022).

97 New Development Bank, [Independent Auditor’s Report and Financial Statements for the Year Ended December 31, 2021](#) (May 19, 2022) 10.

98 New Development Bank, [Independent Auditor’s Report and Financial Statements for the Year Ended December 31, 2021](#) 73.

99 New Development Bank, [Independent Auditor’s Report and Financial Statements for the Year Ended December 31, 2021](#) 6.

100 New Development Bank, [“NDB’s Member Countries.”](#) New Development Bank (accessed June 28, 2022).

101 New Development Bank, [Annual Report 2020](#) 5 (accessed June 28, 2022).

Its Environment and Social Framework, last updated in March 2016, directs potential clients to address climate change in their environment and social project assessments as follows:

Assess both the potential impacts of the project on climate change as well as the implications of climate change on the project and develop both mitigation or adaptation measures as appropriate. Identify opportunities for no- or low-carbon use, where applicable, and for reducing emissions from the project.¹⁰²

As of June 2022, NDB has approved 77 financing projects.¹⁰³ These included 14 “clean-energy” projects for a total of \$4.25 billion, though several are for gas and coal. All but one of these projects, however, was approved in 2019 or earlier. Projects since 2020 include a \$500 mn loan to Brazil for mitigation and adaptation projects that can deliver 4 mt in CO₂ emissions reductions by 2030, as well as \$1.25 billion for rapid transit projects in India and China.

E. Climate Impacts

The Belt and Road Initiative has significant climate impacts. Several studies help estimate the nature and scale of those impacts.

- Chen et al. (2021) estimates 12 Gt of CO₂ emissions over the roughly 40-year life of overseas power plants that were financed by either Chinese policy banks or greenfield FDI and in operation or under construction as of 2019. (12 Gt over 40 years implies an average of roughly 0.3 Gt/year.) The study estimated 10.4 Gt of CO₂ emissions from Japanese-financed plants and 3.4 Gt of CO₂ emissions from US-financed plants.¹⁰⁴
- Springer et al. (2021), estimating emissions intensities (CO₂ emissions per unit of output) for coal power plants operating in Asia in 2018, find that plants with Chinese financing or EPC contracting tended to have modestly lower average emissions intensities and higher energy efficiency than plants without Chinese participation. They project 11 Gt CO₂ of lifetime emissions over 40-year lives from plants with Chinese financing or contracting (0.275 Gt/year), against 25 Gt CO₂ for plants without Chinese involvement (0.625 Gt/year).¹⁰⁵
- Tao et al. (2020) chart the expected lifetime emissions of 458 international power plant projects across 15 BRI countries that signed engineering and construction contracts with Chinese firms between 2005–19. (The 15 countries selected comprised two-thirds of the value of “newly signed project-contracting contracts” along the BRI in 2017.) Their data suggests an estimated 18 Gt of emissions from these plants over

102 New Development Bank, [Environment and Social Framework](#) (March 11, 2016), 17.

103 New Development Bank, [“Projects,”](#) New Development Bank (accessed June 28, 2022).

104 Chen et al., [“Financing Carbon Lock-in in Developing Countries: Bilateral financing for power generation technologies from China, Japan, and the United States,”](#) Applied Energy, Volume 300, (October 15, 2021) 9.

105 Cecilia Han Springer, Samuel Evans and Fei Teng, [“An Empirical Analysis of the Environmental Performance of China’s Overseas Coal Plants,”](#) Environmental Research Letters 16, no. 5 (May 2021): 054062.

lifetimes of around 35 years (roughly 0.5 Gt/year).¹⁰⁶

- New hydropower projects can also drive heat-trapping gas emissions through accompanying land-use changes: for instance, reservoir flooding that prompts methane releases from decomposing organic matter. Measuring these impacts can be very difficult, and footprints vary substantially across projects. Räsänen et al. (2018) use statistical models to produce “tentative” estimates of emissions from around 140 existing and planned hydropower reservoirs in Southeast Asia, where China has been a major hydropower developer. Their results suggest that most dams have similar emissions footprints to other renewables, but that a minority may be similar to fossil fuels in their impacts.¹⁰⁷

Cancellations of coal power projects that had been announced or under construction over the past few years may affect these projections.¹⁰⁸ Still, the studies suggest that infrastructure developed by Chinese investors and contractors abroad over the past two decades will likely produce gigatonnes of carbon emissions in the coming years.

The BRI may also have emissions impacts through a variety of other channels that are more challenging to measure. Infrastructure development may prompt deforestation that removes carbon sinks and a new power plant may increase economic activity that leads to greater demand for carbon-intensive goods such as steel and cement.¹⁰⁹ Indeed, growing trade with the developing world over the past two decades has increased the share of Chinese emissions “embodied” in trade with BRI countries—that is, emissions associated with the production of exported or imported goods.¹¹⁰ Tian et al. (2019) attempt to measure the impact of the BRI upon Chinese embodied emissions from international trade; they estimate an increase of 0.18 Gt

106 Tao, Liang and Celia, [“Electric Power Development Associated with the Belt and Road Initiative and Its Carbon Emissions Implications.”](#) Applied Energy, Volume 267 (June 1, 2020) 9–10.

107 Timo A Räsänen et al., [“Greenhouse Gas Emissions of Hydropower in the Mekong River Basin.”](#) *Environmental Research Letters* 13, no. 3 (March 1, 2018): 034030.

108 Tao et al. “assume the projects with missing commissioning dates (or upcoming commissioning dates) will be completed successfully. When evidence occurs that a project would be discontinued, such as the Lamu coal-fired power plant in Kenya that was halted in June 2019 for lack of thorough environmental assessment, we exclude that project from the dataset to be conservative.” Tao, Liang and Celia, [“Electric Power Development Associated with the Belt and Road Initiative and Its Carbon Emissions Implications.”](#) Applied Energy, Volume 267 (June 1, 2020) 5; Chen et al., [“Financing Carbon Lock-in in Developing Countries: Bilateral financing for power generation technologies from China, Japan, and the United States.”](#) Applied Energy, Volume 300, (October 15, 2021) 4. One 1320 MW coal plant project in Turkey that was cancelled in November 2021 had an announced engineering, procurement and construction contract with a Chinese company as of 2016. Center for Research on Energy and Clean Air, “BRIEFING: 12.8 GW of Chinese Overseas Coal Projects Cancelled, but 19 GW Could Still Go Ahead.” A June 2021 study from the Center for Research on Energy and Clean Air reported that 6.2 GW of coal capacity under construction as of 2017 had been cancelled. Center for Research on Energy and Clean Air, [4.5 Times as Much Overseas Coal Capacity Linked to China Cancelled or Shelved than Progressed to Construction](#) (June 15, 2021), 5.

109 Ray et al. estimate that international development finance institutions’ infrastructure projects in Ecuador, Peru and Bolivia in 2000–15 resulted in deforestation and an associated loss of carbon sinks equivalent to 0.21 Gt CO₂ of emissions. Rebecca Ray, Kevin P Gallagher and Cynthia Sanborn, [“Standardizing Sustainable Development?”](#) Boston University Global Development Policy Center and the Universidad del Pacífico Center for China and Asia-Pacific Studies (2018).

110 Jing Hou et al., [“A Global Analysis of CO₂ and Non-CO₂ GHG Emissions Embodied in Trade with Belt and Road Initiative Countries.”](#) *Ecosystem Health and Sustainability* 6, no. 1 (December 16, 2020): 1761888; Tao Ding, Yadong Ning and Yan Zhang, [“The Contribution of China’s Bilateral Trade to Global Carbon Emissions in the Context of Globalization.”](#) *Structural Change and Economic Dynamics* 46 (September 1, 2018): 78–88.

through 2016 from higher exports to BRI countries, largely reflecting cement and steel trade.¹¹¹

The climate impacts of new BRI projects during the 2020s could look very different from the prior two decades. Coal was the largest target of outbound power-sector investments during the BRI's early years. Xi Jinping's "no new coal" pledge, amidst mounting project cancellations, confirms that these conditions will change. More broadly, BRI outbound economic activity fell significantly in 2020-21 and its post-COVID recovery remains uncertain. This retrenchment offers the opportunity to take up the promise of a greener BRI; doing so would have enormous positive impacts for global decarbonization.

111 Xu Tian et al., "[Trade Impacts of China's Belt and Road Initiative: From Resource and Environmental Perspectives](#)," *Resources, Conservation and Recycling* 150 (2019): 104430; See also Xin Wang et al., "[Mapping the Exchange between Embodied Economic Benefits and CO₂ Emissions among Belt and Road Initiative Countries](#)," *Applied Energy* 307 (February 1, 2022): 118206.

CONCLUSION

CONCLUSION

Based on the review of Chinese climate policies in this Guide, we offer the following observations:

1. ***President Xi Jinping’s pledge that China will achieve carbon neutrality by 2060 elevates low-carbon development as a priority within the Chinese system.***

In China’s top-down governance system, leaders’ statements carry great weight. President Xi’s high-profile pledge that China will achieve carbon neutrality by 2060 gives low-carbon development an important place in the policy dialogue on a wide range of topics at all levels.

Chinese leaders have spoken about the need to address climate change for many years. Although policy goals in other areas have often taken priority, President Xi Jinping and other Chinese leaders have consistently sent the message that climate change is real, that they are serious about addressing it and that doing so is part of China’s development strategy. There are no known climate deniers in the Chinese leadership—and none with any observable influence on policy.

President Xi’s carbon neutrality pledge elevates low-carbon development—and therefore climate change—within the Chinese system. The pledge implies dramatic and far-reaching change in China’s economy, which has led institutions of all kinds to begin mobilizing to help achieve it. This includes the State Council, National Development and Reform Commission (NDRC) and many ministries, all of whom have highlighted the pledge in 14th Five-Year Plan documents. Indeed, President Xi announced a new series of government policy papers—known as “1+N” documents—that specifically focus on the 2060 carbon neutrality and 2030 carbon peaking goals.¹

Attention to the carbon neutrality goal reaches well beyond ministries and other government agencies. Leading Chinese banks, for example, made a range of commitments to increase green finance following President Xi’s carbon neutrality pledge. China Development Bank announced that green loans will account for more than 5% of its credit assets by 2025 and 30% of its credit assets by 2030. Bank of China announced it will provide at least RMB 1 trillion in green finance during the 14th Five-Year Plan period and its proportion of green credit will increase each year. Coal-fired power plants were removed from the list of projects that can be considered “green.”²

Central government enforcement related to climate change is being strengthened as well. In 2021, the Central Environmental Inspection Team, led by Vice Premier Han Zheng, conducted prominent inspections of the National Energy Administration and various local governments, subjecting them to criticism and calling for changes. Though these inspections mostly focused on local environmental issues, the signal was clear that the inspection team would hold officials to account on climate policies as well.

1 Embassy of the People’s Republic of China in the US, [“China’s 1+N Policy Framework,”](#) (November 17, 2021).

2 Sun Chi, [“Chinese banks see growth in green credit balance in first 9 months,”](#) China Daily (December 21, 2021); People’s Bank of China, National Development and Reform Commission, and China Securities Regulatory Commission, [Notice on Issuing the Green Bond Endorsed Projects Catalogue \(2021 Edition\)](#). See Chapter 20 of this Guide.

In many western countries, the long-term nature of the 2060 carbon neutrality pledge would lead many people to dismiss it. This is much less true in China, with its tradition of long-term planning and expectation of governance continuity for the decades ahead. In many Chinese institutions—from central government ministries to provincial and local governments to energy companies to manufacturers to financial institutions and more—work is underway to figure out how to help move the country toward carbon neutrality in the years ahead.

Indeed the response to President Xi’s carbon neutrality and carbon peaking goals by some officials was so strong that, in August 2021, China’s Politburo took the unusual step of warning against excessive actions in pursuing these goals. In a meeting chaired by President Xi, the Politburo called for “carrying out the carbon peaking and carbon neutrality work in a coordinated and orderly manner” and “rectifying campaign-style carbon reduction”. The latter phrase has been interpreted to mean that local officials should not become overly-zealous in seeking to achieve the carbon neutrality and carbon peaking goals.³

2. ***In the near-term, COVID control, economic growth and energy security are higher priorities for Chinese policymakers than low-carbon development.***

While President Xi’s carbon neutrality pledge has the potential to reshape industries and living patterns over the long-term, other issues have higher priority for Chinese policy makers in the near-term. In the past several years, COVID control, economic growth and energy security have been the highest priorities.

The priority Chinese leaders attach to COVID control has been especially strong. Strict quarantine rules for entry into China have dramatically reduced people-to-people exchanges for almost three years. Strict lockdowns in Shanghai and other cities during 2022 have had huge impacts on the lives of hundreds of millions of people and gained enormous global attention. To an extent that has surprised some observers, Chinese leaders have been willing to sacrifice short-term economic growth to contain the spread of COVID. Chinese leaders have never given the carbon neutrality or carbon peaking goals anything approaching that level of priority.

At the same time, economic growth remains overwhelmingly important for Chinese leaders. In recent years, challenges in managing China’s economy have grown. First, the torrid pace of economic growth from the first decade of the 21st century inevitably slowed. Then property bubbles, municipal debt and trade disputes created pressures. Most recently, COVID lockdowns in China and its key export markets led to unprecedented contractions in economic activity.

In response to the nationwide COVID lockdown in winter 2020, the Chinese government launched economic recovery programs that focused heavily on energy- and carbon-intensive sectors. Structural economic shifts seen during the early years of the 13th Five-Year Plan period (2016–2020) slowed or reversed. The energy intensity reduction ultimately achieved

³ [“China to rectify ‘campaign-style’ carbon reduction,”](#) Xinhua (August 17, 2021); Xiaoying You, [“China issues new ‘single-game’ instructions to guide its climate action,”](#) CarbonBrief (August 4, 2021).

during the 13th Five-Year Plan was 13.2%—less than the initial target of 15%.⁴ Economic growth took priority over low-carbon development.

Despite increasingly ambitious climate policies, the Chinese government’s macroeconomic priorities continue to shape its emissions trajectory. The longer-term economic rebalancing envisioned by policy makers includes a shift toward a more consumption- and service-led economy. But for now, China’s economy remains energy- and carbon-intensive. This is due to the high share of heavy manufacturing in China’s economy, the importance of coal in fueling these industrial processes, and the lack of market signals to motivate energy efficiency in some sectors.⁵ The long-term direction of travel toward carbon neutrality remains, but short-term economic stimulus measures run contrary to this goal.

Meanwhile energy security—long a priority of Chinese leaders—has grown in importance in recent years. Chinese policy makers’ renewed focus on energy security was evident in remarks by Premier Li Keqiang at a meeting of the National Energy Commission in October 2019 and has continued to dominate speeches and policy documents since then. US-China trade tensions, domestic power outages and the Russia-Ukraine conflict have all contributed to a continuing focus on energy security.⁶

In highlighting the importance of energy security, Chinese leaders have looked especially to coal—a domestic resource that China has in abundance. Although the *14th Five-Year Plan* calls for “strict controls” on coal use, it contains no limits on domestic coal production, consumption or power generation capacity. Instead, the *14th Five-Year Plan* calls for “strengthening coal’s role as an energy security guarantee...” and “the regulating role of coal power in the power system.” Although policy documents call for starting to phase down coal use during the 15th Five-Year Plan (2026–2030), new coal mines and coal-fired power plants continue to be built in China on a significant scale.⁷

This support for coal is about economic growth as well as energy security. The coal industry is at the heart of the economy in many provinces and supports more than 2.5 million jobs nationwide. Moreover, construction projects in the coal sector and coal-consuming industries can often boost GDP in the short-term—especially important to many provincial and local officials whose promotion may depend on hitting GDP targets.⁸

Significantly, the *14th Five-Year Plan* says that coal-fired power plants will be built or retrofitted to operate as flexible resources (balancing zero-carbon solar and wind power), rather than as sources of baseload power. By 2025, around 300 GW (roughly a quarter

4 “China’s energy intensity caps poorly timed amid ongoing fuel shortages.” S&P Global (September 29, 2021).

5 On energy efficiency in China generally, see Chapter 9 of this Guide; IEA, [Energy Efficiency 2018](#) at pp.145–149; Lynn Price et al., [Reinventing Fire: China—the Role of Energy Efficiency in China’s Roadmap to 2050](#) (2017).

6 See Erica Downs, [China’s Quest for Energy](#) (RAND Corporation, 2000); “Premier calls for high-quality energy development,” State Council, People’s Republic of China (October 11, 2019).

7 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (in Chinese) (March 2022) at p.19; Lauri Myllyvirta, “What does China’s coal push mean for its climate goals?,” CarbonBrief (March 29, 2022). See Chapter 5 of this Guide.

8 Alex Clark, Weirong Zhang, “Estimating the Employment and Fiscal Consequences of Thermal Coal Phase-Out in China,” [Energies](#), (January 2022); Bas Heerma van Voss and Ryan Rafaty, “Sensitive intervention points in China’s coal phaseout,” [Energy Policy](#) (April 2022).

of China's coal-fired power plant capacity) will be “flexible power sources”.⁹ This will help achieve the Chinese government's carbon peaking and carbon neutrality goals. Using coal-fired power plants as flexible resources, operating at low capacity factors to balance renewable power, could help reconcile the Chinese government's economic growth, energy security and low-carbon development goals.

3. ***The Chinese government's climate change goals often align with other policy priorities.***

Several policy goals important to the Chinese government align closely with its climate change goals. This gives the climate change goals greater strength and durability.¹⁰

Among the objectives that often align closely with the Chinese government's climate change goals are the following.

Developing “industries of the future.” The Chinese government gives high priority to supporting sectors it believes have high growth potential and will shape the global economy in the decades ahead. This includes artificial intelligence, robotics, 5G and supercomputing.

For many years, the Chinese government has supported several low-carbon technologies. Solar photovoltaic manufacturing and electric vehicles stand out as notable examples. High-voltage transmission and hydrogen fuels—both of which have the potential to contribute carbon neutrality—have also been promoted in part for their growth potential in the decades ahead. The Chinese government's *Made in China 2025* program—which became controversial internationally—includes new energy vehicles, power equipment and green manufacturing as priorities.¹¹

Improving urban air quality. Urban air pollution worsened significantly in many parts of China during the first decade of this century. Fighting urban air pollution has been a priority of China's leaders ever since. In the past decade, the air quality in many Chinese cities has steadily improved, although significant air pollution problems remain.¹²

Many policies for improving urban air quality also help reduce emissions of heat-trapping gases. Measures to reduce coal burning, promote fuel-efficient and electric vehicles, and invest in mass transit are leading examples. A combined approach to urban air quality and carbon neutrality lowers overall costs and reduces the risk that some assets might be stranded or rendered obsolete by future carbon neutrality policies. There is strong alignment between the Chinese government's goals for improving urban air quality and its carbon neutrality and

9 NDRC and NEA, [14th Five-Year Plan for a Modern Energy System](#) (March 2022) at pp.15–16.

10 Anders Hove, Michal Meidan and Philip Andrews-Speed, [Software versus hardware: how China's institutional setting helps and hinders the clean energy transition](#) Oxford Institute of Energy Studies (December 2021).

11 [Made in China 2025 website](#), State Council, People's Republic of China (accessed August 21, 2022); Scott Kennedy, [“Made in China 2025,”](#) Center for Strategic and International Studies (June 2015).

12 See Chapter 17 of this Guide.

carbon peaking goals.¹³

Enhancing energy security. The Chinese government’s energy security goals align with its climate change goals in several respects. Energy security is a factor in the Chinese government’s support for electric vehicles. (More than 70% of the oil consumed in China last year was imported, creating significant strategic vulnerabilities.¹⁴) Energy security is also a factor in the Chinese government’s support for renewable power. (Hydro, wind and solar power all use domestic resources and equipment with a strong domestic supply chain in China.) Electric vehicles and renewable power are both important for achieving the Chinese government’s climate change goals.

However, energy security goals are also an important factor in the recent resurgence of Chinese government support for the coal sector. In remarks on energy security, China’s leaders typically focus far more on coal than on electric vehicles or renewables power. Energy security goals are also important in the Chinese government’s push for greater domestic oil production. Coal and oil consumption are major contributors to climate change.¹⁵

Maintaining close relationships with the Global South. The Chinese government has long prioritized close relationships with other developing countries (often referred to as the “Global South”). In the 1950s and 1960s, Chairman Mao Zedong sought a “united front” of developing countries. In 2002, the 16th Party Congress declared that developing countries are “the foundation” of China’s diplomacy. The vast majority of Belt and Road Initiative projects are in the developing world.¹⁶

Developing countries are, in general, more vulnerable to the impacts of climate change than industrialized countries. Small island states and those with large populations near seacoasts are especially vulnerable. China’s status as the world’s largest emitter of heat-trapping gases creates tensions with many of those countries. This was especially acute at the Copenhagen climate conference in 2009, when the longstanding “G77/China” negotiating bloc split, with many small island states and African countries strongly criticizing China for its negotiating positions. The dynamic has persisted in multiple settings since. China’s policies to curb emissions and transition to carbon neutrality play an important role in its diplomacy with many developing countries most vulnerable to climate change.¹⁷

13 Xi Yang and Fei Teng, “[The air quality co-benefit of coal control strategy in China.](#)” Resources, Conservation and Recycling (February 2018); Kyung-Min Nama et al., “[Synergy between pollution and carbon emissions control: Comparing China and the United States.](#)” Energy Economics (November 2014); Hui Zhang et al., “[More efforts, more benefits: Air pollutant control of coal-fired power plants in China.](#)” Energy (February 2015). See Chapter 17 of this Guide.

14 Zheng Xin, “[China’s oil dependence on imports sees drop.](#)” China Daily (February 24, 2022).

15 “[Premier calls for high-quality energy development.](#)” State Council, People’s Republic of China (October 11, 2019); Zheng Xin, “[China’s oil dependence on imports sees drop.](#)” China Daily (February 24, 2022).

16 Nadège Rolland, “[China’s Southern Strategy.](#)” Foreign Affairs (June 9, 2022).

17 See Björn Conrad, “[China in Copenhagen: Reconciling the ‘Beijing Climate Revolution’ and the ‘Copenhagen Climate Obstinacy.’](#)” The China Quarterly (June 2012); Jonathan Watts et al., “[China blamed as anger mounts over climate deal.](#)” The Guardian (December 20, 2009); Jilong Yang, “[Understanding China’s changing engagement in global climate governance: a struggle for identity.](#)” Asia Europe Journal (2022).

Demonstrating commitment to multilateralism. President Xi Jinping has emphasized China’s commitment to multilateralism on many occasions. At the World Economic Forum in Davos in January 2017, for example, he said “We should adhere to multilateralism to uphold the authority and efficacy of multilateral institutions.” At the Leader’s Summit on Climate in April 2021, President Xi said “We must be committed to multilateralism.”¹⁸

The Chinese government’s climate goals help to position it as an active and responsible participant in the Paris Agreement and other multilateral efforts to combat climate change. In October 2017, after US President Donald Trump withdrew the United States from the Paris Agreement, President Xi said that China would take a “driving seat in international cooperation to respond to climate change” and become a “torchbearer” in creating an ecological civilization. At the Climate Ambition Summit in December 2020, President Xi declared that “Only by upholding multilateralism, unity and cooperation can we deliver shared benefits and win-win for all nations.”¹⁹

Precisely because climate change is such a challenging and far-reaching policy issue, climate policies will be more durable when aligned with other policy goals. In his remarks at the Paris climate conference, President Xi Jinping said that China has “integrated climate change efforts into [our] medium- and long-term program of economic and social development.”²⁰ Continuing to do so will contribute to the Chinese government’s success in addressing climate change.

4. ***The state’s central role in the Chinese energy sector both helps and hinders the low-carbon transition.***

The state has long played a central role in China’s energy sector. State-owned enterprises dominate production of coal, oil and gas, as well as power production and the electric grid. Government agencies set prices and issue administrative allocations on a range of topics including fuel distribution and power plant operating hours.

Starting with the period of Reform and Opening Up in the late 1970s, the state’s role in China’s energy sector has slowly but steadily diminished. The Ministry of Petroleum Industries was dismantled in the 1980s, with most of its functions transferred to two state-owned companies (Sinopec and CNPC).²¹ In 2002, the vertically integrated State Power Corporation was broken into two grid companies (China State Grid and China Southern Grid) and five power companies.²² In recent years, market mechanisms have begun to replace some administrative

18 [Xi Jinping’s keynote speech at the World Economic Forum](#) State Council Information Office (April 6, 2017); [Remarks by Chinese President Xi Jinping at Leaders Summit on Climate](#), Xinhua (April 22, 2021).

19 [Remarks of General Secretary Xi Jinping at the 19th National Congress of the Communist Party of China](#) (October 18, 2017) at p.4; [Remarks by Chinese President Xi Jinping at Climate Ambition Summit](#), Xinhua (December 12, 2020)

20 [“President Xi’s speech at opening ceremony of Paris climate summit,”](#) China Daily (December 1, 2015).

21 Michal Meidan, [The Structure of China’s Oil Industry](#), Oxford Institute of Energy Studies (May 2016) at p.11.

22 Xu Yi-chong, [“The State Grid Corporation of China,”](#) Chapter 6 of *The Political Economy of State-Owned Enterprises in China and India*, Macmillan Publishers Limited (2012) at pp.128-9.

allocations in the power sector.²³

Nevertheless, the state remains a central player in most aspects of China's energy industry. This both helps and hinders the low-carbon transition.

First, the state's role facilitates long-term planning. For decades, the Chinese government has set and managed goals far beyond the time frames of many other governments. The Chinese government currently has a goal for 2049 (the 100-year anniversary of the People's Republic of China)--to build a "prosperous, strong, democratic, culturally advanced and harmonious" country.²⁴ For more than 60 years, Five-Year Plans have guided Chinese policy making.

This capacity for long-term planning offers significant advantages to the low-carbon transition. Many energy assets have useful lives of several decades or more. Making decisions with long-term implications in mind can be key. The Chinese government's demonstrated capacity to establish long-term goals and work successfully to meet them is a significant asset in planning, implementing and sustaining an energy transition.

Second, the state's central role in the energy sector means more public funds are available for the low-carbon transition. For decades, the Chinese government has been willing to support its energy sector with public funding at a scale far beyond most other governments. Tools have included generous grants, loans and feed-in-tariffs, as well as free or deeply-discounted land allotments. This support has been especially pronounced in sectors with significant potential for competitive advantage or strategic benefit, such as solar manufacturing and electric vehicle deployment. Similarly generous support could extend to a range of sectors essential to meeting China's carbon neutrality goal in the decades ahead.

This use of public funds has led to both complaints and praise from abroad. Complaints have often alleged unfair subsidization of Chinese exporters, putting competitors in other countries at a disadvantage. At the same time, some observers have praised China's role in helping bring down the costs of solar panels and related equipment globally.

Third, the tight linkages between the leadership of government ministries and state-owned enterprises means that SOE executives generally adopt government mandates as a high priority. Today, many state-owned industries in China's energy, industrial and financial sector are working diligently to figure out how best to implement President Xi's carbon peaking and carbon neutrality goals.

At the same time, the state's central role in the Chinese economy can hinder low-carbon development.

23 See Chapter 8 of this Guide. Interestingly, the increasing role of market mechanisms in the power sector runs somewhat contrary to broader trends in China's economy which, in the view of many observers, have been marked by an expanded role for the state in recent years. See e.g. Nicholas R. Lardy, *The State Strikes Back. The End of Economic Reform on China?*, Petersen Institute for International Economics (2019). See also Fredrich (Fritz) Karhl et al., "[Issues in China Power Sector Reform: Generator Dispatch](#)," Regulatory Assistance Project (July 5, 2016).

24 See Justin Lin, "[Goal 2049: Modern, strong nation despite hurdles](#)," *China Daily* (August 23, 2021); David Dollar, Yiping Huang, and Yang Yao, editors, *China 2049*, Brookings Institution (2020); "[Li Keqiang Attends the Opening Ceremony of the Taiyuan Energy Low Carbon Development Forum 2021 and Delivers A Keynote Speech](#)," Embassy of the PRC in Ireland (September 3, 2021) (China "is on track to accomplish socialist modernization by the middle of the century").

First, the state's central role has led to overcapacity in many Chinese industries. Businesses that would close for financial reasons in many western economies are often allowed to remain open in China, supported with government funds. The resulting overcapacity in steel manufacturing has contributed to substantial emissions of heat-trapping gases from that sector. The lack of market discipline due to state control is also a factor in the continued approval of new coal-fired power plants. In China, coal-fired power plants operate at roughly 50% of their capacity on average.²⁵ In economies where market signals play a greater role, there is more pressure to operate power plants at higher capacities instead of building new ones.

Second, state ownership of businesses with high carbon emissions can weaken pressures for a transition. This is compounded by China's fragmented governance system, under which provincial and local authorities have considerable authority in implementing central government directives. These provincial and local governments often own conventional carbon-emitting businesses and rely on those businesses for tax revenues and employment. Provincial and local officials—usually rewarded for boosting GDP more than for environmental performance—can be reluctant to interfere with these businesses or shift toward lower-carbon alternatives. (Similar dynamics can occur in systems without state ownership, but the ability of state-owned enterprises to influence policy is even greater under the Chinese system.) The Leading Group on Carbon Peaking and Carbon Neutrality chaired by Vice Premier Han Zhen is intended in part to address this and similar challenges.²⁶

A final aspect of the state dominance of energy in China relates to technical innovation. In all countries, the low-carbon energy transition relies on technical and managerial innovation along multiple supply chains. Many of China's most successful and innovative companies are in the private sector. Research suggests that China's SOEs tend to be less innovative than the private sector. The continued dominance of SOEs in China's energy sector may constrain the pace of low-carbon innovation, especially in design-intensive fields requiring high stakeholder coordination and engagement.²⁷

5. ***Fifth, China—like all major emitters—will need to do more for the world to achieve its climate goals.***

In the Paris Agreement, more than 190 nations agreed to the goal of:

“Holding the increase in the global average temperature to well below 2°C [3.6°F] above pre-industrial levels and pursuing efforts to limit the temperature

25 National Energy Administration, [Statistical data of the national power industry in 2021](#) (in Chinese) (January 26, 2022); National Energy Administration, [Statistical data of the national power industry in 2020](#) (in Chinese) (January 20, 2021). See Chapter 5 of this Guide.

26 Nis Grunberg, “[Revisiting fragmented authoritarianism in China's central energy administration.](#)” in Kjeld Erik Brodsgaard (ed.) *Chinese Politics as Fragmented Authoritarianism*. Earthquakes, Energy and Environment, Routledge (2017); Anders Hove, Michal Meidan and Philip Andrews-Speed, [Software versus hardware: how China's institutional setting helps and hinders the clean energy transition](#) Oxford Institute of Energy Studies (December 2021). On the Leading Group on Carbon Peaking and Carbon Neutrality, see Appendix B of this Guide.

27 Anders Hove, Michal Meidan and Philip Andrews-Speed, [Software versus hardware: how China's institutional setting helps and hinders the clean energy transition](#) Oxford Institute of Energy Studies (December 2021).

increase to 1.5°C [2.7°F] above pre-industrial levels.”²⁸

In the Paris Agreement, these countries also agreed to submit national action plans for addressing climate change (known as Nationally Determined Contributions or “NDCs”). Almost all have now done so. Many countries have also pledged to achieve net zero emissions by mid-century.

However these NDCs and national net zero pledges fail to achieve the goals of the Paris Agreement. According to the United Nations Environment Program, if current NDCs were fully implemented, global average temperatures would nevertheless rise roughly 2.7°C (4.9°F) above pre-industrial levels. If all national net zero emissions pledges were fully achieved as well, temperatures would nevertheless rise roughly 2.2°C above pre-industrial levels.²⁹

Yet the NDCs are not being fully implemented. UNEP reports that Australia, Brazil, Canada, Mexico, the Republic of Korea and the United States, among others, are all at risk of failing to meet their NDC targets. Few if any countries have policies in place to achieve net zero emissions of heat-trapping gases by mid-century.³⁰

For all these reasons, it is clear the world will need to do much more to meet its climate goals. It is also clear that China must play an important role in these efforts, for several reasons.

First and most obvious, China is the world’s largest emitter of heat-trapping gases, by far. There is no solution to climate change without China.

Second, China has enormous potential to contribute to solutions to climate change. In the past decade, it played a central role in dramatic cost reductions for solar power—a technology with the potential to significantly reduce power sector emissions around the world in the decades ahead. China’s current investments in electric vehicles could play a transformational role for that technology, helping reduce transport sector emissions around the world as well. The Chinese government’s focus on innovation and commitment to clean energy could help generate important discoveries and advances with global impacts in the decades ahead.

Third, many countries look to China’s development model with enormous interest. Countless countries would like to emulate China’s economic miracle. The way China integrates climate change into economic development has the potential to be a model for many countries around the world.

Fourth, China’s activities abroad have considerable emissions impacts. The extent to which Chinese financial institutions and companies support low-carbon infrastructure under the Belt and Road Initiative could make a significant difference in global emissions in the decades ahead.³¹

Finally, China will play an important role in climate diplomacy in the next several years and

28 [Paris Agreement](#) Article 2(1)(a).

29 UNEP, [Emissions Gap Report 2021](#) at p. IV.

30 UNEP, [Emissions Gap Report 2021](#) at p. VII.

31 See Chapter 26 of this Guide.

beyond. As the world considers next steps under the Paris Agreement (including the Global Stocktake scheduled for COP-28 in fall 2023), the Chinese government's positions and views will be key to shaping a global consensus.³²

As the world meets the climate challenge in the decades ahead, China's role will be central.

32 On the Global Stocktake, see [Paris Agreement](#) Article 14 and [UNFCCC website-Global Stocktake](#) (accessed August 12, 2022). On China's climate diplomacy generally, see Chapter 25 of this Guide.

APPENDICES

APPENDIX A - GOVERNMENT AND PARTY STRUCTURE

Background

China's government is a party-state system. The Chinese Communist Party chooses the leaders of all government offices and state-owned enterprises. The Party determines general directions, overall priorities and specific policies when it chooses.

The Party and government are deeply intertwined, with senior officials holding positions in both. Xi Jinping, for example, is General Secretary of the Chinese Communist Party and President of the People's Republic of China. Under Xi Jinping, the Party has expanded its remit and become more directly involved in decisions that previously were left to the government.¹

Within the Chinese Communist Party, the top official is the General Secretary. He chairs the powerful Politburo Standing Committee (PSC), which has varied in size over the years but currently has seven members. The PSC is the inner circle of the Politburo, with roughly 25 members. Just below the Politburo in rank is the party's Central Committee, which has several hundred members and generally meets twice a year. Next is the National Party Congress, which has over 1500 members and meets every five years. In June 2021, the Chinese Communist Party had roughly 95 million members—approximately 8% of the population over 15 years of age.²

Within the Chinese government, the top officials are the President and the Premier. The Premier serves as chair of the State Council, which coordinates China's domestic and foreign policy and has been called "China's Cabinet." The State Council's Executive Committee currently consists of the Premier, four Vice Premiers and five State Councilors. Twenty-three ministers, commissioners and other heads of government offices also serve on the State Council, supported by a large bureaucracy³.

Chinese ministries and commissions play a central role in formulating policy within their functional domains. This includes the Ministry of Foreign Affairs, Ministry of Finance, Ministry of Science and Technology, Ministry of Land and Resources, State-Owned Assets and Supervision Commission, and many more. The National Development and Reform Commission (NDRC) is an especially powerful commission with broad authority over China's economy.

One tool used to coordinate work among top officials is the "leading group." Leading groups bring together key stakeholders on priority topics, help shape consensus and can be located within the party or government. President Xi Jinping heads a number of leading groups, including on foreign affairs, the economy and defense. Members of the Politburo Standing

1 With respect to topics discussed in this appendix, see Elizabeth Economy, *The Third Revolution: Xi Jinping and the New Chinese State* (Oxford University Press, 2018); Kelly Sims Gallagher and Xioawei Xuan, *Titans of the Climate*, (MIT Press, 2018) at Chapter 3; Cheng Li, *Chinese Politics in the Xi Jinping Era* (Brookings Press, 2016) at pp.41-76; Kenneth Lieberthal, *Governing China* (W. W. Norton, 2004) at pp.233-242.

2 "[Communist Party of China now has over 95 million members.](#)" Xinhua (June 30, 2021); [China Statistical Yearbook 2021 \(stats.gov.cn\)](#), Table 2-4, Age composition and dependency ratio of population.

3 [State Council website - Ministers](#) (August 21, 2021 update).

Committee and State Council head leading groups on a range of other topics.

China's legislature is the National People's Congress, with roughly 3000 members. The National People's Congress meets for two weeks each March to discuss reports from government leaders and approve laws.

China has 34 provinces, including four municipalities with provincial status (Beijing, Shanghai, Chongqing and Tianjin), five autonomous regions (Tibet, Inner Mongolia, Xinjiang, Ningxia and Guangxi) and two special administrative regions (Hong Kong and Macao).

Provincial governments play a key role in governing China, with a rank equal to that of central government ministries. Provincial governments implement policies from the central government but also engage in considerable policy making on their own. Many provincial governments hold substantial ownership stakes in state-owned enterprises (SOEs) and favor their local SOEs with supportive policies. The structure of provincial governments in general duplicates that of the central government, with control exercised by provincial party leaders and provincial ministries exercising considerable authority within their domains.

APPENDIX B - KEY PLAYERS

Top-level decision-making on Chinese climate policy is coordinated by the National Leading Group for Climate Change, Energy Conservation and Emissions Reduction. Prior to the 20th Party Congress in October 2022, Premier Li Keqiang served as chair and Vice-Premier Han Zheng and State Councilor Wang Yi served as deputies. Thirty ministers, directors and other top officials are members.¹ Among the main tasks of the National Leading Group are to:

- “develop major national strategies, policies and countermeasures on climate change,”
- “study and review international cooperation and negotiation counterproposals;” and
- “organize the implementation of the policies of the State Council on energy conservation and emissions reduction.”²

In addition, a Special Leading Group on Carbon Peaking and Carbon Neutrality coordinates activities related to the 2030 carbon peaking and 2060 carbon neutrality goals. In June 2021, Chinese media reported on a meeting of the Special Leading Group chaired by Vice-Premier Han Zheng and attended by roughly 60 officials from different ministries and committees. The role of the Group is to coordinate efforts to peak carbon dioxide emissions and achieve carbon neutrality.³

China’s Ministry of Ecology and Environment (MEE) has principal responsibility for climate change policy within the Chinese government. According to MEE’s website, MEE’s mandates include:

“Take the leading role in work related to climate change. Initiate the formulation of key strategies as well as plans and policies tackling climate change and greenhouse gas emissions; Along with other governmental departments, participate in international negotiations on climate change; Carry out China’s role in the *United Nations Framework Convention on Climate Change*.”⁴

MEE received these responsibilities as part of a government reorganization in March 2018. Before that, the National Development and Reform Commission (NDRC) had taken the lead on climate change within the Chinese government for many years.⁵

1 State Council, “[Notice on Adjusting the Members of the National Leading Group for Climate Change, Energy Conservation and Emission Reduction](#),” (in Chinese) (October 7, 2019); State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at II(1).

2 People’s Republic of China, [Third National Communication on Climate Change](#) (December 2018) at p.25; People’s Republic of China, [Second Biennial Update Report on Climate Change](#) (December 2018) at pp.5-6.

3 Xiaoying You, “[China creates new ‘leaders group’ to help deliver its climate goals](#),” CarbonBrief (June 3, 2021); NDRC, [Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy](#), October 24, 2021; State Council Information Office, [Responding to Climate Change: China’s Policies and Actions](#) (October 2021) at II(1).

4 Ministry of Ecology and Environment [Mandates](#) at #10 (accessed September 2, 2022).

5 Yang Wanli, “[New ecological environment ministry is a milestone](#),” China Daily (March 17, 2018); Jackson Ewing, “[Tough Tasks for China’s New Environment Ministry](#),” The Diplomat (March 17, 2018).

NDRC has substantial continuing influence on climate change policy. That influence comes in part from NDRC's broad authority over economic development, including over planning processes and project approvals. It comes in part from the National Energy Administration (NEA), which plays a central role in many Chinese energy policies and sits within NDRC. It comes from officials and supporting staff with climate change experience who remain at NDRC as well.⁶

Other parts of the Chinese government that play important roles in policies related to climate change include the:

- Ministry of Foreign Affairs (MFA), which helps shape China's climate change diplomacy;
- Ministry of Finance, which administers taxes and tax incentives relevant to climate policy;
- Ministry of Science and Technology (MOST), which provides billions of RMB for research and development on clean energy technologies;
- Ministry of Industry and Information Technology, which sets vehicles' fuel efficiency standards and develops industrial policies more broadly;
- Ministry of Housing and Rural and Urban Development (MOHURD), which helps administer green cities and other low-carbon pilot programs; and
- International Development Cooperation Agency (CIDCA), established in April 2018, which administers foreign aid and development assistance.⁷

Many quasi-governmental institutions and universities provide research and analytic support that informs the development of Chinese climate change policy. They include the:

- National Center for Climate Change Strategy and International Cooperation (NCSC), which provides considerable analytic and modeling capabilities on all aspects of climate policy;
- Energy Research Institute (ERI), which provides considerable expertise on all aspects of energy policy;
- Development Research Center (DRC), which supports the State Council with research on carbon markets, urbanization, innovation and many other topics related to climate policy;
- Chinese academies (including the Chinese Academy of Sciences and the Chinese

⁶ See NDRC, [Main Functions of the NDRC](#) at Paragraphs 12 and 18(4) (accessed September 2, 2022); NDRC, "Formulation of carbon plan gaining speed," Xinhua (July 22, 2021); Craig Hart, Zhu Jiayan and Ying Jiahui, [Mapping China's Climate and Energy Policies](#) (December 2018) at pp.16-17.

⁷ People's Republic of China, [Third National Communication on Climate Change](#) (December 2018) at p.26; Kelly Sims Gallagher and Xioawei Xuan, [Titans of the Climate](#), MIT Press (2018) at pp.96-97; Craig Hart, Zhu Jiayan and Ying Jiahui, [Mapping China's Climate and Energy Policies](#) (December 2018) pp. 8-11.

Academy of Engineering), which have deep expertise on topics related to climate science and clean energy technologies; and

- leading Chinese universities (including Tsinghua, Peking and Renmin), with professors in many disciplines playing important roles in advising government leaders.⁸

Chinese state-owned enterprises (SOEs) play an important role in shaping China's climate policies. Among those most directly affected by Chinese climate policies are the major power companies, electric utilities, oil and gas companies, and coal companies. CEOs of large central government SOEs generally have high rank in the Chinese Communist Party.⁹

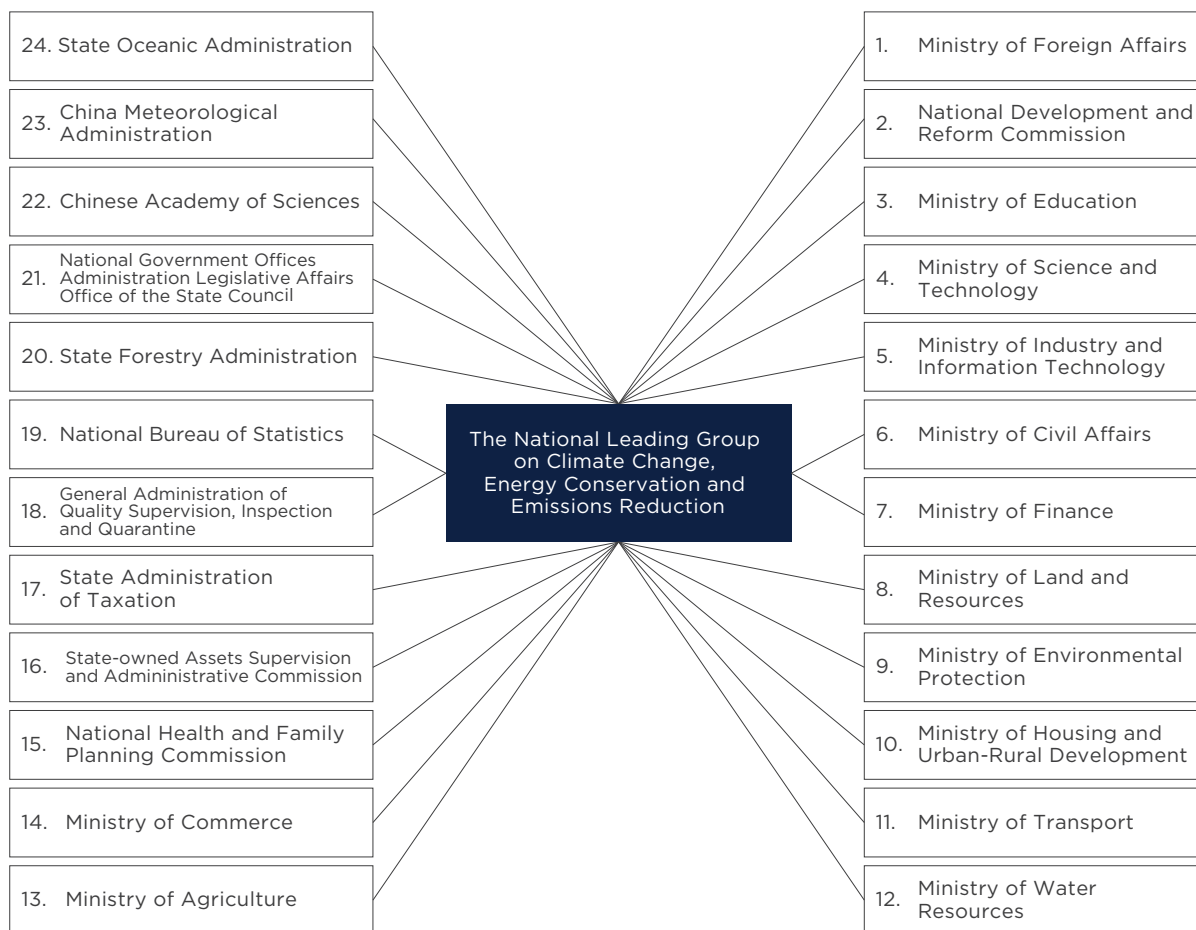
Chinese provinces play a key role in the implementation of climate policies. Under China's "target responsibility system," many of the central government's key climate and energy targets are allocated to individual provinces, with provincial leaders responsible for fulfilling them. Each province has its own Leading Group on Climate Change, chaired by top provincial leaders.¹⁰

8 See Craig Hart, Zhu Jiayan and Ying Jiahui, [Mapping China's Climate and Energy Policies](#) (December 2018) at pp.23-26; Lisa Williams, [China's Climate Change Policies: Actors and Drivers](#) Lowy Institute (July 2014); Ye Qi and Tong Wu, ["The Politics of Climate Change in China,"](#) WIREs Climate Change (June 14, 2013) at p.305.

9 Kelly Sims Gallagher and Xioawei Xuan, [Titans of the Climate](#), MIT Press (2018) at p.77; Craig Hart, Zhu Jiayan and Ying Jiahui, [Mapping China's Climate and Energy Policies](#) (December 2018) at pp.27-34.

10 People's Republic of China, [Third National Communication on Climate Change](#) (December 2018) at p.26.

Figure B-1: The National Leading Group on Climate Change, Energy Conservation and Emissions Reduction



Source: PRC, *Third National Communication on Climate Change (December 2018)*¹¹

¹¹ People's Republic of China, [Third National Communication on Climate Change](#) (December 2018) at p.26.

ACKNOWLEDGMENTS

This *Guide* is a team effort.

We are deeply grateful to the 38 external reviewers who generously took the time to read and provide expert comments on draft chapters. Cyril Cassisa, Kevin Chen, Erica Downs, Michael Eckhart, Jackson Ewing, Wei Feng, Tad Ferris, Julio Friedmann, Sam Geall, Dong Guo, David Hart, Zhuli Hess, Kevin Karl, Nina Khanna, Peter Levi, Joanna Lewis, Bo Li, Ken Lieberthal, Alvin Lin, Jiang Lin, Hongyou Lu, Scott Moore, Xueyao Pan, Kaare Sandholt, Bo Shen, Cecilia Springer, Todd Stern, Xiaopu Sun, Kevin Tu, Jennifer Turner, Yunshi Wang, Dan Wetzel, Yan Qin, Jingjing Zhang, Xiaohua Zhang, Zizhu Zhang, Nan Zhou and Erpu Zhu each brought deep substantive knowledge to their reviews and helped shape the final manuscript. We also benefited from exchanges with Yiheng Tao, Ma Yu and Ma Zhenyu. Mistakes are of course our own.

We are also deeply grateful to the Columbia University graduate students whose research assistance contributed to this *Guide*. During the past year, Baihui Lei, Yifan Li, Yishu Li, Yulin Lou, Wenjing Qin, Youyi Xu, Jiashi Yang and Ziwei Zhang each provided important support.

Special thanks to Kate Teasdale, Anna Gossett, Lisa Simpson and Darren Lingard, who played central roles in the production of this volume.

Enormous thanks to the Hewlett Foundation and Children's Investment Fund Foundation, whose generous financial support makes this *Guide* possible.

Finally, our thanks to all of you who will read this *Guide* and send comments or updates to chineseclimatepolicy@oxfordenergy.org. This is a "living document." It will be updated and modified on the [Guide to Chinese Climate Policy website](#) - chineseclimatepolicy.oxfordenergy.org. We're grateful for any and all thoughts or comments you may have.

ABOUT THE AUTHORS

LEAD AUTHOR

David Sandalow is the Inaugural Fellow at the Center on Global Energy Policy and Director of the Energy and Environment Concentration at the School of International and Public Affairs at Columbia University. He founded and directs CGEP's U.S.-China Program. Mr. Sandalow teaches a 1-2 month short course each year as a Distinguished Visiting Professor in the Schwarzman Scholars Program at Tsinghua University. He is a Distinguished Research Fellow at the Oxford Institute of Energy Studies and chairs the [ICEF Innovation Roadmap Project](#).

Mr. Sandalow has served in senior positions at the White House, State Department and U.S. Department of Energy. He came to Columbia from the U.S. Department of Energy, where he served as Under Secretary of Energy (acting) and Assistant Secretary for Policy & International Affairs. Prior to serving at DOE, Mr. Sandalow was a Senior Fellow at the Brookings Institution. He has served as Assistant Secretary of State for Oceans, Environment & Science and a Senior Director on the National Security Council staff. He is a graduate of the University of Michigan Law School and Yale College.

CO-AUTHORS

Dr Michal Meidan is Director of the China Energy Programme and Director of the Gas Research Programme at the Oxford Institute for Energy Studies. Before joining OIES in July 2019, she headed cross-commodity China research at Energy Aspects. Prior to that, she headed China Matters, an independent research consultancy providing analysis on the politics of energy in China. Michal also held senior analytical roles at Eurasia Group in New York and London, and at Asia Centre-Sciences Po, Paris. She taught undergraduate courses on China's political economy at the Hebrew University in Jerusalem and has authored numerous academic articles. Michal also regularly provides comments for a wide variety of media outlets and is featured as a speaker at industry conferences. Michal holds a PhD in Political Science and East Asian studies from Sciences Po, Paris.

Dr Philip Andrews-Speed is a Senior Research Fellow at the Oxford Institute for Energy Studies. He has 40 years in the field of energy and resources, starting his career as a mineral and oil exploration geologist before moving into the field of energy and resource governance. His main research interest has been the political economy of the low-carbon energy transition. China has been a particular focus for his research

Anders Hove is Senior Research Fellow at the Oxford Institute for Energy Studies. Prior to joining OIES, he was Project Director at GIZ for the German Federal Ministry for Economic Affairs and Climate Action (BMWK)-funded Sino-German Energy Transition Project. He worked on international energy policy cooperation in Beijing from 2010-2022 and has more than 20 years of public and private sector experience related to energy policy and markets, including

nine years on Wall Street and 12 years in China. Hove has both a Master of Science and a Bachelor of Science in Political Science from MIT, and he is a Chartered Financial Analyst. He is the author of numerous reports and articles related to the energy sector in China.

Sally Qiu is a Research Associate at the Center on Global Energy Policy, Columbia University. In this role, she supports CGEP's Inaugural Fellow David Sandalow on the research and management of the US-China Program. Her work focuses on the intersection of low-carbon transition, food systems and US-China relations. Sally has also served as an Environmental Statistics Consultant at UN Food and Agriculture Organization, where she contributed to publications and the FAOSTAT databases related to greenhouse gas emissions from the global food systems.

Prior to joining Columbia University, Sally worked at the ClimateWorks Foundation in San Francisco where she provided research and analysis on the global energy efficiency standards. Sally also interned at the UN Economic and Social Commission for Asia and the Pacific (UNESCAP) in Bangkok, Thailand, focusing on the clean energy transition in the Asia-Pacific. Sally graduated from DePauw University as a Rector Scholar, studying history and environmental geoscience. She holds a Master of Science degree in Public Policy and Management from Carnegie Mellon University, focusing on energy policy and data analytics.

Edmund Downie is a 2nd-year PhD student in the Science, Technology, and Environmental Policy program at the Princeton School of Public and International Affairs (SPIA). He studies political economy and macro energy-systems modeling in China and India, focusing on how industry-government relations will affect the low-carbon transition. Before joining SPIA, he was a non-resident fellow at the Columbia University SIPA Center on Global Energy Policy (CGEP) and a senior analyst in the energy and finance practice areas at Analysis Group in Boston. He has authored or co-authored peer-reviewed reports with CGEP and the Overseas Development Institute (ODI) as well as the *Made in China Journal*. He has also written for *the Washington Post*, *Foreign Policy*, the Center for Strategic and International Studies, *chinadialogue*, and *The Diplomat*.

Edmund was a Fulbright Scholar at Yunnan University in China (2017-18) and a Yale University Gordon Grand Fellow at the Center for Policy Research (Delhi) and the Center for Studies in International Relations and Development (Kolkata) (2014-15). He received an MPhil in International Relations at Nuffield College, Oxford as a Marshall Scholar (2017) and a B.A. in Ethics, Politics, and Economics from Yale University (2014).

PRAISE FOR *GUIDE TO CHINESE CLIMATE POLICY 2022*

“The *Guide to Chinese Climate Change Policy 2022* is an important resource for anyone interested in climate change, China or both. This deeply-researched book provides detailed information on China’s greenhouse gas emissions, energy policies, climate diplomacy and more. I recommend it to policymakers, experts and anyone interested in these important issues.”

-- Kevin Rudd, President, Asia Society and former Prime Minister, Australia

“I’ve been a reader of David Sandalow’s *Guide* for years, use it, and look forward to each edition. It is an excellent, readable, practical discussion of climate policy in a country that is indispensable to combating climate change. Sandalow is great guide, deeply knowledgeable about China and practiced in the art of climate and energy diplomacy.”

-- Todd Stern, Senior Fellow, The Brookings Institution and former US Special Climate Envoy

“David Sandalow’s *Guide to Chinese Climate Policy* is a comprehensive, fact-based, timely summary of China’s actions to address climate change. Highly recommended for anyone seeking to understand China’s efforts to achieve both near and long-term climate goals.”

-- Zou Ji, CEO and President, Energy Foundation China

“David Sandalow’s *Guide to Chinese Climate Policy 2022* brings up to date the outstanding 2019 *Guide* and adds eight chapters on pertinent topics beyond the scope of the earlier work. Like its predecessor, the 2022 *Guide* provides concise, clear, and objective explanations and summary evaluations of China’s wide-ranging, multifaceted policies to address climate change. This deeply researched expanded and updated volume is a truly wonderful resource for anyone interested in this vitally important topic.”

-- Kenneth Lieberthal, Professor Emeritus, University of Michigan

“In the global effort to protect the climate, no country matters more than China. David Sandalow, Michal Meidan, Philip Andrews-Speed, Anders Hove, Sally Qiu and Edmund Downie have compiled the definitive guide to Chinese actions—both at home and abroad. Impressive in scope and depth, their study puts a spotlight on many important signs of progress along with some challenges that are deeply worrying. China remains essential to global engagement on climate change yet, in many ways, trends in Chinese policy are getting harder for outsiders to understand. This book sheds much needed light.”

-- David Victor, Professor of Innovation and Public Policy, School of Global Policy and Strategy, UC San Diego

“In the 2022 edition of *Guide to Chinese Climate Policy* David Sandalow and his fellow authors have produced an important source for understanding the extent of the climate challenge, and China’s response. A global solution to the climate crisis must include China, and the data and analysis here makes clear how vital that participation is.”

-- Jack Lew, Chair, National Committee on US-China Relations and former Secretary, US Department of the Treasury

“David Sandalow’s *Guide to Chinese Climate Policy* provides a comprehensive and insightful overview of both the astonishing advancement and the area for further development in China as it balances economic growth, energy security, and development with climate change mitigation goals.”

-- Nan Zhou, Head, International Energy Analysis Department, Lawrence Berkeley National Laboratory

“David Sandalow has updated his *Guide to Chinese Climate Policy* for the first time in three years. He and his team of co-authors have produced a reference that -- like its predecessor volume -- is comprehensive, up-to-date and a great resource for both researchers and practitioners.”

-- Robert Stavins, A. J. Meyer Professor of Energy and Economic Development, John F. Kennedy School of Government, Harvard University

“David Sandalow’s updated *Guide to Chinese Climate Policy (2022)* offers a comprehensive and balanced overview of China’s energy and climate policies. Given the enormity and complexity of China’s policies and regulations on energy production, consumption and climate change, this Guide is essential for anyone who is interested in getting up to speed on these subjects. I have assigned it as a key resource to my students at UC Berkeley.”

-- Jiang Lin, Nat Simons Presidential Chair in China Energy Policy at the Lawrence Berkeley National Lab



THE OXFORD
INSTITUTE
FOR ENERGY
STUDIES