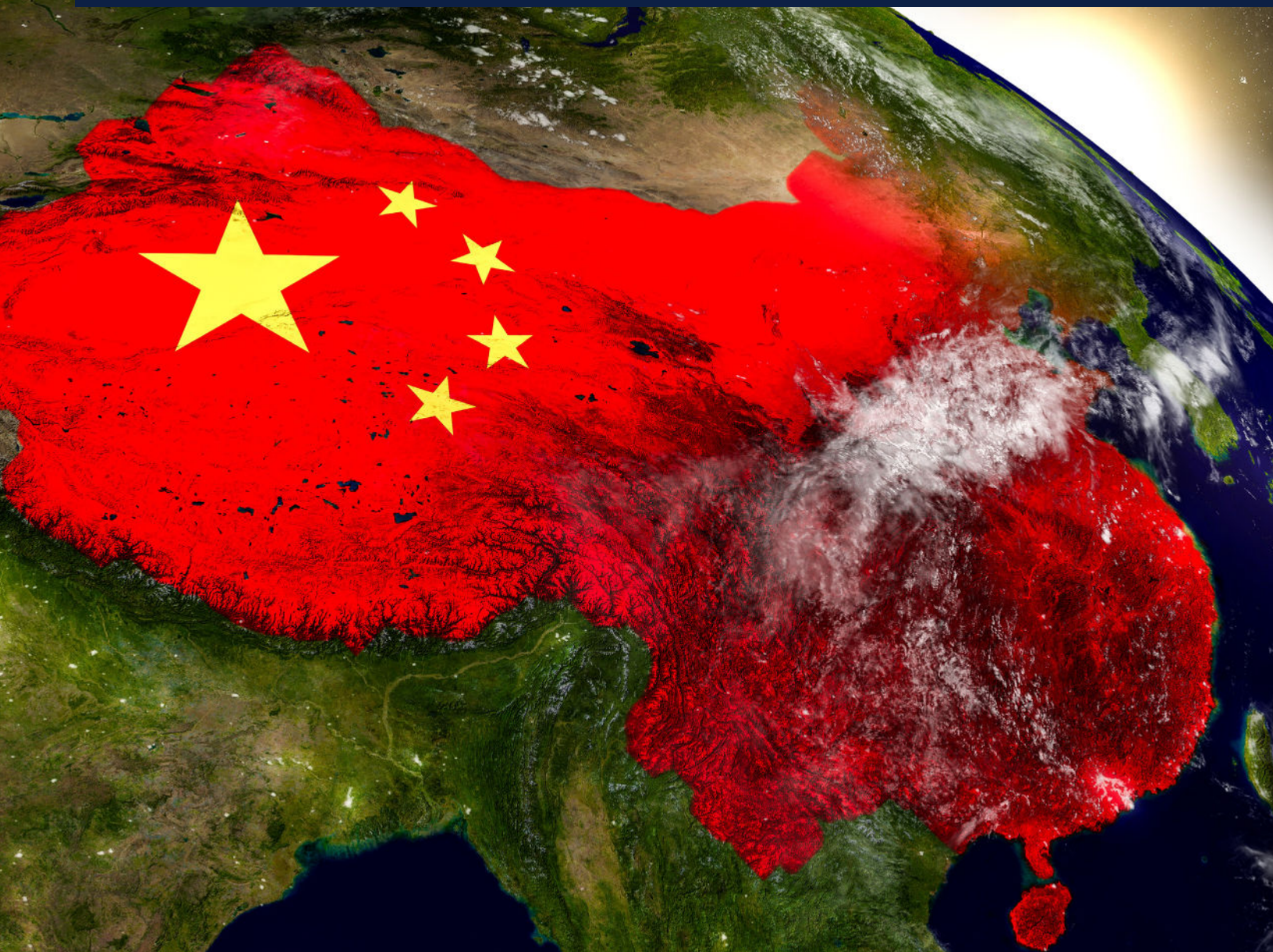
GUIDE TO CHINESE CLIMATE POLICY 2019

DAVID SANDALOW



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Center on Global Energy Policy

GUIDE TO CHINESE CLIMATE POLICY 2019

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TABLE OF CONTENTS

< BACK TO TABLE OF CONTENTS

PREFACE TO 2019 EDITION

July 2019 was the hottest month ever recorded. The Secretary General of the World Meteorological Organization said, "July has rewritten climate history, with dozens of new temperature records." Temperatures soared around the world, including in China. A prominent Chinese scientist predicted that such heat waves would become the "new normal" in the decades ahead.[1]

The first edition of the *Guide* to Chinese Climate Policy was released in July 2018 (the third hottest month ever recorded).[2] My goal was to provide an objective, factual report on climate change policies in the world's largest emitter. Since then, trends in China's response to climate change have been mixed.

On the one hand:

- In 2018, China's emissions of carbon dioxide, the leading heat-trapping gas, rose roughly 2.5%. This was the largest annual increase in five years.[3]
- In 2018, roughly 30 GW of new coal-fired power capacity was added in China (roughly 60 midsized coal plants). Capacity additions for coal-fired power plants continued at the same pace in the first half of 2019.[4]
- China's public financial institutions continued to lead the world in financing new coal-fired power plants abroad.[5]

On the other hand:

- In 2018, China again led the world in renewable power deployment, adding 43% of the world's new renewable power capacity.[6]
- In 2018, China again led the world in electric vehicle deployment. Roughly 45% of the electric cars and 99% of the electric buses in the world today are in China.[7]
- In 2018, seven of the world's nine nuclear power plants that connected to the grid for the first time were in China.[8]

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1 Brady Dennis and Andrew Freedman, "Here's how the hottest month in recorded history unfolded around the world," *Washington Post* (August 5, 2019); Matthew Walsh and Du Caicai, "Deadly Heat Waves Could Be China's 'New Normal,' Scientist Warns," *Caixin* (August 7, 2019).
2 "Another exceptional month for global average temperatures," Copernicus Climate Change Service (August 5, 2019)
3 See Chapter 1 at note 20.
4 See Chapter 8 at note 13.
5 See Chapter 20 at note 39.
6 See Chapter 9 at note 1.
7 See Chapter 13 at note 16.
8 See Chapter 10 at note 1.

- In December 2018, the Chinese delegation played an important role in helping shape a global consensus on steps to implement the Paris Agreement at the 24th Conference of the Parties to the UN Framework Convention on Climate Change (COP-24) in Katowice, Poland.[9]
- On several occasions, including in July and August 2019, China's leaders publicly reiterated their commitment to fighting climate change.[10]

Political tensions between China and the United States escalated dramatically during the past year. Challenges related to the China-US trade war focused China's leaders on economic stability and energy security. Some observers noted that climate change appeared to be a lower priority as a result. Others noted that the Chinese government has used its commitment to limiting emissions and acceptance of climate science to draw contrasts with the Trump administration, positioning itself favorably in the eyes of many around the world.

Climate change is a big topic. It involves natural systems, energy systems, financial systems, political systems and more. Not surprisingly, China's response to climate change is complicated and multifaceted. In some ways, China is a leader when it comes to fighting climate change. In other ways, China lags.

Yet this is clear: there is no solution to climate change without China. China's transition to a low-carbon economy will have far-reaching consequences not just for China but the entire world.

The 2019 edition of the *Guide to Chinese Climate Policy* provides an updated resource for anyone interested in China's response to climate change. I hope you find it useful.

9 See Chapter 19 at note 9.
10 See Chapter 3 at note 25.

INTRODUCTION

In 2018, 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. (Carbon dioxide, the leading heat-trapping gas, stays in the atmosphere for many years once emitted.)

China's leaders have declared that the impacts of climate change "pose a huge challenge to the survival and development of the human race" and that China is "one of the most vulnerable countries to the adverse impacts of climate change."[1] The Chinese government has adopted short- and medium-term goals for limiting emissions of heat-trapping gases and a wide-ranging set of policies that contribute to meeting those goals. Those policies are shaped in part by other objectives, including promoting economic growth, cutting local air pollution and developing 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, I am guided in part by international convention and in part by governments' extensive reporting on this topic. The Intended 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." The Chinese government's official documents on climate change show the same.[2]

1 People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.1; People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016) at p.1.

2 "INDCs as communicated by Parties," UN Framework Convention on Climate Change.

Several official documents are important resources for anyone interested in China's climate policies. Every year the National Development and Reform Commission (NDRC) publishes a report on *China's Policies and Actions for Addressing Climate Change*.[3] These reports provide detailed information on a range of topics. Other key sources for understanding China's climate policies include:

- *China's Intended Nationally Determined Contributions*, submitted to the UN Framework Convention on Climate Change in June 2015;[4]
- *Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan*, issued by the State Council in October 2016;[5]
- *China's First Biennial Update Report on Climate Change*, submitted to the UN Framework Convention on Climate Change in December 2016;[6]
- *China's Second Biennial Update Report on Climate Change*, submitted to the UN Framework Convention on Climate Change in December 2018;[7] and
- *China's Third National Communication on Climate Change*, submitted to the UN Framework Convention on Climate Change in December 2018.[8]

Several themes run through these documents, including strong commitments to low-carbon development, cutting coal use, scaling up clean energy sources, promoting sustainable urbanization 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 the Chinese 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

3 See NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018); NDRC, China's Policies and Actions for Addressing Climate Change (October 2017); NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016).
4 People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015).
5 State Council, "Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan" (October 27, 2016).
6 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016).
7 People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018).
8 People's Republic of China, *Third National Communication on Climate Change* (December 2018).

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 three ways:

1. by purchasing it as a book on Amazon.com
2. by visiting the *Guide to Chinese Climate Policy* website at https://chineseclimatepolicy.energypolicy.columbia.edu/, and
3. by downloading it for free from the website above or the website of Columbia University's Center on Global Energy Policy—http://energypolicy.columbia.edu/

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 regularly.

I welcome comments on and updates to the material in this *Guide*. Please send comments and updates to ChineseClimatePolicy@sipa.columbia.edu.

PART I - BACKGROUND

TERMINOLOGY

***Gt**—gigaton. One billion metric tons.*

***CO_2**—carbon dioxide.*

***CO_2e**—carbon dioxide equivalent, a measure used to compare heat-trapping gases based on their warming potential. The CO_2e value of carbon dioxide is 1.*

***Heat-trapping gases**—also commonly referred 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 (CO_2), methane (CH_4), nitrous oxide (NOx) and fluorinated gases (such as HFCs and SF_6). Of these, carbon dioxide is by far the most important, with roughly 76% of the total warming impact of these gases globally. Methane is the second most important, with roughly 16% of the warming impact, followed by nitrous oxides with 6% 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 "CO_2 equivalent" (CO_2e) is a measure used to compare heat-trapping gases based on their warming potential. One molecule of methane traps roughly 28 times more heat than a carbon dioxide molecule over a 100-year period, for example. Methane is therefore often assigned a CO_2e value of 28. One molecule of nitrous oxide traps roughly 265 times more heat than a carbon dioxide molecule over a 100-year period. Nitrous oxide is therefore often assigned a CO_2e value of 265. The leading fluorinated gases have CO_2e values in the hundreds and thousands.[2]

1 Intergovernmental Panel on Climate Change (IPCC) Working Group III, *Climate Change 2014: Mitigation of Climate Change—Summary for Policymakers (Fifth Assessment Report)* at pg.6.
2 IPCC, *Climate Change 2014: Synthesis, Fifth Assessment Report* at p.87; G. Myhre et al., Chapter 8: Anthropogenic and Natural Radiative Forcing in IPCC, *Climate Change 2013: The Physical Science Basis* at p.714.

CHAPTER 1 - CHINESE EMISSIONS OF HEAT-TRAPPING GASES

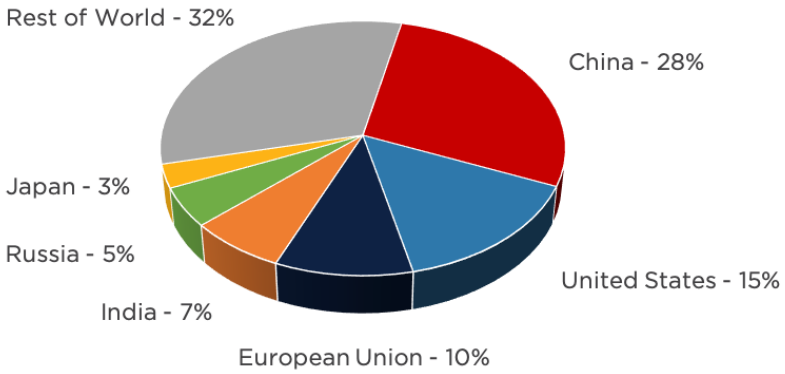
In 2018, China led the world in emissions of heat-trapping gases. Its emissions of roughly 13.5 Gt CO_2e were approximately 25% of the global total.[1]

This chapter starts by examining China's emissions of CO_2—the most important heat-trapping gas. Following sections discuss China's emissions of other heat-trapping gases, uncertainties in emissions estimates and implications of China's emissions for the global carbon budget.

A. Carbon Dioxide

In 2018, China's CO_2 emissions were roughly 11 Gt—approximately 28% of the global total. Roughly 9.5 Gt were from combustion of fossil fuels (coal, oil and gas). Most of the remainder were industrial process emissions. China's CO_2 emissions exceeded those from the United States and European Union combined.[2]

Figure 1-1: CO_2 Emissions from Fossil Fuels—2018



Source: BP Statistical Review of World Energy 2019[3]

1 J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report*, PBL Netherlands Environmental Assessment Agency (December 12, 2018) at p.23 (13.5 Gt CO_2e out of 50.9 Gt global total in 2017); Climate Action Tracker, "China country summary" (accessed July 6, 2019) (forecasting 13.1-13.2 Gt CO_2e out of 52 Gt global total based on 2017 data).

2 EC Joint Research Centre, *Fossil CO_2 emissions of all world countries* (November 2018) at pp.8, 67 (10.87 Gt CO_2 out of 37.1 global in 2017); *BP Statistical Review of World Energy 2019* (June 2019) at p.57 (9.43 Gt CO_2 out of 33.89 Gt global in 2018, fossil fuel combustion only, 2.2% increase over 2017); IEA, *Global Energy and CO_2 Status Report 2018* (March 2019) at p.3 (9.5 Gt CO_2 out of 33.1 Gt global, fossil fuel combustion only, 2.5% increase over 2017). On Chinese industrial process emissions, see Zhu Liu, "National carbon emissions from the industry process," *Applied Energy* (March 15, 2016).

3 *BP Statistical Review of World Energy 2019* (June 2019) at p.57. Roughly 90% of global CO_2 emissions are from fossil fuels (excluding emissions from land use change and forestry). See J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report*, PBL Netherlands Environmental Assessment Agency (December 12, 2018) at pp. 9–10.

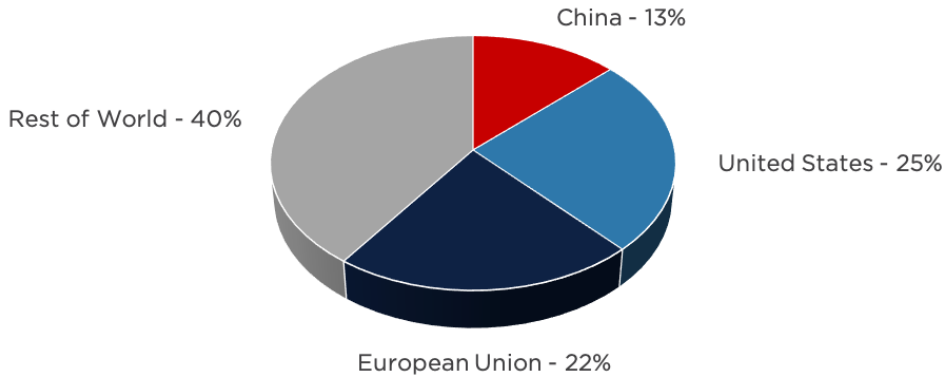
I. Emissions Metrics

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 CO_2 emissions.** Once emitted, CO_2 remains in the atmosphere for many years. According to the IPCC, more than two-thirds of a pulse of CO_2 remains in the atmosphere for several decades, and 15%–40% remains in the atmosphere for more than 1,000 years. Cumulative emissions over long time 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 13% of the CO_2 emitted globally between 1751 and 2017 came from China. Roughly 25% came from the United States and roughly 22% from Europe.[5]

Figure 1-2: Cumulative CO_2 Emissions 1751 to 2017

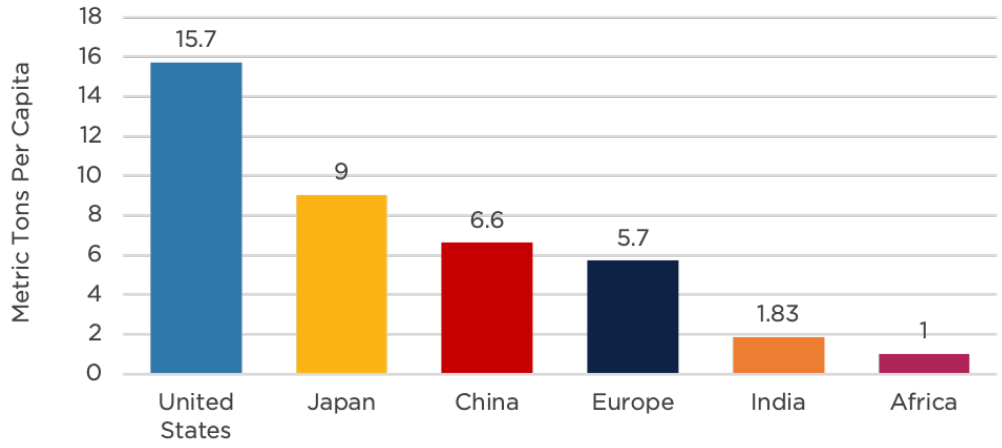


Source: Our World in Data based on CDIAC and Global Carbon Project[6]

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, "CO_2 and other Greenhouse Gas Emissions," *Our World in Data*, based on data published by the Global Carbon Project (accessed August 4, 2019) (fossil fuel and cement emissions).
6 Hannah Ritchie and Max Roser, "*CO_2 and other Greenhouse Gas Emissions*," *Our World in Data*, based on data published by the Global Carbon Project (accessed August 4, 2019) (fossil fuel and cement emissions).

b. **CO_2 emissions per capita.** In 2018, Chinese CO_2 emissions were roughly 6.6 tons per person—much less than the United States (15.7 tons per person) and less than Japan (9.0 tons per person). China emits more CO_2 per capita than Europe (5.7 tons per person) and much more than India (1.8 tons person) and Africa (1.0 ton per person).[7]

Figure 1-3: Per Capita CO_2 Emissions from Fossil Fuels—2018



Sources: BP Statistical Review of World Energy 2019 and UN Department of Economic and Social Affairs" (population data)[8]

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

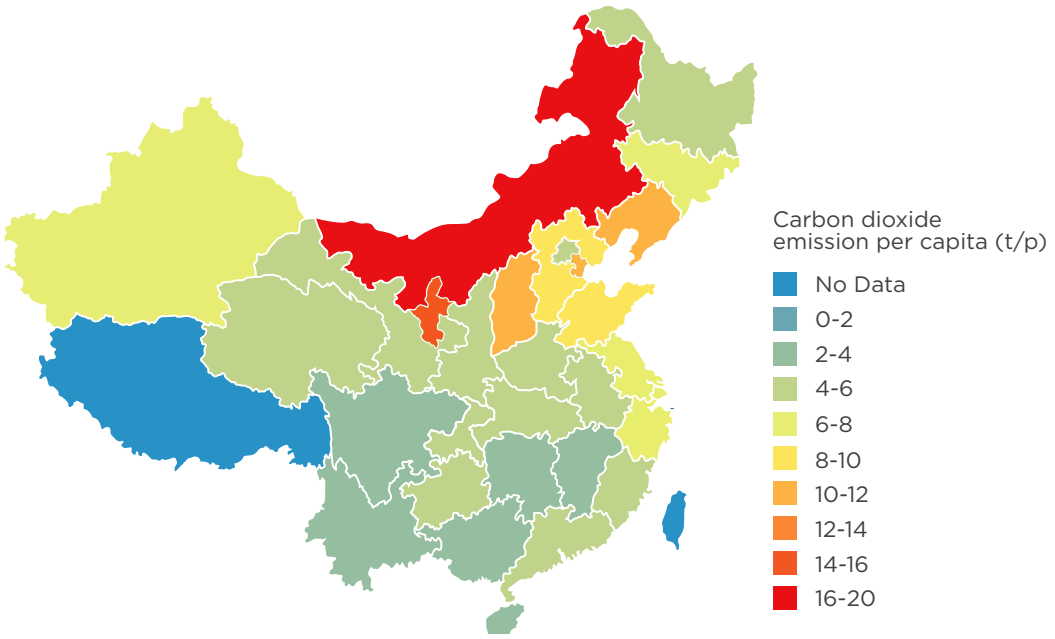
- The highest per capita emissions come from northern provinces, including Inner Mongolia, Ningxia and Shanxi. These provinces have many energy intensive industries and rely heavily on coal for power and heating. Some export electricity to other provinces.
- The lowest emissions came from southern and western provinces, including Sichuan and Jiangxi. Heating demand is less, and hydro provides a greater share of the power supply in these provinces.[9]

7 *BP Statistical Review of World Energy 2019* (June 2019) at p.57 (emissions data); United Nations Department of Economic and Social Affairs, "World Population Prospects 2019" (accessed July 7, 2019) (population data). See also Matt McGrath, "China's per capita carbon emissions overtake EU's," BBC News (September 21, 2014).
8 *BP Statistical Review of World Energy 2019* (June 2019) at p.57 (emissions data); United Nations Department of Economic and Social Affairs, "World Population Prospects 2019" (accessed July 7, 2019) (population data).
9 Zhu Liu, China's Carbon Emissions Report 2016, Belfer Center, Harvard Kennedy School (October 2016) at pp.5–10; Zhu Liu, China's Carbon Emissions Report 2015, Belfer Center, Harvard Kennedy School (May 2015) at pp.9–11.

There are also significant differences between urban and rural residents with respect to per capita emissions.

- One study found 99 Chinese cities with per capita CO_2 emissions greater than 10 tons per person (50% greater than the national average).[10]
- Another study found that Chinese urban residents emit roughly 1.4 times more energy-related CO_2 on average than Chinese rural residents.[11]
- A third study found that the wealthiest 5% of the Chinese population, almost all of whom live in cities, have carbon footprints nearly four times greater than the Chinese average.[12]

Figure 1-4: CO_2 emissions per capita in 2012

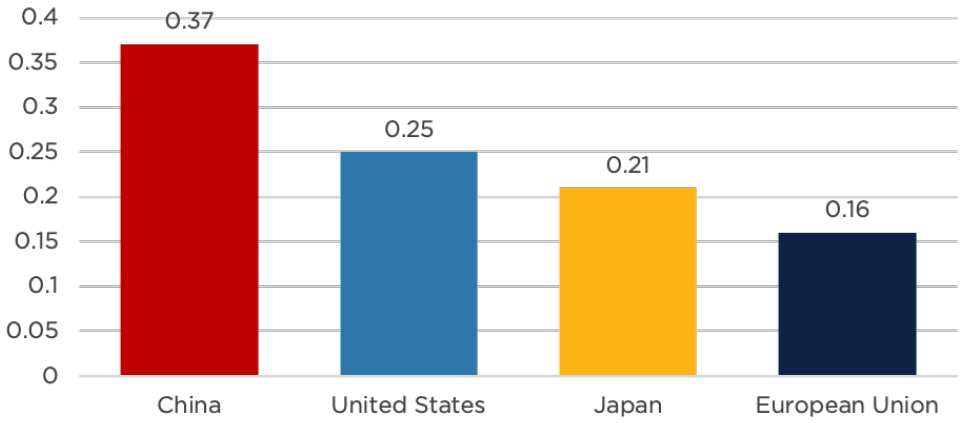


Source: Zhu Liu, China's Carbon Emissions Report 2016[13]

10 Zhu Liu and Bofeng Cai, *High-resolution Carbon Emissions Data for Chinese Cities* (June 2018) at p.9.
11 Stephanie Ohshita, Lynn K. Price, Nan Zhou, Nina Khanna, David Fridley and Xu Liu, *The Role of Chinese Cities in Greenhouse Gas Emission Reduction* (September 2015) at p.4.
12 Dominik Wiedenhofer, et al., "Unequal household carbon footprints in China," *Nature Climate Change* (December 19, 2016).
13 Zhu Liu, "China's Carbon Emissions Report 2016," Belfer Center for Science and International Affairs, Harvard Kennedy School (October 2016) at p.9.

c. **CO_2 emissions per unit of GDP (carbon intensity).** In 2018, China emitted roughly 0.37 kg of CO_2 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 government policies, structural shifts in the Chinese economy (from manufacturing to services) and other factors. However China's carbon intensity remains high in comparison with other major economies, including the United States (0.25), Japan (0.21) and the European Union (0.16).[14]

Figure 1-5: Carbon Intensity 2018



Carbon Intensity = kg CO_2 from fossil fuels per $GDP PPP

Sources: BP Statistical Review of World Energy 2019; IMF, "GDP, current prices, purchasing power parity" (GDP data)[15]

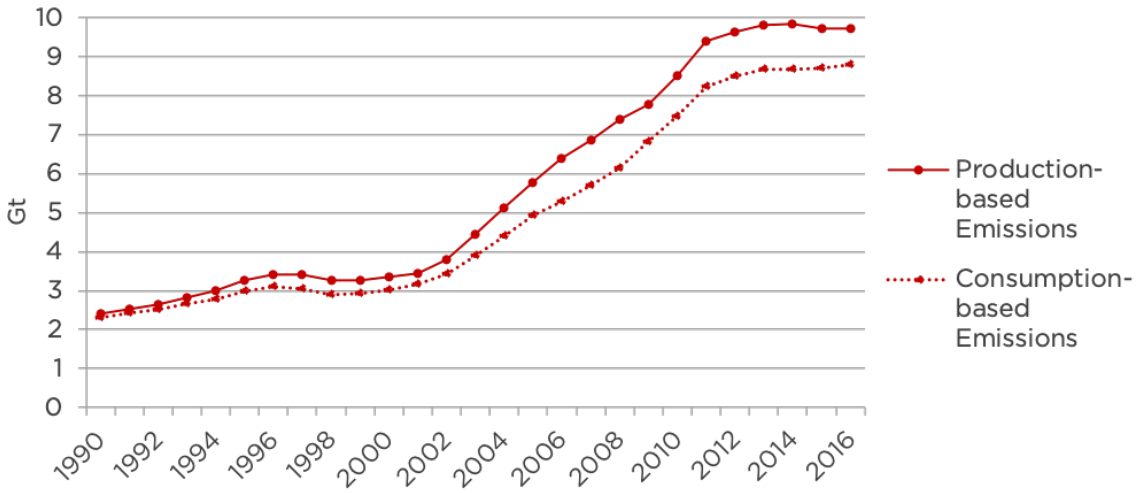
14 BP Statistical Review of World Energy 2019 (June 2019) at p.57 (emissions data, fossil fuels); International Monetary Fund, "GDP, current prices, purchasing power parity," *IMF Data Mapper* (accessed July 7, 2019) (GDP data).
15 BP Statistical Review of World Energy 2019 (June 2019) at p.57 (emissions data, fossil fuels); International Monetary Fund, "GDP, current prices, purchasing power parity," *IMF Data Mapper* (accessed July 7, 2019) (GDP data).

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 exports are produced in carbon-intensive manufacturing processes. As a result, a consumption-based emissions accounting system reduces China's CO_2 emissions totals as compared to traditional territorial emissions accounting.

In a consumption-based emissions accounting system, China was responsible for roughly 25% of global CO_2 emissions in 2016, according to one leading study. The United States was responsible for roughly 16%, the EU 12% and India 6%. Consumption-based emissions accounting reduces China's annual CO_2 emissions by roughly 14% as compared to traditional territorial emissions accounting.[16]

Figure 1-6: Production v. Consumption-Based CO_2 Emissions - China 1990-2016



Sources: Our World in Data; Corinne Le Quéré et al., Global Carbon Budget 2018.[17]

16 Corinne Le Quéré et al., Global Carbon Budget 2018 at section 3.3.1 and accompanying data tables. See also OECD, "Carbon dioxide emissions embodied in international trade" (April 2019 update); Hannah Ritchie and Max Roser, "CO_2 and other Greenhouse Gas Emissions," *Our World in Data* (accessed July 6, 2019); Zeke Hausfather, "Mapped: The world's largest CO_2 importers and exporters," Carbon Brief (July 5, 2017).

17 Hannah Ritchie and Max Roser, "CO_2 and other Greenhouse Gas Emissions," *Our World in Data*; Corinne Le Quéré et al., Global Carbon Budget 2018 at section 3.3.1 and accompanying data tables.

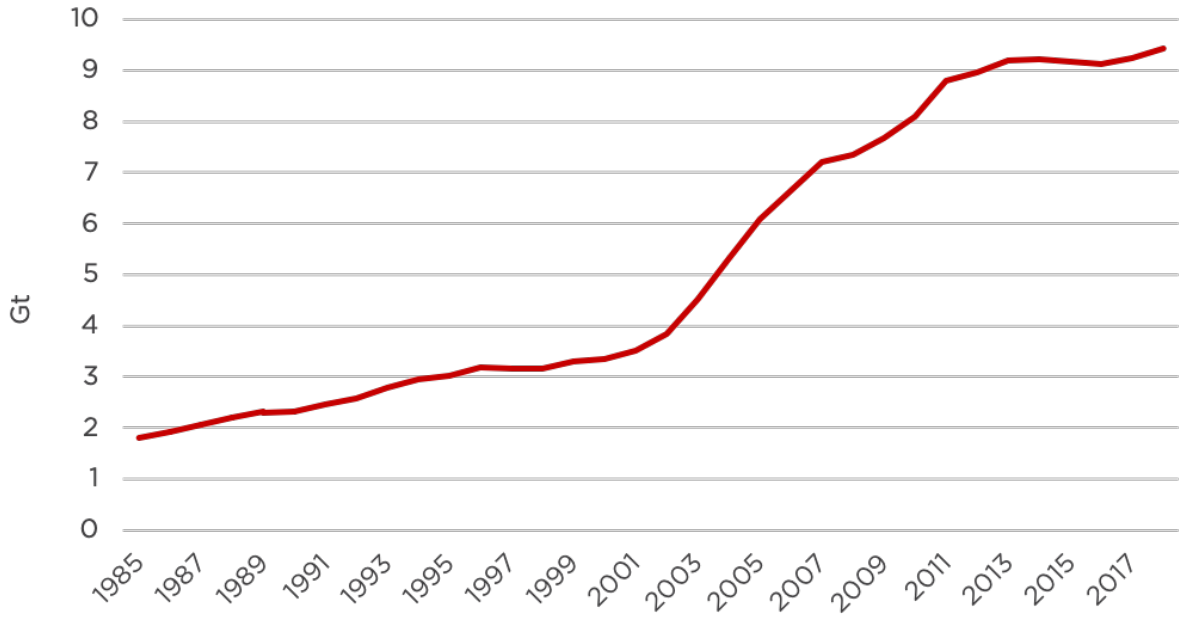
II. Emissions Growth

China's CO_2 emissions have been rising for most of the past 40 years.[18]

- In 1980, China's CO_2 emissions were less than 1.5 Gt. Per capita emissions were roughly the same as in Bhutan and North Korea today.[19]
- Between 1980 and 2000, China's CO_2 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 CO_2 emissions shot up roughly 9.5% per year, reflecting the country's extraordinary economic growth during this period. Chinese CO_2 emissions nearly tripled in 12 years. This period included the largest decadal CO_2 emissions growth of any country in history, by far.
- Between 2013 and 2016, China's CO_2 emissions held roughly steady. During several years in this period, according to some estimates, CO_2 emissions declined. The plateau in China's CO_2 emissions from 2013–2016 was the result of a number 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 (vii) greater hydropower generation due to significant rainfall in several years.[20]
- In 2017 and 2018, China's CO_2 emissions began climbing again. Emissions rose roughly 1.5% in 2017 and 2.5% in 2018, according to leading estimates. 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.[21]

18 For historic data on Chinese emissions, see World Bank, Data-CO_2 Emissions-China and sources in Figure 1-10 below.
19 World Bank, Data-China; World Bank, Data-Bhutan, World Bank, Data-Korea, Dem. People's Rep. (accessed August 31, 2019).
20 See Jan Korsbakken and Glen Peters, "A Closer Look at China's Stalled Carbon Emissions," Carbon Brief (March 1, 2017).
21 IEA, CO_2 Emissions from Fuel Combustion (2017); *BP Statistical Review of World Energy 2019* (June 2019) at pp.3, 4, 57; Jan Ivar Korsbakken, Robbie Andrew and Glen Peters, "China's CO_2 emissions grew less than expected in 2017," *Carbon Brief* (March 8, 2018).

Figure 1-7: China's CO_2 Emissions from Fossil Fuels (Gt)—1985–2018



Sources: IEA, CO_2 Emissions from Fuel Combustion (2017); BP Statistical Review of World Energy 2019[22]

22 IEA, CO_2 Emissions from Fuel Combustion (2017); *BP Statistical Review of World Energy 2019* (June 2019) at p.57.

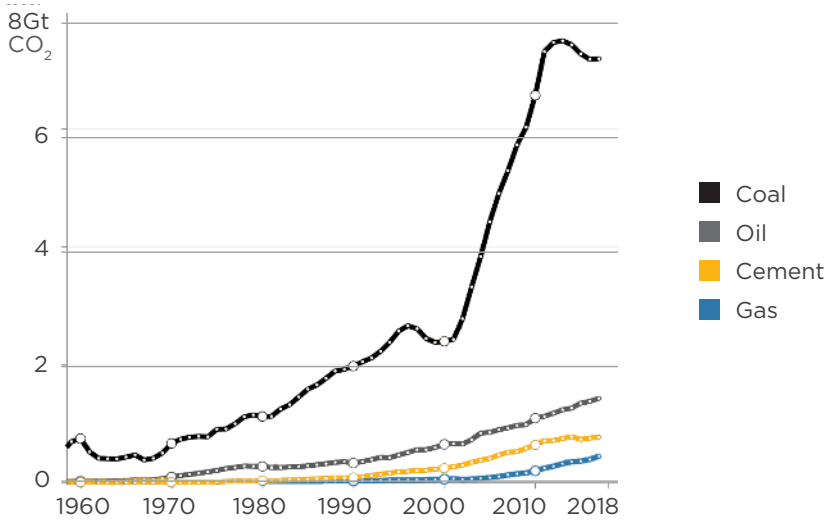
III. Emissions by Sector and Source

Roughly 50% of Chinese CO_2 emissions are from the industrial sector, 40% are from the power sector and 8% are from the transport sector. This sectoral composition of emissions is very different than in most developed countries. In the United States, for example, roughly 22% of heat-trapping gas emissions come from the industrial sector, 28% from the power sector and 29% from the transport sector.[23]

Coal combustion is by far the leading source of heat-trapping gas emissions in China, with roughly 7.5 Gt in 2018.[24]

Land use change and forestry in China are net sinks (meaning they absorb more CO_2 than they release). The most recent 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 CO_2 (roughly 6% of CO_2 emissions) in 2012 and 1,150 Mt CO_2 (roughly 11% of CO_2 emissions) in 2014. The first estimate is from China's *First Biennial Update Report* (December 2016) and the second estimate is from China's *Second Biennial Update Report* (December 2018). The reasons for the difference between the two figures are not clear.[25]

Figure 1-8: China's CO_2 Emissions by Fuel Type 1960–2018



Source: Corinne Le Quéré et al., Global Carbon Budget 2018[26]

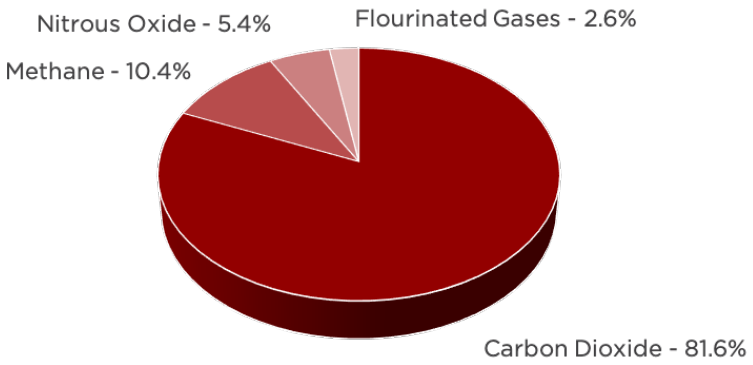
23 People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.19; US EPA, "Sources of Greenhouse Gas Emissions" (accessed July 9, 2019) (2017 data).
24 Corinne Le Quéré et al., *Global Carbon Budget 2018* at slide 34.
25 People's Republic of China, *Second Biennial 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.
26 Corinne Le Quéré et al., *Global Carbon Budget 2018* at slide 34.

B. Other Gases

China is the world's leading emitter of heat-trapping gases other than carbon dioxide. In 2018, such emissions were roughly 2.5Gt CO_2e—about one-fifth of total Chinese emissions. (Data with respect to these other heat-trapping gases are not as good or current as data with respect to CO_2, making precise estimates difficult.)[27]

After CO_2, the most significant heat-trapping gas is methane. Recent estimates of Chinese methane emissions range from just over 1 Gt to 1.75 Gt CO_2e per year (roughly 10%–15% of China's annual emissions of heat-trapping gases). A study released in early 2019 found significant increases in Chinese methane emissions in the past decade. Methane emissions in China come from coal mining, rice farming, waste disposal, livestock production and leakage during production and distribution of natural gas, among other sources.[28]

Figure 1-9: China's Heat-Trapping Emissions by Gas (CO_2e) 2016



Source: People's Republic of China, "Second Biennial Update Report on Climate Change" (December 2018)[29]

27 J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report* (PBL Netherlands Environmental Assessment Agency, December 12, 2018) at pp.38, 42 (2.6 out of 13.5 Gt CO_2e total in 2017); People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.16 (2.0 out of 12.3 Gt CO_2e total in 2014); Jiang Lin et al., "Non-CO_2 Mitigation Pathways for China: Preliminary Results," China Energy Group, Lawrence Berkeley National Laboratory (June 2018).

28 J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report* (PBL Netherlands Environmental Assessment Agency, December 12, 2018) at p.43 (1,740 Gt CO_2e in 2017); People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.16 (1.16 Gt CO_2e in 2014, using a 100-year GWP of 21. If the same data were reported using the 100-year GWP of 28 adopted in the IPCC's Fifth Assessment Report, the value would 1.55 Gt CO_2e in 2014); World Bank Data, "Table 3.9: Trends in Greenhouse Gas Emissions" (1.75 Gt CO_2e in 2012); Scot Miller et al., "China's coal mine methane regulations have not curbed growing emissions," *Nature Communications* (January 29, 2019).

29 *Second Biennial Update Report on Climate Change* (December 2018) at p.16.

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 CO_2. One recent study estimated HFC emissions of 113 Mt CO_2e (1.0% of total emissions) in China in 2013. The Chinese government's *Second Biennial Update Report* to the UNFCCC estimated HFC emissions of 214 Mt CO_2e (1.9% of total emissions) in China in 2014.[30]

In May 2019, *Nature* published a study that found evidence of illegal production of CFCs in Shandong and Hebei. (CFCs are a banned ozone-depleting chemical with a global warming potential more than 4,600 times greater per molecule than CO_2.) In a statement, the Chinese Ministry of Ecology and Environment raised questions about the study findings but stressed its determination and commitment to stopping any illegal CFC production.[31]

30 Xuekun Fang et al., "Hydrofluorocarbon (HFC) Emissions in China: An Inventory for 2005–2013 and Projections to 2050," *Environmental Science & Technology* (2016) at 2030 at p. 2030; People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.16.

31 M. Rigby et al., "Increase in CFC-11 emissions from eastern China based on atmospheric observations," *Nature* (May 22, 2019); James Griffiths, "Spike in banned ozone-eating CFC gases linked to China in new research," CNN.com (May 25, 2019).

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 the past decade, those systems are not as developed or transparent as such systems in many industrialized countries. In addition, some Chinese data may have systematic reporting biases. Provincial economic and energy data may reflect promotion criteria for provincial officials, which have traditionally weighted hitting GDP targets heavily. China's National Bureau of Statistics has revised its estimates of coal consumption and other energy data several times in the past few years, with significant implications for emissions estimates.[32]

Analysis of these topics in the peer-reviewed literature has grown in recent years.

- In 2012, a paper in *Nature* found a 1.4 Gt gap between China's CO_2 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 CO_2 emissions from Japan.[33]
- In 2015, a paper in *Nature* concluded that previous estimates of Chinese carbon dioxide emissions may have been overstated by roughly 10%, due mainly to errors estimating emissions factors for Chinese coal.[34]
- A 2015 *Science* article highlighted China's unique method for estimating percentages of nonfossil energy.[35]
- A 2016 *Nature* paper raised questions about previous estimates of a drop in Chinese coal use and related reductions in emissions.[36]
- A 2018 *Nature* article found uncertainties in China's 2015 emissions estimates of −16% to 25% at a 97.5% confidence level.[37]

Improving climate data systems 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. The State Council's *Work Plan for Controlling Greenhouse Gas Emissions*

32 See Jan Ivar Korsbakken, Robbie Andrew and Glen Peters, "China's CO_2 emissions grew slower than expected 2018," *Carbon Brief* (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 Means Everything and Nothing," *Newsweek* (May 24, 2016).
33 Dabo Guan et al., "The Gigatonne Gap in China's Carbon Dioxide Inventories," *Nature Climate Change* (2012) pp.672–675.
34 Zhu Liu et al., "Reduced carbon emission estimates from fossil fuel combustion and cement production in China," *Nature* (August 20, 2015) at p.2.
35 Joanna Lewis et al., "Understanding China's non-fossil energy targets," *Science* (November 27, 2015).
36 Jan Ivar Korsbakken et al., "Uncertainties around reductions in China's coal use and CO_2 emissions" (February 16, 2016) at p.1.
37 Yuli Shan et al., "China CO_2 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.

in the 13th Five-Year Plan (October 2016) directs 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." The Chinese government's *First Biennial Update Report* and NDRC's *China's Policies and Actions for Addressing Climate Change* (2016) explain the work underway in these areas in some detail.[38]

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.[39]
- 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.[40]
- Among the organizations that publish information on Chinese emissions are the International Energy Agency, EC Joint Research Centre, BP, Climate Action Tracker, Global Carbon Project, PBL Netherlands Environmental Assessment Agency, Lawrence Berkeley National Laboratory's China Energy Group, Climate Watch (a partnership managed by World Resources Institute) and Enerdata. Estimates from these organizations vary in scope.
  - PBL Netherlands Environmental Assessment Agency and Climate Action Tracker publish estimates of emissions of all heat-trapping gases.[41]
  - The EC Joint Research Center's Emissions Database for Global Atmospheric Research (EDGAR) publishes estimates of CO_2 emissions from fossil fuel combustion and industrial processes (including the manufacture of cement, steel and chemicals).[42]
  - The Global Carbon Project publishes estimates of CO_2 emissions from fossil fuel combustion and the cement industry.[43]
  - The International Energy Agency and BP publish estimates of CO_2 emissions from fossil fuel combustion.[44]

38 State Council, "Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan" (October 27, 2016); PRC, "First Biennial Update Report" (December 2016) at pp.97–108; NDRC, "China's Policies and Actions for Addressing Climate Change" (2017) at pp.51–54.
39 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016); People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018).
40 See National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2018* (February 28, 2019); China Electricity Council—Data/Statistics; China Energy Portal.
41 J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report*, PBL Netherlands Environmental Assessment; *Climate Action Tracker—China.*
42 EC Joint Research Centre, *Fossil CO_2 emissions of all world countries* (November 2018).
43 Corinne Le Quéré, Global Carbon Budget (December 12, 2018).
44 IEA, *Global Energy and CO_2 Status Report 2018* (March 2019); *BP Statistical Review of World Energy 2019* (June 2019).

The table below summarizes recent emissions estimates by some leading organizations.

Figure 1-10: Chinese Emissions of Heat-Trapping Gases (Gt)

Data Source	2012	2013	2014	2015	2016	2017	2018
All Gases							
PRC, Biennial Update Reports[45] *(excluding sequestration from land use change and forestry) (CO_2e)*	11.89	--	12.30	--	--	--	--
PRC, Biennial Update Reports[46] (including sequestration from land use change and forestry) (CO_2e)	11.32	--	11.19	--	--	--	--
PBL Netherlands[47] (CO_2e)	--	--	13.3	13.3	13.4	13.5	--
Climate Action Tracker[48] *(all gases) (CO_2e)*	12.22	12.66	12.66	12.70	12.75	13.04	--
CO_2 from Fossil Fuels and Industrial Processes							
EC Joint Research Center[49]	9.97	--	10.55	10.46	10.43	10.88	--
CO_2 from Fossil Fuels and Cement							
Global Carbon Project[50]	9.64	9.80	9.83	9.72	9.71	9.84	--
CO_2 from Fossil Fuels							
International Energy Agency[51]	8.67	9.04	9.08	9.15	9.10	9.17	9.48
BP[52]	8.99	9.24	9.22	9.18	9.12	9.23	9.43
Enerdata[53]	8.75	9.17	9.08	9.06	9.00	9.18	9.47

45 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016) at p.22; People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.16.
46 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016); People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018).
47 J. Olivier and J. Peters, *Trends in Global CO_2 and Total Greenhouse Gas Emissions: 2018 Report*, PBL Netherlands Environmental Assessment at p.23.
48 Climate Action Tracker—China.
49 EC Joint Research Centre, *Fossil CO_2 emissions of all world countries* (November 2018) at p.67; EC Joint Research Centre, *Fossil CO_2 emissions of all world countries* (November 2017).
50 Corinne Le Quéré, *Global Carbon Budget* (December 12, 2018) (2018 National Emissions Excel file)
51 IEA, *Global Energy and CO_2 Status Report 2018* (March 2019); IEA, *CO_2 Emissions from Fuel Combustion* (2018) at p.82; IEA, *CO_2 Emissions from Fuel Combustion* (2017)
52 *BP Statistical Review of World Energy 2019* (June 2019).
53 Enerdata, *Global Energy Statistical Yearbook 2019-China* (accessed August 10, 2019)

D. Chinese Emissions and the Carbon Budget

In the Paris Agreement, more than 185 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" (Article 2.1.a). According to the Intergovernmental Panel on Climate Change, cumulative global CO_2 emissions in the decades ahead must be less than (i) roughly 1170 Gt, to have a 66% or greater chance of meeting the 2°C (3.6°F) goal, and (ii) roughly 420 Gt, to have a 66% or greater chance of meeting the 1.5°C (2.7°F) goal.[54]

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 CO_2 at its current pace of 11 Gt per year, it alone will use up roughly one-third of the global 2°C carbon budget by 2050 and one-third of the global 1.5°C carbon budget by 2032. If China's CO_2 emissions increase in the years ahead, as they did in 2017 and 2018, these goals become even harder to reach.

Of course, industrialized countries emitted far more CO_2 than China during the past century. (CO_2 stays in the atmosphere for many years once emitted.) Industrialized countries are responsible for most of the human-caused CO_2 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, Chinese emissions will have a big impact on the world's ability to meet agreed climate goals.

54 IPCC, *Special Report: Global Warming of 1.5°C—Chapter 2: Mitigation Pathways Compatible with 1.5°C in the Context of Sustainable Development* at p.108.

CHAPTER 2 - IMPACTS OF CLIMATE CHANGE IN CHINA

"China is among those countries that are most severely affected by the adverse impacts of climate change."— *China's Intended Nationally Determined Contributions* (June 2015)[1]

A. China's Vulnerability to Climate Change

China is acutely vulnerable to climate change. China's *Third National Assessment Report on Climate Change*—released in November 2015—found that China faces significant threats from sea level rise, severe weather events, glacier melt and more as heat-trapping gases accumulate in the atmosphere. The 900-page report—based on work by more than 500 experts at China's Ministry of Science and Technology (MOST), the China Meteorological Administration (CMA), Chinese Academy of Sciences (CAS), Chinese Academy of Engineering (CAE) and leading universities—found that the average temperatures in China have increased 0.9°–1.5°C (1.6°–2.7°F) in the past century, which is more than the global average.[2]

China's vulnerability to sea level rise is especially acute. More than 550 million people live in China's coastal provinces—one of the most densely populated regions on Earth. Tens of millions of people live or work in low-lying areas in major Chinese cities, including Shanghai, Qingdao and Xiamen. The *Third National Assessment Report* found that sea levels off eastern China rose 93 millimeters (3.5 inches) between 1980 and 2012. It found that

- sea levels could rise 40–60 centimeters (16–24 inches) above 20th-century averages 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.

Several recent studies have reached similar results, suggesting the risk of even greater sea level rise unless global emissions of heat-trapping gases drop sharply in the decades ahead. The *Third National Assessment Report* found that rising seas will significantly increase risks of

1 People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.2.

2 Liu Zhenhe, "Main Conclusions of China's 3rd National Assessment on Climate Change," *360doc.com* (January 13, 2016); Wang Jing, <第三次气候变化国家评估报告> 发布 [China's Third National Assessment on Climate Change Released] ScienceNet.cn (November 22, 2015); Bing Wang et al., "Comprehensive analysis on China's National Climate Change Assessment Reports," *Frontiers of Engineering Management* (March 2019). A 2019 study by the China Meteorological Administration found that annual average temperatures in China increased 0.24°C (0.43°F) per decade between 1951 and 2018—also more than the global average. See "China's surface temperature shows a clear upward trend," *People's Daily* (April 11, 2019).

flooding and storm damage along China's coasts.[3]

China is also vulnerable to droughts, heavy rains and heat waves. The *Third National Assessment Report* found that climate change would increase all three. 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.[4]

Melting glaciers will also create challenges for China. The *Third National Assessment Report* found that China's glaciers shrank 10% between the 1970s and early 2000s and are likely to shrink more in the decades ahead. It highlighted potential geopolitical risks from disputes with South Asian neighbors over transboundary water resources and smaller river flows caused by shrinking glaciers.[5]

A 2018 study found that China is especially vulnerable to river flooding as a result of climate change. The authors note that costs could be felt throughout global supply chains, many of which depend on goods shipped on China's rivers, and estimate that without adaptation measures economic damage from river flooding in China could increase 80% in the next 20 years.[6]

B. Recent Extreme Weather Events

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.[7] Other heat records have been broken in China in recent years:

- In July 2018, 24 weather stations across China recorded their highest temperatures ever.[8]
- On July 20, 2017, Shanghai had its hottest day ever, with the temperature reaching 40.9°C (105°F).[9]

3 Liu Zhenhe, "Main Conclusions of China's 3rd National Assessment on Climate Change," *360doc.com* (January 13, 2016); Ying Qu et al., "Coastal Sea level rise around the China Seas," *Global and Planetary Change* (January 2019); Hu Yiwei, "Why Sea Level Rise is a Big Deal for China," *CGTN* (June 8, 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); National Bureau of Statistics, "Tabulation on the 2010 Population Census of The PRC" (2010).

4 Liu Zhenhe, "Main Conclusions of China's 3rd National Assessment on Climate Change," *360doc.com* (January 13, 2016); 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).

5 Liu Zhenhe, "Main Conclusions of China's 3rd National Assessment on Climate Change," *360doc.com* (January 13, 2016); Chris Buckley, "Chinese Report on Climate Change Depicts Somber Scenarios," *New York Times* (November 29, 2015); Greenpeace, "Melting Earth: Glacier Retreat and its Impacts in China's Cryosphere" (November 20, 2018).

6 Potsdam Institute for Climate Impact Research (PIK), "China floods to hit US economy: Climate effects through trade chains," *ScienceDaily* (May 28, 2018).

7 "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* (July 29, 2015).

8 Hou Liqiang, "July sees record in temperatures," *China Daily* (August 3, 2019).

9 "Hottest day ever in Shanghai as heat wave bakes China," *Phys.org* (July 21, 2017).

- 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.[10]

Heavy rainfall events in China are increasing in frequency and severity.

- 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.[11]
- A 2016 study found that heavy rain days have increased 10% while light rain days have decreased 13% since 1961.[12]
- Another 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."[13]
- In July 2012, the heaviest rainfall in 60 years hit Beijing, leaving 37 people dead.[14]
- In July 2007, the worst rainstorms in 115 years hit Chongqing, causing dozens of deaths and extensive property damage.[15]

Droughts have also been a problem:

- In 2017, parts of Inner Mongolia experienced the worst drought on record.
- In 2016, drought days in northeastern China were 37% above average.
- 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).[16]

(The combination of more heavy rainfall events and more droughts is one likely result of a warming atmosphere, according to climate scientists.)[17]

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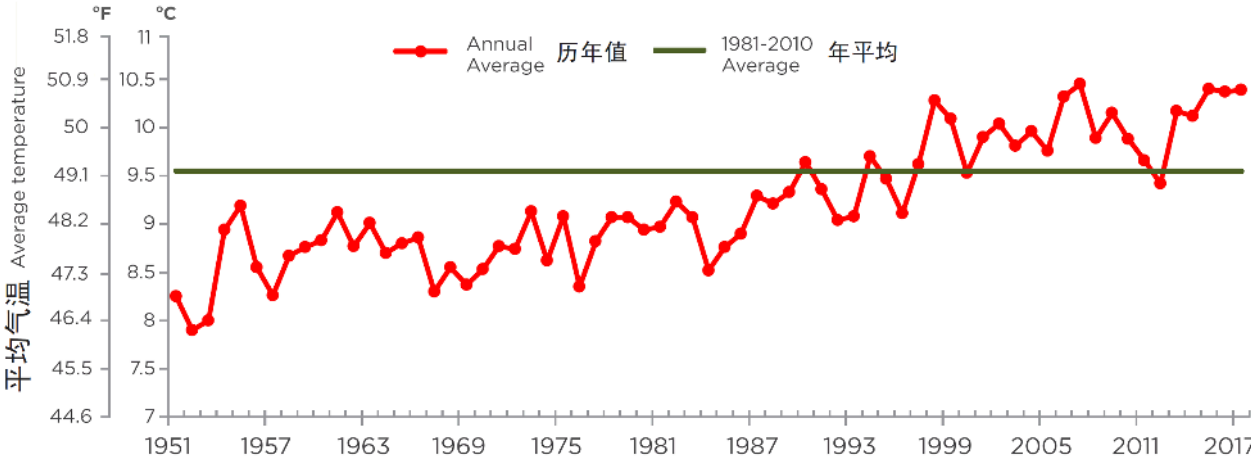
10 "China endures worst heat wave in 140 years," *USA Today* (August 1, 2013); "China's surface temperature shows a clear upward trend," *People's Daily* (April 11, 2019).
11 Li You, "Fall Semester Delayed at 120 Schools in Flood-Ravaged City," *Sixth Tone* (September 5, 2018).
12 China Meteorological Administration, "Global warming has changed pattern of warming in China," (February 17, 2017).
13 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).
14 "Beijing chaos after record floods in Chinese capital," BBC (July 2012).
15 "Rainstorms kill 32 in Chongqing," *China Daily* (July 18, 2007).
16 China Meteorological Administration, "Global warming has changed pattern of warming in China," (February 17, 2017); "Droughts in China," *Facts and Details* (March 29, 2010); Edward Wong, "Northern China suffering from worst drought on record, officials say," *Today China and India* (July 1, 2017).
17 John Schwartz, "More Floods and More Droughts: Climate Change Delivers Both," *New York Times* (December 12, 2018).

In 2018, flooding and debris from glacial melt led to the evacuation of thousands of people in two incidents in western China.[18]

Figure 2-1: Average Annual Temperatures (China 1951–2017)



Source: China Meteorological Administration[19]

18 Greenpeace, Melting Earth: Glacier Retreat and its Impacts in China's Cryosphere (November 20, 2018).
19 China Meteorological Administration, *China Climate Bulletin*, 中国气候公报 (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 text on "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).

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. It began actively participating in Clean Development Mechanism (CDM) projects in the years that followed. 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 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.

- 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); 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," *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 China had become the world's leading greenhouse gas emitter the prior year.[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 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

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 CO_2 emitter," *Guardian* (June 19, 2007).
9 NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2008)
10 Yana Jin, Henrik Andersson and Shiqui Zhang, "Air Pollution Control Policies in China," *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).

participated. Later that year, NDRC announced that five provinces and eight municipalities 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 the seriousness with which 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 to include 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:

- 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 CO_2 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]

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 Emissions 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.

- In 2013, the Chinese government released its first *National Climate Change Adaptation Plan*.[18]
- 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 agreement 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 next 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. President Xi Jinping participated in the opening ceremony, declaring climate change "a shared mission of all mankind" and joining 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. (The announcement by US President Donald Trump that the United States would withdraw from the Paris Agreement did not change that position.)

18 NDRC, "National Climate Change Adaptation Plan" (2013).
19 NDRC, "China's 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); Shannon Tiezzi, "China Celebrates Paris Climate Change Deal" (December 15, 2015).

- In January 2017, President Xi Jinping described the Paris Agreement as 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]

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 in July 2019.[25]

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); Michael Swaine, "Chinese Attitudes Toward the U.S. Withdrawal from the Paris Accords," *China Leadership Monitor* (September 11, 2017).
25 "Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction," *Chinese Government Network* (July 11, 2019); "China to continue efforts to tackle climate change: Premier Li," *Xinhua* (July 12, 2019); Ministry of Ecology and Environment August regular press conference record (August 30, 2019); Ministry of Ecology and Environment August regular press conference record (August 30, 2019).

PART II - DOMESTIC POLICIES

CHAPTER 4 - CLIMATE GOALS

The Chinese government has announced four principal climate goals:

- to achieve the peaking of carbon dioxide emissions around 2030, making best efforts to peak early;
- to lower carbon dioxide emissions per unit of GDP by 60%–65% from the 2005 level by 2030;
- to increase the share of nonfossil fuels in primary energy to around 20% by 2030; and
- to increase the forest stock volume by around 4.5 billion cubic meters from 2005 levels by 2030.

These goals were highlighted in the Intended Nationally Determined Contribution (INDC) China submitted to the UN Framework Convention on Climate Change in June 2015, as well as in other official documents.[1]

The first goal—to achieve peak emissions around 2030 and make best efforts to peak early—was announced by President Xi Jinping in November 2014 at a summit with US President Barack Obama in Beijing. The pledge made headlines around the world, in part because of the setting, in part because the United States jointly announced its own post-2020 climate target in parallel and in part because it was the first time the Chinese government had committed to absolute limits on CO_2 emissions.[2] There is now a considerable literature on China's prospects for meeting that goal, with many analysts projecting that China is likely to achieve peak emissions several years at least before 2030.[3]

The second goal—to lower carbon dioxide emissions per unit of GDP ("carbon intensity") by 60%–65% from the 2005 level by 2030—builds on a similar pledge for 2020 announced by Premier Wen Jiabao just before the Copenhagen climate conference in 2009. That pledge made headlines, in part because it was the first time the Chinese government had committed to limit CO_2 emissions. NDRC reports that as of 2017, China's carbon intensity has declined by

1 People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.5.

2 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, reduce coal's role in the Chinese economy and cut CO_2 emissions per unit of GDP in 2020 and other years before 2030. 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, "FactCheck: 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).

3 See, e.g., 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 CO_2 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); Qilin Liu et al., "China's energy revolution strategy into 2030," *Resources, Conservation and Recycling* (January 2018); Ye Qi et al., "China's post-coal growth," *Nature Geoscience* (2016) at pp.564–566.

approximately 46% as compared to 2005 levels.[4]

The third goal—to increase the share of nonfossil fuels in primary energy to around 20% by 2030—was also announced at the November 2014 Beijing summit with President Obama. In light of China's size and projected economic growth, this goal implies a very substantial increase in renewable and nuclear power generation in the next decade. An influential 2015 paper projected that 900 GW of new renewable and nuclear capacity (almost equal to the entire power generating capacity of the United States) would be required to meet this goal. NDRC reports that 13.8% of China's primary energy came from nonfossil fuels in 2017.[5]

The fourth goal—to increase the forest stock volume by around 4.5 billion cubic meters from 2005 levels by 2030—also builds on a pledge made by Premier Wen Jiabao just before the Copenhagen climate conference. 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. The 2030 pledge implies an increase in forest cover of about 2–4 times the size of the United Kingdom. In July 2019, Premier Li Keqiang announced that China had met this goal (11 years ahead of schedule).[6]

All these goals are implemented through a policy infrastructure that includes Five-Year Plans, guidance documents and regulations issued by relevant ministries, and financial support provided through diverse channels. One common tool is to allocate targets to provinces. After Premier Wen Jiabao's 2009 announcement that China would cut CO_2 emissions per unit of GDP 40%–45% from the 2005 level by 2020, for example, that goal was incorporated into the 12th Five-Year Plan (2011–2015) and a number of specific planning documents under the 12th Five-Year Plan. NDRC then allocated subgoals to individual provinces, giving each province a specific target.

NDRC and the National Bureau of Statistics report annually on progress toward these goals and related indicators.[7]

In addition to these principal goals, the Chinese government sets a number of intermediate or secondary goals related to climate change. For example, in its *Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan* (October 2016), the State Council calls for CO_2 emissions per unit of GDP to be 18% lower than 2015 levels by 2020.[8]

Many Chinese provinces and localities have committed to climate goals as well. At least 23

4 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.

5 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.

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

7 See, e.g.,NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018) at p.16. See also National Bureau of Statistics, "Statistical Bulletin on National Economic and Social Development in 2018" (February 28, 2019) at part XII.

8 State Council, *Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan* (October 27, 2016).

provinces and cities have committed to peaking CO_2 emissions before 2030 as part of China's Alliance of Pioneer Peaking Cities. The city of Wuhan has a *Carbon Emissions Action Plan* with a commitment to peak CO_2 emissions by 2022.[9]

9 Wee Kean Fong, "23 Chinese Cities Commit to Peak Carbon Emissions by 2030," World Resources Institute (June 8, 2016); "Mega-City Wuhan Issues Carbon Peaking Plan With Emissions Cap," EF China News (February 10, 2018)

CHAPTER 5 - URBAN AIR POLLUTION

Background

Severe air pollution chokes many Chinese cities. Soot and smog levels exceed national and international health standards, often greatly.

Extreme air pollution events have been common, especially in the winter. A long period of especially severe air pollution in the winter of 2013 gained widespread attention and was labeled an "airpocalypse." Similar incidents occurred in the years that followed. In January 2017 the Chinese government issued a national red alert for air pollution after dozens of cities across north and central China experienced smog so severe it caused widespread school closings and flight cancellations.[1]

During the fall and winter of 2017–18, air pollution in Beijing and dozens of other Chinese cities dropped dramatically.

- In the fourth quarter of 2017, PM2.5 concentrations in dozens of cities across northern China fell by a third as compared to the same period the year before.[2]
- In January 2018, PM2.5 concentrations in Beijing fell 71% from the previous year, meeting China's national air quality standard for the first time.[3]

The decline in air pollution levels continued during the rest of 2018, although at a slower pace. (Average PM2.5 levels in 338 of China's largest cities fell 9.3% in 2018.) In the first half of 2019, air pollution levels in China's largest cities were on average roughly the same as the year before.[4]

Air pollution remains a serious problem across much of China. Air quality in many Chinese cities is substantially worse than in US and European cities and often fails to meet international health standards.[5]

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;[6]
- roughly 500 million residents of northern China have lost more than 2.5 billion years

1 See Kristin Aunan, Mette Halskov Hansen and Shuxiao Wang, "Air Pollution in China," *China Quarterly* (2017).
2 "How China Cut Its Air Pollution," *The Economist* (January 25, 2018); Lauri Myllyvirta, "Beijing Region Sees Record Breaking Drop in Winter Air Pollution," *Unearthed* (December 12, 2017).
3 Shanghaiist, *Beijing Meets National Air Quality Standards for the First Time* (February 8, 2018).
4 Jennifer Pak, "Beijing declares dramatic success in fight against air pollution," *NPR Marketplace* (May 8, 2019); "China warns of blanket restrictions in new round of environmental inspection," *Xinhua* (July 9, 2019).
5 European Environment Agency, "Air Quality in Europe—2017 Report" (2017) at pp.34–36; US Environmental Protection Agency, "Particulate Matter (PM 2.5) Trends" (accessed June 10, 2018); *US Environmental Protection Agency*, "What Are the Air Quality Standards for PM 2.5" (accessed June 10, 2018); Nick Van Mead, "Cities with the Most Dangerous Air," *Guardian* (February 13, 2017).
6 Robert A. Rohde and Richard A. Muller, "Air Pollution in China: Mapping of Concentrations and Sources," PLOS ONE (August 2015).

of life expectancy due to air pollution from coal burning;[7]

- almost 100 million people in China suffer from chronic obstructive pulmonary disease, and air pollution is one of the biggest causes;[8]
- deaths from cardiovascular and pulmonary disease in 272 Chinese cities are closely related to PM2.5 levels in those cities;[9] and
- PM2.5 and ozone emissions from six sectors in China cause roughly 1.1 million premature deaths and cost approximately RMB267 billion (roughly $38 billion) per year.[10]

Air pollution is a top concern of many Chinese citizens. In a 2015 national survey, 76% of respondents said that air pollution is a "big problem" and 35% of respondents said it is 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.[11]

The principal cause of Chinese air pollution is coal combustion (for industrial processes, space heating and power generation). Vehicle exhaust—especially from diesel freight trucks—also plays an important and growing role. The air quality improvements in northern China since 2017 are due mainly to widespread conversion of coal-fired furnaces and boilers to natural gas.[12]

7 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).
8 Liwen Fang et al., "Chronic Obstructive Pulmonary Disease in China: a Nationwide Prevalence Study," *Lancet Respiratory Medicine* (June 2018).
9 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," ScienceDirect (November 2017); Lei Zhao et al., "Association Between Air Pollution and Cardiovascular Mortality in China," *Oncotarget* (September 12, 2017).
10 Yefy Gu et al., "Impacts of sectoral emissions in China and the implications," *Environmental Research Letters* (July 2018)
11 See also the Associated Press, "As Income 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); George Gao, "As Smog Hangs Over Beijing, Chinese Cite Air Pollution As Major Concern," Pew Research Center (December 2015).
12 "How China Cut Its Air Pollution," *Economist* (January 25, 2018); Lauri Myllyvirta, "Beijing Region Sees Record Breaking Drop in Winter Air Pollution," Unearthed (December 12, 2017); Shanghaiist, "Beijing Meets National Air Quality Standards for the First Time" (February 8, 2018); Paul Kishimoto et al., "The Impact of Coordinated Policies on Air Pollution Emissions from Road Transportation in China," *Science Direct* (July 2017); Mark Dwortzan, "Tackling Air Pollution in China," MIT News (May 2017); Qi Deng and Huazun Yu, "北京PM2.5来源机动车等移动源成最大头" [Motor Vehicles Account for Majority of Beijing's PM 2.5 Pollution], *Beijing News* (May 14, 2018).

Air Pollution Policies

Cutting air pollution is a priority of Chinese leaders. President Xi Jinping promises to "make China's skies blue again" and has spoken about the war against pollution in high-profile settings including the 19th Party Congress in October 2017 and 13th National People's Congress in March 2018. He identifies cutting pollution as one of three priority "tough battles" for China in the years ahead. (The other two are eliminating poverty and reducing financial risks.) Premier Li Keqiang has also spoken about air pollution often. In September 2013, he declared that China would use "iron fists" to combat pollution.[13]

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.[14]

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 targets in three key regions (Beijing-Tianjin-Hebei, Yangtze River Delta and Pearl River Delta). It described "10 tasks" for cleaning the air:

1. Increase efforts in comprehensive control and reduce the emission of multi-pollutants.
2. Optimize the industrial structure and promote industrial restructuring.
3. Accelerate technology transformation and improve the capability to innovate.
4. Adjust the energy structure and increase the clean energy supply.
5. Strengthen environmental thresholds and optimize industrial layout.
6. Better play the role of market mechanism and improve environmental economic policies.
7. Improve the law and regulation system. Carry on supervision and management based on the law.

13 *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] (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" (March 2017).

14 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."

8. Establish a regional coordination mechanism and integrated regional environmental management.

9. Establish a monitoring and warning system. Cope with pollution episodes.

10. Clarify the responsibilities of the government, enterprise and society. Mobilize public participation.[15]

From this general guidance, many specific policies and actions have emerged. Measures to control coal burning have been a top priority. They include a ban on new coal-fired power capacity, improved SO_2 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. (See poster below.)

Other changes include greater incentives for local officials to prioritize air quality, better air pollution monitoring, larger penalties and stricter enforcement. In 2014, Chinese authorities brought roughly 2,000 criminal cases for environmental violations—double the number from the past 10 years combined. In November 2016, more than 1100 Chinese officials were held accountable for violations of air pollution laws.[16]

China's 13th Five-Year Plan (2016–2020) gives priority to fighting air pollution. In addition to limits on coal consumption, the plan sets quantitative goals for air pollution reduction and air quality, including a 15% cut in SO_2 and NO_X levels and a requirement that all cities meet air quality standards at least 80% of the time. Monitoring capabilities are enhanced dramatically, and each province is required to share air quality information regularly. Targets are set for deployment of hydro, wind, solar and nuclear power.[17]

During 2017, strict policies with respect to coal burning, industrial activities and traffic were announced for the Beijing-Tianjin-Hebei area. These helped produce the 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.[18]

15 China's State Council, "National Action Plan on Prevention and Control of Air Pollution" (2013).
16 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] (June 2015); Christopher Beam, "China Tries a New Tactic to Combat Pollution: Transparency," *New Yorker* (February 2015).
17 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).
18 P., "How China Cut Its Air Pollution" (January 25, 2018); Damien Sharkov, "China Issues First National Smog Red Alert," *Newsweek* (2017).

In May 2018, the Ministry of Ecology and Environment (MEE) reported that all 45 key tasks identified in the 2013 Action Plan on Prevention and Control of Air Pollution had been completed on schedule. MEE reported that:

- between 2013 and 2017, the average concentration of PM10 in prefecture-level cities fell 22.7%; and
- 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 in 27.7% in the Pearl River Delta.[19]

In June 2018, the State Council issued its *Three-Year Action Plan for Blue Sky Defense*. According to the plan, its goals are:

> over three years efforts, the total load of main air pollutants will have been significantly reduced, along with less greenhouse gas emissions, and the concentration of fine particular matters will have been notably lowered down, which will have led to much less days with heavy air pollution, remarkably improved air quality, and much greater sense of happiness for the people from the sight of blue skies.[20]

The plan calls for measures to "strictly control the production capacity of resource-intensive and highly-polluting industries," promote clean heating, cut pollution from vehicles (including in particular heavy trucks, grow forests and much more.

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 gases.

So do policies that promote energy efficiency. Policies that promote energy efficiency in Chinese industry, vehicles and buildings all have dual benefits, helping fight both local air pollution and climate change.[21]

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.

- Natural gas produces roughly half the carbon dioxide (CO_2) emissions of coal per unit of energy. Converting China's vast coal-based heating and power infrastructure

19 Ministry of Ecology and Environment, "Circular on the Final Assessment of the Implementation Plan of the Air Pollution Prevention Action Plan" (May 17, 2018).
20 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] (June 27, 2018); "The State Council rolls out a three-year action plan for clean air," Ministry of Ecology and Environment (July 13, 2018).
21 See Mark Dwortzan, "Tackling Air Pollution in China," MIT News (May 2017).

to natural gas would significantly reduce Chinese CO_2 emissions.[22]

- 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, that cancels the climate change benefits of switching from coal to natural gas.[23]
- In addition, new natural gas infrastructure such as pipelines and receiving terminals will likely last for decades. That infrastructure could slow the transition to even cleaner energy sources. There may be a trade-off between the CO_2 emissions reductions natural gas can deliver by displacing coal today and the CO_2 emissions reductions natural gas could delay by slowing deployment of renewables and nuclear power in future years.[24]

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. There is a debate among experts about the extent to which electric vehicles help mitigate CO_2 emissions in China, since those vehicles increase power demand from China's coal-heavy electric grid. Some studies have found little if any short-term climate benefit from electric vehicles as a result of this. Others have found modest benefits. In the long run, as China's grid transitions from coal to low-carbon power sources, electric vehicles will have important climate benefits for China and be essential to "deep decarbonization" strategies.[25]

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 generally increase CO_2 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 significantly increases CO_2 emissions. Policies to

22 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).

23 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 greenhouse 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.

24 See Dave Roberts, "More natural gas isn't a "middle ground"—it's a climate disaster," *Vox* (May 30, 2019)

25 See, e.g., IEA, "Global EV Outlook 2019" at p.51; Qiao Qinyu et al., "Cradle-to-gate greenhouse gas emissions of battery electric and internal combustion engine vehicles in China," *Applied Energy* (May 10, 2017); Qian Zhang et al., "Electric Vehicle Market Penetration and Impacts on Energy Consumption and CO_2 Emission in the Future: Beijing Case," *Energies* (2017); Xinyu Chen et al., "Impacts of Fleet Types and Charging Modes for Electric Vehicles on Emissions Under Different Penetrations of Wind Power," *Nature Energy* (May 2018), 10.1038/s41560-018-0133-0; Leah Burrows, "Environmental Impact of Electric Vehicles in China? It Depends on How They Are Charged," Harvard University (May 2018); Charles Clover, "Pollution Studies Cast Doubt on China's Electric-car Policies," *Financial Times* (May 2018).

promote synthetic natural gas are counterproductive when it comes to China's climate goals.[26]

Figure 5-1: Beijing's Air Pollution Every Day for a Year

Source: Zou Yi (November 2014)[27]

26 Haijun Zhao, Weichun Ma, Hongjia Dong and Ping Jiang, "Analysis of Co-Effects on Air Pollutants and CO_2 Emissions Generated by End-of-Pipe Measures of Pollution Control in China's Coal-Fired Power Plants," *Sustainability* (2017). See discussion in Chapter 12 of this *Guide*.

27 "Man Took the Exact Same Picture Every Day for a Year to Highlight Beijing's Air Pollution," *PetaPixel* (November 14, 2014).

CHAPTER 6 - EMISSIONS TRADING

Emissions trading programs for carbon dioxide (CO_2) are currently operating in eight Chinese cities and provinces. The Chinese central government is in the process of launching a national CO_2 emissions trading program, starting with the power sector. When fully implemented in the 2020s, the national program is expected to cover more than 5 Gt of annual emissions—by far the largest emissions trading program in the world. The extent to which these programs will be an important factor in reducing China's emissions of heat-trapping gases remains to be determined.[1]

History

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, NDRC authorized Chinese companies to participate in the Clean Development Mechanism (CDM), an international emissions trading program for CO_2 and other heat-trapping gases run by the UN Framework Convention on Climate Change. China soon became the world's biggest supplier of CDM credits, with more than half the world's CDM projects.[2]

In 2011, the Chinese government announced plans to develop a domestic CO_2 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. (See discussion of these pilot programs below.)[3]

As these pilot programs were being launched, Chinese experts conducted extensive research on how best to design emissions trading programs, often drawing on experiences in other countries around the world. Chinese experts began working with experts from California, the European Union and other jurisdictions. Thousands of Chinese emissions trading specialists received training in these programs. Several of these programs continue today.[4]

In 2014, NDRC's Energy Research Institute released a detailed study of emissions trading program design options. The study recommended taking up to 10 years to build "a nationwide

1 See generally Noah Kaufman and Jonathan Elkind, "Can CO_2 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 CO_2 Trading System?" (January 7, 2018); David Roberts, "China is methodically building the world's most ambitious carbon market," Vox (December 27, 2017).

2 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 SO_2 emissions trading, see Wang Jinnan et al., *SO_2 Emissions Trading Program: A Feasibility Study for China* (December 2001).

3 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).

4 "California highlights cooperation with China in combating climate change," Xinhua News (June 6, 2019); "EU and China: strengthening ties between the world's largest emission trading systems in 2017," European Commission-Climate Action (October 21, 2016); EU-China Emissions Trading System.

market with valid functions, completed structures and smooth operations."[5] Also in 2014, 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]

In September 2015, President Xi Jinping announced that the Chinese government would launch a national CO_2 emissions trading program by the end of 2017. The announcement was made three months before the Paris climate conference, at a summit meeting with US President Barack Obama.[7]

National Carbon Trading Program

In December 2017, NDRC released its National Carbon Market Development Plan (Power Generation Sector).[8] The document sets forth a three-phase plan:

- Phase 1 ("Basic Infrastructure Establishment"): "Take approximately one year to build unified national systems for emissions data reporting, registration and allowance trading."
- Phase 2 ("Simulated Operation"): "Take approximately one year to 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."

Power sector entities that emit more than 26,000 tons per year of CO_2 are subject to the plan. CO_2 emissions from these entities are roughly 3 Gt per year. (The largest emissions trading program in the world today, run by the European Union, covers approximately 1.7 Gt per year of CO_2.)[9]

Once the emissions trading program is operational, covered entities will be required to surrender allowances each year to match their emissions. Entities will be allowed to sell surplus allowances and buy allowances to cover any shortfall. Entities that fail to surrender sufficient allowances will be subject to penalties.[10]

5 See Yande Dai, Yanbing Kang and Xiaoping Xiong, "碳交易制度研究" [Carbon Trading System Research], Energy Research Institute, NDRC (May 2014) at section 5.3.
6 NDRC, "碳排放权交易管理暂行办法" [Interim Measures for Managing the Carbon Emission Trading Rights] (December 10, 2014).
7 Julie Hirschfeld Davis and Coral Davenport, "China to Announce Cap-and-Trade Program to Limit Emissions," *New York Times* (September 2015).
8 NDRC, "Program for the establishment of a national carbon emissions trading market (power generation industry)" (December 18, 2017).
9 Frank Jotzo et al., "China's emissions trading takes steps towards big ambitions," *Nature Climate Change* (April 3, 2018); "Emissions trading: emissions have decreased by 3.9% in 2018," *European Commission-Climate Action* (April 6, 2019).
10 See generally Maosheng Duan, Shaozhou Qi and Libo Wu (2018) "Designing China's national carbon emissions trading system in a transitional period," *Climate Policy* (September 2018).

Implementation of China's CO_2 emissions trading program is proceeding slowly. Delays are due in part to the March 2018 government-wide reorganization, in which responsibility for the emissions trading program was transferred from NDRC to the new Ministry of Ecology and Environment (MEE). Delays are also due to data availability and collection challenges. Nevertheless MEE officials insist they will meet the 2020 deadline for full launch of the program and carry out trades between power plants in 2020.[11]

In April 2019, MEE released *Interim Regulations on the Management of Carbon Emissions Trading (Draft for Comment)*. The draft:

- says MEE will regularly publish lists of covered entities and reports on allowance transfers,
- discusses the relationship between central and provincial governments in administering emissions trading, and
- confirms that allowance auctions may be held to stabilize the market.[12]

One issue not addressed by MEE to date is the level of CO_2 emissions that will be allowed. According to press reporting and much commentary, Chinese officials have said that emissions caps will be output based (meaning that as the output of covered entities grows, their emissions caps will grow as well). *The National Carbon Market Development Plan and Interim Regulations* are silent on this topic.[13]

Pilot Programs Today

China's eight pilot CO_2 emissions trading programs remain in operation, covering provinces and cities with a total of more than 250 million people. Allowance prices are reported daily.[14]

These pilot programs have several common features. Each is administered by a municipal or provincial government and imposes obligations directly on covered entities. Most allocate allowances to covered entities for free. (Guangdong's program uses auctions). Most cover CO_2 only. (Chongqing's program includes other heat-trapping gases).

The programs have a range of differences.

- Coverage varies (in terms of both types and sizes of businesses).
- Methods for determining allowance allocations vary. (In some pilots, allocations are

11 "China Is Dawdling on Carbon Trading," *Bloomberg* (May 7, 2019); "China expects first trade in national emissions scheme in 2020," *Reuters* (March 30, 2019); "China admits it still has work to do before carbon trading scheme gets up and running," *South China Morning Post* (November 26, 2018).
12 Ministry of Ecology and Environment, *Interim Regulations on the Management of Carbon Emissions Trading (Draft for Comment)* (April 3, 2019); "China releases draft Interim Regulations on the Management of Carbon Emissions Trading," *International Carbon Action Partnership* (accessed July 21, 2019).
13 See Nectar Gan, "Will China's carbon trading scheme work without an emissions cap?," *South China Morning Post* (January 3, 2018).
14 See, e.g., *Carbon Pulse*.

based on historical emissions, while in others allocations are based on historical emissions intensity.)

- Compliance rules vary. In Beijing, fines are three to five times the average market price of an allowance over the past six months for each shortfall allowance. In other pilots, noncomplying businesses are penalized mainly by receiving fewer allowances in the following year.[15]

As of July 2019, 337 million tons of CO_2 with a value of more than RMB 7.3 billion (roughly US$1 billion) have been traded under these pilot programs. Prices ranged from RMB 71.8 to RMB 87.5 (US$10.50 to US$12.50) per ton.[16]

In 2018 a leading Chinese expert group released an assessment of these pilot programs. The expert group found liquidity in the seven pilots to be very low, with transactions accounting for a low percentage of the overall quotas, and that information disclosure needs to be improved. The group found that, in terms of emissions reductions, the Hubei pilot performed best, with Guangdong and Shenzhen close behind.[17]

According to NDRC's *China National Carbon Market Development Plan* (December 2017), these programs "shall continue to perform their existing roles and gradually transition to a national carbon market when conditions allow."[18]

15 Zhe Deng et al., "Effectiveness of pilot carbon emissions trading systems in China," *Climate Policy* (February 2018); "Looking at the results of the 7 emissions trading pilots," *China Economic Herald* (February 2, 2018); ZhongXiang Zhang, "Carbon Emissions Trading in China: The Evolution from Pilots to a Nationwide Scheme," Australian National University (April 2015) at p.113; Clayton Munnings, Richard Morgenstern, Zhongmin Wang and Xu Liu, "Assessing the Design of Three Pilot Programs for Carbon Trading in China," (Resources For The Future, October 2014) at p.36.

16 "China carbon trading hits 337 mln tonnes by June," Xinhua (July 11, 2019).

17 "Looking at the results of the 7 emissions trading pilots," *China Economic Herald* (February 2, 2018).

18 NDRC, "Program for the establishment of a national carbon emissions trading market (power generation industry)" (December 18, 2017) at section 7.

CHAPTER 7 - ENERGY EFFICIENCY

"Policies put in place by the [Chinese] government to improve efficiency have been one of the most important factors in limiting the growth of energy-related CO_2 emissions anywhere in the world over the past decade."—*IEA Energy Efficiency Market Report 2016.*[1]

Background

China's economy is energy intensive. In 2018, only 11 countries in the world used more energy per unit of GDP than China. China used 82% more energy per unit of GDP than Germany, 66% more than Japan, 59% more than India and 15% more than the United States.[2]

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.[3]

The energy intensity of the Chinese economy has improved dramatically in the past several decades. According to the World Bank, between 1980 and 2010, China's GDP increased by 18 times while Chinese energy consumption increased by only five times. During this period, the energy intensity of the Chinese economy per unit of GDP fell roughly 70%. Except for several years between 2001 and 2005 when energy intensity increased, gains have been steady. Energy intensity improvements have been especially strong in recent years (3%–6% annually).[4]

The steady improvement in China's energy intensity has been caused by (i) energy efficiency gains as a result of technological improvements, policy mandates or both, and (ii) structural shifts in the Chinese economy (in particular from manufacturing to services). According to the International Energy Agency (IEA), energy efficiency gains have been by far the most important, although structural changes in the economy are expected to play a greater role in the years ahead.[5]

China's energy efficiency gains have had an enormous impact on emissions of heat-trapping gases. According to IEA, energy efficiency improvements since 2000 reduced China's 2017

1 IEA, *Energy Efficiency Market Report* (2016) at pp.47–48.
2 *BP Statistical Review of World Energy 2019* (June 2019) at p.8 (primary energy consumption); International Monetary Fund, "GDP, current prices, purchasing power parity," *IMF Data Mapper* (accessed August 16, 2019) (GDP data); Enerdata, *Global Energy Statistical Yearbook 2019-China* (accessed August 16, 2019).
3 On energy efficiency in China generally, see 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).
4 World Bank, *Bringing China's Energy Efficiency Experience to the World: Knowledge Exchange with Asian Countries* (June 27, 2014); IEA, *Energy Efficiency Market Report* (2016) at pp.38, 41; NDRC, *China's Policies and Actions for Addressing Climate Change* (2016) at pp.16–17; "China becomes more efficient, cleaner in energy use" Xinhua News (January 30, 2017); National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2017* (February 28, 2018).
5 IEA, *Energy Efficiency Market Report* (2016) at p.43.

emissions by nearly 1.2 Gt CO_2e (roughly equal to Japan's 2017 emissions).[6]

Policies

In 2017, more than 60% of China's energy use was covered by mandatory energy efficiency policies—more than any other nation in the world.[7]

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 (for the period 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 (for the period 2011–2015) contained a mandatory national target to reduce energy intensity 16% below 2010 levels by 2015.[8]

China's current Five-Year Plan continues in this tradition. The 13th Five-Year Plan (for the period 2016–2020) contains a mandatory national target to reduce energy intensity 15% below 2015 levels by 2020.[9]

These targets are implemented through four main policy tools: (1) annual goals, (2) provincial targets, (3) government spending and (4) regulations and standards.

- Annual goals. The Five-Year Plan targets for energy intensity are supplemented with specific annual goals. In March 2017, for example, NDRC announced a goal of reducing the energy intensity of the Chinese economy by 3.4% during 2017. (In February 2018, the National Bureau of Statistics reported that energy intensity had fallen by 3.7% during 2017.)[10]

- 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 vary from a 17% improvement (for eight provinces, including Beijing, Shanghai and Guangdong) to 10% (for Xinjiang, Tibet and Qinghai). The process of allocating energy intensity targets is overseen by NDRC and reflected in plans issued by the state council. NDRC and other ministries monitor progress toward meeting these targets, releasing quarterly reports on the results. Those results are used to evaluate the job performance of provincial officials and included

6 IEA, *Energy Efficiency 2018* at p.145.
7 IEA, *Energy Efficiency 2018* at p.147.
8 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, 国务院关于印发节能减排"十二五"规划的通知" [Energy Conservation and Emission Reduction 12th Five-Year Plan] (2012).
9 See 中华人民共和国国民经济和社会发展第十三个五年规划纲要 [Outline of 13th Five-year Plan for National Economic and Social Development], (March 17, 2016) at chap. 2 (item 19); 能源系统效率——单位国内生产总值能耗比 2015 年下降 [13th Five-year Plan on Energy Development] at p.14.
10 L. Wang, "China targets 3.4 pct cut in energy intensity in 2017," CCTV (March 5, 2017). "China to slash coal consumption by 160mn tons in 5 years" (March 6, 2015).

in the central government's performance management system.[11]

- 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 managements 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.[12]

  These programs have a long history. During the 11th Five-Year Plan (2006–2010), the central government spent more than $20 billion on energy efficiency programs, leveraging an additional $100 billion in private spending. In the 1980s and early 1990s, more than 200 Energy Conservation Centers were established to help companies conduct energy audits, implement demonstration projects and train energy managers.[13]

- Regulations and standards. The Chinese central government has issued dozens of regulations standards to promote energy efficiency across a range of sectors. 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:

  - 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.[14]

  - The Top 10,000 Energy-Consuming Enterprises program. Companies within the program are required to appoint energy managers, prepare energy conservation plans and achieve specific energy consumption targets. These 10,000 companies account for roughly half of industrial energy demand.[15]

  - Appliance standards and labels. The Chinese government's appliance energy efficiency standards and labeling programs date back many years. More than 220 energy efficiency standards were issued during the period of the 12th Five-Year Plan (2011–2015). NRDC and MIIT each publish catalogs of recommended energy-saving

11 For breakdown of provincial targets, see *21st Century Business Herald*. See also NDRC, *China's Policies and Actions for Addressing Climate Change* (2016) at pp.10–11.
12 IEA, *Energy Efficiency Market Report* (2016) at pp.51–52; *China Energy Efficiency Report*, *ABB* (February 2013); see also NDRC, *Climate Policies and Actions for Addressing Climate Change (2013)* at p.19.
13 See IEA, *Energy Efficiency Market Report (2016)* at p.50; Jonathan Sinton, Mark Levine, David Fridley, Fuqiang Yang, and Jiang Lin, *Status Report on Energy Efficiency Policy and Programs in China*, Energy Analysis Department, Environmental Energy Technologies Division, Lawrence Berkeley National Laboratory (December 1999).
14 *13th Five-Year Plan for National and Social Development of the People's Republic of China (2016-2020)*, Central Compilation & Translation Press; ABB, *China Energy Efficiency Report* (February 2013) at p.4,
15 ABB, *China Energy Efficiency Report* (February 2013) at p.5.

products and promote their use through public education. NDRC runs an Energy Efficiency Leaders program to recognize top products in different categories.[16]

- 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. As of September 2016, roughly 4500 buildings in China had received green building labels.[17]

16 NDRC, *China's Policies and Actions for Addressing Climate Change* (2016) at p.10–11; Hermann Amecke et al., *Buildings Energy Efficiency in China, Germany, and the United States* (Climate Policy Initiative, April 2013); "The 13th Five-Year Plan for National and Social Development of the People's Republic of China," *Central Compilation & Translation Press* (2016–2020).

17 MOHURD, Chinese Green Building Evaluation website (accessed August 16, 2019); People's Republic of China, *Third National Communication on Climate Change* (December 2018) at p.118; Wei Feng et al., *The Evolution of Building Energy Codes and Standards in China*, Lawrence Berkeley National Laboratory (2017).

CHAPTER 8 - COAL

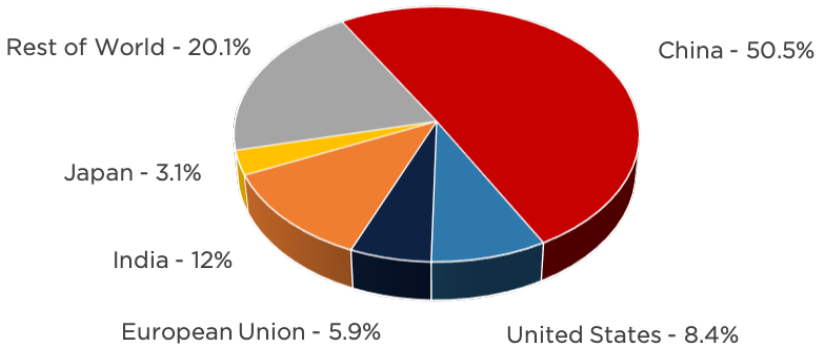
In 2018, roughly 20% of global CO_2 emissions were from Chinese combustion of coal. Despite ambitious programs to reduce coal use, significant construction of new coal-fired power capacity is underway in China. This chapter provides background on China's coal consumption, production and policies.[1]

Background

Coal Consumption

China uses more coal than the rest of the world combined, with just over half of global consumption. Most of the roughly 3.9 billion tons of coal consumed in China in 2018 was burned for power or heat. Coal is also used as a feedstock in several industries, including chemicals, iron and steel.[2]

Figure 8-1: World Coal Consumption 2018



Source: BP Statistical Review of World Energy (June 2019)[3]

In 2018, coal accounted for 59% of primary energy consumption in China, according to official sources.[4]

For decades, coal has helped fuel China's extraordinary economic growth. Between 2001 and 2013, Chinese coal consumption more than tripled. This played a central role in the growth of

1 Global Carbon Project, *Global Carbon Budget 2018* (December 2018) at slide 9, 34 (7.5 Gt CO_2 emissions from coal in China, 37.1 Gt global CO_2 emissions). See below at note 10 for data on coal plant construction.
2 *BP Statistical Review of World Energy* (June 2019) at p.45 (China 2018 coal consumption = 50.5% of world total); Zhang Lei, "In 2018, China's raw coal output reached 3.68 billion tons," *China5e.com* (May 8, 2019).
3 BP Statistical Review of World Energy (June 2019) at p.45
4 National Bureau of Statistics, "Statistical Bulletin 2018" (February 28, 2019) at Part 12.

the Chinese economy, which grew by almost exactly the same amount during this period.[5]

However, coal use has also created extraordinary environmental problems. Due in large part to coal burning, some Chinese cities are among the most polluted in the world. Air pollution levels in many cities cause significant health problems.[6]

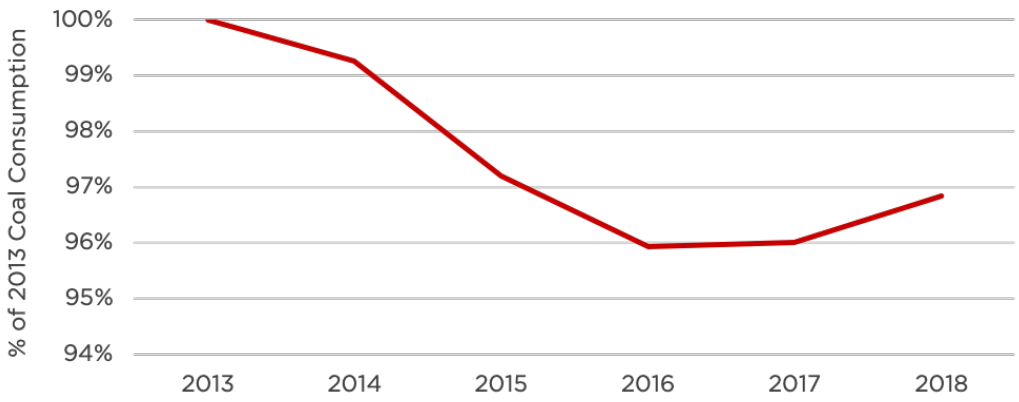
In 2014, Chinese coal consumption dropped for the first time in 15 years, falling roughly 3%. Coal consumption fell again in 2015 and 2016—by almost 4% and almost 5%, according to official statistics. The principal reasons for these decreases were (1) policies to discourage coal consumption; (2) a cyclical slowdown in coal-consuming sectors including iron, steel and cement; (3) a shift in economic activity from manufacturing to the service sector; and (4) lower rates of economic growth than in prior years.[7]

In 2017, Chinese coal consumption began to climb again, increasing in the range of 0.3%–1.0%. In 2018, the increase continued, with coal consumption rising roughly 1% according to official estimates. Factors contributing to these increases included a cyclical rebound in energy intensive manufacturing sectors, cold winters, hot summers, a drop in hydropower productivity and growth in heavy construction activity.[8]

Several leading Chinese energy experts, including former National Energy Administrator Zhang Guobao, project that China's annual coal consumption will never again reach its previous peak (4.2 billion tons in 2013).[9]

5 China Statistical Yearbook 2018: Section 9-5 Coal Balance Sheet (accessed July 26, 2019); World Bank GDP data (accessed July 26, 2019).
6 See "Doctors blame air pollution for China's asthma increases," *Lancet* (December 2016); *American Thoracic Society*, "Chinese air pollution linked to respiratory and cardiovascular deaths," ScienceDaily (February 10, 2017).
7 NDRC, "Notice of Reducing Coal Consumption in 2016" (July 11, 2016); "China says coal consumption falls for third year" (February 28, 2017); Ye Qi, Nicholas Stern et al., "China's Post-Coal Growth," *Nature Geoscience* (August 2016) at p.4.
8 National Bureau of Statistics, "Statistical Bulletin 2017" (February 28, 2018) at Part 12 (0.4% increase in 2017); International Energy Agency, "Global Energy and CO_2 Status Report 2018" (March 2018) at p.7 (0.3% increase in 2017); Qi Ye and Jiaqi Lu, "China's Coal Consumption Has Peaked," Brookings (January 22, 2018) (1.0% increase); IEA, *Global Energy and CO_2 Status Report 2018* (March 2019) (1% in 2018); National Bureau of Statistics, "Statistical Bulletin 2018" (February 28, 2019) at Part 12 (1% in 2018); IEA, *Global Energy and CO_2 Status Report 2018* (March 2019) (1% in 2018).
9 Ye Qi and Jiaqi Lu, "China's Coal Consumption Has Peaked," Brookings (January 22, 2018).

Figure 8-2: Chinese Coal Consumption 2013-2018



Source: BP Statistical Review of World Energy (June 2019)[10]

Coal-Fired Power Plants

Roughly half of China's coal consumption is for electric power. (The other half is for heat, chemicals, manufacturing and other purposes.) In 2018, roughly 67% of China's electric power was from coal.[11]

As of year-end 2018, China had roughly 1000 GW of coal-fired electric generating capacity—almost as much electric generating capacity as in the United States from all sources.[12]

Between 2006 and 2016, China's coal-fired power fleet grew by an average of 50–60 GW per year. (Estimates vary.) Some press reports described this as "two coal-fired power plants per week." Significant construction of new coal-fired power plants continues in China, although at a slightly slower pace. Capacity additions were:

- 28–35 GW in 2017,
- 28–33 GW in 2018, and
- 18 GW in the first half of 2019.

10 *BP Statistical Review of World Energy* (June 2019) at p.45

11 Estimates of the power sector's share of Chinese coal consumption vary. See "China's coal market supply and demand in 2019 may turn to loose," *China Economic Net* (March 1, 2019) (59% in 2018); "How is China's Energy Footprint Changing," *China Power* (accessed July 26, 2019) (42% in 2015). With respect to coal's share of electricity generation, see *BP Statistical Review of World Energy* (June 2019) at p.56 (66.54% in 2018); César Alejandro Hernández Alva and Xiang Li, *Power sector reform in China*, International Energy Agency (November 2018) at p.14 (65.5% in 2017); "2017 electricity and other energy statistics (update of June 2018)," *China Energy Portal* (June 14, 2018) (64.7% in 2017).

12 "2018 electricity and other energy statistics," *China Energy Portal* (January 25, 2019).

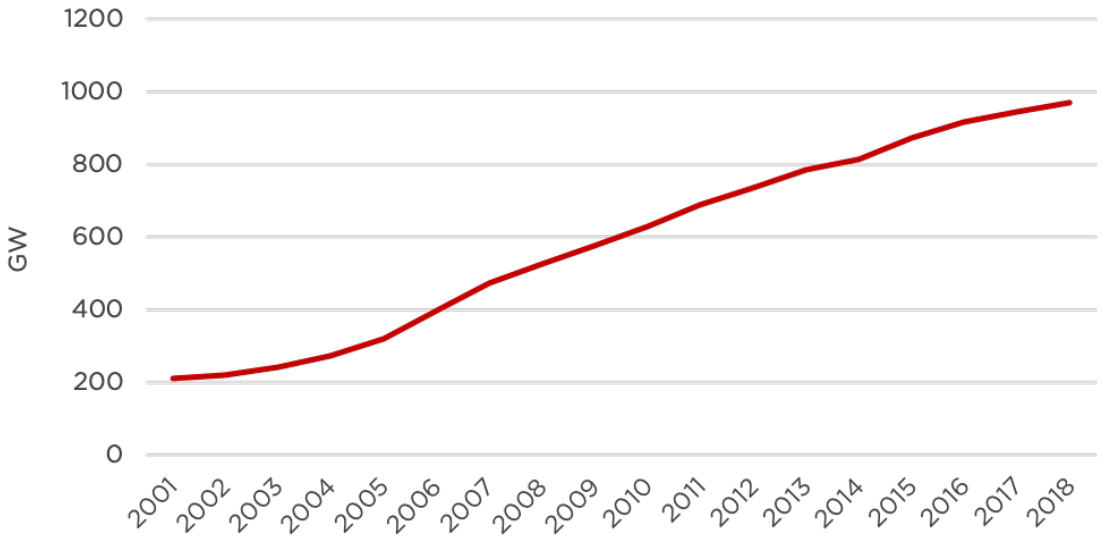
As of March 2019, more than 125 GW of new coal-fired capacity was under construction in China.[13]

In 2018, China's coal-fired power plants operated at less than 50% of capacity. (Overcapacity is widespread throughout Chinese industry, not just in the power sector.)[14]

China's fleet of coal-fired power plants is among the most efficient in the world. In early 2017, 90 of China's 100 largest coal-fired power plants were ultra-supercritical.[15]

In recent years roughly 11% of global CO_2 emissions have come from Chinese coal-fired power plants.[16]

Figure 8-3: Chinese Coal Power Plant Capacity 2001-2018



Source: BP Statistical Review of World Energy (June 2019)[17]

13 *Carbon Brief Infographics: Global Coal Power* (accessed July 26, 2019); "2018 electricity and other energy statistics," *China Energy Portal* (January 25, 2019); "2017 electricity and other energy statistics (update of June 2018)," *China Energy Portal* (June 14, 2018); Christine Shearer et al, *Boom and Bust 2019: Tracking the Global Coal Plant Pipeline* at p.12; Global Energy Monitor, *New Coal-Fired Capacity by Country*, (July 2019); Christine Shearer et al., Tsunami Warning, CoalSwarm (September 2018).

14 "2018 electricity and other energy statistics," *China Energy Portal* (January 25, 2019); Mengjia Ren et al., "China overinvested in coal power: Here's why," *VOX CEPR Policy Portal* (March 16, 2019); Gabriel Wildau and Emily Feng, "China Broadens Campaign Against Overcapacity," *Financial Times* (November 23, 2017).

15 Melanie Hart, Luke Bassett and Blaine Johnson, "Everything You Think You Know About Coal in China Is Wrong," *Center for American Progress* (May 15, 2017); Ben Caldecott et al., "Stranded Assets and Thermal Coal in China," Smith School, Oxford University (February 2017) at p.12.

16 César Alejandro Hernández Alva and Xiang Li, *Power sector reform in China*, International Energy Agency (November 2018) at p.12.

17 BP Statistical Review of World Energy (June 2019) at p.45

Coal Production

China is the world's leading coal producer, with just under half of global production. In 2018, Chinese coal production increased by 4.5% to reach 3.68 billion tons, according to official statistics.[18]

China's proved coal reserves are roughly 139 billion tons—38 years of production at current rates. The main coal-producing provinces include Inner Mongolia, Shanxi and Shaanxi.[19]

Chinese coal imports have fluctuated significantly in the past decade—surging between 2009 and 2013, falling in 2014 and 2015, and climbing in 2016, 2017 and 2018. (In 2018, Chinese coal imports were 281 million tons—7% of total coal consumption—according to official statistics). In 2018, China was the world's third largest coal importer, after Japan and India.[20]

Chinese coal production produces methane emissions. In 2005, these emissions were over 135 million tons of CO_2 equivalent (just over 1% of China's current emissions), according to US EPA. Since then, Chinese coal production has increased by roughly 75%. Considerable investments have been made in capturing coal mine methane during this period as well. Current data on methane from Chinese coal mining are lacking.[21]

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, including after each National Economic Census (in 2004, 2008 and 2013). 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%.[22]

18 National Bureau of Statistics, "Statistical Bulletin 2018" (February 28, 2019) at table 3.
19 *BP Statistical Review of World Energy* (June 2019) at p.42.
20 National Bureau of Statistics, "Statistical Bulletin 2018" (February 28, 2019) at table 11; "China Imports of Coal," Trading Economics (accessed June 22, 2019); Daniel Workman, "Coal Imports by Country" (May 2, 2019).
21 International Energy Agency, "Coal Mine Methane in China" (February 2009) at p.7; "China Coal Production by Year," Index Mundi (accessed June 26, 2018) (Chinese coal production in 2005 = approximately 2 billion tons).
22 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).

- 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).[23]
- 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.[24]
- Official estimates of a roughly 1% increase in Chinese coal consumption in 2018 are difficult to reconcile with electricity consumption and coal production data, both of which suggest a greater increase.[25]

Notwithstanding the foregoing, there appears to be broad consensus that China's coal consumption grew steadily until 2013, dropped or held steady for each of the next three years and then began growing again in 2017 and 2018.

Policies

Cutting coal use is a goal of the Chinese government. The many policies for achieving that goal include a national cap on coal consumption, targets for reducing coal's share of the energy mix, requirements to dramatically reduce coal use in many urban areas, investments in coal-to-gas switching, CO_2 emissions standards for power plants and orders to close tens of thousands of inefficient coal-fired boilers.[26]

At the same time, several Chinese government policies promote coal use. These include grid dispatch rules that favor coal over variable renewables, cheap shipping costs for coal on state-owned railroads, cheap capital for coal power plants from state-owned banks and payments for the use of pollution control technologies without regard to whether facilities are in compliance with pollution control regulations. In addition, the promotion criteria for provincial and local officials, which have historically been heavily weighted toward GDP growth, have provided incentives for those officials to approve new coal plant construction even in the

23 Xinyu Chen et al., "Changing carbon content of Chinese coal and implications for emissions of CO_2," *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.

24 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 CO_2 emissions," *Nature Climate Change* (February 16, 2016); Michael Lelyveld, "China's Coal Consumption Clouded in Mystery," *Radio Free Asia* (May 21, 2018).

25 Jan Ivar Korsbakken, Robbie Andrew and Glen Peters, "China's CO_2 emissions grew slower than expected 2018," *Carbon Brief* (May 3, 2019).

26 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 Inst. (December 2014) at pp.3, 11.

absence of a long-term need for power.[27]

China's coal policies receive attention at the highest levels of government. In August 2015, Premier Li Keqiang said, "We will strive for zero growth in the consumption of coal in key areas of the country," adding that "environmental pollution is a blight on people's quality of life."[28]

Several Chinese government plans and directives have addressed coal consumption in recent years.

- In 2013, the State Council's *Action Plan for Air Pollution Prevention and Control* focused on coal as the first of five major themes, calling for the elimination of small coal-fired boilers, energy efficiency standards for large coal-fired boilers and other steps to address air pollution from coal.[29]
- In 2014, the State Council's *Strategic Action Plan for Energy Development* capped coal consumption nationwide at around 4.2 billion tons per year and called for cutting coal's share of the primary energy mix to 62% by 2020. (That goal was achieved three years early, in 2017.)
- Also in 2014, NDRC released Interim Provisions on Replacing Coal Consumption with Cleaner Energy Sources in Key Regions, calling for reducing coal consumption in many cities, including Beijing.[30]
- In December 2016, NDRC and the National Energy Agency issued the *13th Five-Year Energy Development Plan*, which calls for coal consumption of no more than 4.1 billion tons and 58% of primary energy by 2020.[31]
- Throughout 2017, the Chinese government moved vigorously to convert coal heating to natural gas in many northern Chinese cities.
- Throughout 2017, the Chinese government also cut back on existing and planned coal power plant capacity.
  - In January 2017, the National Energy Administration canceled plans to build 103 coal plants with 130 GW of capacity, including dozens of plants already under construction.[32]

27 Mengja Ren et al., "China overinvested in coal power: Here's why," *VOX CEPR Policy Portal* (March 16, 2019); Craig Hart, Zhu Jiayan and Ying Jiahui, *Mapping China's Climate and Energy Policies* (December 2018) at pp.84–89; IEA, *China Power System Transformation* (February 2019) at pp. 42–45.
28 RT Business, "China to slash coal consumption by 160mn tons in 5 years" (March 6, 2015).
29 State Council, *Action Plan for Air Pollution Prevention and Control* (September 10, 2013)
30 "Beijing to Ban Coal Use," NDRC, *Interim Provisions on Replacing Coal Consumption with Cleaner Energy Sources in Key Regions* (2014); UNFCCC (August 5, 2014).
31 State Council, "Energy Strategic Plan" (November 2014); State Council, "Action Plan for Air Pollution Prevention and Control" (September 2013); NDRC, "Interim Provisions on Replacing Coal Consumption with Cleaner Energy Sources in Key Regions" (December 29, 2014); NDRC and NEA, "13th Five-Year Energy Development Plan" (December 2016); Alvin Lin, "Understanding China's New Mandatory 58% Coal Cap" (March 17, 2017).
32 Michael Forsythe, "China Cancels 103 Coal Plants," *New York Times* (January 18, 2017).

- In March 2017, the State Council announced plans to phase out, stop construction of or postpone more than 50 GW of coal-fired power generation capacity.[33]
- Also in March 2017, the last coal-fired power plant in Beijing shut down.[34]
- In July 2017, NDRC announced plans to cancel or postpone construction of 150 GW of coal-fired power generation capacity, close over 20 GW of coal-fired power plants and limit total installed coal-fired generation capacity to 1100 GW by 2020.[35]

These policies have not stopped new coal plant construction in China. Coal plant capacity has been growing at a rate of roughly 30 GW per year for several years, as noted above. More than 125 GW of new coal-fired power plant capacity is currently under construction. This reflects the continuing priority GDP targets have in promotion criteria for provincial and local officials, the potential tax revenues new coal plants provide such officials and the lack of market discipline in the Chinese power sector, among other factors.[36]

In 2018 and early 2019, policies to reduce coal consumption received somewhat lower priority than in previous years. In part this was due to the cold winter of 2017/2018, when ambitious policies to convert heating from coal to natural gas led to natural gas shortages and buildings without adequate heat in north China. In part, it was due to concerns about a slowing economy.

- In summer and fall 2018, the pace of conversions from coal heating in northern China slowed. In part as a result, air pollution levels in northern China were higher in the winter of 2018/2019 than the year before.[37]
- In March 2019 the China Electricity Council, a trade association serving the state-owned power sector, called for an increase of coal-fired generating capacity to 1300 GW by 2030.[38]
- In March 2019, the National Energy Administration relaxed restrictions on building coal-fired plants in 11 provinces, including Hebei, Chongqing and Guangdong, based on projections of power demand in relation to generation capacity in 2022 and other factors.[39]

33 State Council, "Report on the Work of the Government" (March 16, 2017).
34 Stephen Chen, "Beijing shuts down its last coal-fired power plant as part of bid to clear air," *South China Morning Post* (March 19, 2017).
35 National Energy Administration, "China stopped 2400MW aged coal-fired power generators" (October 31, 2017)
36 See discussion at note 13 above.
37 "In order to ensure the supply of winter gas source to alleviate environmental pressure, it is necessary to promote coal to gas," *21st Century Business Herald* (November 15, 2018).
38 "China Electricity Council suggests 2030 target of 1300 GW of coal-fired power," *China Energy Portal* (March 18, 2019).
39 National Energy Administration, Circular on 2022 risk and early warning for coal power planning and construction (March 27, 2019); GIZ, *China Energy Policy Newsletter* (May and June 2019); "China's Far From Done With Coal as Regulator Eases New Plant Ban," Bloomberg Markets (April 19, 2019).

Chinese coal plants are subject to CO_2 emissions standards. In 2015, large power generation companies were prohibited from emitting more than 650 grams of CO_2 per kWh on average across all their plants. That figure falls to 550 grams by 2020. These standards require Chinese power companies to improve the efficiency of coal production, invest in low-carbon generation or both. In 2016, average emissions across the Chinese electricity system as a whole were 620 grams of CO_2 per kWh. The largest Chinese coal-fired power plants are now substantially more efficient than US coal-fired power plants.[40]

Coal production in China is subject to a tax of 2%–10%, with the exact rate set by individual provinces. In 2015, Inner Mongolia, Shanxi and Shaanxi, which together account for roughly two-thirds of Chinese coal production, set their rates at 9%, 8% and 6.1%, respectively.[41]

40 State Council, "Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan" (October 27, 2016); "National Plan for Addressing Climate Change (2014–2020)" (November 25, 2014) at p.3; Alvin Lin, "China's New Plans Deepen Action on Climate Change" (December 19, 2016).
41 "China Imposes a New Coal Production Tax" (January 13, 2015)

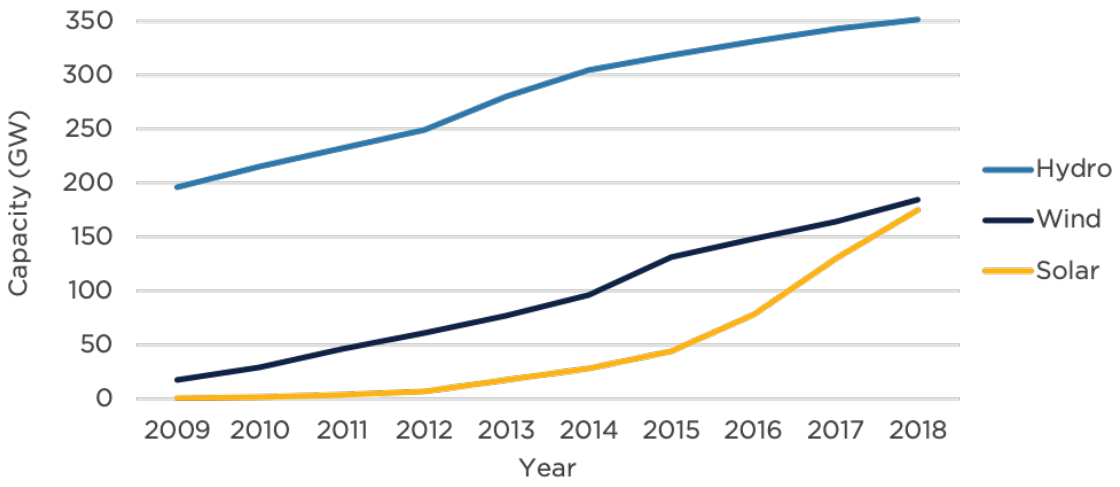
CHAPTER 9 - RENEWABLE POWER

Background

China leads the world in deployment of renewable power, with more than twice as much capacity as any other nation. In 2018, 43% of the renewable power capacity added globally was in China.[1]

Hydropower has been a significant electricity source in China for decades. Wind and solar power have grown dramatically in the past 10 years. In 2018, renewables provided roughly a quarter of the electricity generated in China—18% from hydropower, 5% from wind and 3% from solar.[2]

Figure 9-1: Renewable Power Capacity in China 2009–2018



Source: IRENA, Renewable Capacity Statistics 2019[3]

1 REN21, *Renewables 2019 Global Status Report* at table R2; IRENA, *Renewable Capacity Statistics 2019* at p.2.
2 REN21, *Renewables 2019 Global Status Report*; IRENA, *Renewable Capacity Statistics 2019* at pp.6, 14, 21; Xiaofeng Kang, "Hydropower Development in China: History and Narratives," CGIAR Program on Water and Food; National Bureau of Statistics, "Statistical Bulletin 2018" (February 28, 2019) at part 3; China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019).
3 IRENA, *Renewable Capacity Statistics 2019* at pp. 6, 14, 21.

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." In 2005, the Renewable Energy Law set national renewable energy targets, provided financial support and required grid operators to connect to renewable electricity projects.[4]

The *13th Five-Year Plan on Renewable Energy* was released by NDRC in December 2016. The Plan calls for:

- increasing the share of nonfossil energy in primary energy consumption to 15% by 2020 and 20% by 2030,
- increasing renewable power capacity to 680 GW by 2020,
- promoting offshore wind development,
- innovating in renewable energy technology,
- reducing renewable power curtailment, and
- scaling up distributed solar generation.[5]

The Plan has been implemented with generous feed-in tariffs, access to capital from government policy banks and other policies and measures.

The Chinese government is currently in the process of significantly changing its renewable power polices. Feed-in tariffs—which have been central to the Chinese wind and solar industries for the past decade—are being phased out and replaced with:

1. 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, and
2. "renewable electricity consumption quotas" requiring grid companies, large electricity users and others to purchase minimum amounts of renewable electricity set by the National Energy Administration.

4 State Planning Commission, "新能源和可再生能源发展纲要" [Outline to Develop New Energy and Renewable Energy] (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.
5 NDRC, "13th Five-Year Plan for Renewable Energy."

These changes have been announced in a series of notices during 2018 and 2019.[6] The main reasons for the changes include the high cost of feed-in tariffs, challenges administering the program and falling costs for wind and solar power (which will make those technologies increasingly competitive in the years ahead).

Power sector reforms underway in China could help promote deployment of renewables. 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.[7]

The global consulting firm EY recently ranked China #1 on its Renewable Energy Country Attractiveness Index, a measure of policy support, availability of finance, grid infrastructure, long-term need for renewables and other factors.[8]

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

A. Hydropower

Background

China leads the world in deployment of hydropower, with roughly 28% of global hydropower capacity. As of the end of 2018, China had roughly 352 GW of hydropower. China's hydropower capacity is more than three times that of any other nation.[9]

China also leads the world in new hydropower construction. In 2018, China installed 8 GW of new hydropower capacity.[10]

In 2018, hydropower accounted for roughly 18% of China's electricity generation and 19% of China's installed power capacity.[11]

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6 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" (May 10, 2019); NDRC and NEA, "Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption ('Renewable electricity quota')" (January 7, 2019); NDRC, Ministry of Finance and NEA, "Notice on matters relevant to PV power generation in 2018" (May 31, 2018).

7 See GIZ, China National Renewable Energy Center and Danish Energy Agency, *China Energy Policy Newsletter* (May and June 2019) (as well as other recent newsletters in this series).

8 *Renewable Energy Country Attractiveness Index*, ey.com (accessed August 22, 2019).

9 According to IRENA, the top countries for hydropower capacity as of year-end 2018 were China (352 GW), Brazil (104 GW), the United States (103 GW) and Canada (81 GW); IRENA, *Renewable Capacity Statistics 2019* at pp.6–8. See also REN21, *Renewables 2019 Global Status Report* at table R16 (with slightly different figures). See also *China*, International Hydropower Association (accessed August 22, 2019).

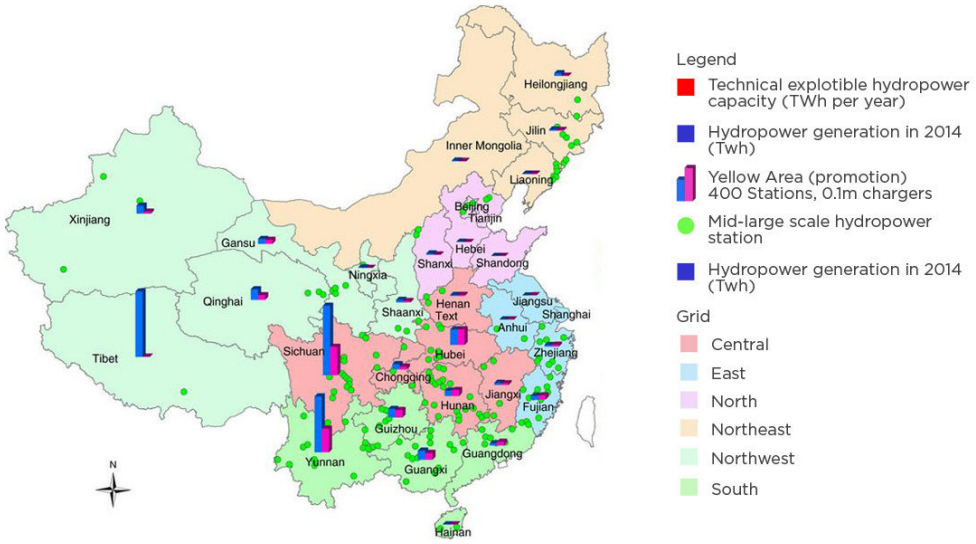
10 China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019); IRENA, *Renewable Capacity Statistics 2019* at pp.6–8. See also REN21, *Renewables 2019 Global Status Report* at table R16 (with slightly different figures).

11 IRENA, *Renewable Capacity Statistics 2019* at p.14; REN21, *Renewables 2019 Global Status Report* at table R20; China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019).

The Three Gorges Dam is the world's largest dam, with an installed capacity of 22.5 GW. Located on the Yangtze River in Hubei, the Three Gorges Dam became fully operational in 2012.[12]

Most Chinese hydropower development is in the western and southern parts of the country. Northern China has very little hydropower development. (See map below.)

Figure 9-2: Hydropower Capacity and Deployment



Source: Nature.com[13]

Chinese hydropower production plays an important role in limiting Chinese emissions of heat-trapping gases:

- In 2018, Chinese hydropower produced 1233 TWh of electricity. If the same power had been produced from coal-fired power plants, those plants would have emitted roughly 1.1 Gt of CO_2 (using generally accepted international emissions factors). 1.1 Gt of CO_2 is roughly 3% of global emissions and more than the total CO_2 emissions from Germany.[14]
- The Chinese National Energy Administration (NEA) estimates that during the 13th Five-Year Plan (2016–2020), hydropower will supply roughly 5600 TWh of electricity in China. The NEA estimates this will avoid roughly 3.5 Gt of CO_2 (a slightly more conservative calculation of avoided CO_2 than the one just above).[15]

12 "Three Gorges Dam," *Encyclopedia Britannica* (accessed June 23, 2019).
13 "Spatial distribution of hydropower resources and production in China," Nature.com; see also "Mapping China's Dams," https://bchellaney.files.wordpress.com/2011/12/chinas-new-dam-projects1.gif.
14 China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019); http://blueskymodel.org/kilowatt-hour (1 kWh of electricity from a coal-fired plant produces on average 0.9 kg of CO_2); https://www.quora.com/Where-can-I-find-data-for-CO_2-emissions-per-MWh-for-electricity-sources-for-example-coal-vs-nat-gas (1 kWh of electricity from a coal-fired plant produces 1.0 kg of CO_2). 1 Gt = one trillion (1012) kg. 1 TWh = 1 billion (109) kWh.
15 NEA, China's Hydropower 13th FYP (2016–2020) at p.27.

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.[16]

Hydropower development remains a priority of the Chinese government. The 13th Five-Year Plan includes a target of 60 GW of new hydropower capacity, to reach a total of 380 GW of hydropower capacity by 2020 and 470 GW of hydropower capacity by 2025. (All figures above include pumped hydro.)[17]

The 13th Five-Year Plan also contains a goal of 40 GW of pumped hydro capacity by 2020 and 90 GW by 2025. In November 2014, NDRC released a paper on pumped storage hydropower plants. The paper stated the following:

- Goals in the next decade include (1) accelerating the construction of pumped hydro plants, (2) more sophisticated and effective regulations and standards, including strategic planning and standardized administrative processes, and (3) bringing in more technical equipment and cutting-edge technology.
- More research is needed on using pumped hydro in connection with solar and wind projects.[18]

B. Wind Power

Background

China leads the world in deployment of wind power, with roughly one-third of global capacity. As of the end of 2018, China had roughly 185 GW of wind power (including 4.5 GW of offshore wind). In recent years China has led the world in deployment of new wind power, with 20 GW of new installations in 2018.

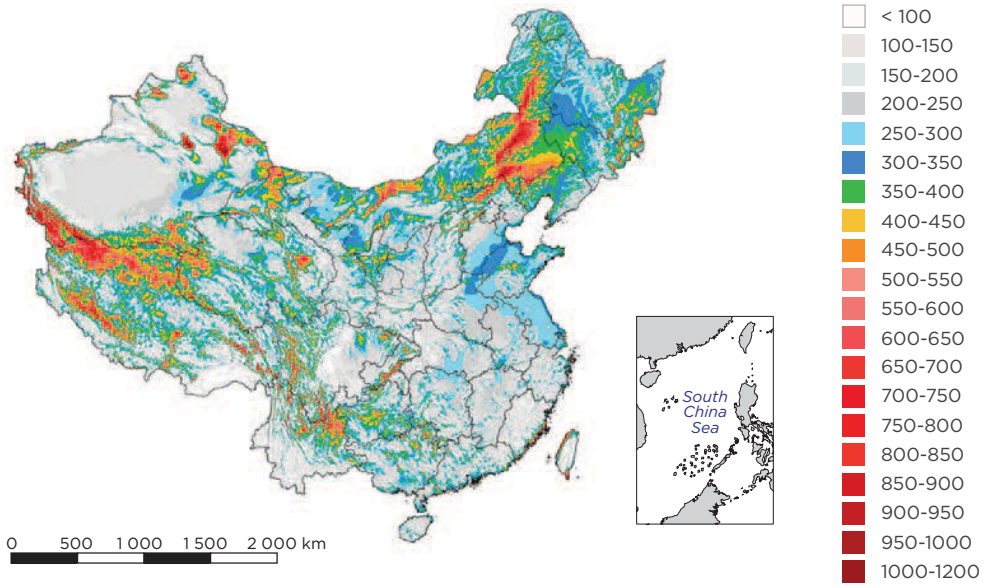
In 2018, wind power accounted for roughly 5% of China's electricity generation and 10% of China's installed power capacity.[19]

China has significant wind power resources, especially in Inner Mongolia, Xinjiang and other

16 NEA, China's Hydropower 13th FYP (2016–2020) at p.2.
17 NEA, China's Hydropower 13th FYP (2016–2020) at p.7.
18 NEA, China's Hydropower 13th FYP (2016–2020) at p.7; NDRC, "国家发展改革委关于关于促进抽水蓄能电站健康有序发展有关问题的意见" [Suggestions on Promoting the Healthy Development of pumped storage hydropower plants] (November 2014).
19 IRENA, *Renewable Capacity Statistics 2019* at p. 14; REN21, Renewables 2019 Global Status Report at table R20; China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019).

northern and western provinces. (See map below.) In 2018, Inner Mongolia produced far more wind power than any other province, followed by Xinjiang, Hebei, Gansu and Yunnan (in that order).[20]

Figure 9-3: China's wind resources: land-based resource potential (WPD ≥ 300 w/m^2, 70 m height)



Source: IEA and ERI (NDRC)[21]

Curtailment is a significant challenge for the Chinese wind power industry, although the situation has improved significantly in the past few years. In 2018, China's wind power curtailment rate was roughly 7% nationally, with rates of 23% in Xinjiang, 19% in Gansu and 10% in Inner Mongolia.[22]

Policy

The 13th Five-Year Plan establishes a goal of 210 GW of grid-connected wind power by 2020 (including 5 GW of offshore wind). Each province is given specific deployment goals, including 27 GW for Inner Mongolia, 18 GW for Xinjiang and 18 GW for Hebei.

20 China Energy Portal, "2018 wind power installations utility and distributed by province" (January 28, 2019).
21 IEA, ERI (NDRC), "China Wind Energy Development Roadmap 2050" at pp.14–15.
22 China Energy Portal, "2018 wind power installations utility and distributed by province" (Janaury 28, 2019); NEA, "2017年风电并网运行情况" [2017 Wind Power Integration Situation] (February 1, 2018). See generally Lori Bird, Jaquelin Cochran and Xi Wang, *Wind and Solar Energy Curtailment*, NREL (2014) at p.iv, ("Curtailment is a reduction in the output of a generator from what it could otherwise produce given available resources, typically on an involuntary basis").

The plan also establishes a goal of 420 TWh of electric generation from wind (which is roughly 6% of China's total electricity generation).[23]

China's feed-in tariff for wind power dates to at least 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. Feed-in tariffs will be phased out entirely starting in 2021 and replaced with an auction system and renewable electricity consumption quotas (see discussion at note 6 above).[24]

In March 2019, the National Energy Administration issued a notice calling for an immediate halt in development and construction of all wind power projects in Xinjiang and Gansu (including those that had already been approved) and ban on approvals of new wind power projects in Inner Mongolia and parts of Shanxi, Shaanxi and Hebei. The notice was intended to address overcapacity and the risk of curtailment in those locations.[25]

C. Solar Power

Background

China leads the world in deployment of solar power, with more than one-third of global solar capacity. At the end of 2018, China had roughly 175 GW of solar power.[26]

In 2018, 45% of the solar power capacity added globally was in China.[27]

China also leads the world in solar manufacturing, as it has for each of the last 10 years. In 2018, roughly two-thirds of global solar module production was in China. Chinese manufacturers held dominant positions throughout the solar supply chain.[28]

In 2018, solar power accounted for roughly 3% of China's electricity generation and 9% of China's power capacity. 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.[29]

Curtailment is a challenge for the Chinese solar power industry, although the situation has improved in the past few years. In 2018, solar power curtailment was roughly 3% nationally,

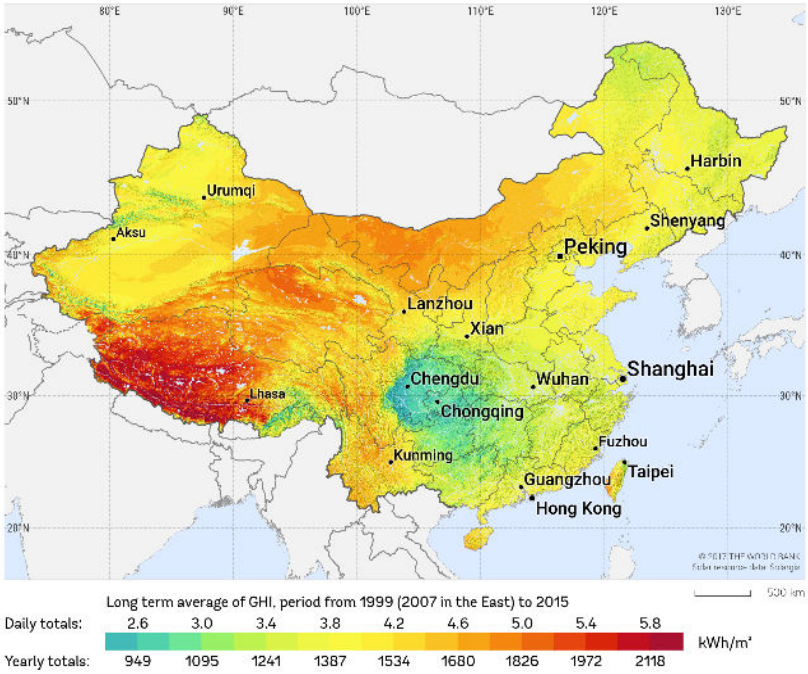
23 NEA, "国家能源局关于可再生能源发展"十三五"规划实施的指导意见" [Guiding opinions on the implementation of the "13th FYP" for renewable energy development] (July 29, 2017); NEA, "风电发展"十三五"规划" [13th FYP development plan for wind power] (November 2016).
24 NDRC and NEA, "Notice on the first batch of 2019 of non-subsidized wind 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" (May 10, 2019); NDRC and NEA, "Notice on the establishment and improvement of a safeguard mechanism for renewable electricity consumption ('Renewable electricity quota')" (January 7, 2019); NDRC, "关于完善风力发电上网电价政策通知" [The Notice on Improving the Pricing Policy for Wind Power Prices] (July 2009); Angel Hang, "Is China Ready for Subsidy-Free Renewables?," Greentech Media (May 31, 2019).
25 NEA, "Circular on 2019 wind power investment monitoring and early warning results" (May 4, 2019).
26 IRENA, *Renewable Capacity Statistics 2019* at p.24; REN21, "Renewables 2019 Global Status Report" at table R17; China Energy Portal, "2018 Electricity & Other Energy Statistics" (January 25, 2019).
27 IRENA, *Renewable Capacity Statistics 2019* at p. 24; REN21, "Renewables 2019 Global Status Report" at table R17.
28 REN21, "Renewables 2019 Global Status Report," Chapter 3 Market and Industry Trends, Solar Photovoltaics at note 177.
29 "Two solar power bases launched in northwestern China," Xinhua (December 29, 2018).

with rates of 16% in Xinjiang and 10% in Gansu.[30]

Photovoltaic (PV) technologies dominate China's solar industry, with roughly 99% of China's solar power capacity. However several concentrating solar power projects are currently operational and at least 20 are in various stages of the development pipeline.[31]

China has excellent solar resources, especially in the western part of the country. (See map below.) However, air pollution may significantly reduce output from solar panels in some parts of China. One recent study estimated losses of 17%–35% in parts of eastern China, depending on how often PV panels are cleaned.[32]

Figure 9-4: China's Solar Resource



Source: SolarGIS[33]

30 National Energy Administration, *Photovoltaic power generation statistics for 2018* (March 19, 2019); China Energy Portal, 2018 National PV Statistics (March 19, 2019). See generally Lori Bird, Jaquelin Cochran and Xi Wang, *Wind and Solar Energy Curtailment*, NREL (2014) at p.iv, ("Curtailment is a reduction in the output of a generator from what it could otherwise produce given available resources, typically on an involuntary basis").

31 "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).

32 Ken Kingery, "Air Pollution Casts Shadow Over Solar Energy Production," Duke Pratt School of Engineering (June 26, 2017).

33 "Solar resource maps of China," solargis.com (accessed August 22, 2019).

Policy

The 13th Five-Year Plan establishes a goal of 153.6 GW of solar capacity in China by 2020. The plan sets targets for individual provinces, including targets of 12 GW for Hebei, Shanxi and Inner Mongolia.[34]

China has provided feed-in tariffs for solar power since at least 2011. Those rates have been declining steadily in recent years.[35]

On May 31, 2018, the Chinese government announced major changes to its solar policies. Allocations of generous feed-in tariffs were reduced and local governments were directed to shift most 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. This announcement has been followed with a series of orders and circulars to move the solar power industry away from feed-in tariffs and towards an auction system. (See discussion at note 6 above.)[36]

For 2019, feed-in tariff rates for most solar projects rates range from RMB 0.4 to 0.55 (roughly US$0.06 to $0.08) per kWh, depending on location. Feed-in tariffs will be phased out starting in 2021.[37]

China's *Five-Year Plan for Solar Energy Development* contains specific goals for solar panel innovation (including commercialized monocrystalline silicon cells with an efficiency of at least 23% and commercialized multicrystalline 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).[38]

The Chinese government has run a solar Top Runner auction program since 2015. The program rewards high-efficiency, low-cost solar panels with subsidies and construction quotas.[39]

China Development Bank and other Chinese policy banks have played an important role in providing debt capital to Chinese solar manufacturers and developers. This was especially

34 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).
35 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, "国家发展改革委员会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] (August 2011).
36 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.
37 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).
38 Jeffrey Ball, Dan Reicher, Xiaojing Sun and Caitlin Pollock, *The New Solar System*, Stanford Steyer-Taylor Center (March 2017), pp.96–99.
39 REN21, "Renewables 2019 Global Status Report," Chapter 3 *Market and Industry Trends, Solar Photovoltaics* at notes 25-28; Ian Clover, "China's Top Runner Program spurring n-type solar cell development, report finds," PV Magazine (February 5, 2018); China Top-Runner Program—2017-2020," ClimateScope (accessed August 22, 2019).

important in helping the Chinese solar manufacturing industry grow in the years following the financial crisis of 2008, when many solar manufacturers in other countries were unable to secure access to capital.[40]

40 REN21, *Renewables 2019 Global Status Report*, Chapter 3 Market and Industry Trends, Solar Photovoltaics at p.55.

CHAPTER 10 - NUCLEAR POWER

China has the third largest nuclear power fleet in the world, behind only the United States and France. In 2018, seven of the nine nuclear power plants in the world that connected to the grid for the first time were in China. Roughly 20% of the nuclear power plants under construction in the world today are in China.[1]

In 2018, nuclear power provided roughly 4% of China's electricity. The government has ambitious plans to expand China's nuclear generating capacity.[2]

Background

China started building its first civilian nuclear reactor in 1985. The program grew slowly, with three reactors in operation by 1994. The Chinese government launched an ambitious expansion of its nuclear power program in the 10th Five-Year Plan (2001–2005), which called 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 construction program and a focus on Generation III technologies.[3]

The Fukushima accident on March 11, 2011, brought the rapid expansion of China's nuclear program to a halt. The 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.[4]

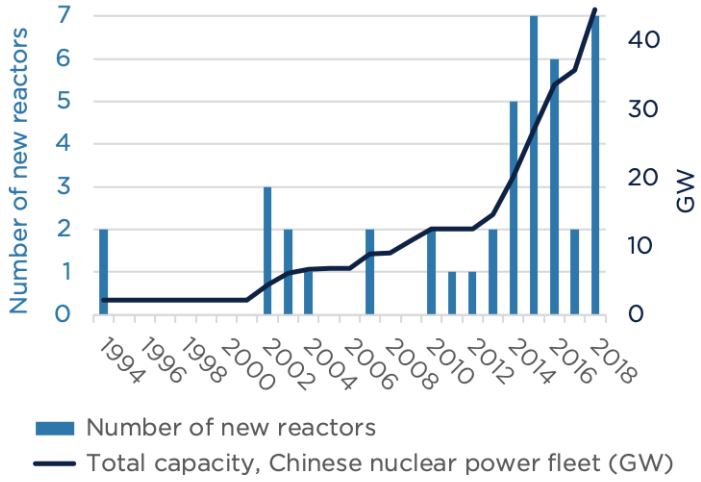
From 2013 to 2018, China opened 29 nuclear power plants (far more than any other country in the world).[5]

In recent years at least two nuclear projects in China have been cancelled 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).[6]

1 IAEA, Power Reactor Information System (World Statistics/Under Construction and Country Statistics tabs) (accessed July 13, 2019).
2 National Bureau of Statistics, *Statistical Bulletin of National Economic and Social Development 2019* (February 28, 2019) at table 3; NDRC, *Energy Development Strategy Action Plan 2014–2020* (June 7, 2014) (Chinese); NDRC, *Energy Development Strategy Action Plan 2014–2020* (June 7, 2014) (English).
3 Antony Froggatt and Joy Tuffield, "Chinese Nuclear Power Development at Home and Abroad," Asia-Pacific Focus (2011); IAEA, "China nuclear profile" (2001).
4 Xinhua Net, "China Focus: China adopts nuclear safety law" (September 1, 2017); World Nuclear Association, "Nuclear Power in China" (June 2018).
5 IAEA, Power Reactor Information System (World Statistics/Under Construction and Country Statistics tabs) (accessed July 13, 2019).
6 Li Jing, "Nuclear fuel plant on hold in eastern China after thousands protest," *South China Morning Post* (August 10, 2016); Minnie Chan and He Huifeng, "Jiangmen uranium plant is scrapped after thousands take part in protests," *South China Morning Post* (July 13, 2013).

As of July 2019, China had 45 operational nuclear power plants and 11 nuclear power plants under construction. All these plants are in coastal provinces. Several dozen additional nuclear power plants are being planned.[7]

Figure 10-1: History of nuclear power development in China



Fuqing Nuclear Power Plant, Fujian Province (2017)

Sources: IAEA, Kevin Tu[8]

Policies

The Chinese government has set ambitious goals for expanding nuclear power. The 13th Five-Year Plan (2016–2020) calls for 58 GW of installed nuclear power capacity and an additional 30 GW under construction by 2020. (As of July 2019, China had roughly 46 GW of capacity installed nuclear power capacity and 12 GW under construction.)[9]

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. (In the past, this was guaranteed to all nuclear power plants. Power market reforms are eroding this favorable treatment, but it still remains in some situations.)

7 Lai Zhikai and He Ling, "China's operational nuclear capacity ranks the third in the world," *Worker's Daily* (April 2, 2019); IAEA, Power Reactor Information System (Country Statistics tab) (accessed July 13, 2019); World Nuclear Association, *Nuclear Power in China* (updated July 2019) (accessed July 13, 2019).
8 IAEA, Power Reactor Information System (Country Statistics tab) (accessed July 13, 2019); Kevin Tu, "Nuclear Power Development in China," presentation at IFRI (July 10, 2019). Photo: M. Klingenböck/IAEA.
9 See "Goals set for nuclear energy development in next five years," *China Daily* (January 18, 2017); NDRC, *Energy Development Strategy Action Plan 2014–2020* (June 7, 2014) (Chinese); NDRC, *Energy Development Strategy Action Plan 2014–2020* (June 7, 2014) (English); IAEA, Power Reactor Information System (Country Statistics tab) (accessed July 13, 2019).

- Second, through policy banks such as China Development Bank, the government provides cheap debt capital to the large state-owned enterprises (SOEs) that dominate China's nuclear power sector (including China National Nuclear Corporation, China General Nuclear Power Group and State Power Investment Corporation).
- Third, in its role as shareholder, the government waives dividend payments from these SOEs.
- Finally, central and provincial authorities help assemble land and arrange for transmission connections at new nuclear power plant sites.[10]

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.

Nuclear waste is currently stored on-site at nuclear power plants and in temporary storage facilities in China. The Chinese government intends to develop a closed fuel cycle with reprocessing capabilities for nuclear waste.[11]

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) and Chinese Atomic Energy Authority (CAEA).[12]

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 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.

China National Nuclear Corporation has begun construction of the country's first floating nuclear plant. The target completion date for the 60 MW unit is 2021.[13]

10 See Mark Hibbs, *The Future of Nuclear Power in China* (Carnegie Endowment for International Peace 2018) at p.65.
11 See generally World Nuclear Association, *Nuclear Power in China*; David Biello, "How Nuclear Power Can Stop Global Warming," *Scientific American* (December 12, 2013).
12 Mark Hibbs, *The Future of Nuclear Power in China* (Carnegie Endowment for International Peace 2018) at p.15.
13 "Ocean-going nuclear plants for South China Sea," *Asia Times* (March 21, 2019); Leng Shumei, "Construction begins on floating nuclear plant in Shandong," *Global Times* (November 5, 2018); Viet Phuong Nguyen, "China's Planned Floating Nuclear Power Facilities in South China Sea," *Maritime Issues* (November 21, 2018).

Impact on CO_2 Emissions

The Chinese government identifies its nuclear power policies as part of its strategy to fight climate change.[14]

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

- Coal plants and nuclear power plants play similar roles on electric grids, producing large amounts of dispatchable electricity 24-7.
- A nuclear plant emits 95%-97% less CO_2 per MWh on a lifecycle basis than a coal-fired power plant.[15]
- That means a 1 GW nuclear power plant replacing coal-fired power avoids roughly 7 million tons of CO_2 per year.[16]
- 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 2018 would be roughly 320 million tons of CO_2 per year—roughly 3% of China's CO_2 emissions and almost 1% of global CO_2 emissions.

14 See People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.7; Tai Zhong, "核电：不该被误解的清洁能源" [Nuclear power should not be misunderstood], Economic Daily (December 24, 2014).

15 NREL, "Life Cycle Assessment Harmonization" (January 2013) (5%); World Nuclear Association, "Greenhouse gas emissions avoided through use of nuclear energy" (accessed July 13, 2019) (approximately 3%).

16 Based on coal plant emissions of 890 tons CO_2/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 CO_2 emissions of coal plants in China = 1230 tons/GWh).

Figure 10-2: Nuclear Power Plants in China

Source: World Nuclear Association (June 2018)[17]

17 World Nuclear Association, "Nuclear Power in China" (June 2018).

CHAPTER 11 - NATURAL GAS

Background

In 2018, China was the world's third largest consumer of natural gas, behind the United States and Russia. Natural gas accounted for roughly 7.5% of China's primary energy use—a much smaller share than the global average (24%).[1]

Natural gas consumption in China is growing rapidly. In 2018, natural gas use in China grew by roughly 18%—almost three times the rate of economic growth—due mainly to government policies to help clean the air in China's cities. Annual consumption reached 283 billion cubic meters (bcm).[2]

Natural gas in China is used mainly in industry (roughly 42%), residential and commercial buildings (roughly 22%) and power generation (roughly 22%).[3]

Across much of northern China, a massive conversion of heating infrastructure from coal to natural gas is currently underway. Seven million households were connected to the natural gas grid in 2017 and 2018. Industrial boilers, district heating networks and building furnaces are being converted. These conversions have helped cut air pollution, although at times they have run ahead of natural gas supply infrastructure. In the winter of 2017–2018, Beijing and surrounding areas had the cleanest air in many years, however natural gas shortages left many buildings cold.[4]

China's natural gas comes from three sources: domestic production, pipeline imports and imports of liquefied natural gas (LNG).

- Historically, most of China's natural gas has come from domestic production, mostly from conventional wells. In 2018, domestic production increased roughly 8% to reach 160 bcm. These gains continued in the first half of 2019, with a roughly 10% year-over-year production increase.[5]
  - China's shale gas resource is the world's largest, however much of the shale gas is very deep, in mountainous areas and challenging to produce. Shale gas production in 2018 was roughly 10 bcm, mostly from Sinopec's Fuling field in

1 *BP Statistical Review of World Energy* (June 2019) at pp.9, 34.
2 *BP Statistical Review of World Energy* (June 2019) at p.34; "China's LNG consumption growing rapidly," *Xinhua* (April 2, 2019); IEA, *Gas 2019: Executive Summary* (June 2019) at p.3; National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2018* (February 28, 2019) (2018 GDP growth = 6.6%)
3 IEA, *Gas 2019* (June 2019) at p.21 (Figure 1.4). Percentages are for 2018. Industry figure includes energy industry own use.
4 *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; 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),
5 National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2018* (February 28, 2019) at Table 3; *BP Statistical Review of World Energy* (June 2019) at p.32; Tim Daiss, "China's Natural Gas Output in May Spikes Nearly 13%," *Natural Gas Intelligence* (June 19, 2019).

Chongqing and CNPC's Changning-Weiyuan field in Sichuan.[6]

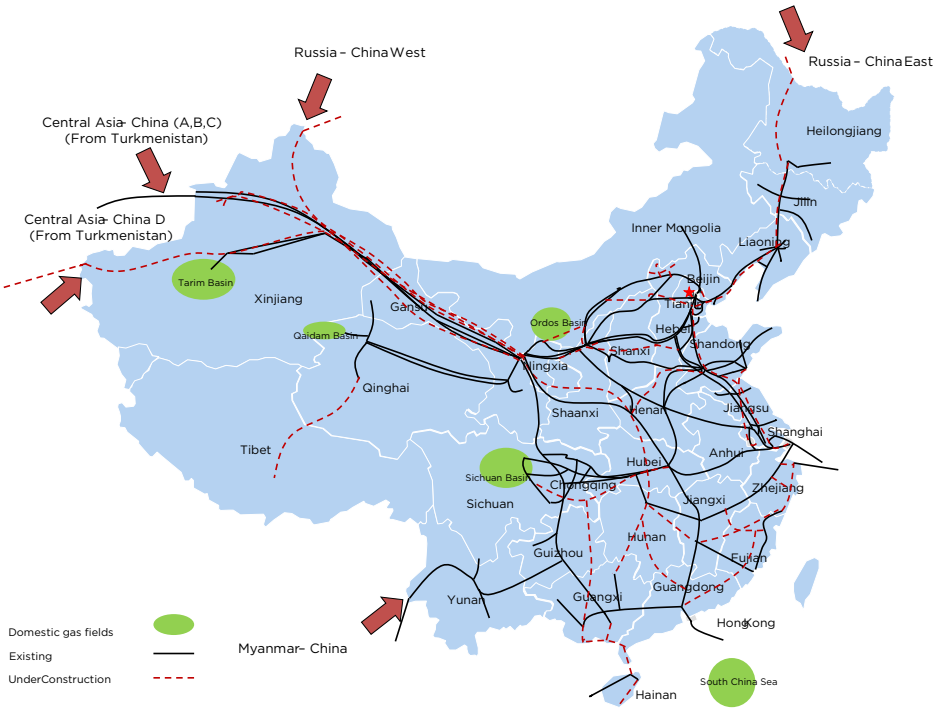
- China currently imports natural gas through two pipeline systems: the Central Asia gas pipeline (from Turkmenistan, Kazakhstan and Uzbekistan) and China-Myanmar pipeline. Total pipeline imports in 2018 totaled approximately 50 bcm. A natural gas pipeline from the Russian Far East is scheduled to open in December 2019. The capacity of the pipeline, known as the Power of Siberia, will eventually reach 38 bcm per year.[7]
- In 2018, Chinese LNG imports grew by 41%, nearly matching the blistering 46% growth rate of 2017, to reach 73 bcm. LNG infrastructure has been severely stressed, but new LNG receiving terminals, natural gas pipelines and natural gas storage facilities are under construction to meet rapidly growing demand. As of August 2019, 22 LNG receiving terminals are operating in China, with more under construction. China has roughly 70,000 kilometers of long-distance natural gas pipelines, shown below.[8]

6 IEA, *Gas 2019* (June 2019); Ocean Zhou et al., "Analysis: China to miss 2020 shale gas production targets amid tough upstream conditions," S&P Global (April 30, 2019); Trent Jacobs, "China Flexes Shale Muscles as CNPC Ups Gas Output 40%," *Journal of Petroleum Technology* (January 10, 2019); David Sandalow, Jingchao Wu, Qing Yang, Anders Hove and Junda Lin, Meeting China's Shale Gas Goals, Columbia University Center on Global Energy Policy (September 2014) at pp.5–6.

7 Stephen O' Sullivan, China: Growing import volumes of LNG highlight China's rising energy import dependency, Oxford Institute for Energy Studies (June 2019) at p.6; "Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019," *Seeking Alpha* (April 8, 2019)

8 "China's LNG import terminals and storage facilities," Reuters (August 16, 2019; "Research Report on Natural Gas Import in China, 2019-2023," *Business Wire* (May 9, 2019);); "Outlook Of Liquefied Natural Gas Versus Pipeline Gas In China After LNG 2019," *Seeking Alpha* (April 8, 2019); Michael Lelyveld, "China Revives Oil And Gas Reform Plan," *Radio Free Asia* (March 11, 2019); David Sandalow, Akos Losz and Sheng Yan, A Natural Gas Giant Awakens, Columbia Center on Global Energy Policy (June 27, 2018)

Figure 11-1: China's Natural Gas Pipeline Network



Source: Credit Suisse[9]

Policy

Converting coal-fired furnaces and boilers to natural gas is a high priority of the Chinese government. Tools for achieving that goal incude financial support for conversions, regulatory requirements and directives to state-owned companies. The principal purpose of these policies is to improve urban air quality. The 13th Five-Year Plan (2016–2020) identifies reducing CO_2 emissions as an objective of these policies as well.[10]

Production and Consumption Goals

The Chinese government has several targets with respect to natural gas. They include:

- increasing the share of natural gas in primary energy consumption to 10% by 2020 and 15% by 2030;

9 Horace Tse et al., *China Gas Sector*, Credit Suisse (June 3, 2019)
10 IEA, *The Role of Gas in Today's Energy Transitions* (2019) at p. 74; NDRC, *Natural Gas 13th Five-Year Development Plan* (December 2016) at pp.5 and 11.

- increasing the share of natural gas in urban dwellings to 50%–55% by 2020 and 65%–70% by 2030; and
- increasing the share of natural gas generating capacity in China's power sector to 5% by 2020.[11]

The 13th Five-Year Plan also calls for increasing domestic production of unconventional natural gas, including shale gas and coalbed methane. The current annual production targets are 30 bcm for shale gas and 10bcm for coalbed methane production 10 bcm 2020. Several government targets for shale gas production have been missed or revised downward in recent years.[12]

Market Reforms

China's natural gas industry is in the midst of significant reforms.

Historically, the National Development and Reform Commission (NDRC) set natural gas prices by adding production costs, transmission costs and fixed margins. Gas prices were 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 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.[13]

Structural changes are underway in China's natural gas pipeline network. Historically the China National Petroleum Corporation (CNPC) has controlled most of China's long-distance natural gas pipeline network. Several years ago, CNPC began transferring pipelines into a subsidiary as part of a plan to establish a separate national pipeline company. In 2016 NDRC reformed pipeline pricing, granting a flat 8% return on investment for interprovincial pipelines and promoting transparency in pipeline costs.[14]

As part of the effort to relieve shortages in natural gas supplies, several private companies are being allowed to build and operate LNG receiving terminals in China.[15]

11 NDRC, *Natural Gas 13th Five-Year Development Plan* (December 2016); State Council, *Energy Development Strategy Action Plan (2014–2020)* (June 7, 2014)
12 NDRC, "Chapter 30, Build A Modern Energy System," in 13th Five-Year Plan For Economic and Social Development (December 2016); Zhen Wang and Qing Xue, "An understanding of China's National l3th Five-Year Plan for Natural Gas Development," *Science Direct* (July 2017); Akira Miyamoto and Chikako Ishiguro, *The Outlook for Natural Gas and LNG in China in the War against Air Pollution*, Oxford Institute of Energy Studies (December 2018).
13 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).
14 Benjamin Haas, "PetroChina to Sell Pipeline Assets Valued at $6.3 Billion," Bloomberg (May 12, 2014); Anders Hove and David Sandalow, *Understanding China's Growing Natural Gas Sector*, Paulson Institute (September 14, 2017).
15 Author interviews (2018).

Environment and Safety Standards

China's 13th Five-Year Plan (2016–2020) emphasizes the importance of protecting the environment when developing natural gas resources. Implementation is left largely to the state-owned enterprises responsible for natural gas production.[16]

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.[17]

Several ministries and industry associations set national safety standards for long-distance transport and local distribution of natural gas. The Ministry of Transport, State Administration of Work Safety and China Natural Gas Standardization Technology Committee all have roles.[18]

Climate Change Impacts

The role of natural gas in fighting climate change is controversial.

- On the one hand, burning methane (the principal component of natural gas) produces roughly half the CO_2 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 CO_2 emissions.[19]
- On the other hand, each molecule of methane has roughly 84 times the warming impact of a molecule of CO_2 over a 20-year period and roughly 28 times the warming impact of a molecule of CO_2 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.[20]
- In addition, new natural gas infrastructure such as pipelines and receiving terminals will likely last for decades. Emissions from use of that infrastructure could make it difficult or impossible to achieve the goals set forth in the Paris Agreement (including limiting the global average temperature increase to 2°C/3.6°F above pre-industrial levels). Much lower-carbon alternatives to natural gas including solar,

16 NDRC, *Natural Gas 13th Five-Year Development Plan* (December 2016) at p.10.
17 Global Methane Initiative website (accessed August 24, 2019); Oil and Gas Climate Initiative website (accessed August 24, 2019).
18 National Natural Gas Standardization Technical Committee et al., "Mandatory National Standard for Natural Gas Transportation GB17820-2012" (October 2012).
19 See IEA, *The Role of Gas in Today's Energy Transitions* (2019) at p.89.
20 Intergovernmental Panel on *Climate Change, Climate Change 2014: Synthesis, Fifth Assessment Report* (2014) at p.87; International Energy Agency, *World Energy Outlook 2017* (November 2017) at pp.416–417; Daniel Raimi, *The Fracking Debate*, Columbia University Press (2017) at p.111.

wind, hydro and nuclear power are available in the power sector. (Lower-carbon alternatives to natural gas are less available in industry and some forms of heating, in particular for the production high grade heat in industry.)[21]

As the Chinese government develops its long-term low carbon development plans, the role of natural gas will be an especially important topic.[22]

21 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).

22 The Chinese government is expected to submit a "mid-century, long-term low greenhouse gas emission development strategy" to the UNFCCC Secretariat in 2020, pursuant the Paris Agreement and a decision of the Conference of Parties to the UNFCCC. See "Communication of Long-Term Strategies," UNFCCC website (accessed August 24, 2019).

CHAPTER 12 - SYNTHETIC NATURAL GAS

China's abundant coal resources can be used to produce synthetic natural gas (sometimes called "SNG"). The SNG can be piped into cities, where it produces less local air pollution when burned than coal. However, there are several problems with such a strategy for cutting local air pollution. First, SNG is expensive. Second, SNG requires enormous amounts of water. Third, SNG production results in significant emissions of carbon dioxide (CO_2). The lifecycle CO_2 emissions of SNG are much more per unit of heat or electricity than coal.[1]

As one Chinese expert said, synthetic natural gas plants "do not reduce emissions. They only shift emissions elsewhere. Actually, they increase emissions."[2]

As of July 2019, five pilot synthetic natural gas projects were operating in China, with a total capacity of just under 6 billion cubic meters per year (bcm/year). In 2018, these projects produced 2.3 billion cubic meters of SNG.[3]

Roughly 80 SNG projects with a cumulative capacity of more than 300 billion cubic meters are in different stages of the development pipeline. Whether these plants will be built is unclear. One source notes that, after 10 years of effort, China's synthetic natural gas industry is still in the "pilot demonstration stage." New projects struggle to receive environmental approvals, with none granted in 2018. Water source approvals are also a challenge.[4]

Several Five-Year Plan targets for SNG capacity have been missed.

- The 12th Five-Year Plan set a goal of 15–18 bcm/year of SNG capacity by 2015, however by 2015 only 3.1 bcm/year of SNG capacity had been built.[5]
- The 12th Five-Year Plan also set a goal of 60 bcm/year of SNG capacity by 2020. The 13th Five-Year Plan cut that 2020 target to 17 bcm/year (roughly 4 bcm/year in each of four locations: Xinjiang Huaidong, western Inner Mongolia, eastern Inner Mongolia and north Shaanxi).[6]

In general, governments in coal provinces support synthetic natural gas projects. In 2017, a

1 Yue Qin et al., "Air quality, health, and climate implications of China's synthetic natural gas development," *Proceedings of the National Academy of Sciences of the US* (April 24, 2017); Henry Gass, "China Push into Synthetic Natural Gas has Pollution Consequences," *Scientific American* (October 2, 2013).
2 Lin Boqiang, Director, China Center for Energy Economics Research, Xiamen University, quoted in "'Irrational' Coal Plants May Hamper China's Climate Change Efforts," *New York Times* (February 7, 2017).
3 ARA International Limited, "China Natural Gas Map" (accessed July 30, 2019); "China Natural Gas Market Review in 2018 and Outlook in 2019," *China Energy News* (January 24, 2019); Hu Yuejun, "煤制天然气深度调查：70个项目大干快上 示范项目盈利难" [Synthetic Natural Gas In-depth Investigation: 70 Projects Launched, but Difficult to Make Profits], China Energy Net (June 16, 2017) at Appendix.
4 ARA International Limited, "China Natural Gas Map" (accessed July 30, 2019); "Most coal-to-gas companies can't survive," China Energy News (December 6, 2018); 北极星电力网新闻中心 [Bjx News Center], "聚焦| 2016年煤制气项目发展状况分析" [Focus: 2016 Synthetic Natural Gas Projects Development Status Analysis] (March 28, 2017); Kathy Chen and David Stanway, "China resumes environmental approval of coal-to-gas projects," Reuters (May 20, 2016).
5 NDRC, "12th Five-Year Plan of National Natural Gas Development" (December 2012).
6 National Energy Administration (NEA), "煤炭深加工产业示范 '十三五' 规划" [13th Five-Year Plan of National Coal Deep Processing Industry Demonstration] (February 2017).

1,279 km synthetic natural gas pipeline project was approved by four provincial governments (Inner Mongolia, Shanxi, Hebei and Tianjin).[7]

In 2017, China's National Standardization Committee began implementing its first synthetic natural gas standard.[8]

The global warming implications of Chinese synthetic natural gas production could be significant. One recent study found that using synthetic natural gas for electricity generation and industrial heat generation produces roughly 40%–70% more CO_2 emissions than directly burning coal.

- Production of 17 bcm/year of SNG (the 2020 goal in China's 13th Five-Year Plan) would result in roughly 72 million metric tons of CO_2 — roughly 0.75% of China's 2018 CO_2 emissions.
- If the industry were to scale from there, reaching the original 2020 target of 60 bcm/year of production, CO_2 emissions from SNG production would exceed 250 metric tons per year -- roughly 2.5% of China's 2018 CO_2 emissions.[9]

NOTE ON TERMINOLOGY

The language used to describe synthetic natural gas can be confusing.

First, SNG is often referred to as "coal-to-gas" or "coal-to-gas conversion," 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 huge 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 synthetic natural gas, although the same terms are sometimes used to describe both.

Second, SNG is also often referred to as "coal gasification." However, the term "coal gasification" is also often used to describe a broader set of processes, including the conversion of coal to chemicals and other products. Synthetic natural gas is in fact just one possible product of coal gasification.

7 Jiansong Sun, "中海油气电集团蒙西煤制天然气外输管道项目获核准" ["The Mengxi Synthetic Natural Gas External Transportation Pipeline Projects at China National Offshore Oil Corporation Gas & Power Group were Approved"], *Sina Finance* (January 18, 2018).
8 Coal China, "煤制合成天然气国家标准获批发布" [National Synthetic Natural Gas Standards were Approved and Released] (January 18, 2017).
9 See Yue Qin et al., "Air quality, health, and climate implications of China's synthetic natural gas development," *Proceedings of the National Academy of Sciences of the US* (April 24, 2017) at Table S5 (comparing coal and SNG CO_2 emissions) and note 13 (4.25 kg CO_2 per cubic meter SNG produced).

CHAPTER 13 - 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 electric 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 electric vehicle programs.

A. China's Vehicle Stock

China's vehicle stock has grown at an extraordinary pace in the past several decades, along with the nation's GDP. In 1990, there were approximately 5.5 million registered motor vehicles in China. As of the end of 2018, there were approximately 327 million. That means there is now roughly one registered motor vehicle for every four people in China. (In the United States, there is almost one registered motor vehicle for every person.)[2]

In 2018, 28 million new motor vehicles were sold in China, making it the world's largest vehicle market by far. (The United States was second, with roughly 17 million vehicles sold.) For the first time in more than two decades, new motor vehicles sales in China fell as compared to the previous year. The decline of roughly 3% was mostly due to an increase in the tax on new motor vehicle purchases and slowing economic growth. This trend continued in the first half of 2019, with a year-over-year decline in new motor vehicles sales of roughly 12%.[3]

China has more than 100 vehicle manufacturers. 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. A 2013 study found that the average Chinese driver spends nine days a year stuck in traffic. Beijing, Tianjin and Hangzhou were rated the worst cities for traffic congestion.[4]

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1 IEA, *CO_2 Emissions from Fuel Combustion 2018* at pp.15 and 81 (in 2016, China's transport emissions = 0.8 Gt CO_2 and China's total CO_2 emissions from fossil fuel combustion = 9.1 Gt); World Bank, "World Development Indicators" (accessed June 26, 2019) (in 2014, transport = 8.6% of CO_2 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% CO_2 emissions and CO_2 emissions = 81.6% of total greenhouse gas emissions).

2 National Bureau of Statistics of China, "National Data" (accessed July 4, 2019) (5.5 million vehicles in 1990); Jiang Ling Feng, "In 2018, car ownership exceeded 200 million for the first time," Ministry of Public Security (January 12, 2019); "China's car population grows up to 240 million units by the end of 2018," China Automotive News (January 14, 2019); US Bureau of Transportation Statistics, "Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances" (accessed July 4, 2019) (272 million registered highway vehicles in the United States in 2017).

3 National Bureau of Statistics, *Statistical Bulletin 2018* (February 28, 2019) at part XII; "China ahead in car sales race for 10 consecutive years," *China Daily* (January 16, 2019); "USA—Flash report, Sales volume, 2018," MarkLines (accessed August 12, 2019); "China—Flash report, Sales volume, 2019," MarkLines (accessed August 12, 2019).

4 Chris Bruce, "The average Chinese motorist loses 9 days a year stuck in traffic" (July 5, 2014).

B. Vehicle Fuel Efficiency

Background

In 2018, the average fuel economy of new passenger cars sold in China was roughly 5.8 liters per 100 kilometers (L/100 km)—equivalent to roughly 40.5 miles per gallon. This was an improvement of roughly 4.3% over the 2017 average.[5]

For at least the past decade, the average fuel efficiency of new cars sold in China has been better than in the United States and Australia but worse than in Europe and Japan.[6]

> ***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 and Calculator Site.*

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."[7] MIIT specifically identifies CO_2 emissions reduction as among the "expected social benefits" of the standards. MIIT estimates that China's 2020 fuel efficiency standards will reduce CO_2 emissions by 113 million tons, as compared to the 2015 standards.[8]

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5 "Average Fuel Consumption of Chinese Passenger Car," China Net Car (July 3, 2019); Ministry of Industry and Information Technology, "2017 Chinese passenger car companies average fuel economy" (July 2, 2018) (average fuel economy for new passenger cars in 2017 was 6.05 liters per 100 km).

6 IEA, *Fuel Economy in Major Car Markets* (March 20, 2019) at figure KF1 and data sets; Zifei Yang and Anup Bandivadekar, *2017 Global Update Light-Duty Vehicle Greenhouse Gas and Fuel Economy Standards*, International Council on Clean Transportation (ICCT) (2017).

7 State Council, "Notice on the issuance of energy-saving and new energy automotive industry development plan (2012–2020)" (June 28, 2012); See generally Innovation Center for Energy and Transportation, China Passenger Vehicle Fuel Consumption Development Annual Report 2017 (September 2017).

8 Ministry of Industry and Information Technology, "Stage 4 Fuel Consumption Standards for Passenger Cars" (January 26, 2015) at part VII.

The Chinese government's fuel efficiency standards have two main parts. First, each vehicle must meet specific fuel efficiency standards based on its weight. The vehicle fleet is divided into 16 categories by weight for this purpose. These standards were first promulgated in 2005 and have been tightened every few years since.[9]

In addition, each vehicle manufacturer must achieve Corporate Average Fuel Consumption (CAFC) limits. These limits apply on an annual basis to each manufacturer's new vehicle fleet as a whole. The standard for 2016 was 6.7 L/100 km. The standard for 2020 is 5 L/100 km. In January 2019, MIIT proposed a standard of 4 L/100 km for 2025.[10]

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 allow manufacturers to count electric vehicles (which use 0 L/100 km) up to five times in determining fleet-wide averages. NEV credits can be (i) earned by manufacturing electric vehicles, or (ii) purchased from electric vehicle manufacturers.
- Second, manufacturers may average performance over several years, using overperformance in one year to compensate for underperformance in other years.[11]

Enforcement of fuel efficiency standards is uneven, with some experts saying manufacturers face few penalties for failing to comply. In 2018, nearly 50 out of 113 domestic auto manufacturers exceeded their CAFC limits, according to MIIT. Under MIIT's regulations, these manufacturers must come into compliance by applying NEV credits or using other flexibility tools.[12]

Nevertheless, one analysis found that China's domestic vehicle manufacturing industry as a whole met the government's fuel efficiency standards in 2016. According to the Innovation Center for Energy and Transportation, a nongovernmental organization, in 2016 the fuel efficiency of the Chinese domestic new vehicle fleet was 6.56 L/100 km, meeting the government standard of 6.7 L/100 km. (When credits for electric vehicles were removed, the fuel efficiency was 6.83 L/100 km.)[13]

The next phase of China's vehicle fuel efficiency program is currently under development.

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9 Josh Miller et al., "China: Light-duty: Fuel Consumption", TransportPolicy.net (accessed August 12, 2019); Innovation Center for Energy and Transportation (ICET), *China Passenger Vehicle Fuel Consumption Development Annual Report 2016* (September 2016) at p.2.

10 Innovation Center for Energy and Transportation, "China Passenger Vehicle Fuel Consumption Development Annual Report 2017" (December 2017); Zheng Yu, "China—Energy-Saving and New Energy Development Plan for the Automobile Industry" (October 28, 2017)

11 Josh Miller et al., "China: Light-duty: Fuel Consumption," TransportPolicy.net (accessed August 12, 2019); *Innovation Center for Energy and Transportation* (ICET), "China Passenger Vehicle Fuel Consumption Development Annual Report 2016" (September 2016) at p.6.

12 "Nearly 50 passenger car companies failed to meet fuel consumption in 2018," *Beijing Daily* (April 10, 2019); "工信部公示2016年度汽车企业平均油耗 43家未达标" [43 Companies failed to meet the standards in 2016] (April 14, 2017; Feng Hao, "China's EV push hurting fuel economy standards," China Dialogue (November 21, 2016).

13 Feng Hao, "China's EV push hurting fuel economy standards," China Dialogue (November 21, 2016); Innovation Center for Energy and Transportation (ICET), "China Passenger Vehicle Fuel Consumption Development Annual Report 2017" (December 2017) at pp.29, 34.

Some stakeholders have expressed concern that an oversupply of NEV credits is adversely affecting fuel efficiency of the Chinese new vehicle fleet under the existing program and recommended changes to address this.[14]

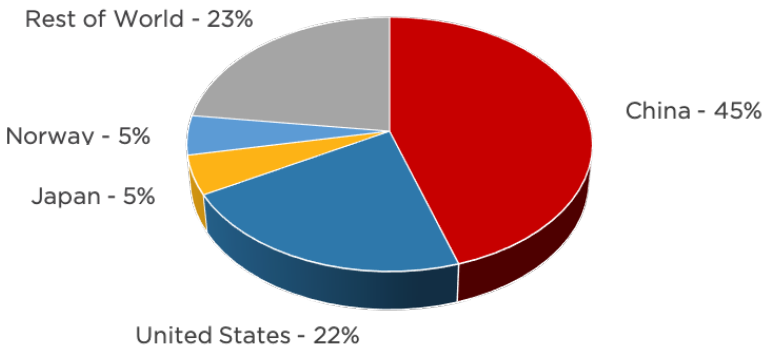
Chinese taxes on the manufacture and import of passenger cars vary by size, with larger cars paying more. This promotes fuel efficiency. There is also a 10% tax on "super-luxury vehicles" (priced above 1.3 million yuan, equal to roughly $190,000). The Finance Ministry says this tax is aimed at encouraging "rational consumption" and promoting energy conservation.[15]

C. Electric Vehicles

Background

China leads the world in deployment of electric vehicles. At the end of June 2019, 45% of the electric cars and 99% of the electric buses in the world were in China. China also dominates global markets for low-speed electric vehicles and electric two-wheelers.[16]

Figure 13-1: World Electric Car Stock—End of 2018 (5.1 million vehicles total)



Source: IEA, Global EV Outlook 2019[17]

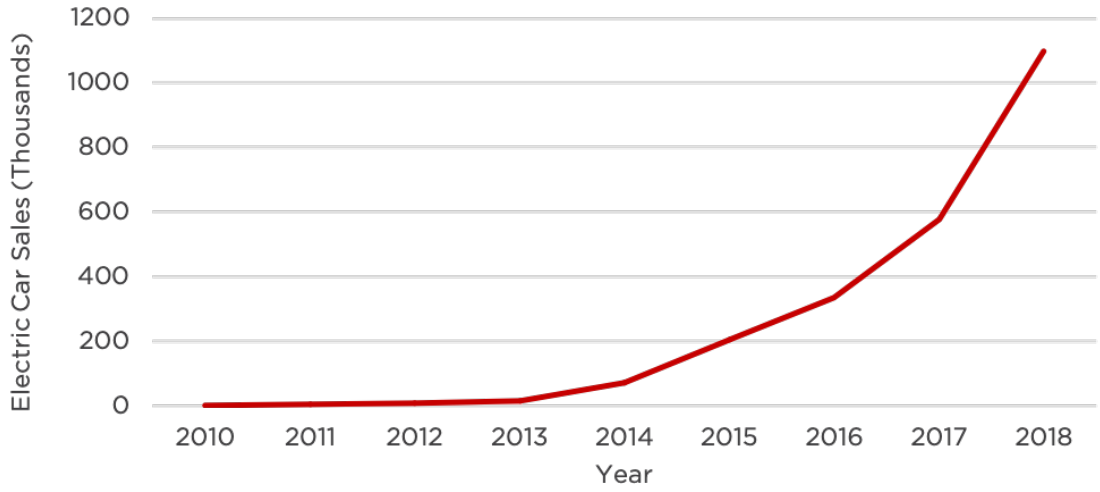
14 See Discussion on the Management of CAFC-NEV Credits (June 21, 2019).
15 Ministry of Finance, "Notice about Additional Taxation on Luxury Vehicles."
16 IEA, *Global EV Outlook 2019* at pp.32, 44 (2.3 million electric cars in China and 5.1 million electric cars in the world at end of 2018); Mark Kane, "Chinese Plug-In EV Market Surges Again In June 2019," *Inside EVs* (July 20, 2019) (633,000 electric cars sold in China H1 2019); Mark Kane, "Global EV Sales In June 2019," *Inside EVs* (July 31, 2019) (1.12 million electric cars sold globally H1 2019).
17 IEA, *Global EV Outlook 2019* at p.210

In 2018, roughly 1.1 million electric cars were sold in China—an 80% increase over 2017 sales. (In contrast, total car sales in China fell by roughly 3%.) Roughly 92,000 electric buses were sold. In 2018, 4.2% of the vehicles sold in China were electric.[18]

The growth in electric car sales continued in the first half of 2019, with more than 632,000 units sold—a 50% increase over the same period in 2018. (Total car sales fell 12% as compared to the same period in 2018.) In June 2019, electric car sales reached 8.5% of the Chinese car market—their highest share ever. That figure was in part due to the June 26 subsidy cuts for electric vehicles, leading some buyers to advance their purchases.[19]

As of the end of June 2019, more than 3.5 million electric vehicles were on the roads in China. This was roughly 1% of the Chinese vehicle stock.[20]

Figure 13-2: Electric Car Sales in China 2010–2018



Source: IEA, Global EV Outlook 2019[21]

18 IEA, *Global EV Outlook 2019* at pp.32–44; "China ahead in car sales race for 10 consecutive years," *China Daily* (January 16, 2019).
19 Mark Kane, "Chinese Plug-In EV Market Surges Again In June 2019," *Inside EVs* (July 20, 2019); Jose Pontes, "June Sales Report," *Clean Technica* (July 23, 2019); Jack Perkowski, "China's Car Slump: When Will It End?," *Forbes* (July 29, 2019).
20 IEA, *Global EV Outlook 2019* at pp.32–44; Mark Kane, "Chinese Plug-In EV Market Surges Again In June 2019," *Inside EVs* (July 20, 2019) (5.1 million electric cars globally end of 2018 × 45% China share = 2,295,000 electric cars; 138,000 electric light commercial vehicles end of 2018; 455,000 electric buses end of 2018; 633,000 electric vehicles sold H1 2019).
21 IEA, *Global EV Outlook 2019* at p.212

The foregoing figures do not include either electric bicycles or low-speed electric vehicles.

- Electric bicycles are omnipresent in China today. More than 250 million electric two-wheelers are on the roads in China, with roughly 25 million new units sold each year.[22]
- Roughly 5 million low-speed electric vehicles (LSEVs) are in use in China. Almost 700,000 were sold in 2018. These LSEVs generally have top speeds of no more than 70 kilometers (40 miles) per hour, short ranges and lead acid batteries. They typically are not counted in tallies of electric vehicles sold. LSEVs are especially popular in Shandong Province.[23]

The number of EV charging stations in China is growing rapidly. In January 2019, the Chinese Electric Vehicle Charging Infrastructure Promotion Agency (EVCIPA) reported 808,000 EV chargers in China (an 80% increase in one year). Of these, roughly 330,000 were public chargers, and 480,000 were home chargers. Other data suggest the number of EV chargers in China could be even higher.[24]

China has hundreds of auto manufacturers, many of which are owned in whole or in part by provincial or local governments. According to some reports, as many as 200 Chinese auto manufacturers have produced electric vehicles. The quality of these products has been uneven.[25]

In 2018, 1527 fuel cell electric vehicles were sold in China, bringing the country's total fuel cell electric vehicle fleet to 3428.[26]

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).[27]

The Chinese government strongly supports electric vehicles. Central government policies include a target of 5 million electric vehicles on China's roads by 2020, EV quotas for vehicle manufacturers and importers, manufacturing subsidies, tax exemptions, government procurement, and support for the construction of electric vehicle charging stations. Many

22 IEA, *Global EV Outlook 2019* at p.40; Qian Zhecheng, "China to Roll Out Stricter Standards for Electric Bikes" (January 17, 2018).
23 IEA, Global EV Outlook 2019 at p.44; IEA, "Global EV Outlook 2018" at pp.28–29.
24 China Electric Vehicle Charging Infrastructure Promotion Alliance, Annual Report (January 21, 2019); Anders Hove and David Sandalow, *EV Charging in China and the United States* (February 2019) at p.16.
25 Adam Minter, "Electric Car Fires in China Should Set Off Alarms," Bloomberg Opinions (March 19, 2019)
26 "China ahead in car sales race for 10 consecutive years," *China Daily* (January 16, 2019); Ayako Matsumoto, *Development Potential of Hydrogen Fuel Cell Electric Vehicles in China* (March 2019).
27 "Local governments claim jurisdiction over e-vehicle charging industry," *Lexology* (October 24, 2016).

provincial governments also support electric vehicles, with preferential access to license plates and other incentives. These policies have three principal goals: to clean the air in China's cities, reduce China's oil import bills and position China for global leadership in a strategic industry.[28]

The Chinese central government's principal policies to promote electric vehicles include the following.

1. **Zero emissions vehicle mandate.** In 2019, each Chinese vehicle manufacturer and importer is required to make or import at least 10% electric vehicles. The percentage will increase to 12% in 2020. These regulations apply to any company that manufacturers or imports more than 30,000 vehicles in China. Companies that fail to achieve the required percentages may purchase credits from companies that over-comply.[29]

2. **Subsidies.** The Chinese government provides subsidies to manufacturers of electric vehicles. These subsidies have been steadily reduced in recent years. In June 2019, many of these subsidies were cut roughly in half, and others were eliminated.

   - All-electric plug-in cars with a range over 400 km are now eligible for subsidies of RMB 25,000 (approximately $3600).
   - All-electric plug-in cars with a range of 250–400 km are now eligible for subsidies of RMB 18,000 (approximately $2600).
   - All-electric plug-in cars with a range of less than 250 km are no longer eligible for subsidies.
   - Plug-in hybrid cars are now eligible for subsidies of RMB 10,000 (approximately $1,500).

   All subsidies for the manufacture of plug-in electric cars are scheduled to be eliminated in 2021. Subsidies for plug-in electric buses are being reduced as well.[30]

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). It also waives 50% of vehicle registration fees for electric vehicles.[31]

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28 See State Council, "节能与新能源汽车产业发展规划(2012 - 2020)" [Energy Saving and New Energy Auto Industry Development Plan (2012–2020)] (June 28, 2012); Jack Gao and Diana Zhou, "Driving The Future Of Future Driving: Scaling Up Adoption Of Electric Vehicles In China," *Kennedy School Review* (August 10, 2016); Anders Hove, "These four lessons will help China win the electric vehicle market" (May 9, 2017).

29 Craig Hart, Zhu Jiayan and Ying Jiahui, *Mapping China's Climate and Energy Policies* (December 2018) at pp.104; *China's New Energy Vehicle Mandate Policy (Final Rule)*, International Council On Clean Transportation (January 2018).

30 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); 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);

31 Zolzaya Erdenebileg, "Shifting Gears: Investing in China's Electric Vehicles Market."

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.[32]

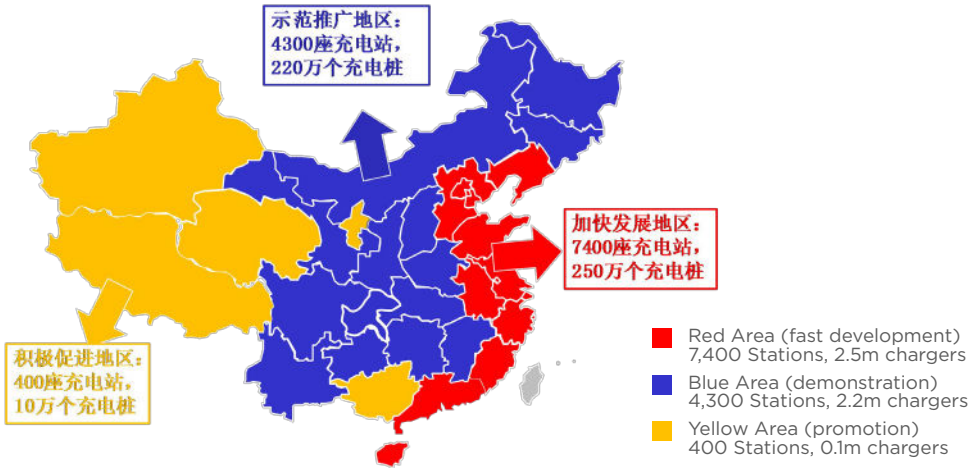
5. **New auto factory requirements.** Chinese regulations strongly discourage the construction of factories for manufacturing internal combustion engine vehicles only. Subject to exceptions that are difficult to satisfy, any new vehicle factory is required to include capacity for the construction of electric vehicles.[33]

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 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 electric utilities, both have programs to promote the development of electric vehicle charging infrastructure.[34]

7. **Support for fuel cell electric vehicles.** The Chinese government offers subsidies 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. These subsidies are not scheduled to be reduced in the years ahead. This is part of a broader program to promote development and deployment of vehicle fuel cell technology, with a focus on heavy duty vehicles in particular. In 2018, the Ministry of Science and Technology announced plans to develop a "hydrogen city" in Shandong Province to promote fuel cell electric vehicles.[35]

32 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).
33 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).
34 Anders Hove and David Sandalow, *EV Charging in China and the United States* (February 2019); NDRC, NEA, MIIT and others, "Action plan for enhancing the charging capacity for electric vehicles" (November 9, 2018).
35 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, "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).

Figure 13-3: Electric Vehicle Charging Infrastructure



Source: NEA, "Guidelines for the Development of Electric Vehicle Charging Infrastructure (2015–2020)"[36]

In September 2017, Xin Guobin, a vice minister at the Ministry of Industry and Information Technology, said at a news conference that government officials are studying a possible timetable for phasing out sales of gasoline-powered cars in China. This announcement received considerable international attention, however it was not an official statement of Chinese government policy. To date the Chinese central government has not announced a timetable for phasing out sales of gasoline-powered cars.[37]

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 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 license plate number but exempt electric cars from such restrictions.
- Some municipalities pay local manufacturers subsidies for electric vehicles.

36 Source: NEA, "Guidelines for the Development of Electric Vehicle Charging Infrastructure (2015–2020)."
37 Wu Yihao, "E-car segment revs up to push throttle full forward," *China Daily* (October 9, 2017).

- Several municipalities, including Beijing and Shenzhen, have announced that their entire taxi fleets will transition to electric vehicles within several years.
- Some local governments are supporting the development of hydrogen fueling stations for fuel cell electric vehicles.
- In March 2019, Hainan provincial officials announced that the sale of fossil fuel cars would be banned in the province starting in 2030.[38]

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:

- *Planning for the Development of the Energy-Saving and New Energy Automobile Industry 2012–2020* (June 2012)[39]
- *Accelerating the Promotion and Application of New Energy Automobiles* (July 2014)[40]
- *13th Five-Year Plan for National Strategic Emerging Industries* (December 2016)[41]
- *Action Plan for Enhancing the Charging Capacity for Electric Vehicles* (November 2018)[42]

Impact on CO_2 Emissions

What impact do electric vehicles have on China's CO_2 emissions? Analyses of the short-term impacts vary widely.

- The IEA estimates that electric vehicles in China avoided 30 MT of CO_2 emissions in 2018.
- A 2017 study by several Tsinghua University researchers found that life-cycle CO_2 emissions from electric vehicles in China today are greater than those from vehicles with internal combustion engines.

38 Anders Hove and David Sandalow, *EV Charging in China and the United States* (February 2019); Juma Feiteng, "Summary of new energy policies in November 2018," (December 3, 2018); Ayako Matsumoto, *Development Potential of Hydrogen Fuel Cell Electric Vehicles in China* (March 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; Hove, "These four lessons" (May 9, 2017); Hall, Moultak and Lutsey, "Electric Vehicle Capitals of the world" (March 2017) at p.39; "China's Quest" (March 29, 2017).

39 See State Council (中华人民共和国国务院), "节能与新能源汽车产业发展规划(2012 - 2020)" [Energy Saving and New Energy Auto Industry Development Plan (2012–2020)] (June 28, 2012).

40 State Council (中华人民共和国国务院), "国务院办公厅关于加快新能源汽车推广应用的指导意见" [Guidance on Accelerating New Energy Vehicles Promotion and Application] (July 21, 2014).

41 "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 National Strategic Emerging Industries Development] (December 19, 2016). See US Information Technology Office, "State Council Announces the 13th FYP for Strategic and Emerging Industries."

42 NDRC, NEA, MIIT and others, "Action Plan for Enhancing the Charging Capacity for Electric Vehicles" (November 9, 2018).

Other studies have found a range of results. The different results are due to different assumptions concerning comparable internal combustion engine vehicles, the energy intensity of manufacturing processes and other topics.[43]

The CO_2 impacts of electric vehicles likely vary within China depending on where the vehicles are charged. (China's electric generation is more carbon intensive in the north than south, for example.)

There is broad consensus that electric vehicles have the potential to significantly reduce CO_2 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 with respect to a low-carbon economy.

43 IEA, "Global EV Outlook 2019" at p.51; Qiao Qinyu et al., "Cradle-to-gate greenhouse gas emissions of battery electric and internal combustion engine vehicles in China," *Applied Energy* (May 10, 2017); Qian Zhang et al., "Electric Vehicle Market Penetration and Impacts on Energy Consumption and CO_2 Emission in the Future: Beijing Case," *Energies* (2017); Rachael Nealer, David Reichmuth and Don Anair, "Cleaner Cars from Cradle to Grave (2015)," Union of Concerned Scientists (November 2015).

CHAPTER 14 - HFCs AND CFCs

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 roughly 1.4 billion air conditioners is projected to more than 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 60% of global HFC production is in China. Chinese HFC consumption increased almost tenfold between 2005 and 2013.[6]

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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.

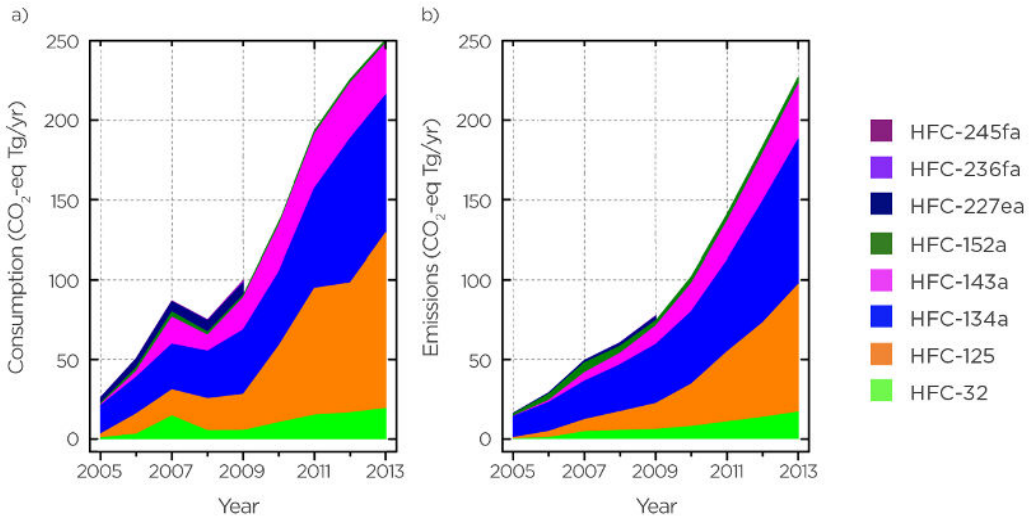
3 K-CEP, IGSD, Energy Foundation, U4E and Carbon Trust, *Efficient, Clean Cooling: A Major Near-Term Opportunity for China* (2018) (estimating 1.6 billion air conditioners currently in use); S. Sachar, I. Campbell and A. Kalanki, Solving the Global Cooling Challenge: How to Counter the Climate Threat from Room Air Conditioners, Rocky Mountain Institute (2018) (estimating roughly 1.2 billion air conditioners currently in use); IEA, *The Future of Cooling* (May 2018).

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 See Feng Hao, "Chinese manufacturers under pressure to phase out HFCs," China Dialogue (November 28, 2016) (60% of global CO_2 production is in China); Xuekun Fang, Guus J. M. Velders, A. R. Ravishankara, Mario J. Molina, Jianxin Hu and Ronald G. Prinn, "Hydrofluorocarbon (HFC) Emissions in China: An Inventory for 2005–2013 and Projections to 2050," *Global Change* (2016) at p.2030 (almost tenfold increase in consumption between 2005 and 2013).

Figure 14-1: HFC consumption and emissions in China (2005-2013)



Source: Fang et al., "Hydrofluorocarbon (HFC) Emissions in China" (2016)[7]

Chinese companies manufacture both HFC chemicals and appliances that use them. Leading Chinese producers and exporters of HFCs include Jinhua Shandong Dongyue Chemical, Sinochem Taicang, Yonghe Fluorochemical and Zhejiang Lantian. Chinese companies manufacture more than 60% of the world's refrigerators and more than 80% of the world's residential air conditioners.[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. 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.

7 Fang et al., "Hydrofluorocarbon (HFC) Emissions in China" (2016) at p.2030.
8 NDRC et al., *Green and High-Efficiency Cooling Action Plan* (June 13, 2019) (Chinese); NDRC et al., *Green and High-Efficiency Cooling Action Plan* (June 13, 2019) (English); Xiaopu Sun and Tad Ferris, "The Kigali Amendments and China's Critical Roles in Evolving the Montreal Protocol," *Trends* (September/October 2018); Won Young Park, Nihar Shah and Brian Gerke, "Assessment of commercially available energy-efficient room air conditioners" (Lawrence Berkeley National Laboratory, October 2017) at p.26; US International Trade Commission, Hydrofluorocarbon Blends and Components from China (August 2016) at p.vii–3.

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.[9]

China joined the second group of countries, committing to peak production and consumption of HFCs by 2024.

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.[10]

Ratification and implementation of the Kigali Amendment was highlighted at the China-EU Summit in 2018 and China-France Summit in 2019.[11]

China's HFC Policies—Domestic

The Chinese government is promoting alternatives to HFCs and working to reduce HFC production capacity.

- In 2013, the Ministry of Environmental Protection released a management plan for phasing out HFCs and held meetings about closing down HFC production lines as part of an awareness-raising campaign.[12]
- In 2014, China's National Plan for Climate Change 2014–2020 called on industry to significantly reduce HFC emissions and enhance investment in research and development for HFC alternatives.[13]
- Similarly, the Action Plan for the Development of Energy Conservation, Emissions Reduction and Low Carbon (2014–2015) calls for "strengthen[ing] the management of hydrofluorocarbons (HFCs) emissions, accelerat[ing] the destruction of HFCs and finding HFCs alternatives." The Action Plan further states that "during 12th FYP period, China should cumulatively reduce emissions [of HFCs] by 280 million tons of carbon dioxide equivalent."[14]

9 "UNEP Fact Sheet."
10 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 and Clean Energy Cooperation" (November 11, 2014).
11 EU-China Leaders' Statement On Climate Change And Clean Energy (16 July 2018); China-France Joint Declaration on Maintaining Multilateralism and Improving Global Governance (26 March 2019).
12 NDRC, *China's Policies and Actions on Climate Change* (2014).
13 NDRC, "国家应对气候变化规划2014–2020年," [China's National Plan for Climate Change 2014-2020].
14 State Council, 《2014 - 2015年节能减排低碳发展行动方案》.

- In May 2015, NDRC issued a notice asking companies to submit an HFC-23 mitigation plan by year end. NDRC also began offering subsidies for HFC emissions mitigation. Subsidies are set at RMB 4 per ton of CO_2e through 2019, after which they transition to 1 RMB per year.[15]
- 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."[16]
- 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."[17]
- In 2019, seven ministries and agencies jointly released the Green and High-Efficiency Cooling Action Plan, which includes plans research, development and deployment of low-global warming potential (GWP) and high-efficiency refrigerants.[18]
- During the 13th Five-Year Plan (2016–2020), the Chinese government is taking 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.[19]

15 NDRC, "Notification Requesting Companies to Submit an HFC-23 Mitigation Plan" (May 13, 2015), http://www.sdpc.gov.cn/gzdt/201505/t20150515_692028.html; Yao Bo et al., *Opportunities to Enhance Non-Carbon Dioxide Greenhouse Gas Mitigation in China* (World Resources Institute, May 2016); NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at p.17.

16 NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2017) at p.13.

17 NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018) at p.13.

18 NDRC et al., *Green and High-Efficiency Cooling Action Plan* (June 13, 2019) (Chinese); NDRC et al., *Green and High-Efficiency Cooling Action Plan* (June 13, 2019) (English).

19 Sun and Ferris, "The Kigali Amendments" (September/October 2018). For more information on China's HFC programs, 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).

ILLEGAL PRODUCTION OF CFCs

Chlorofluorocarbons (CFCs) are powerful heat-trapping gases, capturing many thousands times more heat than equivalent amounts of carbon dioxide. Production and consumption of CFCs have been banned globally under the Montreal Protocol since 2010.[20]

CFC production is illegal in China. Nevertheless, several recent studies, including a study published in Nature in May 2019, suggest that new CFC production continues in several provinces including Hebei and Shandong. Chinese authorities stress their determination and commitment to stop this illegal production, including through a special enforcement inspection launched in 2018. The Chinese government has called for further scientific research and data analysis to identify causes of the unexpected CFC emissions. China's Ministry of Ecology and Environment announced a second round of nationwide enforcement inspections for CFCs and other ozone-depleting substances in June 2019.[21]

20 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."

21 M. Rigby et al., "Increase in CFC-11 emissions from eastern China based on atmospheric observations," *Nature* (May 22, 2019); James Griffiths, "Spike in banned ozone-eating CFC gases linked to China in new research," CNN.com (May 25, 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," *People's Daily* (July 26, 2018).

CHAPTER 15 - LOW-CARBON CITIES

Background

The migration to China's cities during the past several decades may be the largest movement of humanity ever. China's urban population has grown by more than 500 million people since the mid-1980s, due mainly to migration from the countryside. At least six Chinese cities (Shanghai, Beijing, Chongqing, Guangzhou, Tianjin and Shenzhen) have populations of more than 10 million people. At least 120 Chinese cities have populations of more than 1 million people.[1]

Roughly 60% of China's population now live in urban areas. By 2030, roughly 70% of China's population—more than 1 billion people—are expected to live in urban areas.[2]

The urbanization of China has significant implications for emissions of heat-trapping gases. The urbanization process—with construction of buildings, roads and other infrastructure—is energy intensive and produces significant carbon dioxide (CO_2) emissions. In addition, Chinese urban residents typically emit more CO_2 per capita than rural residents. Studies have found that:

- cities contribute roughly 85% of China's CO_2 emissions,[3]
- Chinese urban residents emit roughly 1.4 times more energy-related CO_2 on average than Chinese rural residents,[4]
- 100 million people moving from the countryside to cities in China increases CO_2 emissions an average of 200 million tons per year over five years,[5] and
- 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.[6]

A 2019 study found that per capita CO_2 emissions in Chinese cities peak at a per capita GDP of approximately US$21,000 (2011 PPP). Above that level, as Chinese cities get wealthier, per capita emissions tend to decline.[7]

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1 UN Department of Economics and Social Affairs/Population Division, *World Urbanization Prospects 2018—China* (accessed August 23, 2019). City population estimates vary, depending in part on whether people within city limits or in broader metropolitan areas are being counted. See Rolando Yee, "The Largest Cities in China," World Atlas (July 9, 2019); Yu Xiaoming, "Around 90 Chinese cities see urban population top one million," China Daily (May 7, 2018); Joe Myers, "You knew China's cities were growing. But the real numbers are stunning," World Economic Forum (June 20, 2016); Lang Fang, "The great sprawl of China," *Economist* (January 22, 2015).

2 National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2018* (February 28, 2019) at table 1; Joe Myers, "You knew China's cities were growing. But the real numbers are stunning," World Economic Forum (June 20, 2016).

3 Zhu Liu and Bofeng Cai, *High-resolution Carbon Emissions Data for Chinese Cities* (June 2018) at p.1.

4 Stephanie Ohshita, Lynn K. Price, Nan Zhou, Nina Khanna, David Fridley and Xu Liu, *The Role of Chinese Cities in Greenhouse Gas Emission Reduction*, Stockholm Environment Institute (September 2015) at p.4.

5 K. Feng & K. Hubacek "Carbon implications of China's urbanization," *Energy, Ecology and Environment* (February 25, 2016).

6 Dominik Wiedenhofer, Dabo Guan, Zhu Liu, Jing Meng, Ning Zhang and Yi-Ming Wei, "Unequal household carbon footprints in China," *Nature Climate Change* (December 19, 2016).

7 Haikun Wang et al., "China's CO_2 peak before 2030 implied from characteristics and growth of cities," *Nature Sustainability* (July 29, 2019). This an example of the "environmental Kuznets curve."

Policy

The Chinese government promotes urbanization as a matter of policy. The *National New Type Urbanization Plan (2014–2020)* calls for an additional 100 million people to move from the Chinese countryside to cities by 2020. The *Plan* states that "domestic demand is the fundamental impetus for China's development, and the greatest potential for expanding domestic demand lies in urbanization." These policies were reiterated and further developed as part of the 13th Five-Year Plan.[8]

As part of its approach to urbanization, the Chinese government promotes "green development" and attention to "ecological principles" in city planning. China's "eco-cities" programs have a long history, dating back to at least the 1990s. GDP growth has generally been the main priority of municipal officials, but programs to promote green development are widespread and policy documents often identify environmental sustainability as an important objective.[9]

Low-carbon development has been part of China's green cities programs for more than a decade. In 2008, low-carbon city pilot projects were launched in Shanghai and Baoding. In 2010, 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 the next few years, the Chinese government launched two batches of low-carbon city pilot projects around the country. In 2012, Su Wei, then Director General of the Climate Change Department at NDRC, wrote,

> China's cities will play an increasingly larger role in…China's efforts to mitigate and adapt to climate change. The economic and technical roadmap for urban development will have important "lock-in effects" on China's future energy demand and GHG emissions, making it essential, in the process of urbanization, to accelerate shifts in economic development patterns; increase the use of low-carbon, energy-saving, and environmentally friendly technologies; and strengthen low-carbon and eco-city development.[10]

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.[11]

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8 State Council, "China unveils landmark urbanization plan"; Chris Weller, "Here's China's genius plan to move 250 million people from farms to cities," *Business Insider* (August 5, 2015).

9 NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018) at pp.24–28; David Bulman, *Governing for Growth and the Resilience of the Chinese Communist Party*, Harvard Kennedy School (April 2016); Jing Wu et al., *Incentives and Outcomes: China's Environmental Policy*, National Bureau of Economic Research (February 2013).

10 Su Wei, Foreword, in Axel Baeumler, Ede Ijjasz-Vasquez and Shomik Mehndiratta, eds. *Sustainable low-carbon city development in China*, World Bank (2012) at p.xxii.

11 Biliang Hu, Jia Luo, Chunlai Chen and Bingqin Li, "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* (October 27, 2016).

Also in 2016, the State Council and Communist Party Central Committee released urban development guidelines giving priority to the development of mass transit and calling for "the construction of energy-saving cities."[12]

In 2017, China launched its third batch of low-carbon cities pilot projects, covering 45 more cities. Specific targets and peak years were announced.[13]

The Chinese government's policies to promote low-carbon cities fall into at least three broad categories.

First, the Chinese government makes extensive use of pilot projects to promote low-carbon urbanization. Pilot provinces and cites are required to prepare low-carbon development plans, establish greenhouse gas emissions statistical systems and enforce greenhouse gas emissions control targets. The Chinese governments 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), CO_2 emissions per unit of GDP in these pilots fell 19.4% from 2010 to 2014—faster than the national average.[14]
- According to China's *Second Biennial Update Report* (December 2018), there are now more than 400 provincial pilot low-carbon communities.[15]

The 13th Five-Year Plan calls for expanding low-carbon pilot projects to 100 cities and roughly 1,000 communities, as well as applying the lessons learned in these pilots more broadly. China's Nationally Determined Contribution (submitted to the UN Framework Convention on Climate Change in 2015) highlights low-carbon cities, saying that China will implement low-carbon pilot projects in cities, towns and communities.[16]

The Innovative Green Development Program maintains a database with extensive information on activities in China's low-carbon pilots.[17]

Second, the Chinese government sets specific goals with respect to low-carbon urbanization.

The 13th Five-Year Plan, for example, includes the following goals for 2020.

- Green buildings should account for 50% of new construction in urban areas.

12 CPC Central Committee and State Council, Urban Development Guidelines (February 2016); CC Huang, "Why China's New Urbanization Guidelines Are A Major Milestone For Urban Sustainability" (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).
13 NDRC, *Notice on Launching the Third Batch of National Low Carbon Cities Pilot Projects* (January 24, 2017);
14 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016) at pp.61–62.
15 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.
16 State Council, "Notice on Issuing the Work Plan for Greenhouse Gas Emission Control during the 13th Five-Year Plan Period" (October 27, 2016) at 5(c); People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 30, 2015).
17 Innovative Green Development Program, *Policy Mapping* (accessed August 23, 2019).

- Carbon dioxide emissions of urban passenger transport vehicles should be 12.5% lower per unit of passenger volume than in 2015.

Such goals are intended to help guide urban planners and may be among the metrics used to evaluate the performance of municipal officials. In some cases, the central government makes funding available to meet such goals, either through grants or preferential financing from the China Development Bank and other policy banks.[18]

Third, the Chinese government participates in a wide range of international programs on low-carbon cities. These include programs between central government ministries and counterparts in other national governments, "sister city" programs between Chinese cities and cities abroad, and programs run by international organizations such as the Climate-Smart, Low-Carbon Cities (CSLCC) program funded by USAID under the US-China Joint Agreement on Climate Change. Such programs facilitate shared learning on best practices and tools for promoting low-carbon urban development. Examples include bilateral programs with the United States, United Kingdom, Germany, Singapore and others, as well as the C40 program (a network of megacities committed to addressing climate change).[19]

China's Alliance for Peaking Pioneer Cities has received considerable attention (and in some respects falls into all three categories just above). The 13th Five-Year Plan encourages cities to strive to peak emissions before the national goal of 2030. At least 23 cities and provinces with 27.5% of China's GDP and 16% of its CO_2 emissions are part of the program.[20]

18 State Council, "Notice on Issuing the Work Plan for Greenhouse Gas Emission Control during the 13th Five-Year Plan Period" (October 27, 2016).at 4(a) and 4(b).
19 Xinting Chen, "Bilateral Collaborations in Sino-foreign Eco-cities: Lessons for Sino-Dutch Collaboration in Shenzhen International Low-carbon Town," master's thesis, Delft University of Technology, Delft (2012); C40 website; Liz Schlegel, "Chinese and U.S. Cities Collaborate to Advance Climate-Smart Low-Carbon City Development" (June 7, 2016); The White House, "US-China Joint Presidential Statement on Climate Change" (March 31, 2016).
20 State Council, "Notice on Issuing the Work Plan for Greenhouse Gas Emission Control during the 13th Five-Year Plan Period" (October 27, 2016).at 5(b); Wee Kean Fong, "23 Chinese Cities Commit to Peak Carbon Emissions by 2030," World Resource Institute (June 8, 2016).

CHAPTER 16 - GREEN FINANCE

The Chinese government strongly promotes "green finance," which the People's Bank of China ("PBoC") defines as "financial services provided for economic activities that are supportive of environmental improvement, climate change mitigation and more efficient resource utilization."[1] In September 2016, PBoC promulgated *Guidelines for Establishing the Green Financial System*—the first time any nation's central bank had issued such guidelines. As host of the G20 in 2016, the Chinese government launched a Green Finance Study Group and included the topic of green finance in G20 communiques for the first time. A 2017 report found that China "arguably has been the most proactive country in the world in pursuing a coordinated and comprehensive approach to greening its financial system."[2]

China's green finance policies promote investment in a wide range of assets, including renewable energy projects, water treatment plants, recycling facilities and mass transit. In 2018, China's green finance policies helped mobilize hundreds of billions of RMB (tens of billions of dollars) for qualifying projects.[3]

PBoC's *Green Bond Endorsed Project Catalogue* includes "clean utilization of coal" as an eligible project category. During the first half of 2019, according to one report, Chinese financial institutions provided more than $1 billion to coal projects that qualified as green financing under Chinese standards. International standards for green bond investments do not include coal projects among the eligible categories.[4]

This chapter discusses China's green finance policies and their climate impacts.

Background

The capital required for pollution control and climate mitigation in China is enormous. PBoC estimates the need at RMB 2–4 trillion (roughly $310–$620 billion) per year. To help mobilize that capital, PBoC issued its *Guidelines for Establishing the Green Financial System* in 2016. In its opening paragraphs, the guidelines state,

> 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

1 People's Bank of China, *Guidelines for Establishing the Green Financial System* (September 2, 2016) at 1(1). PBoC is China's central bank.
2 Sean Gilbert and Lihuan Zhou, *The Knowns and Unknowns of China's Green Finance*, Global Commission on the Economy and Climate (March 2017) at p.1.
3 Weihui Dai, Sean Kidney and Beate Sonerud, *Roadmap for China: Green Bond Guidelines for the Next Stage of Market Growth*, Climate Bonds Initiative (April 2016) at p.8; Zhang Mo, "Unified Standards Accelerate the Formulation of China Green Financial Policy System," *Xinhuanet* (May 20, 2019).
4 David Stanway, "China provides $1 billion in 'green' finance to coal projects in first half of the year," Reuters (August 19, 2019); International Capital Markets Association, *Green Bond Principles* (June 2018 update) (accessed August 25, 2019); Climate Bonds Initiative, *Climate Bonds Standards v.2.1* at p.15; Weihui Dai, Sean Kidney and Beate Sonerud, *Roadmap for China: Green Bond Guidelines for the Next Stage of Market Growth*, Climate Bonds Initiative (April 2016) at pp.8, 23.

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.[5]

The *Guidelines* call for policies and actions 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
7. international cooperation.

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. In 2018, Chinese local government entities issued at least US$5.9 billion of green bonds.[6]

At the Second Belt and Road Forum in April 2019, Green Investment Principles for the Belt and Road Initiative were endorsed by 28 financial institutions, including China Development Bank, China International Capital Corporation, China Construction Bank and the Agricultural Development Bank of China.[7]

Green Bonds

Perhaps the greatest amount of green finance activity in China has been in the area of green bonds. In 2018, Chinese green bond issuances were roughly RMB 283 billion (approximately $43 billion). This was an increase of roughly 12% over 2017 and the second highest total of any country, behind only the United States.[8]

In 2018, roughly 28% of China's green bond proceeds went to solar, wind and other clean energy projects. Roughly 33% went to low-carbon transport, including for urban mass transit.

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5 People's Bank of China, *Guidelines for Establishing the Green Financial System* (September 2, 2016).
6 *China Green Bond Market 2018*, Climate Bonds Initiative and China Central Depository & Clearing Company (February 2019) at p.7; Reuters, "China launches five 'green finance' pilot zones," Reuters (June 26, 2017); *Study of China's Local Government Policy Instruments for Green Bonds*, SynTao Green Finance and Climate Bonds Initiative (April 2017) at pp.7–8
7 "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 20 of this Guide.
8 *China Green Bond Market 2018*, Climate Bonds Initiative and China Central Depository & Clearing Company (February 2019) at p.3. See also "In the past year, 36 financial institutions issued a total of 147.7 billion green financial bonds," *Xinhua Finance* (June 21, 2019) (with slightly different figures).

Roughly 26% of China's green bond proceeds went to projects that did not meet international green bond standards, including for retrofits of coal power plants.[9]

Policies concerning green bonds are set forth in PBoC's Guidelines for Establishing the Green Financial System (September 2016), NDRC's *Guidelines for Issuing Green Bonds* (December 2015) and the China Securities Regulatory Commission's *Guidelines* for Supporting Green Bond Development (March 2017). These documents call for guarantees, credit enhancement mechanisms, disclosure requirements and third-party verification. They call on provincial and local governments, as well as rating agencies, to participate actively in establishing a green bond market.[10]

Commercial banks issued roughly 60% of Chinese green bonds in 2018. Nonfinancial corporations issued roughly 18%. Government policy banks issued roughly 3%.[11]

Green Credit

Green credit is an important part of China's green finance landscape. (The volume of bank lending in China far exceeds bond issuances.) In 2018, the balance of green loans in China increased roughly 16% to reach more than RMB 8 trillion (roughly US$1.1 trillion). This included roughly RMB 3.8 trillion (roughly $US500 billion) for transportation and RMB 2 trillion (roughly US$300 billion) for renewables. Green loans were roughly 5.6% of all loans outstanding.[12]

PBoC's Guidelines call for "vigorously develop[ing]" green credit with tools such as central bank relending, guarantee mechanisms and securitization.[13]

China Development Bank's website states that "CDB is one of the earliest advocates of green credit practice in China, which aims to support environmental protection and energy conservation through its designated loans and investments."[14]

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. In 2018, China's

9 *China Green Bond Market 2018*, Climate Bonds Initiative and China Central Depository & Clearing Company (February 2019) at p.9.
10 See generally Ma Jun, "Improve the Environmental Information Disclosure System," *China Finance Journal* (March 17, 2016).
11 *China Green Bond Market 2018*, Climate Bonds Initiative and China Central Depository & Clearing Company (February 2019) at p.6.
12 Zhang Mo, "Unified Standards Accelerate the Formulation of China Green Financial Policy System," *Xinhuanet* (May 20, 2019); *Financial Institution Loan Investment Report* (2018); Sean Gilbert and Lihuan Zhou, *The Knowns and Unknowns of China's Green Finance*, Global Commission on the Economy and Climate (March 2017); PBoC, 2018 Financial Statistics Report (total outstanding loans at the end of 2018 were RMB 141.75 trillion—roughly US$20 trillion).
13 People's Bank of China, *Guidelines for Establishing the Green Financial System* (September 2, 2016).
14 China Development Bank NEWS, "Power plant just part of bank's 'green credit's plan" (July 26, 2016).

green finance policies helped channel tens of billions of dollars into renewable energy and low-carbon transport projects.[15]

China's policies with respect to the use of green bond proceeds for coal-fired power plants have created controversy. Those policies allow green bond proceeds to be used for coal-fired power plants in some circumstances, such as when larger, more efficient coal-fired power plants replace smaller, less efficient ones. Some see this as consistent with climate mitigation goals, since carbon emissions are reduced in the short term. Others see this as inconsistent with climate mitigation goals, since larger coal-fired power plants tend to lock in carbon emissions for the medium and long term, and cheaper, less-polluting alternatives may be available.[16]

Work is underway to harmonize Chinese and international green bonds standards. (Leading international standards prohibit the use of green bond proceeds for coal-fired power plants in all circumstances.)[17]

Meeting the climate goals set forth in the Paris Agreement will require trillions of dollars of capital over several decades. China's green finance polices are intended, in part, to help meet that need. Those policies are relatively new and will continue to evolve in the years ahead. How they do so will could play an important role in the world's response to climate change.

15 *China Green Bond Market 2018*, Climate Bonds Initiative and China Central Depository & Clearing Company (February 2019) at pp.3, 9.

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

17 European Investment Bank—Green Finance Committee of China Society for Finance and Banking, "The need for a common language in Green Finance" (November 11, 2017); Yao Wang and Mathias Lund Larsen, "International investors eye China's green bonds," *China Dialogue* (February 7, 2018); FTSE, "How far and how fast can China build its green bond market?" (February 9, 2018).

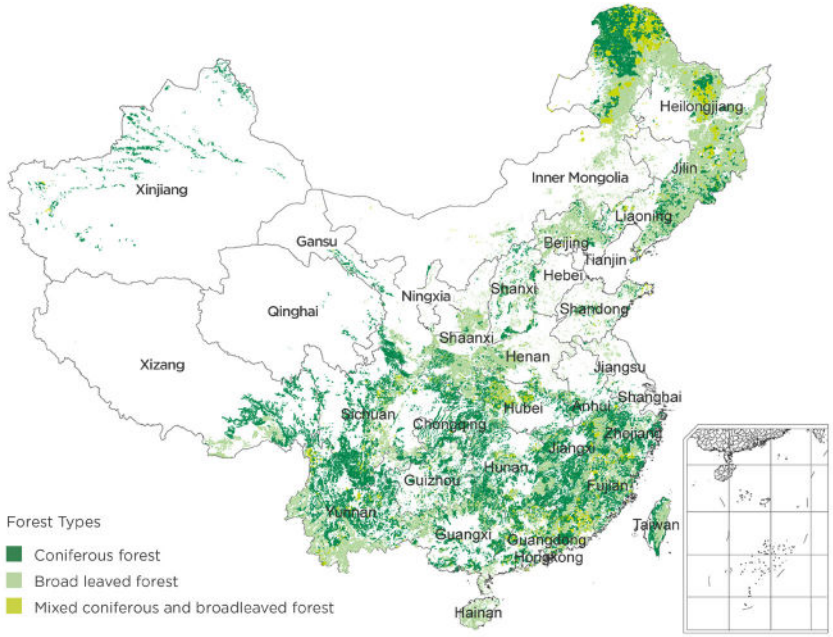
CHAPTER 17 - FORESTRY

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 22% of China's territory is covered with forests, according to both the Chinese government and United Nations Food and Agriculture Organization (FAO).[1]

Figure 17-1: China's Forest Cover



Source: Shi et al. (2011)[2]

1 See NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at p.20, (21.66% forest cover in 2015); Food and Agriculture Organization, Global Forest Resources Assessment 2015 at p.17 (22% forest cover in 2015). See also Global Forest Watch—China country summary, World Resources Institute (16% forest cover in 2010) (accessed July 17, 2019). Different estimates may be due to different definitions of forest and other terms.

2 Lei Shi et al., "The Changes in China's Forests: An Analysis Using the Forest Identity," *PLOS ONE* (June 9, 2011).

China's forest cover has expanded in recent decades, according to a number of sources.

- NDRC reports that more than 7 million hectares of forests were planted in each of 2016, 2017 and 2018—and that China led the world in forest growth in 2017.[3]
- NDRC reports that roughly 15 million hectares of forests were planted between 2011 and 2015.[4]
- China's State Forestry Administration reports that China's forest cover grew from roughly 13% in 1981 to more than 20% in 2010.[5]
- A 2016 study by scientists at Michigan State University found that between 2000 and 2010, 1.6% of China's territory experienced significant increase in forest cover and 0.38% experienced significant forest loss.[6]
- 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.[7]

At least one source finds forest loss in China in recent years. Global Forest Watch, an online platform that provides data for monitoring forests, reports that China lost 439,000 hectares of natural forest in 2018. Global Forest Watch also reports that China lost 9.42 million hectares of tree cover (a 5.8% decrease) from 2001 to 2018.[8]

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.[9]

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3 NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at p.20; NDRC, China's Policies and Actions for Addressing Climate Change (October 2017) at p.15; NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018) at p.16. See also National Bureau of Statistics, *Statistical Bulletin on National Economic and Social Development in 2018* (February 28, 2019) at Part XII; National Bureau of Statistics, Statistical Bulletin on National Economic and Social Development in 2017 (February 28, 2018) at Part XII.

4 NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at p.20;

5 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), 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).

6 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).

7 Lei Shi et al., "The Changes in China's Forests: An Analysis Using the Forest Identity," *PLOS ONE* (June 9, 2011).

8 Global Forest Watch—China country summary, World Resources Institute (accessed July 17, 2019).

9 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).

Forest stock density may be increasing in China as well. The 2011 study Peking University study cited above found that forest stock density in China increased an average of 0.44% annually between 1980 and 2010.[10]

Policies

China's Natural Forest Conservation Program is the largest forest conservation program in the world. It includes massive tree-planting programs, an expansion of forest reserves and a ban on logging in primary forests. The Chinese government spends heavily on these forest programs—more than either the United States or Europe and more than three times the global average per hectare. A study released in 2016 found that "the implementation of the National Forest Conservation Program exhibited a significant relationship with forest gain in China during the first decade of the 21st century."[11]

Historically, the goals of China's forest conservation programs included preventing floods and desertification. The current National Forest Conservation Program was launched in the wake of the catastrophic Yangtze River floods of 1998. 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. Recently the goals of China's forest conservation programs have expanded to include helping fight local air pollution and global warming as well.[12]

China's Intended Nationally Determined Contribution gives high prominence to a forest goal. One of the four principal goals identified in the INDC is "to increase the forest stock volume by around 4.5 billion cubic meters from 2005 levels by 2030." This goal implies a significant increase in forest cover—about two to four times the land area of the United Kingdom. In July 2019, Premier Li Keqiang announced that China had met this goal (11 years ahead of schedule).[13]

To help achieve its forest goals, the Chinese government pledged in its INDC:

- "To vigorously enhance afforestation, promoting voluntary tree planting by all citizens, continuing the implementation of key ecological programs, including protecting natural forests, restoring forest and grassland from farmland, conducting sandification control for areas in vicinity of Beijing and Tianjin, planting shelter belt, controlling rocky desertification, conserving water and soil, strengthening forest tending and management and increasing the forest carbon sink; [and]

10 Lei Shi et al., "The Changes in China's Forests: An Analysis Using the Forest Identity," *PLOS ONE* (June 9, 2011).
11 Ahrends et al., "China's fight to halt" (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).
12 Ahrends et al., "China's fight to halt" (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" (March 2016).
13 People's Republic of China, *Enhanced Action on Climate Change: China's Intended Nationally Determined Contributions* (June 2015) at p.5; Taryn Fransen, Ranping Song, Fred Stolle and Geoffrey Henderson, "A Closer Look at China's New Climate Plan (INDC)," WRI (July 2, 2015); "Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction," *Chinese Government Network* (July 11, 2019).

- "To strengthen forest disaster prevention and forest resource protection and to reduce deforestation-related emissions."[14]

During the 13th Five-Year Plan, the Chinese government aims to increase forest cover from 21.66% to 23% of the country's total land area. Afforestation programs are under way throughout much of China, including the Lower, Middle and Upper Reaches of the Yangtze River; the Pearl River Basin; the Taihang Mountains; and the Beijing-Tianjin-Hebei region.[15]

Official documents setting forth China's forest policies include:

1. *National Afforestation and Greening Plan* (2016–2020)[16]
2. *National Forest Management Plan* (2016–2050)[17]
3. *Action Plan for Climate Change in Forestry in the 13th Five-Year Plan*[18]
4. *Action Plan for Forestry to Adapt to Climate Change* (2016–2020)[19]

The State Forestry and Grassland Administration (SFGA) within the Ministry of Natural Resources has principal responsibility for forest management in China. The SFGA was established in 2018 as part of a government-wide institutional reforms, assuming the functions and responsibilities of the former State Forestry Administration at that time.[20]

The SFGA runs a "carbon forests" program. Under the program (which was launched in 2010), some forests are planted and managed for carbon sequestration. Special procedures and methodologies are required to be sure these forests meet carbon sequestration objectives. These forests may generate credits available for emissions trading. As of the end of 2016, 3.5 million hectares of forests (approximately 2% of China's forested areas) were in the program.[21]

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.[22]

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14 People's Republic of China, Enhanced Action on Climate Change: China's Intended Nationally Determined Contributions (June 2015) at p.10.
15 State Council, Work Plan for Controlling Greenhouse Gas Emissions in the 13th Five-Year Plan at 3(D); PRC, First Biennial Update Report (2016) at chapter 5; "China to Create New Forests Covering Area Size of Ireland: China Daily," Reuters (January 4, 2018).
16 State Forestry Administration, National Afforestation and Greening Plan (2016–2020).
17 State Forestry Administration, National Forest Management Plan (2016–2050).
18 State Forestry Administration, Action Plan for Climate Change in Forestry in the 13th Five-Year Plan.
19 State Forestry Administration, Action Plan for Forestry to Adapt to Climate Change (2016–2020).
20 "State Forestry and Grassland Administration established" (April 11, 2018), National Forestry and Grassland Administration.
21 Wei Zhou, Peichen Gong and Lan Gao, "A Review of Carbon Forest Development in China," Semantic Scholar (2017)
22 "Carbon sink trading sheds new light on China's poverty relief," *XinhuaNet* (July 10, 2018)

Figure 17-2: China's Forestry Development Plan

Source: State Forestry Administration, "China Forestry Development 13th Five-Year Plan"[23]

Sequestration Estimates

China's forest programs sequester significant amounts of carbon.

- 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 CO_2 emissions.)[24]
- 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 CO_2 emissions.)[25]
- 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 CO_2 emissions.[26]

23 State Forestry Administration, *China Forestry Development 13th Five-Year Plan (May 2015)* at p.23.
24 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 CO_2 emissions = roughly 11 Gt. See Chapter 1-Emissions at note 2. 22 Gt C = 81 Gt CO_2,. On C v. CO_2, see Joe Romm, "The Biggest Source of Mistakes: C. v. CO_2," *Think Progress* (March 25, 2008).
25 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 CO_2.
26 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 CO_2; 163.4 TgC = 598 Mt CO_2.

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 1,150 Gt of CO_2 (roughly 11% of China's annual CO_2 emissions) were sequestered by land use change and forestry activities in 2014.[27]
- In its *First Biennial Update Report* submitted to the UN Framework Convention on Climate Change in December 2016, the Chinese government estimated that 576 Gt of CO2 (roughly 6% of China's annual CO_2 emissions) were sequestered by land use change and forestry activities in 2012.[28]

Deforestation Abroad

Significantly, some of China's forest policies, consumption patterns and foreign policies may exacerbate deforestation in other countries, offsetting the climate benefits of the carbon sequestered in China's forests.

- Although the Chinese government has expanded forest reserves and banned logging in China's primary forests, China's timber demand is large and growing. The combination of forest conservation and growing timber demand within China has meant more logging and deforestation in countries that sell timber to China, including Russia, Indonesia, Vietnam and Myanmar.[29]
- Chinese food imports (for soy and other products) are large and growing, contributing to deforestation in other countries as well.[30]
- Some Belt and Road projects have been through forested areas, with adverse impacts on those areas.[31]

From a global perspective, these trends may substantially offset the climate benefits of China's domestic forest conservation policies.

27 People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at p.16.
28 People's Republic of China, *First Biennial Update Report on Climate Change* (December 2016) at p.22.
29 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); Steven Lee Myers, "China's Voracious Appetite for Timber Stokes Fury in Russia and Beyond," *New York Times* (April 9, 2019).
30 Pietro Bertazzi and Sabrina Zhang, "Soy: China's deforestation dilemma," Carbon Disclosure Project (March 21, 2019).
31 Elizabeth Losos, Alexander Pfaff and Lydia Olander, "The deforestation risks of China's Belt and Road Initiative," Brookings (January 28, 2019).

CHAPTER 18 - ADAPTATION

The Chinese government released its *National Strategy for Climate Change Adaptation* in 2013.[1] The *Strategy* sets forth principles for climate change adaptation, including:

- "Set priorities. Based on a comprehensive assessment of the impacts and damage of climate change…China should prioritize and focus on adaptation action for vulnerable fields, regions and groups of people."
- "Take the initiative to adapt. Strengthen monitoring and early warning capabilities, in order to reduce losses caused by climate change."
- "Widen the scope of participation. Improve public awareness about adapting to climate change and mechanisms for social participation in climate adaptation."

The *Strategy* also sets out goals, including:

- significantly reduce the vulnerability of climate-sensitive areas, regions and populations,
- significantly strengthen monitoring, early warning capability, disaster prevention and mitigation capacity for extreme weather events,
- significantly improve climate change fundamental research, observation and forecasting capability, and
- significantly enhance public awareness of climate change.

The *Strategy* was released by NDRC along with eight ministries and bureaus (the Ministry of Finance, the Ministry of Housing and Urban and Rural Development, the Ministry of Transportation, the Ministry of Water Resources, the Ministry of Agriculture, the State Forestry Administration, the Bureau of Meteorology, and the Maritime Bureau). The *Strategy* highlights the need for capacity building in areas including response to extreme weather events, protection of water resources and prevention of soil erosion.[2]

Since the release of the *National Strategy for Climate Change Adaptation*, the Chinese government has adopted climate change adaptation plans in a number of sectors. These plans include:

- *Action Plan on Climate Change Adaptation in Urban Areas*, released by NDRC and MOHURD,
- *Action Plan for Forestry to Adapt to Climate Change* (2016–2020), released by the State Forestry Administration, and

1 NDRC et al., *National Strategy for Climate Change Adaptation* (November 18, 2013).
2 Ibid. See also 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).

- *Plan on Building a Meteorological Disaster Information Management System*, released by the Bureau of Meteorology.[3]

NDRC's *Policies and Actions to Address Climate Change 2018* highlights a number of recent activities to adapt to climate change, including:

- implementation of the National Forest Fire Prevention Plan (2016–2025), with a central budget of more than RMB 2 billion to strengthen forest fire prevention infrastructure,
- issuance of the China Sea Level Communique 2017 "to assess sea level rise and its impact comprehensively and provide the basis for addressing climate change scientifically in coastal regions," and
- release of the Blue Book of Agriculture for Addressing Climate Change.[4]

The Chinese government has dozens of pilot projects underway to help improve approaches for adapting to climate change. *The National Strategy for Climate Change Adaptation* identified 14 pilot projects to improve climate resilience, including projects on urban infrastructure in Shanghai, soil conservation in Jilin Province and emergency response in Hainan Province. *The Working Plan for Pilot Programs on Climate-Adaptable Urban Development* launched a process in which 30 pilot cities are being selected to implement climate adaptation initiatives. (The goal is that climate adaptation principles will be mainstreamed into development planning processes and urban construction standards in the pilot cities by 2020.) The State Oceanic Administration runs pilot projects on disaster risk planning. The State Forestry Administration runs climate change adaptation projects as well.[5]

3 NDRC, China's Policies and Actions for Addressing Climate Change (October 2017) at pp.16–26; NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at pp.20–28; PRC, *First Biennial Update Report on Climate Change* (December 2016) at pp.119–123.
4 NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018) at pp.20–21.
5 NDRC, *China's Policies and Actions for Addressing Climate Change* (October 2016) at pp.20–28; PRC, *First Biennial Update Report on Climate Change* (December 2016) at pp.119–123.

PART III - FOREIGN POLICIES

CHAPTER 19 - UNFCCC

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Rio Earth Summit in 1992. More than 190 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 2002.

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 CO_2 emissions per unit of GDP 40%–45% from 2005 levels by 2020—its first international pledge to limit CO_2 emissions. China also pledged to increase the share of non-fossil fuels in primary energy consumption to 15% and increase forest cover 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 all major emitters, including China, received considerable criticism for the meeting's outcome.[4]

1 UNFCCC, "Parties," (accessed July 27, 2019).
2 See generally 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 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 in December 2015. The joint announcement marked a turning point in the global climate negotiations, with the leaders of world's two largest emitters—the largest developed and developing 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, submitted in June 2015, 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 Paris Agreement. It 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 monitoring, reporting and verification of emissions. Unresolved issues prior to the Katowice conference included the amount of transparency that would be required and 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. Minister Xie Zhenhua, head of the Chinese delegation, said that developing countries are "willing to be transparent because transparency is the basis for mutual confidence. But we have to take into

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" (November 3, 2017); Michael Swaine, "Chinese Attitudes Toward the U.S. Withdrawal from the Paris Accords," *China Leadership Monitor* (September 11, 2017).

consideration that developing countries vary in capabilities and we must admit that fact."[9]

Some commentators noted that the United States' intent to withdraw from the Paris Agreement strengthened China's hand in the negotiations.[10]

Following a high-level meeting at the G20 Summit in June 2019, the Chinese and French governments issued a statement reporting they had reaffirmed their commitment "to update their Nationally Determined Contributions in a manner representing a progression beyond the current one and reflecting their highest possible ambition," as well as to publish "long-term mid-century low greenhouse gas emissions development strategies" by 2020.[11]

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 Kalina Oroschakoff and Paola Tamma, "5 Takeaways from the COP24 Climate Summit," *Politico* (December 16, 2018.
11 "Press Statement on Climate Change following the Meeting Between the State Councilor and Foreign Minister of China, Foreign Minister of France and the United Nations Secretary-General" (June 29, 2019).

CHAPTER 20 - BELT AND ROAD INITIATIVE

The Belt and Road Initiative (BRI) is the largest infrastructure initiative ever. As part of the BRI, Chinese entities will provide financing, goods and services worth hundreds of billions of dollars to thousands of projects in dozens of countries.

The climate change impacts of the Belt and Road Initiative are enormous. The BRI's role in the construction of coal-fired power plants is especially significant. This chapter explores the Belt and Road Initiative's green development policies, energy sector projects, financial institutions and climate impacts.

A. Background

President Xi Jinping announced the Belt and Road Initiative in 2013. The BRI promotes economic cooperation and cultural exchange between China and countries around the world. The word "belt" refers to overland routes from China to the west, including the ancient Silk Road through Central Asia, Iran and Turkey to Europe. The word "road" refers to a sea route—the ancient Maritime Silk Road that started in China and stopped in Vietnam, Indonesia, Malaysia, Sri Lanka, India, Kenya and Djibouti, among other places, before reaching Europe.[1]

The Belt and Road Initiative's geographic scope now extends far beyond these overland and sea routes. The Chinese government reports entering into bilateral cooperation agreements with more than 120 countries in connection with the BRI. Chinese official media discuss projects in Latin America as part of the BRI. The Belt and Road Initiative has become a broad framework for significant parts of China's foreign policies.[2]

President Xi Jinping has convened two Belt and Road Forums in Beijing. The first, in May 2017, was attended by 29 heads of state and representatives from more than 60 countries. The second, in April 2019, was attended by 36 heads of state (including 12 from Europe) and representatives from more than 100 countries.[3]

The Belt and Road Initiative has been incorporated into the Constitution of the Chinese Communist Party. Within the Chinese government, a Leading Small Group on Advancing the Construction of the Belt and Road and BRI office within the National Development and Reform Commission (NDRC) help supervise BRI activity. BRI leading small groups have been created within ministries and provincial governments.[4]

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1 For background on the Belt and Road Initiative, see the Chinese government's Belt and Road Portal; State Council, *Action plan on the Belt and Road Initiative* (March 30, 2015); Yuen Yuen Ang, "Demystifying Belt and Road," *Foreign Affairs* (May 22, 2019); Nadège Rolland, *A Concise Guide to the Belt and Road Initiative*, National Bureau of Asian Research (April 11, 2019); Andrew Chatzky and James McBride, "China's Massive Belt and Road Initiative," Council on Foreign Relations (May 21, 2019); David Sandalow and Xu Qinhua, *Belt and Road Initiative Green Development Conference*, Columbia University and Renmin University (November 19–21, 2017).

2 Zhu Wenqian, "China has signed 171 B&R cooperation documents," *China Daily* (March 7, 2019); Cui Can, "Green Belt and Road Initiative powered by new energy projects," China.org.cn (April 28, 2019).

3 "Second Belt and Road Forum Top-Level Attendees," *The Diplomat* (April 27, 2019); Shannon Tiezzi, "Who Is (and Who Isn't) Attending China's 2nd Belt and Road Forum?," *The Diplomat* (April 27, 2019); "Ministry of Foreign Affairs briefing—April 19, 2019," Second Belt and Road Forum website (accessed August 10, 2019).

4 Nadège Rolland, *A Concise Guide to the Belt and Road Initiative*, National Bureau of Asian Research (April 11, 2019).

As of October 2018, Chinese companies had participated in roughly 6000 infrastructure projects under the Belt and Road Initiative, according to China's State-owned Assets Supervision and Administration Commission (SASAC). Roughly half were undertaken by state-owned enterprises controlled by the central government, according to SASAC. Projects developed under the BRI include roads, railways, ports, pipelines, transmission lines and power plants.[5]

Figure 20-1: Ancient Silk Road and Maritime Silk Road

Source: Quartz, citing Reuters[6]

5 "Central enterprises undertake 3116 projects along the "Belt and Road," State-owned Assets Supervision and Administration Commission (October 31, 2018); James Suokas, "Chinese state enterprises undertake over 3,100 Belt and Road projects," *GB Times* (October 31, 2018); Wang Yajie, "SASAC unveiled the latest transcripts of the "One Belt, One Road" of central enterprises, with a total profit of over 100 billion," *eeo.com.cn* (October 30, 2018).

6 Zheping Huang, "Your guide to understanding OBOR" (May 15, 2017).

B. Green Development Policies

The Chinese government identifies green development as a goal of the Belt and Road Initiative. Speaking at the First Belt and Road Summit in May 2017, President Xi Jinping said:

> We should pursue the new vision of green development and a way of life and work that is green, low-carbon, circular and sustainable...We propose the establishment of an international coalition for green development on the Belt and Road, and we will provide support to related countries in adapting to climate change.[7]

President Xi reiterated those themes in his opening speech at the Second Belt and Road Forum in April 2019, emphasizing the importance of "green and clean cooperation" and highlighting several green development programs under the BRI. The joint communique adopted by the dozens of leaders attending the Second Belt and Road Summit says: "We underline the importance of promoting green development and addressing the challenges of environmental protection and climate change including by enhancing our cooperation to implement the Paris Agreement."[8]

Many green development initiatives were announced at the Second Belt and Road Summit.

- The BRI International Green Development Coalition was launched by the Ministry of Ecology and Environment, United Nations Environment Program (UNEP) and more than 130 partners, including environment ministries, international organizations and NGOs. According to UNEP, the Coalition will help countries that receive Belt and Road investments "establish the enabling conditions to ensure that the investments are environmentally sustainable."[9]
- The Belt and Road Green Cooling Initiative was launched by NDRC, several United Nations agencies and Energy Foundation. The Initiative will promote deployment of energy efficient technologies in the cooling and air conditioning industries with policy dialogues, information exchanges and capacity building programs.[10]
- The Belt and Road Green Lighting Initiative was launched by NDRC and several UN agencies. The Initiative will promote deployment of energy lighting technologies,

7 Xi Jinping, "Speech at Opening of Belt and Road Forum," *Global Times* (May 14, 2017),.
8 "Xi tells summit that China's 'Belt and Road' initiative must be green and sustainable," *Reuters/Japan Times* (April 26, 2019); "Xi Jinping Chairs and Addresses the Leaders' Roundtable," Second Belt and Road Forum for International Cooperation website (accessed August 7, 2019); *Joint Communique of the Leaders' Roundtable of the 2nd Belt and Road Forum for International Cooperation*, Ministry of Foreign Affairs, People's Republic of China (April 27, 2019).
9 Hou Liqiang, "China officially launches green development coalition under BRI," *China Daily* (April 25, 2019); "Belt and Road Initiative International Green Development Coalition," UNEP website (accessed August 7, 2019). See also "*China promotes green development along Belt and Road*," *Xinhua* (May 4, 2019) .
10 "Stakeholders Join Hands to Boost Cooling Efficiency in BRI Countries," EF China News (April 28, 2019); Hu Min and Diego Montero, "Leveraging China's 'Green Soft Power' For Responsible Belt and Road Initiative Investment," *Forbes* (May 14, 2019); "Belt and Road forum builds consensus on green, sustainable development," *China Daily* (April 27, 2019).

also with policy dialogues, information exchanges and capacity building programs.[11]

- The BRI Environmental Big Data Platform will provide information on environmental laws, regulations, standards, policies and technologies in Belt and Road countries. Its five subplatforms include the Shanghai Cooperation Organization's Environmental Information Sharing Platform.[12]

- Twenty-seven financial institutions from around the world adopted the *Green Investment Principles for the Belt and Road Development*, first released in December 2018. Signers included major Chinese financial institutions that invest abroad, including China Development Bank, the Export-Import Bank of China, Agricultural Development Bank of China, China International Capital Corporation and Silk Road Fund.[13]

The Chinese government's policies with respect to green development under the Belt and Road Initiative are set forth in the *Guidance on Promoting Green Belt and Road*, issued by the National Development and Reform Commission (NDRC), Ministry of Environmental Protection (MEP), Ministry of Commerce (MOFCOM) and Ministry of Foreign Affairs (MFA) in May 2017.[14] The document highlights the importance of "ecological civilization and green development." It says:

> We will encourage enterprises to prioritize low-carbon, energy-saving, environment-friendly and green materials and technical processes...We will also guide the businesses to tighten their R&D efforts on key technologies to address climate change.

The *Guidance* calls on companies participating in the Belt and Road Initiative to

- "promote environmental infrastructure construction and improve green and low-carbon construction and operation," and

- "observe...the laws, regulations, policies and standards of host countries on eco-environment protection, [and] attach great importance to the appeals of the local residents on environment protection."

The *Guidance on Promoting Green Belt and Road* builds on the *Guidelines on Environmental Protection in Overseas Investment and Cooperation*, issued by MEP and MOFCOM in 2013. The earlier guidelines encourage Chinese companies investing abroad "to identify and

11 "The Belt and Road Green Lighting initiative (BRGLI) was Officially Launched," International Solid State Lighting website (April 25, 2019) (accessed August 8, 2019); Catherine Benson Wahlén, "Second Belt and Road Forum Results in Over 283 Deliverables," IISD/SDG Knowledge Hub (May 2, 2019).
12 Hou Liqiang, "China officially launches green development coalition under BRI," *China Daily* (April 25, 2019); Hou Liqiang, "Online tools will allow sharing on environment," *China Daily* (June 15, 2019).
13 "Green Belt and Road principles receive industry backing," *People's Daily* (April 26, 2019); "Twenty-seven Global Institutions Sign up to Green Investment Principles for the Belt & Road," Hong Kong Trade Development Council (May 3, 2019)
14 NDRC, MEP, MOFCOM and MFA, *Guidance on Promoting Green Belt and Road* (May 8, 2017) (Chinese); NDRC, MEP, MOFCOM and MFA, *Guidance on Promoting Green Belt and Road* (May 8, 2017) (English)

preempt environmental risks in a timely manner."[15]

Neither the *Guidance on Promoting Green Belt and Road* nor *Guidelines on Environmental Protection in Overseas Investment and Cooperation* contain implementation or enforcement mechanisms. NDRC and MOFCOM, which are responsible for approving many overseas projects under the BRI, have limited experience evaluating the potential climate change impacts of projects. The Chinese government does not require the evaluation of climate change impacts or environmental impacts more broadly in connection with BRI projects.[16]

C. Energy Sector Projects

Energy sector projects are a significant part of the Belt and Road Initiative. Under the BRI, Chinese policy banks, commercial banks, state-owned energy companies and private energy companies are participating in hundreds of energy projects worth hundreds of billions of dollars around the world. The overwhelming majority of these projects are in coal, oil and gas, although the number of renewable energy projects is growing.

Several recent studies have collected data on Chinese energy sector projects in Belt and Road countries.

- A 2019 study by the International Energy Agency (IEA) found an average of US$10.5 billion in annual investments and contracts by Chinese entities in the energy sectors of non-OECD Asian countries between 2013 and 2017. The study found that "China has become a major provider of capital, construction services, and equipment to the energy sectors of developing and emerging economies."[17]
- A 2018 study by the World Resources Institute (WRI) and Boston University's Global Development Policy Center of Chinese energy sector financing in BRI countries from 2014 to 2017 found more than $130 billion in syndicated bank loans by six large Chinese banks, $45 billion of loans provided exclusively by China Development Bank or China Exim, $3.5 billion of equity and debt financing from the Silk Road Fund and $60 billion of greenfield investments or merger and acquisition activity from Chinese companies.[18]

15 Kelly Sims Gallagher and Qi Qi, "Policies Governing China's Overseas Development Finance: Implications for Climate Change," The Fletcher School, Tufts University (March 2018) at p.18.
16 Kelly Sims Gallagher and Qi Qi, "Policies Governing China's Overseas Development Finance: Implications for Climate Change," The Fletcher School, Tufts University (March 2018) at pp.18-19; Jonathan Elkind, "Toward a Real Green Belt and Road," Columbia Center on Global Energy Policy (April 25, 2019).
17 David Bénazéraf et al., *Chinese Companies Energy Activities in Emerging Asia*, International Energy Agency (April 2019) at pp. 2 and 4.
18 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/ Boston University Working Paper (2018).

At least 10 organizations maintain databases with information on Chinese energy sector activities around the world.

- China's State-owned Assets Supervision and Administration Commission (SASAC) collects information on energy and other infrastructure projects with Chinese involvement in Belt and Road countries. SASAC provides high-level summaries of that data, including on the number of projects in the oil and gas sector.[19]
- American Enterprise Institute's China Global Investment Tracker covers Chinese investments and construction contracts in all sectors globally dating back to 2005. It identifies over $150 billion of energy sector investments by Chinese entities globally between 2014 and 2019 and over $180 billion in energy sector construction contracts by Chinese companies abroad during the same period.[20]
- Boston University's Global Development Policy Center tracks overseas development finance in the energy sector provided by China Development Bank and China ExIm. It identifies roughly $125 billion of financing from these two policy banks for energy sector projects globally between 2014 and 2018.[21]
- Mercator Institute for China Studies' maintains a database with more than 2000 Chinese projects abroad "most often related to transport or energy infrastructure in certain parts of Asia, Europe and East Africa." Mercator researchers find that "about two thirds of Chinese spending on completed BRI projects went into the energy sector." [22]
- The Center for Strategic and International Studies' Reconnecting Asia project maintains a database of Asian infrastructure including power plants, pipeline and transmission lines. The database includes information on roughly 500 Belt and Road projects.[23]
- Global Energy Monitor maintains a database of "coal projects receiving foreign support from a major G20 public finance institution" from 2013 through mid-2018. It finds that Chinese financial institutions were supporting roughly 27 GW of coal projects as of November 2018, with another 24 GW in the pipeline as of that date.[24]
- Natural Resources Defense Council maintains databases of coal projects financed by G20 countries (including China) and renewable energy projects supported by

19 "Central enterprises undertake 3116 projects along the "Belt and Road," State-owned Assets Supervision and Administration Commission (October 31, 2018); James Suokas, "Chinese state enterprises undertake over 3,100 Belt and Road projects," *GB Times* (October 31, 2018); Wang Yajie, "SASAC unveiled the latest transcripts of the "One Belt, One Road" of central enterprises, with a total profit of over 100 billion," *eeo.com.cn* (October 30, 2018).
20 American Enterprise Institute, *China Global Investment Tracker* (accessed July 24, 2019).
21 Global Development Policy Center, Boston University, *China's Global Energy Finance* (accessed July 27, 2019).
22 Mercator Institute for China Studies, Belt and Road Tracker (accessed July 27, 2019) Thomas Eder and Jacob Mardell, "Powering the Belt and Road," Mercator Institute for China Studies (June 27, 2019).
23 Center for Strategic and International Studies, Reconnecting Asia Database—Belt and Road (accessed July 27, 2019).
24 Global Energy Monitor, *Global Coal Finance Tracker* (accessed August 7, 2019).

Chinese entities in BRI countries.[25]

- The East-West Institute maintains a BRI Projects Database with information on "timeline, status, financing, contracting and terms" of BRI energy sector and other projects."[26]
- The Chinese Academy of Social Sciences maintains a Belt and Road database with thousands of articles on Belt and Road topics, including energy.[27]
- Xinhua News' Silk Road database maintains information on laws and regulations in Belt and Road countries and other topics relevant to energy sector projects.[28]

Energy projects receive attention in Chinese government policy statements on the Belt and Road Initiative. The State Council's 2015 *Action Plan on the Belt and Road Initiative* includes a discussion of the energy sector, saying:

> We should increase cooperation in the exploration and development of coal, oil, gas, metal minerals and other conventional energy sources; advance cooperation in hydropower, nuclear power, wind power, solar power and other clean, renewable energy sources...[29]

A "Belt and Road Energy Partnership" was announced at the Second Belt and Road Forum in Beijing in April 2019. Ministers from more than 30 countries agreed to "strengthen infrastructure connectivity, enhance energy investment and promote cooperation in clean energy, energy efficiency, capacity building and personnel training."[30]

25 See Han Chen, "Greener Power Projects for the Belt & Road Initiative," Natural Resources Defense Council (April 22, 2019); Han Chen, "Carbon Trap: How International Coal Finance Undermines the Paris Agreement," Natural Resources Defense Council (November 14, 2016).
26 East-West Institute, BRI Projects Database (accessed August 10, 2019).
27 Chinese Academy of Social Sciences, Belt and Road Database (accessed August 10, 2019).
28 Xinhua News, Xinhua Silk Road Database (accessed August 10, 2019).
29 State Council, *Action plan on the Belt and Road Initiative* (March 30, 2015) at part IV (Unimpeded trade).
30 "Belt and Road Energy Partnership inaugurated in Beijing," *Xinhua* (April26, 2019).

Coal Power

Chinese companies play a significant role in the development, construction and financing of coal-fired power plants around the world. In the first half of 2019, media outlets reported on Chinese support for new coal power plants in many countries, including the Philippines, Vietnam, Indonesia, Bangladesh, Pakistan, Kenya, Mozambique, Malawi, South Africa, Zimbabwe and Serbia.[31]

Several recent studies have reported data on this topic.

- A 2019 study by the Institute for Energy Economics and Financial Analysis (IEEFA) found that "[o]f the 399 gigawatts (GW) of coal plants currently under development outside China, Chinese financial institutions and corporations have committed or offered funding for over one-quarter of them (102 GW)."[32]
- A 2019 study by the International Energy Agency found a Chinese role in 48 GW of coal-fired power plant capacity in non-OECD Asia between coming online between 2013 and 2022.[33]
- A study by the Global Environmental Institute found Chinese involvement in more than 100 coal-fired power plants in planning or under construction in Belt and Road countries as of May 2017. (This included consulting, design, equipment exports, construction and financing.)[34]

Several databases maintain information on the Chinese role in coal power plants around the world.

- Boston University's Global Development Policy Center identifies $23.4 billion of coal investment by China Development Bank and China ExIm abroad between 2014 and 2018.[35]

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31 "Lanao Kauswagan power station," *SourceWatch* (July 19, 2019); "Congratulations Pakistan: Thar coal plant starts producing electricity," *Global Village Space* (March 19, 2019); "GCM and POWERCHINA Inks US$4bn Power Deal," *GCM Resources* (January 17, 2019); "Construction Resumes on $1.5 Billion Zimbabwe Power Project," *POWER Magazine* (March 3, 2019); Ashfaq Ahmed, "Pakistan opens its first coal power plant in the most backward area of Thar," *Gulf News* (Aril 10, 2019); Dana Ullman, "When Coal Comes to Paradise," *Foreign Policy* (June 9, 2019); Dusan Stojanovic, "China's Spending Influence in Eastern Europe worries West," *AP News* (April 10, 2019); Gary Sands, "How China's Belt and Road Initiative could lead Vietnam away from renewable energy," *South China Morning Post* (June 11, 2019); Jonathan Watts, "Belt and Road summit puts spotlight on Chinese coal funding," *The Guardian* (April 25, 2019); Karl Mathiesen, "China scrubs its coal projects from 'world heritage in danger' in decision," *Climate Home News* (May 7, 2019); Oliver Griffin, "Ncondezi Energy Shares Rise on Agreement With CMEC, General Electric's Swiss Unit," *Morningstar* (July 23, 2019); Rangga Prakoso, "Lontar Extension PLTU Operates in September," *Berita Satu* (March 29, 2019); Michael Lelyveld, "China's Belt And Road Initiative Blackened By Coal," *Eurasia Review* (February 1, 2019).

32 Christine Shearer et al., "China at a Crossroads," Institute for Energy Economics and Financial Analysis (January 2019).

33 David Bénazéraf et al., *Chinese Companies Energy Activities in Emerging Asia*, International Energy Agency (April 2019).

34 Ren Peng, Liu Chang and Zhang Liwen, "China's Involvement In Coal-Fired Power Projects Along The Belt And Road," Global Environmental Institute (May 2017) at pp.1, 5 (106 new coal-fired power plants under construction or in planning pipeline as of May 2017).

35 Global Development Policy Center, Boston University, *China's Global Energy Finance* (accessed July 27, 2019).

- The American Enterprise Institute's China Global Investment Tracker identifies $23.5 billion of coal investments and $36.4 billion of coal contracts by Chinese entities abroad between 2014 and July 2019.[36]
- Global Energy Monitor finds that Chinese public financial institutions were supporting roughly 27 GW of coal projects abroad as of November 2018, with another 24 GW in the pipeline as of that date.[37]
- Natural Resources Defense Council maintains databases of coal projects financed by G20 countries (including China).[38]

China's state-owned policy banks provide substantially more support for coal-fired power plants abroad than any other public financial institutions.

- As of early 2019, China's state-owned policy banks were supporting roughly 44 GW of coal-fired power plants in the development pipeline abroad. South Korean financial institutions were supporting roughly 14 GW and Japanese financial institutions were supporting roughly 10 GW. [39]
- From 2013–2018, China's state-owned policy banks supported roughly 27 GW of coal-fired power plants abroad. Japanese financial institutions supported roughly 20 GW and South Korean financial institutions supported roughly 8.5 GW.[40]
- Multilateral development banks and export credit agencies in North America and Europe have rules that either prohibit or very strictly limit financing of coal-fired power plants.[41]

Decisions concerning the type of technology used in coal power plants (subcritical, supercritical or ultra-supercritical) are left to host governments under the Belt and Road Initiative. Chinese government policies neither require nor provide incentives for more efficient coal power technologies in Belt and Road projects. IEFFA found that, as of early 2019, 38% of the coal-fired power plant capacity under development around the world with Chinese support used ultra-supercritical technology, 35% used supercritical and 23% used subcritical.[42]

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36 American Enterprise Institute, *China Global Investment Tracker* (accessed July 24, 2019).
37 Global Energy Monitor, *Global Coal Finance Tracker* (accessed August 7, 2019).
38 See Han Chen, "Carbon Trap: How International Coal Finance Undermines the Paris Agreement," Natural Resources Defense Council (November 14, 2016).
39 Christine Shearer et al., "China at a Crossroads," Institute for Energy Economics and Financial Analysis (January 2019) at p.3; Han Chen, "The Questionable Future of Overseas Coal Investments," Natural Resources Defense Council (November 27, 2018).
40 Han Chen, "The Questionable Future of Overseas Coal Investments," Natural Resources Defense Council (November 27, 2018). See Christine Shearer et al., "China at a Crossroads," Institute for Energy Economics and Financial Analysis (January 2019) at p.4 ("From 2013 to 2016, the five biggest Group of Twenty (G20) coal plant financiers were located in China, totaling US$15 billion in financing.")
41 Paul Baruya, *International finance for coal-fired power plants*, International Energy Agency (April 2017); "World Bank pulls out of Kosovo coal power plant project," Reuters (October 10, 2018); Tim Buckley, *Over 100 Global Financial Institutions Are Exiting Coal, With More to Come*, Institute for Energy Economics and Financial Analysis (February 27, 2019).
42 Christine Shearer et al., "China at a Crossroads," Institute for Energy Economics and Financial Analysis (January 2019).

Oil and Gas

China is the world's largest importer of oil and natural gas. In part due to energy security concerns, Chinese government policies have long encouraged China's large state-owned large oil companies, related service companies and financial institutions to invest in oil and gas projects abroad. These businesses have extensive investments and operations in upstream and midstream oil and gas operations around the world.

Chinese investment in oil and gas operations abroad is enormous.

- State-owned enterprises owned by the Chinese central government have participated in more than 60 oil and gas projects in over 20 countries since 2013, according to SASAC.[43]
- The 2019 WRI/Boston University study found over $100 billion of syndicated loans for oil, gas and petrochemical projects abroad between 2014 and 2017.[44]
- The American Enterprise Institute's China Global Investment Tracker identifies $54 billion of oil and gas investments and $56 billion of oil and gas contracts by Chinese entities abroad between 2014 and July 2019.[45]
- Boston University's China Global Energy Finance database identifies $62 billion of financing from China Development and China ExIm for oil and gas sector projects between 2014 and 2018.
- The IEA found that Chinese national oil companies invested US$7.3 billion in production rights in 26 oil fields in nine Asian countries in 2017.[46]

China National Petroleum Company (CNPC), one of three large Chinese state-owned oil companies, is a member of the Oil and Gas Climate Initiative —"a voluntary CEO-led initiative taking practical actions on climate change."[47]

Hydropower

Chinese banks and companies have played a significant role in hydropower construction abroad.

- In Southeast Asia, Chinese entities have helped build more than 135 hydropower

43 "Central enterprises undertake 3116 projects along the "Belt and Road," State-owned Assets Supervision and Administration Commission (October 31, 2018); James Suokas, "Chinese state enterprises undertake over 3,100 Belt and Road projects," *GB Times* (October 31, 2018); Wang Yajie, "SASAC unveiled the latest transcripts of the "One Belt, One Road" of central enterprises, with a total profit of over 100 billion," *eeo.com.cn* (October 30, 2018); "SASAC responds to the concerns of the Belt and Road project," *BHI.com.cn* (March 11, 2019).
44 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/Boston University Working Paper (2018).
45 American Enterprise Institute, *China Global Investment Tracker* (accessed July 24, 2019).
46 David Bénazéraf et al., *Chinese Companies Energy Activities in Emerging Asia*, International Energy Agency (April 2019) at p.11.
47 Oil and Gas Climate Initiative website (accessed August 10, 2019).

dams with 65 GW of capacity.[48]

- The American Enterprise Institute's China Global Investment Tracker identifies $22 billion of hydropower investments and $46 billion of hydropower contracts by Chinese entities abroad between 2014 and July 2019.[49]
- The IEA identified 10 GW of hydropower capacity coming online with Chinese support in non-OECD Asia between 2013 and 2022.[50]
- Boston University's database identifies $21.9 billion of hydropower projects supported by China Development Bank and China ExIm between 2014 and 2018.[51]

These dams have been controversial. Although hydropower is a low-carbon power supply, it can have serious adverse impacts on local ecosystems. Chinese-financed hydropower projects in Mongolia, the Democratic Republic of the Congo, Indonesia and the Mekong Basin have been criticized for causing serious environmental damage.[52]

At the Second Belt and Road Summit in April 2019, China's Ministry of Water Resources signed an MOU with the United Nations Industrial Development Organization (UNIDO) to promote small hydropower development in Belt and Road countries.[53]

Solar and Wind Power

Solar and wind power projects are a small but growing part of the Belt and Road Initiative.

- A 2019 Greenpeace study found Chinese equity investment in 1.7 GW of installed solar and wind power projects abroad as of the end of 2018, with another 10.8 GW in the pipeline.[54]
- A 2019 Natural Resources Defense Council study found $5.5 billion in loans for renewable energy projects from Chinese policy banks and commercial banks between 2014 and 2019."[55]
- A 2018 World Resources Institute/Boston University study found roughly $3 billion in syndicated loans by Chinese banks for solar and wind power projects between 2014 and 2017 (out of almost $130 billion in such loans for energy projects more broadly). The study also found roughly $2.4 billion of solar and wind power financing by China Development and China ExIm during this period (out of roughly $45 billion of

48 Brian Eyler, "Can solar diplomacy green the Belt and Road?," *China Dialogue* (January 2019) at p.7.
49 American Enterprise Institute, *China Global Investment Tracker* (accessed July 24, 2019).
50 David Bénazéraf et al., *Chinese Companies Energy Activities in Emerging Asia*, International Energy Agency (April 2019).
51 Global Development Policy Center, Boston University, *China's Global Energy Finance* (accessed August 10, 2019).
52 Hu Min, Diego Montero, "Leveraging China's 'Green Soft Power' For Responsible Belt and Road Initiative Investment," *Forbes* (May 14, 2019).
53 Hou Liqiang, "China signs hydropower agreement with UN," *China Daily* (April 26, 2019).
54 Greenpeace, *China's Equity Investments in Overseas Coal, Wind, and Solar Energy Projects* (July 29, 2019).
55 Han Chen, "Greener Power Projects for the Belt & Road Initiative," Natural Resources Defense Council (April 22, 2019) (see graph—"Chinese Project Loans for Renewables 2013–2018).

total energy sector lending). It identified roughly $8 billion of solar and wind power investments by Chinese nonfinancial companies (almost all privately owned).[56]

- A 2019 IEA study found 3.1 GW of Chinese solar and wind power projects in non-OECD Asia solar from 2013–2022.[57]

Chinese banks and companies are supporting several large, high-profile renewable energy projects around the world.

- In Saudi Arabia, Shanghai Electric and ACWA Power are building a 950 MW concentrated solar power plant—the largest in the world.[58]
- In Argentina, China Development Bank and China Export-Import Bank are financing construction of a 500 MW solar PV plant—the largest in Latin America.[59]
- In Kazakhstan, China Power International built a 100 MW wind power project—the largest in Central Asia. The project opened in July 2019. [60]

The solar and wind power potential in Belt and Road countries is huge. The solar and wind resources in many BRI countries are enormous, domestic targets encourage deployment and many countries have made pledges to increase renewable power deployment as part of the UN Framework Convention on Climate Change (UNFCCC) process.[61]

- A recent Harvard University study found that the projected power demand in BRI countries in 2030 could be met with 3.7% of the solar energy that reaches those countries.[62]
- A Natural Resources Defense Council study found that the renewable energy capacity of BRI countries could reach 644 GW in 2030, based on those countries' domestic renewable energy targets.[63]
- The WRI/BU study found 327 GW of new renewable energy capacity would be needed by 2030 to meet the commitments of 31 BRI countries in their Nationally Determined Contributions submitted to the UNFCCC.[64]

56 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/Boston University Working Paper (2018).
57 David Bénazéraf et al., *Chinese Companies Energy Activities in Emerging Asia*, International Energy Agency (April 2019) at p.9.
58 "ACWA, Shanghai Electric lead Dubai 950 MW Concentrated Solar Power -PV NOOR Energy 1 Project," helioscsp.com (accessed August 21, 2019) .
59 Hu Min and Diego Montero, "Leveraging China's 'Green Soft Power' For Responsible Belt and Road Initiative Investment," *Forbes* (May 14, 2019).
60 Wen Long Jie, "Central Asia's largest wind power investment project opened in Kazakhstan," China News (July 18, 2019).
61 See Brian Eyler, "Can solar diplomacy green the Belt and Road?," *China Dialogue* (January 2019).
62 Shi Chen et al., "The Potential of Photovoltaics to Power the Belt and Road Initiative," Joule (June 27, 2019).
63 Han Chen, "Greener Power Projects for the Belt & Road Initiative," Natural Resources Defense Council (April 22, 2019);
64 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/Boston University Working Paper (2018).

D. Financial Institutions

Funding for the Belt and Road Initiative comes through many channels. Those include Chinese policy banks, such as the China Development Bank and Chinese Export-Import Bank; multilateral development banks in which China plays a leading role, including the Asian Infrastructure Investment Bank and New Development Bank; and Chinese state-owned enterprises.

China Development Bank

China Development Bank (CDB) is the world's largest development finance institution. At the end of 2018, its assets were RMB 16.18 trillion ($2.35 trillion) and loan balance was RMB 11.68 trillion ($1.7 trillion). This is more than the assets and loan balances of the World Bank and Asian Development Bank combined.[65]

China Development Bank was established in 1994. According to its website, CDB is "a policy financial institution under the direct leadership of the State Council."[66] Its largest shareholder is the Chinese Ministry of Finance, which owns roughly 36.5% of outstanding shares, and its debt is backed by China's sovereign credit. China Development Bank invests in infrastructure, basic industries, energy and transport around the world. It provides loans, loan guarantees and a range of other financial tools. Its objectives include promoting economic growth within China and promoting the competitiveness of Chinese entities abroad.

China Development Bank was an early advocate of green finance practices. In 2008, CDB began implementing the Equator Principles, a tool to help financial institutions assess the environmental and social risks of projects. CDB has developed an environmental and social risk assessment system for its international projects in accordance with the UN Global Compact principles. China Development Bank does not have a separate, stand-alone climate change or low-carbon policy.[67]

According to its 2018 Annual Report, China Development Bank made RMB 342.8 billion (about $50 billion) in green loans in 2018, bringing its total green loans outstanding to around RMB 1.984 trillion (about $288 billion). This is a 16% increase from 2017. "Green loans" include those for energy-saving projects, clean energy, industrial pollution control, circular economy and urban environmental improvement. CDB calculates that its green loan portfolio helps reduce carbon dioxide emission by 140.55 million tons each year.[68]

In April 2019, CDB signed the Green Investment Principles for the Belt and Road.[69]

65 *China Development Bank Annual Report 2018* at p.6; *World Bank Group Annual Report 2018* at pp. 80–88; *Asian Development Bank Annual Report 2018—Financial Highlights* (accessed July 29, 2019).
66 China Development Bank website (accessed July 29, 2019).
67 See Zhao Shijun, "Power plant just part of bank's 'green credit' plan," *CDB News* (July 26, 2016).
68 *China Development Bank Annual Report 2018* at pp.6, 14, 43.
69 See note 14 below.

China Development Bank is one of the largest financiers of coal-fired power plants in the world. In the past decade it has provided more than $23 billion for at least 30 coal power plants abroad.[70]

China ExIm

The Export-Import Bank of China (China ExIm) was also established in 1994. It operates under the direct leadership of China's State Council and is solely owned by the Chinese government. Its mission is to support China's foreign trade, investment and international economic cooperation. China ExIm provides loans, loan guarantees and a range of other financial tools.[71]

According to its 2017 annual report (the most recent available), China ExIm had RMB 3.64 trillion (roughly US $541 billion) in total assets and RMB 2.88 trillion (roughly $417 billion) in outstanding on-balance-sheet loans as of December 31, 2017.[72]

> China ExIm highlights its record in promoting clean energy. Its website reports that China Exim has actively supported the strategic emerging industries and the sector of green and clean energy. It has worked to facilitate the green transformation of traditional manufacturing and establish an industry system for green and low-carbon cyclic development…It has also assisted highly energy-consuming and high-emission enterprises with technological transformation.[73]

China ExIm is one of the largest financiers of coal-fired power plants in the world. In the past decade, it has provided at least $18 billion for at least 30 coal power plants abroad.[74]

Asian Infrastructure Investment Bank

According to its website, the Asian Infrastructure Investment Bank (AIIB) is "a multilateral development bank with a mission to improve social and economic outcomes in Asia and beyond." China proposed establishment of AIIB in 2013 and waged a successful diplomatic campaign over several years to bring countries on board as members. AIIB started operations in 2016, with a Beijing headquarters. As of December 31, 2018, AIIB had assets of $19.56 billion, $7.5 billion in outstanding loans (for 35 projects) and 93 member countries.[75]

The AIIB describes its core values as "Lean, Clean, and Green." Its Environment Framework calls for environmental and social due diligence on all projects, as well as public disclosure of social and environmental risks. AIIB specifically addresses climate change in its Environment Framework, stating that

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70 Global Development Policy Center, Boston University, China's Global Energy Finance (accessed July 29, 2019).
71 *Export-Import Bank of China Annual Report 2017* at p.29.
72 *The Export-Import Bank of China Annual Report* 2017 at pp.3, 16.
73 "Green Finance," The Export-Import Bank of China website (accessed August 25, 2019).
74 Global Development Policy Center, Boston University, China's Global Energy Finance (accessed July 29, 2019).
75 "Who We Are," AIIB website (accessed August 25, 2019); PricewaterhouseCoopers, Asian Infrastructure Investment Bank Auditor's Report and Financial Statements for the Year Ended Dec. 31, 2018 (April 3, 2019) at pp.2 and 5; 2018 AIIB Annual Report and Financials (accessed July 29, 2019). See Daniel Poon, "AIIB: Experiments in scaling-up development finance," United Nations Conference on Trade and Development (March 2018).

> The Bank recognizes the challenges presented by climate change and the need to support both mitigation and adaptation measures in a Project facing such challenges. The Bank supports its Clients in their evaluation of both the potential impacts of the Project on climate change and the implications of climate change on the Project. To this end, the Bank plans to prioritize investments promoting greenhouse gas emission neutral and climate resilient infrastructure, including actions for reducing emissions, climate-proofing and promotion of renewable energy.[76]

AIIB released its Energy Sector Strategy in June 2017. The strategy's "Principle 3" is "Reduce the carbon intensity of energy supply." The text states:

- "The Bank will support clients to reduce the carbon intensity of energy to help them achieve their long-term climate goals provided in the Paris Agreement…"
- "The Bank will support and accelerate its members' respective transitions toward a low-carbon energy mix through investments in RE and reduction of carbon emissions from fossil fuels…"
- "The Bank will support clients to develop intermittent RE—hydropower, wind, solar, and other sources—to reduce fossil fuel consumption and increase access to modern energy through decentralized generation, and mini- and micro-grids…"
- "The Bank will focus on supporting and accelerating its members' respective transitions toward a low-carbon energy mix, including lower carbon emissions from fossil fuels…Supported fossil fuel-based generation facilities would be expected to use commercially available least-carbon technology."
- "Carbon efficient oil- and coal-fired power plants would be considered if they replace existing less efficient capacity or are essential to the reliability and integrity of the system, or if no viable or affordable alternative exists in specific cases."[77]

As of July 2019, AIIB has approved 15 projects in the energy sector, including a geothermal power plant in Turkey, a natural gas infrastructure project to replace coal in Beijing, a power system upgrade in Bangladesh, a solar PV feed-in tariff program in Egypt and hydropower projects in Nepal, Tajikistan, Myanmar and Pakistan.[78]

New Development Bank (or BRICS Bank)

The New Development Bank (NDB) was established in 2014 by the five BRICS countries—Brazil, Russian, India, China and South Africa. Its headquarters are in Shanghai. Each member country pledged a capital contribution of $10 billion.[79]

76 AIIB, *Environmental and Social Framework* (February 2016) at p.8, para.16.
77 AIIB, Energy Sector Strategy: Sustainable Energy for Asia (June 15, 2017) at pp.12, 15, 17.
78 AIIB, "Approved Projects" (accessed July 23, 2019).
79 "About Us," New Development Bank website (accessed August 25, 2019); Stephany Griffiths-Jones, "Financing Global Development: The BRICS New Development Bank," German Development Institute (November 2015) at pp.1–3.

The purpose of the New Development Bank is "to support infrastructure and sustainable development efforts in BRICS and other underserved, emerging economies for faster development through innovation and cutting-edge technology." New Development Bank materials say the following:

> The 21st century has brought with it tremendous development. However, this progress has been skewed, insufficient and often harmful to our environment. We will collaborate with Initiatives that drive growth and employment while ensuring environmental protection.[80]

The New Development Bank gives priority to clean energy in its lending. As of July 2019, NDB has approved 38 loans, nine of which were for clean energy, energy conservation or environmental protection projects. These nine projects had a cumulative loan amount of $2.6 billion.[81]

New Development Bank's Environmental and Social Framework directly addresses climate change, stating the following in the section on "Core Principles":

> NDB seeks to promote mitigation and adaptation measures to address climate change. Recognizing the sustainable nature of green economic growth and the associated benefits, NDB aims to build upon existing green economic growth initiatives and provide support for the new ones at regional, national, sub-national and private sector level. NDB also encourages climate proofing of its infrastructure financing and investments to build resilience to climate change.[82]

In evaluating potential projects, NDB staff are directed to:

> [a]ssess 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.[83]

Silk Road Fund

The Silk Road Fund (SRF) was established in 2014 with investments by the State Administration of Foreign Exchange, China Investment Corporation, China Development Bank and Export-Import Bank of China. Its total paid-in capital is now $54.5 billion. The Silk Road Fund provides financing for trade and economic cooperation under the BRI. It is primarily an equity investment fund.[84]

From 2014 to 2017, 93% of the Silk Road Fund's energy sector investments were in fossil fuel projects, including a coal-fired power plant in the UAE and natural gas power plant in Egypt. The Silk Road Fund has also invested in a hydropower project in Pakistan. In June 2019 the Silk Road

80 "About Us," New Development Bank website (accessed August 25, 2019).
81 "Projects," New Development Bank website (accessed August 25, 2019).
82 New Development Bank, *New Development Bank Environment and Social Framework* (March 11, 2016) at pp.4–5.
83 New Development Bank, *New Development Bank Environment and Social Framework* (March 11, 2016) at p.17.
84 Silk Road Fund website (accessed July 27, 2019).

Fund purchased a 49% stake in the renewable energy subsidiary of a Saudi power company.[85]

The Silk Road Fund's website says it "pays close attention to environmental issues and sustainable development."[86]

E. Climate Impacts

The Belt and Road Initiative will have enormous climate impacts in the decades ahead. Due to the BRI's vast scale, focus on infrastructure development and role in the power sectors of dozens of countries, among other factors, the choices made under the Belt and Road Initiative will have a significant impact on the world's ability to meet the goals set forth in the Paris Agreement.[87]

There are no comprehensive analyses of the climate impacts of the Belt and Road Initiative. Such an analysis would be challenging for several reasons. First, there is no clear definition of what constitutes a Belt and Road project. Second, emissions data with respect to most Belt and Road projects are lacking. Third, defining "baselines" or counterfactuals to analyze what might happen in the absence of a Belt and Road project is often difficult at best.

Nevertheless, several studies help to indicate the nature and scale of the BRI's climate impacts:

- One study found that "most Chinese deals in energy and transportation are still tied to traditional sectors and do not show a strong alignment with the low-carbon priorities included in BRI governments' NDCs." ("NDCs" are the climate action plans submitted by national governments to the UN Framework Convention on Climate Change, known as "Nationally Determined Contributions.") This suggests that many BRI projects are already making it more difficult to meet national and global climate goals.[88]

- Another study found that foreign power plants supported by Chinese financial institutions between 2001 and 2016 release almost 600 million tons of CO_2 per year (more CO_2 than all but seven countries in the world) and that if these plants operate for 30 years on average, lifetime CO_2 emissions from the plants will be almost 18 Gt (roughly half of global emissions in 2017).[89]

The "lock-in effect" of BRI infrastructure may have especial significance with respect to

85 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/Boston University Working Paper (2018) at pp.3, 16–17; Max Hall, "Saudi's ACWA Renewables sells 49% stake to China's Silk Road Fund," *PV Magazine* (June 24, 2019).
86 Silk Road Fund website (accessed July 27, 2019).
87 See Isabel Hilton, "How China's Big Overseas Initiative Threatens Global Climate Progress," *Yale Environment 360* (January 3, 2019); Simon Zadek, "The critical frontier: Reducing emissions from China's Belt and Road Initiative," Brookings (April 25, 2019); Kelly Sims Gallagher, "China's Belt and Road is a conduit for polluting investments," *Financial Times* (August 9, 2018); Elizabeth Economy, "Why China is No Climate Leader," *Politico* (June 12, 2017). The goals set forth in the Paris Agreement include limiting the increase in global average temperatures to "well below" 2°C/3.6°F over pre-industrial levels and achieving global net zero emissions in the second half of this century. Paris Agreement Articles 2.1(a) and 4.1.
88 Lihuan Zhou et al., *Moving The Green Belt And Road Initiative: From Words To Actions*, World Resources Institute/Boston University Working Paper (2018) at pp.1, 26.
89 Kelly Sims Gallagher, "The Carbon Consequences of China's Overseas Investments in Coal," The Fletcher School, Tufts University (2016), at p.49 (country emissions data); BP, *BP Statistical Review of World Energy*, 67th ed. (June 2018).

climate change. Coal-fired power plants built as part of the Belt and Road Initiative may last for decades, even as costs for lower-carbon power sources such as solar and wind power with energy storage continue to fall. Once built and placed in service, assets such as coal-fired power plants can be very difficult to retire.

The Belt and Road Initiative has tremendous potential to help mitigate climate change and contribute to low-carbon development. The Green Cooling and Green Lighting Initiatives announced at the Second Belt and Road Summit highlight this potential. The Green Investment Principles for the Belt and Road Development adopted by all major Chinese banks have the potential to help channel funding away from high-carbon development and toward lower-carbon development. Mobilizing the networks and connectivity developed through the BRI toward low-carbon development goals more broadly could have very high impact. To date most development under BRI has been on a higher-carbon path, but there is considerable potential for dramatically improved results.[90]

90 See Helena Wright, "Why China should green its overseas finance," *China Dialogue* (May 14, 2019); Simon Zadek, "The critical frontier: Reducing emissions from China's Belt and Road Initiative," Brookings (April 25, 2019).

CONCLUSION

CHINESE CLIMATE POLICY: AN ASSESSMENT

As the Chinese economy grew roughly 42% in the past five years, Chinese carbon dioxide (CO_2) emissions grew 2%–5%. From 2014–2016, according to several estimates, Chinese CO_2 emissions fell.[1]

Several factors contributed to the partial decoupling of Chinese economic growth and emissions growth. Structural shifts in the economy (from manufacturing to services) played an important role. Government policies—including policies to replace coal with cleaner energy sources—played an important role as well.[2]

Based on the review of Chinese climate policies in this *Guide*, I offer five observations:

First, the Chinese government is taking significant steps to address climate change.

Steps the Chinese government is taking to address climate change include:

Cutting Coal Consumption. Reducing coal's role in China's economy is a goal of the Chinese government. Policies and programs for achieving that goal include:

- Five-Year Plan targets for limiting coal use,
- programs to phase out coal heating in much of northern China,
- programs to shut down inefficient coal power plants, boilers and furnaces,
- coal power plant efficiency standards, and
- market-based reforms that weaken coal's historic dominance in power generation.[3]

These policies have helped deliver results. Chinese coal consumption is roughly 3% lower than its peak in 2013. Structural shifts in the economy and a cyclical downturn in some industries contributed this decline, but Chinese government policies have been a key factor.[4]

Deploying Low-Carbon Power. The Chinese government is committed to significant growth in solar power, wind power, hydropower and nuclear power. Policies for accomplishing those goals include:

- Five-Year Plan targets with ambitious deployment goals,
- generous feed-in tariffs for wind and solar power for much of the past decade (now being replaced with an auction system and other market mechanisms),

1 See chapter 1 of this Guide at notes 20-21 and Figure 1-7.
2 See Dabo Guan et al., "Structural decline in China's CO_2 emissions through transitions in industry and energy systems," Nature Geoscience (July 2, 2018) at p.5 ("structural changes have been reinforced by policies"); IEA, *Global Energy and CO_2 Status Report* (March 2018) at p.8 (coal-to-gas switching, renewables and nuclear power limited emissions growth).
3 See chapter 8 of this *Guide*.
4 *BP Statistical Review of World Energy* (June 2019) at p.45.

- requirements that grid companies purchase minimum amounts of renewable power,
- help assembling land and arranging for transmission connections at new nuclear power plant sites, and
- cheap debt capital and waivers of dividend payments for the state-owned companies developing nuclear power plants.

These policies have delivered results. In 2018, China led the world in deployment of solar power, wind power and hydropower—by far. Seven of the nine nuclear power plants in the world that connected to the grid for the first time in 2018 were in China. Continued deployment of low-carbon power will be essential to reducing coal's role in China's power sector.[5]

Putting a Price on Carbon Emissions. The Chinese government is implementing a program to put a price on CO_2 emissions. CO_2 trading programs—some dating back to 2013—are operating in eight cities and provinces. A nationwide CO_2 trading program for the power sector was launched at the end of 2017.

China's CO_2 emissions trading program is still under development. Important questions about the program remain. (Are sufficient plant-level emissions data available to run the program adequately? At what level will the cap be set? How will the program be enforced?) But the program has the potential to be an important tool for limiting Chinese emissions.[6]

Improving Energy Efficiency. Improving energy efficiency is a long-standing goal of the Chinese government. The 13th Five-Year Plan (2016–2020) contains a mandatory target to improve energy efficiency 15% from 2015 levels by 2020. This and other national energy efficiency targets are implemented through provincial targets, government spending, regulations and standards. The Chinese government sets energy efficiency standards for appliances, vehicles, buildings, businesses, coal-fired power plants and more.[7]

According to the International Energy Agency (IEA), energy efficiency improvements since 2000 reduced China's 2017 emissions by nearly 1.2 Gt CO_2e (roughly equal to Japan's 2017 emissions). In 2016, IEA wrote that "Policies put in place by the [Chinese] government to improve efficiency have been one of the most important factors in limiting the growth of energy-related CO_2 emissions anywhere in the world over the past decade."[8]

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5 See chapters 9 and 10 of this *Guide*.

6 See chapter 6 of this *Guide*; Noah Kaufman and Jonathan Elkind, "Can CO_2 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 CO_2 Trading System?" (January 7, 2018); David Roberts, "China is methodically building the world's most ambitious carbon market," Vox (December 27, 2017).

7 See Chapter 7 of this *Guide*; "中华人民共和国国民经济和社会发展第十三个五年规划纲要"[Outline of 13th Five-year Plan for National Economic and Social Development], *Xinhua News Agency* (March 17, 2016) at chapter 2 (item 19), "能源系统效率——单位国内生产总值能耗比 2015 年下降" [13th Five-year Plan on Energy Development] at p.14.

8 IEA, *Energy Efficiency 2018* at p. 145; IEA, *Energy Efficiency Market Report 2016* at pp.47–48,

Adopting Many Other Policies. The Chinese government has dozens of other policies that reduce emissions of heat-trapping gases. These include policies to:

- build mass transit,
- promote green finance,
- accelerate destruction of hydrofluorocarbons (HFCs), a superpollutant used in refrigeration and air conditioning,
- develop HFC alternatives,
- conserve forests and grasslands, and
- plant trees on a mass scale.[9]

Committing to Peak CO_2 Emissions by 2030. The Chinese government's highest-profile climate change goal is "to achieve the peaking of carbon dioxide emissions around 2030, making best efforts to peak early."[10]

Some experts have debated the ambition of that goal.

In one respect, the 2030 peaking goal is not especially ambitious. Many recent forecasts project that Chinese carbon dioxide emissions are likely to peak several years before 2030. Some forecasts project peaking could occur as early as the first part of the next decade. Chinese leaders do not generally make international commitments without confidence they can meet them.[11]

Yet when the Chinese government made this pledge in 2014, leading studies indicated that China could peak CO_2 emissions before 2030 only with significant additional policy action. To meet its 2030 peaking goal, the Chinese government adopted additional policies that address climate during the 13th Five-Year Plan (2016–2020) and will need to take even further action in the 14th Five-Year Plan. Policies that limit CO_2 emissions are central to China's ability to meet its 2030 peaking goal.[12]

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9 See chapters 14, 15, 16 and 17 of this *Guide*.

10 People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015).

11 See Josh Gabbatis, "China's emissions could peak 10 years earlier than Paris climate pledge," *Carbon Brief* (July 29, 2019); Feng Hao and Tang Damin, "China could peak carbon emissions in 2023," China Dialogue (November 23, 2017); Qilin Liu, Qi Lei, Huiming Xu and Jiahai Yuan, "China's energy revolution strategy into 2030," Resources, Conservation and Recycling (January 2018); Ye Qi, Nicholas Stern, Wu Tong, Lu Jiaqi and Fergus Green, "China's post-coal growth," Nature Geoscience (2016) at pp.564–566.

12 Nan Zhou et al., "China's energy and emissions outlook to 2050: Perspectives from bottom-up energy end-use model," *Energy Policy* (February 2013); Xiliang Zhang et al., *Carbon emissions in China: How far can new efforts bend the curve?*, Tsinghua-MIT China Energy and Climate Project (October 2014).

Furthermore, the peaking of China's CO_2 emissions will occur when China's GDP per capita is projected to be in the range of $22,000–$26,000 (depending on when in the 2020s peaking occurs, structural transformations in the Chinese economy and the GDP growth rate). In contrast, the peaking of CO_2 emissions for the United States happened when GDP per capita was roughly $42,000 per capita (in 2005), for Japan when GDP per capita was roughly $37,000 per capita (in 2007) and for OECD countries as a whole when GDP per capita was roughly $31,000 (in 2007). (All figures are in PPP 2005$.) In this respect the timing of China's emissions compares favorably to other leading emitters in terms of ambition.[13]

Speaking Publicly on Climate Change. In their public statements, President Xi Jinping and other Chinese leaders send 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. Calls for low-carbon development are common, including President Xi's call for a "green, low-carbon, circular and sustainable way of life."[14] President Xi has said that

> "addressing climate change and implementation of sustainable development is not what we are asked to do, but what we really want to do and we will do well."[15]

At the Paris climate conference in December 2015, President Xi said that China will "build a low-carbon energy system, develop green buildings and low-carbon transportation" and that "tackling climate change is a shared mission for mankind."[16] In October 2017, after US President Donald Trump's rejection of the Paris Agreement, President Xi said,

> "taking the driving seat in international cooperation to respond to climate change, China has become an important participant and torchbearer in the global endeavor for ecological civilization."[17]

These themes are repeated in many official documents and speeches.[18]

13 Qi Min, Chai Hua and Qing Xuc, "Modeling an emissions peak in China around 2030," Advances in Climate Change Research (December 2014) at table 2,. Chinese GDP per capita in December 2018 was $9776 at market exchange rates (CEIC Data) (accessed August 3, 2019). Conversion to 2005 PPP yields approximately $18,250 GDP per capita. If Chinese GDP growth rate averages 5% per year, China's GDP per capita in 2005 PPP terms in the mid-2020s would be in the range of $22,000–$26,000.

14 President Xi Jinping, "Speech at UN Geneva Office" (January 18, 2017).

15 "State Council Information Office briefing on climate change," China.org.cn (September 19, 2014).

16 "President Xi's speech at opening ceremony of Paris climate summit," *China Daily* (December 1, 2015),

17 "Xi Jinping's report at 19th CPC National Congress" (October 18, 2017).

18 See "China to continue efforts to tackle climate change: Premier Li," XinhuaNet (July 11, 2019); People's Republic of China, "Intended Nationally Determined Contribution" (June 2015) at p.1; NDRC, "China's Policies and Actions for Addressing Climate Change" (2017); National Development and Reform Commission, Ministry of Environmental Protection, Ministry of Foreign Affairs and Ministry of Commerce, "Guidance on Promoting Green Belt and Road" (May 8, 2017), https://eng.yidaiyilu.gov.cn/zchj/qwfb/12479.htm and http://www.zhb.gov.cn/gkml/hbb/bwj/201705/t20170505_413602.htm.

In China's top-down governance system, leader statements carry great weight in the direction of government policy at all levels. Statements about the importance of addressing climate change shape policies on economic development, energy, urbanization and other topics. Such statements also encourage Chinese citizens in many walks of life to help contribute to solutions to climate change. Harnessing the talents of Chinese engineers, scientists, businesspeople and students—among many others—could make a significant difference in responding to climate change.

There are no known climate deniers in the Chinese leadership—and none with any observable influence on policy. In part, this reflects a respect for science and scientists that runs deep in Chinese culture. Indeed, Chinese officials have often expressed puzzlement about statements by some US government officials rejecting the global scientific consensus with respect to climate change.[19]

Second, many Chinese policies that address climate change have multiple objectives. (This is a strength from the standpoint of climate mitigation.)

Chinese official documents identify dozens of policies that help fight climate change, including policies to convert heating from coal to natural gas, scale up renewables, improve vehicle fuel efficiency, protect forests and promote sustainable urbanization.[20] Many of these policies have multiple objectives.

- Switching from coal to natural gas is central to cleaning the air in China's cities.
- Support for solar power, wind power and electric vehicles are part of a strategy to position China for success in industries with growing global markets.
- Vehicle fuel efficiency and electric vehicle programs reduce China's oil import dependence.

19 In 1977, Chinese leader Deng Xiaoping said, "The key to achieving modernization is the development of science and technology." *Selected Works of Deng Xiaoping*, vol. 2, reprinted in "Respect knowledge, respect trained personnel," *China Daily* (October 15, 2010). See Geoff Dembecki, "The Convenient Disappearance of Climate Denial in China," *Foreign Policy* (May 31, 2017).

20 See, e.g., NDRC, *China's Policies and Actions for Addressing Climate Change* (November 2018); People's Republic of China, *Enhanced Actions on Climate Change: China's Intended Nationally Determined Contributions* (June 2015).

- Forestry programs help fight flooding and desertification.
- Sustainable urbanization programs help make China's cities more livable.

Many other governments around the world also identify policies with multiple objectives as "climate policies." In part, this reflects the realities of governance. Important policies rarely have single objectives. In part, it reflects the challenges of climate change as a policy issue. Precisely because climate change is such a challenging policy issue, climate policies will be more durable when aligned with other policy goals.[21]

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." Continuing to do so will be central to China's success in addressing climate change.[22]

Third, China's governance systems have strengths and weaknesses when it comes to addressing climate change.

The Chinese government sets goals far beyond the time frames of many other governments. The "Two Centenary Goals" are perhaps most notable. First articulated in 1997 and given major prominence starting in 2012, they call for China to achieve a "moderately prosperous society" by 2021 and build a "prosperous, strong, democratic, culturally advanced and harmonious" country by 2049. (2021 is the 100-year anniversary of the Communist Party of China. 2049 is the 100-year anniversary of the People's Republic of China.) In addition, for more than 60 years, Five-Year Plans have guided Chinese policy making over multiyear periods. The Chinese government is currently on its 13th Five-Year Plan. Preparations for its 14th Five-Year Plan are underway.[23]

This capacity for long-term planning offers significant advantages in responding to climate change. Solutions to climate change involve fundamental changes to energy systems, many of which require years or decades to implement fully. 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.[24]

Other parts of the Chinese governance system are less favorable in addressing climate change.

- The promotion system for provincial and municipal officials is heavily weighted toward GDP targets. Clean air and clean energy targets typically receive much less weight. This has led to provincial and municipal officials approving construction of coal plants, polluting factories and urban infrastructure that boost GDP in the short term but increase carbon emissions and local pollution. Although clean air and clean

21 For other government's policies, see *INDCs as communicated by Parties*, UNFCCC.
22 "President Xi's speech at opening ceremony of Paris climate summit" (December 1, 2015).
23 On the Two Centenary Goals, see Shi Jia, "中央文献重要术语译文发布," ["Translation of Important Terms in the Central Literature"], Central Compilation and Translation Bureau (April 27, 2015).
24 On energy transitions, see Vaclav Smil, *Energy Transitions: History, Requirements, Prospects* (Praeger, 2010); Richard Rhodes, *Energy: A Human History* (Simon and Schuster, 2018).

energy targets have received more weight in promotion decisions in recent years, the system often still rewards decisions to build carbon-intensive, polluting facilities.[25]

- In many policy areas, China's implementation and enforcement systems are still in development. Corruption frustrates enforcement of many laws. Many ministries lack sufficient resources to monitor and enforce compliance with regulations. Although environmental enforcement cases have increased significantly in recent years, ensuring compliance with environmental laws and regulations remains a challenge.[26]
- Chinese statistical systems face similar issues. Although China's statistical systems have made enormous strides in the past decade, they too are still in development. Systematic reporting biases can undercut the reliability of results.[27]

Fourth, some Chinese policies run counter to climate change goals.

Many Chinese policies help reduce emissions of heat-trapping gases, as discussed above. However, at least three sets of Chinese policies do the opposite.

Domestic Coal Plant Construction. Significant construction of new coal-fired power plants continues in China. Roughly 30 GW of new capacity was added in each of 2017. (This is equivalent to roughly 60 midsize coal power plants.) Roughly 30 GW of new capacity was added again in 2018. Capacity additions continued at roughly the same pace in the first half of 2019. More than 125 GW of new coal-fired power plant capacity was under construction in China as of mid-2019.[28]

This construction continues despite a number of central government policies to discourage coal use. It continues despite the steep drops in the price of renewable power, which is now cheaper than coal power in many circumstances. It continues even though existing coal plants in China are operating at less than 50% capacity.[29]

25 David Bulman, *Governing for Growth and the Resilience of the Chinese Communist Party*, Harvard Kennedy School (April 2016); Jing Wu et al., "Incentives and Outcomes: China's Environmental Policy," National Bureau of Economic Research (February 2013); Jun Mai, "Chinese officials in Guizhou told to fight pollution or forget about promotion," *South China Morning Post* (December 22, 2017).

26 David Cyranoski, "Pollution Coverup Exposed in Chinese Provinces," *Nature* (May 28, 2019); Dorcas Wong, Environmental Compliance for Businesses in China: Five Major Trends," *China Briefing* (November 7, 2018); Peter Corne and Johnny Browaeys, "China Cleans up Its Act on Environmental Enforcement," *The Diplomat* (December 9, 2017).

27 See chapter 1.C of this Guide; Jan Ivar Korsbakken et al., "Uncertainties around reductions in China's coal use and CO_2 emissions" (February 16, 2016) at p.1; Derek Scissors, "China's Economic Statistics Means Everything and Nothing" (May 24, 2016).

28 "2018 electricity and other energy statistics" *China Energy Portal* (January 25, 2019); "2017 electricity and other energy statistics (update of June 2018)," *China Energy Portal* (June 14, 2018); *Carbon Brief Infographics: Global Coal Power* (128.65 GW under construction) (accessed August 3, 2019); Christine Shearer et al., *Boom and Bust 2019: Tracking the Global Coal Plant Pipeline* at p.12; Global Energy Monitor, *New Coal-Fired Capacity by Country* (July 2019); Christine Shearer et al., *Tsunami Warning*, CoalSwarm (September 2018).

29 See IRENA, *Renewable Power Generation Costs in 2018* (2019); "Two solar power bases launched in northwestern China," *Xinhua* (December 29, 2018) (solar plant in Qinghai selling electricity for less than benchmark price for electricity from coal)

Why does the construction continue? In part due to the lack of market-based signals and traditional preferences for coal in China's electric sector. In part due to the promotion incentives of municipal officials. In part due to the considerable power of China's coal industry.

In 2018, China's coal-fired power plants were responsible for roughly 10% of global CO_2 emissions. The continued addition of dozens of coal-fired power plants to China's electric grid each year threatens the ability to meet global climate goals.

Synthetic Natural Gas. Synthetic natural gas ("SNG") plants convert coal to gas, typically to be piped into cities where the gas produces less local air pollution when burned than coal. The climate change impacts of this process are negative: One recent study found that using synthetic natural gas for electricity and industrial heat generation produces roughly 40%–70% more CO_2 emissions than directly burning coal.[30]

As of July 2019, five pilot synthetic natural gas projects were operating in China. Roughly 80 SNG projects were at least nominally in different stages of the development pipeline.[31]

Whether these plants will be built is unclear. SNG plants are expensive and require enormous amounts of water, raising questions about the viability of many projects. Environmental authorities have been reluctant to grant approvals, with none granted in 2018. Several Five-Year Plan goals for SNG have been missed, and others have been scaled back. SNG production in 2018 (2.3 billion cubic meters) lagged far behind the 13th Five-Year Plan's annual goal for 2020 (17 billion cubic meters).[32]

However if China's SNG industry were to take off, the climate change implications could be significant. SNG production of 17 billion cubic meters would result in roughly 72 million metric tons of CO_2—roughly 0.75% of China's 2018 CO_2 emissions. SNG production of 60 billion cubic meters (the 2020 goal in the 12th Five-Year Plan) would result in CO_2 emissions of more than 250 metric tons—roughly 2.5% of China's CO_2 emissions in 2018.[33]

30 See chapter 12 of this *Guide*; Yue Qin et al., "Air quality, health, and climate implications of China's synthetic natural gas development," *Proceedings of the National Academy of Sciences of the US* (April 24, 2017) at table S5.
31 ARA International Limited, "China Natural Gas Map" (accessed July 30, 2019).
32 "Most coal-to-gas companies can't survive," *China Energy News* (December 6, 2018); "China Natural Gas Market Review in 2018 and Outlook in 2019," *China Energy News* (January 24, 2019) (2.3 billion cubic meters SNG production in 2018); National Energy Administration, "煤炭深加工产业示范‘十三五’规划" [13th Five-Year Plan of National Coal Deep Processing Industry Demonstration] (February 2017).
33 See chapter 12 of this *Guide*; Yue Qin et al., "Air quality, health, and climate implications of China's synthetic natural gas development," *Proceedings of the National Academy of Sciences of the US* (April 24, 2017) (4.25 kg CO_2 per cubic meter SNG produced).

Overseas Coal-Fired Power Plants. Chinese banks and companies play a leading role in the construction of coal-fired power plants around the world. In the first half of 2019, media outlets reported on Chinese support for new coal-fired power plants in many countries, including the Philippines, Vietnam, Indonesia, Bangladesh, Pakistan, Kenya, Mozambique, Malawi, South Africa, Zimbabwe and Serbia.[34] As of early 2019, Chinese banks and companies had committed or offered funding to more than 100 GW of power plants abroad (roughly 25% of the power plants under development outside China).[35]

China's state-owned policy banks provide substantially more support for coal-fired power plants abroad than any other public financial institutions. One study found that "In terms of international financing for future coal plants by state-owned policy banks, China is by far the leader with 44GW of capacity, followed by South Korea with 14GW and Japan with 10GW." (Multilateral development banks and public financial institutions in North America and Europe have rules that either prohibit or very strictly limit financing of coal-fired power plants.)[36]

Chinese government policies do not limit the type of coal power plant technology that can financed or sold abroad, leaving that decision to host governments. Historically, most of the coal power plants Chinese banks and companies supported abroad had subcritical technologies. This appears to be changing as some host governments seek more advanced technologies.[37]

According to one estimate, coal power plants outside China financed by China Development Bank and China ExIm produce almost 600 million metric tons (MMT) of CO_2 each year—more CO_2 emissions than all but seven countries in the world. If these plants operate on average for 30 years each, they will cumulatively emit 17.8 Gt of CO_2—almost half of global CO_2 emissions in 2018.[38]

34 "Lanao Kauswagan power station," *SourceWatch* (July 19, 2019); "Congratulations Pakistan: Thar coal plant starts producing electricity," *Global Village Space* (March 19, 2019); "GCM and POWERCHINA Inks US$4bn Power Deal," *GCM Resources* (January 17, 2019); "Construction Resumes on $1.5 Billion Zimbabwe Power Project," *POWER Magazine* (March 3, 2019); Ashfaq Ahmed, "Pakistan opens its first coal power plant in the most backward area of Thar," *Gulf News* (Aril 10, 2019); Dana Ullman, "When Coal Comes to Paradise," *Foreign Policy* (June 9, 2019); Dusan Stojanovic, "China's Spending Influence in Eastern Europe worries West," *AP News* (April 10, 2019); Gary Sands, "How China's Belt and Road Initiative could lead Vietnam away from renewable energy," *South China Morning Post* (June 11, 2019); Jonathan Watts, "Belt and Road summit puts spotlight on Chinese coal funding," *The Guardian* (April 25, 2019); Karl Mathiesen, "China scrubs its coal projects from 'world heritage in danger' in decision," *Climate Home News* (May 7, 2019); Oliver Griffin, "Ncondezi Energy Shares Rise on Agreement With CMEC, General Electric's Swiss Unit," *Morningstar* (July 23, 2019); Rangga Prakoso, "Lontar Extension PLTU Operates in September," *Berita Satu* (March 29, 2019)

35 Christine Shearer et al., "China at a Crossroads," Institute for Energy Economics and Financial Analysis (January 2019).

36 IEEFA, http://ieefa.org/wp-content/uploads/2019/01/China-at-a-Crossroads_January-2019.pdf at p.3; Paul Baruya, International finance for coal-fired power plants, IEA (April 2017).

37 K. Sims Gallagher, *The Carbon Consequences of China's Overseas Investments in Coal*, Center for International Environment and Resource Policy, Fletcher School of Law and Diplomacy, Tufts University (May 2016)

38 K. Sims Gallagher, *The Carbon Consequences of China's Overseas Investments in Coal*, Center for International Environment and Resource Policy, Fletcher School of Law and Diplomacy, Tufts University (May 2016); *BP Statistical Review of World Energy* (June 2019) at p. 57 (2–18 global emissions from fossil fuels = 33.89 Gt).

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 increase to 1.5° C (2.7° F) above pre-industrial levels.[39]

Before the Paris climate conference, almost all of those nations also submitted national action plans for addressing climate change (known as Nationally Determined Contributions or "NDCs"). However, those plans, taken together, do not put the world on a path toward achieving the agreed 2°C (3.6°F) goal, let alone the more ambitious 1.5°C (2.7°F) goal. If all NDCs were fully implemented, according to one leading study, global average temperatures would increase roughly 3°C (5.4°F) by 2100 and continue increasing after.[40]

To compound the problem, many nations are not fully implementing their NDCs. The European Union, United States, Republic of Korea, Canada and Australia, among others, are all at risk of failing to meet their NDC targets and pledges.[41]

Furthermore, most NDCs describe plans only until 2030. For the world to achieve its climate goals, significant action to reduce emissions will be required after 2030. (Indeed the Paris Agreement calls for "rapid reductions" in emissions after a global peak and net zero emissions during the second half of this century.)[42]

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. 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.

39 Paris Agreement Article 2(1)(a).
40 *Emissions Gap Report 2018*, UN Environment Program (November 2018).
41 *Emissions Gap Report 2018*, UN Environment Program (November 2018) at p.8; Climate Action Tracker; David Victor et al., "Prove Paris was more than paper promises," *Nature* (August 1, 2017).
42 Paris Agreement Article 4(1).

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 as opposed to high-carbon infrastructure under the Belt and Road Initiative will make an enormous difference in global emissions in the decades ahead.[43]

Finally, China will play an important role in climate diplomacy in the next several years and beyond. As the world considers next steps under the Paris Agreement, the Chinese government's positions and views will be key to shaping a global consensus.[44]

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As the world meets the climate challenge in the decades ahead, China's role will be central.

43 See chapter 20 of this *Guide*.
44 See chapter 19 of this *Guide*.

APPENDICES

APPENDIX A: GOVERNMENT 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 and the 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. Li Keqiang is the second-ranking member of the Politburo Standing Committee (a party body) and Premier of the State Council (a governmental body).[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. Today the Chinese Communist Party has roughly 88 million members total—roughly 7.5% of the population over 18 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. 25 ministers, commissioners and other heads of government offices also serve on the State Council, supported by a large bureaucracy.

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 Committee and State Council head leading groups on a range of other topics.

Chinese state-owned enterprises exert considerable influence on Chinese policy making. The leaders of major state-owned enterprises often have rank equal to (and sometimes greater than) the heads of ministries and commissions.

1 With respect to topics discussed in this appendix, see generally 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; Kelly Sims Gallagher and Xioawei Xuan, *Titans of the Climate*, MIT Press (2018), Chapter 3.

2 Cheng Li, *Chinese Politics in the Xi Jinping Era* (2016) at p.42 (87.8 million CCP members at end of 2014; 7.5% of population over 18).

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 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 on Climate Change, Energy Conservation and Emissions Reduction, chaired by Premier Li Keqiang. Twenty-six ministries and commissions are members. Among the main tasks of the 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."[1]

In July 2019, official Chinese media reported on a meeting of the Leading Group convened by Premier Li Keqiang. All four Vice-Premiers and other top officials attended.[2]

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*."[3]

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.[4]

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.[5]

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1 People's Republic of China, *Third National Communication on Climate Change* (December 2018) at pp.25–26; People's Republic of China, *Second Biennial Update Report on Climate Change* (December 2018) at pp.5–6.
2 "Li Keqiang presided over the National Leading Group Meeting on Climate Change, Energy Conservation and Emissions Reduction," *Chinese Government Network* (July 11, 2019); "China to continue efforts to tackle climate change: Premier Li," *Xinhua* (July 12, 2019).
3 Ministry of Ecology and Environment website-Mandates at #10 (accessed August 25, 2019).
4 "China expected to play bigger role in tackling climate change," *Xinhuanet* (May 27, 2018); 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).
5 See NDRC website; Craig Hart, Zhu Jiayan and Ying Jiahui, *Mapping China's Climate and Energy Policies* (December 2018) at pp.16–17.

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;
- the Ministry of Housing and Rural and Urban Development (MOHURD), which helps administer green cities and other low-carbon pilot programs; and
- the International Development Cooperation Agency (CIDCA), established in April 2018, which administers foreign aid and development assistance.[6]

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 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.[7]

Chinese state-owned enterprises 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 these

6 See 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; Wang Binbin, "After China's ministerial shake-up, what's next for South-South climate cooperation?," *China Dialogue* (June 19, 2018).

7 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: Actor and Drivers," Lowy Institute (July 2014); Ye Qi and Tong Wu, "The Politics of Climate Change in China," WIREs Climate Change (June 2013) at p.305.

companies generally have rank equivalent to that of ministers within the Chinese government.[8]

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.[9]

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)[10]

8 See Craig Hart, Zhu Jiayan and Ying Jiahui, *Mapping China's Climate and Energy Policies* (December 2018) at pp.27–34; Kelly Sims Gallagher and Xioawei Xuan, *Titans of the Climate*, MIT Press (2018) at p.77.
9 People's Republic of China, *Third National Communication on Climate Change* (December 2018) at p.26.
10 People's Republic of China, *Third National Communication on Climate Change* (December 2018) at p.26.

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